No. 812,380. PATENTED FEB. 13, 1906.

T. SUZUKI.

FURNACE.

APPLICATION FILED MAR. 3, 1905.

4 SHEETS—SHEET 1.

Fig. 4.

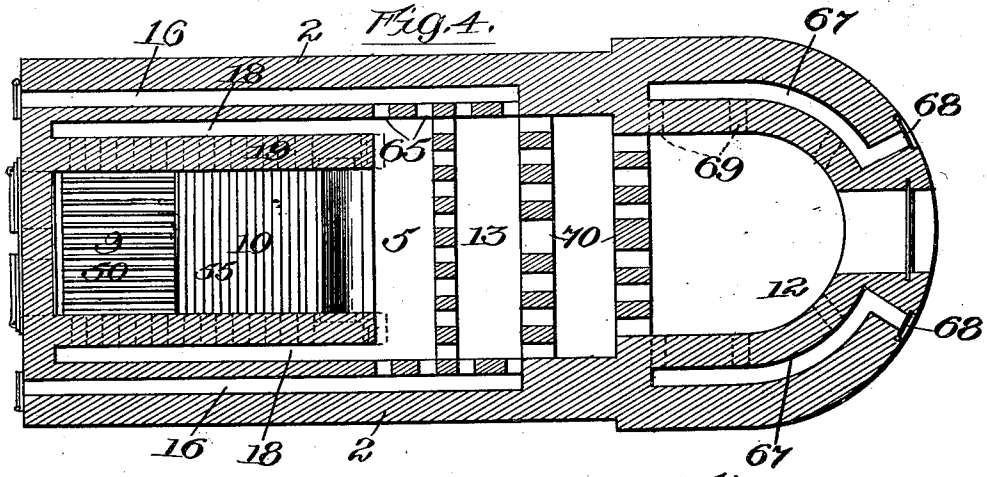


Fig. 3.

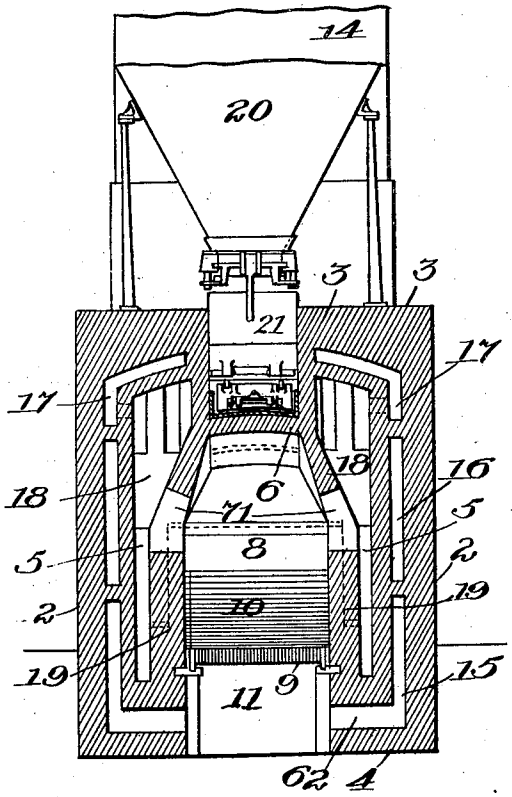
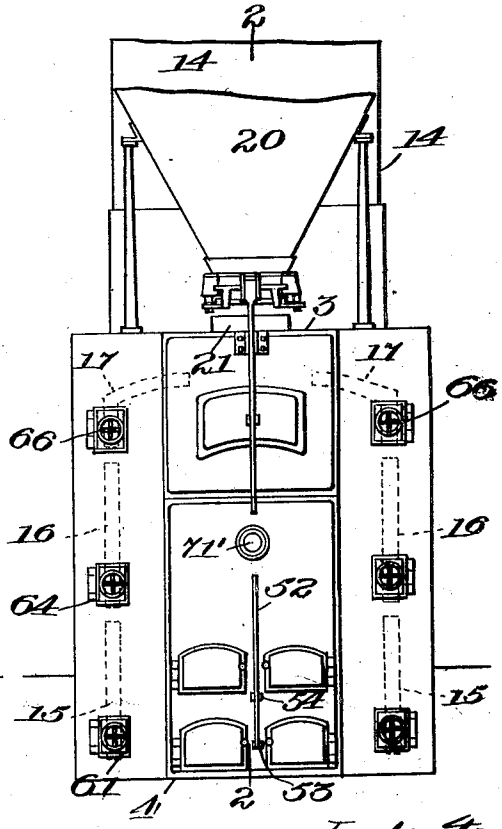


Fig. 1.



Witnesses:

O. M. Kennick

C. H. Crawford

Inventor:

Tozaburo Suzuki.

by B. Singer

Atty.

No. 812,380. PATENTED FEB. 13, 1906.

T. SUZUKI.

FURNACE.

APPLICATION FILED MAR. 3, 1905.

4 SHEETS—SHEET 2.

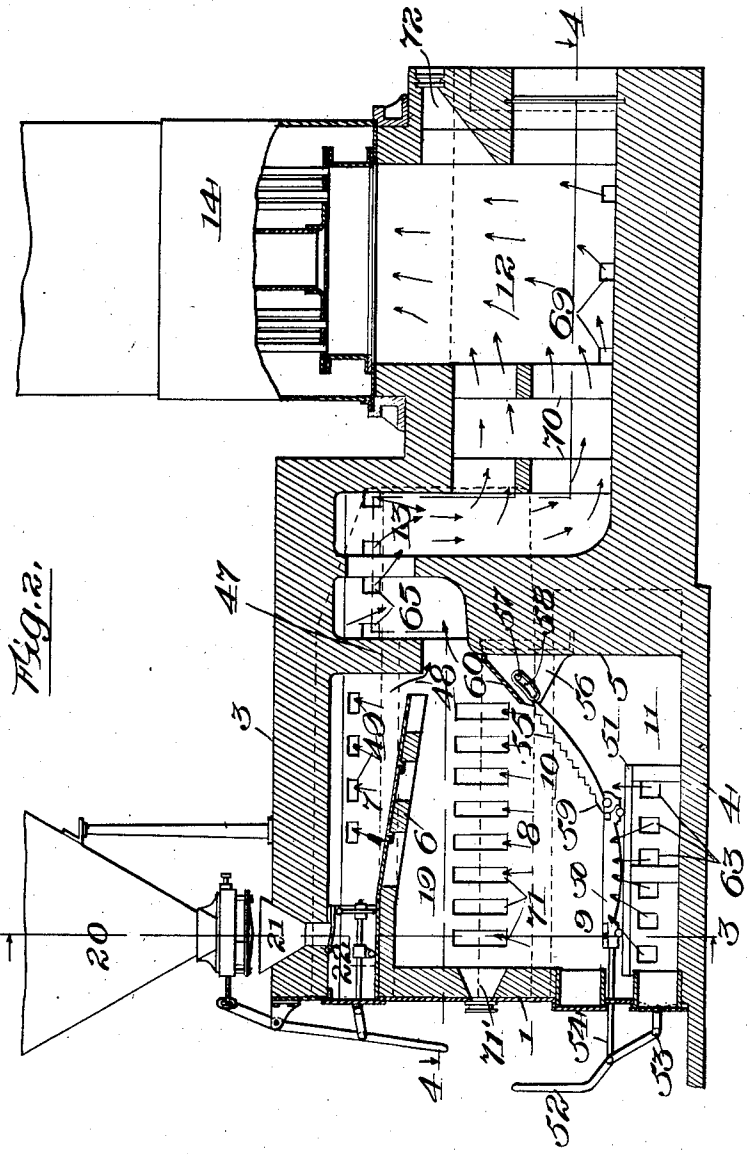


Fig. 2.

Witnesses:
W. Wemmick
H. Crawford

Inventor:
Tozaburo Suzuki
by B. Singer
Atty.

No. 812,380. PATENTED FEB. 13, 1906.

T. SUZUKI.

FURNACE.

APPLICATION FILED MAR. 3, 1905.

4 SHEETS—SHEET 3.

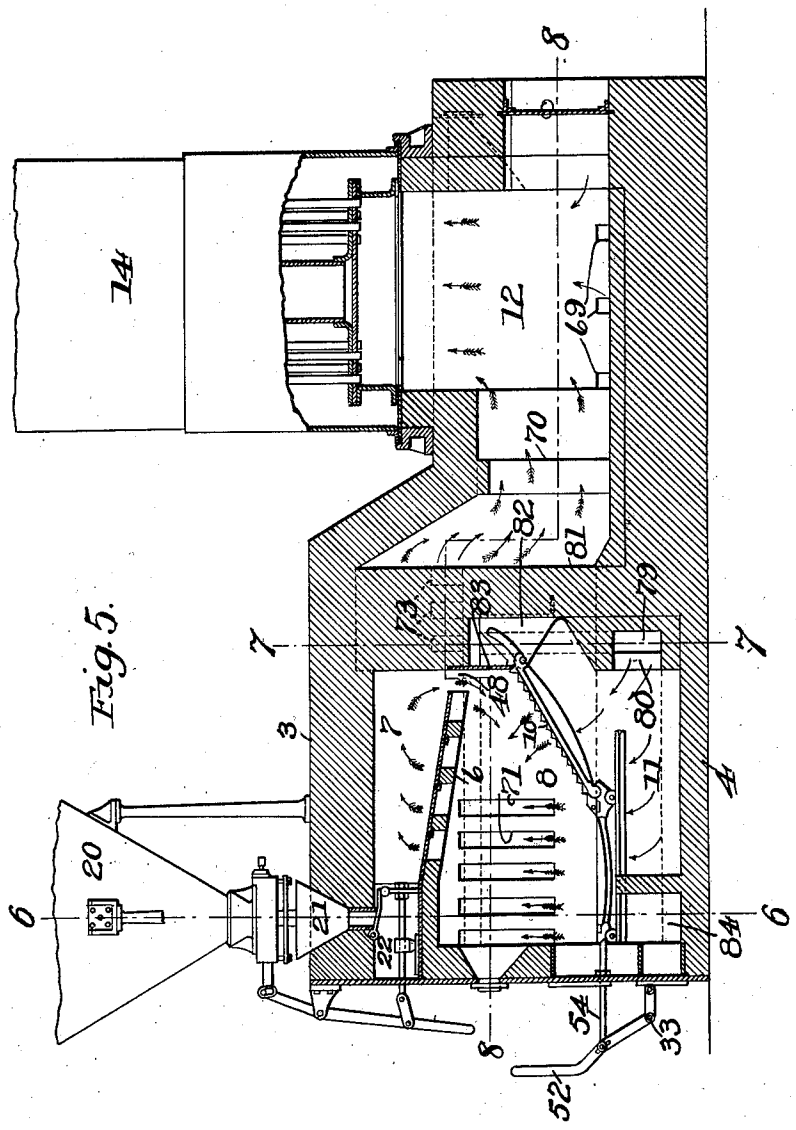


Fig. 5.

Witnesses:
C. H. Crawford
M. S. Relden.

Inventor:
Tozaburo Suzuki,
By B. Singer
Atty.

No. 812,380. PATENTED FEB. 13, 1906.

T. SUZUKI.

FURNACE.

APPLICATION FILED MAR. 3, 1905.

4 SHEETS—SHEET 4.

Fig. 6.

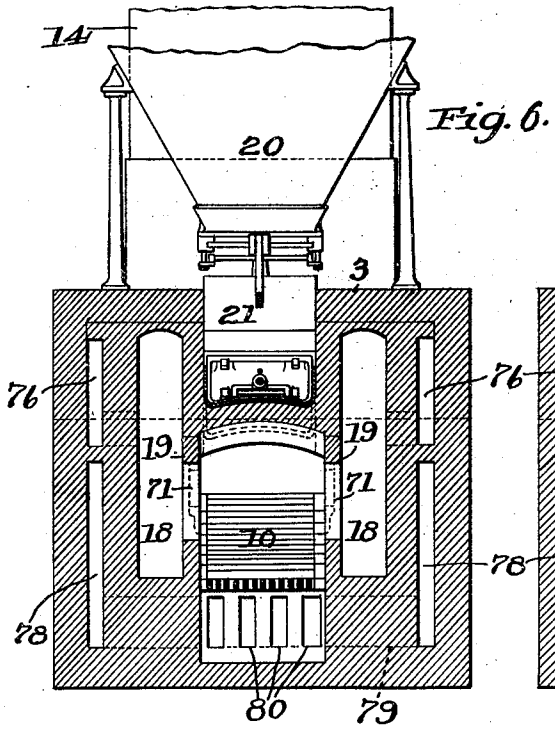


Fig. 7.

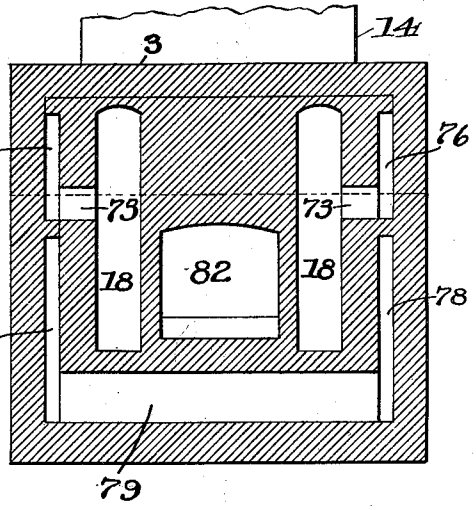
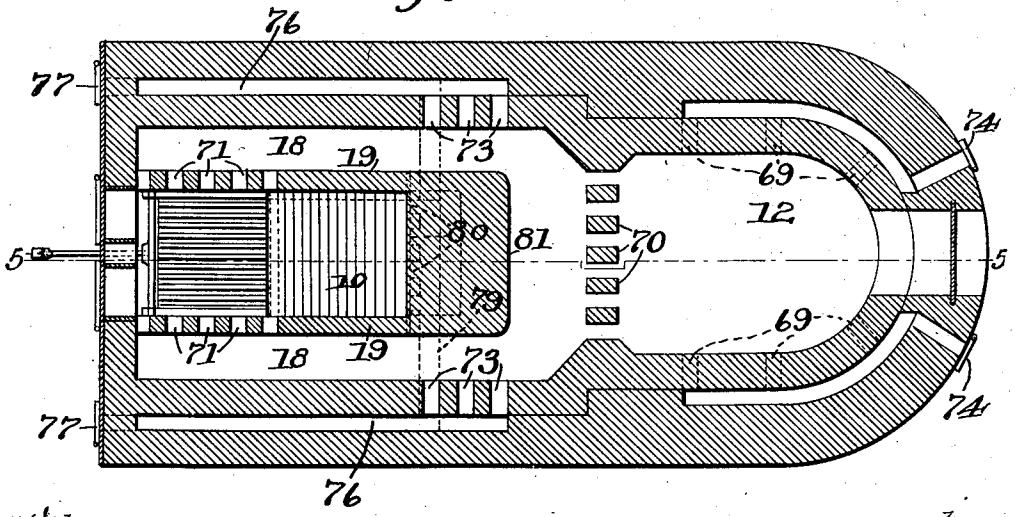


Fig. 8.



Witnesses:
C. S. Crawford
M. S. Redder

Inventor:
Tozaburo Suzuki,
By B. Singer
Atty.

UNITED STATES PATENT OFFICE.

TOZABURO SUZUKI, OF SUNAMURA, JAPAN.

FURNACE.

No. 812,330. Specification of Letters Patent. Patented Feb. 13, 1906.

Application filed March 3, 1905. Serial No. 248,319.

To all whom it may concern:

Be it known that I, TOZABURO SUZUKI, a subject of the Emperor of Japan, residing at No. 401 Jibeishinden, Sunamura, in the county of Minami-Katsushika, in the Province of Tokyo, Japan, have invented certain new and useful Improvements in Furnaces, of which the following is a specification.

My invention relates to improvements in furnaces.

One object of my invention is to provide a distilling-chamber in connection with the furnace in which the fuel may be received and stored before the same is deposited on the furnace-grate.

A further object is to equip the furnace with a primary combustion-chamber and a secondary combustion-chamber and auxiliary communication-passages, whereby heated air is combined with the products of combustion in their passage from one combustion-chamber to the other.

My invention has other important and advantageous features, which will hereinafter be more fully described in connection with the accompanying drawings and will be more particularly pointed out in the appended claims.

In the drawings, Figure 1 is a front elevation of a furnace embodying the main features of my invention. Fig. 2 is a vertical longitudinal section on line 2 2 of Fig. 1. Fig. 3 is a vertical section on line 3 3 of Fig. 2. Fig. 4 is a horizontal longitudinal section on line 4 4 of Fig. 2. Fig. 5 is a longitudinal vertical section of the modified form of my improved furnace, taken on line 5 5 of Fig. 8. Fig. 6 is a vertical section taken on line 6 6 of Fig. 5. Fig. 7 is a vertical section taken on line 7 7 of Fig. 5. Fig. 8 is a horizontal section taken on line 5 5 of Fig. 5.

Like characters are designated by similar characters of reference throughout the different figures of the drawings.

My invention, as shown, comprises two rectangular structures connected by a mixing-flame trunk, the forward structure being provided with a front wall 1, side walls 2, and top and bottom walls 3 and 4, respectively. A transverse wall 5, extending parallel with the front wall 1, forms a main chamber, which is subdivided by a horizontally-disposed wall 6 into an upper distilling-chamber 7 and a lower primary combustion-chamber 8 and is further subdivided by grates 9 and 10 into an ash-pit 11. The furnace is preferably provided at its rear end with a secondary combustion-chamber 12, which communicates by a flame-trunk 13 with the primary combustion and distilling chambers 7 and 8, respectively. Said secondary chamber 12 discharges directly into a boiler 14 or other suitable receiving means.

The gases from the distilling and main combustion chambers 7 and 8 in their passage to the secondary combustion-chamber 12 are mixed with hot air supplied from air chambers or jackets 15 16 17, formed in the lateral walls 2 2. Intermediate the air-jackets and combustion-chamber are gas-chambers 18, formed by walls 19, said chambers 18 receiving the distilled gases from the distilling-chamber 7, which are mixed with the vapor or unconsumed gases passing from the main combustion-chamber 8, the said gases and air being finally mixed and fully utilized in the secondary combustion-chamber 12, which will be hereinafter more fully described.

There is shown superposed upon the top of the furnace supplying and measuring hoppers 20 and 21, together with a stoking apparatus 22, which mechanisms in the preferred construction convey the fuel to the distilling-chamber in predetermined quantities.

I will now describe the construction and function of the chamber 7. Said chamber is in the preferred form a subdivision of the general combustion-chamber of the furnace and is located, as shown, immediately above the fire-grates. The lower wall 6 of said chamber 7 is slightly inclined rearwardly and extends from the front wall 1 of the furnace rearwardly to a point adjacent and above the rear end of the fire-grates. The rear end wall of the chamber 7 is formed by a depending wall 47, which extends downwardly from the upper wall 3 to a point slightly below the upper surface of the wall 6. An outlet 48 is formed between the ends of the wall 6 and the depending wall 47, through which the coal in the chamber 7 is permitted to pass to the fire-grate. The side walls of said chamber are formed by the upper ends of main lateral walls 19, which also constitute side walls for the main combustion-chamber. Near the upper ends of said walls 19 or near their juncture with the wall 3 is formed a plurality of apertures 49. The function of the chamber 7 is to receive and hold the fuel deposited from the hopper 21 until certain of the volatile gases are released. It will be obvious that the intense heat to which the wall 6 is

subjected because of its close proximity to the grates will quickly heat the fuel and cause the same to partially or completely coke. In other words, the chamber 7 constitutes a distilling-chamber wherein certain of the gaseous properties of the fuel are distilled or released and allowed to pass out through the openings 49 before the fuel is deposited in the combustion-chamber. It will be obvious that by the use of a distilling-chamber of this nature the temperature in the main combustion-chamber will never be lowered by the introduction of fresh fuel, as in the case where the latter is directly stoked into the furnace without first being heated. In the latter case the efficiency of a boiler which is heavily fed is greatly reduced, for the reason that a considerable amount of heat is utilized in the operation of combustion, this defect being entirely avoided by the use of the distilling-chamber 7. It will further be noted that while the chamber 7 is shown provided with outlets the same might be an important feature in furnace construction if used merely as a heating-chamber. It will be seen by reference to Fig. 2 that the outer or front end of said chamber, which accommodates the stoker 34, is completely and permanently closed and that said stoker is operated by means of the rod which passes through said closed wall. Therefore substantially no cold air is permitted to enter the main combustion-chamber when fuel is introduced, inasmuch as the door 33 will be immediately closed after the contents of the measuring-hopper has been deposited in the chamber 7. Fuel passes from the distilling-chamber 7 through the outlet 48 at the rear and is deposited directly upon the grates of the furnace.

The grate 9 preferably consists of a plurality of horizontally-disposed grate-bars 50, which operate upon ways 51, anchored in any suitable manner to the side walls 19. Said grate-bars 50 are operated by a lever 52, which is pivotally secured at 53 to the outer front wall 1 of the furnace and is connected with the grate 50 by a link 54. In the preferred form the grate-bars 50 do not extend throughout the entire depth of the combustion-chamber, but are supplemented by an extension 10, having bars 55, which are desirably inclined with respect to the bars 50. The said inclined bars 55 are mounted at their upper ends upon metallic brackets 56, the latter having trunnions 57, adapted to engage slots 58, formed on the outer ends of the grate 55. Said slots are of sufficient length to permit the bars 50 and 55 to be reciprocated in forward and rearward directions to their extreme limit of movement. Said inclined bars 55 are pivotally secured to the bars 50 and are provided with an overlapping grate-bar 59, which prevents fuel from clogging the pivotal juncture. By reference to Fig. 2 it will be seen that as the lever 52 is moved toward and away from the furnace a uniform reciprocation of the grate 50 and 55 will be effected. Said brackets 56 are provided with a protecting-apron 60, which extends from the rear wall 5 forwardly some distance over the inclined grate 55. By reference to Fig. 2 it will be noted that the apron 60 is in direct vertical alinement with the outlet of the chamber 7 and that said apron therefore receives the discharged fuel direct from the distilling-chamber and deflects said fuel directly upon the grate, thereby effectively protecting the slot and trunnion connection.

Distilled fuel from the chamber 20 falling upon the grate will be quickly ignited, as it will be in a very dry condition, and it will also be of a brittle and granular consistency, thereby retarding instead of promoting the formation of clinkers. Thus the fire-bed will not be at any time rigidly compact, but will be comparatively loose, thereby insuring uniform reduction of the fuel to a soft ash. It is well known that while it is desirable to spread the fire-bed uniformly over the grate and completely cover the same it is not desirable that the bed should crust and become a rigid layer, since such a formation entirely precludes the passage of air, and consequently retards combustion. While the fuel coming from the distilling-chamber will not ordinarily crust, the constructions of the grate-bars are such that any such tendency in case cheap fuel is used can be prevented. In the first place the inclined position of the bars 55 would naturally cause the fuel falling thereon to agitate the fire-bed, break it up, and fill in the broken spaces. In addition to this feature the operator may by means of the lever 52 not only vary the inclination of the bars 55, but impart thereto a vibratory or oscillatory movement, the result of which would not only loosen the fire-bed, but would cause any clinker formation to gradually work forward thereon and descend onto the said grate 50, when it would be gradually moved forward by oscillatory movement of the grate and descend to the ash-pit.

I will now describe the construction of the air-chambers, whereby heated air is mixed with the gases on their passage from the primary to the secondary combustion-chamber, and also the air-chambers supplying heated air directly to the ash-pit and the secondary combustion-chamber.

Referring now to Figs. 2 and 3, air chambers or jackets 15 15, formed in the side walls 2, are shown extending rearwardly from the front wall 1 of the furnace. The ends of said jackets at the wall 1 are closed by doors 61, having adjustable dampers. By means of horizontal passages 62, terminating in apertures 63, air is supplied to the main combustion-chamber beneath the grates thereof. It

will be obvious that as the air is passing through the chambers 15 it will be quickly heated, so that when it reaches the fire-bed the temperature of the same will not be decreased and the draft supplied thereto will be far more effective than would cold air. In order that the chambers 15 may serve to protect the furnace from cold blasts, the said air-chambers, as shown in dotted lines in Fig. 2, extend rearwardly slightly beyond the transverse wall 5. Immediately above the chambers 15 are formed like chambers 16, having their air-inlets controlled by doors 64, having adjustable dampers. Said chambers 16 extend rearwardly in the walls 2 and terminate in apertures 65. Jackets or chambers 17 17 are also provided, which communicate with the apertures 65 and form additional jacketing for the furnace. The chambers 17 are likewise provided with closable inlets 66, having dampers, Fig. 1. Air-chambers 67, having inlets 68, closed by doors having adjustable dampers, are formed in the walls of the rear or secondary combustion-chamber 12, said air-jackets having terminal openings 69, whereby delivery of the heated air is made to the secondary combustion-chamber, Figs. 2 and 4.

The vapors and products of combustion pass from the fire-grates through apertures formed near the top of the wall 5 and thence downwardly through apertures formed in transverse walls 70 into the secondary combustion-chamber. A portion of the flame and vapors pass out laterally through apertures 71, formed in the walls 19, and mix in the intermediate chambers 18, with the released gases passing outwardly through openings 49. As said mixed gases pass rearwardly through openings in the transverse wall 5 they are mixed with heated air entering through openings 65, at which point combustion of the mixed air and vapor takes place, the same entering the secondary combustion-chamber 12 in a state of partial combustion. Combustion of said flame and gases is completed in chamber 12 by the further introduction of heated air through openings 69. It will be noted that the mixed air and gases passing through the openings in the walls 5 and 70 are confined in a relatively restricted area. Therefore combustion will necessarily be incomplete and gradual, whereas when the gases are introduced in the chamber 12 they suddenly enter into an increased area, the consequent expansion and the further supply of air promoting therein immediate and complete combustion. Because of the location of the boiler at this point the greatest heat and most complete combustion is desirable. It will be obvious that by means of peep-windows 71′ and 72, formed, respectively, in the primary and secondary combustion-chambers, the operator is permitted to examine the conditions under which the furnace is operating. When using fuel of one grade, it may be necessary to shut off the supply of heated air in the chamber 12, while in the use of other grades such supply will be necessary to effect complete combustion. Therefore a great advantage is obtained by introducing heated air at different points throughout the passage of the products of combustion over furnaces wherein mixture is only possible at one point, generally at the forward end of the furnace. In the last-mentioned arrangement, which is a prevalent one, the air in-take can only effect combustion in the rear of the furnace after effecting combustion at the forward end. In the use of high-grade coal, where combustion is very complete, the air-supply could be to a great extent closed, while in the use of a cheaper grade of fuel, where combustion is promoted with greater difficulty, the air-supply needed at the rear end of the furnace could not be produced, because the supply would have to be carried entirely from the front end.

With my improved system of air-chambers the furnace is not only completely jacketed by heated air, but the latter may be supplied to the combustion-chamber at any desired point in any desired quantity. Because of the complete and effective combustion which I am enabled to produce a high efficiency may be obtained from a relatively cheap grade of fuel.

In the modified form shown in Figs. 5 to 8, inclusive, the main combustion-chamber 8 is provided with a distilling-chamber 7, wherein the distilled gases pass out through discharge end 48 and mix with the plain and heated vapor of the combustion-chamber and in this mixture pass outwardly through openings 71. The gases passing from the main combustion-chamber 8 enter intermediate mixing-chambers 18 and pass rearwardly on either side of the lateral walls 19 of the main combustion-chamber. It will be noted that except for the outlets 71 the main combustion-chamber is entirely closed and is unprovided with a rear outlet to the flame-trunk. This form of furnace is especially adapted in cases where the draft at its minimum is very strong. The mixture of the distilled gases and heated vapors taking place in the combustion-chamber instead of in the mixing-chamber has many advantages for this type of furnace. The gases passing from the combustion-chamber are mixed with the heated air entering at 73, the combined heated air and gases passing rearwardly through walls 70 into the secondary combustion-chamber 12 and upwardly therefrom into the furnace 14. The secondary combustion-chamber 12 is provided with independent air-jackets for supplying heated air which enters the chamber through openings 69 and is admitted to jackets through closable doors 74. Air-jackets 76 admit air in

the openings 73 and are controlled by closable inlets 77. In the modified form the air-jackets 78 are provided with a communicating subterranean passage 79, which is provided with suitable outlets 80 in the end wall 81, whereby the heated air is permitted to pass directly into the combustion-chamber to points beneath the grate-bars, and are located in such a position as to direct the inlet of heated air directly through the inclined bars and upwardly therethrough to the outlets 71. By this means it will be seen that the heated air entering the chamber 8 through the outlets 80 will be forced to pass through both the inclined and horizontal grate-bars to the openings 71, this disposition of the air-inlets producing a very effective draft. In constructions where the rear wall of the combustion-chamber is closed the mounting of the inclined grate-bars is desirably located within the recessed portion 82 and the fuel discharging from the distilling-chamber is received directly upon the inclined grate-bars 10 instead of being received upon an overhanging apron, as shown in Fig. 2. The upper end of the recessed portion 80 is preferably closed by a downwardly-projecting deflecting-plate 83, which serves to effectively protect the trunnion-and-slot connection of the inclined grates from being clogged by the fuel and serves in addition to prevent the discharged fuel from passing rearwardly over the end of the grate 10. This is a very advantageous construction, inasmuch as the deflecting-plate is at no time directly subjected to heat of the fuel. I also desirably provide a special clinker-chamber 84 in the forward end of the ash-pit 11, which serves to receive the clinkers as they are moved upwardly upon the grate by reciprocation of the latter. It will be noted that while the clinker-chamber 84 will to some extent be filled with ashes the clinkers will nevertheless be to a great extent received in said chamber, and will thereby be automatically separated from the larger amount of ashes deposited in the ash-pit.

While I have herein shown a single embodiment of my invention, it will be obvious that changes may readily be made therefrom without departing from the spirit of the invention. Therefore

What I claim, and desire to secure by Letters Patent, is—

1. A furnace comprising a main combustion-chamber, a secondary combustion-chamber, a flame-trunk connecting said chambers, a distilling-chamber formed in said main combustion-chamber, intermediate mixing-chambers adapted to receive distilled gases and vapors from said distilling and combustion chambers, said intermediate chambers communicating with the flame-trunk, and means supplying heated air to said flame-trunk.

2. A furnace comprising a combustion-chamber having a main outlet-passage for the products of combustion, means supplying heated air to said outlet, a distilling-chamber formed in said combustion-chamber, and means whereby the distilled gases are conveyed to the outlet-passage.

3. A furnace comprising a combustion-chamber having a main outlet-passage, air chambers or jackets surrounding said combustion-chamber, means controlling the admission of air to said chambers, said air-chambers having openings terminating in said main outlet-passage, mixing-chambers located between said combustion and air chambers, a distilling-chamber formed in said combustion-chamber, means whereby the distilled gases and vapors are conveyed to said mixing-chambers, and means whereby said gases and vapors are conveyed to said main outlet-passage.

4. A furnace comprising a main combustion-chamber, a secondary combustion-chamber, a flame-trunk connecting said chambers, a distilling-chamber formed in said main combustion-chamber, intermediate mixing-chambers adapted to receive distilled gases and vapors from said distilling and combustion chambers, said intermediate chambers communicating with the flame-trunk, means supplying heated air to said flame-trunk, and means whereby heated air may be introduced in said secondary chamber.

5. A furnace comprising a combustion-chamber, having a main outlet-passage for the products of combustion, means supplying heated air to said outlet, a distilling-chamber formed in said combustion-chamber, means whereby the distilled gases are conveyed to the outlet-passage, and a secondary combustion-chamber connected with said main outlet-passage.

6. A furnace comprising a combustion-chamber, having a main outlet-passage for the products of combustion, means supplying heated air to said outlet, a distilling-chamber formed in said combustion-chamber, means whereby the distilled gases are conveyed to the outlet-passage, a secondary combustion-chamber connected with said main outlet-passage, and means whereby heated air may be supplied to said last-mentioned chamber.

7. A furnace comprising a combustion-chamber having a main outlet-passage, air chambers or jackets surrounding said combustion-chamber, means controlling the admission of air to said air-chambers, said air-chambers having openings terminating in said main outlet-passage, mixing-chambers located between said combustion and air chambers, a distilling-chamber formed in said combustion-chamber, means whereby the distilled gases and vapors are conveyed to said mixing-chambers, means whereby said gases and vapors are conveyed to said main outlet-passage, and a secondary chamber connected

with said main outlet and adapted to receive the products of combustion, gases and air.

8. A furnace comprising a combustion-chamber having a main outlet-passage, air chambers or jackets surrounding said combustion-chamber, means controlling the admission of air to said chambers, said air-chambers having openings terminating in said main outlet-passage, mixing-chambers located between said combustion and air chambers, a distilling-chamber formed in said combustion-chamber, means whereby the distilled gases and vapors are conveyed to said mixing-chambers, means whereby said gases and vapors are conveyed to said main outlet-passage, a secondary combustion-chamber connected with said main outlet and adapted to receive the products of combustion, gases and air, and means supplying heated air to said secondary chamber.

In testimony whereof I affix my signature in presence of two witnesses.

TOZABURO SUZUKI.

Witnesses:

UHACHI ISHIWARA,

GENJI KURIBORA.