W. THOMAS AND A. E. MAINWARING.

HEAT GENERATING FURNACE.

APPLICATION FILED MAR. 9, 1917.

1,349,537. **Patented Aug. 10, 1920.**

5 SHEETS—SHEET 1.

Fig. 1.

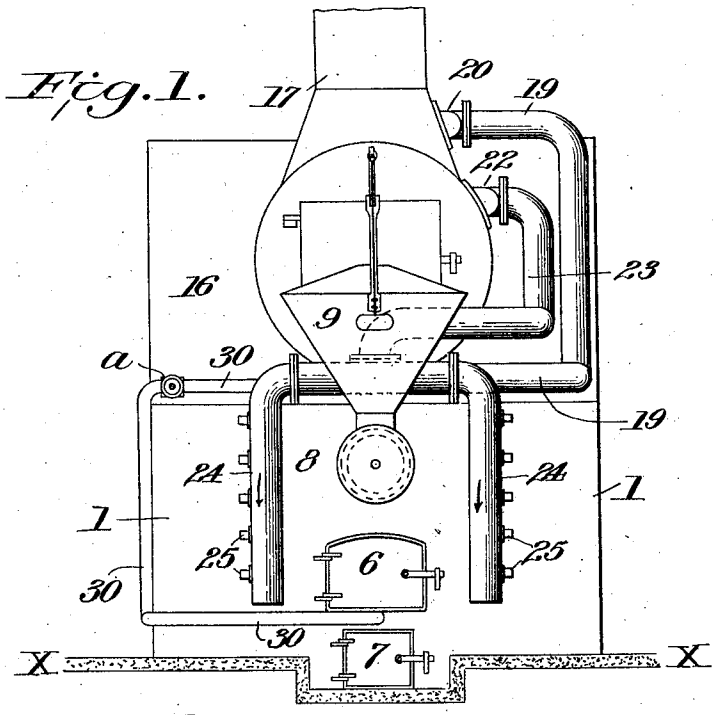
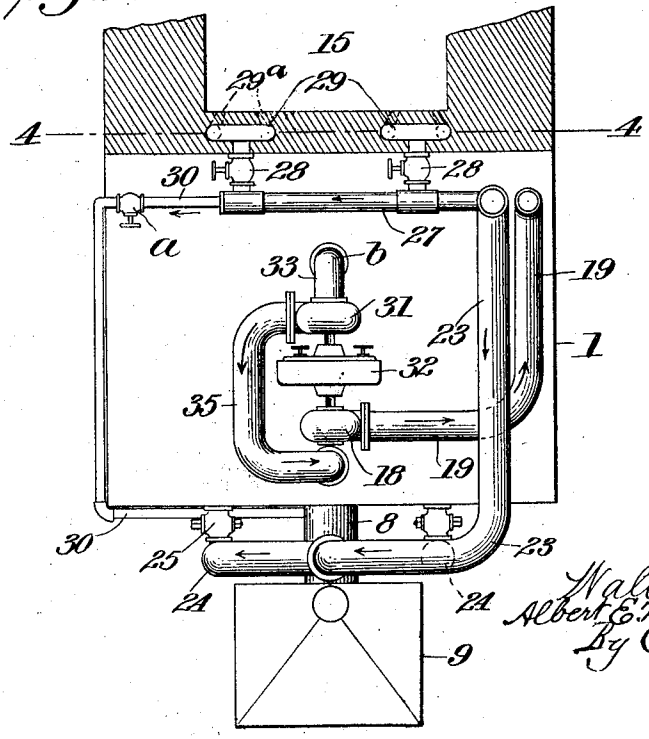


Fig. 2.



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5 SHEETS—SHEET 2.

Fig. 3.

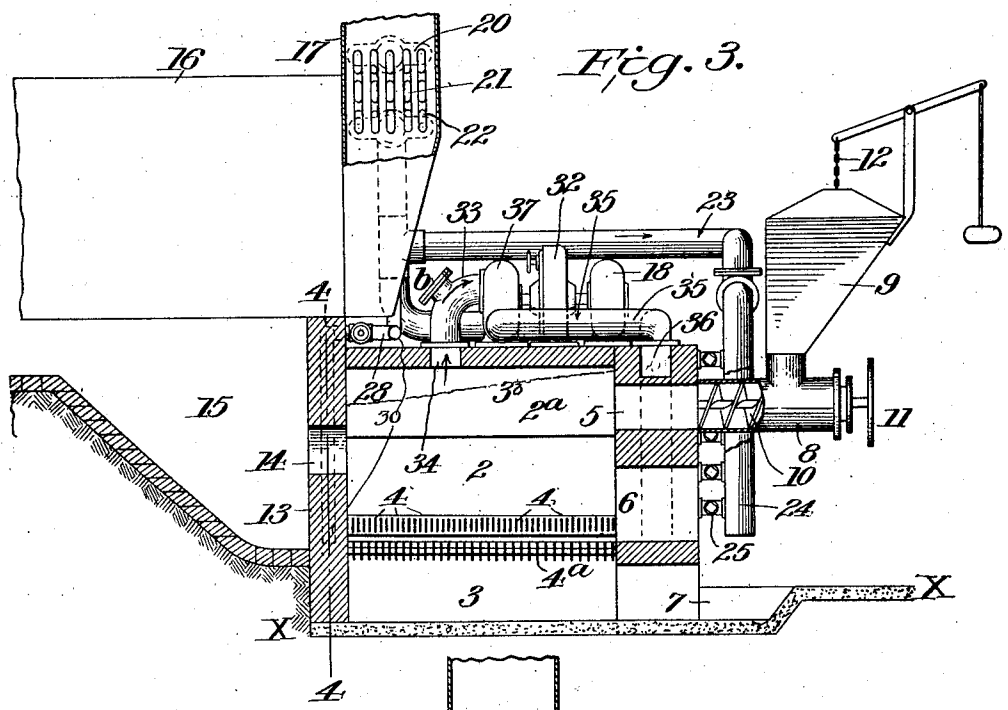


Fig. 4.

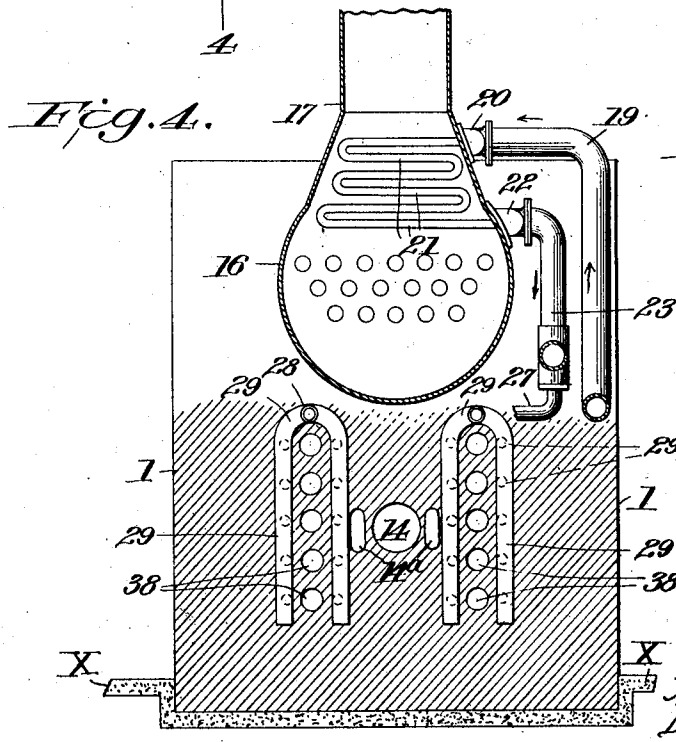
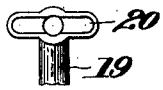


Fig. 4a.



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5 SHEETS—SHEET 3.

Fig. 5.

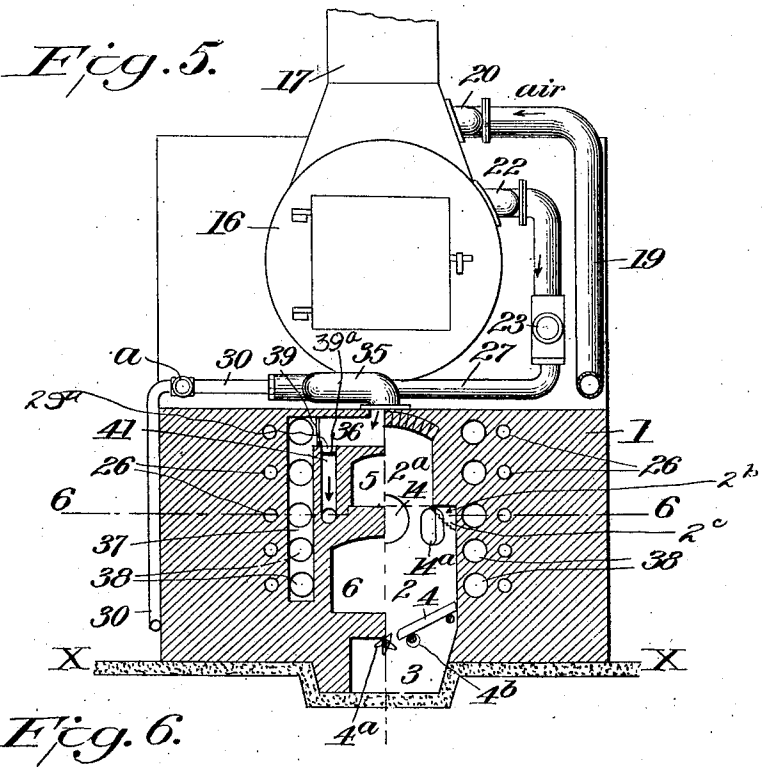


Fig. 6.

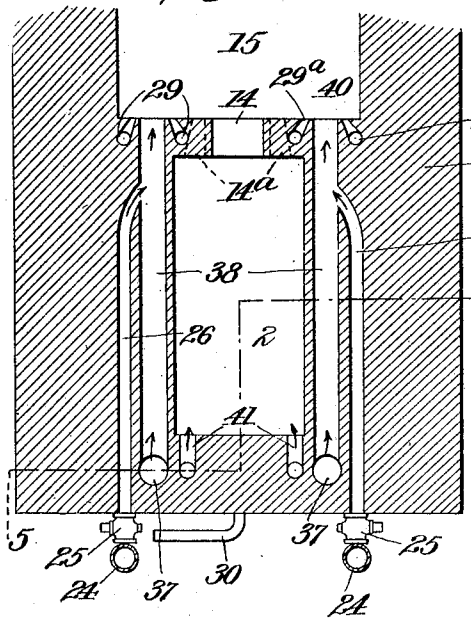
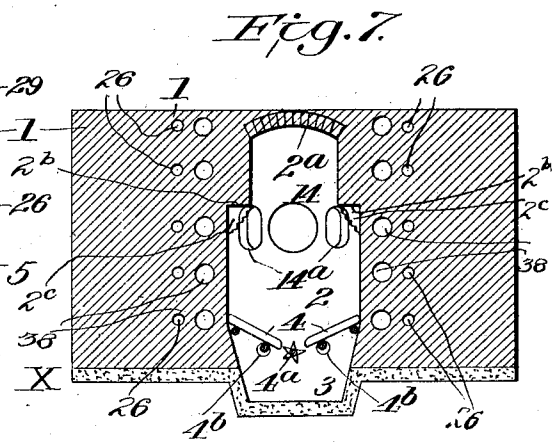


Fig. 7.



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5 SHEETS—SHEET 4.

Fig. 8.

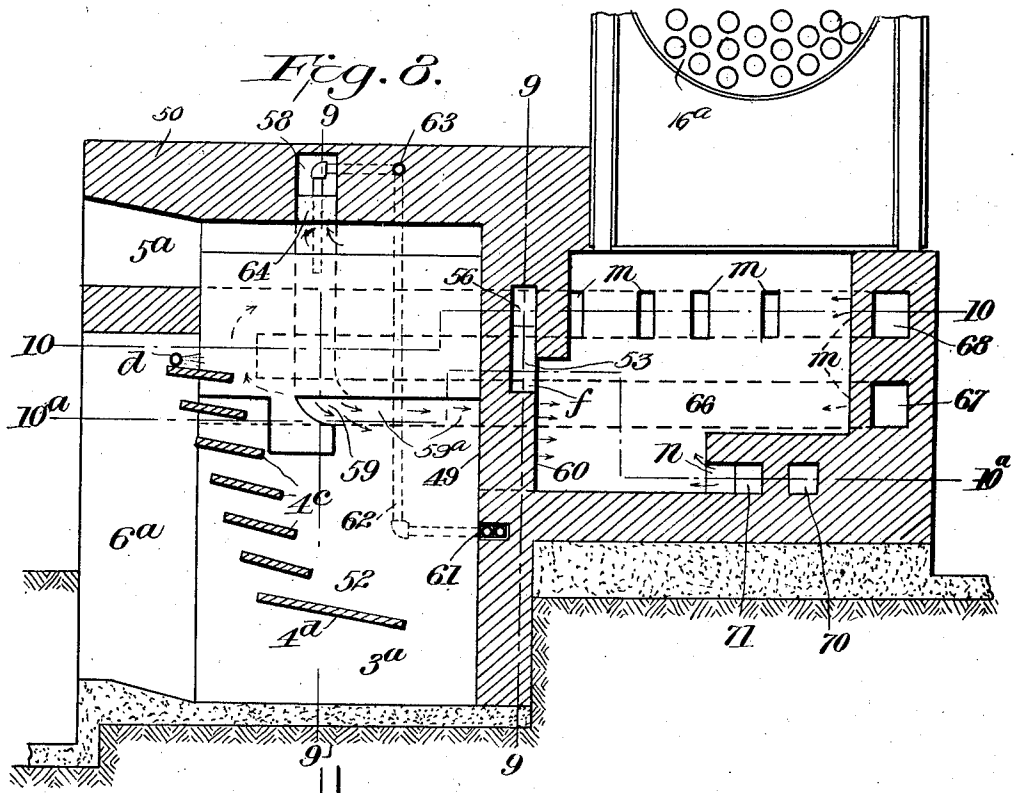
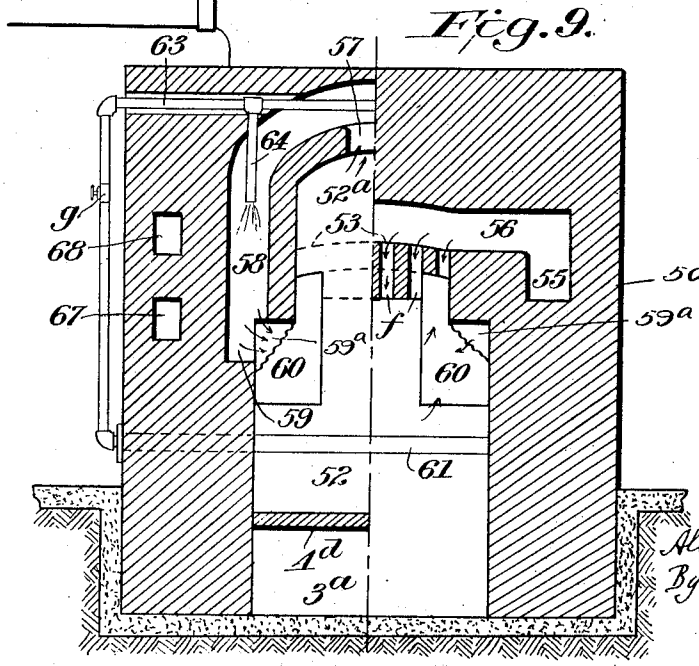


Fig. 9.



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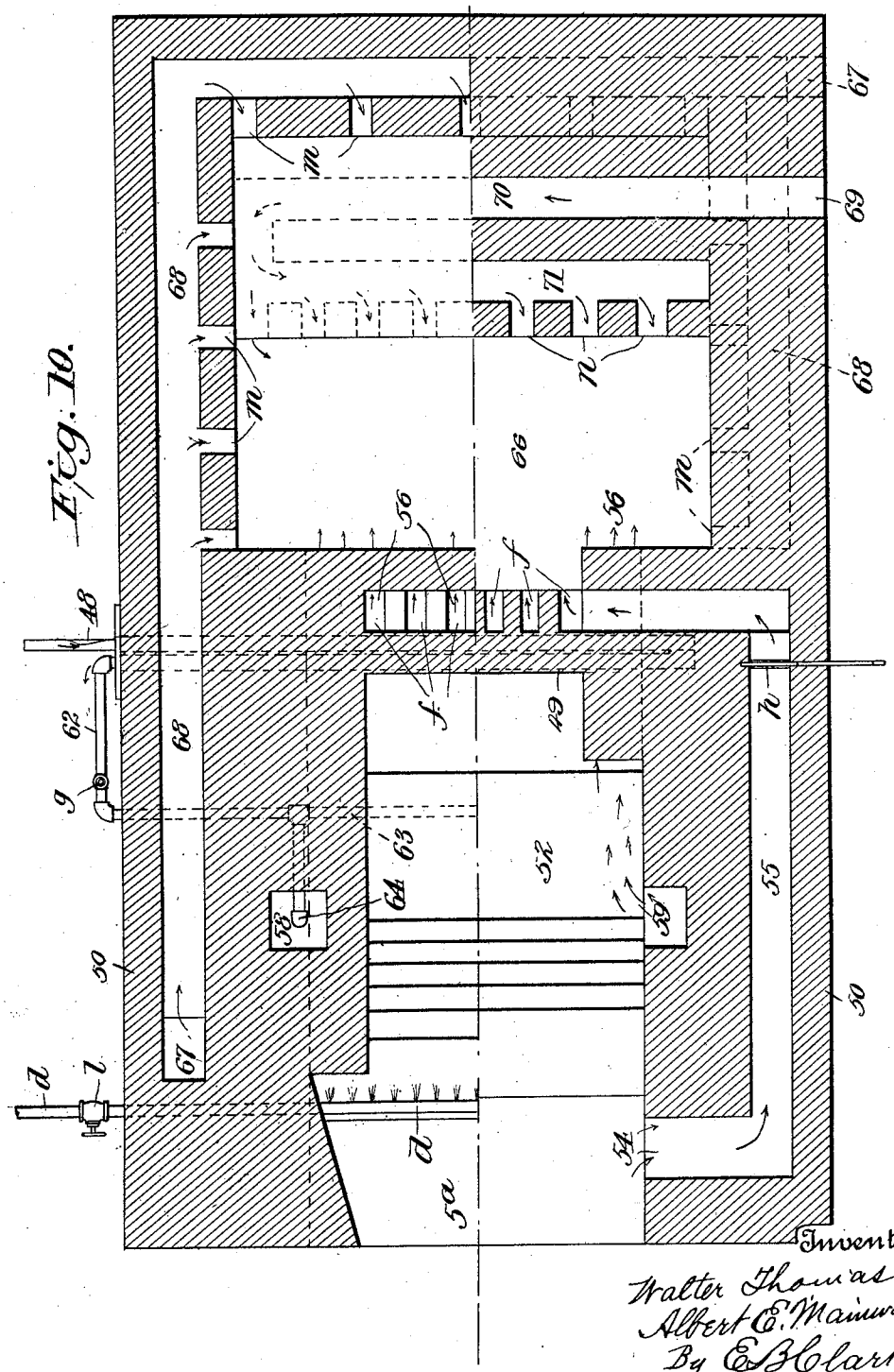
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5 SHEETS—SHEET 5.

Fig. 10.



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UNITED STATES PATENT OFFICE.

WALTER THOMAS AND ALBERT EDWARD MAINWARING, OF NANAIMO, BRITISH COLUMBIA, CANADA, ASSIGNORS TO FUEL CONSERVATION COMPANY LIMITED, OF VANCOUVER, BRITISH COLUMBIA, CANADA, A CORPORATION OF BRITISH COLUMBIA, CANADA.

HEAT-GENERATING FURNACE.

1,349,537. Specification of Letters Patent. Patented Aug. 10, 1920.

Application filed March 9, 1917. Serial No. 153,653.

To all whom it may concern:

Be it known that we, WALTER THOMAS and ALBERT EDWARD MAINWARING, subjects of the King of Great Britain, residing at Nanaimo, in the county of Nanaimo, British Columbia, Canada, have invented certain new and useful Improvements in Heat-Generating Furnaces, of which the following is a specification.

This invention relates to a heat generating furnace, adapted to burn low-grade or other fuel and all combustible gaseous products (so called smoke), for heating steam boilers of all classes and for other industrial purposes, such as heating bakery ovens, brick and pottery kilns, ore roasting furnaces, lime and cement kilns or retorts, buildings, etc., in a scientific manner and with great saving of fuel.

This heat generator is designed and especially adapted for burning all kinds of low-grade and, at present, waste fuels, such as mine waste, lignite, and other waste fuels which are well known to be plentiful in most places where fuel is used for steaming and other purposes. Our furnace is particularly adapted for gasifying, or evolving the volatile vapors and gases from fuel and to draw such heated vapors and gases through a body of fresh coal or other fuel to more rapidly liberate the volatile vapors and to mix with the gases and vapors a sufficient quantity of air to produce perfect combustion within the combustion chamber and before any so called smoke can escape to the stack, whereby perfect combustion is obtained and the highest possible calorific value of the fuel is utilized.

Many difficulties have arisen in efforts heretofore made to maintain a uniform heat and to produce a perfect and continuous combustion of fuel for generating steam. By means of numerous experimental constructions of heat generating furnaces we have overcome many difficulties heretofore encountered in producing continuous and uniform combustion so as to obtain a uniform heat for a number of hours and we have embodied our improvements in a furnace or furnaces illustrated in the accompanying drawings.

The principal object of our invention, therefore, is to provide for generating high heat under perfect control, from low-grade or other fuels by partially coking the fuel and drawing part of the resulting hydrocarbon vapors and gases and other hot vapors through a body of fresh fuel, whereby their volatile vapors will be evolved and carried off to be mixed with air and burnt in the same combustion chamber with the gaseous products from the coked fuel.

A special object of our invention is to provide for simplifying the construction of the generating furnace—doing away with a separate coking chamber or retort—and to provide for better separating the gases from the fresh fuel, then heating them and intermixing them with air at their entrance to the secondary combustion chamber.

Another object of our invention is to provide for continuously feeding fuel by suitable mechanical stokers, and also for removing clinker and cleaning the fire, so as to make the operation of firing a boiler continuous and uniform.

Another object is to provide for producing a more perfect secondary combustion of gaseous products by supplying hot air to the gases and vapors and thereby burning all of the hydrocarbons and particles of fixed carbon which are carried off from fuel and which frequently escape unburned from the stack.

Other objects and purposes of our invention will appear in the detailed description of the apparatus and its operation by reference to the accompanying drawings, in which:—

Figure 1 represents a front elevation of our heat generating furnace.

Fig. 2 represents a top plan view with parts in horizontal section.

Fig. 3 represents a longitudinal vertical section of the generator with connecting parts in elevation.

Fig. 4 represents a transverse section on the line 4—4 in Figs. 2 and 3.

Fig. 4ª represents an inner face view of a header for the air heating coil in the stack.

Fig. 5 represents a vertical section on the two planes indicated by the irregular line 5—5, Fig. 6.

Fig. 6 represents a horizontal section on the line 6—6 of Fig. 5.

Fig. 7 represents a transverse section through the fuel chamber, the view being

intended to show the agitating grates and a clinker breaking device.

Fig. 8 represents a sectional elevation of a modified form of a heat generator and a steam boiler.

Fig. 9 represents a transverse section on the two planes indicated by the dotted lines 9—9, Fig. 8.

Fig. 10 represents a horizontal section taken on the irregular lines 10—10 10^a—10^a, Fig. 8.

In the construction and operation of our heat generator we provide for causing circulation of gas either by a blower or a jet of steam, and for forcing streams of air under pressure into both primary and secondary combustion chambers for burning the fixed carbon and gas.

The walls of the generator furnace 1 are constructed with brick and may be lined with fire-brick, erected on a concrete foundation X. The brick walls may be also inclosed in a jacket of plate iron in a well known manner. A steam boiler is mounted above the generator furnace in a well known form of setting and in the illustration we have shown a tubular boiler. To the rear of the generating furnace we provide a secondary combustion chamber 15 under the boiler.

In a heat generator we construct the fuel and primary combustion chamber of special form, composed of two parts, namely, a lower part 2 constituting a main fuel and combustion chamber and an upper, contracted part 2^a for containing fresh or green fuel, in which coking and distillation are effected. The fuel level or surface is indicated in Fig. 3 by the irregular line 3^b. The lower part 2 is made wider and occupies the full width of the chamber adjacent to the grate, and the upper part 2^a is made narrower and arranged centrally above the grate and in line with the fuel feeding opening 5 with which connects a suitable automatic feeding or stoking device for delivering a continuous supply of fuel without opening a door. At the junction of the wider longitudinal lower part 2 and the narrower longitudinal upper part 2^a is formed an offset 2^b, Figs. 5 and 7, on each side of the fuel chamber. These offsets provide two longitudinal channels 2^c for hot gases along the body of fuel from the upper part 2^a to the secondary combustion chamber 15, as will be hereinafter more fully described. At the base of the generator is constructed the usual ash-pit 3 and above the same a shaking grate 4 having a longitudinal clinker breaker 4^a which may be revolved in any suitable manner. Below each grate or set of grate bars is placed an eccentric 4^b or other suitable means for rocking or agitating the grate. In the front wall of the furnace are provided the upper fuel openings 5, the fire opening and door 6 and the opening and door 7. The body 8 of the coal feeding device connects with the front wall on a line with the opening 5 and has mounted upon it a coal hopper 9, having connected to it a chain and lever 12. Within the body 8 is arranged a screw-conveyer 10 which is preferably provided with a friction clutch 11. Although we have shown only a screw-conveyer for feeding coal, we propose to use any known form of mechanical stoker for delivering a continuous and uniform supply of coal, as required.

A rear furnace wall 13 separates the primary combustion chamber from the secondary combustion chamber 15 and is provided with the ports 14 and 14^a, Figs. 6 and 7, for products of combustion. These ports are in the nature of contracted nozzles, each having an inclined wall from the larger inlet to the discharge outlet, as shown in dotted lines in Fig. 6. The boiler 16 is provided with the usual stack pipe 17 which contains sets of coils or serpentine pipes 21 for heating air. A fan or rotary air blower 18, which may be a power blower, is preferably placed on top of the furnace and has a shaft which connects with the turbine engine 32, the shaft of which also connects with the rotary gas fan or blower 31. The discharge pipe 19 of blower 18, Figs. 1 and 2, is provided with a header 20 which connects with the stack pipe and with which communicate the coils or serpentine pipes 21 of comparatively small diameter. These pipes communicate at their lower ends with the header 22 which is also secured to the stack pipe. A discharge pipe 23 communicates with header 22 and extends forward and communicates with branches 24 which extend downward at the front of the furnace. These pipes 24 are provided with a series of short branches having cocks or valves 25 opening into two series of horizontal pipes 26, Figs. 5 and 6, in the side walls of chambers 2 and 2^a. A branch air pipe 27, Figs. 2 and 5, extends transversely at the top of the furnace and connects by short branches and valves 28 with the upper ends of the vertical air flues 29, Figs. 2 and 4, in the rear wall 13. These pipes 29 are double, in the form of an inverted **U**, as shown in Fig. 4. Each branch or leg is provided with a series of short inclined nozzles 29^a at the burners 40, as shown in Fig. 6. An air pipe 30, a continuation of pipe 27, Figs. 1 and 2, and having a valve *a* extends downward and forward and connects in the front wall with the primary combustion chamber 2 for burning the fixed carbon.

A gas fan or rotary exhauster and blower 31, Figs. 2 and 3, is mounted on a shaft of the turbine 32 and has an inlet pipe 33 which connects with a port 34, Fig. 3, in the roof of the fuel chamber 2^a. This pipe

33 is provided with an air valve b for admitting air to dilute the gases which may be too rich in hydrocarbons. This valve may be a rotary valve or damper of a well known kind. The discharge pipe 35, Figs. 2 and 3, of blower 31 extends forward and connects with the transverse horizontal gas flue 36, Fig. 5 in the front of the furnace and this flue 36 connects on each side of the fuel chamber with the vertical downtake flue 37, Figs. 5 and 6. With these flues connect on each side of the fuel chamber a series of horizontal longitudinal flues 38. It will be noted by reference to Fig. 6 that the horizontal air flues 26 connect near their rear ends with the gas flues 38 and that the latter have nozzles adjacent to the inclined air ports or nozzles 29^a which discharge into the combustion chamber 15. In the front wall of the furnace, adjacent to the feeding opening 5 are constructed two gas flues 41 opening at the top into gas flue 36 and discharging at their lower ends into the fuel chamber 2, as clearly shown in Figs. 5 and 6. The gas flues 36 and 41 are controlled by sliding dampers 39 and 39^a, Fig. 5, for controlling the flow of rich gas either through the flues 37, 38, or through the short flues 41. The outlets of flues 41 are in line with the longitudinal gas channels 2^c below the offsets 2^b, Figs. 5 and 7, so that the gas will have a free passage along the body of fuel to the ports 14^a opening into the secondary combustion chamber 15.

A modified construction of our heat generating furnace, embodying the main features of construction above described, is illustrated in Figs. 8, 9 and 10, in which, however, the air-heating flues are differently arranged, and a steam jet is used for exhausting and causing circulating of hydrocarbon vapors and gases from the fresh distilling fuel to the secondary combustion chamber. A steam boiler 16^a is mounted above and beyond or to one side of the secondary combustion chamber. The generator 50 is constructed of brick and has a transverse dividing wall 49 separating the fuel and primary combustion chamber, 52—52^a, from the secondary combustion chamber 66. The primary chamber is composed of the lower and wider longitudinal part 52 adjacent to the grate, and the narrower longitudinal part 52^a at the top, where coking and gasification are effected. An arch 53, having numerous ports f for discharge of hot air to the combustion chamber 66, is constructed in the rear wall 49 and contains a transverse air flue 56 leading from a longitudinal flue 55, having an inlet port 54, Fig. 10, in the front wall on a level shown in Fig. 9. The air passing out through ports f is the first air admitted to chamber 66, The flue 55 has a regulating damper, h, Fig. 10. The front wall is provided with the upper fuel feed opening 5^a and a fire door opening 6^a, the doors of which are not shown. A step grate 4^c, of known construction, is arranged at the front of the lower part 52 of the primary chamber, and has, next to the ash pit 3^a, Figs. 8 and 9, a broad clinker table or bar, 4^d. A perforated pipe d, having a valve l, is placed on a bar of the step grate to supply water for cooling the bars.

It will be noted that the arched roof of part 52^a is extended down on interior lines slightly below the top of the step-grate, as indicated in Fig. 8, thus providing a narrower part 52^a. An off-set is made on each side on a line with gas port 59, thus making a wider part 52 in the primary chamber, where the fixed carbon is burned. In the arched roof, Fig. 9, is made a central opening 57 into a flue 58, extending down on each side (one-half being shown in Fig. 9) and opening by outlet ports 59 at the off-set in the walls. In the rear wall 49 is made two large gas outlet ports 60 for gas and products flowing into the secondary combustion chamber 66. A transverse steam superheater coil or manifold 61 is set into the lower part of wall 49, Figs. 8 and 10, and has a supply pipe 48 and a discharge pipe 62, provided with a valve g and connecting with a transverse upper pipe 63, with which connect the nozzle pipes 64 in the gas flues 58, one of which is shown in Fig. 9.

Provision is made for both a second air supply and a third air supply to the secondary combustion chamber 66. The second air is admitted by the lower flues 70—71 and ports n, Figs. 8 and 10, and the third air supply is admitted by the flues 67 and 68 and ports m. An inlet port, Fig. 10, on the level shown in Fig. 8, opens into the transverse and longitudinal flue 67, which connects at the front of the furnace with an upper return flue 68, Fig. 10, which is extended transversely and then longitudinally on the opposite side of the furnace, as shown in Fig. 10, and is provided with numerous ports m opening into chamber 66. An air inlet port 69 admits air to the lower transverse flue 70, which connects with a return flue 71, provided with ports n. Air will be heated in the flues. The secondary combustion chamber 66 is thus supplied with hot air through numerous ports f, m and n for completely burning the large volume of gaseous products flowing from the primary chamber through the large ports 60.

The off-set at the port 59 and extending to the rear wall 49 will provide a channel 59^a along the body of fuel for the flow of gases to the port 60 on each side of the chamber.

By providing a comparatively narrow or contracted part 2^a or 52^a in the upper part of the coking and primary combustion

chamber, we provide for coking and gasifying only the requisite quantity of fresh fuel,—just sufficient to furnish a quantity of coke which can be consumed in the lower part of the chamber. In this construction and arrangement of the furnace the fresh fuel will be coked and gasified rapidly, because of being in contact with the hot coke, and as the fresh fuel is coked and expanded it will feed by gravity down into the lower part of the chamber.

By reason of drawing part of the hot fixed gases up through the fresh fuel, the rich hydrocarbon gases will be quickly evolved and carried off by the hot fixed gases and the whole product will then be passed partly down into the fuel chamber and partly into the secondary combustion chamber, where they will be commingled with hot air and completely burned, without the possibility of any waste or of any smoke escaping to the external air.

The feeding of the fuel will be readily understood by the skilled fireman and will preferably be accomplished by a mechanical stoker in both forms of furnace shown. The combustion will be controlled and regulated by the valves in the air supply pipes, so that no excessive air shall be fed into the combustion chambers.

Having described our invention, what we claim and desire to secure by Letters Patent, is:—

1. In a heat generating furnace, the combination with a combined coking and combustion chamber having a wider longitudinal lower part and a narrower longitudinal upper part, said parts having at their junction, on each side, an offset, thereby providing longitudinal gas channels along the body of fuel, and said upper part having a gas outlet in its roof, of a secondary combustion chamber, a transverse division wall having ports in line with said channels, flue connections from said gas outlet in the roof to the longitudinal channels, means in said connections for drawing hot gases and vapors from the fresh fuel and discharging them into said channels, and means for feeding fuel to the upper part of said first named chamber.

2. A heat generating furnace comprising a combined coking and combustion chamber having a wider longitudinal lower part and a narrower longitudinal upper part into the latter of which fresh fuel is fed and distilled, and a secondary combustion chamber, the two combustion chambers being separated by a transverse division wall having an outlet port for gaseous products below said narrower part of the coking chamber, said upper part having a gas outlet in its roof, the side walls of said coking and combustion chamber having a series of longitudinal gas flues and a series of longitudinal air flues each of said gas flues being joined by one of said air flues and discharging into the secondary combustion chamber, an exhausting and forcing device communicating with said gas outlet in the roof, and a pipe communicating from said device with said gas flues in the side walls for drawing hot gases from the fixed incandescent carbon below through the distilling fuel above, thereby carrying off rich hydrocarbon vapors from the distilling fuel and discharging them into said gas flues and thence into the secondary combustion chamber, and separate means for supplying air to the air flues and secondary combustion chamber, whereby perfect combustion of the fixed carbon and of gases may be effected in the secondary combustion chamber.

3. In a heat generating furnace, the combination with a combined coking and combustion chamber having a wider longitudinal lower part and a narrower longitudinal upper part, said parts having at their junction, on each side, an offset, thereby providing longitudinal gas channels along the body of fuel, and said upper part having a gas outlet in its roof, of a secondary combustion chamber, a transverse division wall having a port from said lower part for passage of gases into the secondary combustion chamber, pipe and flue connections from said gas outlet in the roof to the longitudinal channels, and having means for drawing hot gases and vapors from the fresh fuel and discharging them into said channels for producing complete combustion of the fuel and gaseous products.

4. In a heat generating furnace, the combination with a combined coking and combustion chamber having a wider longitudinal lower part and a narrower longitudinal upper part, the latter part having an upper gas outlet, of a secondary combustion chamber, a transverse division wall separating the chambers and having an outlet for gaseous products from said lower part into the secondary chamber, said division wall also having vertical air flues and inclined discharge nozzles opening into the secondary chamber, the side walls having horizontal gas flues opening adjacent to said nozzles in the division wall, an exhausting and forcing device communicating with the upper gas outlet of the coking part and with said gas flues, and means for forcing air into said air flues.

In testimony whereof we affix our signatures in presence of two witnesses.

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ALBERT EDWARD MAINWARING.

Witnesses:
WILLIAM E. RUMMING,
ARTHUR W. BRADFIELD.