No. 641,755. Patented Jan. 23, 1900.

W. R. ADDICKS.

HEAT GENERATING APPARATUS.

(Application filed Oct. 31, 1895.)

(No Model.) 2 Sheets—Sheet 1.

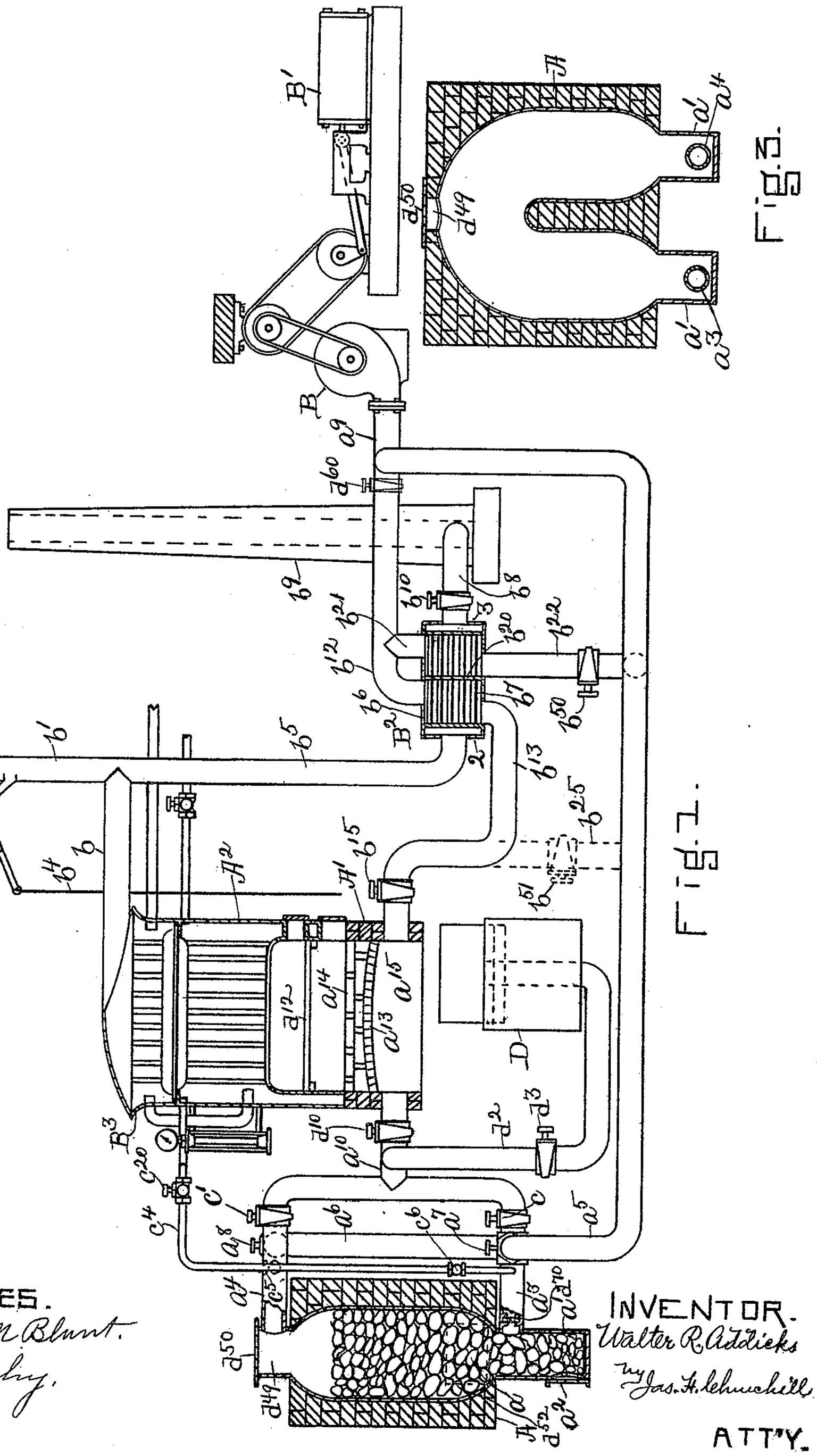

FIG. 1.

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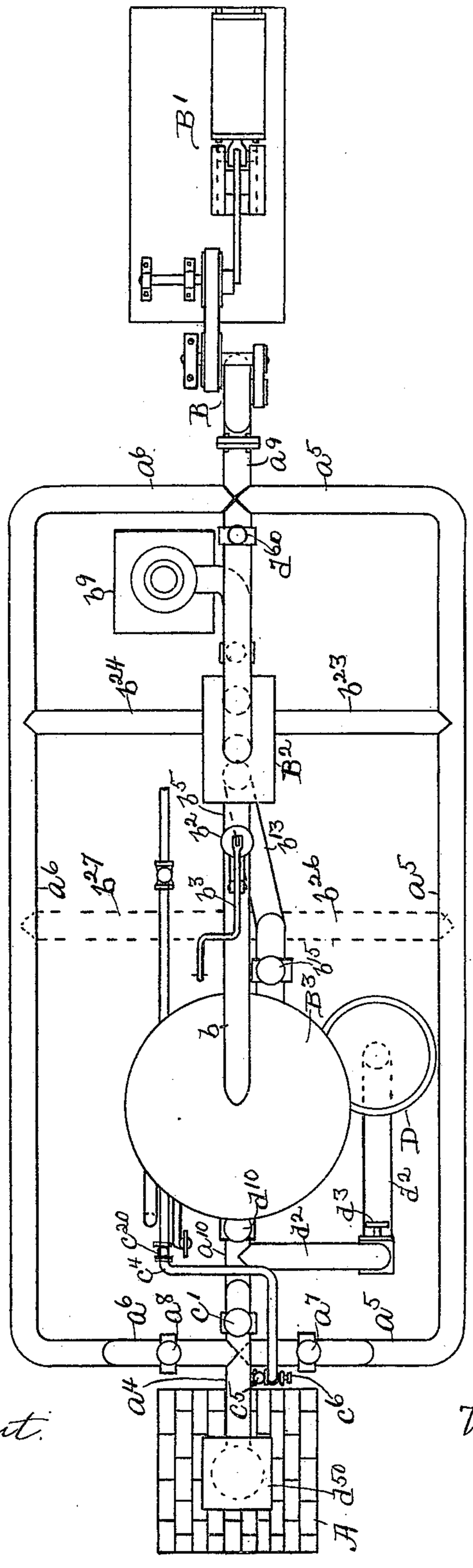

Fig. 2.

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UNITED STATES PATENT OFFICE.

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HEAT-GENERATING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 641,755, dated January 23, 1900.

Application filed October 31, 1895. Serial No. 567,509. (No model.)

To all whom it may concern:

Be it known that I, WALTER R. ADDICKS, residing in Brookline, county of Norfolk, and State of Massachusetts, have invented an Improvement in Heat-Generating Apparatus, of which the following description, in connection with the accompanying drawings, is a specification, like letters and figures on the drawings representing like parts.

This invention relates to an apparatus for the production of heat at a minimum cost, and is especially designed to be used for the generation of steam for power or other purposes, and is also particularly well adapted for utilization in manufacturing purposes.

In order that this invention may be fully understood, I will hereinafter specifically describe one form of apparatus in which the heat generated is utilized in the production of steam.

In accordance with this invention a fire-pot or producer containing the fuel to be consumed and which may be similar in construction to a generator or producer such as now commonly employed in illuminating-gas plants is provided at the opposite ends of the fuel therein with gas-outlet pipes, both of which are connected to a separate chamber provided with an air-inlet pipe supplying air to the said chamber to effect complete combustion of the gases admitted therein through the outlet-pipes of the fire-pot, the products of the complete combustion being directly utilized for commercial purposes—such, for instance, as the generation of steam—in which case the said products of combustion may and preferably will pass directly into a steam-boiler, where they are utilized in the production of steam therein. The fire-pot referred to is provided with an air-supply pipe communicating therewith one at each end of the fuel in said fire-pot, and preferably the said fire-pot is provided with aqueous vapor or steam supply pipes communicating therewith at the opposite ends of the fuel in said fire-pot.

An apparatus such as above briefly described is especially applicable for power purposes and is particularly well adapted, among other uses, to be employed in the power-houses of electric-light plants, wherein the steam generated in the boiler is employed to drive the dynamo-engines, and in order that the fire-pot or producer may be disconnected from the combustion-chamber and the steam-boiler for cleaning or other purposes without interrupting the supply of gases to the combustion-chamber, and thereby without interrupting the generation of steam in the boiler, a gas holder or reservoir is preferably provided, which is connected with the said fire-pot or gas-producer and also with the combustion-chamber, so that when desired the said fire-pot or producer may be completely cut off from the combustion-chamber and the supply of gas to the combustion-chamber furnished from the reservoir or holder. The combustion-chamber referred to, as above stated, may form the combustion-chamber of a steam-boiler; but so, also, it may be the combustion-chamber of a heating-furnace of any suitable or desired construction. These and other features of this invention will be pointed out in the claims at the end of this specification.

Figure 1 represents in section and elevation one form of apparatus embodying this invention; Fig. 2, a top or plan view of the apparatus shown in Fig. 1, and Fig. 3 a modified form of fire-pot or gas-producer.

Referring to Fig. 1, A represents a fire-pot or gas-producer which may be of any desired or suitable construction—such, for instance, as now commonly employed in illuminating-gas-producing apparatus—the said fire-pot or producer being filled or partially filled with a bed a of coal or other suitable combustible material which may or may not be supported upon a grate-surface, and which fire-pot in the present instance is shown as provided with a bottom extension a', having a suitable door a^2.

The fire-pot or producer A is provided at or near the opposite end of the fuel a therein with gas-outlet pipes a^3 a^4. In the present instance the pipes a^3 a^4 are represented as having connected to them pipes a^5 a^6, respectively, (see Fig. 2,) which are designed to supply the air-blast requisite for the combustion of the coal or other fuel a in the producer or fire-pot A, the said air-blast pipes being provided with valves a^7 a^8, respectively, one of which is closed when the other is opened, according to which end of the bed of fuel the air-blast is being supplied. In one condition the air is supplied to the bottom of the pro-

ducer and with the construction of fire-pot shown in Fig. 1 passes up through the bed of fuel therein, and the products of combustion, hereinafter termed the "producer-gases," pass off through the pipe a^4, in which case the air-blast valve a^8 is closed. When the air-blast is supplied to the opposite end of the bed of fuel—namely, through the other air-blast pipe a^6—the air-blast valve a^8 is opened and the valve a^7 in the air-blast pipe a^5 is closed. The air-blast pipes a^5 a^6 may and preferably will be directly connected with the outlet-pipe a^9 of a blower B of any suitable construction, the said blower being herein represented as driven by a suitable engine B', which may be of any suitable or usual construction and a detailed description of which is not deemed herein necessary. In the present instance the gas-outlet pipes a^3 a^4 are represented as connected to a common outlet-pipe a^{10}, which in accordance with this invention constitutes a gas-inlet pipe for a combustion-chamber A', which may be of any desired or suitable construction and which in the present instance is shown as provided with an arch or partition a^{13}, dividing the chamber A' into upper and lower compartments a^{14} a^{15}, the upper compartment a^{14} preferably containing fire-brick or other refractory material arranged so as to produce a checker-work or staggered effect, to thereby retard the passage of the gases through the combustion-chamber A' and also to absorb heat, and thereby maintain the combustion-chamber at a high temperature after the supply of gases is cut off for a purpose as will be described.

The compartment a^{15} in the present instance is represented as containing no refractory material, for a purpose as will be described. The combustion-chamber A' in accordance with this invention communicates directly with the apparatus to be heated, which in the present instance is represented as a boiler A^2, which may be of any suitable or usual construction; but I prefer to employ a tubular boiler, the said boiler being connected with the chamber A' for the direct passage of the gases from the said chamber into and through the boiler.

In the present instance the boiler A^2 is represented as an upright tubular boiler and is supported upon and above the chamber A', and it is preferably provided with a feed-water heater B^3, having its upper end or dome provided with a gas-outlet pipe b, herein represented as communicating with an upwardly-extended pipe b', open at its upper end and normally closed by a valve or cover b^2, adapted to be opened and closed by an operating-lever b^3, herein represented as provided with an operating-handle, which may be a rod b^4.

The pipe b may and preferably will be connected to a downwardly-extended pipe b^5, forming the gas-inlet pipe of an air-blast heater B^2, herein represented as consisting of a casing b^6, containing tubes b^7, through which pass the waste gases into a gas-outlet pipe b^8 for the said heater, the said gas-outlet pipe b^8 being shown as substantially diametrically opposite to the gas-inlet pipe b^5 and communicating with the chimney or stack b^9, the said gas-outlet pipe b^8 being provided, as herein shown, with a valve b^{10}. The heater B^2 is further provided, as herein shown, with an air-inlet pipe b^{12}, represented as communicating with the top of the casing b^6, and an air-outlet pipe b^{13}, communicating with the bottom of the said casing. The air-inlet pipe b^{12} is connected to the air-outlet pipe a^9 of the blower B, as clearly shown in Fig. 2. The air-outlet pipe b^{13} for the blast-heater B^2 communicates with the compartment a^{15} of the chamber A' and constitutes the air-blast inlet-pipe for the said chamber, it being provided, as herein shown, with a valve b^{15}, by which the air-blast may be cut off from the chamber A' when so desired.

The casing of the heater B^2 may be provided, as herein shown, with a partition-wall b^{20}, through which the tubes or pipes b^7 extend, and which wall practically divides the heater into two parts or separate heaters 2 3, the said parts being provided with separate air inlets and outlets, air being admitted into the part 2 by the pipe b^{12} and into the part 3 by the pipe b^{21} and conducted away from the respective parts by the pipes b^{13} b^{22}, the latter pipe being connected to the air-blast pipes a^5 a^6 by the pipes b^{23} b^{24}. (See Fig. 2.) The air-outlet pipe b^{13} may also be connected to the air-blast pipes a^5 a^6 by the pipe b^{25} and its branches b^{26} b^{27}, (shown only by dotted lines,) this arrangement of pipes being made for a purpose as will be described.

In the production of the producer gases the air-blast is carried through the bed of fuel a in one direction—as, for instance, in an upward direction—and in this case the air-blast valve a^7 is opened, while the air-blast valve a^8 is closed, and in order to cut off communication between the lower end of the fire-pot or producer and the combustion-chamber A' the pipe a^3 is provided with a valve c, which in the present arrangement is intermediate of the producer and the junction of the pipe a^3 with the pipe a^{10}, and the pipe a^4 is also provided with a like valve c', by which communication between the upper portion of the fire-pot or producer A may be cut off from the chamber A'. When the air-blast is admitted at the bottom of the producer, the valve c is closed, the valve a^7 is opened, the valve a^8 is closed, and the valve c' is opened, so that the gases pass out from the fire-pot through the pipe a^4 and through the pipe a^{10} into the compartment a^{15} of the chamber A', where they meet the air-blast admitted through the pipe b^{13}, and the products of combustion or gases resulting therefrom then pass up through the checker-work in the compartment a^{14} and from the said compartment the gases pass up through the boiler, out through the pipe b, and, if desired, they may pass through the upper end of the stack or pipe

b' to the atmosphere, the valve b^2 being at such time lifted from its seat, or they may pass down through the pipe b^5, through the blast-heater B^2, and out to the stack b^9, the valve b^2 at such time being closed. It will thus be seen that the gases on their passage to the pipe b' or to the stack b^9 are directly utilized for heating the contents of the boiler A^2.

In operation the fire is started in the fire-pot or producer and the air-blast is admitted to raise the fuel to a state of incandescence, and steam or aqueous vapors may and preferably will be admitted into the fire-pot along with the air-blast in suitable quantities or proportions to form a mixture of water-gas and the products of combustion of the fuel a, which mixture of gases is completely consumed in the heating-chamber A'. The steam may be supplied, as herein shown, from the boiler A^2 by a pipe c^4, connected with the pipe a^4 by a branch pipe provided with a valve c^5, by which the admission of steam to the pipe a^4 may be controlled, the pipe c^4 also communicating with the pipe a^3 and being provided near the pipe a^3 with a valve c^6, by which supply of steam to the lower end of the producer or fire-pot A may be controlled. When the steam-valve c^6 is opened to supply steam to the air-blast pipe a^3, and thereby to the fire-pot at one end of the bed of coal, the steam-valve c^5 is at such time closed. The steam admitted into the lower end of the fire-pot A with the air-blast passes up through the incandescent body of coal and produces water-gas, which admixes with the blast-gases, and the said mixture of gases passes out through the pipe a^4 and through the pipe a^{10} into the compartment a^{15} of the chamber A', where it meets a blast of heated air supplied through the pipe b^{13} from the heater B^2, the mixture of air-blast gases and water-gas passing up into the compartment a^{14}, where the passage of the same is retarded sufficiently to effect complete combustion of the mixed gases, thereby creating or generating substantially great heat, which passes up through the boiler A^2, imparting its heat to the water contained therein, and passing out from the boiler to the stack b^9, as above described. The gases which pass out from the boiler I prefer to term the "waste" gases and to utilize these gases in the heating of the air-blast in the heater B^2. When it is desired to reverse the course of the steam and the air-blast through the fire-pot or producer A, the valve c' is closed, the valve c is opened, the valves a^8 c^5 opened, and the valves a^7 c^6 closed. In practice these operations may and preferably will be effected simultaneously by means of a single operating mechanism—such, for instance, as a lever to which these valves are operatively connected, so as to be operated reversely by a single motion of the lever. In the condition of the valves just described the steam and the air-blast are admitted to the fire-pot or producer A at the opposite end of the fuel therein, which in the construction shown in Fig. 1 is the top of the said fire-pot, and pass down through the incandescent body of fuel, thence out through the pipe a^3, and through the pipe a^{10} into the compartment a^{15} of the chamber A', where they meet the hot blast admitted through the pipe b^{13} and commingle therewith, as above described, complete combustion being effected in the compartment a^{14}, the products of complete combustion passing up through the boiler A^2 and out through the pipe b to the stack b^9, following the course previously described.

When the steam and air-blast valves are operated by a lever or other single actuating mechanism, a throttle-valve c^{20} in the steam-supply pipe c^4 is closed until the fuel in the fire-pot has been brought to incandescence, and at such time the throttle-valve c^{20} is opened and the supply of steam to the fire-pot placed under the control of the steam-valves c^5 c^6. In practice I prefer that the air-blast admitted into the fire-pot or producer A, which I prefer to designate the "primary" air-blast, should be of a lower temperature than that admitted into the chamber A', and in order that the primary air-blast may be cold, if desired, the blast-pipes a^5 a^6 may be connected directly to the outlet-pipe a^9 of the blower B, as herein shown, and in order, when desired, that the primary air-blast may be tempered by an admixture with it of a preferably moderately heated air-blast the air-blast pipes a^5 a^6 are tapped by the pipes b^{23} b^{24}, connected to the heater B^2 by the pipe b^{22}, which latter may be provided with the valve b^{50}, by which the amount of heated air admitted into the primary blast-pipes a^5 a^6 may be controlled.

By reference to Fig. 1, it will be seen that the air-blast pipe b^{12} communicates with the part 2 of the heater B^2, which part receives the waste gases from the boiler A^2, and therefore the air admitted into the part 2 of the heater robs the waste gases of considerable of their heat before the air admitted into the port 3 of the heater is acted upon by the waste gases. As a result the air supplied to the chamber A' is more highly heated than the air conducted to the blast-pipes a^5 a^6 through the pipe b^{22}, communicating with the part 3 of the blast-heater. If it is desired that the primary air-blast should be more highly heated, a portion of the highly-heated air-blast passing through the pipe b^{13} may be admitted into the blast-pipes a^5 a^6 by opening the valve b^{51} in the pipe b^{25}. In this way the primary air-blast admitted into the fire-pot or producer may be brought to any desired or required temperature within limits, and by closing the valves b^{50} b^{51} the air-blast pipes a^5 a^6 may be cut off from the blast-heater B^2.

The pipe a^{10}, as herein represented, is open in the normally-operative condition of the apparatus, as above described; but it is adapted to be closed when it is desired to cut off the fire-pot or producer A from communication

with the chamber A′—as, for instance, when it is desired to clean out the said producer. In practice the fire-pot or producer A requires cleaning usually once in twenty-four hours, and when it is so desired to clean the same it is likewise desired to maintain the heat in the chamber A′, and thereby in the boiler or other apparatus, so that when the fire-pot or producer A is cut off from the chamber A′ and is no longer doing its work the heat in the chamber A′ and boiler A^2 may not be interrupted, but may be maintained at the same or substantially the same temperature. This result may and preferably will be effected after the manner herein shown and as will now be described. In accordance with this feature of the invention a gas holder or reservoir D, which may be of any suitable or desired construction, is connected with the pipe a^{10} by a pipe d^2, provided with a valve d^3, the said pipe constituting the inlet-pipe for the reservoir or holder D, so that when it is desired to cut off the fire-pot or producer A the valve d^3 is opened while the apparatus is running, and it will be seen that a portion of the gases generated in the producer A will pass through the pipe d^2 into the reservoir or holder D, from which it will pass back through the pipe d^2 into the compartment a^{15} of the chamber A′, when the producer is cut off by closing the valves c c'. When the demand for steam ceases, the valve d^{10} is closed and the refractory material in the compartment A^{14}, being highly heated, retains the combustion-chamber at a high temperature after the supply of gas is cut off by the valve d^{10} and prevents the sudden cooling of the boiler, and thereby avoids the tendency to produce leaks which would result from such sudden cooling.

In practice it may become necessary to clean the producer, say, once in twenty-four hours, which cleaning process might take about one hour, and during this hour the temperature of the boiler and of the combustion-chamber is prevented from being reduced so as to be injurious to the boiler, as above described. Furthermore, the chamber A′ and the boiler B^2 may be cut off from the gas-holder D and the producer A by means of a valve d^{10} in the pipe a^{10}, thereby permitting the boiler, which is provided with the usual grate surface or bars d^{12}, to be fired and used in the ordinary manner.

In Fig. 1 I have shown one form of fire-pot or producer; but I do not desire to limit my invention to the particular form therein shown, as other forms of producer may be used, provided that the pipe connections with relation to the bed of fuel remain the same. In Fig. 3 another form of producer or fire-pot A is shown, it comprising two chambers connected at their upper ends for the passage of the gases from the bed of fuel in one chamber down through the bed of fuel in the other chamber, the said chambers being provided with the gas-outlets a^3 a^4.

The fire-pots or producers shown in Figs. 1 and 3 are provided with a fuel-inlet d^{49} at their top, normally closed by a suitable cover d^{50}, and the said inlet may be utilized to start the fire in the producer.

The fire-pot or producer when made, as shown in Figs. 1 and 3, with the extension a' may be provided with a suitable door d^{52}, (indicated by dotted lines in Fig. 1 only,) through which removable grate-bars may be inserted to support the main body of fuel when it is desired to remove the ashes. By means of the uptake or pipe b', provided with the valve b^2, the waste gases may be conveyed directly to the atmosphere, thereby permitting access to be had to the blast-heater and stack for purpose of repairs without interrupting the working of the heating apparatus. In this case the supply of air to the blast-heater could be cut off by a valve d^{60} in the pipe b^{12} and air could be supplied direct from the blower to the combustion-chamber A′ through the pipes a^5 a^6, branch pipes b^{26} b^{27}, and pipes b^{25} b^{13}.

I have herein described the invention as embodied in an apparatus for generating steam and have represented the chamber A′ as provided with a single boiler located above it; but it is manifest that any desired number of boilers may be heated by the products of combustion passing through and from the chamber A′, and so also the chamber A′ may support or be connected with other forms of apparatus which it is desired to heat—such, for instance, as a battery of retorts for the distillation of coal, and, for instance, heating or melting furnaces. The compartment a^{15} of the chamber A′ is preferably left free from firebricks, so that the heated-air blast may be quickly and thoroughly commingled with the gases.

From the above description it will be noticed that the process of generating the heat is continuous, and therefore is especially applicable for power purposes, such as require the heat to be continuously generated—as, for instance, electric railways or other electric power plants.

When the fire-pot or producer A is provided with an extension a', with which the air-blast pipe is connected, the said pipe will preferably have placed in it near its discharge outlet or mouth a screen d^{70}.

I claim—

1. The combination of the following instrumentalities, viz: a producer provided at the opposite ends of the fuel therein with gas-outlets having means for controlling the passage of the gases out of the producer, air-admission pipes connected to the producer at the opposite ends of the fuel therein, a combustion-chamber separate from the producer but connected directly thereto by the gas-outlets for said producer, a boiler located above said combustion-chamber, refractory material in said combustion-chamber, and an air-supply pipe for said combustion-chamber, whereby the gases generated in the producer

may pass directly into the combustion-chamber and be consumed therein, substantially as and for the purpose specified.

2. The combination of the following instrumentalities, viz: a gas-producer, gas-outlet pipes connected to the producer at the opposite ends of the fuel therein, air-admission pipes connected to the producer at the opposite ends of the fuel therein, a combustion-chamber separate from the gas-producer and connected directly thereto by said gas-outlet pipes, and a separate air-supply pipe for said combustion-chamber, whereby the gases generated in said producer are led directly into the said combustion-chamber and are consumed therein, substantially as described.

3. The combination of the following instrumentalities, viz: a gas-producer, gas-outlet pipes connected to the producer at the opposite ends of the fuel therein, air-admission pipes connected to the producer at the opposite ends of the fuel therein, a combustion-chamber separate from the gas-producer and connected directly thereto by said gas-outlet pipes, a separate air-supply pipe for said combustion-chamber, a tubular boiler located above said combustion-chamber, and refractory material in said combustion-chamber which is heated by the gases consumed in said combustion-chamber, for the purpose specified.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

WALTER R. ADDICKS.

Witnesses:
JAS. H. CHURCHILL,
J. MURPHY.