J. M. W. KITCHEN.

METHOD OF AND MEANS FOR GENERATING POWER.

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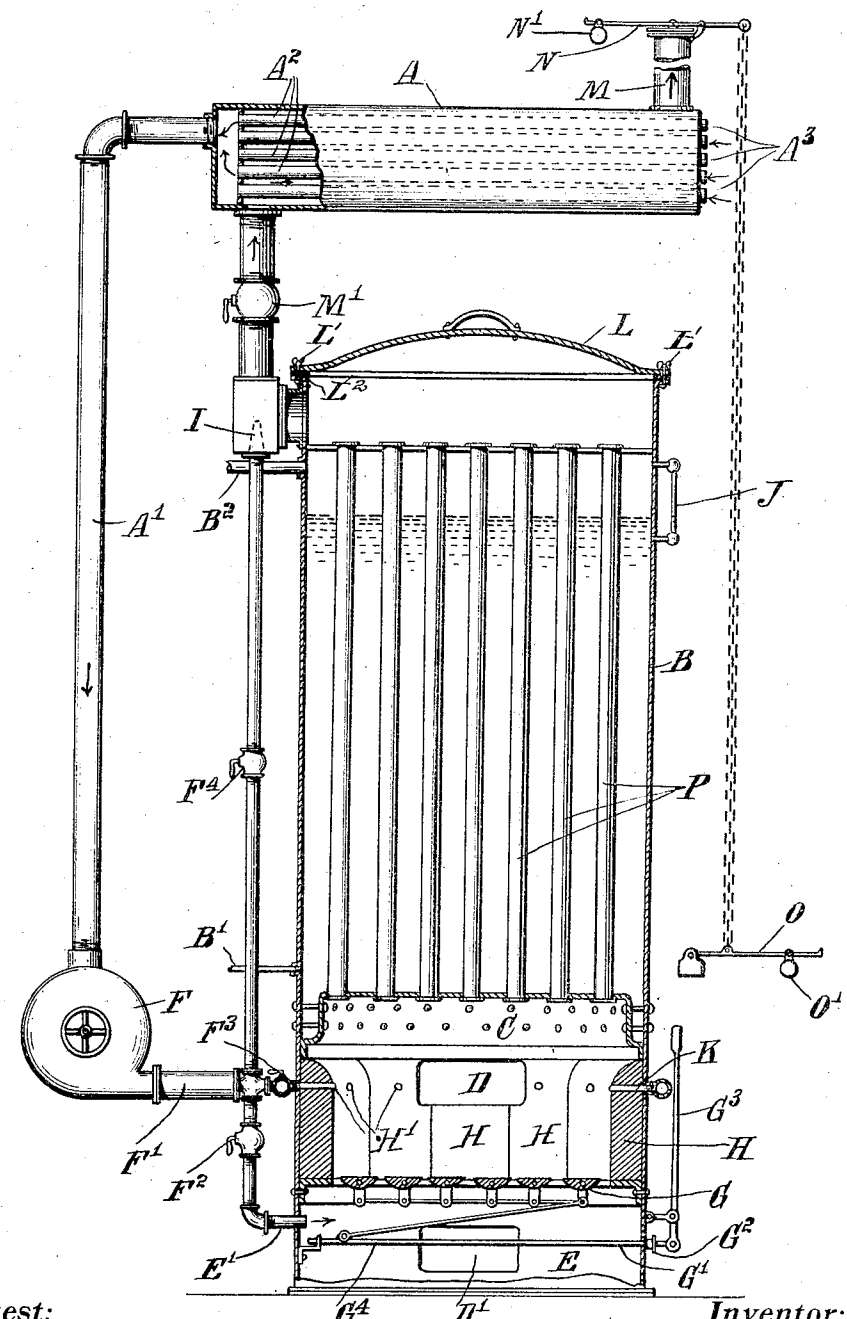

Attest:

A. Bernstein

Inventor:

by Joseph Moses Ward Kitchen

Geo. L. Wheelock

his Atty

UNITED STATES PATENT OFFICE.

JOSEPH MOSES WARD KITCHEN, OF EAST ORANGE, NEW JERSEY.

METHOD OF AND MEANS FOR GENERATING POWER.

1,046,308. Specification of Letters Patent. Patented Dec. 3, 1912.

Application filed November 22, 1911. Serial No. 661,847.

To all whom it may concern:

Be it known that I, JOSEPH MOSES WARD KITCHEN, a citizen of the United States, residing in the city of East Orange, county of Essex, State of New Jersey, have invented certain new and useful Improvements in Methods of and Means for Generating Power, of which the following is a specification.

The object of the invention is to secure a more perfect combustion of fuels, including especially those that are difficult to burn smokelessly; to secure in the generation of steam a more complete transmission of the heat generated in the burning of the fuel; and to secure a regenerative use of the lower degrees of waste heat.

In particular, the invention is useful in securing a substantially smokeless combustion of fuels widely varying in type; and in securing a high rating of boilers when desired, as may be the case during unusual demands of load to be met either in stationary plants, in marine or in locomotory work. Under this method, coals so hard as to be difficult to use under ordinary conditions may be utilized.

Some of the ideas of the invention were disclosed and partly claimed by me in United States Patent No. 995,154, issued June 13th, 1911; and in my co-pending application for patent Serial No. 551,196, filed March 23rd, 1910.

Some of the inventive ideas herein claimed are those which could not be claimed under Patent Office rules in the referred to applications, and which also pertain to new developments that have been evolved since the filing of the referred to patent and application.

The invention here described, especially pertains to a method of burning fuel under a selected, designated pressure, and securing the transmission of the heat generated in the burning, also under a selected pressure of the heating gases. To this method I have given the name "compressed draft." It is to a certain degree, a variety of forced draft; but the results secured are very different from the results secured from ordinary forced draft. Forced draft is a quick draft, and is characterized by an intense rapid combustion, and usually an uneconomical, quick contact with, and rapid travel of the heating gases over the heating surfaces. But "compressed draft" as a slow draft, and though an intense one, it accomplishes a complete and smokeless combustion of any burnable fuel, and secures an almost complete transmission of the generated heat to water in the boiler heated by the gases under the compressed draft.

The underlying principle applied in the invention is that of securing the consumption of the fuel through the use of a mechanically compressed air supply delivered to the fuel both below and above the fuel mass, and in maintaining the burned gases in a state of compression until the heat in the gas has been transmitted to the working media, which in this case are both water and air. One of, if not the greatest source of heat wastes in the use of fuel is due to the lowering of temperature in the heating gases through the expansion of the burning gases. Heat energy in coal is in a concentrated form; but when it is diffused in a gas that is expanded under the influence of an induced draft, the heat made nsible is of relatively low temperature. Other things being equal, the transmission of heat from gases to water is most effective when the heat of the gases is most intense; and the combustion of fuel is best performed when only enough air is passed through the fuel-mass to volatilize the fuel; and when enough, and only enough of air is quickly and intimately admixed with the volatilized gases above the fuel mass to effect their complete burning. Furthermore, that burning is most completely effected if the burning gases are prevented from being lowered in temperature until after the combustion of the gases is effected. Hence in this invention I supply air for combustion to the fuel under considerable pressure, mechanically produced; and by one small mechanical expenditure of force I overcome the relatively weak and inefficient action of the force of gravity, and introduce the air for combustion both below and above the fuel-mass in the amounts needed in each place, and in the places best suited to secure the aimed for result. By adding a regulatable, pressure reducing and relief valve to a boiler at or beyond its exhaust gas exit, and effecting a regulated back pressure on the gases in the boiler and in its co-acting furnace, I secure

in connection with a fixed air pressure, a slow draft as well as an intense air and gas pressure. Through this method, the gases are more completely burned close to the level of the fuel-mass, and in their burning are not so quickly brought into contact with heat absorbing surfaces, which quick contact in the case of boilers, very rapidly reduces the heat of the gases to a temperature below that at which they can burn. This intensity of pressure of the gases, also serves to secure a better transmission of the generated heat to the water in the boiler.

Under ordinary methods of steam power generation, heating gases usually escape into the atmosphere from the boiler at a temperature of from 400° to 600° F., and in case of very rapid drafts, at even higher temperatures. But with my method, and pre-supposing that the temperature of the water in the boiler is about 350° F., the temperature of the exhaust gases after they have expanded to atmospheric pressure, need not be over 150° F.; and when it is desired, this same principle may be applied in the transfer of the lower degrees of heat in the exhaust gases to pre-heat air that may then be used for combustion purposes. In this exhaustive utilization of heat, the heating gases may be delivered to the atmosphere at a temperature not to exceed over 50° F. In this connection it may be said that it is usually advantageous to exhaust the heating gases at a temperature somewhat higher than the temperature of the atmosphere, so as to secure a high level diffusion of the exhaust gases into the atmosphere, and thus avoid contamination of air breathed at lower levels.

The principles applied in this invention may be applied in a large range of structural forms of steam generators but in some forms to better advantage than in others. In one form in which the principles of the invention can be applied, the fuel may be gasified in any ordinary type of internally fired, pressure gas generator, in which the fuel is introduced and poked through the top of the generator; and in which the gas may be burned in a furnace having a very high run combustion chamber for securing the burning of the gas before the gas is brought into contact with the heating surfaces of the boiler, and in which the highest heat is absorbed in a steam disengaging drum high above the furnace, in which a bed of solid fuel or some other means of maintaining a hot flame is provided in order to secure a continual ignition of the gas from the generator, which is usually of a moderate or low degree of richness, and which is somewhat difficult to keep ignited, especially if not quite warm and burned with pre-heated air. The type now referred to, and which is illustrated in my co-pending application for patent Serial No. 551,196, filed March 23rd, 1910, has a vertical water heater through which the gases are forced in a downward travel, and in the parts of which the gases are burned and the heat transmitted under a back pressure, controlled by a pressure reduction and relief valve located beyond or at the exit for exhaust gases from the apparatus. The form which is illustrated diagrammatically in the accompanying drawing is one especially suited for installing in sea-going vessels; or elsewhere where only small floor space is available. This form is especially useful when high internal pressures are desired, with high rating of the boiler. It permits of a special construction which prevents gas leakages from within the furnace, combustion chamber and other parts and helps to retard the too quick contact of the heating gases with heat transferring surfaces. It will be understood that the fuel feed and ash pit doors that are indicated, as well as the grate shaking device of the generator, are constructed so as to prevent gases from escaping through the usual openings provided for these features. The drawing represents in elevation and partly in section, a boiler, an air heater and an air exhauster and blower, as well as other features of my invention.

The reference characters indicate as follows:—

A is a counter-current air heater.
A^1 is a warm air conduit.
A^2 are air heating tubes.
A^3 are inlets to the air heating tubes.
B is the boiler.
B^1 is a feed water conduit.
B^2 is a steam conduit.
C is the combustion chamber.
D is the rear face of the fuel-feed door.
D^1 is the rear face of the ash-pit door.
E is the ash pit.
E^1 is an air inlet.
F is an air exhauster and blower.
F^1 is a compressed air conduit.
F^2, F^3, and F^4 are air valves.
G is a grate.
G^1 is a horizontally disposed grate shaking bar.
G^2 is a stuffing box.
G^3 is a shaking handle.
H are fire brick.
H^1 are air twyer openings.
I is an induced draft injection device.
J is a water gage.
K is an air twyer.
L is a clean-out cover.
L^1 is a gasket.
L^2 are winged bolts.
M is the gas exhaust stack.
M^1 is a gas valve.
N is a regulatable pressure reducing and relief valve.
N^1 is a sliding weight.

O is the relief regulator for the valve N.

O^1 is a regulating weight.

P are fire tubes.

The fuel-feed door D and the ash-pit door D^1 are constructed to resist escape of internal air and gas pressures, the intensity of which pressures are governed by the compression given to the air for combustion by the blower F, and by the influence of the back pressure and relief valve N. The air is introduced in suitable amounts below the grate G through the air inlet E^1, controlled by the valve F^2: and also above the fuel-mass through the air twyer inlets H^1 controlled by the valve F^3. The back pressure is exerted by the action of the pressure-reduction-relief valve N, which pressure is regulated automatically after setting the weights N^1 and O^1. Any suitable pressure reducing valve may replace the valve N and its regulator O. When the furnace is to be fed with fuel, the compressed draft is changed to an induced draft, by opening the valve N and injecting compressed air from the blower F through the injection device I. Warm air heated by heat radiated from the installation, after rising to a high level, is drawn through the air inlets A^3, through the tubes A^2 in counter-current to the travel of the exhaust gases which surround the tubes, and then find exit through the stack M. Where there is sufficient room, I prefer to use a vertical counter-current air heater for heating the air. If a variation in pressure between that in the gas passages of the boiler and that in the air heater A is desired, such variation may be given by actuating the valve M^1.

By a proper manipulation of the several parts of the apparatus, a substantially smokeless combustion of any burnable fuel may be secured, and an almost complete transfer of the heat generated by the combustion may be made to water and to air for combustion, which air it will be noted, is first heated with heat radiated from outside of the boiler A and other features of the installed apparatus, and then heated by the pipes A^2 in the air heater A; the last heating of the air being enhanced by keeping the exhaust gases surrounding the air tubes A^2 under compression by the action of the valve N. The heated air is exhausted downwardly by the exhauster and blower F, and is then forced into contact with the fuel in the boiler's furnace, much of the low degrees of heat of waste heat being thus used regeneratively, and a complete combustion of the gases from the fuel is effected at a level immediately above the fuel-mass and before the burning gases are conveyed against the heating surfaces. In this simple manner is effected the prevention of large losses which occur from the imperfect combustion and defective transmission of the heat generated in steam power generation. The rating of the boiler may be raised by increasing the speed of the blower F, which may be replaced by a piston air compressor if very high rating is wanted for the boiler, and by increasing the back pressure through weighting the valve N.

The principles of the invention may be applied in a wide variety of forms of steam apparatus comprising special fuel-feeding appliances without effecting the aim and scope of the invention. The hand-fed furnace here shown may be replaced by an under-feed stoker, or by over-feed stokers of various types; and in certain instances, where intermitted firing is dispensed with and an entire prevention of smoke is desired, such modification of the herein described type of apparatus may be used. It should be understood however, that a wide divergence from the type herewith shown, although securing effective combustion, is likely to be defective in transmission of the heat generated.

Attention is directed to the shaking device for the grate G, in which motion is given to a horizontally disposed rod G^4, working in a horizontal plane through the air pressure resisting stuffing box G, and actuated by the handle G^3. This device allows the grate to be operated without loss of air pressure in the ash pit E.

As exemplifying the breadth to which the principles of this invention can be applied it may be mentioned that in those cases in which a substantially entire smokeless combustion of soft bituminous or other fuels, ordinarily difficult to burn in a satisfactory manner, is desired or necessitated, the fuel would be first gasified in some form of producer gas generator, and then the gas would be forced to a place of burning below or close to the boiler, and in such cases the fuel bed as shown in the drawing would be replaced by a mass of refractory material in which the complete combustion of the fuel gas would be consummated with a proper admixture of air in or just above the refractory material, the object being to secure a complete combustion of the fuel before the heating gases would be brought into contact with the heating surfaces, in the process of substituting a slow compressed draft for a rapid forced and induced draft, as is commonly practised. As a further illustration of the idea of interposing some physical obstacle to the too quick forcing and drawing of the gases to and over the heating surfaces, in certain cases I introduce lava ferrules in the upper part of the fire tubes of a boiler above the water line of the boiler. This not only protects the metal of the tubes from the corrosive action of highly heated sulfur compounds in the heating gases, but also aids the relief back pressure valve of the apparatus in securing the back pressure

which I desire in order to get a more quick and complete transmission of the heat generated.

What I claim as new is:—

1. In a steam generating plant, the combination with a boiler of, (1) means comprising a gas generator and an air compressor for generating a combustible gas under a controlled forced air pressure, (2) means for and a place for admixing air for combustion with the combustible gas, said place being located apart from where the gas is generated, and (3) means for securing the burning of the admixed gas and air at the place where the gas and air are admixed, said burning being performed under a controlled forced pressure and under a controlled back pressure.

2. In a steam generating plant, the combination of, (1) means comprising a gas generator, an air compressor and a back pressure valve for generating a combustible gas under a controlled forced pressure and under an automatically controlled uniformly exerted and selected degree of back pressure, (2) means for and a place for admixing air with and for burning the gas generated, said burning being effected under a mechanically produced pressure of air in the said place, which place is apart from where the gas is generated, said burning being effected under a controlled back pressure on the gas being burned, said back pressure being automatically and continuously maintained by the means effecting the back pressure independent of the aid of steam pressure generated in the plant, and (3) a boiler for generating steam from the heat of the burning of the gas, said steam being formed under the continued gas pressure controlled by the means for producing the named forced and back pressures.

3. In a steam generating plant, the combination of, (1) means comprising a furnace and boiler for generating and burning a combustible gas and generating steam, (2) a gas conduit for conveying away burned gases from the boiler, (3) a mechanically actuated air blower and other means for producing forced air drafts through and over the fuel in said means for generating and burning the gas and generating steam, and (4) means for intermittently forcibly injecting a current of the forced air in said exhaust conduit at will, thereby inducing a draft in said conduit.

4. In a steam generating plant the combination of, (1) means comprising a gas generator for volatilizing a combustible gas from fuel, and (2) means comprising a boiler for mechanically securing an admixture of air with the volatilized gas and for burning the admixed gas and air and for generating steam from the heat of the burning, said second named means comprising provision for effecting in said means a controlled, combined forced and back pressure greater than atmospheric pressure, said provision comprising a pressure controlling device operatively connected with the gas exit of said boiler, said device being adjustably controllable for determining a selected back pressure independent of pressures effected by the means for forcing the air or by steam in the boiler.

5. In a steam generating plant, the combination of, (1) a furnace, (2) a boiler heated by gases burned in the furnace, (3) an air heater for heating air with the exhaust gases from the boiler, (4) means for forcing a draft through said furnace of the air heated in said air heater, and (5) means for securing and maintaining a back pressure in said furnace, boiler and air heater greater than atmospheric pressure and for controlling at will the pressure maintained.

6. In a steam generating plant, the combination of, (1) a furnace comprising a grate, (2) a boiler heated from the furnace, and (3) means for compressing air and forcing the air into the furnace, and other means for securing the burning of the fuel in the furnace under and for maintaining the gases produced from the burning in a state of compression greater than atmospheric pressure, said furnace having gas tight doors for fuel feeding and ash removal and means for agitating the grate from without the furnace and for preventing loss of gaseous pressure in the furnace through the means for agitating the grate.

7. The combination of, (1) a furnace, said furnace comprising a grate, a fuel-feed door opening, an ash-pit and ash-pit door opening, gas impervious doors to said fuel-feed door and said ash-pit door openings, and gas impervious means through which is passed means for shaking the grate from outside the furnace, and said means for shaking the grate, (2) means for introducing air for combustion underneath the grate, (3) means for introducing air over the fuel on the grate in multiple currents or streams, (4) a vertical tubular boiler integrally connected with said furnace and controlled as to its openings by gas tight structural provisions, fire brick and a surrounding water leg forming with said fire brick a combustion chamber for said furnace and boiler, (5) fire tubes vertically connecting said combustion chamber at a high level of the combustion chamber with a gas chamber located above the tubes, (6) said gas chamber and a removable cover to the gas chamber providing for admission to said tubes for cleaning and repairs, (7) means at a high level above the gas exit of said boiler for heating air with the exhausted gas from the boiler, and (8) means for compressing the heated air and for feeding the heated

air into said furnace and through said boiler tubes.

8. The combination of, (1) an internally fired gas generator, said generator being fed by a forced air pressure draft, and means for creating the forced pressure draft, said generator comprising means for maintaining an ignited fuel therein and further means for forcibly admixing said gas with the air forced and for burning the admixed air and gas above or beyond the fuel being gasified in the generator, (2) a boiler for absorbing the sensible heat of the burned gas and air, and (3) means for automatically maintaining a predetermined back pressure of the gases and air in the generator and of the burned gases as they pass through said boiler, said last named means comprising provisions for regulating the degree of compression desired and for affording relief for undesired accumulations of gas in said combination.

9. The combination of, (1) a furnace, (2) a boiler connected with the furnace, (3) means comprising radiating piping for transferring to air for combustion heat of low temperature exhausted from the furnace and boiler, said means being constructed and arranged to use air pre-heated by the external surfaces of the furnace and boiler and to give the pre-heated air a higher heating with the said heat exhausted from the furnace and boiler, and (4) means for forcing the heated air into the furnace and other means for securing a controlled automatic pressure of the air and gases in the furnace, boiler, and means for transferring heat to air.

10. The combination of, (1) a furnace and boiler, (2) means connected with, and for forcing draft through, the furnace and boiler, (3) means located beyond the exit of the boiler but connected therewith at a level above the boiler for securing back pressure of gas burned in the boiler and furnace, and (4) means exemplified by a weighted lever located at a low and easily accessible level of the combination for regulating the degree of back pressure.

11. The combination of, (1) means connected with a furnace for forcing air into the furnace, (2) said furnace, which comprises a point for the introduction of the forced air, (3) a boiler connected with the furnace, said boiler comprising a point where the heating gases are exhausted, and (4) means other than said first named means for maintaining and controlling forced and back pressures in the furnace and boiler, said elements being substantially impervious to gases at all points except where the air is forced into the furnace and where the heating gases are exhausted from the boiler, the fuel feed and ash doors being impervious to gases when closed, said boiler and said furnace comprising means for preventing a direct free and uninterrupted rising of hot gases from the fuel bed in the furnace to the higher levels of the boiler's heating surfaces and for securing through the coaction of the means for exerting back pressure a slow compressed draft in the furnace and a combustion of all the gases at a level below the heating surfaces of said boiler.

12. The method herein described for generating steam power, which consists in, (1) generating a combustible gas from a non-gaseous fuel, (2) admixing air for combustion with the gas in suitable proportions to secure its complete combustion, said combustion being effected at a place apart from where the gas is generated, (3) burning the admixed air and gas at said place, said steps being performed under separately controlled forced air pressure and back gas pressure, and (4) securing under an automatically controlled continually exerted back pressure the transmission to water of the heat of the burning, forming steam and super-heating the steam, said back pressure being sufficiently exerted to provide for the burning of the air and gas before heat of the burning gas is transmitted to the water, said steps being performed substantially as set forth.

13. The method herein described for generating steam power, which consists in, (1) securing a substantially complete combustion of fuel, (2) securing the transmission of the high degrees of heat of the combustion of the fuel to water under a controlled back pressure of the gases carrying the heat, whereby steam under pressure is formed and the degree of the steam pressure is controlled, (3) securing the transmission of the low degrees of heat of the combustion of the fuel to air for combustion under a controlled back pressure on the gases carrying the low degrees of heat, and (4) using the air thus heated in securing the combustion of the fuel, whereby the low degrees of heat are economized by a regenerative use.

14. The method herein described for generating steam power, which consists in, (1) generating combustible gas from a bed of fuel under a controlled forced air pressure, (2) completely burning the gas generated under a controlled forced and back pressure on the gas equal to or greater than that of the forced pressure used in generating the gas, and (3) generating steam from the burning of gas under the controlled forced and back pressures.

15. The method herein described for generating steam power, which consists in preparing a fuel mass for burning, forcing air at a pressure greater than atmospheric pressure through said fuel mass, burning completely some of the fuel at a low level zone of said fuel mass, and which further con-

sists in restricting the flow of the gases from the fuel burned at the low level zone, in the passage of said burned gases through the high levels of the fuel mass, and which further consists in burning the gas generated in said fuel mass above said low level zone with a controlled amount of air and under a controlled back pressure, and which consists in generating steam by means of the heat of the gas burning, said gas being completely burned before water is heated by heat of the burned gases in the step of generating the steam power.

16. The method herein described for generating steam power, which consists in, (1) gasifying and partly burning fuel with a supply of air controlled as to its pressure and forced through the fuel, thereby producing a compressed gaseous fuel, (2) admixing compressed air with the compressed gaseous fuel and burning the admixed air and gaseous fuel under a back pressure equal to or greater than atmospheric pressure and uninfluenced by an induced suction draft, and (3) transmitting the heat of the burning to water under an undiminished compressed state of the gases produced by the burning of the gases under forced and back pressures.

17. The method herein described for generating steam power, which consists in, (1) gasifying a solid fuel by high heat generated under a controlled forced pressure and a back pressure automatically controlled separately and independent of the forced pressure and controlled separately and independent of pressures generated from the heat developed in the method, (2) admixing air with the gaseous fuel and burning the admixed air and gas under controlled forced and back pressures, (3) transmitting the heat of said burning to water in a step in which the gas heated by its burning under a forced and a back pressure has the compression of the burned gas and air maintained while heat in the burned gas is being transmitted.

18. The method herein described for generating steam in a boiler which consists in, (1) generating a combustible gas and admixing air with and burning the gas at a place apart from the place of generating the gas and at a level below the heating surfaces of the boiler, said burning being effected by a mechanically forced pressure of the air used in the burning of the gas and by a back pressure of the burned gas sufficiently strong to secure the burning of the gas at the said level below the heating surfaces, and (2) transmitting the heat of the burning of the gases through the heating surfaces of the boiler under an undiminished pressure of the gases at all parts of the boiler's heating surfaces.

19. The method herein described for generating steam power, which consists in, (1) burning fuel under a combined forced pressure and a back pressure, (2) transmitting the high heat of the burning to water for forming steam under a combined forced pressure and a back pressure, (3) transferring the low heat of the burning to and heating air for combustion under a combined forced pressure and a back pressure, and (4) using the air thus heated in creating the forced pressure of the first named step.

JOSEPH MOSES WARD KITCHEN.

Witnesses:
BEATRICE MIRVIS,
GEO. L. WHEELOCK.