No. 871,597. PATENTED NOV. 19, 1907.

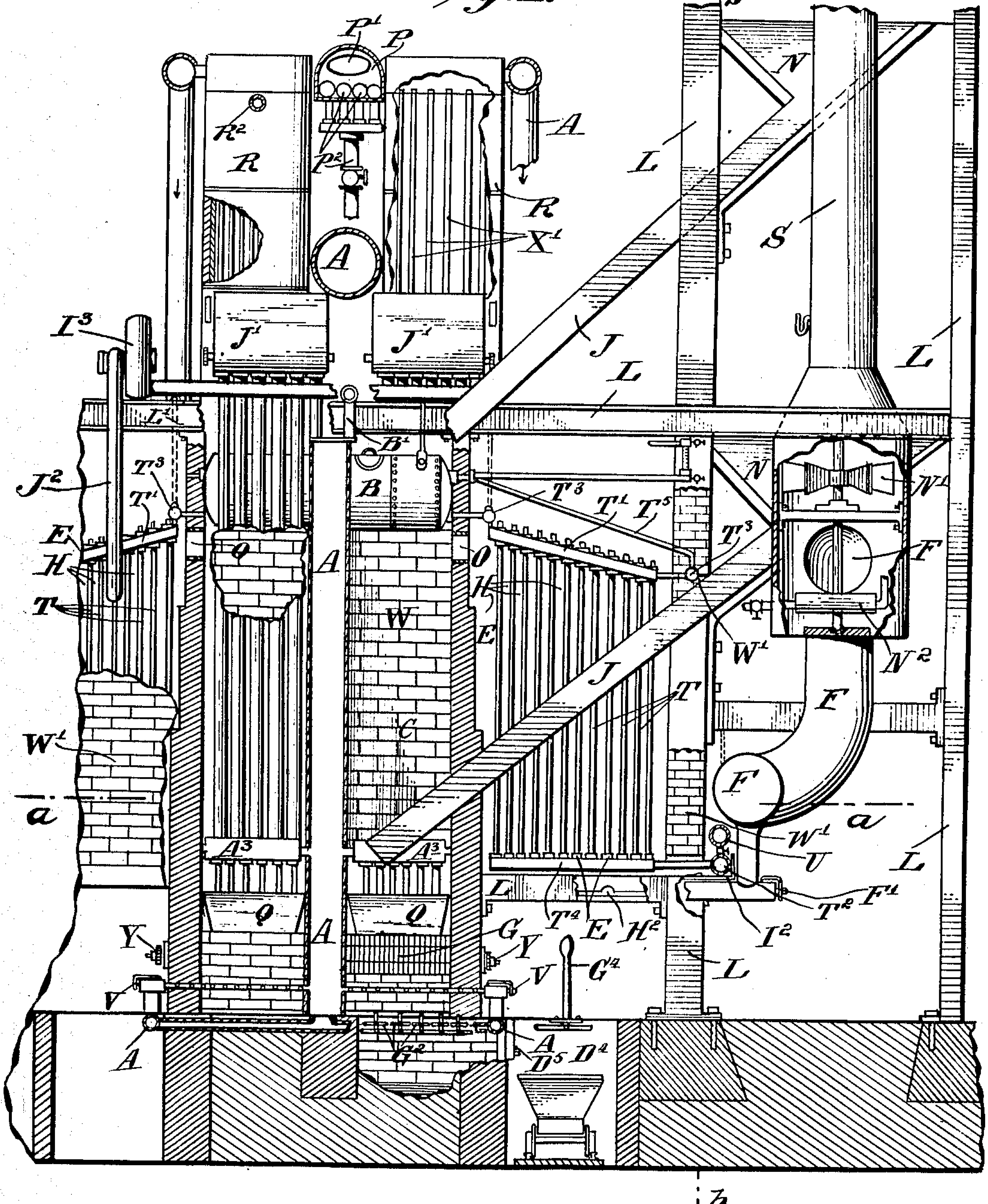
J. M. W. KITCHEN.

COMBUSTION APPARATUS.

APPLICATION FILED MAY 31, 1906.

4 SHEETS—SHEET 1.

Fig. 1.



Attest:

E. C. Mitchell

Olive B. King

Joseph M. W. Kitchen

Inventor:

by Geo. L. Wheelock

Atty

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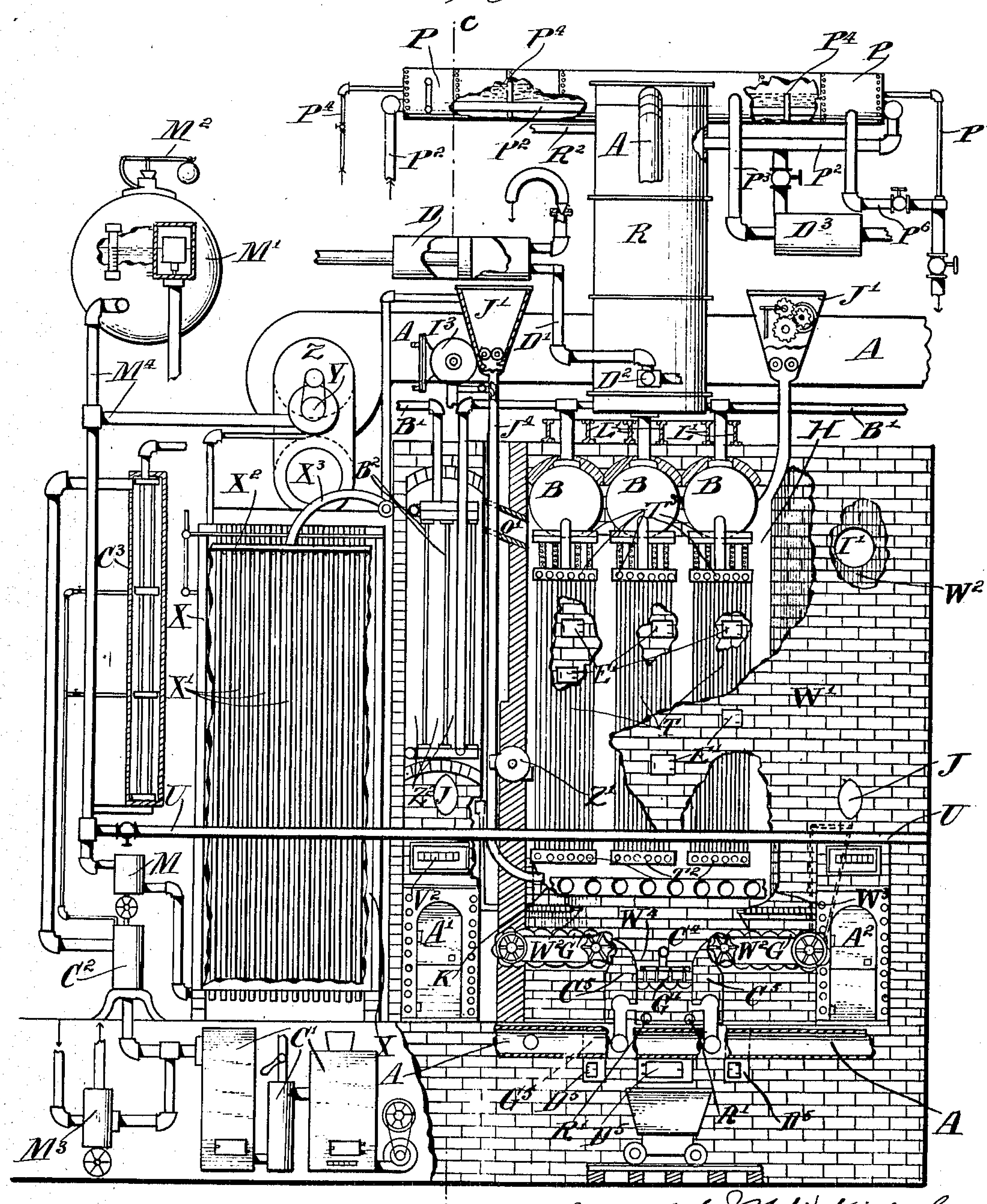
Fig. 2



Attest:

E. A. Mitchell

Clive B. King

Joseph M. W. Kitchen
Inventor:

by Geo. L. Wheelock
Atty

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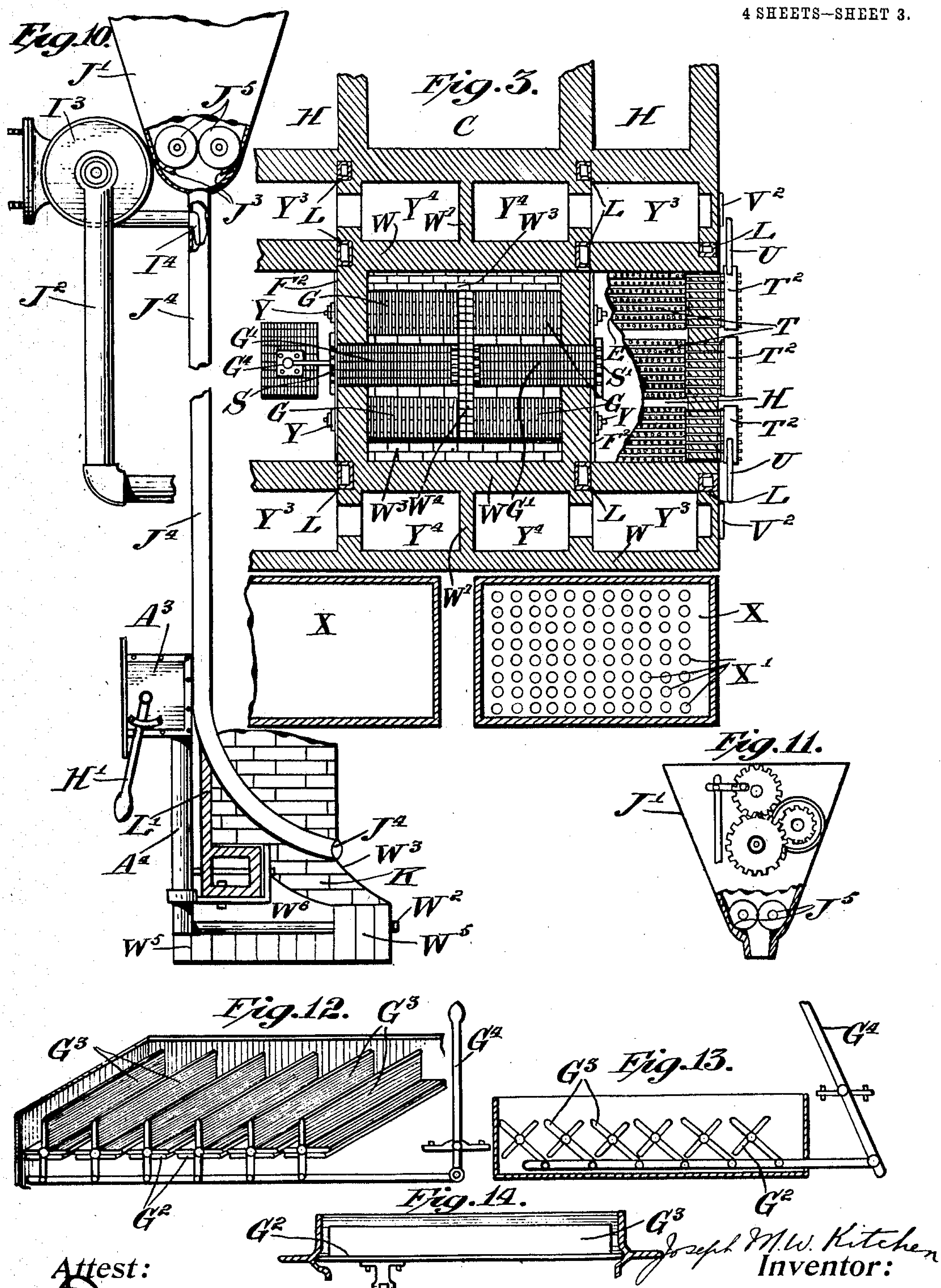

Attest:

E. G. Mitchell

Elise B. King

Joseph M. W. Kitchen
Inventor:

by Geo. L. Wheelock
Atty

No. 871,597. PATENTED NOV. 19, 1907.

J. M. W. KITCHEN.

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4 SHEETS—SHEET 4.

Fig. 6.

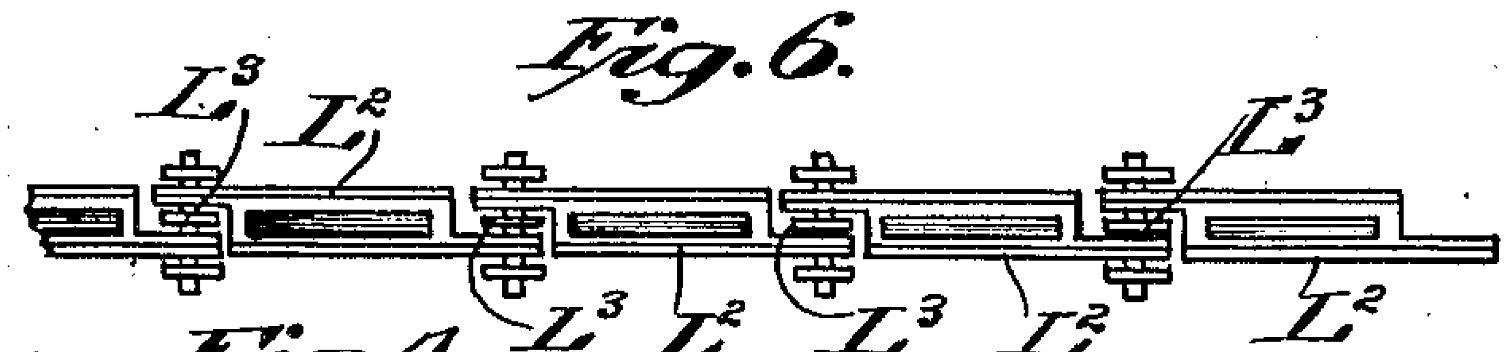


Fig. 5.

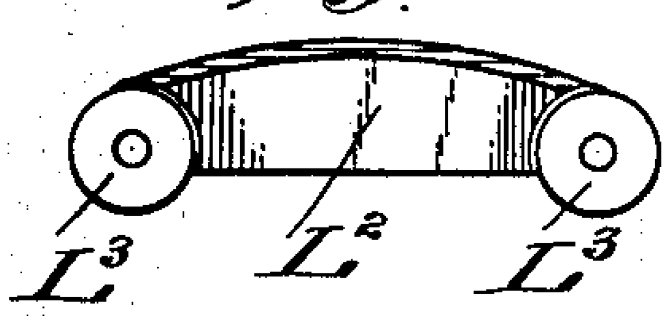


Fig. 4.

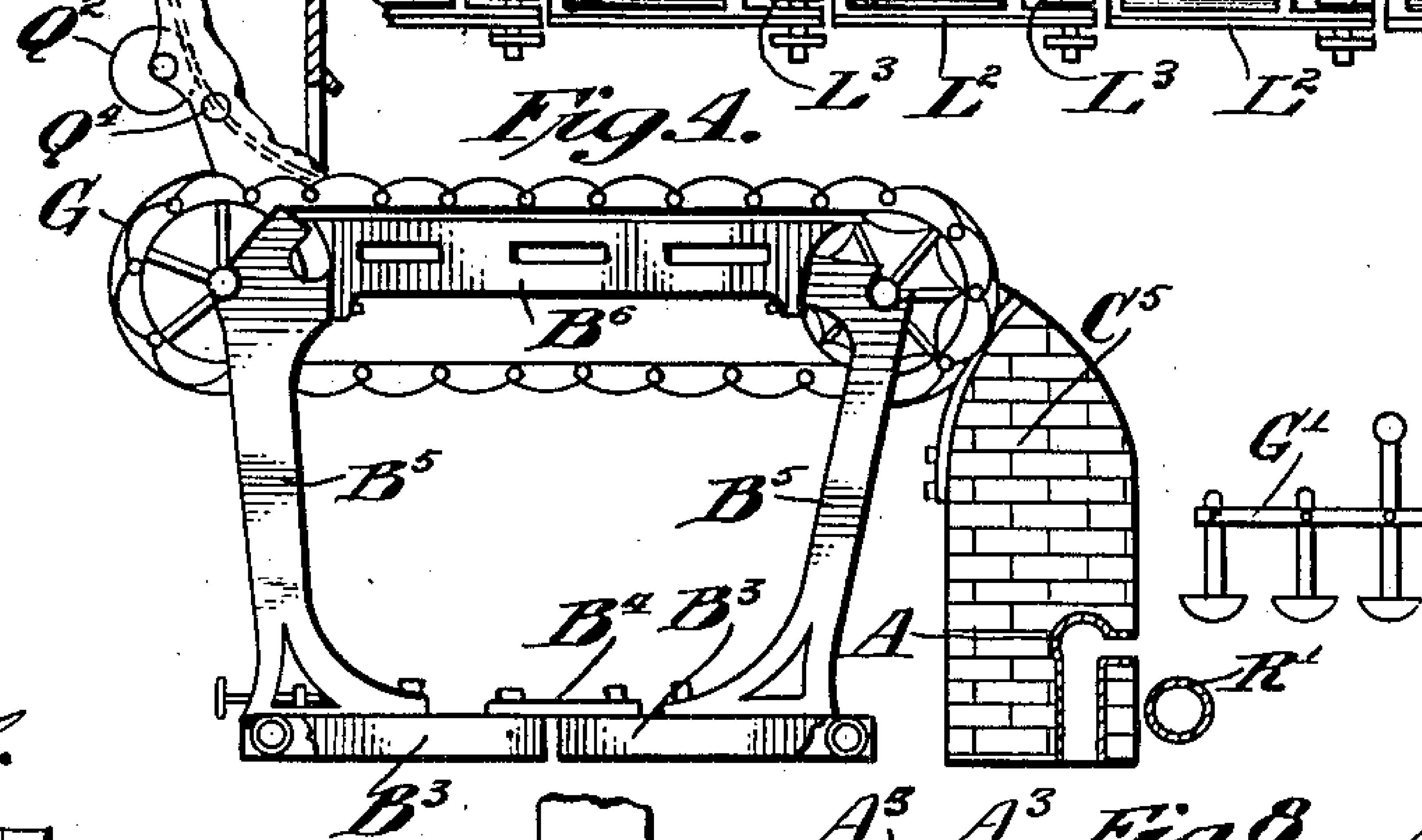


Fig. 7.

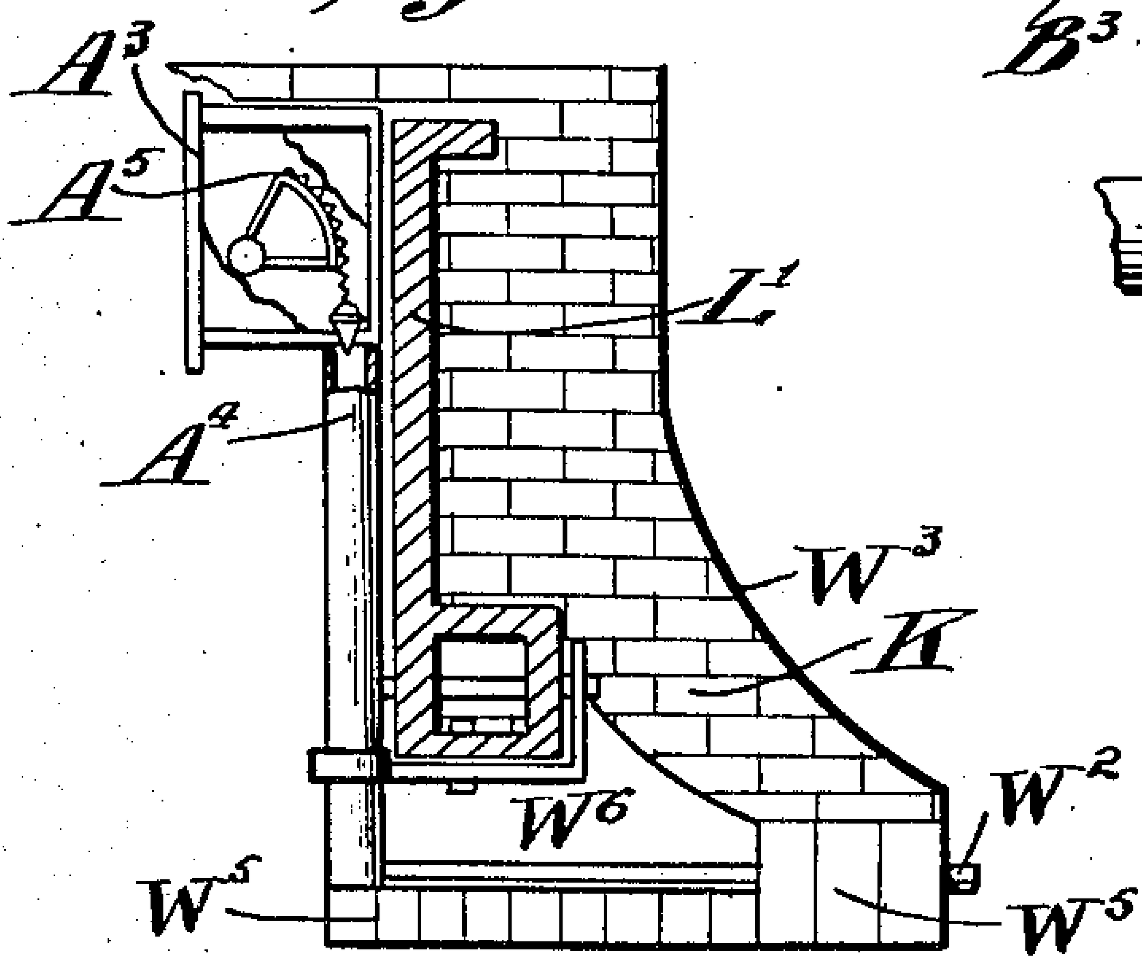


Fig. 8.

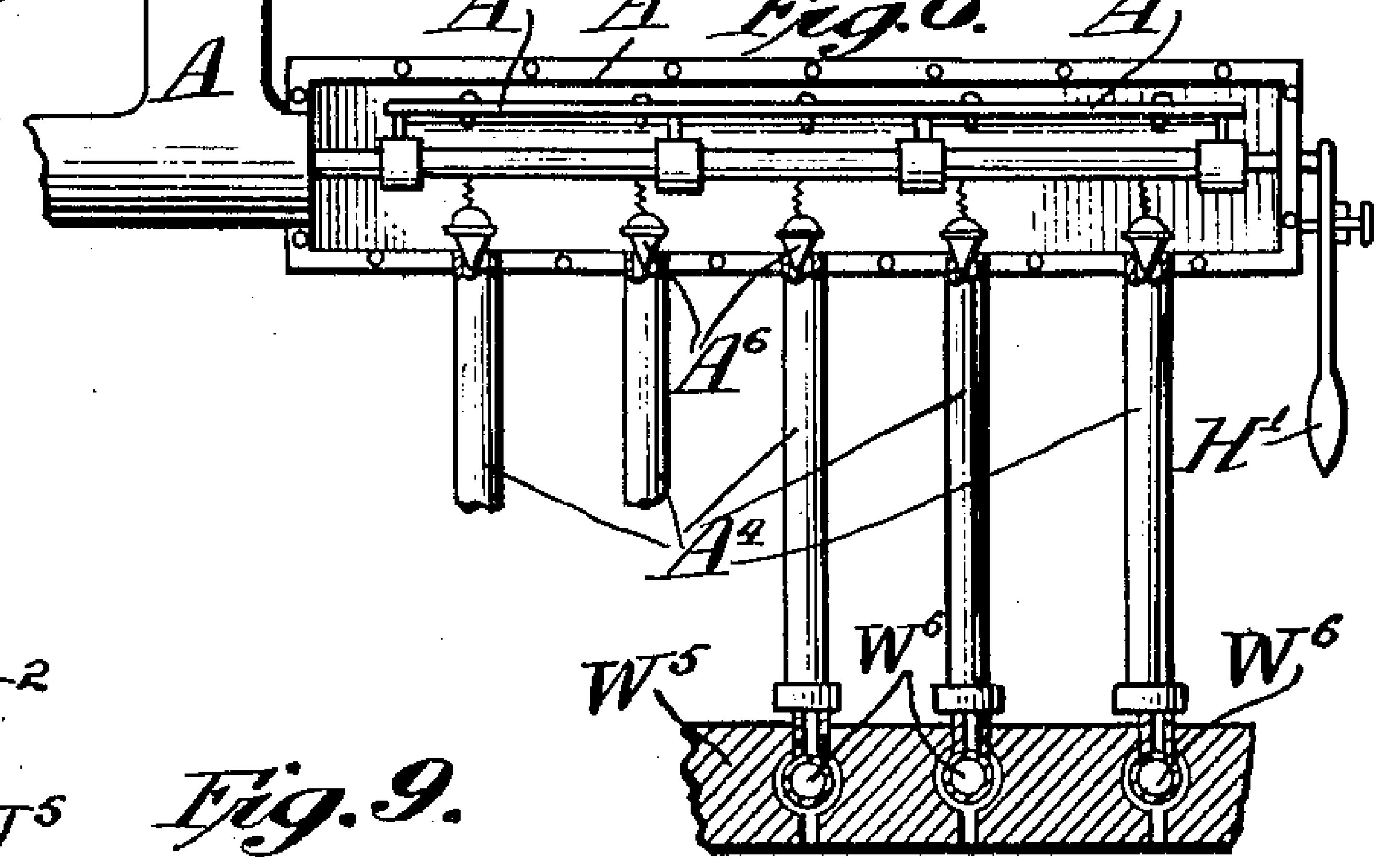
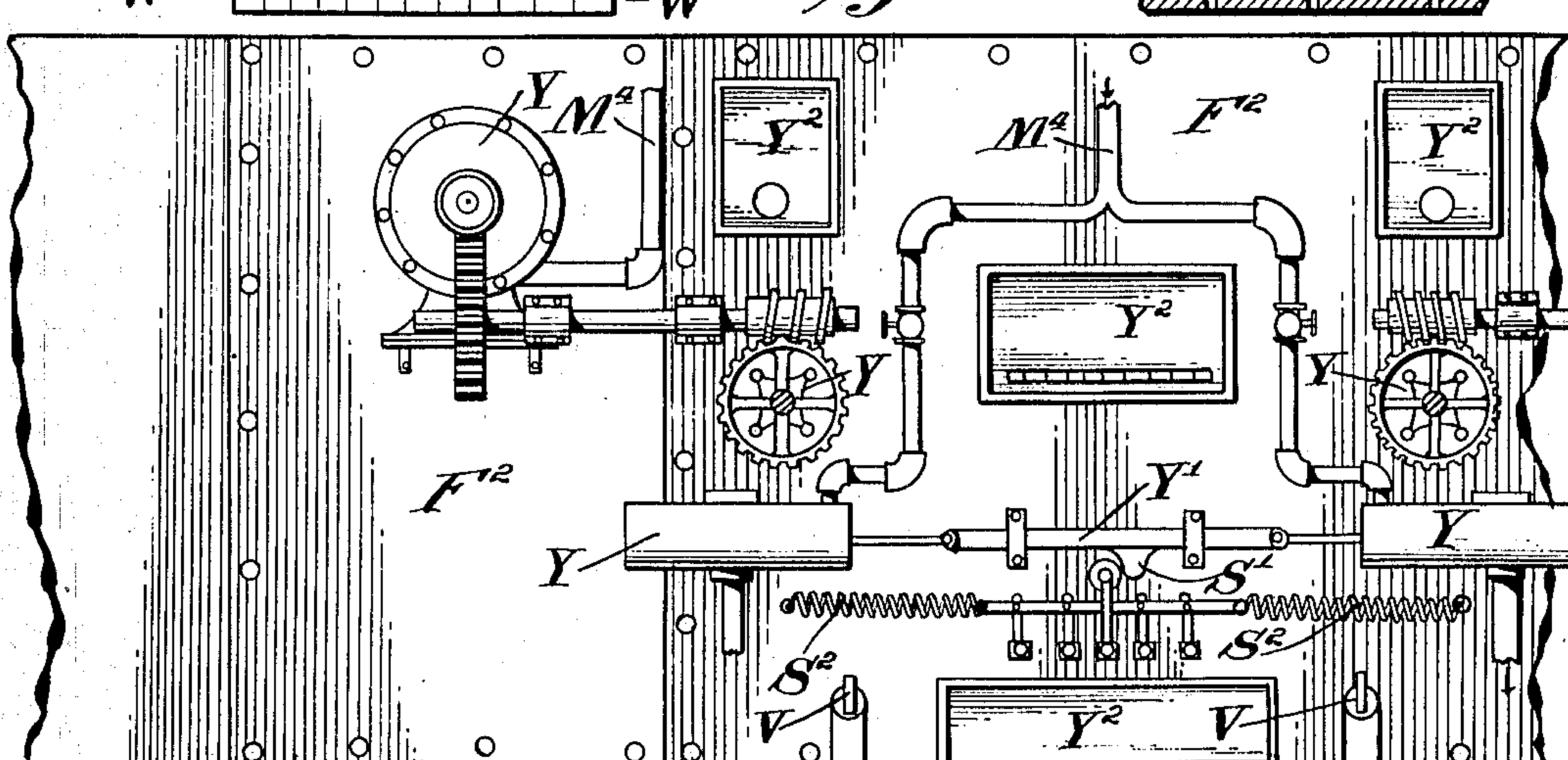


Fig. 9.



Attest:

E. Mitchell

Olive B. Ring

Joseph M. W. Kitchen

Inventor:

by Geo. L. Wheelock

Atty

UNITED STATES PATENT OFFICE.

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

COMBUSTION APPARATUS.

No. 871,597. Specification of Letters Patent. Patented Nov. 19, 1907.

Application filed May 31, 1906. Serial No. 319,584.

To all whom it may concern:

Be it known that I, JOSEPH MOSES WARD KITCHEN, a citizen of the United States of America, and a resident of East Orange, Essex county, and State of New Jersey, have invented certain new and useful Improvements in Combustion Apparatus, of which the following is a specification.

My invention is for the purpose of securing an improvement in combustion processes for creating heat, light and power.

It is specially designed to utilize the less expensive fuels.

It consists of a combination of elements the most prominent features of which are a furnace with a very high combustion chamber having a long run, and mechanically actuated fuel mechanisms located at the bottom of the chamber and at a very high level.

As adjunct to these, and essentially important to the perfect working of the invention as a whole are: a boiler and combined economizer, a combustion engine, a gas producer, a steam super-heater, a system for introducing a compressed power transmitting fluid between the combustion engine and a prime motor, a steam condenser and air heater, a system for actuating motors and the motors used in the generator, means for producing induced and forced draft in correct proportions, a water purifier and evaporator, and various pumps for compressing air, steam and water, and for exhausting.

For convenience of consideration the prominent features of my invention may be described as having two fronts and two sides.

In the accompanying drawings: Figure 1 represents a vertical cross sectional view of my invention, taken from one side and in the line of *c—c* Fig. 2, with parts left out for clearness, is partly in section, and parts are broken away. Fig. 2 represents my invention taken from one front and in the line of *b—b*, Fig. 1, and is a vertical cross sectional view partly in section, with parts broken away, and with parts left out for clearness. Fig. 3 is a horizontal sectional view of my invention, taken in the line of *a—a*, Fig. 1, partly in section, partly broken away, and parts left out for clearness. Fig. 4 is a vertical side view of a chain grate, fuel hopper, and combustion pit wall, comprised in my invention, on a larger scale. Fig. 5 represents a single link of the chain grate and is on a still larger scale, as is also Fig. 6, which represents a series of links joined by bolts. Fig. 7 is an end sectional view of a part of my invention, which is located immediately above the chain grate, and is part of the wall surrounding the combustion chamber; it comprises means for introducing over the fire air for combustion, a fire arch, and a fuel shunting surface. Fig. 8 is a side view of the air introducing means shown in Fig. 7. Fig. 9 represents a metallic plate used in facing the lower front faces of my invention, and having attached thereto fuel introducing and grate shaking motors. Fig. 10 represents a gravity actuating gas-blowing, fuel-dust feeding mechanism. Fig. 11 represents the external mechanism for operating the fuel feeding rolls of the dust feeding hopper shown in Fig. 10. Fig. 12 represents an ash-pan ash discharger with its slats in a closed position. Fig. 14 represents one of the shutter slats of the ash discharger. Fig. 13 represents the slats of the discharger in a partially opened position, allowing the ashes to fall into a closed secondary cavity below it.

The reference characters represent like parts in all the drawings.

The elements of my invention are in and are grouped around a centrally located combustion chamber C Figs. 1, and 3. This chamber has a vertically disposed, very high run. It is surrounded by a heavy brick wall, W, Figs. 1, and 3, built up from a solid foundation, and partly supported by a steel frame L, Figs. 1, and 3. This is lined with fire brick. In the lower part of the combustion chamber are located four chain grates, represented by G, Figs. 1, 2, 3 and 4, and two combustion pits represented by C^4, Fig. 2. These pits have unusual depth and width for holding a very thick bed of fuel, most of the fixed fuel being burned in them with the aid of a forced draft of heated air and some steam. The relative depth of this pit is not adequately shown in the drawings, as the pit is also a wide one to allow of a considerable diffusion of the air for combustion through the grate to avoid the imperfect burning of the fuel due to too rapid a rate of combustion at any one place; but in reality, this pit is always deep enough to hold a deep layer of fuel, and, even when diffused, I provide a sufficient draft to allow for the production of producer gas through this draft, and by simply not introducing air for combustion above the fuel mass. Thus at will in this apparatus I can produce combustible gas at the lower part of the combustion chamber and burn it there; or I can by induction draw the gas away to be used for combustion processes in explosion engines, or for burning in the open air, for heating, reduction processes, etc. A low dividing wall W^4, Figs. 2 and 3, separates the two chain grates and one combustion pit on one front of the apparatus from those on the other front, thus enabling separate observation of the fire surfaces and the stoking management to be in manual reach from either front of the combustion chamber. Underneath the floor line are tunnels D^4, Fig. 1, running parallel with the two fronts, enabling ashes to be drawn into ash cars from the ash door D^5, Figs. 1 and 2. At the top of the combustion chamber C, are suspended shell boilers B, Figs. 1 and 2, from steel beams L^1, which rest on the masonry sides of the walls of the combustion chamber, and which are also connected with the general steel skeleton supporting frame L, Figs. 1, and 3.

At each front of the apparatus and adjoining, the combustion chamber, is a heating cavity H, Figs. 1, 2 and 3, in which are suspended water tube sections E, Figs. 1, 2 and 3, having water tubes T, Figs. 1, 2 and 3, with headers T^1, T^2, T^3 and T^4. These sections are all hung and arranged in their relation to other parts so that any section can be lifted from and removed from the cavity in which it hangs. The interior of any header or tube can be reached and cleansed by removing a screw plug opening into the interior of each. A group of sections is connected with the ends of each of the shell boilers B, and provision for the circulation of water at the head of each section is made by passing down water through the pipe T^5, Fig. 1, through the header T^3, and upward back to the boiler through the header T^1. The cross headers T^2 and T^3 are only of a width equal to each group of sections, and feed water is run into each bottom cross header T^2 from the general feed pipe U, Fig. 1. Valves are placed both at the extreme top and extreme bottom of each group of headers so that if needed the apparatus may remain in commission even if one group of sections may need cleaning or removal for repair. There is no circulation in this boiler as generally understood other than that before noted. Cold feed water is forced in at the bottom of each group of vertical tubes, and is gradually heated in its ascent, most of the steam being disengaged in the shell boilers B. Unlike most other boilers, the best efficiency of this one depends in connection with heat absorption on the lowest possible temperature of the feed water.

The heating cavities extend from the combustion chamber outwardly to the two fronts. These cavities are surrounded by masonry walls W^1, in which cleanout doors E^1 are conveniently located, through which the interior of the cavities may be cleaned with a steam spray. In certain cases I may use a mechanically actuated rising and descending scraper in these cavities. The lowest level of the cavities is at a height above that of the height of a man, for the purpose of allowing the stoking attendant to walk under them and come close to the combustion chamber, the several grates, and to the passage-ways provided at either side of the combustion chamber on the ground level. Access to these passage-ways, which contain fuel hoppers Q, is gained through the doors A^1; and from one front to the other through the doors A^2, which is located in a dividing wall W^7, Fig. 3. The space on both sides of the combustion chamber is divided into two air shafts Y^4, by the wall W^7. To the front of the shafts Y^4 are other shafts Y^3 on either side of the heating cavities.

Under ordinary use when producer gas is not wanted, induced air for combustion is drawn into the shafts Y^3 through the ventilators V^2 Fig. 2 up through the shafts Y^3, to and through the opening I^1, Fig. 2, in the wall W^7, thence down the shaft Y^4 under and up through the chain grates, up through the combustion chamber C, through the gas openings O, Fig. 1, down through the heating cavities H to the lowest levels of said cavities, and thence horizontally through numerous small flues into the larger smoke flue F Fig. 1, to the smoke stack S, Fig. 1. The gases are thus distributed through a number of horizontally placed pipes at the bottom of the heating cavities, in order to get a uniform distribution of the heat in the cavities. Each of these outlets is governed by a piston shaped or other formed valve F^1, all of which may be removed to clean the bottom of the cavities H, and also may be so disposed as to uniformly distribute the outflow of the gas through them. The draft induced is created by the fan N^1 Fig. 1, actuated by its motor N^2. In this invention I use an induced draft accelerator in connection with a natural draft. At the bottom of the stack S is an enlarged chamber with a large disk fan N^1 running on a vertical shaft actuated by a turbine motor N^2 resting upon a multiple ball bearing. The size of this chamber at the bottom of the shaft, and the air spaces in the fan afford easy access of waste gases through the accelerating chamber from the conduit F to the stack S, and hence if enough heat escapes with the gases, the fan is not used, but the draft thus naturally produced can be accelerated at any time by actuating the fan by the turbine motor N^2.

The heating cavities H are surrounded by the brick walls W^1, which are supported in part by the general steel frame L. The bottom of each cavity is inclosed by non-conducting movable slabs having metallic frames H^2 Fig. 1 in the drawings. These can be hinged to allow for their easy opening for cleaning purposes. The headers T^2 are in a trough I^2 Fig. 1 filled with clay dust, which is needed to close the elongated apertures through which the connecting pipes reach the headers T^2 from the headers T^4. The sections E besides being joined to the shell boilers B are partly suspended by chains connecting the headers T^3 with the frame L, and partly by the resting of the headers T^3 on the outer masonry walls W^1.

The tops of the sections at the highest level of the cavities, are covered in with non-conducting material, not shown, as also are the shell boilers B. Coal bins N, Fig. 1, are connected with fuel chutes J, Figs. 1 and 2, which discharge into the hoppers Q, Figs. 1 and 2, which feed on to the chain grates. The chutes J also discharge into the dust feeders J^1, Figs. 2, 10 and 11 the relation not being shown in the drawings. In the apparatus as here shown provision is made for burning bituminous coking coal on the grates in the lower part of the combustion chamber, it being coked in being drawn into the combustion pit C^4. The coked fuel falls into the pit C^4, and is burned there in a thick bed, by the use of a forced draft, introduced under the grate G^1, with or without steam introduced through the pipe R^1, Figs. 2 and 4. In addition to this fuel, anthracite dust or small sized anthracite coal is fed from the top of the combustion chamber from the feeders J^1, motor actuated rolls under control determining the amount fed. The dust dropping through the dust conduit J^4, Fig. 10 along the walls at the sides of the combustion chamber strikes the curved shunting surfaces W^3 of the fire arches K, Figs. 10, 2 and 7, and is shunted towards the combustion pit, being more or less diffused in the rising gases, and is burned in the atmosphere of the combustion chamber, the larger particles of the fuel gravitating to the fuel mass below.

In preferred forms of my invention I gravitate dust from a high level through chutes, such as J^4 Figs. 2 and 10, from a feeder J^1 on the outside of the combustion chamber walls, shunting the dust through a curved part of the chute into the bottom of the combustion chamber over the fuel mass in a diffused manner. This diffused introduction of fine fuel is accelerated by a current of hot gas drawn from an adjacent heating cavity through the conduit J^2 by the blower I^3 through the injection twyer I^4 into the upper part of the feeding chutes J^4. The hot gas thus blown is taken from the level of a cavity in which the gas is of a sufficiently high temperature to dry and heat the coal dust, but not so hot as to damage the blower and conveying conduits. When producer gas is being made in the apparatus, the gas thus used to blow fuel into the lower part of the combustion chamber would be that gas which has lost part of its primary heat to the heating surfaces of the steam generating means connected with the apparatus. The height of the combustion chamber allows for the volatilization of fine dust by the heat evolved in the combustion pit before the dust can be cooled and carried out of the combustion chamber into the heating cavities or flues of the apparatus. In some cases I use the burned gaseous products of combustion containing a large proportion of carbon dioxid for the blowing of fuel into the combustion chamber. Over the fire air for combustion is forcibly introduced through the twyer apertures W^2, Figs. 2 and 7.

The air for forced draft is supplied by the fan Z, Fig. 2, actuated by its motor Y. The air thus supplied is drawn through a preliminary air heater, which is composed of tubes X^1, Fig. 2, which pass through the water tank X. The warm water of condensation is conveyed to the top of this tank X, and is therein cooled by the air for combustion being drawn through the tubes X^1 by the fan Z. As the water cools, it is drawn downward to replace water pumped from the bottom of the tank for boiler feeding and motor actuating purposes. Water of condensation and air from the condenser R, is injected into the top levels of the tank X through the distributing and injecting tubes X^2, which float on the top of the water by means of the connected flexible tubes X^3. The air for combustion is further heated by being forced through the condenser R, Figs. 1 and 2, passing through vertical tubes therein placed, the air entering at the bottom and emerging from the top, being heated by exhaust steam introduced at the top of the condenser through the opening R^2, Figs. 1 and 2. The air, after being heated by the waste steam, is further forced through the air conduits A, Figs. 1 and 2, and is carried into the equalizing distributer box A^3, Fig. 7, through the metallic brackets W^6, and contracted twyer openings W^2, into the combustion chamber, there expanding and blowing the volatilizing gases generated on the chain grates towards the zone of the greatest heat at the center of the combustion chamber. Any excess of heated air not needed for under grate or over fire combustion, escapes through overflow valves not shown in the drawings, and is drawn under and through the chain grates; the amount of air for combustion needed at any point is controlled by valves V, Fig. 1. Much of this heated air is carried to and discharged into the upper parts of the ash pits under the grates of the combustion pits. The air for induced draft is somewhat heated from the radiation from the sides of the combustion chamber in its course up and down through the shafts Y^3 and Y^4. When producer gas is being made in this apparatus, no air supply is allowed to be drawn under the chain grates, the avenues for the entrance of the air thereto being closed.

P, Figs. 1 and 2 represents a water purifier and vaporizer divided internally into compartments by the partitions P^4, each of which is slightly lower than its predecessor so that water introduced at one end of the purifier in gravitating successively over these partitions cannot be diffused backwardly in the line of the travel of the water. Hence the water in each compartment becomes more and more concentrated, and the last compartment contains the largest proportion of earthy salts or other impurities Waste steam is conveyed therethrough in the pipes P^2, passing horizontally from one end to the other; unpurified water is passed through the purifier P, at a level covering the pipes P^2. It enters at the opposite end from the end where the waste steam enters, and its flow is regulated by valves on the inflow and outflow pipes. The outflow pipe is carried to a low level and discharges into a deeply located water seal, not shown in the drawings, to prevent inflow of air being drawn into the vaporizer when a vacuum is created therein. There is space in the vaporizer above the maintained water line, and an exhausting pump D^3, Fig. 2, communicates therewith. When the water in the vaporizer is heated and the pump D^3 is working, vapor arises from the water and is forced into the air heater and condenser R at a level where about the same temperature prevails as that of the vapor introduced. After descending to the bottom of the condenser, any excess of vapor along with air and water of condensation is forced by the pump D, Fig. 2, into the higher levels of the tank X, and to the ash pit pipe R^1 inducing more or less of a vacuum in the condenser R. As the water which enters the vaporizer P through the pipe P^4 progresses towards the other end, it becomes more dense from the accumulation of earthy salts and organic impurities, and which escape ordinarily through the outflow pipe P^5. The whole vaporizer can be internally cleaned by means of the blow-out pipe P^6, and the hand hole P^1, Fig. 1.

D^1 is the conduit for air and water leading to pump D.

D^2, Fig. 1, is the water conduit leading to the pump D, Fig. 2.

C^1, Fig. 2, represents a producer gas apparatus; C^2 represents a combustion engine; M represents a water pump, and M^3 represents a combined combustion engine and compressor for compressing a medium for transmitting power from the combustion engine to a motor. This compressor is used for compressing steam generated from the waste heat of the combustion engine, or for compressing and forcing steam through a super-heater, such as B^2, Fig. 2, in the cavity Z^2, and for forcing said compressed steam into a storage and pressure equalizing inclosed tank, not shown in the drawings. Such a tank would be of ordinary cylindrical type, made of unusually strong pressure resisting sheet metal.

The object of the mechanical compression of steam is to allow of the production of large volumes of steam in the boiler of the apparatus at relatively low pressures and temperature, thus avoiding excessive strain on the boiler and decreasing risks from explosions, and to reuse exhaust steam. The pump M, and its connecting adjuncts leading to a motor, would be of unusually strong construction; but because of the lesser weight of metal, which would be then needed in the general boilers of the apparatus, this related arrangement would be economical. The pump M takes cold water from the bottom of the tank X, and forces it into the main leading to the feed water pipe U, and to the various motors Y, actuating the fuel feeders, draft fans, shakers, and other economizing features. Pressure in the water mains is maintained and equalized by connection through the pipe M^4, Fig. 2, with the tank M^1, Fig. 2, the upper part of which acts as a compression air chamber. This tank is supplied with a safety valve M^2, and with a water level gage and an automatic regulator for keeping the level of the water at a proper height in its relation to the compressed air in the tank. The gas producer C^1, and the engines C^2 and M^3, are connected with ordinary means, not shown in the drawings, for heating water and producing steam by the waste heat of the gas producer and the combustion engines. The steam thus produced may be run in with that produced by the boilers of the apparatus, or it may be equalized in pressure with the steam produced by those boilers, by means of the compressor M^3. The steam super-heater B^2, Fig. 2, is located in a cavity separate from the combustion chamber C of the boiler, but communicating therewith by the passage O^1 at a high level.

Hot gases are drawn through the passage O^1 and down through the cavity Z^2 by means of the inducing fan Z^1, the control of which, through an individual motor, determines the degree of super-heat imparted to the steam passing therethrough, and which is introduced in the bottom of the super-heater and taken out from the top through the pipe B^1. The heated gases, after being drawn through the cavity Z^2 by the fan Z^1, are blown into an adjacent economizing cavity H at a level in which the usual temperature of the heated gases in the cavity H are approximately the same as those passing through the fan Z^1.

In my invention, in economizing waste heat, I practice the principle of introducing the medium conveying the waste heat at a level in the economizer where the temperature of the medium to be heated is approximately the same as the temperature of the medium conveying the waste heat. Thus, in the utilization of the heat of the combustion engine, I lead the hot gases into an economizer at an appropriate level to apply this just mentioned principle, as indicated in the economizer C^3, Fig. 2, where illustrative provision is made to apply such waste heat at several levels.

The super-heater B^2 Fig. 2 is strongly made, to resist high internal pressures, and is not in a position to be damaged by the direct exposure to the excessive heat of very hot gases or flame, as is the case where a super-heater is introduced in a combustion chamber.

Fig. 4 represents a side vertical view of a chain grate G, a fuel hopper Q, and one lateral wall C^5, of the combustion pit C^4, four of which grates are used in the apparatus. The grate is supported on a sectional frame with a bed plate B^3 unitedly held rigid by the splice plate B^4 Two bracketed uprights B^5 are bolted to B^3, and hold the two shafts of the grate. The shaft nearest the pit C^4 has sprocket wheels which run in connection with the chain web. The actuating motor Y, see Fig. 9, is connected with this shaft, and hence the chain web is dragged away from the fuel hopper Q. instead of being pushed from it as in other stokers. This provision allows for a looser chain web being maintained, and hence lessens friction. The sides of the fuel hopper Q are cast in one piece with the supporting bracket under the hopper. The rear side of the hopper Q is hinged at the top to the hopper, and the side is hinged in itself at Q^4. The cam Q^2 pushes the side Q^3 inward, and thus regulates the flow of fuel on to the chain web. Track beams B^6 are bolted to and connect the bracketed uprights, and on these tracks run the wheels included in the chain web. Fig. 5 represents one side view of one chain web link L^2, and the traveling wheels L^3. Fig. 6 represents a horizontal under side view of several of the links and traveling wheels bolted together, with washers outside of the links. The top of the links L^2 are curved in harmony with the circle they travel in being carried around the actuating shaft. This enables the pointed top of the wall C^5 to be constructed close to the curvatures of the tops of the links, and to completely separate the fuel from the chain web and cause it to fall into the combustion pit. A duplicate chain grate and wall being opposite to the one described, and at a regulated distance from it, enables the fuel as it falls from both grates to more or less fill the combustion pit, the level of the fuel therein being regulated by the rapidity with which the chain grates are run and the intensity of the enforced draft acting through the pit, and the activity of the grate shaking mechanism actuating the grate bars of the grate G^1.

Fig. 7 represents the construction of the wall of both sides of the combustion chamber immediately above the chain grates. Heavy steel supporting beams L^1 are carried across and above the chain grates, and support the masonry walls built on them. Metallic brackets W^6 are bolted to the supporting beams. Air cavities run through these brackets, connecting at one end with the air pipes A^4, and at the other end with the twyer openings W^2. Specially formed fire brick W^5 are run between the brackets, resting on curvatures on the sides of the brackets, and form the bottom of the fire arch K. These fire brick protect the metallic brackets from too great heat. Other specially formed brick are built over the brackets, forming the surface of the shunting slope W^3 of the fire arch K. The air tubes A^4 fit in the bottom of the air distributer box A^3, and cone shaped stoppers are hung into the tops of the tubes A^4, and are drawn up or let down by chains run over the partial rim A^5, actuated by a shaft. As the stoppers are more or less lowered, the entrance of air to the air tubes is shut off, and thus the air for combustion can be distributed equally into the combustion chamber C, through the twyer openings W^2. Fig. 8 shows a rear view o the parts shown in Fig. 7. The air goes into the box A^3 through the air conductor A. The handle H^1 raises and lowers the cone shaped stoppers of the lifting air valves A^6. In the same figure W^5 shows the fire brick in section, and W^6 a bracket in section.

Fig. 9 is a front vertical view of the metallic plates F^2, with which are faced the lower fronts of the combustion chamber, and in which are located observation doors Y^2, and to which are attached the motors Y, and the trip spring shaker Y^1. This shaker consists of a horizontal bar which is moved from side to side by reciprocating cylinders on both sides. A spur S^1 on the horizontal bar engages with a lever carried upward from the grate bars. As this spur S^1 is pulled one way after passing the lever a certain distance, the lever is released and is sprung back in place with a quick jerk by the spring S^2, which action dislodges the ashes from the fuel mass in the combustion pit C^4. This jerking action is repeated with each reciprocal passage of the tripping horizontal bar. A rotary motor may be used with this shaker. Water under pressure is carried to the several motors through the water conduits M^4, each of which has an independent valve, the manipulation of which regulates the speed of the motors.

The ash discharger shown in Figs. 12, 13 and 14 is located below the combustion pit

C^4, and divides the ash pit there situated into an upper part and a lower part. G^2 Figs. 12, 13 and 14 are the bed plates of the discharger in a closed position. G^3, Figs. 12, 13 and 14 are ash moving ridges. The discharger is actuated by the handle G^4, Figs. 12 and 13. This ash discharger allows ashes to be drawn from the ashes collected in the upper part of the ash pit at the bottom of the accumulated ashes, where the heat of the ashes has been conveyed upwardly; and allows particles of partly burned fuel, which pass through the grate G^1, to complete their combustion in the presence of the heated air forced into the combustion pit. The cool strata of ashes is sifted through the discharger into the lower part of the ash pit without carrying therewith the hot layer of ashes. G^5 are ash chutes leading from below the chain grates. In this apparatus I force air or other gases from the periphery of the combustion chamber at a level just above the fuel mass of the apparatus in a manner so as to have opposing currents meet in a part of the combustion chamber immediately above the zone of the most intense heat, thereby securing a very quick and complete admixture of the gases at a very low level in the combustion chamber. It is obvious that this principle can be applied in a combustion chamber having a circular form, and having a centrally located place of intense combustion.

In a combustion apparatus of the nature herein described, a great advantage is gained by having an outside source of power generation and providing means for its application to the various motors actuating the grates, draft fans, fuel feeding and other motored parts of the apparatus, through the ability to increase or decrease the rate of combustion in the apparatus by one action in connection with the management of the outside source of power generation. For example: the mere turning of a valve on the delivery pipe from the compressed air and water tank M^1, or the manipulation of the valve supplying gas to the engine C^2, would synchronously control the activity of all the motors in the system pertaining to the combustion process. Hence the rate of combustion in the apparatus can be conveniently varied without producing through derangement any defect in the quality of the combustion process. This advantage is not enjoyed in stationary power plants at the present time; in which plants great derangement in the combustion process is experienced whenever there is a sudden call for a large increase in the rate of combustion to meet exigencies depending upon increase of load in the plant motored by the power generated in the combustion apparatus of the plant.

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

1. In a combustion apparatus having a combustion chamber and two sides, and combined therewith, a coal burning device having two chain grates supplied with fuel from hoppers located at the sides of said apparatus and conveying fuel towards the center of said chamber, said hoppers, a combustion pit at the center of said chamber of large vertical depth and lined with heat refractory material, a shaking and dumping grate for said pit, an ash pit below said combustion pit, means for inducing a draft in said combustion chamber, means for forcing a draft through the fuel in said combustion pit, means for introducing steam under said fuel in said combustion pit, and means for forcing air for combustion in divided currents over said chain grates toward said combustion pit.

2. In a combustion apparatus having a front and two sides and a combustion chamber, the combination of means for securing free access to all parts of the fuel mass from the front of said apparatus, means for the introduction of fuel on both sides of said apparatus and for coking said fuel and for moving the said fuel towards the center of said apparatus, a grate at said center comprising means for shaking and dumping said fuel, means for diffusedly introducing air for combustion around the periphery of the combustion chamber of the said apparatus, means for preventing the escape of gaseous products of combustion through the means for introducing air, means for controlling the supply of air thus introduced, and means for protecting from excessive heat the means for air introduction.

3. In a combustion apparatus, the combination of a combustion chamber having an elongated vertically disposed run of sufficient height to secure the combustion of coal-dust and of volatilized gases before said dust and gases are brought into contact with heat absorbing surfaces and before said dust can be carried out of said combustion chamber, a mechanically acting fuel feeding grate, means for feeding fine fuel into said chamber from a high level, means for securing the diffusion of said fine fuel in the atmosphere of said chamber and over said grate, said grate being located at a low level of said chamber, said elements acting in harmony with the force of gravity in securing the said distribution of fuel in the passage of said fuel from the high level from which said fuel is fed, and means for forcibly introducing air for combustion under and above said grate and for drawing gases over the heating surfaces of a boiler.

4. In a combustion apparatus having a front and two sides and a combustion chamber, first, means for storing fuel at the two sides of said apparatus, second, means for drawing fuel from the two sides of said apparatus towards the center of said combustion

chamber and for volatilizing said fuel, a combustion pit at said center surrounded at the sides of said pit by heat refractory fuel retaining walls, means for preventing the loss of fuel by sifting through said second named means, means for separating said fuel from the second named means and for securing its entrance into the said pit, a grate in said pit, means for shaking and dumping said grate, means for forcibly introducing air for combustion under said grate through said pit and over the several named means and for drawing gases over the heating surfaces of a boiler.

5. In a combustion apparatus having a combustion chamber, the combination of means for drawing fuel from a side of said apparatus and for volatilizing said fuel and for discharging said fuel into a place of combustion, said place of combustion providing for the maintenance of a thick bed of fuel and for the shaking and dumping of said fuel, means for forcing a draft through said thick bed of fuel, means for feeding fine fuel diffusedly into the atmosphere of said combustion chamber and over the fuel being drawn to said place of combustion and over said thick bed of fuel by the action of gravity operating on said fine fuel in descending from a fuel feeder highly located to the lower part of said combustion chamber, and through deflection and through the aid of air forcibly introduced at the side of said combustion chamber, said highly located fuel feeder, means for producing a forced draft above and below said bed of fuel comprising means for forcibly introducing air at the side of the combustion chamber, means for producing an induced draft in said apparatus, means for distributing the air introduced equably in said combustion chamber, and means for securing an equable horizontal diffusion of the heating gases over all levels of the heating surfaces of a boiler.

6. In a combustion apparatus, the combination of means for making so-called producer gas comprising a deep combustion pit and a high run combustion chamber, said combination including means for diffusedly introducing fine fuel into said apparatus by blowing said fine fuel over a gas producing heat engendering mass of fuel automatically fed, means for automatically feeding said last named fuel said blowing being accomplished with a gas free of uncombined oxygen, such as carbon dioxid and other gaseous products of combustion, for securing a fuel diffusion in the atmosphere of said means and for avoiding explosion.

7. In a combustion apparatus, the combination of means for making so-called producer gas comprising a deep combustion pit and a high run combustion chamber, said combination including means for diffusedly introducing fine fuel into said apparatus by blowing said fine fuel over a gas producing heat engendering mass of fuel automatically fed, means for automatically feeding the last named fuel, said blowing being accomplished with a gas free of uncombined oxygen, such as carbon dioxid and other gaseous products of combustion, for securing a fuel diffusion in the combustion chamber of said first named means and for avoiding explosion, and means for securing a diffused fuel feeding in said apparatus by a high drop of said fuel from a fuel feeder.

8. In a combustion apparatus, means for making a combustible gas, said means comprising a grate for burning soft bituminous coal having a high percentage of easily volatilized gaseous elements, means for supplying and accurately controlling the amount of air supplied under said grate and above the fuel mass of said apparatus, means for containing burning and baking a thick fuel mass in making said gas, means for conveying said gas to a high level and for absorbing heat from said gas by first applying said gas to said heat absorbing means at said high level and progressively applying said gas at progressively lower levels cooling said gas in the progressively downward travel of said gas, and means for an exit of said gas at a low level, said last named means comprising provision for conveying a cold fluid through said means from a low level to a high level, said cold fluid in its progress upwards gradually absorbing heat from said gas and cooling said gas.

9. In a combustion apparatus, the combination of a grate, a cavity under said grate, a second cavity containing a gas of a lower temperature than that of the highest temperature of the gases in said apparatus, means for drawing gas from the second named cavity and conveying said gas to the cavity below said grate for keeping said grate cool and for modifying the intensity of the rate of combustion and for effecting a diminution in the average temperature of the gases formed in said apparatus through an augmentation of volume of newly formed heating gases and yet not changing the chemical character of the gases, means for effectively absorbing the diluted diminished heat of the augmented volume of gas, said last named means comprising an economizer, and means for controlling the amount of gas thus used to augment the volume of gas and for diminishing the temperature of said gas.

10. In a combustion apparatus having two fronts and two sides, the combination of a combustion chamber having an elongated vertical run and having heat refractory walls, fuel grates at a low level of said chamber, accessory fuel feeders at a high level of said apparatus for the gravity feeding of fuel, a steam producing device at the top of said chamber, two heating cavities located adja-

cent said chamber and extending to the front of said apparatus, said cavities extending downward to a level slightly above the altitude of a man to allow the furnace attendant to have free access to the fronts of said combustion chamber, air conveying passages or shafts at the sides of said apparatus for conveying induced air drafts over the radiating sides of said apparatus, means for inducing a draft through said air passages combustion chamber and cavities, and means for forcing a draft under and above said grates.

11. In a combustion apparatus, the combination of a combustion chamber, a horizontally moving grate drawing fuel from a hopper to a place of combustion, said hopper, said place of combustion, means for inducing a draft in said apparatus, means for forcing a draft through said place of combustion, means for controlling the induced draft passing under and through said horizontally moving grate, and means for controlling the amount of air being forced through said place of combustion, said combination being constructed to vary at will the rate of combustion being carried on in the fuel in said place of combustion, and to secure a very intense rate of combustion therein while only the volatilization of hydrogen gases is secured in the coking of the fuel that is being conveyed from said hopper to said place of combustion.

12. In a combustion apparatus, the combination of a combustion chamber a grate for burning fuel, means for diluting hot gases of combustion from said fuel with cooler gases and for reducing the temperature of the hotter gases, and means for economizing the heat given to the cooler gases in the diluting processes through the progressive application of the combined gases of average lower temperatures to heat absorbing surfaces having appositely to said surfaces a fluid traveling in a reversed direction from that traveled by the combined hot and cooler gases.

13. In a combustion apparatus comprising a combustion chamber of sufficient vertical extent for the burning of coal dust and having a fuel burning grate at its lowest level and having an adjacent heating cavity and accessory fuel feeder at a high level, means for conducting fine fuel from said feeder downwardly and into a lower level of said combustion chamber, means for drawing hot gases from said cavity and injecting said gases into the top of said last named means said gases being as hot as the drawing and injecting structures will withstand without damage, for accelerating the motion of the fuel fed from a high level, and for heating and drying said fuel, and for diffusing said fuel in said combustion chamber.

14. In a furnace, the combination of two chain grates conveying fuel to a centrally located combustion pit constructed and arranged to contain and burn a thick bed of fuel, said combustion pit, means for forcing an air draft through said combustion pit, means for inducing a draft in said furnace, means for shaking the fuel in said pit for freeing said fuel from ashes, an ash pit, and means for removing ashes from said ash pit without disturbing the draft forced through said combustion pit and for heating the air of the draft forced through said combustion pit.

15. In a combustion apparatus, the combination of (1) a vertically elongated combustion perfecting chamber having heat refractory side walls, (2) means located at a low level of said combustion chamber for moving fuel from the sides of said apparatus, volatilizing said fuel, and discharging said fuel into a place of combustion for fuel below said level in the center line of said chamber, (3) said place of combustion, said place having heat refractory walls and being arranged for the maintenance of a thick bed of fuel, (4) means for feeding fine fuel into the lower part of said combustion chamber from a level high in its relation to said apparatus, for securing through the momentum acquired by a long drop, a diffused introduction of said fuel into the said chamber, (5) means for assisting said diffusion by blowing said fine fuel with a gas of a selected temperature, (6) means for forcing a draft through the fuel in said place of combustion, (7) means for introducing steam through said fuel, (8) means for forcing a draft of air for combustion over the fuel introduced by said second named means from opposite sides of said combustion chamber for the impact of currents of air thus introduced at a low level and over said place of combustion and for regulating the supply of air thus introduced, (9) means for mechanically inducing a draft in said apparatus, (10) means for securing the absorption of large volumes of heat of low degrees of temperature in said apparatus, (11) means for securing the regenerating economization of the latent heat of the steam produced in said apparatus after said steam has expanded in passing through a motor, and (12) means for exploding gases, (13) means for compressing a power transmitting medium and for using said medium in transmitting power to means for actuating the fuel-moving, draft producing, pumping and compressing devices of said apparatus, and (14) said devices.

16. In a combustion apparatus having a combustion chamber and having provision for an approach to and access to the two fronts and two sides of the combustion chamber of said apparatus, the combination of (1) means for said access and said approach, (2) means for storing fuel on both sides of said apparatus, (3) means for receiving and burning a vertically thick or deep bed of fuel, said third named means being located in line with the center of said combustion

chamber and being constructed to substantially prevent the lateral transmission of heat generated in said third named means, (4) means for transferring fuel from said second named means in a thin horizontally disposed and horizontally moving layer into said third named means without substantial escape of fuel from below or at the sides of said third and fourth named means and comprising provision for pulling said fuel from said second named means to said third named means, (5) means for automatically giving a short, quick, regularly interrupted shaking motion to said fuel for keeping said fuel substantially continuously free from ashes, (6) means for forcing air for combustion through said thick bed of fuel, (7) means for forcing air for combustion or other gases in divided currents at distributed intervals over said third and fourth named means, and (8) means for separately and accurately controlling the amount of any gas introduced into said apparatus that may affect the combustion process in said apparatus.

17. In a combustion apparatus, the combination of a combustion chamber having a high vertical run, and heat refractory, non-conducting lateral walls, means for producing at will at the bottom of said chamber a combustible gas, and for burning said gas in said chamber, means for securing the economization of the heat of said gas for the production of steam, and for the super-heating of steam by conveying hot gas and applying said gas from a high level to a low level, and for controlling the amount of gas thus produced and conveyed, means for preventing radiation by surrounding said chamber by heat economizing cavities, means for utilizing the naturally induced draft in said apparatus, and accelerating said natural draft by the action of a mechanism for inducing a draft and yet not interfering with the passing of said gases through said mechanism when acting under the influence of the natural draft, said mechanism for inducing a draft, means for producing a distilled vapor by a counter-current of waste steam passed through a current of water, and for utilizing said vapor in the replenishment of steam used in the said apparatus, means for the primary heating of air for combustion with hot water of condensation and for the secondary heating of the same air with exhaust steam, means for utilizing exhaust steam in modifying the combustion process in said pit, means for exploding gas and for compressing steam, air and water, and for utilizing exhaust heat by its economizing absorption at any selected level in the economizing cavities in the said apparatus, means for utilizing compressed steam through its use in actuating motors, and means for securing the complete combustion of the fuel sifted through the grates of said apparatus, and for preventing the loss of heat in the ashes of said fuel.

18. In a combustion apparatus, the combination of means for supplying fuel from two sides of the apparatus, means for drawing fuel from two sides to the center of said apparatus and for burning said fuel in a thick mass at said center, means for supplying an appropriate supply of air for effecting the combustion of said fuel in a thick mass, and means for intermittently shaking said fuel mass for clearing the ashes therefrom.

19. In a combustion apparatus having two fronts and two sides, the combination of means for gaining access to the full width of the lower part of the combustion chamber along the said fronts of said apparatus said combustion chamber, means for supplying fuel from the two said sides of said apparatus, and a grate, said grate comprising mechanically actuated automatic means for the coking of fuel, for the burning of the fuel when coked, and for keeping the fuel free from ashes.

20. In a combustion apparatus having two fronts and two sides, the combination of a combustion chamber, a combustion pit for a thick bed of fuel, means for forcing air for combustion through said thick bed of fuel, means for coking fuel with the radiant heat of the burning fuel in said apparatus, automatically acting means for keeping said fuel mass free from ashes, means for preventing the lateral loss of heat from said fuel in said pit, means for preventing sifting of unburned fuel to a place outside of the place for burning fuel in said combustion apparatus, means for supplying fuel at the two sides of said apparatus, means for drawing said fuel from the two sides of said apparatus to the zone of the greatest intensity of heat in said apparatus and for securing the combustion of said fuel both in solid and gaseous state at said zone of most intense heat, first at a low level and then progressively in a rising current over said zone, means for facilitating the dismemberment and removal laterally through said two sides of the parts of said element for conveying fuel.

21. In a combustion apparatus, the combination of means for heating air with the heat of waste steam and hot water of condensation, and means for using said heated air in said apparatus for economically improving combustion in said apparatus said means comprising a storage reservoir for storing a deep body of water of condensation and for transferring the heat in the water stored in said reservoir to said air on the principle of heating said air progressively in its progress through said water, and for losing the heat in said water progressively to said air.

22. In a combustion apparatus, the com-

bination of means for heating air with waste steam and the hot water of condensed steam, and for using air thus heated in said apparatus, said air being first heated with the heat of the hot water of condensation at a low level and then heated with the heat of said waste steam at a higher level, and means for conveying waste steam through the burning fuel in said apparatus, said elements assembling and all co-acting in the improvement of combustions and economizing fuel in power production or for heating.

23. In a combustion apparatus, the combination with a combustion chamber of (1st) means for conveying waste steam and air vertically in counter currents for progressively heating air for combustion and progressively losing heat from said waste steam to said air, (2) means for heating and vaporizing water with waste steam, and (3) means for taking the warm vapor produced in said first and second named means and compressing the same and conducting said compressed vapor under and into the burning fuel in said apparatus, said elements co-acting for the production of an economical combustion.

24. In a combustion apparatus, the combination of a combined steam condenser and air heater, means for drawing air through said condenser and air heater for heating said air and for using said air when heated for processes of combustion, and means for drawing steam and vapor from said condenser and for passing said steam and vapor through a bed of burning fuel.

25. In a combustion apparatus, the combination with a combustion chamber of means for heating air for combustion in said apparatus, said means comprising, (1st) a part for storing the water of condensation and waste steam and for passing air therethrough for the primary heating of said air, and (2nd) a part for passing air through uncondensed waste steam for the increased heating of said air, and means for employing vapor from said second named part and forcing said vapor through the fuel mass in said apparatus, for the production of an economical combustion.

26. In a combustion apparatus, the combination of a deep fire pot for holding a thick mass of fuel, means for forcing air for combustion through said thick mass of fuel, means for continuously introducing fuel into the combustion chamber of said apparatus from the side of said chamber and for conveying said fuel to and discharging said fuel into the top of said deep fire pot, and means for introducing a horizontally directed supply of air above and across said fire pot and for controlling the amount of air thus introduced, and for entirely preventing such air introduction when desired, said elements co-acting to secure a perfected combustion and to prevent undesirable air dilution of the gaseous products of combustion.

27. In a combustion apparatus, the combination of a combustion chamber, a place of combustion centrally located in said apparatus and comprising a deep fire pot, means for separately forcing an intense rate of combustion through said fire pot and for also regulating another rate of combustion in said combustion chamber in places apart from said centrally located place, and means for forcing gases from the periphery of said combustion chamber at a low level towards the center of said combustion chamber to the fuel mass at said center and immediately above the said centrally located place of combustion for the intimate intermingling of air and gases of combustion at a low level in said combustion chamber and for protecting structure that would be destroyed by too intense heat.

28. In a combustion apparatus, the combination of a combustion chamber and a grate, a storage reservoir for a fluid, and a system for actuating the motor elements of said apparatus, said system comprising a motor and pressure pump, said pump drawing fluid from said reservoir and directing it to said motor, pipes leading from said pump to a fluid and compressed air storage tank, said tank, a pipe connecting said tank and a motor actuated element for actuating said element with the fluid stored under pressure in said tank and delivered under pressure to said actuated element, said motor actuated element, and means for conveying fluid from said last named element to said storage reservoir, said elements co-acting in the economical production of a perfected combustion in said apparatus.

29. In a combustion apparatus, the combination of a combustion chamber and a grate, means for producing explosive gases, means for exploding gases, means for transferring the power created by explosion to a power transmitting elastically expansible medium and for distributing said power through said medium to means for actuating the moving parts of said apparatus, said means for actuating said moving parts, said named combination being for the equalization and distribution of the power generated by explosion and for actuating motors used in connection with gaining an economical perfected combustion in said apparatus, said combination being exemplified by a system comprising a producer gas generator, a combustion engine, a water and compressed air tank, motor actuated fans, shaking grates, air heating means, and means for forcing steam through the burning fuel.

30. In a combustion apparatus, the combination of a furnace having a high run combustion perfecting chamber to give time and space for the perfection of combustion be-

fore the heating gases are brought in contact with heat absorbing surfaces, means for a diffused overfire air introduction, means for economizing low degrees of heat from the heating gases, the heat economizing absorbing features of said apparatus being separate from said combustion perfecting chamber, a grate, said grate comprising means for coking fuel at the sides of said grate and for moving said fuel towards the center of said grate and for shaking said fuel at the center of said grate, and means at the front of said apparatus for securing free access to the entire width of said grate in the management of said apparatus.

31. In a combustion apparatus, the combination of a combustion chamber, a motor actuated grate, a draft producing fan, other motor devices pertaining to said apparatus, and means comprising provision for independently generating power and for supplying the power thus generated to all the motor driven parts of said apparatus and for controlling from said means the rate of combustion produced in said apparatus through synchronous action of the motor driven devices.

Signed at New York, N.Y. this 29″ day of May 1906.

JOSEPH MOSES WARD KITCHEN.

Witnesses:
OLIVE B. KING,
GEO. L. WHEELOCK.