No. 883,809. PATENTED APR. 7, 1908.

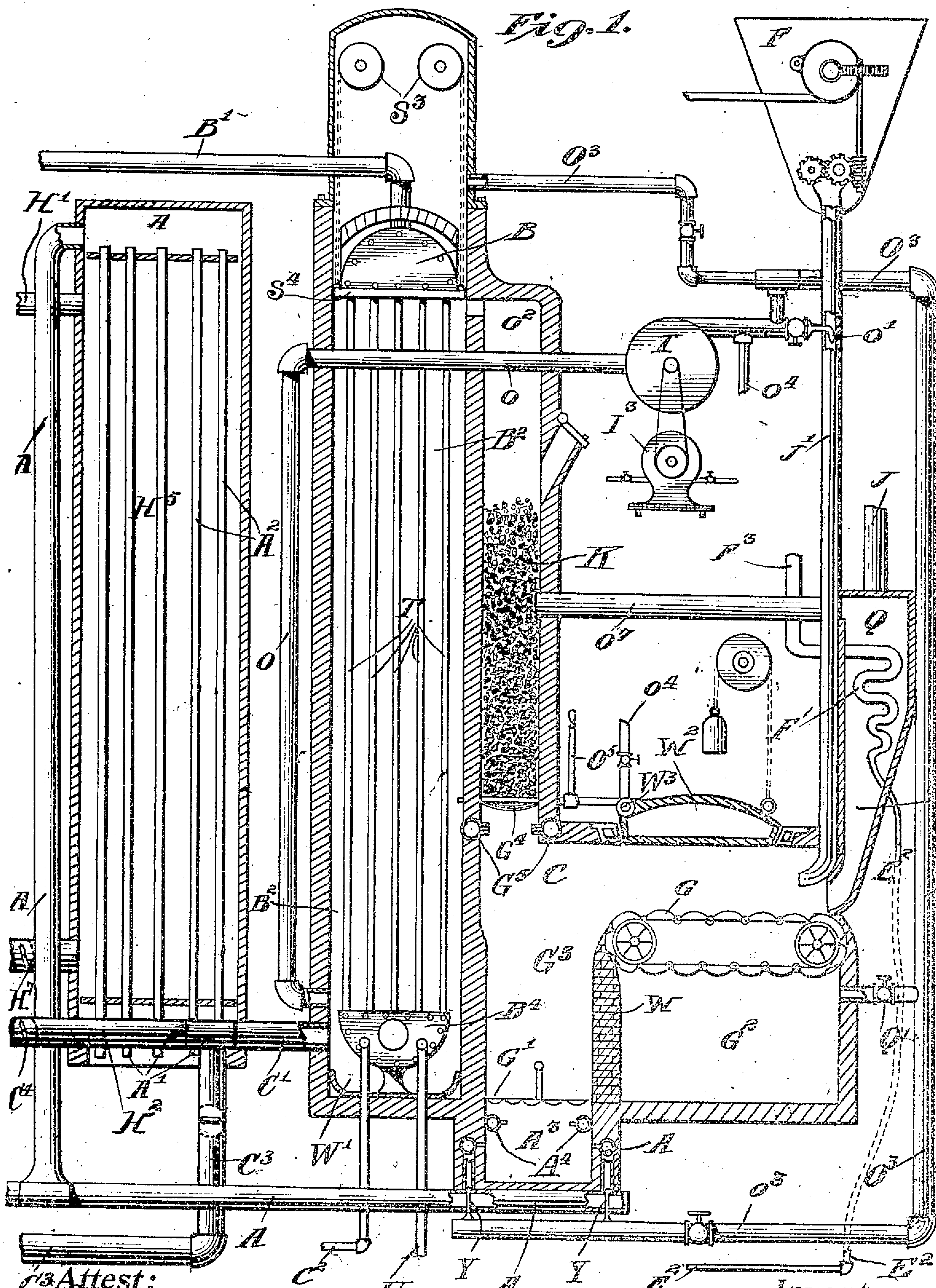
J. M. W. KITCHEN.

POWER GENERATING SYSTEM.

APPLICATION FILED JUNE 2, 1906.

3 SHEETS—SHEET 1.

Fig. 1.



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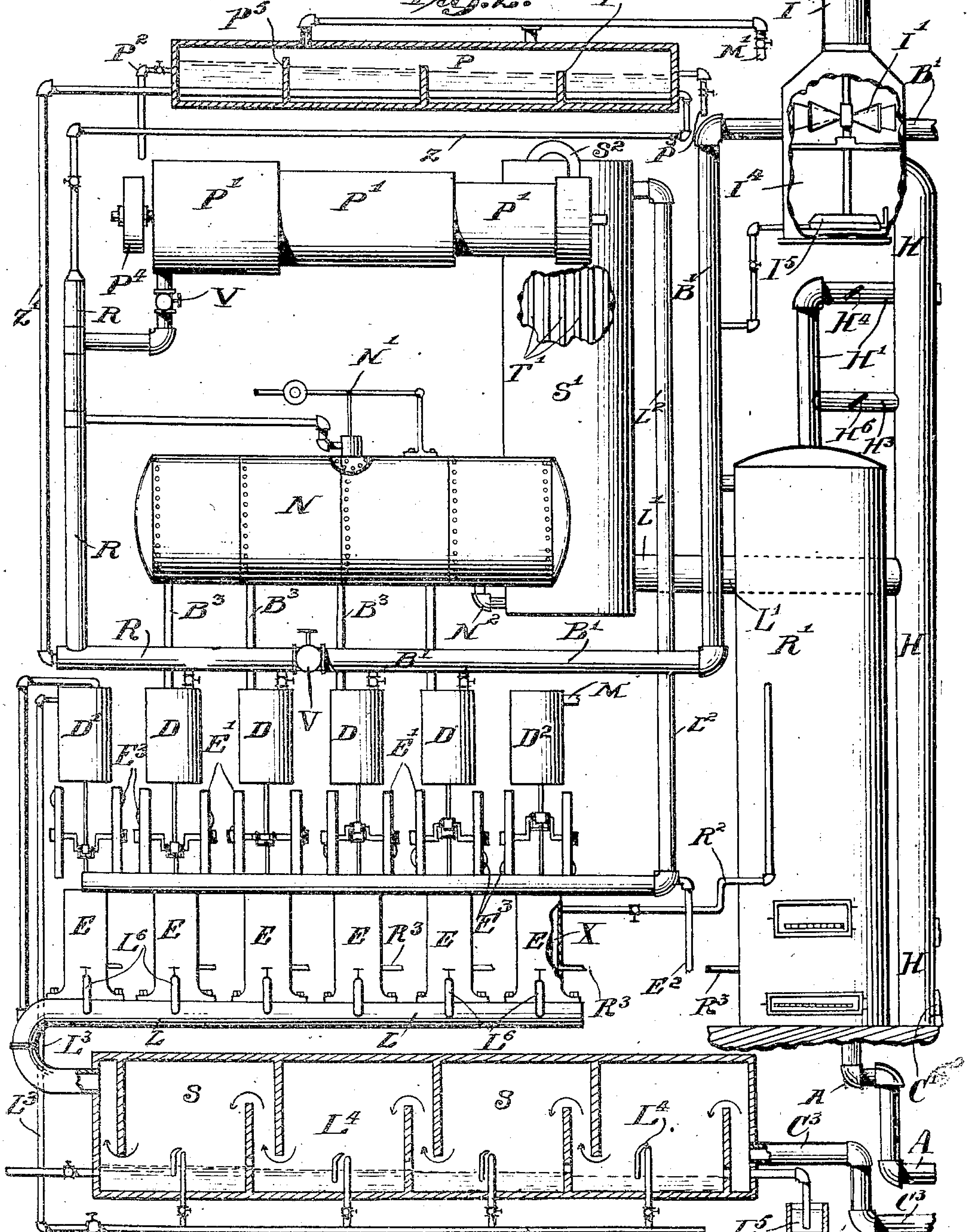
3 SHEETS—SHEET 2.

Fig. 2.



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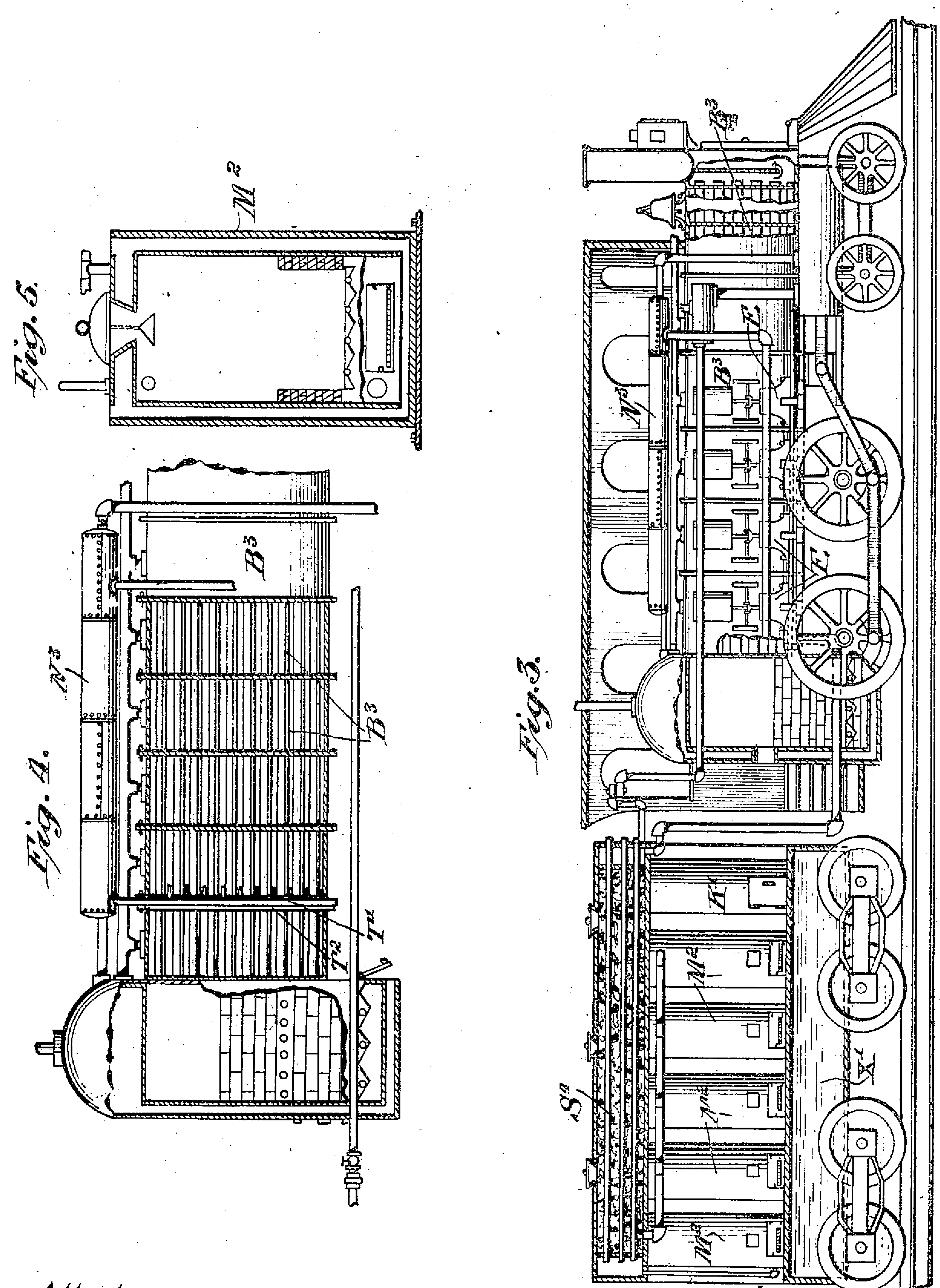
3 SHEETS—SHEET 3.



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UNITED STATES PATENT OFFICE.

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

POWER-GENERATING SYSTEM.

No. 883,809. Specification of Letters Patent. Patented April 7, 1908.

Application filed June 2, 1906. Serial No. 319,373.

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 Power - Generating Systems, of which the following is a specification.

The object of my invention is to secure economy in power generation by preventing wastes in various lines that have been common in power generators.

In carrying out the purpose of the invention I apply both the expansive force of gas explosion and of steam generated from the heat of explosion. I also use steam produced from the heat of gas generation. I interpose between the force of gas explosion and the motor to be actuated an intermediate elastic heat absorbing medium, such as steam, air or other gas singly or admixed with vapor or steam, and after this interposed power transmitting means has passed through the motor and become expanded, I recompress the power transmitting medium using it in a circuitous round. In this way I render the explosive force of gases more tractable when used in power transmission; and inasmuch as I generally use steam as the power transmitting medium, I secure the advantages which pertain to the use of steam as a motive agency, and yet secure the force of explosion in actuating a prime motor without doing damage to that motor and its connected mechanism from too great heat, and from the jarring shock of intermittent explosions. I apply in this system various interdependent economies which are coactive in securing the unitary aimed for result. I introduce features for producing explosive gas from the very cheapest fuel. I provide for securing by-products of considerable value, such as ammonia. I utilize latent heat and exhaust steam to generate watery vapor free from earthy salts to replenish and make good the steam leakages in the system.

In economizing the waste heat of the system I apply the lowest degrees of the waste heat for heating air for combustion; a higher degree of heat for progressively heating water in an economizer steam boiler; a still higher degree of heat for producing steam of greater or less pressure; and apply the highest degree of the waste heat for superheating steam that has been highly compressed. In this way I economize large volumes of low degrees of heat in power generation that are usually lost, and thus secure in power generation the application of both the expansive force of explosion and the heat of explosion in the distribution of heat energy.

It should be understood that so far as possible I create vapor and steam at a low pressure, and increase the pressure of that steam by the force of explosion. I withdraw exhaust steam from the prime and other motors of the system, and from the steam generating economizers in the system by means of suction pumps, thus securing the advantages of a vacuum exhaust to the motors and a large generation of steam or vapor in the economizers from low degrees of heat. The steam and vapor thus drawn into the mechanism, by suction, is immediately forced into a storage compression tank, from which it is drawn to the various motors as needed.

I prefer to use steam as a power transmitting medium because, besides being compressible and cleanly, it absorbs very large amounts of heat, and when expanding does not interfere with practical results by creating too low a temperature. Steam dilutes the intense heat of explosion, and makes that force more smooth and controllable.

In this invention I make use of the force of gravity in economizing waste heat by applying the medium carrying that waste heat from a high level to a low level through the economizer, and in heating air, water or steam progressively in a travel from a low level to a high level. In some applied forms of my invention, as for example, locomotives, I use the principle of progressive heating by the use of several sectional horizontally placed tubular boilers; and in some cases I also use various other boilers placed in horizontal relation to each other. I also utilize waste heat by passing such waste heat through fuel for the preliminary heating of the fuel. In such instances I have the heat travel in a reverse route from that traveled by the fuel heated.

In applying the principle of utilizing both the expansive power of explosion and its heat, I may take the waste heat and transfer that heat into steam, and in turn create electrical energy through the expansive force of steam, and generate heat with the electrical current in the interior of a fuel mass with the view of heating the fuel mass and volatilizing the fuel, producing a combustible gas without admixture with air.

I do not confine myself to any specific application of such economizing ideas, as every case requires special modifications to suit the conditions present.

In this system I also use a forced current of cool gas, such as producer gas, to dilute the heat of the gas being produced, to blow fine fuel, to cool heated surfaces, to accelerate drafts of air for combustion, for diluting air for combustion, to reduce the intensity of the rate of combustion, and for inducing a draft.

In reusing the expanded steam that has passed through a motor, and recompressing it by the force of explosion, and then reconveying it to the motor again in a circulatory manner, I avoid the loss of much of the latent heat of steam. In generating a replenishing supply of vapor for making good the steam leakages in the system in the way that I do, I can use water of any character, and yet avoid the damaging effects of the deposition of earthy salts and organic impurities.

My invention comprises a gas producer with several novel features, it being designed to use soft bituminous coal, and also coal dust in gas production, and which gas is used in the various gas engines comprised in the system. I use the special means herein shown for feeding fuel, for producing steam with the heat of the newly produced gases, and for purifying the gas generated from tarry, ammoniacal and sulfur contaminants by securing their condensation on the tubes of the steam producer, running cold water through those tubes from a low level to a high level, and in some cases using other refrigerating means to secure the desired condensation. In some cases I pass the gas through a series of compartments filled with a fluid atomized spray in the upper levels of the compartments, while the fluid used for producing the spray is gravitated from one compartment to another, gradually becoming impregnated with ammonia and sulfur compounds. The current taken by the gas thus subject to purification is in a reversed direction to that taken by the water or other fluid used to cleanse the gas by being blown in an atomized spray through the gas current. The force inducing the spray is that of a compressed supply of the same gas as that which is being cleansed. In some instances I may use a tower scrubber to clean the gas.

In this invention I use the force of gravitation to give a sufficient momentum to gravitating fuel to secure its introduction into the gas generator in a diffused manner. The diffusion is also helped through injecting a gas free from uncombined oxygen to blow fuel and dry the fuel thus fed. Such a gas however, may have combined oxygen with it, as carbon monoxid, carbon dioxid, or hydrocarbon gases.

In the accompanying drawings: Figure 1 represents, in part schematically and in outline, the right hand half of a power generating system embodying my invention. Fig. 2 represents the left hand half of the same system. Fig. 3 shows a side vertical view of a locomotive and tender embodying my invention. It is shown partly in section and is partly cut away. Fig. 4 shows the main boiler of the locomotive. Fig. 5 represents in section a gas generator of which a number are used to furnish producer gas used in the locomotive.

In Fig. 1, C represents the gas cavity of the gas generator. G represents an endless chain grate, located in a cavity or pit G^2. The pit is impervious except at its top, where the grate is introduced. In this cavity is forced cool gas free from uncombined oxygen through the pipe Q^1, for keeping the grate cool; the gas being forced up through the interstices of the grate and of the fuel moved by the grate from the fuel hopper Q. I may use water in this pit. G^3 is a combustion pit with heat refractory walls W, of a sufficient depth for holding a deep enough bed of fuel to make producer gas or water gas. G^1 is a shaking and dumping grate. Heated air for combustion is supplied from the air conduit A under the grate, as is also the steam, through the pipes A^4, used in gas production. The gas after its production may be cooled by an admixture of cooler gas through the tubes G^5 to prevent damage to the structure of the apparatus. The producer gas is drawn through a mass of coke K, or other purifying material, resting on a hollow grate G^4 which is cooled by a current of cool gas passing through the grate from the pipe O^4. This grate is shaken by the handle O^5. The purifying material K removes soot and dust from the gas, which is then drawn through the gas passage O^2, to the top of the heating cavity B^2, in which is located the economizer steam boiler B with water tubes T, mud drum B^4, and the scraper S^4, which is operated by the lifting and lowering devices S^3. The scraper S^4, when in a lifted position, is heated by hot gases, and when lowered scrapes the tarry matters from the lower parts of the tubes T, on which they have condensed, it being understood that cold water is forced into a low level of the boiler B through the feed pipe C^2. As the gas is cooled, it is also drawn to the bottom of the cavity B^2, and is drawn through the conduit C^1, and C^3 through the scrubber and purifier S, Fig. 2, and through the gas supply pipe L to the engine cylinders E, E, E; being purified by the atomizers L^4. When desired, fine fuel is fed from the feeder F, Fig. 1, through the chute J^1 into the gas cavity C, and is given an impetus by the gas forced through the injector nozzle O^1. J represents a fuel chute conveying fuel to the fuel hopper Q, through which hopper a coil F^1 is passed, which conveys hot exhaust gases therethrough and then out through the outlet F^3. Gas thus volatilized from the fuel in the hopper Q by the heat in the coil F^1 is drawn through the conduit O^7 into the gas passage O^2. I represents an induction and forcing fan operated by the motor I^3. It draws cool producer gas from the bottom of the heating cavity B^2 through the duct O, through the fan I, and forces the gas through the ducts O^3 and O^4, to and through the safety lid W^2, which is provided to give a free exodus to any explosion of gas that may occur in the cavity C. The lid and its frame have gas cooled cavities, and a hinge W^3 through which the cooling gases are forced into the lid and frame, and from the lid and frame through a pipe, not shown in the drawings, leading into the passage O^2. The cooling gases besides passing through the pipe Q^1 into the grate cavity G^2, are also forced through the injectors Y, which are arranged to accelerate the induced draft passing through the ash pit A^3 from the hot air conduit A, and without undesirably diluting with nitrogen and carbon dioxid the producer gas being made.

R^1, Fig. 2, represents an auxiliary steam boiler of ordinary construction, with a direct up-draft exit H^3, which has a damper H^6, and a low level exit communicating with the cool exhaust gas stack H, which communicates with an inducing draft accelerator I^4 having a disk fan I^1 actuated by a turbine I^5, which assists the natural draft to pass the exhaust gases through the outlet stack I^2 above the draft accelerator.

The engines E, E, E, have water jackets X, and have a water circulation connected with the boiler R^1 through the pipes R^2 and R^3. Each gas engine is independent in its action of the other, or sections of engines devoted to special work may be run in series; only all have in common the same source of gas supply. Each engine has either a connected pump D for steam compression, and has valves for allowing steam to flow into the pump, or a pump D^2 for pumping feed water where needed through the pipe U or for exhausting work. The pump D^2 forces its outflow through the pipe M into the pipe U. Other uses may be fulfilled by individual engines, such as D^1 which is used in compressing and forcing gas through the pipe L^3 for atomizing the cleansing fluid in the scrubber S. Some draw watery vapor or receive newly formed steam through the pipe B^1, and after compressing force the compressed vapor or steam into the equalizer and storage tank N through the pipes B^3. Others draw exhaust steam through the pipe R making a vacuum exhaust for the prime motor P^1, and also force it into the compression and storage tank N.

E^1, E^1, represent fly wheels having counter-weights E^3.

V represents valves.

N^1 is a safety valve.

Steam is passed through the pipe N^2 from the tank N into the super-heater S^1, having the heating tubes T^1, and then through the supply pipe S^2 to the turbine motor P^1, the pulley of which is represented by P^4, from whence the exhaust steam is returned for compression to the pump D, and is thus used in a circulatory manner.

To replenish the steam supply, in case of an impure water supply, some of the exhaust steam is drawn through the pipe Z, through the feed water purifier and evaporizer P, and back to the pumps D through the pipe Z^1, the impure water which is partly evaporated in passing through the evaporizer P, is forced by a pump not shown through the pipe P^2 and gravitates from compartment to compartment over the partitions P^5 and out through the pipe P^3, having lost a large amount of its water, and being hot and in concentrated form, is run under the grate G^1 in the ash pit A^3 to furnish warm vapor for moderating the too intense heat of the fire. The vapor created in the evaporizer P is drawn through the pipe M^1 by a pump, not shown, and is compressed by that pump and forced into the tank N to be mixed there with other vapor and steam. A somewhat similar construction is adopted in the scrubber S in conveying water or other scrubbing fluids therethrough. Apertures are provided at progressively lower levels in the partitions which separate the fluids in the several compartments of the scrubber, and the fluids gravitate through these apertures from one compartment to the next. In this way as the gas traverses the scrubber in a reversed direction from that followed by the scrubbing fluid it is subjected to a progressive cleansing as it passes through each successive compartment by the atomizers L^4 located in each compartment and which are actuated by the compressed gas forced by the pump D^1 through the pipe L^3. As the cleansing fluid progresses through the scrubber it becomes more and more impregnated with the ammonia and sulfur compounds of the gas, and is finally drawn off through the fluid seal L^5.

L^2 is the pipe conveying hot exhaust gases of combustion into the top of the super-heater S^1. E^2 is another pipe, which in the drawing is broken in its course for clearness, carrying the same gas to the fuel heating coil F^1 in the hopper Q, to which there is a gas exit leading into the gas conduit O^7.

C^4 is a by-pass gas damper.

In starting this power generating apparatus, a fire is first built in the boiler R^1, the damper H^6 is opened and a direct natural draft created up through the draft accelerator I^4 and stack outlet I^2; the form of the accelerator and its large fan openings allowing for the free passage of gases into the stack I^2. The by-pass damper C^4 is opened and a fire started in the combustion pit G^3. As soon as steam is generated in the boiler R^1, the turbine I^5 and its connected fan I^1 is started, and this creates a draft through the passage O^2, the heating cavity B^2, the conduit C^1, the gas by-pass H^2 with a damper C^4, and the lower gas stack H. Air for combustion is first admitted into the gas cavity C, and the feeding grate G is started. When all parts are heated up and the boiler B generating steam, the damper C^4 is closed, and the damper H^7 is opened, when the waste gases from the boiler R^1 are drawn into the top of the heater H^5 through the conduit H^1. Air for combustion is then drawn dividedly through the heater H^5 from below upward, becoming thus heated, into the ash pit of the boiler R^1, and the ash pit A^3 of the gas generator, and the damper H^2 being opened a plunging draft through the air heater H^5 is created by the draft accelerator fan I^1. The supply of air for combustion now being shut off from the gas cavity C, producer gas is created, and the gas engines E, E, being started, an induced suction draft is created, the producer gas being drawn to the engines E, E, through the pipes C^1, C^3 and L, and through the branches L^6 connecting with the several engine cylinders, each branch being controlled by a separate valve. After the exhaust gas from the engine cylinders is forced through the super-heater S^1, it finally finds its exit from the bottom of the super-heater through the exhaust pipe L^1 which connects with the stack H.

A^1 represents the entrance to the air heating tubes A^2.

C^2 is a feed water pipe.

W^1 is a tar collecting pan.

H^1 is the waste gas conduit leading to the air heater H^5 through which run the heating tubes A^2.

H^4 is a damper.

In connection with the elements herein shown there would in practice be means provided for withdrawing the producer gas made in the gas generator and for forcing it into a storage tank or a compression tank, neither of which are shown in the drawings for clearness, from which means the gas can be conveyed to the places where it will be needed for explosion or other purposes.

In my invention I dilute hot newly made gas with a cooler gas of the same or of a diverse composition, before allowing the newly produced gas to come in contact with a heat absorbing surface that might be damaged by too great degree of heat in the newly formed gas. In this way I protect the structure of my invention in its several parts from destructive conditions. In such cases of dilution I usually provide a sufficient amount of heat absorbing surface for the absorption of the heat generated, to provide for the absorption of the larger volume of diluted heat in the mixed gases of a common lower temperature. In doing this I usually adopt the principle of applying heat progressively from above downwardly to a heat absorbing recipient traveling from below upwardly. In carrying out this process I provide means for controlling the amount of cooler gas that I admix with the hotter gas, and use a gas that will not adversely affect the quality of the gas being produced. I also provide for the place in the system where the admixing process occurs, this being particularly the case when I desire to protect certain parts; as *e. g.* the heat refractory walls of the combustion chamber that might become disintegrated by the intense heat of burning coal dust, and also the fuel moving grate G. The place of admixture is also arranged so as not to interfere with the nature of the combustion process taking place in the apparatus.

In the locomotive and tender indicated by Fig. 3, I show in modified form an application of my invention. The engine and driving machinery of the locomotive are practically the same as is generally used. There is a fire box in the usual place, but of smaller size. This is used to get up steam and to supply an auxiliary supply of steam when needed. The boiler of the locomotive is rather in the nature of a heat economizer producing small volumes of steam, and an equalizing pressure tank, than a producer of large volumes of steam; for in this apparatus very little of the exhaust steam produced is wasted. The draft is effected through the boiler by a system of twyers T^1, Fig. 4, discharging exhaust exploded gas in a forward direction to the funnel of the locomotive. This gas traverses the heating tubes of the boiler. This injecting system is placed in an interspace T^2, Fig. 4, between the last section of the boiler which is connected with the combustion chamber, and the section next forward to it. In this position the twyers and their connecting pipes are protected from the too great heat generated in the combustion chamber. Cold feed water is forced from the water tank X^1, Fig. 3, which is located at the bottom of the tender, into the most forward section of the boiler, and is forced and gravitates gradually through the sections to and around the combustion chamber. The hottest gases pass into the heating tubes at the rear of the boiler and passing forward, the water of the rear sections receives the most heat and produces the most steam, while the cooler water in the forward sections affords progressively a recipient for low and progressively decreasing degrees of heat that is usually lost in running locomotives.

Most of the energy used in the locomotive is produced by a line of combustion engines E, E, Fig. 3, which are arranged on both sides of the boiler, and which are reached from inside the cab, which covers about three-fourths of the rear end of the locomotive. The several engines have special work to do; but are mainly employed in compressing newly formed steam or exhaust steam, and forcing it into the boiler and through the super-heater N^3, through which it is drawn and delivered to the engine cylinders of the locomotive. After having done its work there, it is returned to the combustion engines for re-compression. The gas for these engines is generated in a series of producer gas generators M^2, located in the tender, in numbers equal to the work required of the locomotive, such as length of run, load to be carried, etc. Most of the coal needed for a run is stored in these generators, rather than in the tender itself. The tender is elongated sufficiently to afford space for a sufficient number of generators and for fuel bins K^1, from which the fuel is taken to supply the fire box of the boiler. In the space at the center of the tender, and at a high level which allows of a man passing beneath it, there is provided a horizontally placed combined dry scrubber and air heater S^4. In this application of my invention, only a good quality of hard coal or coke is used for generating gas. Each gas generator has as an envelop a water heater or boiler, which absorbs the first heat of the generated gas. The steam generated by these enveloping boilers is conveyed to the compression engines and is forced into the boiler. The producer gas is drawn through the scrubber S^5 in a diverse direction from that taken by the air for combustion, which is drawn through the scrubber and under the grates of the gas generators by the sucking action of the gas engines.

The exploded gases, after leaving the engines E, E, E, is first run through the super-heater N^3 before passing through the twyers into the heating tubes of the main boiler. In the special application of my invention here shown to a locomotive, I indicate in a general way the application of the power generating system here claimed; but I do not restrict myself to the specific form shown. Various other arrangements of the elements of the invention are practically possible. The same elements can be arranged in a different manner for other applications of the invention. For example: by modified arrangements, the same system can be applied to the propulsion of vessels of many types, and also to certain types of automobiles, especially in those cases where this class of invention is used for traction purposes.

In further explanation of my invention it should be said that I neither claim nor consider as an invention the use of compressed air carrying ordinary amounts of watery moisture in the transmission of power, whether that air is compressed by the power of gas explosion or by other power; though a specific means for compressing air by explosive power may be so considered. Pneumatic transmission of power has been in extensive use for a long time. But if air is intentionally impregnated with enough watery moisture in the form of either spray, vapor or steam to make the combined gas and fluid a better absorber of heat and a better transmitter of power than ordinary air, and is then compressed mechanically and utilized in a motor, such use involves in part, the inventive idea claimed herein.

In transferring the heat of explosion through water into steam and then mechanically compressing the steam, the expansive force in the steam is utilized on one side of the pistons of the compression pumps and through the crank shafts connecting both pumps and explosion cylinders, and fly wheels of the engines, in partially overcoming the friction and inertia that must be overcome in the mechanical compression of the steam.

The amount of compression given to the vapor or steam evolved from the waste heat will depend upon varying conditions. Usually, to economize force, I do not compress the vapor or steam to a degree that will raise the temperature of the compressed vapor or steam to above a point where it will readily absorb the higher degrees of the heat of explosion in a superheater; but in some simple forms of apparatus, such as in the case where a liquid hydro-carbon is used to generate the gas for explosion, I utilize all the jacket heat and exploded gas exhaust in one economizer boiler, and then compress the vapor or steam produced in that boiler to a point that will give, through the force of mechanical compression alone, a good working pressure in the accumulator-steam tank, and that will secure a sufficient super-heat in the steam.

In some cases of simple forms of apparatus I use mechanically compressed ordinary air to initiate power transmission through the motors of the system until steam or vapor can be produced from the heat of explosion to be used for the compressed medium of power transmission.

What I claim as new is:

1. In a power generating system, the combination of (1) means for generating steam, (2) means for generating power through explosion, (3) means for transferring the force of explosion to steam, (4) means for conveying the steam carrying the force of explosion to a motor, and (5) said motor.

2. In a power generating system, the combination of (1) means for generating steam, (2) means for generating power through explosion, (3) means for transferring the force

of explosion and the heat of explosion to steam, (4) means for conveying the steam carrying the combined force and heat of explosion to a motor, and (5) said motor.

3. In a power generating system, the combination of (1) means for utilizing low degrees of heat to produce vapor or steam of low pressure, (2) means for compressing said vapor or steam when formed, (3) means for applying the force of explosion to actuate the compressing means, and (4) means for utilizing said compressed steam.

4. In a power generating system, the combination of (1) means for exploding gases, (2) means for compressing a heat absorbing power conveying fluid medium by the force of explosion, (3) means for transferring the heat of explosion to said medium, (4) means for conveying said compressed medium bearing the absorbed heat of explosion to a motor, (5) said motor, (6) an exhaust conduit for said medium leading to an exhaust pump, and (7) means comprising said pumps for the reintroduction of said medium to said compressing means for the travel of said medium in a circuitous round between said compressing means and said motor.

5. In a power generating system, the combination of (1) means for producing explosive gases, (2) means for producing motive power by the explosion of said gases, said second named means comprising an engine, (3) means for producing steam, including provision for its generation from the waste heat of said engine, (4) means for utilizing the force of the explosive gases to compress the steam, (5) a motor, and (6) means for conveying the compressed steam to the motor for utilizing the force of the compressed steam in the motor.

6. In a power generating system, the combination of (1) means for producing explosive gas, (2) an internal combustion engine for producing heat and energy through the explosion of said gas, (3) a water jacket for said engine for absorbing heat from said engine, (4) a supplementary boiler deriving heat from said engine and jacket for heating water and producing steam, and (5) an economizer providing for the passage of a medium for heat absorption and steam formation in a vertical current from a low level to a high level and for the travel of the heating gases generated in a reverse current from a high level to a low level.

7. In a power generating system, the combination of (1) a generator of combustible gas, (2) an engine actuated by the explosion of said gas, (3) means actuated by said engine for compressing a medium for transmitting power, said third named means being exemplified by a pump for compressing steam, (4) means for storing said medium in a compressed state and for securing an equalized expansive outflow of said medium from said storing means, (5) means for conveying said medium under pressure to a motor, (6) said motor, and (7) economizers for heating air for combustion and for producing steam with the waste heat produced in said generator of gas and in said engine.

8. In a power generating system, the combination of (1) a gas generator, (2) an internal combustion engine for exploding said gas, (3) means actuated by said engine for compressing a medium for power transmission, (4) means for storing said power compressed medium and for equalizing the outflowing pressure of said medium from said storage means, (5) means for inducing a draft through the said system, (6) heat absorbing economizers comprising passages for absorbing heat generated in said system for gas travel, and (7) means for controlling the amount of heat passing through said system and said passages for gas travel of said economizers.

9. In a power generating system, the combination of (1) means for producing explosive gas, (2) an internal combustion engine for exploding said gas, (3) means for producing vapor or steam of low pressure from the heat generated in said system, (4) motors actuated by said vapor or steam, (5) means for compressing said vapor or steam of low pressure and also for compressing exhaust steam from said motors, and (6) means for accumulating and for conveying said compressed vapor or steam to said motors.

10. In a power generating system, the combination of (1) an internal combustion engine, (2) a steam generator for furnishing steam for starting the motors of said system and for equalizing the amount of steam needed in said system, (3) a steam boiler for economizing waste heat and for producing steam as an adjunct source of power to that created by said engine, (4) a superheater for controlling the temperature of the steam used in actuating the motors of said system, (5) said motors, (6) an air heater for heating air for combustion with waste heat, (7) means for inducing a draft in said system, (8) means for forcing a draft in said system, (9) a gas producer comprising provision for automatically feeding fuel into said gas producer, (10) means for supplying and controlling the supply of steam and heated air to said gas producer, (11) means for storing the power created by said engine and for conveying said power to a prime motor, and (12) said prime motor.

11. In a power generating system, the combination of (1) means for exploding gases, (2) means for producing steam at relatively low pressure, (3) means for the mechanical compression of the steam produced at low pressure, said third named means being actuated by the force generated by exploding gases, (4) means for conveying

the steam thus mechanically compressed to a motor, and (5) said motor.

12. In a power generating system, the combination of (1) an explosion engine, (2) means for producing steam, (3) means for compressing said steam with the power evolved by said engine and for forcing said steam to a motor, (4) said motor, (5) means for drawing said steam back into said third named means for the repeated use of said steam as a circulatory motive medium without the loss of much of the latent heat of said steam, (5) means for replenishing the volume of said steam with vapor free from earthy salts and other contaminants, (6) means for heating said steam when compressed, (7) means for producing steam from the heat generated in making a combustible gas, and (8) means for introducing said steam into any desired part of said system through suction or by compression.

13. In a power generating system, the combination of (1) a producer gas generator, (2) means for cooling the newly made gas evolved in said gas generator, and for making steam from the cooling of said gas, (3) a plurality of independently actuated explosion engines for effecting with separate engines the various lines of work needed for the operation of said system, (4) other means of producing steam for initiating action in said system and for equalizing the amount of steam needed in said system, (5) means for the mechanical compression of steam and for the use of said steam at various parts of said system, (6) means for conveying steam to various parts of said system, (7) means for heating air for combustion with waste heat generated in said system and for feeding said heated air to said gas generator, and (8) a motor actuated by the expansive force of said compressed steam, said combination comprising provision for the circulatory use of said steam and for the economization of the latent heat of said steam.

14. In a power generating system, the combination of (1) means for making producer gas with low cost fuel, (2) means for cooling said gas and producing steam, (3) means for purifying said gas, (4) means for exploding said gas and producing power by said explosion, (5) means for economizing the heat of explosion (such as in heating fuel in the hopper Q), said fifth named means comprising provision for producing combustible gas by volatilizing fuel with said economized heat without the gases bearing the heat of explosion becoming mixed with said combustible gas volatilized by the heat of explosion, and (6) means for conveying the newly formed combustible gas to a place of combustion.

15. In a power generating system, the combination of (1) means for generating gas, (2) means for generating and compressing steam, (3) means for purifying said gas, said means for purifying gas comprising provision for condensing tar, (4) means for removing other contaminants in said gas, (5) means for exploding gas, and (6) means for transmitting the power of explosion to the means for compressing steam.

16. In a power generating system, the combination of (1) means for generating steam, (2) means for utilizing said steam for motive power, (3) means for creating watery vapor or steam of low pressure from the waste heat of said system for replenishing the leakages or wastes of steam used for power transmission in said system, and (4) means for giving expansive force to said vapor or steam of low pressure by mechanical compression and for adding said compressed vapor or steam to the steam generated by the first named means.

17. In a power generating system, the combination of (1) means for making explosive gas, (2) an engine for the explosion of said gas, (3) means for producing steam or vapor of low pressure from the low degrees of heat produced by the explosion of gas in said engine, (4) means for mechanically compressing said steam produced by low degrees of heat with the force of said engine, (5) means for superheating with the high degrees of heat generated by said engine the steam mechanically compressed by said engine, (6) means for utilizing in a motor the steam thus generated, compressed and superheated, (7) said motor, and (8) means for economizing the exhaust steam from said motor.

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

JOSEPH MOSES WARD KITCHEN.

Witnesses:

OLIVE B. KING,
GEO. L. WHEELOCK.