E. E. LAMSON.

GAS AND STEAM POWER GENERATOR.

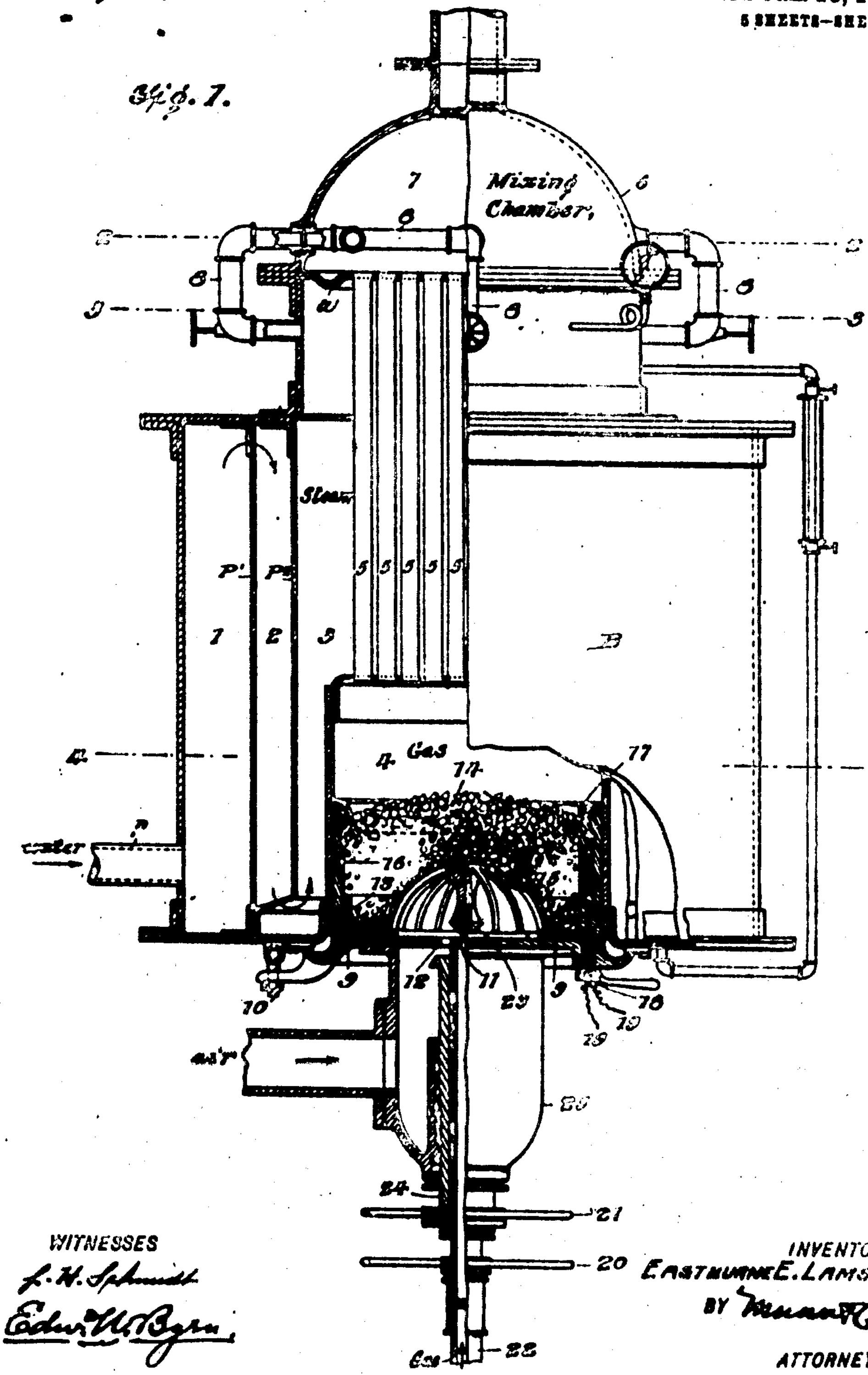
APPLICATION FILED APR. 20, 1909.

947,107.

Patented Jan. 18, 1910.

5 SHEETS—SHEET 1.

Fig. 1.



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6 SHEETS—SHEET 2.

Fig. 2.

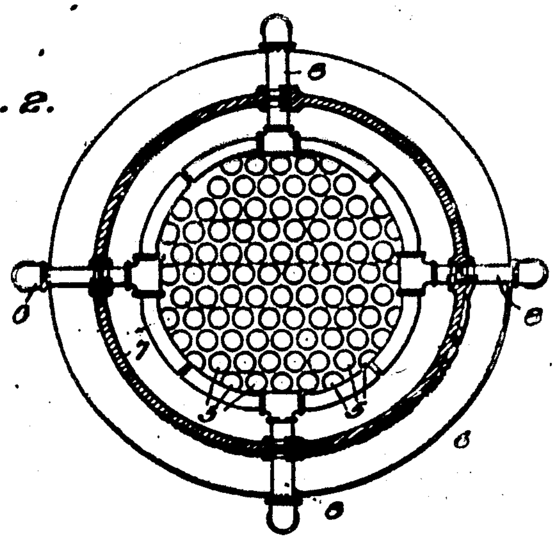
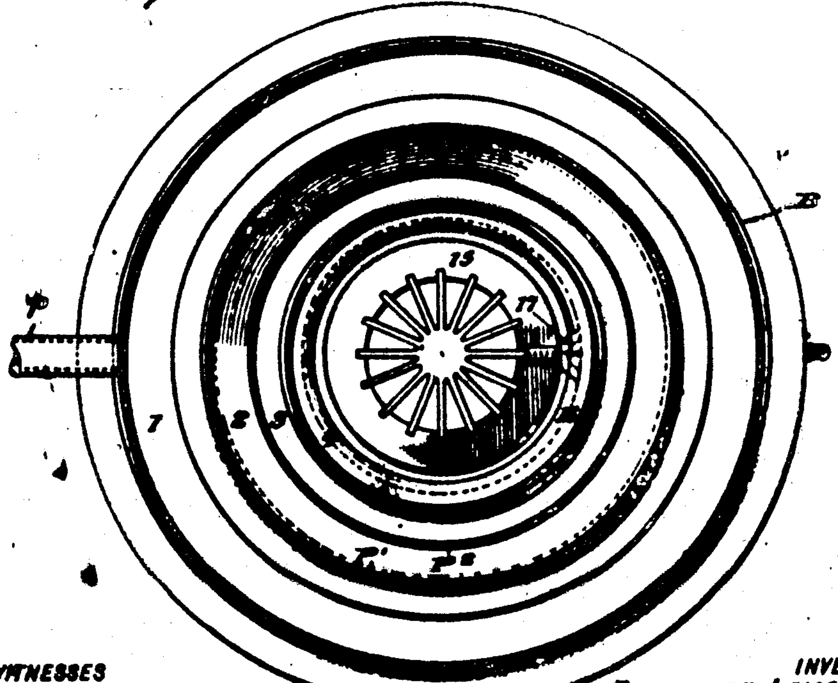


Fig. 4.



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6 SHEETS—SHEET 3.

Fig. 3.

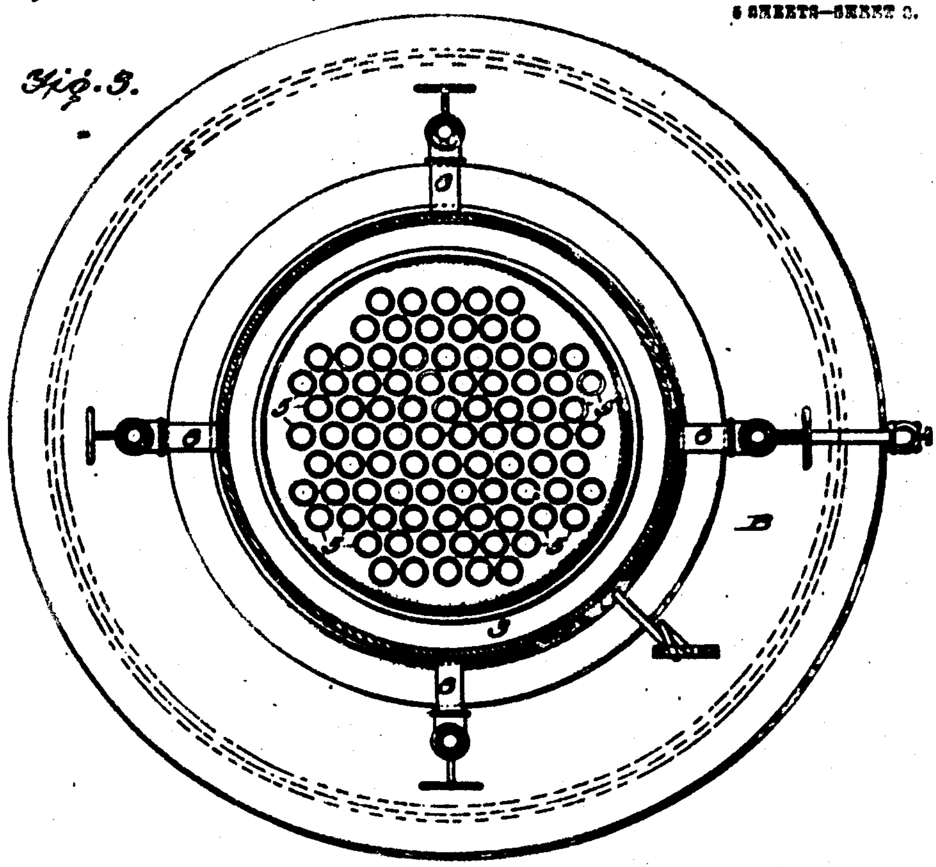


Fig. 5.

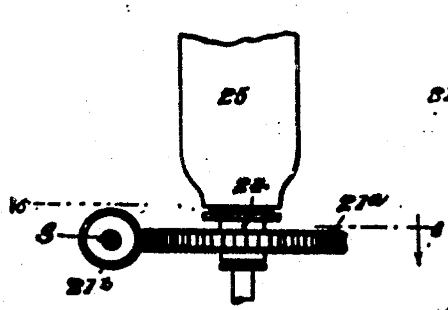
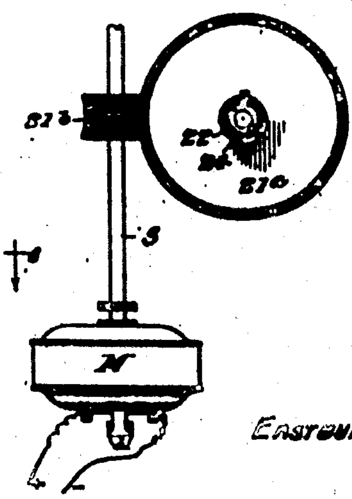


Fig. 6.



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947,107. Patented Jan. 18, 1910.

5 SHEETS—SHEET 4.

Fig. 7.

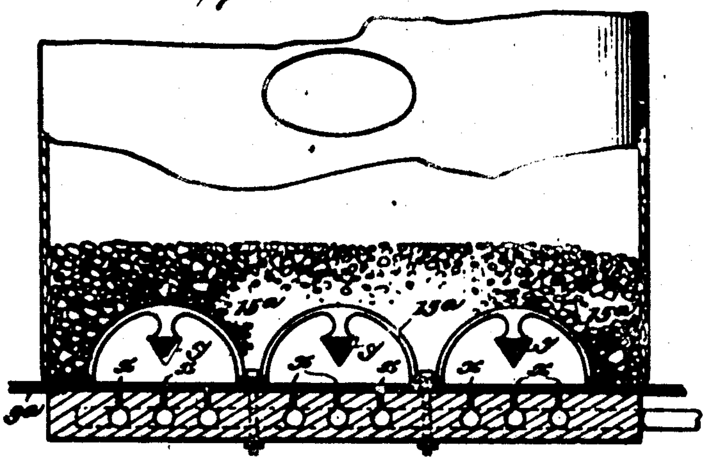

Fig. 10.

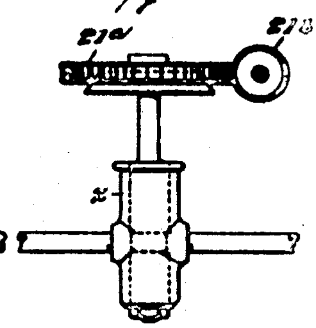

Fig. 8.

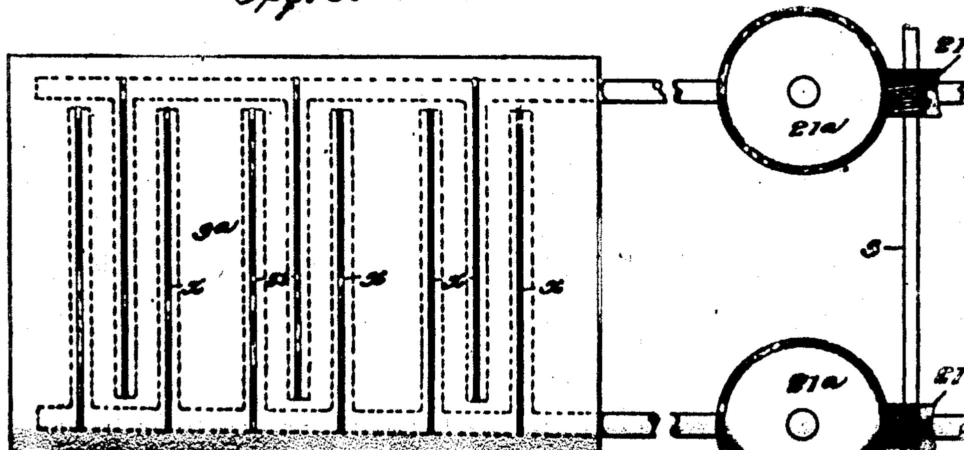

Fig. 9.

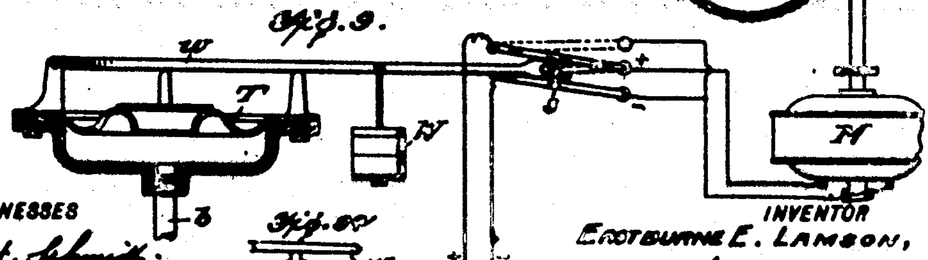

Fig. 8a

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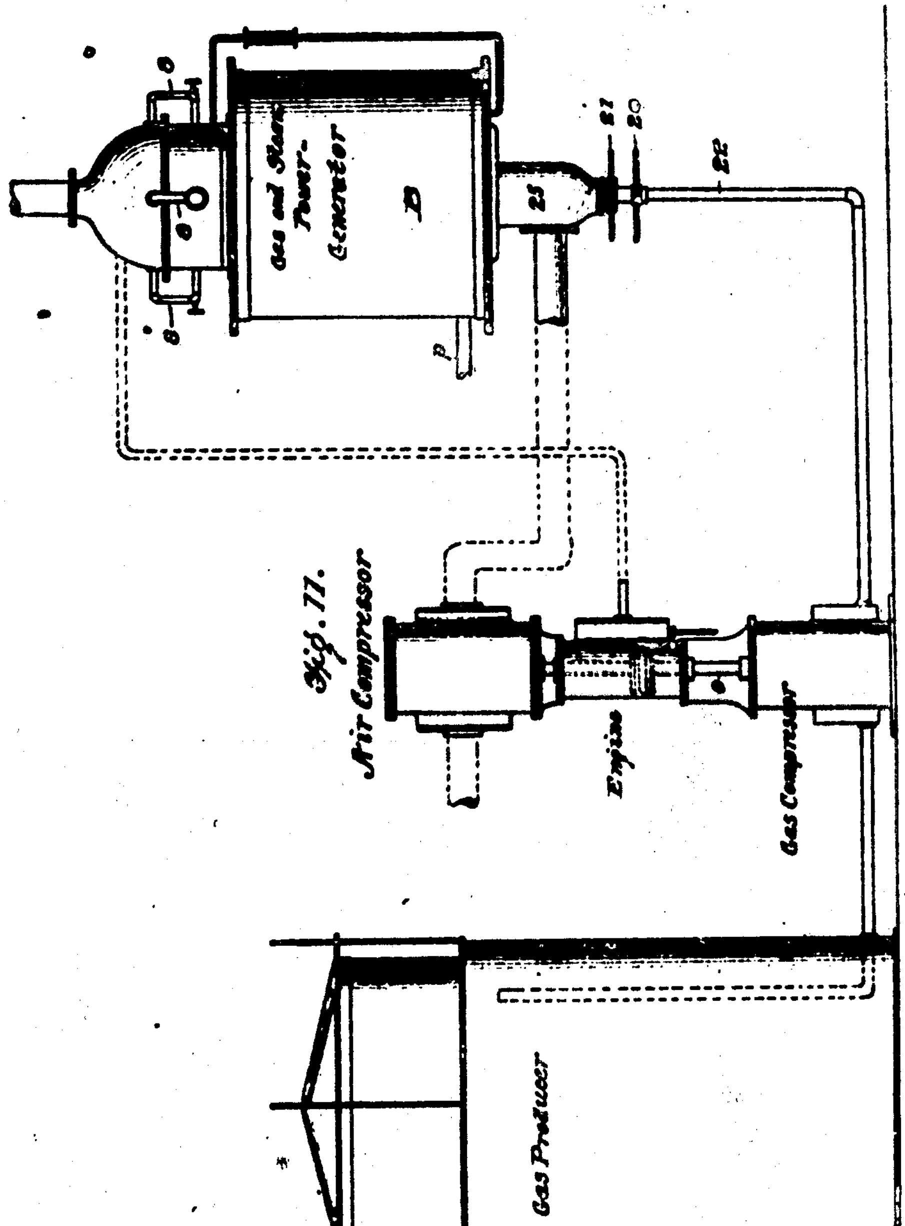
947,107. **Patented Jan. 18, 1910.**

6 SHEETS—SHEET 5.



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UNITED STATES PATENT OFFICE

EASTBURNE E. LAMSON, OF SALT LAKE CITY, UTAH.

GAS AND STEAM POWER-GENERATOR.

947,107. Specification of Letters Patent. Patented Jan. 18, 1910.

Application filed April 30, 1908. Serial No. 430,061.

To all whom it may concern:

Be it known that I, EASTBURNE E. LAMSON, a citizen of the United States, residing at Salt Lake City, county of Salt Lake, and State of Utah, have invented certain new and useful Improvements in Gas and Steam Power-Generators, which are fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to means for supplying an elastic fluid under pressure for the operation of the steam reciprocating and turbine types of engines.

The object of the invention is to transpose the heat units of gas fuel into a mixture of steam and combustion gases suited in pressure and mass and temperature to supersede steam in operating those types of engine; and, by thus linking them to gas producing apparatus, to embody a gas and steam power-system which will retain the advantages of the steam engines and combine with them the thermal efficiency of the explosive gas engine.

The heat is produced by the combustion under constant pressure of gas and air mixed in explosive or chemical proportions. These supplies of gas and air are pre-compressed by any suitable apparatus and admitted to the combustion chamber at a pressure of several atmospheres, varying according to the richness of the gas in combustible elements.

The steam is produced by contact with the sides and tubes of the combustion chamber and its outlets, of water contained in a water jacket surrounding them.

The mixture is made by causing the products of combustion and the steam to diffuse together, in a mixing chamber, into which the combustion gases are discharged from the outlets of the combustion chamber and from which mixing chamber the mixture passes to the engine.

In the accompanying drawings of the apparatus for making the mixture, which I call a gas and steam power-generator, similar reference numbers and letters are used for identifying the same parts in all the views.

Figure 1 is a side elevation of the power-generator with the left hand part in vertical central section. Fig. 2 is a horizontal transverse section on line 2—2 of Fig. 1, looking down. Fig. 3 is a similar section on line 3—3 of Fig. 1. Fig. 4 is a similar section on line 4—4 of Fig. 1. Figs. 5 and 6 represent in detail electrically operated worm gears for the automatic regulation of the air and fuel gases. Fig. 7 is a sectional elevation of a modified form of the generator for larger units. Fig. 8 is a plan view of the bottom plate seen in Fig. 7. Fig. 9 is a sectional view of an automatic pressure regulator for the air and gas. Fig. 9a a detail of a modification thereof. Fig. 10 is a side view of the regulating cut-off valve, and Fig. 11 is a side view, on a smaller scale, of my power-generator connected to a gas producer and compressor.

The generator is in effect, an upright tubular cylinder boiler B, see Fig. 1, with several annular compartments 1, 2, and 3, surrounding a central combustion chamber 4, and its outlet tubes 5, surmounted by a hemispherical dome 6 containing the separate mixing chamber 7, into which are injected the products of combustion through the outlet pipes 5 and steam through the external steam pipes 8.

The feed water enters the annulus 1 through pipe p, near its bottom, and, under pressure from the feed pump, flows upward and through the top of the partition P' into the annulus 2, thence downward and through the bottom of the partition P^2 into the annulus and inter-tube space 3, and thence as steam into the mixing chamber. Thus there are, surrounding the combustion chamber, three concentric water jackets the contents of which flow constantly toward the centrally located heating surfaces, intercepting and accumulating heat on their way.

The combustion chamber is cylindrical in form and placed centrally in the lower part of the generator. Its bottom or floor 9 must be removable, and adjustable to place, with strong bolts or cams 10, to resist the expansion of the compressed fuel and of combustion. The compressed supplies of gas and air are admitted through separate but concentric inlets 11 and 12 in the center of the floor, whence they diffuse freely through a mound of small fragments of broken magnesite or other refractory material 14. To promote commixture and to prevent the fragments from choking the inlets, the cage or screen 15 is superposed over and around them, and is formed with openings for the passage of the fuel supplies therethrough. It will be seen that the bottom 9, which may be a steel casting, has a circumferential flange fitting the interior of the combustion chamber, and that the flange is surmounted by a ring 16, continuous in form: the flange and the ring together making a basin for holding the magnesite fragments. The upper edge of the ring coincides in height with the flame cap of combustion, covering the mound which may be called the "burner." The upper rim of the ring 16 is thickened that it may serve as a magazine to store and maintain an inflaming heat should there be a temporary stoppage of combustion.

Provision for electric ignition of the fuel gases is made through the hole 17 cored in the castings 9 and 16 to serve as a gas duct from the inlets to the upper surface of the burner. The plug 18 serves as a gate for the duct and also as the seat of the electric connections 19.

When a kindling charge of the explosive mixture has passed through the open gate, a slight turn of the plug at the same time closes the gateway and produces the firing spark in the vertical part of the duct.

The supply inlets 11 and 12, shown as wide open, are designed to admit the gas and air in proportions for chemical or perfect combustion. As these proportions must vary according to the richness, in combustibles, of the gas, the inlets may be relatively adjusted in area or capacity by turning the hand wheels 20 and 21. Such turning of the wheel 20, will screw the gas pipe 22 toward or from the pendent cone surface 23 on cage 15 with the effect of partly or wholly closing or opening the gas inlet, and such turning of the wheel 21 will likewise affect the sleeve 24 for adjusting the air inlet. The air receiver 25 serves both to deliver the air supply and also to support and to direct the devices for adjusting the relative volumes of supply.

The relative volumes of gas and air being in adjustment by the position of the pipe 22 within the sleeve 24, it is evident that regulation of the total volume of gas and air may be attained by screwing the sleeve toward or from the inlet 12, according to the demands of the engine and its load. Should those fluctuate violently, automatic regulation may be attained by the devices shown in Figs. 5, 6 and 9, that is to say, by gear wheel 21^a and worm 21^b fixed to a shaft S on which is a small reversible electric motor M arranged to revolve in opposite directions by electric currents whose circuits are alternately made, broken and reversed as to polarity by the vibration of a flexible diaphragm T, Fig. 9, which, being fixed upon the end of a pipe *b*, connected with the mixing chamber, is under stress from the expansion within and is also under stress from a spring or weight W without. This weight is attached to a lever *w*, which rests on a bearing on top of diaphragm T and the other end controls a 3-point pole changing switch *s*.

When the two forces on opposite sides of the diaphragm are balanced, the motor M would be without power, as the switch arms will then occupy a position between the contact points. With deficient pressure within, the recession of the diaphragm should complete the opening circuit of the motor which increases the fuel supply. With excessive pressure within, the protrusion of the diaphragm reverses the poles of the switch and completes the circuit of the motor to operate in the reverse direction, to wholly or partially close the supply inlets.

For high pressures, instead of using a diaphragm T as in Fig. 9, I may use a piston T′ working in a cylinder as seen in Fig. 9^a.

The pendent cone 23, Fig. 1, serves not only to regulate, as described, the influx of gas, but also to promote its diffusion with the air. For, although the two concentric streams will begin diffusion when they issue from the inlets, it is evident that, as soon as the central stream of gas reaches the cone surface, the combustible atoms must diverge from their direct course and spread into that of the annular stream of air, creating a multitude of subdivided and intermingling streamlets of gas and air and opportunities for diffusion as the elements rise through the interstices of the multi-cell burner.

The end and tube sheets of the boiler may be made with plane surfaces or be dished, domed, or corrugated with concentric corrugations as at *a* Fig. 1, as may best serve the purpose of taking up heat expansion and preventing strains.

I have so far shown, as the simplest and most convenient example of my invention, the upright cylinder boiler with its homologous fire chamber and burner and appurtenances, but for units of power exceeding the ordinary limits of the upright boiler, utility may require horizontal boilers and variant forms for other analogous parts. In an oblong fire chamber, seen in Figs. 7 and 8, a semi-cylindrical burner cage 15^a, or several of them, may be the analogue of the hemispherical burner. The analogue of the concentric supply inlets may be a group of three slits *x*, in the floor 9^a of the fire chamber, arranged in conformity to the axis of their burner. The analogue of the spreading cone may be a wedge or prism *y* presenting an edge to the gas inlet slit. Gas and air may be supplied to their respective slits through suitable pipes or holes, cored in the floor casting, parallel, like the slits to the axis of the burner; and two straightway service cocks *z*, Fig. 10, arranged in pipes at the entrances of these holes, and geared together, with provision for relative adjustment of volume, may be the simplest analogue of the automatic regulating device heretofore described.

In Fig. 11 I have shown the general combination of my invention consisting of a gas producer, a compressor and a power-generator of the kind described all connected in operative relation.

To help maintain a flame cap or combustion surface coincident everywhere with the burner surface it is desirable that all points of the latter should be equally accessible from the fuel inlets. The diameter or width of the fuel inlets will be the subtense of the curve of equal radii for the burner surface. Spreading the inflowing stream of supplies is equivalent to widening the fuel inlet and lengthening the subtense, and, therefore, of flattening the curve of the burner surface.

As it may be expected that the loose materials of the burner will in service, settle together and somewhat degrade any surface curve, the flatter the burner surface the better, if equal accessibility be secured.

It is evident that the spreading surfaces of the cone (or prism) may be adjusted to secure, for the divergent streams of fuel, equal accessibility and distribution to very flat curves; also that in an oblong fire chamber, for a large unit of power, several fuel inlets with accessory spreading prisms may require, for equal distribution to their joint burner, a surface nearly or quite level.

The word "fuel" here means all elements of gas and air proper for combustion; and the phrase "fuel inlet" means an aperture or a group of apertures for the admission of those elements in proportions proper for combustion; "multicell" (or multicellular), applied to the type of burner here described, distinguishes it from all those which, like the Bunsen burner and the blast lamp, provide but a single apartment or cavity for seclusion and diffusion of the elements, pending the reaction of combustion; a "gate" is "anything which shuts or bars a passage".

If we compare such a power generator with the explosive type of engine we find that the combustion chamber and water jacket have been separated from the engine cylinder; that independent compression of supplies leaves the engine free for motor duty exclusively; that constant pressure has been substituted for constant or measured volume; that the water jacket, in the form of a boiler, contributes steam to be used in common with the combustion gases. Evident advantages are; saving the engine mechanism from excessive combustion heat and the cylinder from explosive stresses concurring with the strains of unequal heat expansion; saving fuel in the work done by the surplus heat heretofore wasted in jacket water.

If we compare the ordinary steam boiler with such a power generator we find that, for ordinary fuel has been substituted an explosive mixture; for ordinary or slightly forced draft has been substituted combustion under constant pressure of several atmospheres; for wide diffusion is substituted confinement of heat and steam to an inner compartment surrounding the heating surfaces, toward which flows the feed water, with a slight but constant and sufficient current; for the steam dome is substituted a separate and independent mixing chamber; for superheating apparatus is substituted actual contact of steam with the fire and diffusion with the combustion gases as they pass together to the engine; and for a stoker is substituted an electric motor acting automatically to increase or diminish the fuel supply to meet the requirements.

"The most direct and effective way of improving steam-engine economy is by the use of superheated steam." See Peabody's "*Thermodynamics of the Steam Engine*" pp. 368–869.

"Superheating has for its sole purpose and result * * * the extinction or reduction of the internal thermal wastes of the engine consequent upon 'initial' or 'cylinder condensation.'" "Superheating even a few degrees improves considerably the performance of the engine, and, in the average case superheating 100 degrees F. will entirely extinguish that waste. The obstruction at the boiler has been, and still remains, difficulty of construction of a superheating system which will be at once effective, safe and durable." See "Thurston's *Manual of Steam Boilers*" pp. 868–869.

It is thus evident that superheating is of the utmost importance for steam engine economy; that there are economic constructive and material difficulties in imparting superheat to steam through intervening metallic walls; that the most logical and practical method must therefore dispense with the walls and superheat the steam by direct contact with the fire and combustion gases, substantially as heretofore described. It is also evident that, within reasonable limits, the steam may be so superheated, or the combustion gases so tempered to any degree suitable for the immediate purpose. The engine will be then, approximately, a gas engine or, approximately, a steam engine, according to the elements predominating in the mixture.

"With mixture of gases * * * the entropy of one constituent is not influenced by the presence of the other constituent." See Stodola's *The Steam Turbine*, p. 395 note. "When it (the mixture) is complete the steam expands, at exhaust, to 1 atmosphere, and not to partial pressure, leaving the machine as wet steam at 100 degrees C. temperature, and heats the surrounding air particles to an equal degree." *Ibid.* p. 410 note. "The physicist, Pictet, suggested a peculiar way of lowering the temperature drop of a non-condensing steam engine. He intends to heat compressed air to the temperature of the steam and to mix this with the steam leading to the engine. If the mass ratio of air to steam is above 2 to 1, then, according to Pictet, the latter supplies about ⅓ of the existing total pressure. If the total pressure was 1 pound per square inch, then the steam has about ⅓ pound per square inch pressure, and therefore the exhaust into the atmosphere would expand just as much as though a condenser were used. From this Pictet concludes that the steam consumption of this non-condensing engine approaches nearly that of a condensing engine." *Ibid.* p. 410. It is evident that this advantage, sought by Pictet in his mixture of steam and air, must as certainly, and more fully, be found in my mixture of steam and combustion gases if tempered to the required conditions; for while in his system it is the object of an expenditure of energy, on the contrary in my system it is an additional economy incident to saving the heat energy of the steam.

I claim—

1. A steam boiler comprising an interior combustion chamber, a plurality of compartments surrounding said combustion chamber, an inlet for feed water in the outer of said compartments, and communicating passages between said compartments arranged to conduct the feed water successively through said compartments from said inlet to the interior heating surfaces, thereby intercepting and accumulating heat during its progress.

2. A steam boiler comprising an interior combustion chamber, a plurality of concentric annular compartments surrounding said combustion chamber, an inlet for feed water in the outer of said compartments, and communicating passages between said compartments arranged to conduct the feed water successively through said compartments from said inlet to the interior heating surfaces, thereby intercepting and accumulating heat during its progress.

3. A gaseous fluid power-generator, comprising a central combustion chamber, an annular upright boiler, surrounding said combustion chamber, a plurality of feed water compartments surrounding said boiler, a mixing chamber, having communication with said boiler and with the interior of said combustion chamber, an inlet for the feed water in the outer feed water compartment, said inner compartment having direct communication with the boiler, the passages between said feed water compartments being so arranged that the feed water is forced to travel the entire length of each compartment in its movement toward the boiler.

4. In a power-generator, an annular upright boiler, a fluid fuel burner centrally disposed thereof and provided with refractory material for retaining the heat of said burner in close proximity to the inner vertical sides of the boiler, a plurality of feed water compartments surrounding said boiler, means for causing the feed water to traverse the length of each compartment, an independent mixing chamber surmounting said boiler and a series of exhaust tubes communicating with said mixing chamber.

5. In a power-generator, a fluid fuel burner, a combustion chamber containing a mass of refractory material disposed above said burner, an upright annular boiler surrounding said combustion chamber and extending above the same, concentric annular feed-water compartments surrounding said boiler, communicating passages between said feed water compartments, the adjacent passages being at the opposite ends of the compartments, a mixing chamber surmounting said boiler and a series of exhaust tubes connecting said combustion chamber with said mixing chamber and disposed in the upper part of said chamber.

6. In a power generator, an interior combustion chamber, a plurality of concentric water heating chambers surrounding said combustion chamber, communicating passages between adjacent water chambers, each passage being at the opposite end of the chambers from the one preceding it, thereby causing the incoming feed water to flow successively through the length of each of the chambers.

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