(No Model.) 3 Sheets—Sheet 1.

T. M. FELL.

PROCESS OF OBTAINING MOTIVE POWER.

No. 287,917. Patented Nov. 6, 1883.

Fig. 1.

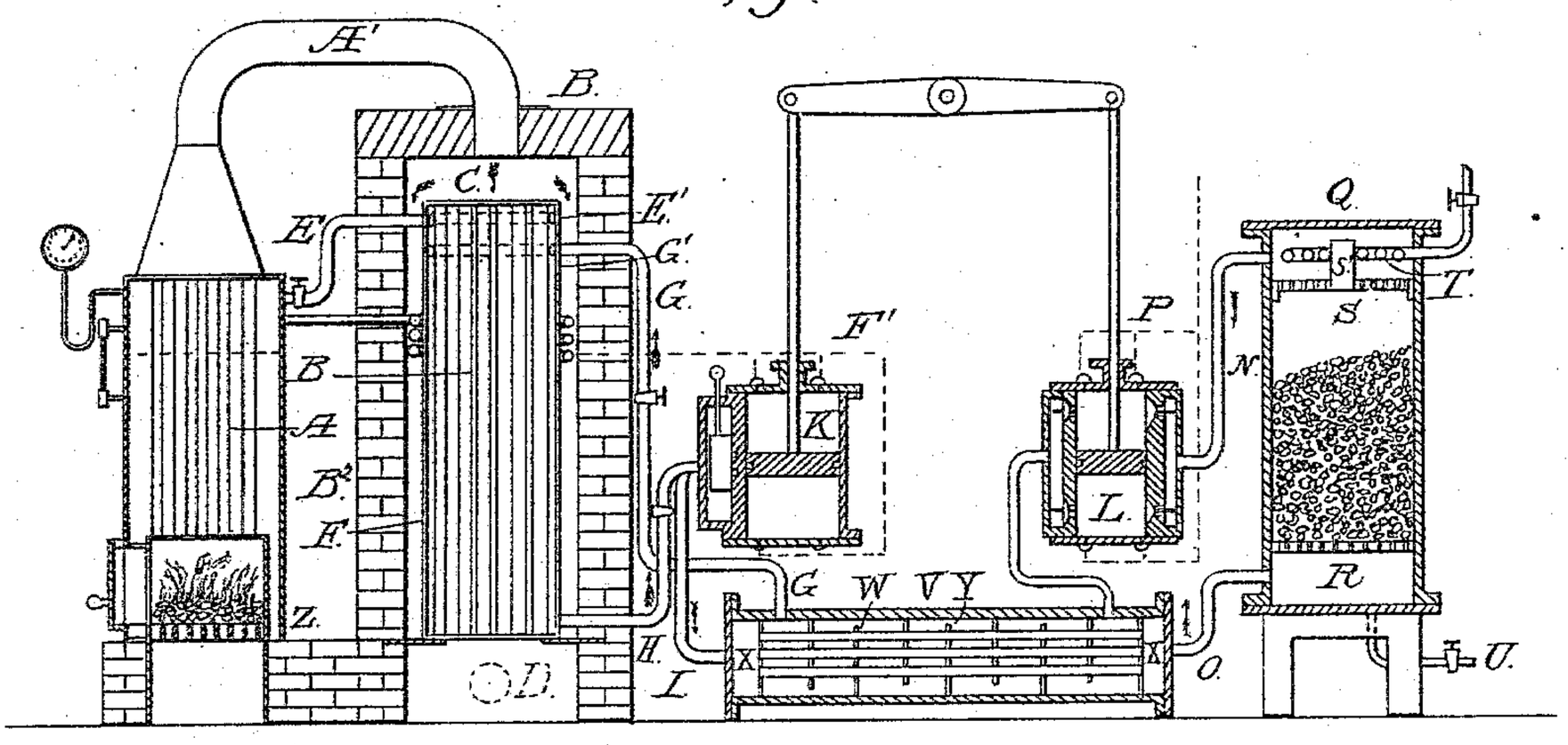

Fig. 2.

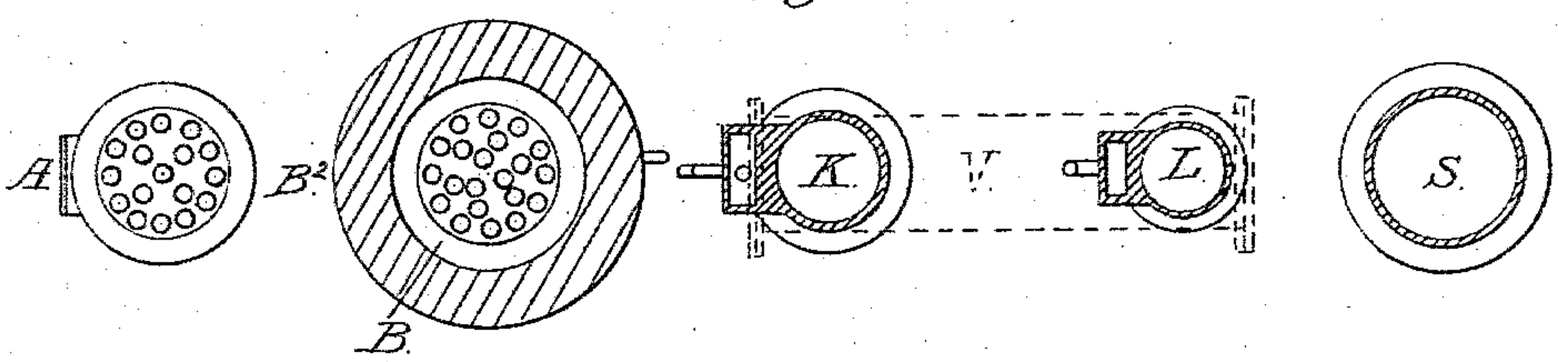

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Fig 3

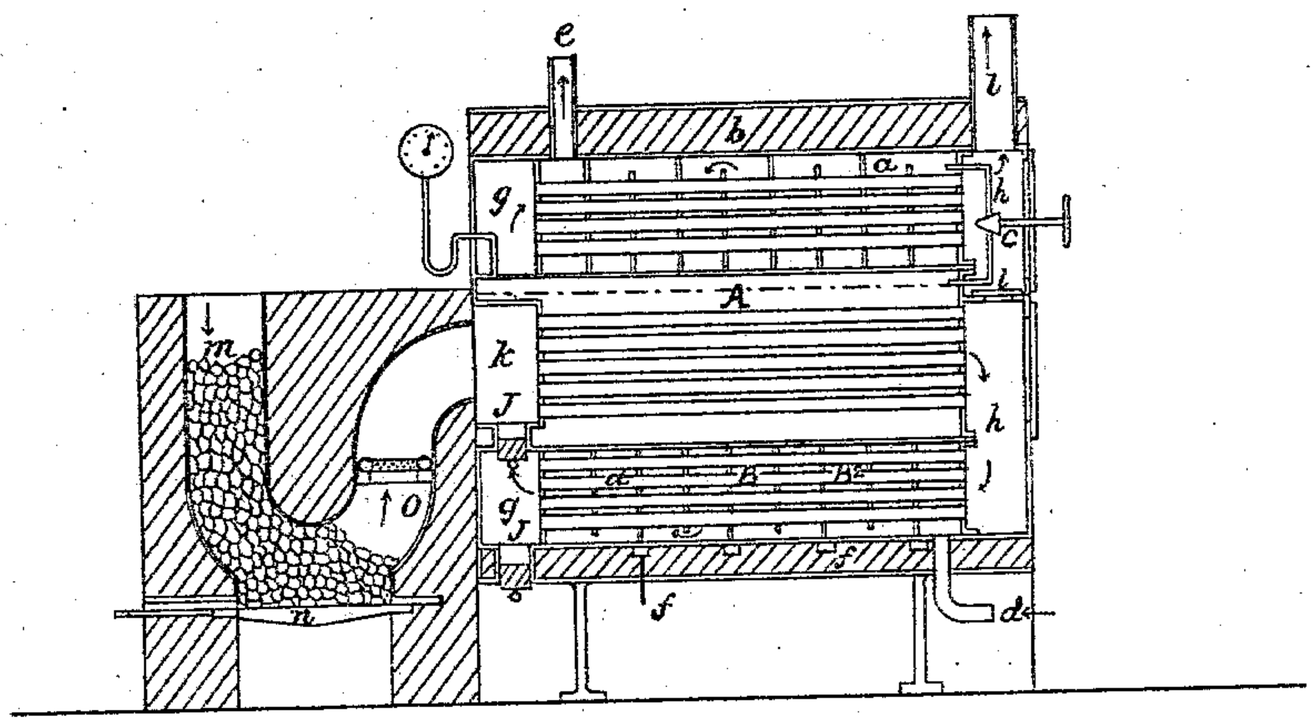

Fig 4

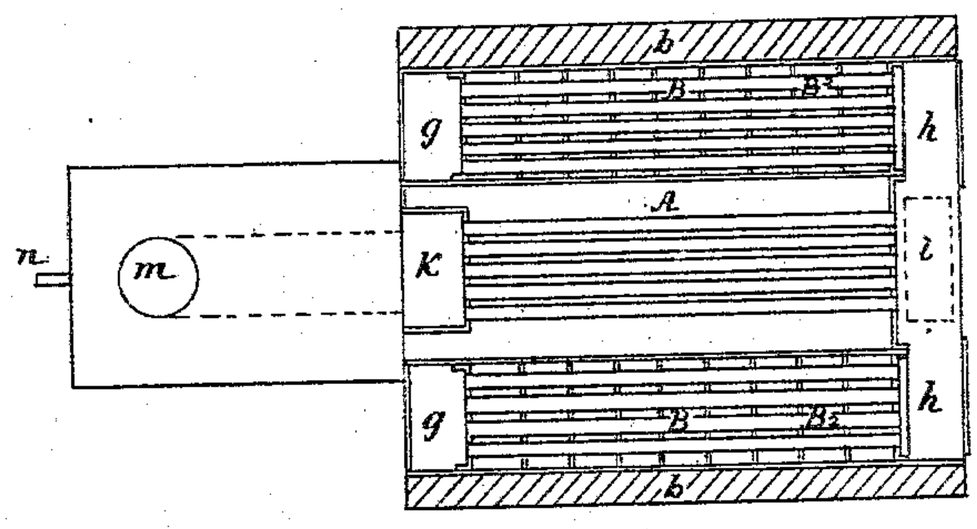

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Fig 5

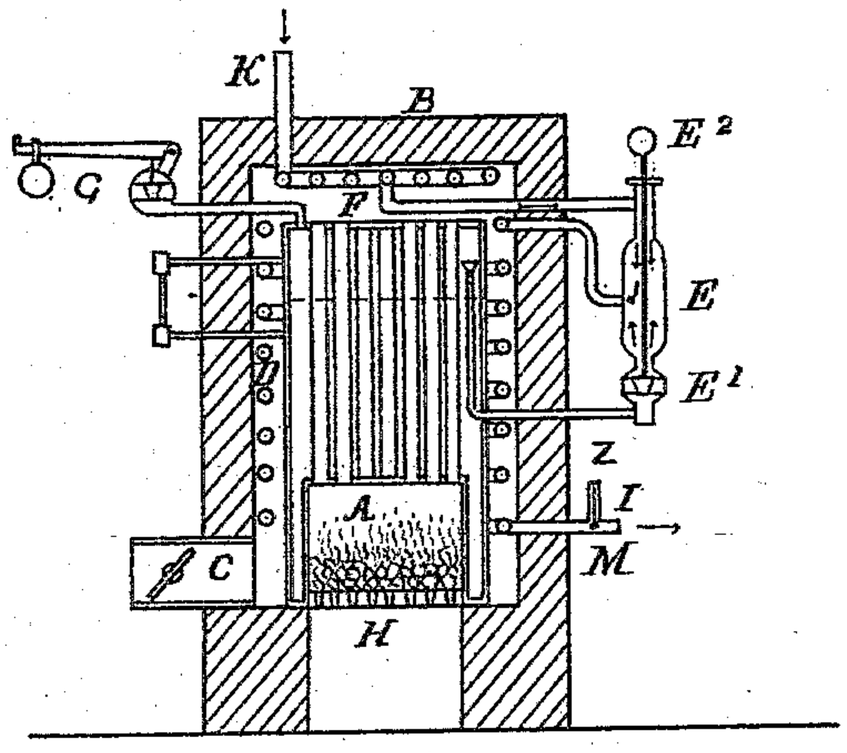
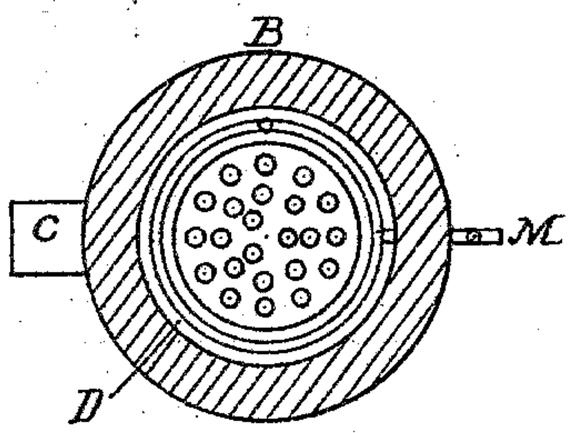


Fig 6



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UNITED STATES PATENT OFFICE.

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PROCESS OF OBTAINING MOTIVE POWER.

SPECIFICATION forming part of Letters Patent No. 287,917, dated November 6, 1883.

Application filed January 23, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS MARA FELL, civil engineer, a citizen of the United States, residing at Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in the Process of Obtaining Motive Power; and I do hereby declare that the following is a full, clear, and exact description of the invention, which will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to a method or process of producing and utilizing a highly-elastic gas or vapor by means of heat, water, and air, and mechanism therefor, which I term a "pneumatic-vapor engine;" and the object of my invention is to furnish an economical and available force for purposes of motive power.

The first feature of my invention relates to generating a pneumatic vapor of high density by saturating compressed air maintained under a constant but variable pressure with aqueous moisture, and by heating and extracting the large amount of heat held by such moisture, producing a highly-elastic fluid possessing a large proportion of the mechanical force now held latent in ordinary steam.

The second feature relates to utilizing this force by working between a maximum and minimum pressure, the first being the pounds or power produced, and which is operated so as to maintain the full mean effect upon the engine or cylinder, and the latter a result brought about by expansion and a system of coolers or condensers.

A third feature relates to operating the various parts without change of temperature, which I accomplish by securing a constant flow of the vapor in one continuous direction, while at the same time securing all the benefit which is derived from the conservation of heat.

The drawings attached hereto represent the mechanism by which my invention may be carried into effect, Figure 1 being a vertical longitudinal view of all the parts, and Fig. 2 a general plan, in which A is a small ordinary steam-boiler, which may be either upright, as shown, or horizontal, or other kind of generator. In this view the ordinary gases of combustion are made to pass over to a large superheating or hot-vapor vessel, B, by a chimney, A'.

I construct the vapor-superheater so as to expose a large surface to the action of the heat, which I obtain by means of the tubes C and the outside shell. Surrounding this superheater is a wall of non-conducting material, B^2, and at the bottom an exit-chimney, D, through which the gases of fire-combustion should be made to pass at or above the temperature of the produced steam, so as to maintain a proper degree of heat; E, a pipe delivering steam by means of a coil, E', and placed on the inside of said superheater; F, a superheating steam-coil placed within the fire-chamber of the superheater; G, an air-pipe delivering air to a perforated coil, G', and which I place just below the coil E'; H, pneumatic-vapor-delivery pipe, and I cylinder exhaust-pipe; K, the cylinder or engine, fitted with the usual parts, and which I operate with a cut-off; L, the compression air-pump, with the usual inlet and outlet valves, and having an exhaust-pipe, M, and a supply-pipe, N; O, pipe leading to the condenser, and P cold-water-spray-injection pipes; Q, a cold-water condenser, which may be in the form of a tubular condenser, or act by direct surface, as shown, and in which R is a perforated plate, upon which are placed loosely-packed pieces of coke, brick, or other material. S is a finely-perforated plate or disk having an outlet-pipe, S'; T, a coil and cold-water pipe, and U an overflow-pipe and tap. V is a vessel termed an "economizer," having a number of tubes, W, placed in an outer shell, and two heads, into which the tubes are fastened, and enough short so as to leave two end spaces, X. Y are a number of vertical partitions having an outlet alternately on each plate, at the top and bottom, so as to form a long run across the outer surfaces of such tubes.

Besides the above-described mechanism, I employ a small atmospheric air pump and vessel (not shown) for the purpose of compensating for any leakage, and which I also employ for starting the motor when first used.

The operation is as follows: Excepting the

boiler and the flues leading to the chimney, the entire apparatus is first filled with compressed air—the vessel B with any determined pressure as a maximum force, (which we will presume is one hundred pounds,) and all other parts with a determined minimum pressure of, say, twenty-five pounds, provided the cut-off be one-fourth. This filling is done by starting the auxillary air-pump by steam from the boiler. Working under these conditions, it is now necessary to maintain the steam a few pounds above one hundred pounds, which is injected by the pipe and coil E′ in fine spray form, and on coming in contact with the fine streams of cold air entering by the lower coil, G′, immediately mixes and expands the same. The heat supplied by the tubes and shell of the superheater prevents any tendency to cool, and by maintaining the maximum temperature enables the colder body of air to extract not only a proportion of the thermometric heat, but also the greater part of the latent thermal heat held by the steam, and in this manner producing a highly expansive pneumatic vapor. The vapor passes by the pipe H to the engine or cylinder K, in which it is expanded by means of the cut-off, and after imparting its mechanical energy to the movable piston is exhausted at the lower or minimum pressure, (twenty-five pounds.) The exhaust-pipe I now leads to the economizer V by way of the tubes, and by the pipe O at the other end to the condenser Q, and thence, after passing up through and between the cooled surfaces, and thereby depositing or exchanging its warm vapor particles for a fresh supply of cold aqueous moisture, and becoming contracted in bulk, although still maintaining the minimum pressure, passes out by the pipe N. By the action of the compressor L, which may be much less in capacity than the cylinder K, this cooled saturated air is drawn out of the condenser by the pipe N and compressed to the original maximum pressure. The circuit is continued by passing to the economizer V, (by the pipe M,) through which it circulates around the dividing-partitions Y, and is gradually heated by passing over the outer surfaces of the tubes to the pipe G, through which it once more reaches the superheater by the lower coil, G′, and is re-expanded by the incoming steam-spray, as before explained.

The function of the economizer V is to utilize a large proportion of the otherwise waste heat passing off by the pipe I, and is of further advantage in thus lessening the duty of the cold condenser. The condenser Q is fitted with a cold-water-supply pipe and coil T, which feeds the distributing-plate S and an overflow-pipe, U.

In the working of my system of obtaining expansion, and in order to maintain the maximum temperature until the exhaustion takes place in the engine or cylinder, I introduce a small quantity of highly-superheated steam at both ends of such cylinder. This steam is heated by a separate coil, F, Fig. 1, and is taken from the boiler by a pipe and enters the cylinder in one or two jets by the pipes following the dotted lines indicated at F′. The advantage of this arrangement is that the effect of cooling consequent in expansion is removed, and I thereby obtain the full mean effect throughout the entire stroke. For a contra reason I also furnish the compressor L with a similar set of injection-pipes, as indicated by the dotted lines marked as P; but through these jets I introduce a spray of cold water, in order to overcome the effect of compression, and by thus removing the heat enable the compressor to pass a full supply to the economizer V. The amount of heat necessary for producing the expansions may be calculated from the known capacity or difference of units held by water, air, and steam, which, reckoned from a temperature of 60° Fahrenheit, gives for one pound of air sixty-six, water (heated to 212°) one hundred and eighty, and steam eight hundred and sixty-nine thermal units; and as one pound of air is in bulk 12.4 cube feet, it requires only 5.32 units for the expansion of one cubic foot. By proportioning the steam entering by the coil E′ very little as steam will enter the cylinder, the pneumatic vapor consisting largely of atmospheric molecules, having extracted the bulk of the latent heat.

My invention is essentially and distinctly different from an ordinary air-engine, which for great power so far has proved impracticable, and which is owing to the fact that normal air does not possess a diathermal property, especially when under compression. The destruction of parts caused by the use of high temperatures does not occur under my system, which may be operated to produce an almost unlimited amount of force at no higher degree of heat than is now employed in the production of ordinary steam. A further advantage of my system consists in obtaining either more or less power without effecting the consumption of fuel, the first being accomplished by raising the maximum pounds or by altering the condition of the cut-off.

The volume of pneumatic vapor being largely in excess of the volume of air permits the use of a comparatively small compressor. My power is derived from the difference of area of the cylinder and compression-pump, by expanding and exhausting by means of the cut-off directly to the minimum pressure, the difference between the initial and exhaust pressure, and in the manner of maintaining and operating both pressures.

Having now described one set of mechanism by which my invention may be practically carried out, I now refer to an improved plan of combining the steam-generator and the superheater as one vessel. The other parts, being the same as before explained, are not shown.

Fig. 3 shows a vertical longitudinal section,

and Fig. 4 a plan, of this arrangement, and in which A represents the steam generator or boiler, with its flues placed horizontally, and surrounding this boiler is constructed the superheater B, with its tubes. *a* are a number of division-plates having an opening alternately at the top and bottom; *b*, a circular casing of non-conducting material on the outside shell; *c*, the steam-pipe and tap; *d*, the inlet-pipe for the cold saturated air, and *e* outlet of pneumatic vapor passing to the engine. *f* are small flood-pipes for drainage of hot surplus water; *g*, front circular space for the passage of the fire-gases; *h*, the back space communicating with the chimney; *j*, man-holes and doors for cleaning purposes, and *k* the tube-chamber. Extending horizontally across the back chamber or space, *h*, and just above the tubes of the boiler, is a horizontal partition having a movable damper, *l*, which (when required) permits the fire gases to pass direct to the chimney. I prefer to construct this arrangement so as to have a downward system of burning fuel, and therefore build the furnace of brick on the outside and at one end, and in which *m* is the feed-hole, *n* a set of shaking bars, and *o* a contracted throat fitted with a perforated pipe for delivering fine streams of air by means of a small fan or pump. This method of heating not only prevents the deposition of soot in the system of flues, but affords the means of obtaining a more perfect combustion.

The operation is as follows: The fire-gases pass from the furnace into the chamber *k* through the tubes of the boiler and into the lower space, *h*, and by being shut off from the chimney by the plate and damper *l* pass downward and by the lower half of the tubes B^2 to the front space or chamber, *g*, thence upward and around the end of the boiler to the upper half of the tubes, and then exit by the chimney *i*. Steam enters by the pipe and valve *c*, and meets the cold saturated air entering by the pipe *d*, which then passes along and over the heated surfaces of the tubes B^2 and the outer shell of the steam-generator, and by the pipe *e* proceeds to the cylinder of the engine.

For working at very high pressures the form of these vessels may be still further changed to that of the coil system of boilers, and as a very small amount of steam or moisture is required, water may be injected into said coil.

As a further modification, the cold current passing by the pipe G may be injected at the point marked Z of Fig. 1, or directly into the water of the steam-generator, in which case it will enter the superheater by the pipe and coil E and E′.

For small motors I prefer to construct that part of my mechanism which furnishes the motive force in the form shown in Figs. 5 and 6, the latter a sectional view, in which A is the steam-generator, surrounded by a brick wall or casing, B, leaving a space around the sides and at the top. C is the chimney; D, a long coil used as a superheater; E, a small mixing-chamber provided with a valve, E′, which is loaded by a weight, E^2. F is a separate top coil; G, safety-valve; H, ordinary grate-bars, and I a pyrometer for ascertaining the temperature. The cold current of saturated air coming from the condenser, as before explained, first enters the top coil by the pipe K, and by the return end of the coil delivers into the small mixing-vessel E, in which it meets the steam coming by the pipe Z and valve E′, and then through the long coil or worm D and the pipe M to the cylinder of the engine, after which the steam circulates through the economizer, condenser, and compression-pump in the manner before described.

The object of the valve E′ is to control the entrance of the steam at such density and temperature as may be required.

Now, what I claim as my invention is—

1. The method of obtaining motive power from heat, air, and aqueous mixture by saturating air with water, expanding such moisture by steam and heat, and circulating and maintaining the resulting vapor under a constant but variable pressure through a mechanism or an engine, in the manner substantially as described.

2. The method of obtaining motive power from air or other fixed gas by saturating such air or gas with aqueous moisture, expanding the mixture to a maximum pressure by superheated steam, passing the same through a motor operated with a cut-off, in order to produce an exhaust minimum pressure, contracting the volume by means of coolers, and then compressing the cooled air, gas, or vapor back to the first or maximum pressure, substantially as described.

3. In combination with an air or vapor motor, a separate jet or jets of superheated steam or air applied to the cylinder as a means of preventing cooling consequent on using such air or vapor expansively, substantially in the manner specified.

4. In air or vapor motors, a steam-boiler, A, delivering steam into a superheater, B, in which it meets a current of air for expansion, in combination with an economizer, V, cylinder K, compression-pump L, and cold condenser Q, all operated for the purposes and substantially in the manner as specified.

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