(No Model.) I. R. BLUMENBERG, Dec'd. 3 Sheets—Sheet 1.

W. BLUMENBERG, Administratrix.

VAPOR GENERATOR AND MOTOR.

No. 290,964. Patented Dec. 25, 1883.

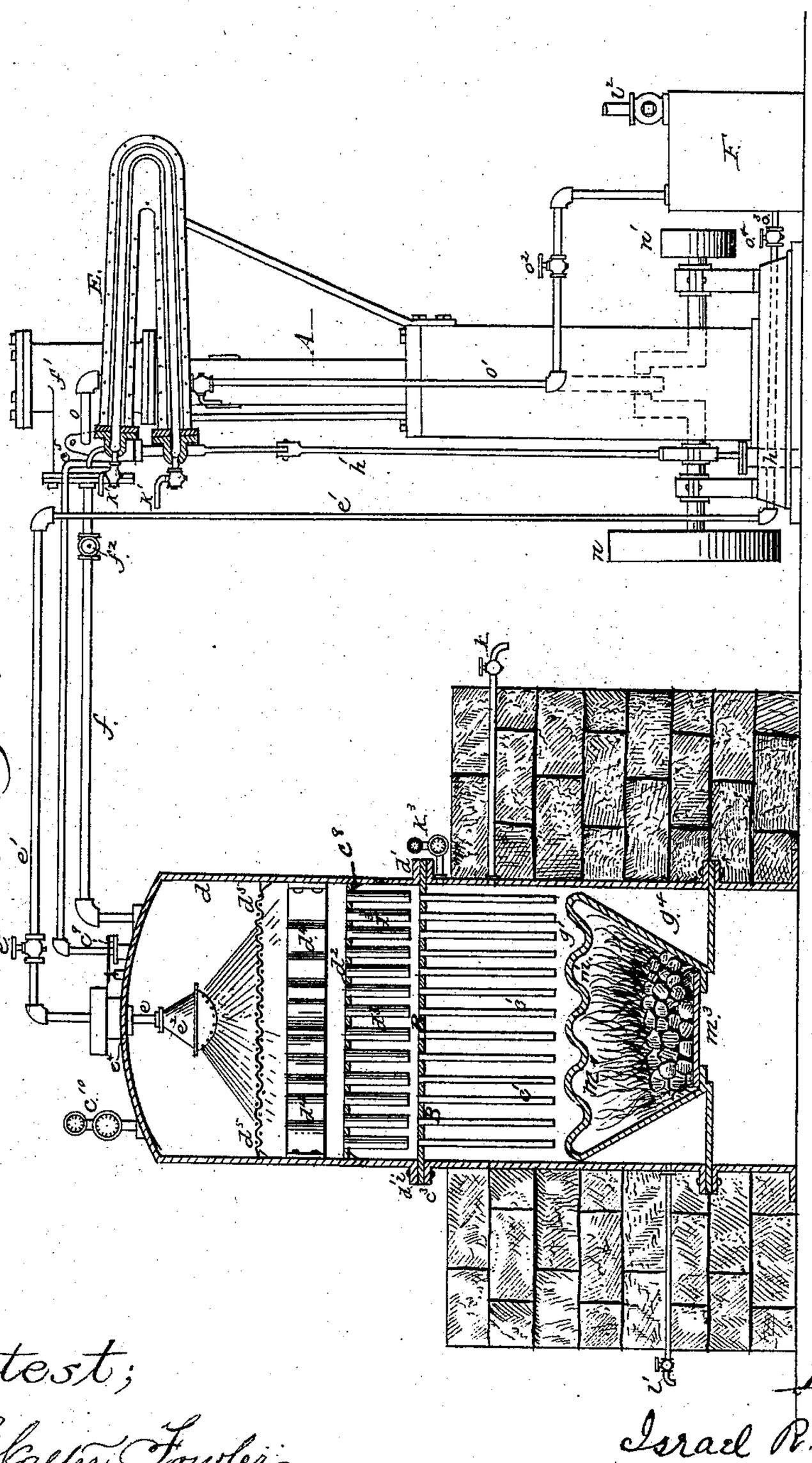

Fig. 1.

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His attorney

(No Model.) I. R. BLUMENBERG, Dec'd. 3 Sheets—Sheet 2.

W. BLUMENBERG, Administratrix.

VAPOR GENERATOR AND MOTOR.

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Fig. 3.

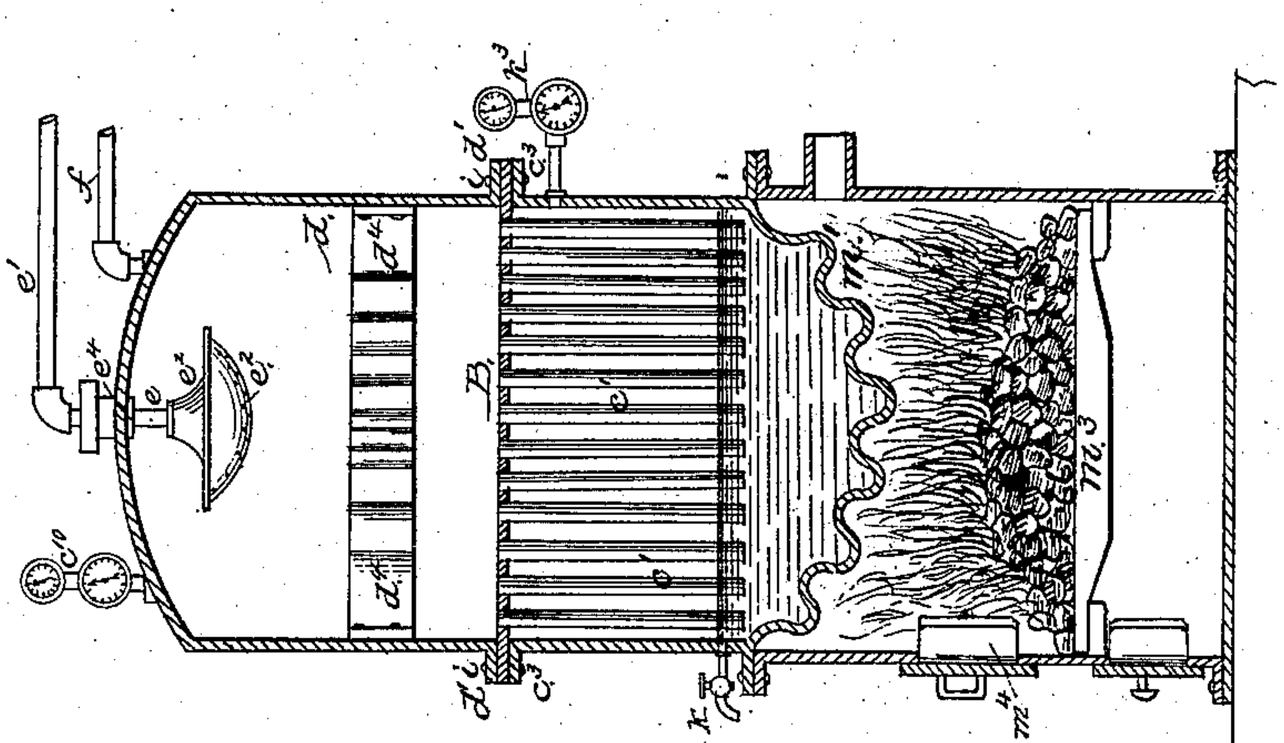
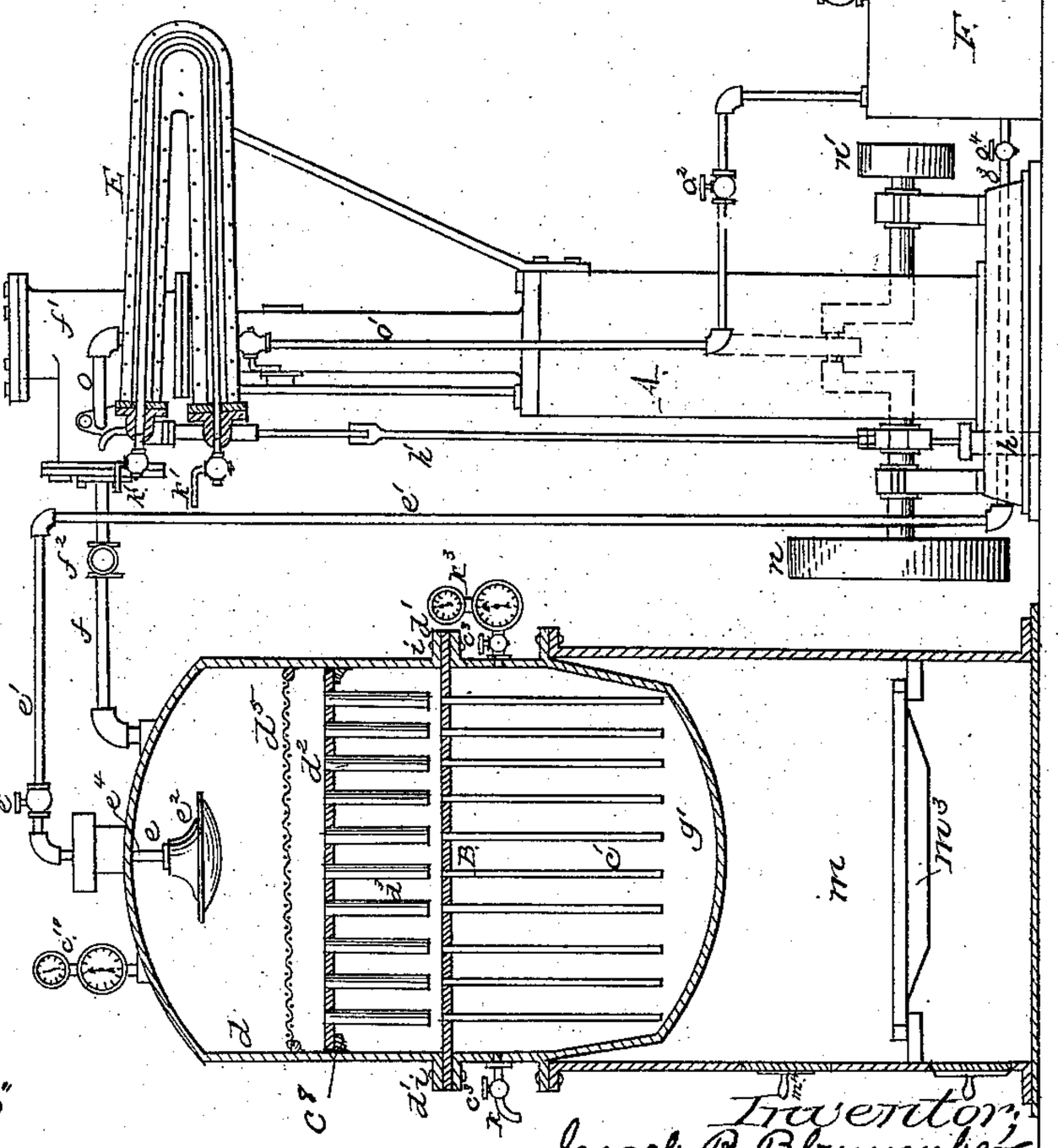


Fig. 2.



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(No Model.) 3 Sheets—Sheet 3.

I. R. BLUMENBERG, Dec'd.

W. BLUMENBERG, Administratrix.

VAPOR GENERATOR AND MOTOR.

No. 290,964. Patented Dec. 25, 1883.

Fig. 4

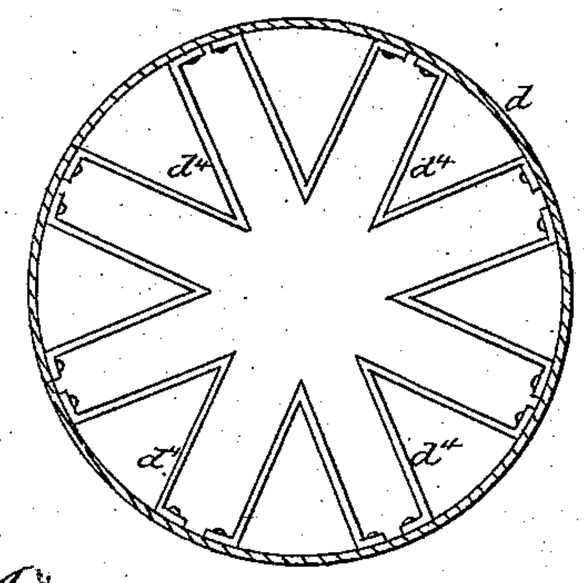


Fig. 5

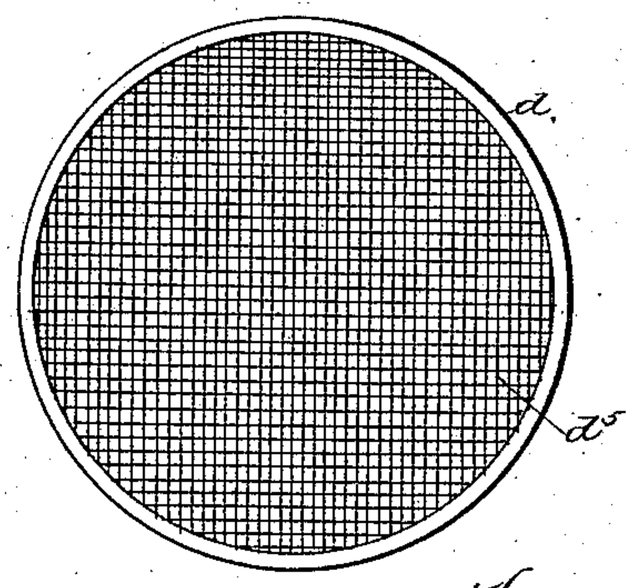


Fig. 10.

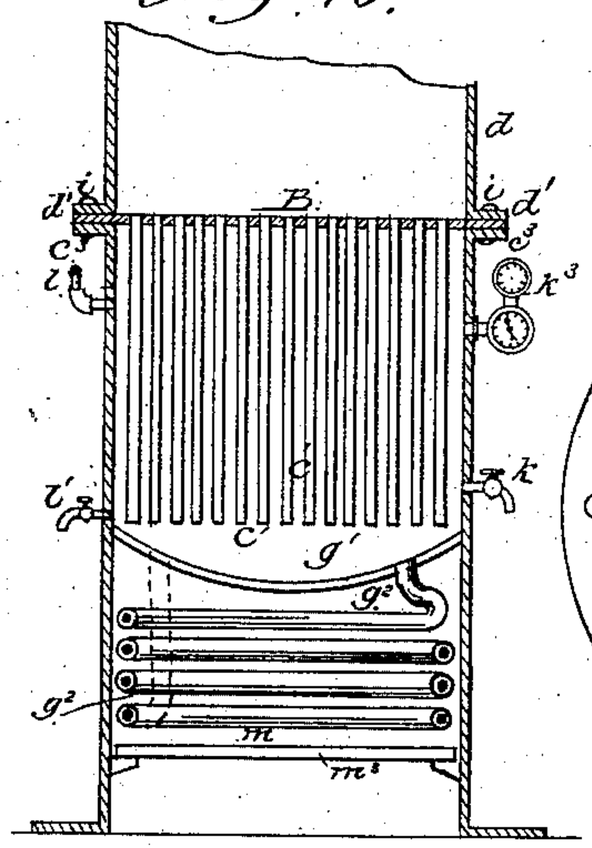


Fig 6

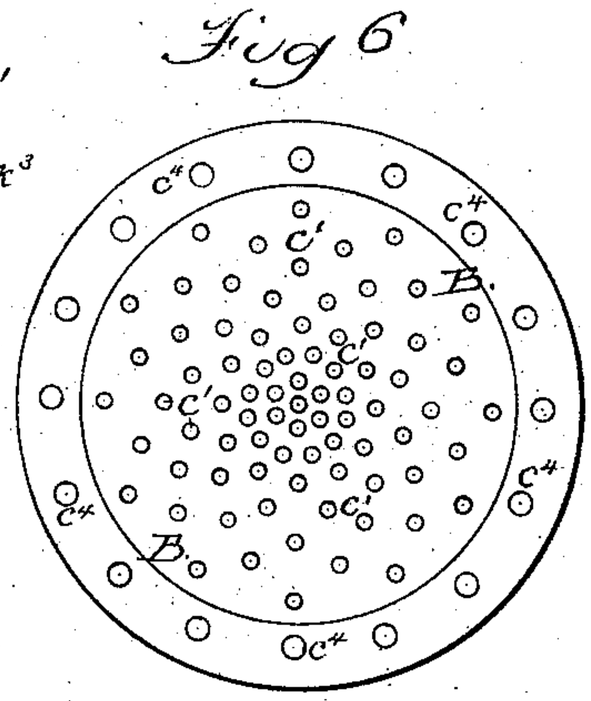


Fig. 9.

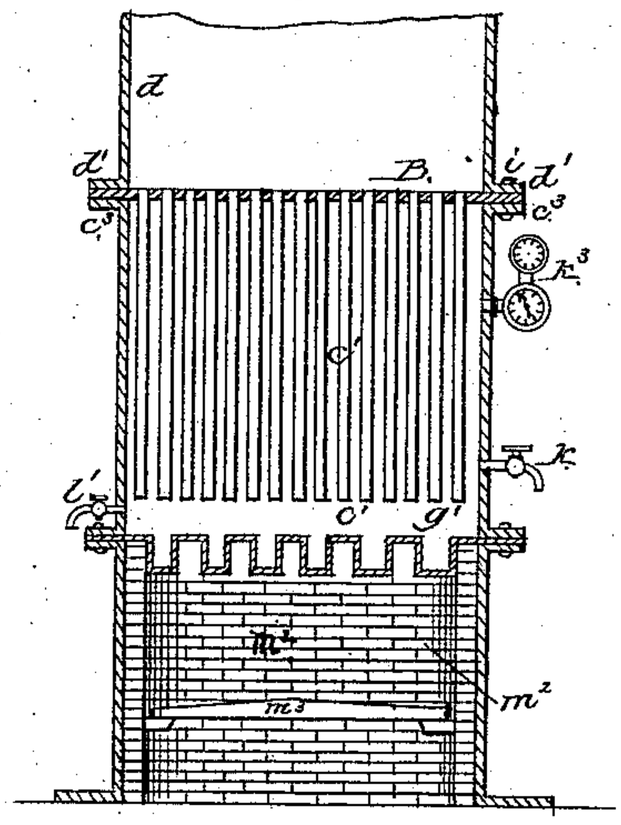


Fig. 7

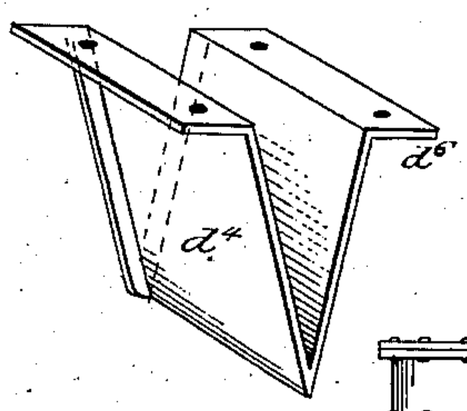


Fig. 8

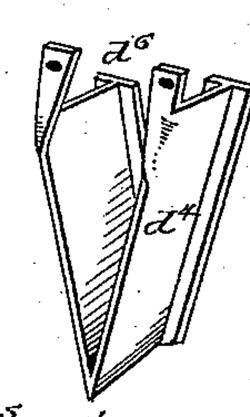
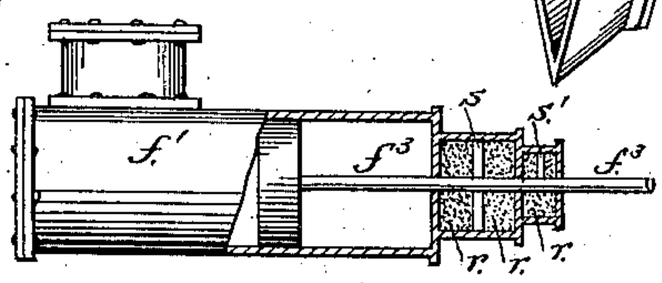


Fig. 11.



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Inventor;
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His attorney

UNITED STATES PATENT OFFICE.

ISRAEL R. BLUMENBERG, OF WASHINGTON, DISTRICT OF COLUMBIA; WILHELMINA BLUMENBERG, ADMINISTRATRIX OF SAID BLUMENBERG, DECEASED, ASSIGNOR TO FRANCIS H. SMITH, OF SAME PLACE.

VAPOR GENERATOR AND MOTOR.

SPECIFICATION forming part of Letters Patent No. 290,964, dated December 25, 1883.

Application filed February 3, 1883. (No model.)

To all whom it may concern:

Be it known that I, ISRAEL R. BLUMENBERG, a citizen of the United States, residing at Washington, in the District of Columbia, have invented certain new and useful Improvements in Vapor-Generators and Motors, of which the following is a specification, reference being had therein to the accompanying drawings.

My invention relates to improvements in the method of resolving volatile fluids into power-vapor, as well as in the form, construction, and arrangement of power-vapor generators, steam-boilers, and furnaces, and in the mode of adjusting and connecting the several parts one to the other; and it consists in adjusting and securing a bell or dome shaped empty vertical cylindrical vapor-generator having a circling flange on the lower rim, and provided with a vapor-gage, a safety-valve, induction-pipe terminating in a rose on the inside, an eduction-pipe and protuberances on the inner wall, on the upper side of a disk or plate of metal containing numerous long slim tubes, secured therein and extending outward, and closed at the outer ends, secured in a substantial manner on the open upper end of a steam-boiler, arranged over and forming part of a heating-furnace, and provided with a corrugated bottom with annular water-legs, or a coil-pipe extending from the bottom down into the furnace beneath, the idea being to present as great a surface as possible to the fire in the furnace for heating purposes, the said boiler being provided with an induction-pipe for water, a waste-pipe to draw off, a steam-gage to test the pressure, and a blow-off pipe to relieve the boiler of air.

It further consists in providing protuberances on the inner wall of such vapor-generators for supporting in place removable diaphragms, and in securing thereon a metal lattice or wire diaphragm, a metal plate or disk containing numerous short open tubes, or a series of V-shaped brackets, when it is desired to increase the power without increasing the external diameter or the consumption of fuel, all of which is more particularly shown and pointed out in the accompanying drawings and specification.

Similar letters of reference indicate corresponding parts.

Figure 1 is a vertical section of a steam-boiler with annular water-legs, furnace, ash-pit, and vapor-generator, showing sets of closed and open tubes, two tube-plates or diaphragms, a series of V-shaped brackets, a wire diaphragm, a distributing-rose, a liquid-induction pipe and general supply-pipe, vapor-gage, and vapor-eduction pipe *f*, a safety-valve, c^9, supports, &c.; also a side elevation of a vertical engine, A, showing the various connections therewith, a vapor-condenser, E, reservoir F, and a pump, *h*. Fig. 2 is a side elevation of a vapor-engine with a vapor-condenser, E, attached, a fluid-reservoir, F, and a pump, *h;* also a vertical section of a vertical furnace, steam-boiler and vapor-generator, the latter showing two sets of vaporizing-tubes, a rose or fluid-distributer, and the connecting-pipes, as well the steam and vapor gages, throttle-valves, and stop-cocks. Fig. 3 is a vertical section of a combined furnace, steam-boiler, and vapor-generator, the bottom of the steam-boiler being corrugated to present a greater heating-surface to the action of the fire, and the vapor-generator showing adjusted therein a series of V-shaped brackets; also the connecting-pipes, gages, stop-cocks, and throttle-valves. Fig. 4 is a horizontal cross-section of the vapor-generator, showing the plan of the V-shaped brackets. Fig. 5 is a plan of a wire diaphragm used, when desired, in the vapor-generator. Fig. 6 is a plan of the "tube-plate" B, showing the tubes c', secured therein, and the bolt-holes c^4. Fig. 7 is a perspective of one form of V-shaped brackets. Fig. 8 is a perspective of another form of V-shaped brackets. Fig. 9 is a vertical section of a combined vapor-generator, furnace, and steam-boiler, the latter showing a tubulated bottom, the inside of the furnace bricked up to prevent radiation and loss of heat. Fig. 10 is a vertical section of a combined vapor-generator, furnace, and steam-boiler, the latter showing a pipe passing out at one point, and after passing in a coil through the furnace returning at another. Fig. 11 is a sectional view of the fluid-packing reservoir in the packing-box of the cylinder.

d is a vertical cylindrical vapor-generator, of metal of great strength, the height being equal to about from one and one-half to two and one-half diameters, constructed in almost any form, preference being given to the inverted-bell shape, open at the bottom, and having an external flange, *d'*, around the edge of the open end, perforated for bolts *i*, provided with a vapor-gage, c^{10}, a safety-valve, c^9, and internal protuberances, c^8, on which the diaphragms d^2 and d^3 and brackets d^1 rest or are secured. In the top of the generator *d* is introduced a general supply-pipe, *e*, having a distributing-nozzle, e^2, and provided with a check-valve, e^1; also a vapor-eduction pipe, *f*, provided with a throttle-valve, f^2, the former connecting the generator with the reservoir F through the pump *h*, and the latter connecting the generator with the motor-engine.

Connected by one end to the supply-pipe *e* and by the other to force-pump *h* is a general supply-pipe, e', having a stop-cock and check-valve, e^2, through which the volatile fluid is carried from the reservoir F through pump *h* to the generator *d*, and the flow thereof is regulated by the stop-cock e^3, the check-valve e^4 preventing the generated vapor from passing back into the pipes. The open part of the generator *d* rests on and is secured by bolts *i* to a tube-plate, B, which is as large in diameter as both the generator *d* and its flange *d'*. The plate B is a circular disk or diaphragm, of metal of great tensile strength, of the same diameter as both the generator *d* and its flange *d'*, into which is secured, by their open ends, a large number of long slim tubes, *c'*, flush with one side and extending their full length beyond the other, and closed and made vapor-tight at the outer ends. The disk B serves as a bottom to the vapor-generator *d*, and separates it from the steam-boiler *g'* beneath, and is perforated, near its periphery, its entire circumference, with bolt-holes c^4, by which it is secured both to the generator *d* and the steam-boiler *g'*, into which the tubes *c'* extend their entire length, by bolts *i*. The under side of the plate B, with its myriad of tubes *c'* extending full depth into the boiler *g'*, presents an extensive area to the action of the heat required to convert the volatile liquid into vapor. I call this plate and its tubes my "tube-plate." In the simple generator the volatile liquid is thrown in a spray onto the plate B and into the mouths of the open tubes *c'*, and there being such an extensive heated surface a very large quantity of fluid is instantly converted into power-vapor, so that with a generator thirty-six inches in diameter and about two-thirds of the diameter in height, with tubes twenty inches deep, I can obtain from one to five hundred horse-power in vapor, using not to exceed ten pounds of steam-pressure for heating purposes; but when I increase my heating-surface by adding internally-adjusted diaphragms or brackets, or both, as hereinafter shown, I multiply my power without increasing either the external dimensions or the consumption of fuel.

g' is a cylindrical boiler, constructed of proper material and of the same diameter as the generator *d*, provided with an external flange, c^3, around the open upper edge, perforated with bolt-holes, by which it and the tube-plate B and the vapor-generator *d* are secured together, a blow-pipe, *k*, a steam-gage, k^3, a water-tap, *l'*, and a water-induction pipe, *l*. This vessel is necessarily but a little deeper, vertically, than the length of the closed tubes *c'* in the tube-plate B, which protrudes into it, as shown in Figs. 1, 2, 3, 9, and 10, and may have a plain bottom, as shown in Fig. 2, a corrugated bottom, as shown in Fig. 3, or a corrugated bottom with annular water-legs g^4, surrounding the furnace, as shown in Fig. 1, or a tubulated bottom, as shown in Fig. 9, or, as shown in Fig. 10, it may have protruding from the bottom at one point a coil-pipe, g^2, extending into the furnace and again entering the boiler. These various forms of boilers are suggested by the necessity of presenting as great a superficial surface to the action of the fire as can be had without materially increasing the area to be occupied by the boiler and generator or increasing the size of the furnace, the idea being as well the economy of fuel as of space. By using the corrugated bottom, or the boiler with a corrugated bottom and annular water-legs, or the modifications shown, I materially increase my heating-surface without necessarily increasing the quantity of water or fuel requisite to accomplish the purpose—*i. e.*, generating a sufficient moist heat to instantaneously vaporize the fluid as it is injected into the vapor-generator.

m m' m² are furnaces or fire-places, differing only in detail of construction, the furnace *m* being only the ordinary stove-furnace provided with a grate, m^3, ash-pit, draft, dampers, &c., appurtenant to such furnaces. The furnace *m'* is constructed within annular water-legs extending down from the boiler *g'*, while the furnace m^2 is walled on the inside with fire-brick. These various forms or classes of furnaces have all the usual and most improved accessories pertaining to furnaces. The furnace *m*, *m'*, or m^2 selected and the boiler *g'* are adjusted and firmly secured together by any approved mode, the tube-plate B put in place on the open upper end of the boiler *g'*, the tubes *c'* extending down into the boiler, the vapor-generator *d'* placed on the top of the tube-plate B and secured to the boiler *g'* by bolts *i* in the flanges *d'* and c^3 and the plate B, the several joints having previously been carefully packed by any suitable packing, to prevent any possibility of leakage either of the vapor or the steam. I prefer, however, to use the packing invented by myself and secured to me by Letters Patent No. 230,996, and dated August 10, A. D. 1880, and the whole set up and adjusted as indicated, and connected with the pump *h* and engine A.

The volatile liquid is automatically pumped into the generator as required, and the vapor is generated by moist heat from the boiler g' continuously, as hereinafter described.

The induction-pipe e, preferably a copper pipe of about seven-eighths of an inch in diameter, secured in the crown of the vapor-generator, is provided with a check-valve, e^4, near the shell of the generator, to prevent the vapor from forcing its way out through the supply-pipe e', and thence to the pump h, and terminates in a rose, e^2, within the generator, and is connected with the supply-pipe e'. The rose e^2 is of any approved design that will best perform the function of distributing the volatile liquid in a spray or shower, as desired, and over the most extensive surface. The supply-pipe e' is an ordinary metal pipe about seven-eighths of an inch in diameter, provided with a stop-cock or globe-valve, e^3, to regulate the flow of the liquid, and is attached at one end to the induction-pipe e and by the other with the pump h, and is used for conducting the volatile liquid from the pump to the generator.

The eduction-pipe f should be constructed of metal of considerable tensile strength, may be of any diameter requisite, and is provided with a throttle-valve, f^2, through which the flow of the vapor from the generator to the cylinder f' of the engine A is regulated. This pipe is secured by one end to the generator by a vapor-tight joint and by the other end to the engine-cylinder by a similar joint.

c^{10} is an ordinary vapor-gage to show the power-pressure.

c^9 is an ordinary weighted safety-valve, connected by a pipe, c^6, with the surface-condenser E, or any other condenser used, so that if by any chance there should be too heavy a head of vapor in the generator it could escape through the safety-valve to the condenser, be immediately converted into fluid, and avoid accident.

c^8 are protuberances on the inner wall of the generator d, which support the auxiliary diaphragms or brackets which it may be deemed necessary to adjust therein, as hereinafter explained.

It is a well-known and recognized fact among those informed on the subject that in vapor generated by heat there is a certain amount of latent heat, which, when properly husbanded, may be utilized in generating other power. To be better understood I wish to say, a unit of water at its boiling-point requires 535.77 units of heat to convert it into steam at the same temperature as the water from which it was derived, while a unit of volatile liquid—say, for instance, bisulphide of carbon—at its boiling-point requires only 86.67 units of heat to convert it into vapor at the same temperature as the bisulphide of carbon from which it was derived—about one-sixth of that required for water. Therefore bisulphide of carbon vaporized under heat generated by steam will carry off from four to six times as much heat as is requisite to vaporize and usefully employ the vapor. This heat I propose to use when I desire to multiply my power without increasing the external diameter of my generator, boiler, and furnace; and with this end in view I have devised several forms of adjunct metal diaphragms and brackets, which I adjust within the vapor-generator d, which occupy no material space and do not interfere with the free expansion or action of the vapor.

These features are set forth in an application for another patent, in which they are claimed; but to show their relation to this character of generator I will outline them here.

d^2 is a light metal plate or disk, of the diameter of the interior of the generator d, into which is securely fastened one end of a large number of open tubes, d^3, considerably larger in diameter, though shorter, than the tubes c'.

d^4 is a V-shaped bracket having projections on the lower edge and a flange for securing it in place, and d^5 is a metal screen, of the same diameter of the interior of the generator d. When I desire to increase my power, as stated, I adjust the tube-plate d^2 within the generator d, by resting it on the projections c^8 therein, or adjust a series of brackets, d^4, around the interior of the generator, as shown in Figs. 4 and 5; or I adjust the screen d^5 within the generator; or, if I prefer it, I employ any two or more of these, which are heated by the latent heat from the vapor, so that when the fluid is thrown upon them in a spray it is either vaporized or heated to that degree that it is readily vaporized when it reaches the tube-plate B. By this means I obtain a surface for vaporizing an additional quantity of fluid without employing any additional fuel or external space.

k^2 and k^3 are the ordinary steam-gages, used to indicate the pressure of the steam in the boiler.

l is a small pipe for supplying the boiler g' with water. l' is a waste-pipe or tap, for drawing off the water from the same. k is an ordinary escape or blow pipe and cock, all being shown in Fig. 10.

A is a motor-engine, vertical or horizontal, having a band-wheel, n', and a balance-wheel, n; and in addition to its other functions, through a reciprocating rod, h', attached to an eccentric and connected with the pump h, it automatically supplies the fluid to the generator d. Connected with the engine by an exhaust-pipe, o, is a surface-condenser, E.

E is a surface-condenser, fully described in the specification to Letters Patent No. 238,754, granted to me March 15, A. D. 1881, and its function is to condense the vapor after it has been used in the cylinder f', before it is returned through the pipe o' to the reservoir F, and is attached to the engine by the exhaust-pipe o. While I prefer this style of condenser, I do not confine myself exclusively to its use or to any form, using as well the coil-pipe or

any approved form in use. k' are blow-pipes on the condenser E, through which an accumulation of air or vapor is blown off.

F is a liquid-reservoir. It may be of any form or size, and of any suitable material. It is provided with an induction-pipe, o', an eduction-pipe, o^3, a blow-pipe by which it is relieved of pressure from the accumulation of air, and an induction funnel and cock, l^2.

h is a force-pump operated through the rod h' by an eccentric on the engine A. By this pump the fluid is drawn from the reservoir F through the pipe o^3, and injected into the empty chamber of the vapor-generator d, through the pipe c' c and distributing-rose c^2.

The various parts having been adjusted and connected as herein shown, the reservoir supplied with fluid, and steam having been generated in the boiler g' and brought in contact with the under side of the tube-plate B and the outsides of the tubes c', heating them to a temperature sufficient to vaporize the fluid, the volatile liquid is injected into the empty chamber of the generator d, through the supply-pipe c, and by the rose c^2 thrown in a shower or spray onto the tube-plate B and into the open mouths of the tubes c', or onto the auxiliary parts d^2 d^4 d^5, and the tube-plate B, where it is instantly converted into power-vapor and conducted by the eduction-pipe f to the engine-cylinder f', where, by direct impact on the piston f^3 of the motor-engine A, which is actuated and which through an eccentric thereon actuates the pump h, which draws the volatile fluid from the reservoir F through the pipe o^3, and automatically supplies it to the generator d, the vapor having performed its office, passes from the engine-cylinder f' through the exhaust to the condenser E, where it is again converted into fluid and returned to the reservoir F, to be again used. The operation being continuous, the liquid may be used *ad infinitum*, without loss or waste, and there being no escape for the steam, there is no loss of water—a barrel of water per day being sufficient to run an engine of twenty to one hundred horse-power, and, after the first heating, as the boilers are not replenished by cold water, it will require less fuel to keep up the temperature necessary to generate vapor.

I am aware that numerous attempts have heretofore been made to advantageously employ vapor generated from bisulphide of carbon and other volatile fluids as an active motor agent, and many devices have been devised to that end. The difficulty heretofore has been to so construct the machinery as to secure a steady, uniform, reliable power, and at the same time economize fuel, space, cost of machinery, and money, as well as to produce something that may be introduced into every-day use. By my invention and several improvements on my motor-power vapor-generating devices and methods of generating and utilizing such vapors, I claim that I have accomplished this, in that, by my tube-plate B, within an apparently limited space, I, on the one side, present an extensive surface to the action of the heating medium, steam, and on the other side an extensive area raised by steam to a temperature to between four and five times greater than is actually required to vaporize the volatile fluid, and that by injecting the volatile fluid in a continuous shower or spray into the empty heated generating-chamber, enlarged by the many tubes c, and the tube-plate B, and, when desired, by the adjunct diaphragms d^2, d^4, and d^5, therein secured, I augment my power to almost any reasonable extent without increasing the consumption of fuel, keeping up at the same time a uniform power, be it greater or less; and then, by preventing loss or waste of the vapor generated by constructing a reservoir of fluid packing within the packing-box of the engine-cylinder, and packing the several connecting-joints with my "joint-packing," which practical experience has abundantly demonstrated will wholly seal up the parts and prevent the escape of the vapor; and, by condensing and reusing the volatile fluid, safety, utility, and economy are secured.

The above-described method of utilizing volatile fluid, and in packing the joints as well as packing the engine-cylinder, are shown in various modified forms and claimed in other applications for patents which I now have pending and in patents granted to me. I do not therefore claim them, broadly, in the present application.

By the use of the boiler with corrugated bottom, or the boiler with corrugated bottom and annular water-legs, or the modifications thereof, I present no inconsiderable steam-boiler area to the action of the fire for heating purposes, I require less fuel to generate steam by continuously using the same heated water for supplying the heat required for generating the power-vapor, and I economize the fuel required or necessary for raising the water from its then mean temperature to that of boiling water or steam.

As compared with the cost of steam, exclusive of the difference in the cost of the two characters of motors, &c., as well as the difference in the space occupied by the two classes of motors, as another item of economy I may suggest, first, that the specific heat required to raise bisulphide of carbon from a comparable to a boiling-point, water being 1 or unit, is .248967. In other words, it takes only about one-fourth as much heat to raise bisulphide of carbon or similar volatile fluids from a common temperature to its boiling-point as it does water to its boiling-point, which of course cuts off at least three-fourths of the fuel demanded by steam for that part of the work; second, the latent heat of vaporization—*i. e.*, the amount of heat required to convert a unit of a body, at its boiling-point, from the liquid to its vapor state, both

liquid and vapor being at the same temperature—of bisulphide of carbon is only one-fifth that of water; hence one-sixth of the amount of heat required by water will do the same work with my motor; third, the loss of heat by radiation from my motor will be very much less than where steam is employed, for two reasons: first, the lower temperature—that is to say, the 180° of heat required to vaporize the fluid used in vapor-motors as compared with the 240° to 700° or more required for steam-engines, as the ratio of radiation advances rapidly as the temperature rises, and second, the smallness of my generator, as compared with steam-boilers, presents much less surface for throwing off heat, and to the consumer these are matters of grave importance; fourth, in my generator the bottom tube-plate, B, with its myriad of small tubes *c'*, is heated to a temperature of from 212° to 700° Fahrenheit and greater, heating the empty chamber above it to the same degree of temperature. The volatile fluid introduced into the chamber, falling upon this tube-plate B, is heated to the same degree of temperature and converted into power-vapor, and as this vapor rises through the diaphragms carrying with it this volume of heat the diaphragms are necessarily heated to that same temperature. As the volatile fluid pumped into the generator, and in a shower or spray, is brought in contact with the heated metal diaphragms, the temperature of the fluid is raised either to the vapor state, or to that degree of temperature that, when brought in contact with the tube-plate B, it is made a power-vapor at a lesser cost of heat.

The device which I show as my vapor-motor generator is simple in construction, easily handled, and equally as tractable as steam-power devices, and, I claim, more safe, for the following reasons: By simply opening the valve e^3, and increasing the supply of fluid, I can raise my power from zero to from one to five hundred pounds pressure; with a steam-pressure, for heating purposes, of from three to ten pounds, and by simply shutting off the supply of fluid, I again reduce the power to zero, and that, too, without changing the steam-pressure; but should it so chance that too great a pressure of vapor is generated in the generator, the safety-valve will give way and permit the vapor to discharge into the condenser E, when it is again condensed into a harmless fluid; but should an explosion take place there are no ponderous metal boilers to be torn, and, together with superheated steam and boiling water, be made the instruments of death and destruction.

A patent, No. 236,411, has already issued to me on an inchoate idea of this invention, wherefore I do not purpose claiming, broadly, what is herein described; and while in my drawings and specifications I show a reservoir of fluid packing in my engine-cylinder, I do so merely to show its location and the mode of confining the vapor. Having shown and claimed this feature in another application allowed to me, I do not claim it herein.

What I esteem as new, and desire to protect by Letters Patent, is—

1. The method of producing power-vapor by automatically and as it is required continuously injecting volatile fluid, in a shower or spray, into a vertical metal chamber over internally-adjusted auxiliary metal parts and into the mouths of numerous long slim tubes arranged parallel with the flow of the liquid, and secured by their ends in a metal disk placed at the bottom of said cylinder at right angles to the line of the shower, the said chamber, tubes, and disks being heated by boiling water or steam externally applied, substantially as shown and described.

2. A vertical bell-shaped vapor-motor generator having a flange on the lower rim by which it is secured in place, and provided with an induction-pipe through which connection is made with a motor-engine cylinder, and an induction-pipe connecting through a pump with a general supply-reservoir, and terminating within the generator in a flaring distributing-rose for delivering the liquid in a spray or shower onto the heated metal below, arranged on the upper side of a disk of metal, in which is secured by their open ends a large number of long slim tubes, the open ends thereof being flush with the upper face of the disk and the closed ends protruding therefrom their entire length into the open top of a steam-boiler, having a corrugated bottom and annular water-legs surrounding a heating-furnace, over which it is secured, substantially as shown and described.

3. A combined furnace and steam-boiler, the latter having a corrugated bottom and annular water-legs extending down around the furnace, and provided with a water-induction pipe, a waste-pipe, a blow-off pipe to relieve the boiler of air, and steam-gage, substantially as shown and described.

4. In a vertical vapor-motor generator, a combined furnace and cylindrical steam-boiler, the latter having a corrugated bottom with annular water-legs extending down about the fire in the furnace below, and provided with a flange on the upper edge perforated for bolts, by which a tube-plate containing numerous long slim tubes and a vertical vapor-generator are secured thereon, substantially as shown and described.

5. In combination, vertical vapor-generator *d*, supply-pipe *e'*, induction-pipe *e*, distributing-rose e^2, wire screen or lattice diaphragm d^5, tube-plate B, steam-boiler with corrugated bottom having annular water-legs, furnace *m*, and eduction-pipe *f*, substantially as shown and described.

6. In a device for generating motor-power vapor through the medium of steam and boiling water, constructed substantially as shown, a vertical furnace and steam-boiler, the latter having a corrugated bottom and provided

with a water-induction pipe, a waste-pipe, a blow-off pipe, and a steam-gage, substantially as shown and described.

7. A steam-generating boiler, g', having a corrugated bottom with annular water-legs g^4, in combination with a furnace, m, and a tube-plate, B, in a device for generating motor-power vapor from volatile fluid, substantially as shown and described.

8. A steam-generating boiler, g', having a corrugated bottom with annular water-legs g^4, and provided with steam-test gage k^3, a blow-off pipe, k, a water-induction pipe, l, and a waste-pipe, l', in combination with and surrounding a furnace below, and with a tube-plate, B, in a device for generating motor-power vapor, substantially as shown and described.

9. In combination, steam-generator g', having a corrugated bottom and provided with a steam-gage, blow-off pipe, water-supply pipe and waste-pipe, furnace m, tube-plate B, vapor-generator d, tube-plate diaphragm d^2, induction-pipe e, distributing-rose e^2, check-valve e^4, supply-pipe e', force-pump h, and reservoir, substantially as shown and described.

10. In combination, steam-generator g', furnace m, tube-plate B, vapor-generator d, auxiliary diaphragms d^2 d^4 d^5, induction-pipe e, distributing-rose e^2, check-valve e^4, supply-pipe e', pump h, and reservoir F, eduction-pipe f, having a throttle-valve f^2, engine-cylinder f', exhaust o, condenser E, and reservoir F, substantially as shown and described.

11. In combination, plate B, provided with and securing, by their open upper ends brought flush with one side thereof, a large number of long tubes, c', hermetically closed at the opposite outer ends, vapor-generator d, provided with internally arranged metal diaphragms and brackets, a furnace, m, and a steam-boiler, g', the latter having a corrugated bottom and annular water-legs g^4, surrounding the fire-place, in a device for generating the initial heat as well as motor-power vapor, substantially as shown and described.

12. Plate B, provided with and securing, by their open upper ends brought flush with one side thereof, a large number of long tubes, c', hermetically closed at the outer ends, in combination with a vertical cylindrical vapor-generator, d, a furnace, m, and steam-boiler g', the former having internally-arranged metal diaphragms, and the latter having a corrugated body provided with annular water-legs surrounding the furnace, the whole constructed and arranged for generating initial heat and motor-power vapor, substantially as shown and described.

13. A vapor-generator, d, provided with induction-pipe e, check-valve e^4, and distributing-rose e^2, eduction-pipe f, tube-plate B, and diaphragms d^2, in combination with steam-boiler g', having a waste-pipe, substantially as shown and described.

In testimony whereof I hereunto affix my signature in presence of two witnesses.

ISRAEL R. BLUMENBERG.

Witnesses:
A. P. RUTHERFORD,
HENRY POLSZ.