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

W. BLUMENBERG, Administratrix.

VAPOR GENERATOR AND MOTOR.

No. 290,962. Patented Dec. 25, 1883.

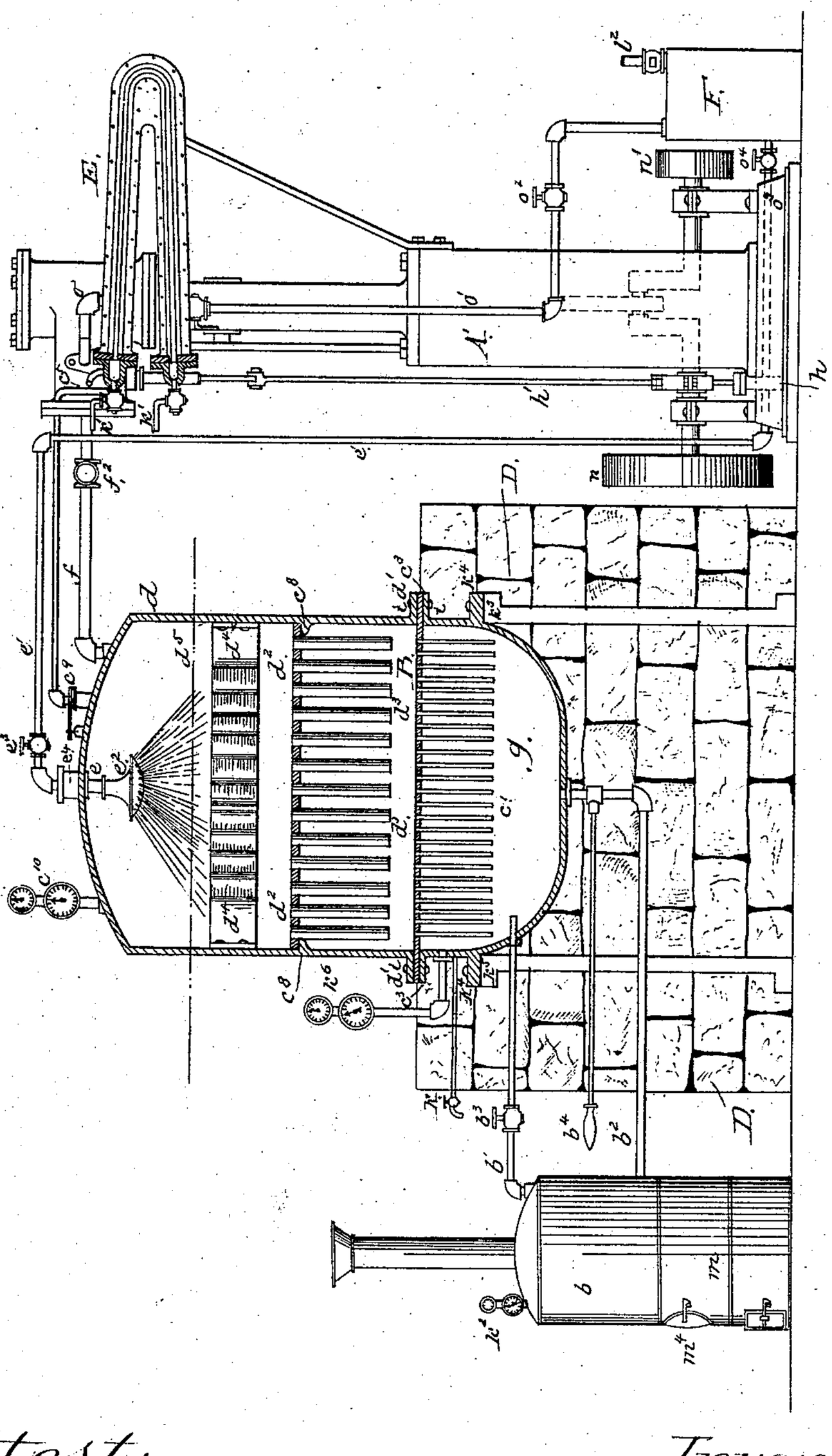

Fig. 1.

Attest;

S. Wheeler, Fowler,

Henry Glassie

Inventor;

Israel R Blumenberg

By D. H. Glassie

his Atty.

(No Model.) 3 Sheets—Sheet 2.

I. R. BLUMENBERG, Dec'd.

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VAPOR GENERATOR AND MOTOR.

No. 290,962. Patented Dec. 25, 1883.

Fig. 2.

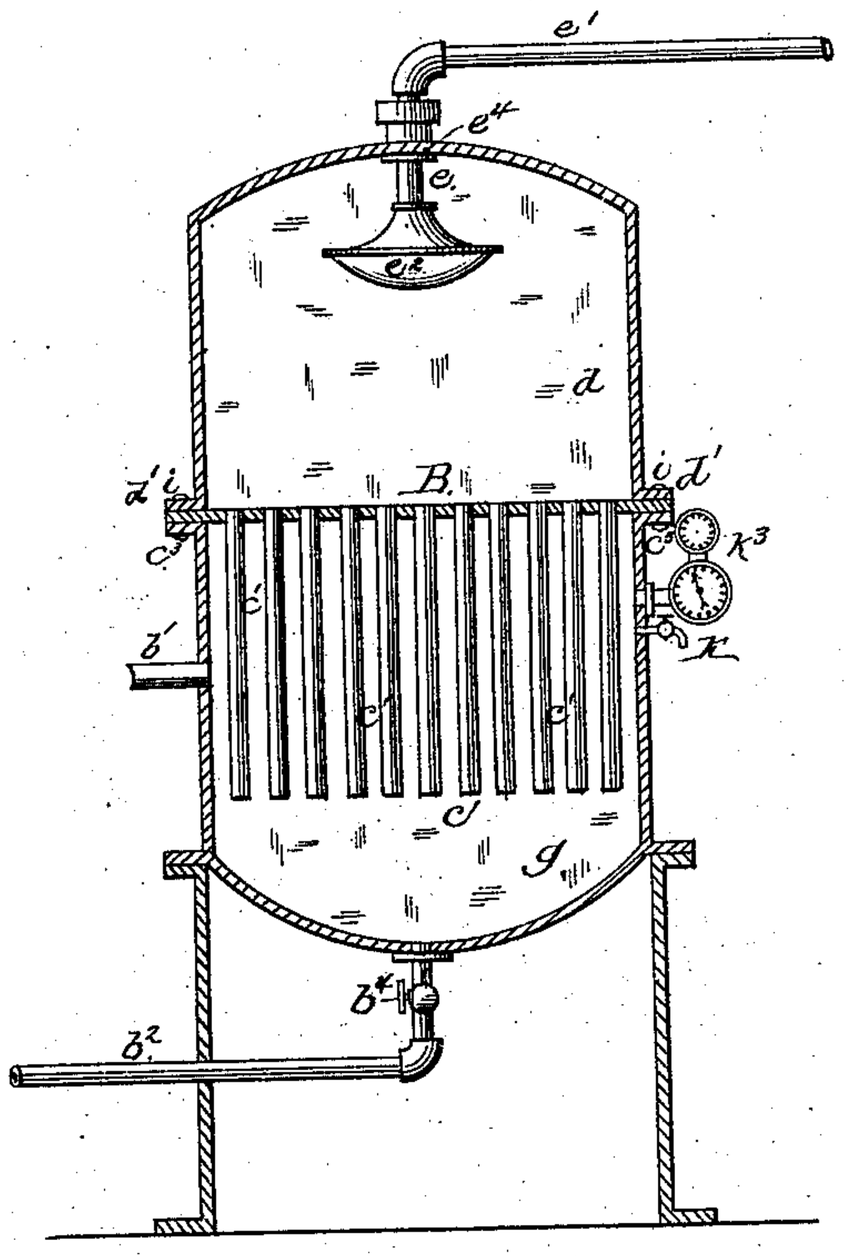


Fig. 3.

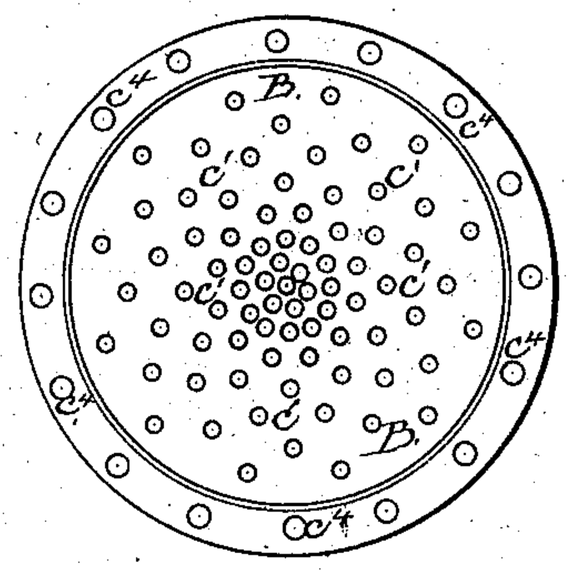


Fig. 5

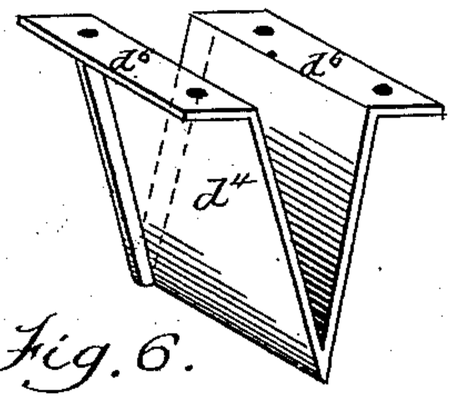
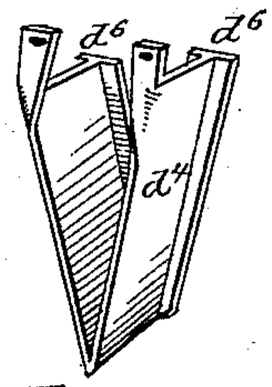


Fig. 6.



Attest;

Walter Fowler

Henry Glassie

Inventor;

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By Henry Glassie

his attorney

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

W. BLUMENBERG, Administratrix.

VAPOR GENERATOR AND MOTOR.

No. 290,962. Patented Dec. 25, 1883.

Fig. 7.

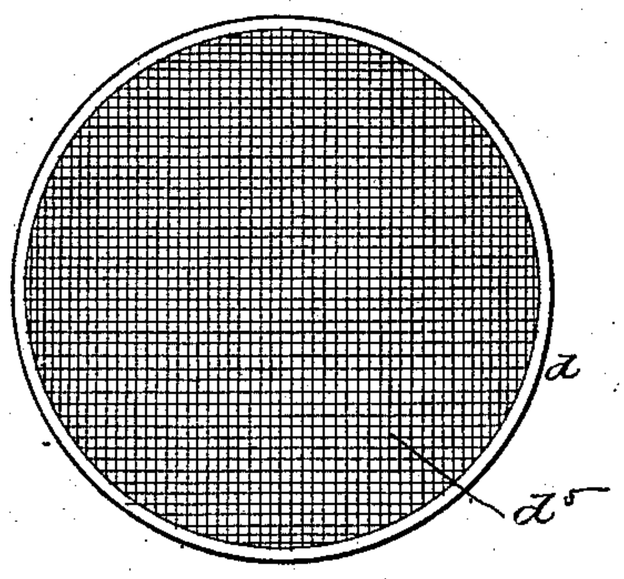


Fig. 4

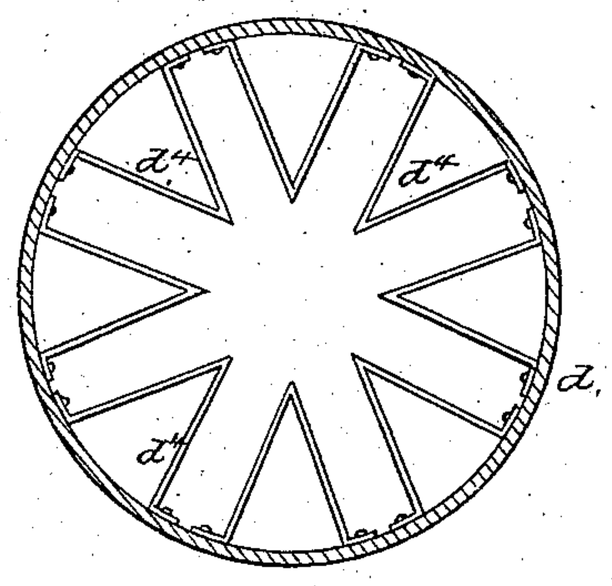
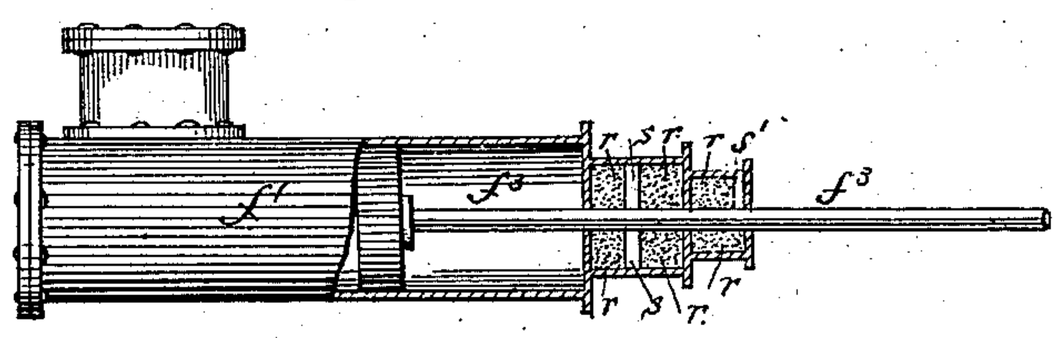


Fig. 8.



Attest;

B. Walter Fowler,

Henry Glassie

Inventor;

Israel R. Blumenberg

By D. & G. Glassie

his Attorneys

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. 290,962, 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 of America, residing at the city of Washington, and District of Columbia, have invented certain new and useful Improvements in Vapor Generator and Motors, of which the following is a specification, reference being had therein to the accompanying drawings.

My invention relates to new and useful improvements in the method of utilizing volatile fluid as a power-motor, heating-boilers, and power-vapor generators, as well as in the mode of adjusting and connecting the several parts one to the other; and it consists in the method of automatically, and as it is required, injecting volatile fluid, in a shower or spray, over internally-adjusted auxiliary metal parts into the empty metal chamber of a vapor-generator, to be instantly converted into power-vapor, and by bringing it in contact with a metal disk containing numerous small tubes protruding down into a steam-chest and closed at their outer ends, and the whole heated by steam circulating on the outer side of the said disk and tubes.

It also consists in arranging a vertical vapor-generator with internally-adjusted auxiliary parts, and provided with induction and eduction pipes, a vapor-gage, and safety-valve on the upper side of a disk or plate of metal, wherein is secured the open ends of a large number of long slim tubes, the closed ends of which protrude down into and in a substantial manner securing the two on the open upper end of a steam-chest connected by induction and eduction pipes with an auxiliary steam-generator, and provided with a steam-gage and blow-off pipe.

It further consists in providing protuberances on the inner wall of a vapor-generator, and introducing and securing therein a metal lattice or wire diaphragm, a metal plate or disk containing numerous open tubes, and a series of V-shaped brackets, one, more, or all, as desired, when it becomes necessary to increase the power and to present more surface upon which to generate vapor.

It also consists in injecting, through a rose or distributing-nose secured on an induction-pipe within the chamber, into the empty generating-chamber, onto the V-shaped brackets or diaphragms and naked tube-plate bottom, a shower of volatile fluid as and sufficient to generate the power required.

Figure 1 is a side elevation of a steam-boiler, furnace, and ash-pit, a vertical cross-section of a vapor-generator and steam chamber or chest, 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, steam-induction pipe, b', and an eduction-pipe, b^2, supports, &c.; also a side elevation of a vertical engine, A, showing the various connections therewith, a vapor-condenser, E, a reservoir, F, and a pump, *h*. Fig. 2 is a vertical section of a plain steam chamber or chest, the tube-plate, showing the tubes c' and induction and eduction steam-pipes and stop-cocks. Fig. 3 is a plan of the tube-plate B, showing the tubes c' secured therein and the bolt-holes c^4. Fig. 4 is a cross-section of the vapor-generator, showing a plan of the V-shaped brackets. Fig. 5 is a perspective of one form of V-shaped brackets. Fig. 6 is a perspective of another form of V-shaped brackets. Fig. 7 is a plan of wire diaphragm used when desired, in the vapor-generator. Fig. 8 is a side elevation of an engine-cylinder, broken away to show the fluid-packing reservoir in the packing-box.

Similar letters of reference indicate corresponding parts.

d is a vertical vapor-generator, of metal of great tensile strength, constructed in almost any form. I prefer, however, the inverted bell-shape, with a height equal to from two-thirds of one to two diameters, open at the bottom, and provided with an external flange, d', around the lower edge, perforated for bolts *i*, by which it is secured in place with a vapor-gage, c^{10}, a safety-valve, c^9, and with protuberances c^8 around the inner wall, on which the auxiliary diaphragms rest or are secured. Into the top of the generator *d*, I introduce a general-supply pipe, *e*, provided with a distributing-nozzle, e^2, and a check-valve, e^4, also a vapor-eduction pipe, *f*, provided with a throttle-valve, f^2, the former for supplying the volatile liquor to the generator from the reservoir F, and the latter for conducting the generated vapor from the generator *d* to the cylinder f' of the engine A. The open lower

part of the generator *d* rests on and is secured by bolts *i* to a tube-plate, B, which rests on and is secured on the open upper side of the steam chest or vessel *g*. *f* is a metal eduction-pipe of great tensile strength, provided with a throttle-valve, f^2, by which connection is made between the vapor-generator *d* and the engine-cylinder *f'*, and through which the power-vapor is carried from the generator to the engine-cylinder.

e' is a general-supply pipe, preferably of copper or phosphor-bronze, provided with a stop-cock and check-valve, e^3 e^4, the latter close down to the generator, connected at one end with the induction-pipe *e* and at the other with the pump *h*, by which connection is made between the reservoir F, pump *h*, and generator *d*, and through which the volatile fluid is supplied, automatically and as it is required, to the generator *d*, impelled by the pump, and governed by the stop-cock and valve g^3, the valve e^4 being arranged to prevent the generated vapor from passing into the supply-pipe.

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 are secured, by their open ends, a large number of long slim tubes, *c'*, closed and made vapor-tight at the opposite ends, which disk, with the open mouths of the tubes *c'*, serves as a bottom to the generator *d*, at the same time serving as a cover to the steam-chests *g* below, and it is perforated near its periphery, its entire circumference, with bolt-holes c^4, by which it is secured in place both to the generator *d* and the steam chest or vessel *g*, into which latter the closed ends of the tubes *c'* extend their entire length. The under side of the plate B, with its myriad of tubes *c'*, extending full depth into the steam-vessel *g*, presents an extensive surface 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 tubes *c'*, and, there being such an extensive heated surface, large quantities of fluid are instantly converted into 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 two hundred and fifty 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 diaphragm or brackets, or both, as hereinafter shown, I multiply my power without increasing the external dimensions of my motor.

g is a cylindrical steam chest or vessel, of the same diameter as the generator *d*, and need be but a little deeper than the length of the tubes *c'*, constructed of suitable metal, and either firmly secured on supports k^4 by legs k^5 or embedded in masonry D; and to make it more substantial and firm in its position, I prefer to secure it by lugs k^4 on metal supports k^5, as shown in Fig. 5. The said steam-chest *g* is provided with a blow-pipe, *k*, as an air-escape when steam is being introduced, a steam-gage, k^2, to test the steam-pressure, a steam-induction pipe, *b'*, a small metal pipe for carrying the steam from the boiler, and a similar-sized eduction-pipe, b^2, for carrying the partially-condensed steam back to the boiler. Both of these latter pipes have stop-cocks b^3 and b^1, respectively. It is also provided with a flange, c^3, perforated with bolt-holes, by which it is bolted to the plate B and vapor-generator *d*. The steam from the boiler *b* or any other steam-boiler is carried by the induction-pipe *b'* into the vessel or steam-chamber *g*, where it comes in contact with the outer surface of the closed tubes *c'* and the under side of the plate B, heating both to the temperature required, the eduction-pipe b^2 being open to permit the condensed or partially condensed steam to escape back to the boiler. The tube-plate having been heated, the volatile liquid is injected into the empty chamber of the generator *d* and thrown in a spray or shower upon the tube-plate B and into the open mouths of the tubes *c'*, where it is instantly converted into power-vapor and carried by the eduction-pipe *f* to the engine-cylinder *f'*, putting the engine in motion and starting the pump *h*, which automatically keeps up the supply of liquid through the pipes e^3 and *e'* from the reservoir F, the vapor being recondensed and returned to the reservoir F, as will hereinafter be shown. The steam-chest *g* is connected by a suitable induction-pipe, *b'*, and an eduction-pipe, b^2, with either an auxiliary steam-boiler, *b*, employed for the purpose, or with a steam-boiler generating steam for any other purpose, through which is kept up a current of fresh steam upon the tube-plate B and the tubes *c'*, which extend nearly to the bottom of the said steam-chest *g*. The vapor-generator *d*, having been adjusted in place on the top of the tube-plate B, over the steam-chest *g*, and the three properly secured together by bolts *i* through the flanges *d'* c^3 and the plate B, and the several joints having been packed by any suitable joint-packing to prevent leaking or the escape of the vapor, (I prefer 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 proper connections made between the generator *d* and the reservoir F through the pump *h* and pipes *e*, *e'*, and e^3, and between the generator *d* and the engine-cylinder *f'* through the pipe *f*, and the proper connections made between the steam-chest *g* and a steam-boiler, *b*, through the induction-pipe *b'* and eduction-pipe b^2, the device is ready for work, as herein shown.

The induction-pipe *e*, preferably of copper, is secured in the crown of the vapor-generator, and is provided with a check-valve, e^4, near the shell of the generator, to prevent the escape of the vapor, and terminates in a rose, e^2, within the generator, and connects with

one end of 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 over the most extensive surface. The supply-pipe e' is an ordinary metal pipe, provided with a stop-cock or globe-valve, e^3, to regulate the flow of the liquid, and is connected at one end with 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 of metal of considerable tensile strength, may be of any diameter requisite, is provided with a throttle-valve, f^2, secured by one end to the generator d by a vapor-tight joint and by the other end to the engine-cylinder f' by a similar joint, and the several joints thereof are so constructed, adjusted, arranged, and packed that the power-vapor cannot escape therefrom. The power-vapor is carried through pipe f from the generator d to the engine-cylinder f', and the flow thereof is regulated by the throttle-valve f^2; and to prevent the escape of the vapor from the engine-cylinder through the action of the reciprocating rod f^3 within the packing-box r, in the midst of the packing, I construct a reservoir, s, (see Fig. 8,) through which the reciprocating rod passes, and fill it with glycerine or any suitable fluid packing that will serve the purpose and as a lubricant, and which will fill in and seal up the interstices in and about the reciprocating rod, whereby the channels are hermetically sealed, while the piston-rod, passing backward and forward through the fluid packing, automatically lubricates the cylinder.

I have an application for Letters Patent now pending for this lubricating and packing device, hence do not claim it, broadly and by itself, in connection with this case; but with a view to showing its relation to this device I have briefly described it here.

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

c^9 is an ordinary weighted safety-valve, connected by a pipe, c^5, 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 would escape through the safety-valve to the condenser, be immediately converted into a liquid, and avoid accident.

c^8 are protuberances on the inner wall of the generator d, which support the auxiliary diaphragms or brackets that 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 excess of 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 it 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.

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. 1 and 4; 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 redundancy of 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. In my generator the bottom tube-plate, B, is heated to a temperature of from 212° to 370° Fahrenheit, and greater, heating the empty chamber above it to the same degree of temperature. The volatile fluid introduced into the chamber, falling upon the tube-plate B, is heated to the same degree of temperature and converted into power-vapor, and as this vapor rises through the diaphragms they are necessarily heated to that same temperature. As the volatile fluid is then pumped into the generator and 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 less cost of heat.

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

A is a motor-engine, vertical or horizontal, which, in addition to its other functions, through a rod, h', attached to an eccentric and

connected with it, actuates the pump *h* and 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 is employed 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 engine by an 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. *k k'* are blow-pipes on the condenser E, to relieve the condenser of any extraordinary accumulation of air or vapor.

F is a fluid-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 to relieve the general reservoir of any accumulation of air, and induction-funnel and cock l^2. The fluid to be used is put into the reservoir F through funnel l^2 in a quantity sufficient to about half fill it. The air is then exhausted and the reservoir is hermetically closed. If I prefer it, I can adjust my pump *h* within the reservoir and operate the same down through the top thereof.

h is a force-pump operated through the rod *h'* by an eccentric on the engine-shaft of 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 *e' e* and distributing-rose e^2.

The various parts having been adjusted and connected as herein shown, the reservoir supplied with fluid, and generator heated up to the requisite temperature by steam obtained for the purpose, the pump *h* is set in motion and to drawing liquid from the reservoir F through the pipe o^3 and forcing it in to the generator *d*, where, through the induction-pipe *e* and rose e^2, it is distributed in a spray upon the heated tube-plate B, or through the auxiliary parts d^2 d^4 d^5, to be immediately converted into power-vapor, which, by the induction-pipe *f*, is carried to the cylinder *f'* and made to actuate the piston f^3 of the motor-engine, escaping thence through the exhaust *o* to the condenser E, where it is again converted into fluid and returned to the reservoir F, to be reused, the operation being continuous. The fluid is 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 as, after the first heating, the boilers are not replenished by cold water, but by partially-condensed steam, it will require less fuel to keep up the temperature required 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 suggested to that end. The difficulty heretofore has been to so construct the machinery as to secure a steady, uniform, reliable power and motion, 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. I claim that I have accomplished this, in that by my tube-plate B, within an apparently limited space, I present on the one side an extensive surface to the heating medium—steam—and on the other an extensive area heated for generating the vapor required; that by injecting the volatile fluid in a spray into the empty heated chamber enlarged by the many tubes *c'* in plate B, as well as by the adjunct diaphragm d^2 d^4 d^5 when employed, I can increase as required and keep up a uniform power almost without limit, without consuming additional fuel, and by preventing the escape of vapor by my packing, which practical experience has demonstrated cannot be surpassed, if it can be equaled, by any packing now in use, and by the reservoir of fluid packing arranged within the packing-box of the engine-cylinder, and by condensing and reusing the fluid, I avoid an immense expense and produce economical results not heretofore accomplished—that is to say, in addition to the great saving of space for both the motor and fuel, the cost of the machine or motor, I save the cost of the difference in the quantity of fuel required to convert volatile liquid into power-vapor and that for raising a large continuous supply of fresh water from its normal temperature to that of steam, for scientifically it will be recognized that the specific heat required to raise from a comparable to a boiling-point, water being one or unit, bisulphide of carbon is .248967; or, in other words, it takes only about one-fourth as much heat to raise bisulphide of carbon from ordinary temperature to its boiling-point as it does water to its boiling-point. This cuts off three-fourths of the fuel for that part of the work. Again, the latent heat of vaporization (*i. e.*, the amount of heat required to convert an 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, or one-sixth of the amount of heat required by water will do the same work with my motor. The loss of heat by radiation from my generator 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 my motor as compared with the 240°, or more, required for steam-engines—as the ratio of radiation advances rapidly as the temperature rises; and, secondly, a large body will naturally throw off more heat than a smaller one; hence the smallness of my generator as compared with steam-boilers presents much less surface for the emission of heat, whereby fuel, heat, and power are economized.

Power-vapor motors are no more complicated or difficult to understand, but are much more easily handled, than a steam-motor, and are perfectly tractable. By simply turning or opening the valve e^3 in my device, I can raise my power from zero to five hundred pounds pressure to the square inch, and by reversing or closing the valve reduce it again to zero, the whole operation taking but a few seconds, and this with but from three to ten pounds of steam-pressure for heating purposes. Power-vapor motors are safer than steam, for the moment the pump ceases to supply the fluid, or the valve through which it is introduced is closed, the power to do mischief is gone. If, however, by any chance too great a pressure of vapor is permitted to accumulate in the generator, the safety-valve will give way and inject the vapor into the condenser, where it is immediately resolved into a harmless liquid. Even should an explosion take place, there are no ponderous boilers to be rent and, with superheated steam and boiling water, made the instruments of death and destruction.

A patent, No. 236,411, has already issued to me on a vapor-generator; wherefore, in my present application I do not purpose claiming, broadly, what I have here described; but

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

1. A vertical vapor-generator having an induction-pipe terminating in a distributing-rose and an eduction-pipe forming a connection with an engine-cylinder, a horizontal plate containing numerous long slim tubes, open on top and extending outward, and closed at their opposite ends, provided with an internally-adjusted removable diaphragm, of thin metal, having numerous short open tubes secured therein, substantially as shown and described.

2. A vertical vapor-generator having an induction-pipe terminating on the inside in a rose, for distributing the liquid in a shower or spray, an eduction-pipe connected with and for carrying the vapor to the engine, and a horizontal bottom plate containing numerous long slim tubes, open on top and extending outward, and closed at the outer ends, and provided with internally-adjusted V-shaped removable brackets arranged on the inner walls thereof, substantially as shown and described.

3. A vapor-generator provided with induction-pipe e, stop-cock e^3, check-valve e^4, eduction-pipe f, tube-plate B, steam-chest g, the latter having steam induction and eduction pipes b' b^2, stop-cocks b^3 b^4, and the steam-boiler b, in combination with engine-cylinder f', substantially as shown and described.

4. The combination, in a power-vapor generator, of the generator d, induction-pipe e, supply-pipe e', pump h, and reservoir F, also with eduction-pipe f and engine-cylinder f', exhaust-pipe o, condenser E, and reservoir F, and also with tube-plate B, steam-chest g, and auxiliary boiler b and suitable connections, substantially as shown and described.

5. A vapor-generator, d, provided with induction-pipe e, check-valve e^4, distributing-rose e^2, tube-plate B, and diaphragm d^2, in combination with steam-chest g, having induction and eduction pipes connecting with steam-boiler b, substantially as shown and described.

6. A vapor-generator, d, provided with eduction and induction pipes, check-valve, and distributing-rose, and a tube-plate, and with internally-adjusted removable V-shaped brackets for increasing the vaporizing-power of the vapor-generator, in combination with steam chest or vessel g, induction-pipe b' and eduction-pipe b^2, and steam-boiler b, substantially as shown and described.

7. In combination, steam-boiler b, induction-pipe b', eduction-pipe b^2, steam chest or vessel g, tube-plate B, vapor-generator d, eduction-pipe f, throttle-valve f^2, engine-cylinder f', exhaust-pipe o, condenser E, pipe o', reservoir F, pump h, supply-pipe e', throttle-valve e^3, check-valve e^4, induction-pipe e, and distributing-rose e^2, all adjusted and arranged substantially as shown and described.

8. V-shaped removable brackets, in combination with a vertical vapor-generator, d, removable bottom tube-plate, B, and induction-pipe having a distributing-rose, e^2, substantially as shown and described.

9. A removable metal-disk diaphragm, d^2, containing numerous short open tubes, in combination with vapor-generator d, removable bottom tube-plate, B, induction-pipe e, distributing-rose e^2, and eduction-pipe f, substantially as shown and described.

10. In vertical vapor-generators, the combination of tube-plate B, removable tube-plate diaphragm d^2, removable V-shaped brackets d^4, induction-pipe e, distributing-rose e^2, supply-pipe e', pump h, and eduction-pipe f, engine-cylinder f', exhaust-pipe o, condenser E, and general reservoir F, substantially as shown and described.

11. Plate B, provided with and securing by their open ends a large number of tubes closed at the opposite ends, in combination with steam-chest g, arranged for receiving steam from an auxiliary boiler, substantially as shown and described.

12. In a device for generating and using power-vapor obtained from volatile fluid, in combination, a vertical vapor-generator, d, induction-pipe e' e, distributing-rose e^2, bottom tube-plate, B, adjustable diaphragms d^2 d^4, eduction-pipe f, engine-cylinder f', containing a fluid-packing reservoir, s, exhaust-pipe o, and condenser E, substantially as shown and described.

In testimony whereof I hereunto affix my signature, in presence of two witnesses, this 12th day of January, 1883.

ISRAEL R. BLUMENBERG.

Witnesses:
A. P. RUTHERFORD,
HENRY POLSZ.