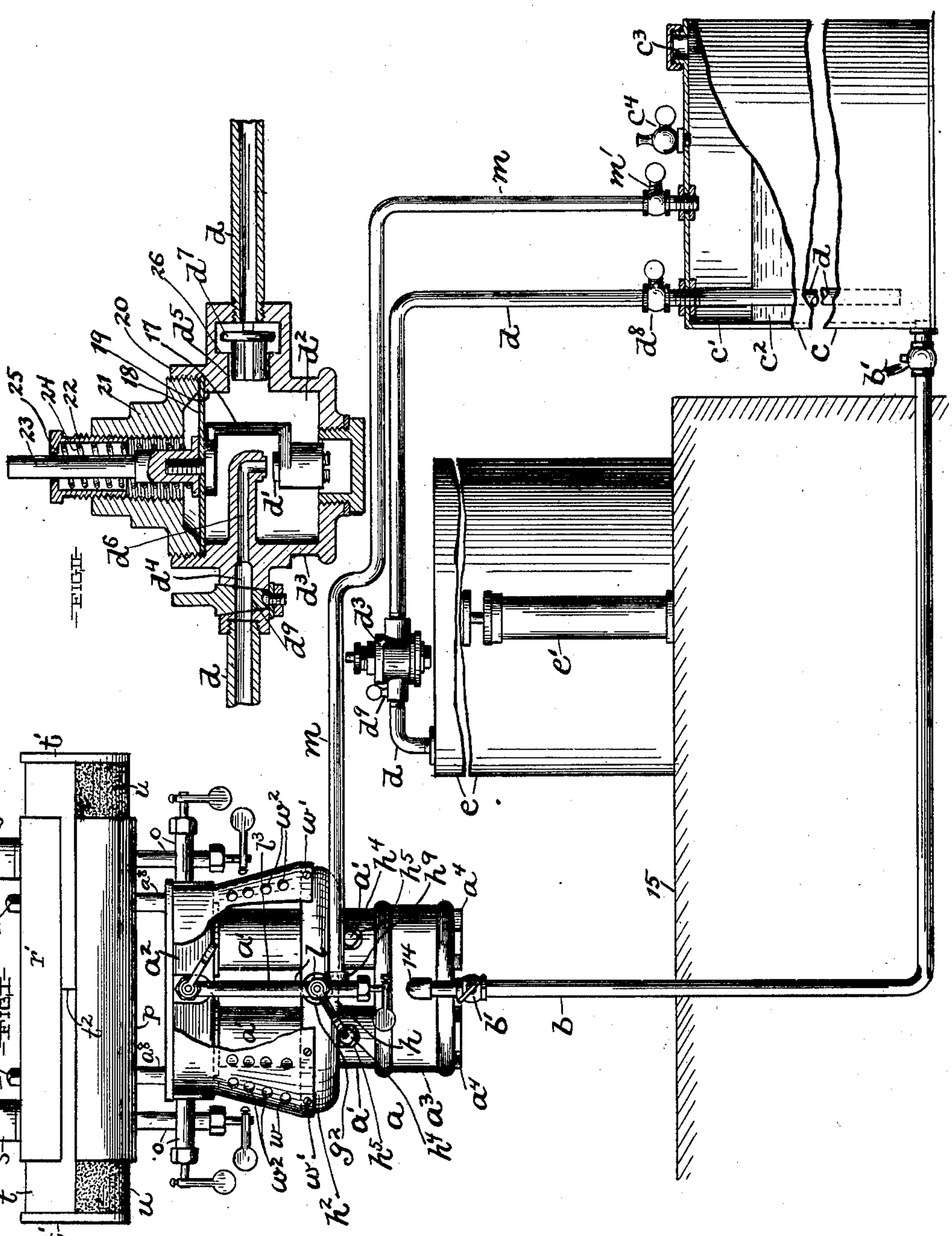
No. 707,689. Patented Aug. 26, 1902.

T. J. FORDE.

VAPOR GENERATING APPARATUS FOR HYDROCARBON BURNERS.

(Application filed Apr. 11, 1901.)

(No Model.) 3 Sheets—Sheet 1.



WITNESSES:
Daniel E. Daly.
A. H. Parratt

INVENTOR
Thomas J. Forde
BY
Lynch & Boyer
his ATTORNEYS

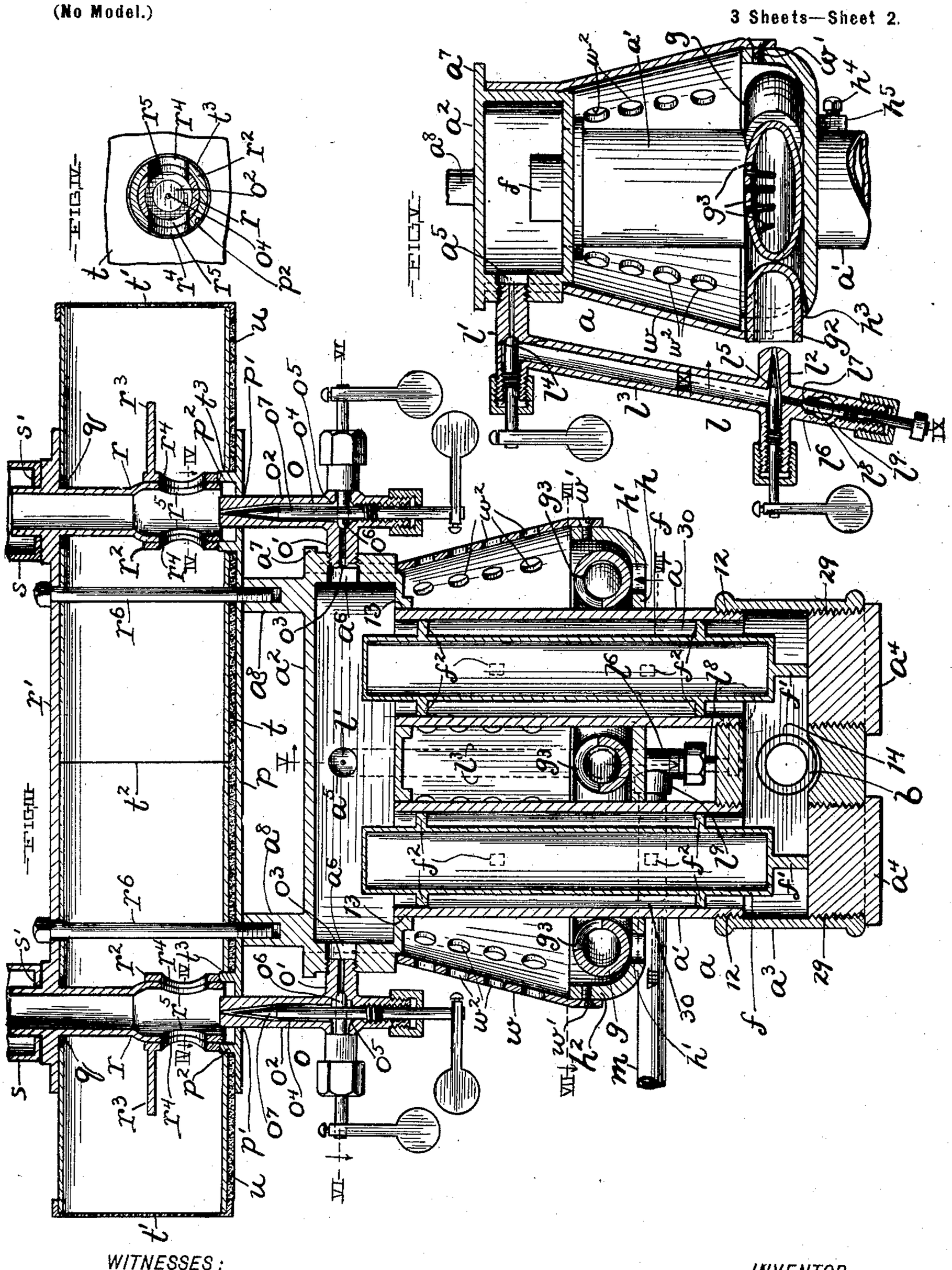
No. 707,689. Patented Aug. 26, 1902.

T. J. FORDE.

VAPOR GENERATING APPARATUS FOR HYDROCARBON BURNERS.

(Application filed Apr. 11, 1901.)

(No Model.) 3 Sheets—Sheet 2.



WITNESSES:

Daniel E. Daly.

A. H. Parratt

INVENTOR

Thomas J. Forde

BY

Lynch & Dorer

his ATTORNEYS

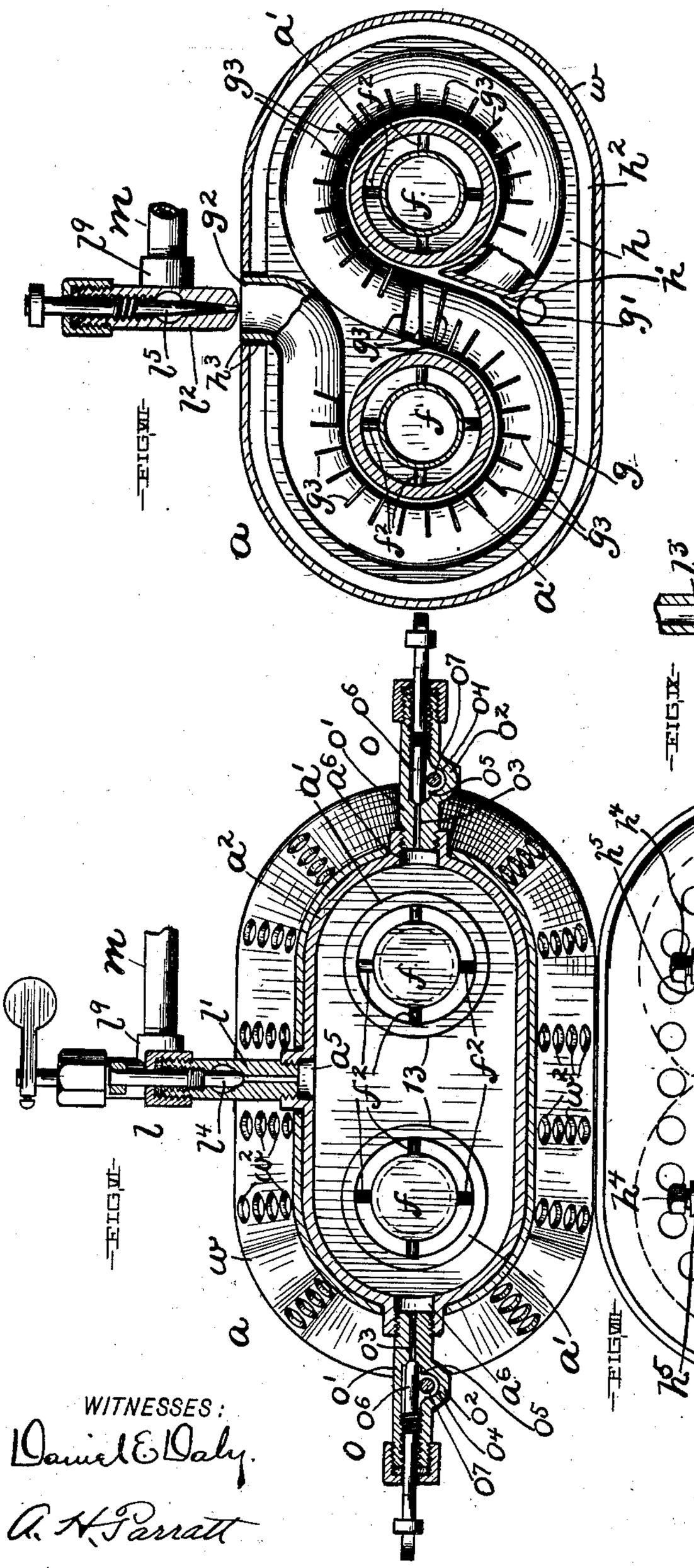
No. 707,689. Patented Aug. 26, 1902.

T. J. FORDE.

VAPOR GENERATING APPARATUS FOR HYDROCARBON BURNERS.

(Application filed Apr. 11, 1901.)

(No Model.) 3 Sheets—Sheet 3.



WITNESSES:
Daniel E. Daly.
A. H. Parratt

INVENTOR
Thomas J. Forde
BY
Lynch & Dorer
his ATTORNEYS

UNITED STATES PATENT OFFICE.

THOMAS J. FORDE, OF GENEVA, OHIO.

VAPOR-GENERATING APPARATUS FOR HYDROCARBON-BURNERS.

SPECIFICATION forming part of Letters Patent No. 707,689, dated August 26, 1902.

Application filed April 11, 1901. Serial No. 55,284. (No model.)

To all whom it may concern:

Be it known that I, THOMAS J. FORDE, a resident of Geneva, in the county of Ashtabula and State of Ohio, have invented certain new and useful Improvements in Vapor-Generating Apparatus for Hydrocarbon-Burners, and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it pertains to make and use the same.

My invention relates to improvements in vapor-generating apparatus for hydrocarbon-burners.

The primary object of this invention is to provide apparatus of the character indicated which is capable of producing an aeriform or gaseous inflammable fluid well adapted for burning with an incandescent mantle, which has an exceedingly large capacity and is very economical and reliable in its operation, and comprises such a construction and arrangement of parts that the liability to fires or explosions heretofore liable to result from the operation of apparatus of the character indicated is successfully avoided.

With this general object in view and to the end of realizing other advantages hereinafter appearing the invention consists in certain features of construction and combinations of parts hereinafter described, and pointed out in the claims.

In the accompanying drawings, Figure I is a side elevation, partly in section, of apparatus embodying my invention, and portions are broken away and in section in this figure to reduce the size of the same and to more clearly illustrate the construction. Fig. II is a side elevation, largely in section, of a valve-casing containing a back-pressure valve, a check-valve, and cut-off valve, and instrumental in maintaining the required air-pressure upon the body of oil within the oil-supply reservoir of the apparatus, and this figure shows the parts full size. Fig. III is a side elevation, mainly in vertical section, of the vapor-generator and the connected generator-heater and valve-casings and other portions of my improved apparatus, showing the parts approximately full size. Fig. IV is a horizontal section on either one of lines IV IV, Fig. III. Fig. V is a vertical section on line V V, Fig. III, looking in the direction indicated by the arrow. Fig. VI is a horizontal section on line VI VI, Fig. III. Fig. VII is a horizontal section on line VII VII, Fig. III, and portions are broken away in this figure to more clearly show the construction. Fig. VIII is a horizontal section on line VIII VIII, Fig. III, looking upwardly. Fig. IX is a section on line IX IX, Fig. V, looking in the direction indicated by the arrow.

Referring to the drawings, a designates a vapor-generator which comprises, preferably, two parallel vertically-arranged pipes or hollow cylindrical members a' and a', arranged a suitable distance apart laterally and forming the central section of the generator, a hollow cap or top section a^2, and a hollow base or bottom section a^3. The tubular sections or pipes a' and a' have their lower ends screw-threaded externally and engaging (see Fig. III) correspondingly-threaded apertures 12, formed in the upper wall of the base a^3, and consequently the passage-ways extending through the pipes a' and a' are in open relation at their lower ends with the chamber of the base a^3. The pipes a' and a' of the generator have their upper ends engaging corresponding apertures 13, formed in the lower wall of the top section a^2, which is brazed or otherwise rigidly secured to the said pipes a' and a'. The base or bottom section a^3 has (see Figs. I and III) a lateral aperture 14, which is engaged by the discharging end of the oil-supply pipe-line b. The aperture 14 constitutes the oil-inlet of the generator. The said inlet is of course located below, but preferably centrally, between the pipes a' and a' of the generator. The inflammable gasolene or hydrocarbon oil is introduced, therefore, into the chamber of the hollow base a^3 of the generator, and the vapor generated within the generator ascends through the pipes a' and a' into the chamber of the cap or top section a^2 of the generator. The oil-supply pipe-line b has its receiving end connected and in open relation with the lower or oil-containing portion of the oil-supply reservoir c, (see Fig. I,) which is located a suitable distance from the generator and preferably outside of the building supplied with the inflammable aeriform or gaseous mixture produced by my improved

apparatus for heating and lighting purposes. The reservoir *c* is shown located at an elevation below the floor-line 15 of a building provided with the said apparatus. The upper portion of the chamber of the reservoir *c* constitutes an air-space *c'*, into which air under suitable pressure—a pressure of from five to thirty pounds, according to circumstances—is introduced, and the air under pressure within the said air-space is instrumental in forcing oil from the said reservoir into the pipe-line *b* and becomes saturated or laden with vapor rising from the body of oil c^2 within the said reservoir. The pipe-line *b* is provided with a valve or valves *b'* for controlling the supply of oil to the generator. The pipe-line *b* has preferably two valves *b'*, located the one near the generator and the other in close proximity to the oil-reservoir. Both of the said valves *b'* are opened, if not already open, to establish a flow of oil from the said reservoir to the generator, and the valve *b'*, next to the reservoir, will be left open until repairs in or a rearrangement of the pipe-line *b* becomes necessary; but the valve *b'* next to the generator is opened or closed according as the generator is to be placed into or out of service. An air-conducting pipe-line *d* supplies air to the upper and air-containing portion of the oil-supply reservoir *c*. (See Fig. I.) The pipe-line *d* extends, preferably, through the top of the oil-supply reservoir straight downwardly into the lower and oil-containing end of the said reservoir, so that the air supplied to the said reservoir has to pass through the body of oil within the reservoir, whereby the saturation or lading of the air with oil-vapor is facilitated. The pipe-line *d* has its receiving end connected with the upper end of the air-supply reservoir *e*, which is provided in any approved manner with a pump *e'* for supplying the said reservoir *e* with air under pressure. The air-supply reservoir *e* and the connected pump *e'* are preferably located above the floor-line 15 in the building wherein the generator is provided. The pump is operated until a suitable pressure—say from sixty-five to one hundred pounds of pressure, according to circumstances—is established within the air-reservoir.

The pipe-line *d*, which, as already indicated, connects the air-reservoir with the oil-reservoir, is provided with a back-pressure valve *d'*, whereby the desired air-pressure within the oil-reservoir can be maintained notwithstanding a difference of air-pressure within the two reservoirs. The valve *d'* (see Fig. II) is located within the chamber d^2 of the valve-casing d^3 between the inlet d^4 and the outlet d^5 of the valve casing, and said outlet and inlet are arranged in the line of the pipe-line *d*. A port d^6 is in open relation with and extends inwardly from the inlet d^4 of the valve-casing and has its inner and discharging end arranged to discharge into the valve-casing chamber d^2 toward the valve *d'*, which is movable toward and from the said end of the port d^6 and opens or closes the said port according as it is actuated from or against the port. The valve *d'* is formed upon an arm 17 of a flexible diaphragm 18, which is suitably applied within the valve-casing and forms one of the walls of the valve-casing chamber d^2 with which the inlet d^4 and the outlet d^5 connect. The diaphragm 18 engages an outwardly-facing shoulder 19, formed on the valve-casing. The valve-casing has an annular internally-screw-threaded flange 20 around the shoulder 19, and a correspondingly-screw-threaded ring 21 is screwed into the said flange. An externally-screw-threaded endwise-adjustable sleeve 22 engages corresponding threads formed internally of the outer end of the ring 21. The diaphragm 18 has a stem 23, extending outwardly centrally of and through the ring 21 and through the sleeve 22, and a spiral spring 24 is mounted and confined upon the stem 23 between the diaphragm and a flange or shoulder 25, formed upon and internally of the outer end of the sleeve 22. The spring 24 is under tension and acts to retain the valve *d'* open, so as to establish continuity in the passage-way between the inlet d^4 and the outlet d^5 of the valve-casing, and the tension of the spring is regulated by means of the adjustable sleeve 22, being increased or decreased according as the said sleeve is turned in the one direction or the other. Obviously if an air-pressure of twenty-five pounds is to be maintained upon the body of oil within the oil-supply reservoir the tension of the spring should be so regulated by a proper manipulation of the sleeve 22 that a back pressure of twenty-five pounds in the chamber of the valve-casing d^3 and against the inner side of the diaphragm 18 shall be required to somewhat more than counterbalance the action of the spring, so as to result in the actuation of the said diaphragm outwardly, and thereby move the valve *d'*, connected therewith, into its closing position. Obviously the air-pressure required upon the oil within the oil-reservoir will be greater or less according as the vapor-generator is located at a higher or lower elevation. The air-pressure required will also vary with the temperature of the atmosphere. Vapor-laden air from within the oil-reservoir is utilized in supplying the generator-heater, hereinafter described, in commencing the operation of the said heater, and oil will vaporize more readily at a higher than at a lower temperature.

The pipe-line *d* at any suitable point between the back-pressure valve *d'* and its discharging end, (see Fig. II,) preferably within the outlet d^5 of the valve-casing d^3, is provided with a check-valve d^7, and the said outlet is provided upon its surrounding wall with a seat 26 for the said check-valve, and the arrangement of parts is such that the check-valve will engage the said seat, and thereby obstruct continuity in the passage-way through the outlet as soon as the desired air-pressure

upon the body of oil within the oil-supply reservoir has been established. The provision of the check-valve d^7 and the back-pressure valve d' in one and the same valve-casing simplifies the construction and renders the assemblage of the parts convenient. The presence of a check-valve d^7 between the chamber d^2 of the valve-casing d^3 and the air-pressure inlet of the oil-supply reservoir is important, because thereby any injury to or impairment of the diaphragm 18 of the said valve-casing which necessitates the repairing or renewal of the diaphragm will not interfere with the operation of the air-pressure already supplied to the oil-reservoir.

The pipe-line d to accommodate repairs in or a rearrangement of the said line between the valve-casing d^3 and the oil-reservoir and to accommodate repairs on or a renewal of the check-valve d^7 is provided in close proximity to the oil-reservoir with a valve d^8 (see Fig. I) for interrupting continuity in the passageway through the said pipe-line next to the oil-reservoir. The valve d^8 remains open, however, until closed for the purpose of repairing or renewing parts, as aforesaid.

The inlet d^4 of the valve-casing d^3 is provided with a cut-off valve—such, for instance, as a plug-valve d^9—for cutting off the supply of air-pressure from the air-supply reservoir, and consequently by closing the valve d^9 repairs in or a renewal of the diaphragm 18 and connected valve d' or seat for the latter are accommodated without interfering with the air-pressure within the air-reservoir.

The oil-supply reservoir (see Fig. I) has its top provided with a suitably-closed inlet c^3 and has the said top provided also with an air-discharge valve c^4. By closing the valve d^9 and opening the valve c^4 air-pressure within the oil-reservoir is relieved. A discharge of vapor-laden air from the oil-reservoir preparatory to replenishing the said reservoir with oil is important to guard against the possibility of an explosion resulting from accident, and the removal of air-pressure from within the said reservoir preparatory to replenishing the reservoir with oil is important also to prevent the passage of oil to the vapor-generator should by inadvertence the valves b' of the oil-conducting pipe-line b be left open.

Each upright pipe a' of the generator is (see Fig. III) provided internally with an oil-heating and oil-vaporizing cylindrical hollow drum f, which is arranged centrally of the said pipe a'. The said drum f has such dimensions transversely and such arrangement within and relative to the generator-pipe a' surrounding it that an annular vaporizing-space 30 is formed around the said drum within the said pipe a'. The said drum f extends from within the chamber of the bottom section a^3 of the generator upwardly through the said pipe a' of the generator into the chamber of the cap or top section a^2 of the generator. The said drum is closed, of course, top and bottom, and has its bottom provided centrally with a depending stem f', which rests upon the bottom of the chamber of the base a^3 of the generator, and consequently holds the drum elevated above the said bottom. The said drum is held centrally within the surrounding generator-pipe a' in any approved manner and preferably by means of several lugs f^2, formed upon and externally of the drum at suitable intervals circumferentially of the drum. The said drum adds greatly to the area of the vaporizing-surface of the generator, and consequently facilitates the vaporizing of the oil supplied to the generator. Especially is the hollow drum illustrated well adapted for use in facilitating the vaporizing of the oil, because the hollow drum is quickly heated and the air within the chamber of the drum is an excellent non-conductor of heat.

The lower wall of the chamber of the bottom section a^3 of the generator is provided below each drum f with an aperture 29, which has its surrounding wall screw-threaded and is large enough in diameter to accommodate the introduction of the said drum into the generator and accommodate also the removal of the drum for cleaning purposes. A correspondingly externally threaded plug a^4 closes the said aperture 29 and forms a portion of the bottom of the chamber of the section a^3 of the generator, and the depending stem f' of the said drum rests upon the said plug. The apertures 29 formed in the lower wall of the bottom section a^3 of the generator and closed by the removable plugs a^4 accommodate not only the introduction into and removal from the generator of the drum f, but afford also access to the interior of the generator-sections a', a', and a^3 for cleaning purposes. I would here remark that the generator is supported in any approved manner, but is preferably mounted and secured upon a bracket or stand. (Not shown.)

The generator heater or burner (see Figs. III, VI, and VII) comprises, preferably, an S-shaped coil or pipe g, extending around both pipes a' of the central section of the generator and arranged in a horizontal plane. The said coil g is closed at one end, as at g', Fig. VII, adjacent to the space between the pipes a' and a' of the generator, thence extends around one of the said pipes a' in one direction, thence extends between the two pipes a' and a', and thence around the other pipe a' in the opposite direction, and thence terminates adjacent the space between two pipes in an inlet-forming arm g^2, to which vapor-laden air from the air-space of the oil-reservoir is conducted by means of a suitably-valved pipe-line m, which leads from the top of the said reservoir, as shown in Fig. I. The coil g is provided at the top (see Figs. III, V, and VII) with vapor-discharging perforations, preferably in the form of slots g^3, extending transversely of the coil and arranged at short intervals longitudinally of the coil. The slots

g^3 in the central portion of the coil g extend entirely across the top of the coil, so that the flames issuing from the said slots upon the ignition of the vapor discharged at the slots shall impinge against both pipes a' and a' of the generator. The slots g^3 in the remaining portions of the coil g are formed only next adjacent to the said pipes a', so that the flames issuing from the last-mentioned slots upon the ignition of the vapor discharged at the said slots impinge only against the adjacent pipe of the generator. The coil g rests upon a shelf h, which extends around and between the pipes a' and a' of the generator, and the said shelf is provided with numerous vertical perforations or air-inlets h' (see also Fig. VIII) for supplying air from below to the flames issuing from the coil during the operation of the burner or generator heater formed by the said coil. To effect a proper circulation of the air thus supplied to the burner-coil g, the shelf h is provided with an upwardly-projecting flange h^2, extending along the surrounding edge of the shelf around the generator and cut away, as at h^3, to accommodate the location of the inlet-forming arm g^2 of the coil. The flange h^2 is instrumental in confining or detaining the air supplied to the burner from below within the chamber formed within the said flange, and thereby causes the said air to participate in establishing proper combustion during the operation of the burner. The shelf h is secured to the vapor-generator, preferably by means of two set-screws h^4, (see Figs. I, V, and VIII,) which extend through correspondingly-threaded holes formed in lugs h^5, which are formed upon and depend from the said shelf, into engagement with the pipes or members a' of the generator. Obviously, therefore, the shelf h is adjustably supported and upon loosening the screws h^4 is rendered free to be adjusted up or down to enable the setting of the shelf at the desired elevation and is secured in the desired adjustment by tightening the said screws. It appears almost superfluous to remark that the flames issuing from the burner or generator heater and impinging against the pipes a' and a' of the generator heat the generator as required to effect the vaporizing of the oil supplied thereto.

A valve-casing l and valves for controlling communication between the vapor-accumulating chamber of the top section a^2 of the generator and the vapor-inlet g^2 of the generator-heater is provided at one side of the generator, preferably centrally between the pipes a' and a' of the generator, as shown in Figs. III, V, and VII. The valve-casing l (see Fig. V) comprises an upper horizontal tubular member l', having one end connected with the top section a^2 of the generator, a lower horizontal tubular member l^2, arranged in line and in close proximity to the vapor-inlet g^2 of the generator-heater, and an upright tubular member l^3, which connects the aforesaid members l^2 and l' together. The vapor-accumulating chamber of the top section a^2 of the generator has a vapor-outlet a^5, communicating with the inner end of the vapor-conducting passage-way formed in the upper member l' of the valve-casing l, and the vapor-conducting passage-way formed in the upright member l^3 of the said valve-casing connects the said passage-way in the upper valve-casing member l' with the vapor-conducting passage-way formed in the lower member l^2 of the valve-casing, which last-mentioned passage-way is arranged to discharge, as already indicated, into the vapor-inlet g^2 of the generator-heater. The passage-way in the upper member l' of the valve-casing is suitably shaped to form a seat for a suitably-applied stub-valve l^4, arranged to control communication through the said passage-way and employed to establish and interrupt communication between the chamber of the top section a^2 of the generator and the vapor-inlet g^2 of the generator-heater. The passage-way formed in the lower horizontal member l^2 of the valve-casing l is shaped as required to accommodate the reception and operation of a suitably-applied needle-valve l^5, extending into the said passage-way and employed to regulate the discharge of oil-vapor from the said passage-way into the vapor-inlet g^2 of the generator-heater.

The valve-casing l (see Fig. V) is provided with a tubular member l^6, depending from the member l^2 of the said casing and arranged in line with, but of course below, the upright tubular member l^3 of the said casing. The depending member l^6 has the passage-way therethrough connected with the passage-way formed in the member l^2 of the valve-casing and is provided internally, a short distance below the passage-way in the said member l^2, with a seat l^7 for a suitably-applied stub-valve l^8, employed to interrupt and establish communication through the passage-way of the said depending member l^6 of the valve-casing, and the said depending member l^6, below the valve-seat l^7 therein, is provided (see Figs. I and IX) with a laterally-projecting tubular arm l^9, connected, in any approved manner with the pipe-line m, which, as already indicated, extends from the air-space of the oil-supply reservoir. The members l', l^2, and l^3 and the member l^6 and its arm l^9 are made of a single casting, and, obviously, the needle-valve l^5 is instrumental in regulating the supply of vapor to the inlet g^2 of the generator-heater from the vapor-conducting pipe m, as well as from the chamber of the top section a^2 of the generator. The pipe m is preferably provided, in close proximity to the oil-supply reservoir, with a valve m' for cutting off the supply of vapor-laden air to the said pipe-line when repairs or alterations in the said pipe-line or in the connected valve-casing l become necessary.

The peculiar construction of the valve-casing l, hereinbefore described, is meritorious not only because it reduces to a minimum

the number of parts required to conduct vapor from the pipe m and from the generator to the vapor-inlet g^2 of the generator-heater, but because it is exceedingly convenient in the assemblage of the parts.

Two valve-casings o and o are arranged at opposite sides, respectively, of the top section a^2 of the generator and secured to the said section a^2 in any approved manner. Each valve-casing o (see Figs. I, III, and VI) is composed, preferably, of a cross-shaped casting comprising a horizontally-arranged tubular member o' and a vertically-arranged tubular member o^2 intersecting the member o'. The member o' is screw-threaded externally at its inner end and engages a correspondingly-threaded lateral aperture a^6, formed in the generator-section a^2. The passage-way o^3, formed in the horizontal member o' of the said valve-casing, extends to the inner extremity of the said member and there communicates with the chamber of the top section a^2 of the generator. The passage-way o^4, formed in the vertical member o^2 of the said valve-casing, extends to the upper extremity of the said member and there discharges into the lower end of a suitably-supported vertically-arranged cylindrical tube r, which has its upper end discharging into the lower end of an upwardly-extending service-pipe s, which is closed at its lower end, as at s', around the tube r. The passage-ways o^3 and o^4, formed in the members o' and o^2, respectively, of the said valve-casing, intersect at o^5. The passage-way o^3 of the said valve-casing is suitably shaped to form a seat for a suitably-applied stub-valve o^6, which extends into the said passage-way and controls communication between the said passage-way and the passage-way o^4 of the valve-casing. The last-mentioned passage-way o^4 is formed as required to accommodate the reception and operation of a suitably-applied needle-valve o^7, employed to regulate the feed of the heated vapor received thereby to the aforesaid tube r. Each valve-casing o has its intersecting passage-ways o^3 and o^4 formed during the operation of casting the said casing, so as to avoid the necessity of subsequently boring holes and other expensive workmanship. Heretofore valve-casings of the character indicated were made by boring holes to form two passage-ways arranged at right angles to each other and then boring a third hole between and connecting together the said passage-ways and plugging the said third hole at the outer end after having established communication between the two psssage-ways. Such construction was, obviously, not only expensive, but objectionable, in that leakage at the plugged end of the hole connecting the two passage-ways could not be efficiently and satisfactorily avoided. By my improved construction, involving the formation of the intersecting passage-ways o^3 and o^4 during the operation of casting the valve-casing, no subsequent drilling or expensive workmanship is required to connect the said passage-ways together, and leakage at or adjacent to the junction of the said passage-ways is successfully avoided. Two vertically-arranged cylindrical tubes r and r, (see Fig. III,) supported as will hereinafter appear, are in open relation, therefore, at the lower end with the upper and discharging end of the vapor-discharging passage-way o^4 of the adjacent valve-casing o.

The top section a^2 of the generator is preferably provided at the top with an external flange a^7, extending around the said section a^2. The said generator-section a^2 is provided upon its upper surface with two upwardly-projecting and vertically-arranged lugs a^8 and a^8, which are formed integral with the said section a^2 and are located a suitable distance apart and arranged between and adjacent to the vertically-arranged members o^2 of the different valve-casings o and o. The lugs a^8 and a^8 have their upper ends forming a support for a horizontally-arranged saddle p, wherein a horizontally-arranged air-chamber-forming casing t is seated, and the said saddle p is provided with two vertically-arranged apertures p' and p', snugly engaged by the upper end of the vertically-arranged member o^2 of the different valve-casings o and o, respectively, and the said saddle is provided around each aperture p' with an upwardly-projecting annular flange p^2, snugly embracing the lower end of the adjacent vapor-receiving tube r. The air-supply casing t extends a suitable distance laterally beyond the outer side of each tube r and the valve-casing o, adjacent to the said tube, and is provided at each end with a removable perforated or screen-forming cap t', by removing which access is had to the interior of the casing t. The casing t is composed, preferably, of two metallic sections that are joined end to end, as at t^2, centrally between the tubes r and r, which extend through or approximately through the said casing. A top plate r' rests upon and extends longitudinally of the casing t, preferably between the tubes r and r and a suitable distance beyond the outer sides of the said tubes. The casing t is perforated, as at q, to accommodate the extension of the tubes r from within the said casing into the service-pipes s. The tubes r and the plate r' are preferably composed of a single casting. The casing t is provided at the lower end of each tube r with an aperture t^3, which accommodates the location of the saddle's flange p^2 embracing the said tube, and the said flange p^2 forms a seat for a valve-forming sleeve r^2, which snugly, but easily, embraces the lower end of the said tube r and is provided with a handle r^3 for turning the same. The said sleeve r^2 has lateral apertures or air-inlets r^4, arranged to register in the full open position of the said sleeve or valve with different lateral apertures or air-inlets r^5, formed in the sleeve-em-

braced portion of the said tube r. Obviously the air supplied to each tube r from within the air-supply chamber of the casing t is regulated by a proper manipulation of the valve-forming sleeve r^2, with which the said tube is provided. The air supplied to the tubes r from within the chamber of the casing t commingles with the heated oil-vapor conducted to the said tubes from the vapor-generator and improves the combustion of the oil-vapor at the burners, (not shown,) which are supplied with the commingled oil-vapor and air by the service-pipes s. The sleeves r^4 and r^4 rest upon the different flanges p^2 and p^2, respectively.

The plate r' is rigidly but removably secured in place upon the air-supply casing t by means of two bolts r^6 and r^6, which extend vertically through the said plate and through the casing t into the different lugs a^8 and a^8, respectively formed on the top of the generator, as hereinbefore described. The heads of the bolts abut the upper surface of the plate r', and the shanks of the bolts engage correspondingly-threaded holes formed in the said lugs, which consequently perform the function of nuts, between which and the heads of the bolts the saddle p, the casing t, and the plate r' are clamped together upon tightening the bolts.

It will be observed that the lugs h^6 elevate the saddle p and the air-supply casing t above the vapor-generator, so as to form an air-circulating space between the said saddle and the top of the said generator and accommodate a free circulation of air around the air-supply casing t, and thereby reduce the liability of the air within the said casing being heated by the heat rising or radiating from the generator-heater when the latter is in operation. To positively prevent the air within the air-supply casing t from being modified in temperature by heat rising or radiating from the generator-heater, I cover the said casing at the bottom and well up on the sides with a layer u of asbestos or other material that is not only a good non-conductor of heat, but is fireproof, and therefore there is no liability of the origin of an explosion or fire within the tubes r or the connected service-pipes, and any flame arising from the generator or sparks resulting from the ignition of dust or combustible particles upon the generator and connected parts have no ingress to the interior of the casing t, tubes r, and connected service-pipes from below the said casing. I would remark, also, that to confine the flame arising from the generator-heater during the operation of the said heater below the top of the vapor-generator and to obtain the proper combustion during the operation of the said heater I have provided a guard-forming laterally-perforated casing w, preferably of sheet metal, extending around the vapor-generator between the generator-heater and the flange a^7 of the top section a^2 of the generator. The said guard, at its upper end, abuts against the under side of the said flange a^7 and is slotted or cut away to accommodate the location of the valve-casings o and o and l where the said casings join the top section a^2 of the generator. The said guard at its lower end embraces the flange h^2 of the generator-heater-supporting shelf h and is secured to the said flange h^2, preferably removable by means of screws w'. The said guard w has numerous lateral perforations or air-inlets w^2 for admitting to the flames issuing from the generator-heater during the operation of the heater the requisite supply of air to support the combustion. The said guard prevents an external draft or currents of air from interfering with the flames issuing from the generator-heater and is instrumental in confining the said flames below the top section a^2 of the generator and around the pipes a' and a' of the generator. The said guard is instrumental also in excluding dirt and dust from the generator-heater and from the generator between the heater and the top section of the generator.

The operation of the apparatus, as already indicated, is as follows: The tank c is kept supplied with oil, and the desired air-pressure is maintained upon the body of the oil within the said tank. The valve or valves b' of the oil-supply pipe b are opened, if not already open, preparatory to the operation of the vapor-generator, so as to flow oil from the said pipe into the generator, and the valve m' of the vapor-conducting pipe m is opened if not already opened. Oil having been supplied to the vapor-generator the normally closed valve l^8 of the valve-casing l is opened, so as to supply vapor-laden air from the pipe m to the vapor-inlet g^2 of the generator-heater. The mixture of oil-vapor and air discharged into the generator-heater is ignited by means of a lighted match held next to the heater next below the shelf h or at perforations w^2 in the casing w. Vapor quickly accumulates within the generator and is conducted from the chamber of the top section a^2 of the generator through the valve-casing l by opening the stub-valve l^4, which is normally closed, to the vapor-inlet g^2 of the generator-heater. The needle-valve l^5 is manipulated to obtain the desired flow of vapor from the valve-casing l to the generator-heater. Of course as soon as the generator has been heated by the flame resulting from the ignition of vapor-laden oil supplied to the generator by the pipe m to form a suitable quantity of vapor within the generator the valve l^8 of the valve-casing l is closed, so that the generator-heater is then only supplied with vapor conducted from the generator. The vapor is conducted from the generator through the valve-casings o into the tubes r, into which a suitable quantity of air, by proper manipulation of the valves with which the said tubes are provided, is introduced, and the air and vapor conducted to the said tubes r commingle and rise into the service-pipes s.

The construction, assemblage, and application of the parts p, r, r', r^2, and t are, it will be observed, exceedingly simple and convenient for cleaning and repairs.

What I claim is—

1. Apparatus of the character indicated, comprising a vapor-generator having an oil-inlet at the lower end and a vapor-outlet at its upper end, means for supplying oil to the said oil-inlet, a generator-heater arranged between the upper and lower ends of the generator and provided with a vapor-inlet, a pipe-line for supplying oil-vapor-laden air to the generator-heater, and a valve-casing having the following: an upper tubular vapor-receiving member in open relation with the aforesaid vapor-outlet of the generator and extending laterally of the generator outwardly from the said vapor-outlet, a lower tubular vapor-discharging member arranged to discharge into the vapor-inlet of the generator-heater, an upright tubular member having the passage-way therethrough connecting the passage-ways formed in the aforesaid vapor-receiving member and vapor-discharging member of the valve-casing, a valve for interrupting and for establishing a flow of vapor from the generator through the said valve-casing, a tubular member having the passage-way formed therein connected with the passage-way of the said vapor-discharging valve-casing member, a needle-valve for regulating the discharge of vapor from the vapor-discharging member of the valve-casing, and a valve for establishing and for interrupting the flow of vapor-laden air from the said pipe-line to the said vapor-discharging member of the valve-casing, substantially as and for the purpose set forth.

2. Apparatus of the character indicated, comprising a vapor-generator having an oil-inlet at the lower end and a vapor-outlet at its upper end, means for supplying oil to the said oil-inlet, a generator-heater arranged between the upper and lower ends of the generator and provided with a vapor-inlet, a pipe-line for supplying oil-vapor-laden air to the generator-heater, and a valve-casing having the following: an upper tubular vapor-receiving member in open relation with the aforesaid vapor-outlet of the generator and extending laterally of the generator outwardly from the said vapor-outlet, a lower tubular vapor-discharging member arranged to discharge into the vapor-inlet of the generator-heater, an upright tubular member having the passage-way therethrough connecting the passage-ways formed in the aforesaid vapor-receiving member and vapor-discharging member of the valve-casing, a valve for interrupting and for establishing the flow of vapor from the generator through the valve-casing, a tubular member depending from the aforesaid vapor-discharging member of the valve-casing and having the passage-way formed therein connected with the passage-way of the said vapor-discharging valve-casing member, which depending valve-casing member has a laterally-projecting tubular arm connected and in open relation with the aforesaid pipe-line, a needle-valve for regulating the discharge of vapor from the vapor-discharging member of the valve-casing and another valve for establishing and for interrupting the flow of vapor-laden air from the said pipe-line into the said vapor-discharging member of the valve-casing, substantially as and for the purpose set forth.

3. Apparatus of the character indicated, comprising a vapor-generator having an oil-inlet at the lower end and a vapor-outlet at its upper end, means for supplying oil to the said oil-inlet, a generator-heater arranged between the upper and lower ends of the generator and provided with a vapor-inlet, a pipe-line for supplying oil-vapor-laden air to the generator-heater, and a valve-casing having the following: an upper tubular vapor-receiving member arranged to receive vapor from the aforesaid vapor-outlet of the generator and extending laterally of the generator outwardly from the said vapor-outlet, stub-valve within the said vapor-receiving member of the valve-casing, a lower tubular vapor-discharging member arranged to discharge into the vapor-inlet of the generator-heater, a needle-valve within the said vapor-discharging member of the valve-casing, an upright tubular member having the passage-way therethrough connecting the passage-ways formed in the aforesaid vapor-receiving member and vapor-discharging member of the valve-casing, a tubular member depending from the said vapor-discharging member and having the passage-way formed therein connected with the passage-way in the said vapor-discharging member, which depending member has a laterally-projecting tubular arm connected with and in open relation with the aforesaid pipe-line, and a stub-valve within the said depending member, substantially as and for the purpose specified.

4. The combination, with a vapor-generator comprising a chambered bottom section having an oil-inlet, a chambered top section having vapor-outlets, and an upright tubular central section establishing open relation between the chamber of the bottom section and the chamber of the top section, and means for supplying oil to the aforesaid inlet, of a generator-heater comprising a coil extending around the central section of the generator and provided with perforations arranged to discharge against the said central section, which coil has a vapor-inlet; a shelf bearing the said coil and having air-supply perforations, and means for controlling and regulating the supply of vapor from one of the aforesaid vapor-outlets of the generator to the vapor-inlet of the said coil, substantially as and for the purpose set forth.

5. The combination, with a vapor-generator

comprising a chambered bottom section having an oil-inlet, a chambered top section having vapor-outlets, and an upright tubular central section establishing open relation between the chamber of the bottom section and the chamber of the top section, and means for supplying oil to the aforesaid oil-inlet, of a generator-heater comprising a coil which is provided, at the top, with perforations arranged to discharge against the said central section, and has a vapor-inlet; a shelf bearing the said coil and having air-supply perforations, which shelf is provided with an upwardly-projecting flange extending around the coil, and means for controlling and regulating the supply of vapor from one of the aforesaid vapor-outlets of the generator to the vapor-inlet of the said coil, substantially as shown, for the purpose specified.

6. The combination, with a vapor-generator comprising a chambered bottom section having an oil-inlet, a chambered top section having vapor-outlets, and an upright tubular central section establishing open relation between the chamber of the bottom section and the chamber of the top section, and means for supplying oil to the aforesaid oil-inlet, of a generator-heater comprising a coil extending around the central section of the generator and provided, at the top, with perforations arranged to discharge against the said central section, which coil has a vapor-inlet; means for controlling and regulating the supply of vapor from one of the aforesaid vapor-outlets of the generator to the vapor-inlet of the said coil; a shelf bearing the said coil and supported from the generator, which shelf has air-supply perforations, and a guard-forming laterally-perforated casing extending around the central section of the generator between the top section of the generator and the said shelf and secured to the said shelf, substantially as and for the purpose set forth.

7. The combination, with a vapor-generator comprising a chambered bottom section having an oil-inlet, a chambered top section having vapor-outlets, and an upright tubular central section establishing open relation between the chamber of the bottom section and the chamber of the top section, and means for supplying oil to the aforesaid oil-inlet, of the generator-heater comprising a coil extending around the central section of the generator, and provided, at the top, with perforations arranged to discharge against the said central section, which coil has a vapor-inlet; means for controlling and regulating the supply of vapor from one of the aforesaid vapor-outlets of the generator to the vapor-inlet of the said coil, a shelf bearing the said coil and extending around and supported from the central section of the generator, which shelf has air-supply perforations and a surrounding upwardly-projecting flange, and a guard-forming laterally-perforated casing extending around the central section of the generator and secured to the said flange, substantially as and for the purpose set forth.

8. The combination, with a vapor-generator comprising a bottom section having an oil-inlet, a chambered top section having vapor-outlets and an external laterally-projecting flange and an upright tubular central section establishing open relation between the chamber of the bottom section and the chamber of the top section, and means for supplying oil to the aforesaid oil-inlet, of a generator-heater comprising a coil extending around the central section of the generator, and provided, at the top, with perforations arranged to discharge against the said central section, which coil has a vapor-inlet; means for controlling and regulating the supply of vapor from one of the aforesaid vapor-outlets of the generator to the vapor-inlet of the said coil and extending around and supported from the central section of the generator, a shelf bearing the said coil and having air-supply perforations, and a guard-forming laterally-perforated casing surrounding the central section of the generator and extending from the aforesaid flange of the top section of the generator to the said shelf and attached to the shelf, substantially as and for the purpose set forth.

9. The combination, with a vapor-generator comprising a chambered bottom section having an oil-inlet, a chambered top section having vapor-outlets, and an upright tubular central section establishing open relation between the chamber of the bottom section and the chamber of the top section, and means for supplying oil to the aforesaid oil-inlet, of a generator-heater comprising a coil surrounding the central section of the generator, and provided, at the top, with perforations arranged to discharge against the said central section, which coil has a vapor-inlet; means for controlling and regulating the supply of vapor from one of the aforesaid vapor-outlets of the generator to the vapor-inlet of the said coil; a shelf bearing the said coil and adjustable vertically, and means for securing the said shelf in the desired adjustment to the central section of the generator, substantially as and for the purpose set forth.

10. Apparatus of the character indicated, comprising a vapor-generator having a chambered top section provided with vapor-outlets, an upright tubular central section in open relation at its upper end, with the chamber of the top section, and a chambered bottom section having its chamber in open relation with the lower end of the central section and provided with an oil-inlet, which bottom section has the lower wall of its chamber provided with an aperture in registry with the central section of the generator, a removable plug closing the said aperture, a drum arranged internally and centrally of the central section of the generator and extending from within the bottom section to within the top section of the generator, means for holding the said

drum centrally of the central generator-section, means for holding the drum elevated above the lower wall of the bottom section of the generator, the generator-heater having a vapor-inlet, and means for controlling and regulating the supply of vapor from one of the aforesaid vapor-outlets of the generator to the vapor-inlet of the generator-heater and the aforesaid plugged aperture being large enough to accommodate the introduction into, or removal from, the central generator-section, of the aforesaid drum.

11. Apparatus of the character indicated, comprising a vapor-generator having a chambered bottom section provided with an oil-inlet, a chambered top section having vapor-outlets, and pipes arranged a suitable distance apart laterally and establishing open relation between the chamber of the bottom section and the chamber of the top section, a generator-heater comprising a coil extending around the aforesaid pipes and having perforations arranged to discharge against the said pipes and provided with a vapor-inlet, and means for controlling and regulating the supply of vapor from one of the aforesaid vapor-outlets of the generator to the vapor-inlet of the said coil.

12. Apparatus of the character indicated, comprising a vapor-generator having a chambered bottom section provided with an oil-inlet, a chambered top section having vapor-outlets, and upright pipes arranged a suitable distance apart laterally and establishing open relation between the chamber of the bottom section and the chamber of the top section, a generator-heater comprising a coil extending around the said pipes and closed at one end and having a vapor-inlet at its other end, which coil is provided, at the top, with perforations arranged to discharge against the said pipes, and means for controlling and regulating the supply of vapor from one of the aforesaid vapor-outlets of the generator to the vapor-inlet of the said coil.

13. Apparatus of the character indicated, comprising a vapor-generator having a chambered bottom section provided with an oil-inlet, a chambered top section having vapor-outlets, and two upright pipes arranged a suitable distance apart laterally and establishing open relation between the chamber of the bottom section and the chamber of the top section, a generator-heater comprising an S-shaped coil surrounding both of the said pipes and extending between the pipes and provided, at the top, with perforations arranged to discharge against the said pipes, which coil is closed at one end and has its other end terminating in a vapor-inlet, and means for controlling and regulating the supply of vapor from one of the aforesaid vapor-outlets of the generator to the vapor-inlet of the said coil.

14. Apparatus of the character indicated, comprising a vapor-generator having a chambered bottom section provided with an oil-inlet, a chambered top section having vapor-outlets, and two upright pipes arranged a suitable distance apart laterally and establishing open relation between the chamber of the bottom section and the chamber of the top section, a generator-heater comprising an S-shaped coil surrounding both of the said pipes and extending between the pipes and provided, at the top and at suitable intervals longitudinally of the coil, with perforations arranged to discharge against the said pipes, which coil is closed at one end and has its other end forming a vapor-inlet means for controlling and regulating the supply of vapor from one of the aforesaid vapor-outlets of the generator to the vapor-inlet of the said coil, a shelf instrumental in supporting the coil and secured to both of the aforesaid pipes, which shelf has air-supply perforations, and a laterally-perforated guard-forming casing extending around the generator next above and attached to the said shelf, substantially as and for the purpose set forth.

15. In apparatus of the character indicated, a vapor-generator having its upper end provided with a vapor-outlet, a saddle elevated above the generator so as to form an air-space between it and the top of the generator, an air-receiving casing arranged in a horizontal plane and seated on the aforesaid saddle, an upwardly-extending service-pipe, an upright tube arranged to discharge into the said service-pipe and having an air-inlet arranged to receive air from within the air-receiving casing, and a valve-casing interposed between the aforesaid vapor-outlet of the generator and the lower end of the said tube and having valved passage-ways for controlling and regulating the passage of vapor from the generator to the said tube.

16. In apparatus of the character indicated, a vapor-generator provided with a chambered vapor-receiving top section having two lateral vapor-outlets arranged diametrically opposite each other; upwardly-projecting lugs formed upon the said top section; a saddle mounted on the said lugs, an air-receiving casing arranged in a horizontal plane and mounted on the said saddle; two upwardly-extending service-pipes arranged a suitable distance apart longitudinally of the top of the said casing; two upright tubes arranged to discharge upwardly into the different service-pipes, respectively, and extending approximately through the aforesaid air-receiving casing and provided, respectively, with a lateral air-inlet, and two valve-casings interposed between the different vapor-outlets, respectively, of the generator and the lower end of the different aforesaid tubes, respectively, and having valved passage-ways for controlling and regulating the passage of vapor from the generator to the said tubes.

17. In apparatus of the character indicated, a vapor-generator having two vapor-outlets arranged a suitable distance apart; an air-receiving casing arranged in a horizontal

plane and supported above the generator; two upwardly-extending service-pipes arranged a suitable distance apart longitudinally of the top of the said casing; two upright tubes arranged to discharge upwardly into the different service-pipes, respectively, and extending approximately through the aforesaid air-receiving casing and provided, respectively, with lateral holes or apertures; two sleeves turnably mounted upon the different aforesaid tubes, respectively, and having lateral holes or apertures arranged to render them capable of registering with the lateral holes or apertures of the respective tubes, and two valve-casings interposed between the different vapor-outlets, respectively, of the generator and the lower end of the different aforesaid tubes, respectively, and having valved passage-ways for controlling and regulating the passage of vapor from the generator to the said tubes, substantially as and for the purpose set forth.

18. In apparatus of the character indicated, a vapor-generator provided with a chambered vapor-receiving top section having two lateral vapor-outlets arranged a suitable distance apart; two upwardly-projecting lugs formed upon the said top section and arranged a suitable distance apart; a saddle mounted on the said lugs and having two apertures arranged a suitable distance apart and upwardly-projecting flanges extending about the apertures; an air-receiving casing arranged in a horizontal plane and seated on the saddle and perforated at the bottom to accommodate the location of the aforesaid flanges; two upwardly-extending service-pipes arranged above the said casing over the different saddle-apertures, respectively; two upright tubes arranged to discharge upwardly into the different service-pipes, respectively, and extending into the different saddle-apertures, respectively, and provided, respectively, with a lateral air-inlet, and two valve-casings interposed between the different vapor-outlets, respectively, of the top section of the generator and the lower end of the different aforesaid tubes, respectively, and having valved passage-ways for controlling and regulating the passage of vapor from the generator to the said tubes, substantially as and for the purpose set forth.

19. In apparatus of the character indicated, a vapor-generator provided, at its upper end, with two vapor-outlets arranged a suitable distance apart; upwardly-projecting lugs formed upon the upper end of the generator, a saddle mounted upon the said lugs; an air-receiving casing arranged in a horizontal plane and composed of two tubular sections arranged end to end and seated in the aforesaid saddle; a top plate extending over and resting upon both of the said sections; bolts or screws extending through the said top plate into the aforesaid lugs; two upwardly-extending service-pipes arranged above and a suitable distance apart longitudinally of the said casing; two upright tubes arranged to discharge upwardly into the different service-pipes, respectively, and extending approximately through the said casing, and provided, respectively, with an air-inlet in open relation with the chamber of the aforesaid casing, and two valve-casings interposed between the different vapor-outlets, respectively, of the generator and the lower end of the different aforesaid tubes, respectively, and having valved passage-ways for controlling and regulating the passage of vapor from the generator to the said tubes.

20. In apparatus of the character indicated, a vapor-generator provided, at its upper end, with a vapor-outlet; upwardly-projecting lugs formed upon the upper end of the generator; a saddle mounted upon the said lugs; an air-receiving casing arranged in a horizontal plane and seated in the saddle; a layer of fireproof material, which is a good non-conductor of heat, covering the lower portion of the said casing; means for supplying oil to the generator; a generator-heater extending around the generator; a service-pipe extending upwardly above the aforesaid air-receiving casing; an upright tube arranged to discharge upwardly into the service-pipe and extending approximately through the said air-receiving casing and provided with a lateral air-inlet in open relation with the chamber of the said casing, and a valve-casing interposed between the vapor-outlet of the generator and the lower end of the aforesaid tube and having valved passage-ways for controlling and regulating the passage of vapor from the generator to the said tube, substantially as and for the purpose set forth.

Signed by me at Cleveland, Ohio, this 2d day of April, 1901.

THOMAS J. FORDE.

Witnesses:
C. H. DORER,
A. H. PARRATT.