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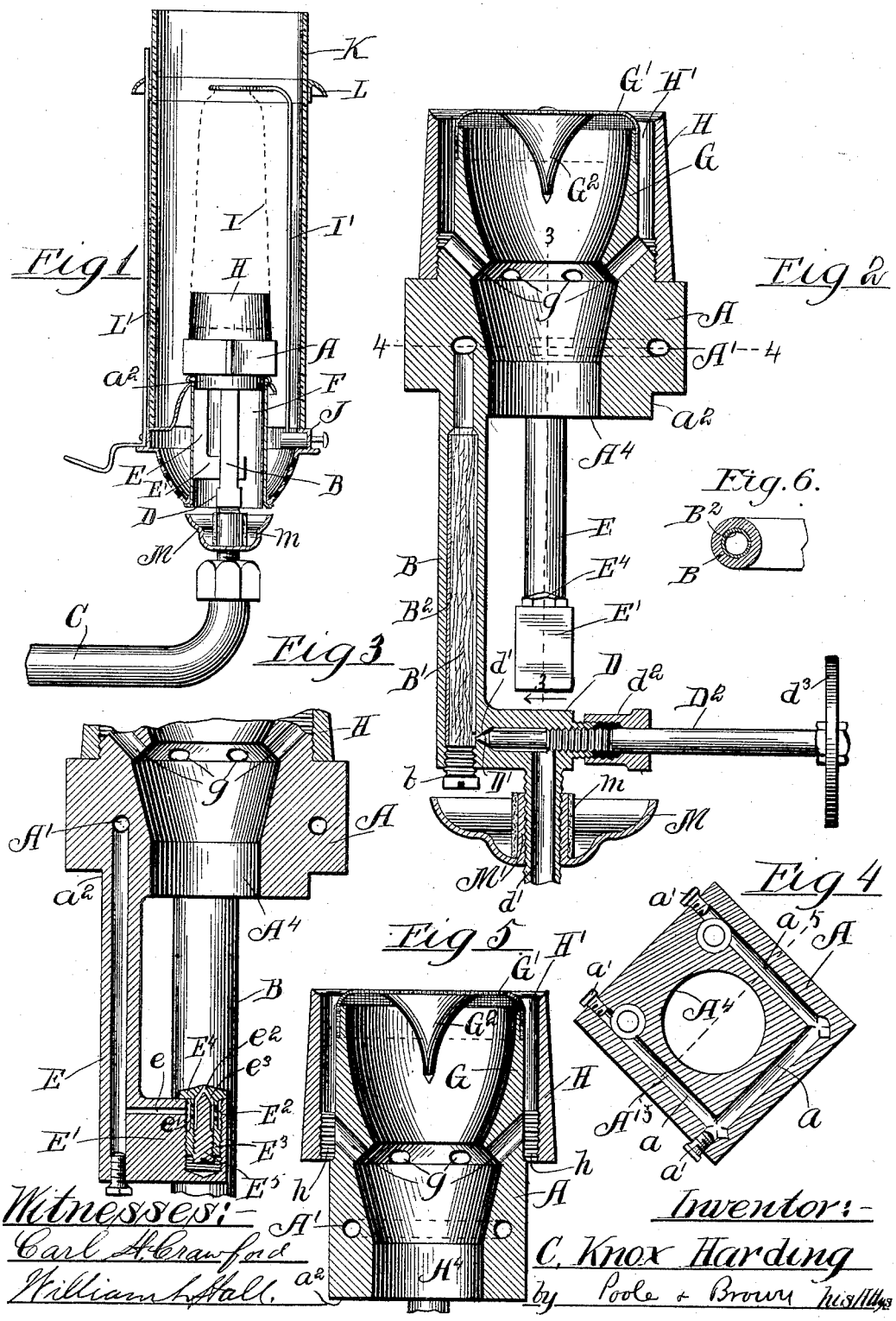
C. K. HARDING.

INCANDESCENT HYDROCARBON BURNER.

(Application filed May 24, 1899.)

(No Model.)



UNITED STATES PATENT OFFICE.

CHARLES KNOX HARDING, OF CHICAGO, ILLINOIS.

INCANDESCENT HYDROCARBON-BURNER.

SPECIFICATION forming part of Letters Patent No. 649,637, dated May 15, 1900.

Application filed May 24, 1899. Serial No. 718,012. (No model.)

To all whom it may concern:

Be it known that I, CHARLES KNOX HARDING, of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Hydrocarbon-Burners; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to improvements in lamp-burners of that kind adapted for the combustion of an admixture of gas and vapor and air and which is used in connection with an incandescing reticulated tube of refractory material, which is heated by the non-illuminating flame of the burner and constitutes the source of light.

The invention consists in the matters hereinafter set forth, and more particularly pointed out in the appended claims.

As shown in the drawings, Figure 1 is a longitudinal vertical section of a lamp-burner embodying my invention. Fig. 2 is an enlarged vertical section of the parts thereof to which my invention is applied, said view being taken in a plane at right angles to the plane of view of Fig. 1. Fig. 3 is a vertical section taken on line 3 3 of Fig. 2. Fig. 4 is a cross-section taken on line 4 4 of Fig. 2. Fig. 5 is a detail section taken on line 5 5 of Fig. 4, and Fig. 6 is a cross-section of a vapor-tube and removable filling-tube.

As shown in said drawings, A designates a generating-head provided with a superheating-passage A′ and a central-vertical opening extending therethrough and at the top of which the admixture of vapor and air is burned.

B designates a vaporizing-pipe attached at its upper end to the head A and in communication with said superheating-passage and connected at its lower end with a supply-pipe C, which leads from a suitable elevated tank or source of supply for liquid hydrocarbon. Said pipe B is provided at its lower end with an arm D, which latter is provided with a passage which connects the supply-pipe C with the pipe B.

E designates a pipe which is connected at its upper end with the discharge end of the superheating-passage and is provided at its lower end with a laterally-extending arm E′, in which is formed a jet-nozzle, through which the vapor is delivered to the burner.

The generating-head A is shown as consisting of a solid casting which is rectangular, as seen in plan view, and the superheating-passage A′ therein consists of three connected passages $a\,a\,a$, which are formed therein parallel with three sides of the head by a drilling-tool. The ends of said passages opening at the outer part of the head are closed by screw-plugs $a'\,a'\,a'$. The eduction end of the superheating-passage is in communication with an opening with which the pipe B has open connection. The discharge end of said passage is in communication with a similar opening with which the gas or vapor pipe E is connected.

F designates a tube which surrounds the pipes B and E and the lower part of the generating-head and forms the mixing-chamber of the burner, said tube fitting in an annular rabbet a^2 in said head. The lower end of said tube is open to admit air to the burner. The head A is provided with a central opening A^4, which, together with the space surrounded by said tube, constitutes the mixing-chamber of the burner, into the lower end of which the vapor from the pipe E is discharged and in which the admixture of vapor and air is formed.

The head A is provided at its top with a tubular upward extension G, which forms the upper part of the central recess or passage of the head. The upper end of said tubular extension G is provided with a foraminous cap or plate G′, through which the mixture of vapor and air is discharged and at the upper side of which the combustion takes place. Said foraminous plate is provided centrally with a depending conoidal spreader G^2, which causes the admixture of air and vapor to be discharged from the burner-ring in a relatively thin annular jet. The margin of said plate overlaps the upper end of the burner-ring and fits into the annular rabbet therein. Over the burner is located an incandescent tubular mantle I, of refractory material, which in the operation of the burner is maintained

in a state of incandescence by the heat of the flame which impinges thereon.

A regulating-valve by which the flame may be controlled is located between the supply-pipe and the vaporizing-pipe B, whereby the supply of liquid hydrocarbon to such pipe may be varied as the needs of the burner require. As herein shown, said valve is located in the passage formed in the arm D at the lower end of the pipe B, and consists of a conical valve-plug formed on the end of a valve-stem D^2, which engages a conical valve-seat d' at the end of the passage in said arm D adjacent to the pipe B. Said valve-stem has screw-threaded engagement with the arm D, and said arm is provided with a stuffing-box d^2 to prevent the escape of liquid past the same. Said stem is provided on its outer end with a disk d^3, by which the stem may be conveniently rotated. As herein shown, the head A, pipe B, and arm D thereon are made integral or from a single casting. The passages in the arm D and the pipe B are made by the use of a suitable boring-tool, and said passage in the pipe B at the lower end thereof is closed by a screw-threaded plug *b*. The supply-valve is located within the lower ends of the tube F, which latter is imperforate throughout its length.

Within the vaporizing-pipe B is a capillary mass or filling B′ of absorbent or fibrous material. Said filling prevents the direct flow of the liquid through the vaporizing-pipe, the material used therefor being such that the liquid passes therethrough by capillary action. Provision is made for removing and renewing the capillary material, the same being herein shown as inclosed in a tube B^2, which may be removed from the pipe B by unscrewing the plug *b* at the lower end of said pipe. Said tube B^2 will preferably be split throughout its length and made of a metal possessing some resiliency, so that its parts may exert outward pressure against the walls of the pipe and will act to hold it in place, while enabling it to be readily removed from and inserted into the pipe.

The jet-nozzle at the lower end of the pipe E and from which the vapor is discharged into the mixing-chamber is made as follows: The arm E′ is provided near its outer end with an upwardly-opening recess E^2, Fig. 3, which is in communication with the interior of the pipe E through a passage *e*. Within said recess is contained a thimble E^3, which, as shown, has screw-threaded engagement with the wall of the recess and is provided at its outer end with a head E^4. Said head overlaps the upper surface of said arm and affords a gas-tight joint between the same and is shaped for engagement thereof with a wrench, by which it is turned into and out of place. Said thimble is reduced near its upper end to provide an annular space around the same, into which the passage *e* opens, and said space is connected with the interior of the thimble through a series of circumferential ports or passages *c′* in the wall of said thimble. A contracted jet-opening e^2 in the upper end of said thimble affords a discharge-opening for the vapor from the interior of the thimble. E^5 designates a plug located centrally within said thimble and provided with an upper conical end which fits within the contracted upper end of the interior of the thimble. Said stud is reduced at its upper end opposite the ports or passages *e′* to provide an annular space or chamber e^3, which is in communication with the jet-opening e^2 of the thimble. An annular wick *m* surrounds the pipe and is adapted to be submerged at its lower end in the fluid in the cup. Said stud is shown as having screw-threaded engagement at its lower end with the thimble and as inserted thereinto and properly adjusted before the thimble is placed within the recess E^2. The vapor which passes from the interior of the thimble outwardly through the jet-opening e^2 therein impinges upon the conical upper end of the stud on all sides thereof and issues from said jet-opening into the mixing-chamber in a conical jet or current which diverges in every direction and becomes intermingled with the upwardly-rising air-current which enters the mixing-chamber at the lower end of the tube F. The construction of the jet-nozzle is not intended to control the quantity of vapor which passes therethrough, as such control is effected solely by the valve D before described. The plug E^5 will therefore be adjusted to the thimble in a manner to effect the required spreading of the vapor-jet and consequent intermixture of the vapor and air, and said plug will not be disturbed thereafter unless it be desired to spread the jet more or less to alter the proportion of such mixture or for other purpose.

An annular wall or ring H surrounds the upper part or tubular extension G of the generating-head, said ring, as herein shown, having screw-threaded connection with the head A at the base of the tubular extension H. Said ring H is of greater internal diameter than the external diameter of the extension G, thereby providing between the same an angular passage or chamber G′, which opens at its upper end near the point of combustion of the admixture. The internal diameter of said ring is greater than the width of said head in planes perpendicular to the sides thereof, so that said ring engages a head only at the corners thereof, as shown in Figs. 2 and 3, while it stands laterally outside of said head between said corners, as shown in Fig. 4. This arrangement provides inlet-openings *h* at the lower margin of said ring, through which air may enter said passage or chamber *h′*. The generator-head is further provided with a plurality of jet-openings extending from the central recess or passage thereof outwardly to the outer surface of the head, near

the lower or main part thereof, which contains the generating-passages. Said jet-openings serve to convey a part of the admixture passing upwardly through the head outwardly to the outer surface of the extension G, where it is turned. The ring H, arranged as described, extends around or outside of the outer or exit ends of the jet-openings *g*, so that combustion of the admixture issuing from said jet-openings takes place in the annular space inclosed by said ring, and the annular flame thereby produced rises around the flame produced by the admixture issuing from the top of the central passage. To facilitate the deflection of the admixture outwardly through said jet-openings, the wall of said central passage is provided with a downwardly-facing shoulder, preferably inwardly inclined or oblique, as shown in Fig. 1, and the said jet-openings terminate at their inner ends at said shoulder. Obviously in place of the several jet-openings described and shown a continuous or practically-continuous annular opening or slot may be formed in the generating-head, the flame produced in such case being an annular one instead of a series of jets, such as will be produced in the construction illustrated.

The mantle I is supported over the burner-ring in the usual manner by an upright arm I′, which is attached at its lower end to a clamping device connected with the chimney-supporting ring J. The chimney-supporting ring is sustained from the tube F in the usual manner, said tube, ring, and connecting part being permanently connected together. K designates a chimney supported on said ring, said chimney being kept in place by a frame consisting of an upper ring L, which engages the upper end of the chimney, and standards or parts L′, attached to said ring and connected at their lower ends with the supporting-ring J in the usual manner. The tube F is adapted to fit tightly at its upper end upon a cylindric projection on the bottom of the head and fits closely the outer side of the pipes B and E and the outer end of the stuffing-box *d′* on the arm D, the frictional contact between said tube and part ordinarily being sufficient to hold said tube in place. The valve-stem B^2 may pass through said tube and hold the same in place.

In order to produce an initial heating of the generating-heads to produce vaporization of the liquid hydrocarbon and start the burner in operation, a cup M is provided, which is located below the arm D and within which alcohol or the like is to be burned to produce the necessary heat for such vaporization, said cup being provided with a centrally-arranged tube M′, which has screw-threaded engagement with the nipple *d* of said arm D, so that the cup may be adjusted vertically with respect to the bottom of the tube F to give a larger or smaller air-inlet opening at this point.

One important feature of my invention is embraced in the construction by which the generating-head is provided with openings or passages leading from the central passage thereof outwardly below the top of the head where the admixture of gas and air passing upwardly through said passage is burned, said openings or passages serving to afford an annular auxiliary flame surrounding said central passage and below the top of the same. Such annular or auxiliary flame is in contact with the outer surface of the head, and thereby greatly facilitates the heating of the generating-passage of the head by reason of the proximity of the part of the head which is heated by said supplemental flame to the lower portion of the head which contains said passages. In such burners as heretofore constructed it has been common to extend or prolong the upper tubular part of the head above the point of combustion, so as to afford a flange which surrounds the flame and receives heat therefrom, the intent being that the heat transmitted to said flange will be conducted therefrom to the lower part of the generating-head which contains the generating-passages. Such upwardly-directed tubular part is objectionable for the reason that it distorts the flame and operates to direct it upwardly and elongates it vertically instead of permitting it to expand laterally against the mantle in a manner necessary for most effectively heating the same. In my improved construction, as above described, not only is the projection of the upper end of the burner above the point of combustion avoided, so that the flame may be free to spread laterally, and thereby come properly in contact with the mantle, but the heating of the generating-head is more effectively accomplished, because in such prior construction the tubular prolongation referred to is at a considerable distance above the passages in the generating-head, and therefore serves very inefficiently to conduct heat thereto, while in my construction the auxiliary flame, being below the top of the generator and adjacent to said passages, affords a much superior heating effect. Moreover, this feature of the passages or openings affording an external supplemental flame is of practical value, whether the external ring shown in the drawings as surrounding the top of the generator be present or not, for the reason that even if such ring be absent the auxiliary flame at the point referred to serves to better heat the generating-head, as above described, and also tends to increase the heating effect of the flame on the mantle, because such auxiliary flame induces an upward flow of air around the main body of the flame, thereby tending to promote combustion at the exterior flame when it comes in contact with the mantle and where an intense heat is most required. The employment of the external ring referred to, forming an annular passage surrounding the central passage of the burner,

is, however, of great advantage, for the reason that said ring being subject to the heat of the auxiliary flame impinging thereon and being in contact at its lower end with the body of the generating-head becomes highly heated and communicates its heat directly to the lower part of the generating-head in which the generating-passages are located. Said ring, moreover, when provided with air-inlet openings at its bottom produces more complete combustion and increased heating effect of the auxiliary flame, it being obvious that the upwardly-directed jets of the admixture entering said annular passage serve to induce an inward flow of air at the lower end of said passage, thus securing the same effects that are obtained in the well-known Bunsen burner. The said ring, which constitutes the outer wall of the annular passage referred to, moreover, serves to confine and direct upwardly the auxiliary flame, directing the same against the lower part of the mantle, the lower part of which fits around said ring. It will of course be understood that combustion takes place within the said annular passage adjacent to the outer ends of the jet-openings leading from the central passage and that the admixture issuing from said jet-openings will be ignited from the main flame at the time of lighting the burner. It will be further understood that the auxiliary flame referred to carries with it an excess of air, which enters the lower part of said annular passage, which air is heated by contact with the sides of said passage and the flame, and this excess of air serves to greatly promote combustion not only of the lower part of the auxiliary flame, which comes in contact with the lower part of the mantle, but also the exterior portion of the main flame, which comes in contact with the mantle and in which the highest possible degree of heat is needed. I preferably make the central cone or spreader of such shape as to deflect the main-burner flame outwardly toward the mantle to such extent that the auxiliary flame rising through said passage will give such general direction to the exterior part of the combined flame as will carry the same upwardly along the mantle in a manner most effective for heating of the same.

An important feature of the invention is comprised in the construction described, embracing a generating-head, a vaporizing-pipe leading thereto, in which pipe and generating-head the hydrocarbon is vaporized and superheated, a controlling-valve located between the supply-pipe and vaporizing-pipe, and an imperforate tubular extension depending from the head around the vaporizing-pipe and extending below the supply-valve. With this construction the upper end of the vaporizing-pipe is maintained at a high temperature, while the lower end thereof is maintained relatively cool by reason of the passage of the incoming air thereover. The vaporization of the liquid fuel therefore takes place above the lower end of the vaporizing-pipe, and the supply-pipe below the valve is prevented from becoming so highly heated as to permit the vaporization of the liquid fuel therein. Back pressure in the supply-pipe to drive the liquid fuel away from the supply-valve and the consequent fluctuation of the flame is therefore avoided and the feed of the fuel to the heated part of the pipe is even, thereby insuring a continuous and uniform vaporization of the fuel and a steady flame. Moreover, the passage of the incoming air over the lower end of the vaporizing-pipe and the valve not only maintains said parts suitably cool, but heats the incoming air, so that it forms, with the vapor issuing from the vapor-pipe, a combustible mixture, which is relatively hot, and enables the flame to be maintained at a higher temperature than if the air were mixed with the vapor at its normal temperature. Furthermore, by reason of the construction described the liquid hydrocarbon is never admitted to the superheating-passages of the burner, and the accumulation of residuary matter in said passages or at the exit-opening of the vapor-pipe is avoided, it being obvious that in cases where the controlling-valve is located at the vapor-exit opening the liquid necessarily fills the generating-passage before the burner is started, and the vaporization of the liquid in such passage will necessarily leave a deposit on the walls of the passage, which deposit will not only in time close the passage and prevent the free flow of vapor therethrough, but will greatly diminish the generating capacity of the burner, because the coating thereby formed on the walls of the passage serves to prevent the direct and rapid transmission of the heat from the metal to the gas or vapor therein. Furthermore, by reason of the construction described accumulation of residuary matter at the exit-opening of the vapor-pipe is prevented, so that the usual means heretofore provided for keeping clear the exit for the vapor in burners as commonly made may be omitted.

A special advantage is gained by the use of the cup for containing liquid fuel to start the burner in operation, which will appear from the following: It will be apparent that the said cup being located beneath the vaporizing-tube and the vapor-discharge tube and also beneath the horizontal arm through which the liquid reaches the vaporizing-tube and the valve therein located, when the liquid in said cup is ignited the flames will arise around said vaporizing-tube and serve first to heat the lower portion of said tube, which is first reached by the liquid that is admitted from the supply-pipe. This construction insures a prompt and rapid heating of such oil, or, in other words, it insures the preliminary heating of the part of the generating-passage where vaporization should first take place—

namely, the part herein called the "vaporizing-tube" or that containing the filling of capillary material in which vaporization takes place in the usual operation of the burner. By this construction, therefore, the possibility of the generating-passage being filled with oil when starting the burner is obviated, inasmuch as the vaporizing-tube is heated so hot as to prevent any of the liquid flowing through or past the same and reaching the superheated passage in the generating-head. Moreover, the location of the cup below the depending tube, which forms the lower part of the mixing-chamber, insures an inflow of air around the margin of the cup, which carries the flame from the burning liquid in the cup upwardly through the center of the burner, so that not only is the vaporizing-tube heated, but the heat of the flame is communicated to the inside surface of the central passage in the generating-head, thereby tending to heat rapidly and quickly the entire generating-head and also the depending vapor-tube and jet-nozzle, with the effect of quickly heating the entire burner and placing it in condition for continuous operation with the expenditure of a relatively-small quantity of liquid fuel. An important advantage is gained by the employment of the annular wick in the said cup, for the reason that such wick produces a better flame and concentrates the flame in a central part of the cup, where it is most effective for producing a flame of the proper shape to heat the several parts of the generating-head.

I claim as my invention—

1. The combination of a head provided in its lower part with passages in which the fuel is vaporized and superheated and having a central passage for the admixture of the vapor and air at the top of which said admixture is burned, and a mantle fitted over the upper end of said head, said head having below its upper end and adjacent to said passages radial openings arranged symmetrically around said passage which receive a part of the admixture to afford an auxiliary flame around the upper end of the central passage, which auxiliary flame combines with the flame of the said central passage.

2. A burner comprising a generating-head provided with a central passage for the admixture of vapor and air which is burned at the top of said passage, an exterior annular passage surrounding the upper part of said central passage, openings or passages permitting the passage of part of the admixture from said central passage to the external passage, wherein combustion of the admixture passing through said openings or passages takes place, and a mantle fitted over said head and inclosing the central and auxiliary passages.

3. A burner comprising a generating-head provided with a central passage for the admixture of vapor and air, a perforated screen at the top of said passage, an exterior annular passage surrounding the upper part of said central passage, and radial openings through which a part of said admixture passes from the said central passage to the said annular passage in which combustion of the portion of the admixture passing through said openings takes place, and a mantle fitted over said head and inclosing the central and auxiliary passages.

4. A burner comprising a generating-head provided with a central passage for the admixture of vapor and air which is burned at the top of said passage, and an exterior annular passage surrounding the upper part of said central passage and connecting with the central passage by openings through which a portion of the admixture passes and is burned in said annular passage, that portion of the head exterior to said annular passage being in contact with that part of the generating-head below said annular passage in order to transmit heat thereto, and a mantle fitted over said head and inclosing the central and auxiliary passages.

5. A burner comprising a generating-head provided in its lower part with passages in which the fuel is vaporized and superheated and having a central passage for the admixture of vapor and air at the top of which such admixture is burned, said burner having at its upper part an annular passage surrounding said central passage, which annular passage is connected by radial passages in the head with said central passage for supplying a portion of the admixture to the said annular passage, in which the same is burned, that portion of the head outside of said annular passage being in contact with that portion of the head which contains said vaporizing and superheating passages in order to transmit heat to the same, and a mantle fitted over said head and inclosing said central and auxiliary passages.

6. A burner comprising a generating-head, provided at its lower part with passages in which the fuel is vaporized and superheated and having a central passage for the admixture of vapor and air at the top of which said admixture is burned, and provided with an annular passage surrounding the upper part of said central passage and extending to the top of said central passage, said head being also provided with openings adjacent to the lower part of the head supplying a portion of the admixture to the said external passage in the lower part of which the same is burned, and a mantle fitted over said head and inclosing said central and auxiliary passages.

7. A burner comprising a generating-head provided at its lower part with passages in which the fuel is vaporized and superheated and having a central passage at the top of which the admixture is burned and in its upper part an annular passage surrounding said central passage, said annular passage being connected by radial openings in the head

with the central passage and having at its lower end air-inlet openings, and a mantle fitted over said head and inclosing said central and auxiliary passages.

8. A burner comprising a generating-head having a central passage for the admixture of gas and air, an external ring surrounding the upper part of the burner-head and forming an annular passage around said central passage, the head being provided with radial openings leading from said central passage to the said annular passage and said ring being in contact with the lower part of the generating-head to conduct heat thereto.

9. A burner comprising a head having a central passage for the admixture of vapor and air at the top of which said admixture is burned, said head containing a superheating-passage and being provided with a depending tubular extension which forms the lower part of the mixing-chamber and which is imperforate from its upper to its lower end, a vertical vaporizing-tube depending from said head and connected with one end of the superheating-passage, a jet-nozzle connected with the other end of said superheating-passage and discharging into the lower end of said tubular extension, said vaporizing-pipe being located at the side of said tubular extension and provided at its lower end with a horizontal arm which extends radially toward the central axis of said tubular extension and is provided centrally of the burner with a depending nipple adapted for connection with a fittings-pipe, and a controlling-valve located in said arm, said depending tube extending below said arm whereby the arm, nipple and valve are subjected to the influence of the incoming air which enters the lower end of said tubular extension.

10. A burner comprising a generating-head, an upright vaporizing-pipe attached at its upper end to the generating-head, a vapor-pipe depending from the head and having at its lower end a discharge-nozzle, a tube attached to the head and depending around the said vaporizing-pipe and vapor-pipe, and an initial heating-cup for liquid fuel located below the said tube and adjustable vertically with respect to the said tube.

11. A burner comprising a generating-head, an upright vaporizing-pipe attached at its upper end to the generating-head, the vapor-pipe depending from said head, and having at its lower end a discharge-nozzle which is located centrally of the burner, a tube attached to the head and depending around said vaporizing and vapor pipes, a valve at the lower end of the vaporizing-pipe located within the depending tube, and an initial heating-cup located below this tube and adjustable vertically with respect to the tube.

12. A burner comprising a generating-head, an upright vaporizing-pipe connected at its upper end with the head and having at its lower end a lateral arm provided with a depending nipple in the central axis of the burner, a controlling-valve in said arm, a vapor-pipe depending from the head and provided with a lateral arm having a discharge-nozzle in the central axis of the burner and located above the lateral arm of the vaporizing-pipe, a depending imperforate tube attached to the head and surrounding said vapor-pipe and valve, and a cup of equal or greater diameter than the tube attached to the said nipple and arranged concentrically with respect to said tube.

13. A burner comprising a head having a depending vapor-discharge pipe terminating at its lower end in a laterally-directed arm, said arm being provided with a socket open at one end only, and in communication with said pipe, a thimble having screw-threaded engagement with said socket and provided at its upper end with a contracted exit-opening and having lateral openings connecting its interior with said socket and a plug located in said thimble having a tapered upper end the apex of which is located adjacent to the contracted exit-opening of the thimble, said plug being removable with the thimble from the socket.

14. The combination of a head having a central passage for the admixture of vapor and air, an external ring surrounding the upper part of said burner-head and forming an annular passage around said central passage, and an incandescent mantle fitted over said ring, said head being provided with a series of radial openings arranged symmetrically therearound which lead from the central passage to the lower part of the annular passage, and said ring being in contact with the lower part of the head to conduct the heat thereto.

15. A burner comprising a generating-head, an upright vaporizing-pipe connected at its upper end to the generating-head, a vapor-pipe depending from said head and having at its lower end a discharge-nozzle located in the central axis of the burner, a horizontal arm on the lower end of the vaporizing-pipe which extends radially past the central axis of the burner, a nipple depending from said arm and adapted for attachment to a fittings-pipe, a controlling-valve in said horizontal arm which extends laterally from the burner on the side opposite to said vaporizing-pipe, and a plug closing the lower end of said vaporizing-pipe.

16. A burner comprising a generating-head, an upright vaporizing-pipe attached at its upper end to the generating-head, a vapor-pipe depending from said head and having at its lower end a discharge-nozzle which is located in the central axis of the burner, a horizontal arm on the lower end of the vaporizing-pipe which extends radially past the central axis of the burner, a nipple depending from said arm and adapted for attachment with a fittings-pipe, a controlling-valve in said horizontal arm which extends laterally from the

burner on the side opposite to the said vaporizing-pipe, a plug closing the lower end of said vaporizing-pipe, and a tube which depends from said generating-head around said vaporizing and vapor pipe, said tube being imperforated and extending below said controlling-valve.

In testimony that I claim the foregoing as my invention I affix my signature, in presence of two witnesses, this 20th day of May, A. D. 1899.

CHARLES KNOX HARDING.

Witnesses:
C. CLARENCE POOLE,
WILLIAM L. HALL.