Aug. 19, 1941. W. J. DEBLER 2,253,266

OIL BURNER

Filed Nov. 21, 1939 2 Sheets-Sheet 1

Fig. 1.

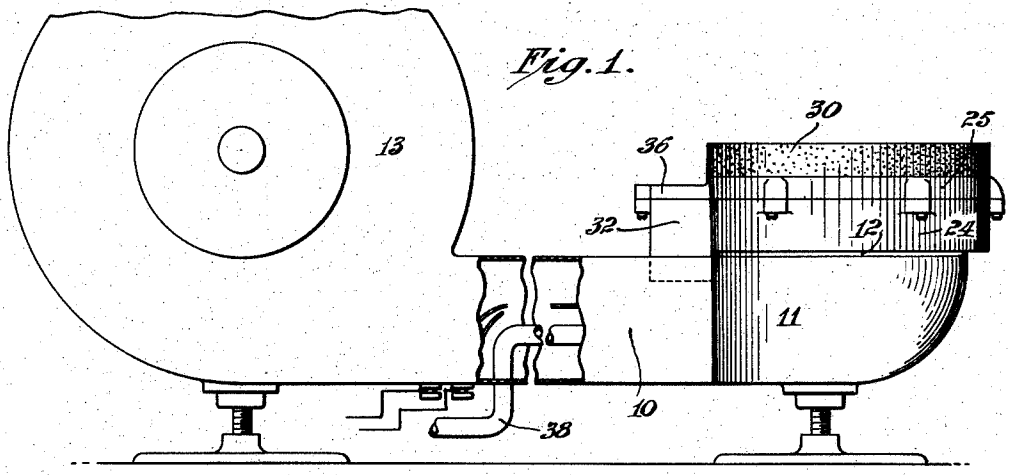
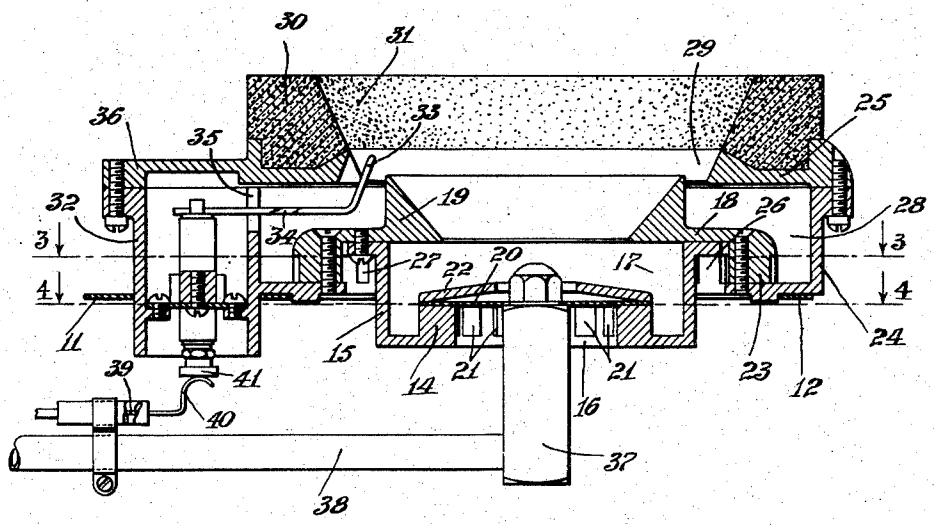


Fig. 2.



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Fig. 3.

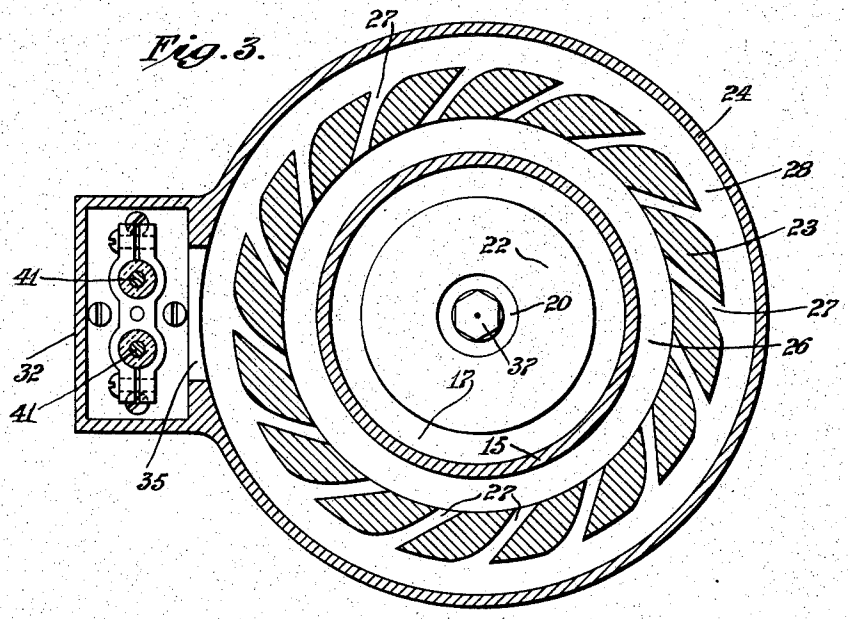
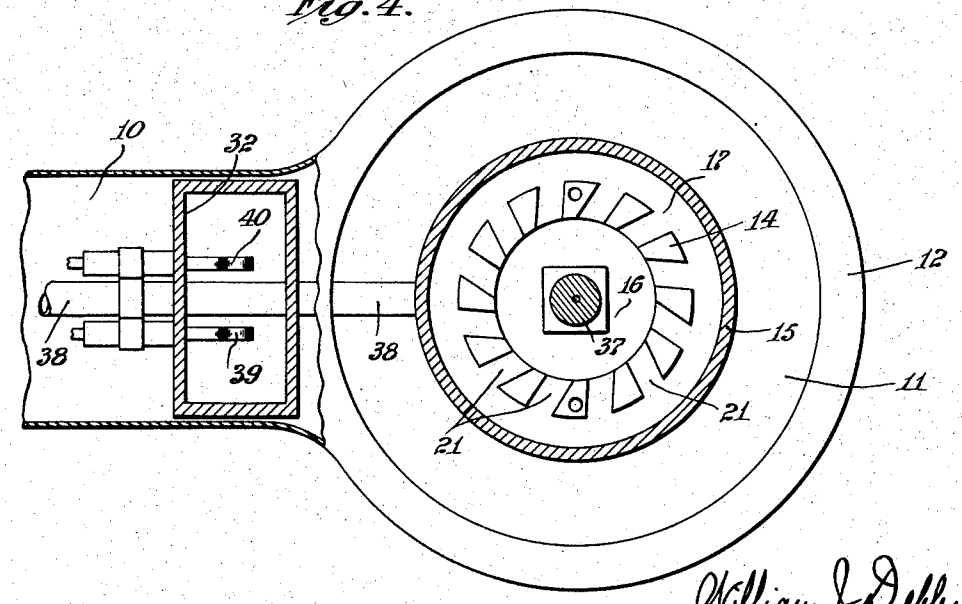


Fig. 4.



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Patented Aug. 19, 1941 2,253,266

UNITED STATES PATENT OFFICE

2,253,266

OIL BURNER

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Application November 21, 1939, Serial No. 305,425

6 Claims. (Cl. 158—28)

The invention relates to oil burners, and more particularly to a burner of the type having a vertically directed oil jet nozzle, an in which means are provided to deliver primary air adjacent the nozzle and secondary air within a firebox about the flaming combustible mixture.

In an oil burner embodying the invention, the construction is such as to secure an effective and uniform combustion of the combustible mixture by so forming and locating the primary and secondary air inlets as to ensure an adequate supply of air for forming the combustible mixture and for supporting combustion while preventing the clogging of the jet nozzle and said inlets in a manner to cause a diminution in the relative volume of oil or the air being delivered, a variance in the velocity of either the oil or the air, or a change in the direction of flow of the air in a manner to cause a change in the form of the flame.

The arrangement of parts and their construction are such as to prevent the jet nozzle reaching a temperature sufficiently high to cause carbonization of the fuel about the jet opening of the nozzle. Furthermore, the same conditions which prevent fouling of the jet nozzle prevent the accumulation of carbon upon the ignition points, in a manner to interfere with the functioning of the ignition with the actuation of the automatic control devices now required in the operation of oil burners.

In the operation of oil burners, it is practically impossible to secure such an admixture of vaporized hydrocarbon and primary air, as will prevent the separation of some oil from the combustible mixture, and such unmixed or free oil descends by gravity and is deposited upon metallic parts of the burner where it is carbonized by the high temperatures prevailing about the burner. This may cause the fouling of the tip of the jet nozzle and of the ignition points, and the clogging of air inlet passages.

The burner of my invention is provided with means so positioned as to receive any precipitated oil, and to volatilize same in the presence of secondary air, thus not only preventing fouling and clogging of the various burner openings, but utilizing same to secure a more complete and effective consumption of all oil delivered through the jet nozzle. This construction also ensures the subjection of the combustible mixture, during burner operation, to a temperature sufficiently high to aid in the formation of a highly combustible mixture, and result in the reduction of the quantity of oil which may not properly combine or admix with the primary air.

By controlling the velocity, volume and direction of the incoming primary and secondary air, the shape of the flame may be so controlled as to secure an effective distribution of heat about the side walls of the combustion chamber of a furnace, and prevent overheating of the crown of said chamber.

In a burner embodying the invention, the air distributing elements are so constructed and arranged as to prevent the accumulation therein of carbon, scale or other foreign matter which will tend to interfere with the delivery of a constant volume of air with a proper direction of flow, or cause the introduction into the combustible mixture of foreign substances which will tend to interfere with the free burning of the mixture and the formation of soot upon the walls of a furnace.

The various parts are so combined as to facilitate the assembly of the burner in a furnace and the making of the necessary electrical connections in the ignition system.

The burner possesses further advantages which will hereinafter appear.

The invention consists primarily in an oil burner embodying therein two co-axial walls forming a primary air chamber, the inner of said walls having an air input chamber within same and obliquely extending openings connecting said chambers, a top closure for said input chamber having a nozzle opening therethrough, a top ring projecting inwardly from said outer wall to above said inner wall, said ring having an upwardly and outwardly extending inner surface, co-axial inner and outer walls about said primary air chamber forming a secondary air chamber, the inner wall of which is spaced from the outer wall of said primary air chamber to form an air input channel, said last named inner wall having obliquely extending openings therethrough connecting said channel and said secondary air chamber, a top ring for said secondary air chamber extending toward but spaced from the top ring of the primary air chamber, and refractory material carried by the top ring of said secondary air chamber, said refractory material having an outwardly and upwardly inclined inner surface, a vertically extending oil jet nozzle positioned below the top ring of said primary air chamber, ignition means, means whereby air is delivered to said primary air input chamber and said secondary air input channel, and means whereby oil is delivered to said nozzle; and in such other

novel features of construction and combination of parts as are hereinafter set forth and described, and more particularly pointed out in the claims hereto appended.

Referring to the drawings,

Fig. 1 is a condensed side elevation of a burner embodying the invention, partly broken away;

Fig. 2 is a vertical section through the burner head upon a larger scale;

Fig. 3 is a section on the line 3—3 of Fig. 2; and

Fig. 4 is a section on the line 4—4 of Fig. 2.

Like numerals refer to like parts throughout the several views.

In the embodiment of the invention shown in the accompanying drawings, I provide an air duct 10 which is preferably square in cross section, and is provided with a circular end portion 11 having a seat 12 for receiving the burner proper. Air is delivered to the burner through this duct by means of any desired force feed mechanism, such as the blower 13 which supplies both primary and secondary air at the same low pressure.

The burner proper is so constructed as to secure an effective mixture of the comminuted or vaporized fuel oil and primary air, and to ignite this combustible mixture in the presence of the secondary air supply at a point sufficiently above the jet nozzle to prevent the presence of flaming gases about this nozzle. To secure this result, the supply of primary air is separated from the supply of secondary air, and the flow of each air supply is so controlled as to not only secure the results above referred to, but to give a cup-shaped form to the flame and prevent the flattening of this flame by variation in the supply of either primary or secondary air, or natural draft conditions in the combustion chamber.

The manner of dividing and controlling the supply of primary and secondary air is such as to so cover and protect the various parts of the device as to prevent the formation of carbon or the accumulation of foreign substances, such as carbon or boiler scale, in and about these parts to an extent to interfere with the direction of flow or the volume of air delivered therethrough.

The head proper is composed largely of cast iron, and the weight of this head is sufficiently great to maintain it in position upon the seat 12 when it merely rests thereon. The head is made up of various castings, so formed as to facilitate the assembly thereof and to produce a head having the desired structural characteristics.

This head comprises two co-axial walls 14 and 15, the outer wall 15 being of greater depth than the inner wall 14, and the latter wall being of greater thickness than the outer wall so as to provide air ducts having the desired length and width. The space within the inner wall 14 provides an air input chamber 16 which is connected with a primary air chamber 17.

Surmounting the outer wall 15 and projecting inwardly across the primary air chamber 17 to a point above the inner wall 14, is a ring 18 having an upwardly extending hollow cylindrical portion 19, the substantially vertical outside perimeter of which controls the flow of air from a secondary air chamber. The inner wall of the ring 18, including the upwardly extending portion 19, is upwardly and outwardly projected, or in the form of an inverted truncated cone, permitting the combustible mixture to follow an upward and outward or flaring path away from the axis of a jet nozzle.

The top of the primary air input chamber is closed by a metal plate 20, except for a central opening by means of which an oil jet nozzle is mounted in relation to the primary air chamber.

Extending through the inner wall 14 are a plurality of openings 21, placing the air input chamber in communication with the lower portion of the primary air chamber. These openings 21 extend obliquely to a vertical plane paraliel with the axis of the jet nozzle, each opening having the same degree of obliquity and being of the same capacity, so as to ensure a uniform supply of air throughout different portions of the primary air chamber. The angularity or obliquity of the various openings 21, in conjunction with the rounded inner surface of the outer wall 15, imparts a swirling movement to the primary air and the diffusion of this air throughout the chamber, the ring forming the top of the chamber giving a component of movement to the air toward the center opening of the ring, so that the primary air will follow the upwardly and outwardly inclined inner wall of said ring with a circular component of movement.

In other words, the arrangement is such as to provide a hollow stream of air, the direction of flow of which is outwardly of the burner head, and the ring 18 is so positioned in relation to the jet nozzle as to cause this air and the oil to admix at a point sufficiently above the jet nozzle to cause combustion to occur sufficiently away from the nozzle to prevent overheating of the nozzle itself.

Supported from the top of the inner wall 14 is an upwardly dished plate 22 which will aid in giving the entire volume of primary air an upward trend as it flows below the top wall formed by the ring 18.

A secondary air chamber is formed by an inner wall 23 and an outer wall 24 co-axial with each other and with the walls forming the primary air chamber.

The outer wall 24 is of greater height than the inner wall 23, and surmounting this outer wall is a ring 25, the bottom of this ring being positioned adjacent the top of the portion 19 of the ring 18 of the primary air chamber 17.

The inner wall 23 is of a diameter to be spaced from the outer wall 15 to an extent to form an air input channel 26 opening downwardly in the same manner as the air input chamber 16, both chambers opening into the air duct 11.

Extending through the inner wall 23 are a plurality of openings 27 which, like the openings 21, extend obliquely to a vertical plane parallel with the axis of the jet nozzle. All of the openings 27 have the same degree of obliquity and, like the openings 21, the direction of flow of the air through these openings and its impingement upon the inner surface of the outer wall 24 will impart a swirling movement to the air as it is introduced adjacent the bottom of the secondary air chamber formed by the walls 23 and 24 and the top ring 25, this chamber being indicated at 28 in the drawings. The width of the ring 25 is such as to leave an opening or slot between the inner wall of this ring and the top of the portion 19 of the ring 18.

The inner wall of the ring 25 has an upwardly and outwardly inclined inner surface 29, and surmounting this ring is a block 30 of refractory

material such as fire clay or cement, circular in form and having an upwardly and outwardly inclined inner surface 31 forming a continuation of the surface 29 of the ring. The degree of inclination of the surfaces 29 and 31 is such that the normal upward and outward trend of the combustible mixture passing through the ring 18 may continue in its normal path and be admixed with secondary air as said air emerges through the outlet opening about the portion 19 of the ring 18. The secondary air, together with said combustible mixture, will have the swirling action which will not only assist in forming an intimate admixture of the primary air and oil and the secondary air, but will impart to the flaming mixture the cup-like form or ring of flame of gradually increasing diameter. The velocity of the combustible mixture and of the secondary air being substantially the same, since both the primary and the secondary air are drawn from the same source at the same pressure, an effective combustion of the mixture is assured.

The outer surface of the portion 19 of the ring 18 is preferably substantially vertical in order to properly deflect the secondary air in controlling its direction of travel. The direction of flow of the combustible mixture across the normal path of the secondary air aids materially in providing a proper support of combustion by this secondary air, and also brings the flame closely adjacent or against the refractory block 30. Hence any unmixed oil which descends by gravity or is precipitated, will fall upon the heated surface of said block and be converted by the heat of this block and by the radiant heat of the flame, into a highly combustible mixture in the presence of air from the secondary air supply, which will have sufficient volume to form a combustible mixture with such oil and still support combustion.

It will be noted that the openings 21 and the openings 27 both have large capacity, and that both of them are protected at the outlet ends thereof by the plate 20, as to the primary air supply, and by the top of the inner wall 23 above the openings 27 as to the secondary air supply, as well as the overhanging rings 18 and 25.

The location of the openings adjacent the bottom of the primary and the secondary air chambers will always ensure a temperature about these openings which will prevent the carbonization of any oil which might possibly fall into these chambers, as for example, in the event of a failure of the ignition system when starting the burner, and that no foreign substances such as free carbon, scale or dirt from the furnace can enter these openings because of the above conditions, and the further condition that, when the burner is in operation, there is always a flow of air through said openings which will prevent the accumulation of such matter therein.

Exteriorly of the wall 24 is a housing 32 in which are supported, in any desired manner, the electrodes or spark points 33 and 34 of the ignition system, the ends of these points being located in the space between the ring 25 and the portion 19 of the ring 18, so that a combustible mixture passing from within the ring 18 to within the ring 25 will be within the range of the arc between the electrodes 33 and 34. The form of the porcelains and of the conductor cores of such electrodes, and the manner of supporting these within the housing 32 are immaterial to the invention.

The electrodes pass through an opening adjacent the top of the outer wall 24, said opening being indicated at 35. The ring 25 is provided with an extension 36 closing the top of this housing.

The jet nozzle is shown at 37. The tip of said nozzle passes through the opening in the plate 20 and through an opening in the shield 22, but terminates below the ring 25. The plate 20 is clamped between the tip of the jet nozzle and the body thereof, thus maintaining the jet nozzle in the proper relation to the air chambers at all times. An oil supply communicating with the jet nozzle 37 is shown at 38. The nozzle is of the jet spray type.

I have shown, at 39 and 40, spring terminal contacts so positioned in the air duct below the housing 32 as to be engaged by contacts 41 upon the conductor cores of the porcelains supporting the electrodes 33 and 34. By this construction, when the burner head is mounted upon the air conduit, the lower portion of the housing 32 passes through an opening in the top of the conduit, as does the lower portion of the burner head proper through an opening in the enlarged portion of the conduit.

As heretofore stated, the head is sufficiently heavy to ensure its remaining in this position, and with the use of spring contacts 39 and 40 as described, the electrical connection of the electrodes with the source is automatically made. This manner of making the connection permits the disconnection of the electrodes from the electrical source by merely lifting the head from the air conduit.

In the drawings, a two-wire ignition system is shown, although it is obvious that it is necessary to connect only one of the electrodes to the source through a single wire, and to ground the other electrode upon the head or upon some other part of the burner equipment.

A pressure feed system is provided for delivering oil to the nozzle 37, but this being well known and forming no part of the invention is not herein shown and described.

The operation of a burner embodying the invention is substantially as follows:

When beginning the operation of the burner, air at low pressure is forced through the conduit 10 by the blower or other air feed means 13, passing through the enlarged head 11 of said conduit into the primary air input chamber 16 and into the secondary air input channel 26. At the same time, oil under pressure is delivered to the jet nozzle 37, by which it is sprayed through the ring 18 and into the path of the primary air to form a combustible mixture. The volume of oil is controlled by the size of the orifice in the jet nozzle and the pressure at which it is delivered to said nozzle. The volume of primary air is controlled by the pressure at which it is delivered and the size of the various openings 21.

To secure the desired admixture of the oil and primary air, and at the same time have it delivered within the combustion chamber in a manner to produce a hollow, cup-shaped flame, the air is given a direction of flow and controlled by the walls of the primary air chamber in a manner to impart a swirling movement to the air as it emerges from this chamber and is admixed with the oil spray.

The supply of secondary air is controlled as to volume and as to the direction of its flow in the same manner as the supply of primary air, but it is delivered at a point beyond or approximately

at the point of ignition of the combustible mixture, so as to secure a supply of secondary air adequate to ensure a high rate of combustion of the mixture of primary air and oil.

As primary air is delivered through the openings 21, it is impinged against the lower portion of the curved inner face of the outer wall 15 with a direction of flow tending to cause it to follow along this wall while it is rising toward the top of the primary air chamber. As the air reaches the bottom of the ring 18, it is diverted inwardly or toward the nozzle 37, still having a circular and upward trend, so that when it reaches the lower edge of the opening of the ring 18, it moves diagonally along, or in relation to, the upwardly and outwardly inclined inner wall of the ring 18 and of its upwardly extending portion 19, being admixed with the hydrocarbon vapor while having such movement.

It will be noted that the primary air supply moves outwardly of the primary air input chamber into the primary air chamber where it has the desired swirling movement imparted thereto, and in leaving said chamber, moves inwardly or toward the burner until it passes outwardly through the opening in the ring 18 with the oil vapor. Secondary air flows outwardly from the input channel 26 through the various openings 27 with an oblique trend, and is impinged against the curved inner surface of the outer wall 24 so as to have imparted thereto a combined circumferential and axial trend for imparting a swirling movement thereto.

When this secondary air reaches the top of the chamber 28, it is directed inwardly by the bottom of the ring 25 forming the top of the secondary air chamber, passing from this chamber through the circular opening between this ring and the portion 19 of the ring 18. The stream of secondary air, at least in part, impinges against the circular, substantially vertical outer wall of the portion 19, which prevents diffusion of the air at the point of the admixture of the oil vapor and the primary air, and also assists in maintaining the desired circular trend of the stream of secondary air.

When leaving the secondary air chamber, the air has the swirling action above referred to in connection with the primary air, and moves along the inclined surfaces 29 and 31 of the ring 25 and of the refractory block 30. The supply of secondary air moves in the same direction as the combustible mixture passing through the ring 18.

The combustible mixture is ignited by the spark points 33 and 34 as it leaves the ring 18, and the rate of flow of the combustible mixture, being greater than the rate of propagation of flame toward the nozzle, the temperature at the nozzle is always sufficiently low to prevent carbonizing of the hydrocarbons in or about the opening thereof.

The proximity of the flaming mixture closely adjacent or against the block 30 of firebrick or other refractory material, and the radiant heat from this flame, will raise the temperature of said material to a point where, if any oil is separated from the mixture and falls upon this block, it will be vaporized by the heat of the block and will go into a highly combustible mixture because of the presence of the secondary air admitted toward the bottom of said block.

The various parts of the burner head will become heated by the conduction of heat from said block and from the walls of the combustion chamber, but the flow of air, both primary and secondary, about the parts of this head, will prevent overheating of these parts, and at the same time utilize such heat in preheating both the primary and the secondary air, thus improving the quality of the combustible mixture.

It will be noted that both the primary air chamber and the secondary air chamber are closed at the bottom and are provided with an overhanging ring forming the top portion of the chamber for directing the air inwardly of the burner head, and that while the primary air is impinged against the outer wall 15 and has its line of movement diverted as a result of this impingement, it is directed inwardly by the overhanging ring 18. When it reaches the inner edge of this ring it has a free upward path, the central portion of the ring being entirely unobstructed. This permits sufficient diffusion of the air to secure an effective admixture thereof with the oil vapor without interfering with the flow trend.

It will also be noted that the secondary air, in addition to being deflected by the outer wall 24 and directed outwardly by the overhanging ring 25, impinges against the outer face of the portion 19 in a manner to prevent the secondary air being commingled with the combustible mixture before the same has been ignited.

The conditions about the burner are such that under no circumstances can carbon deposits form in or about the jet nozzle, or in or about the various air openings leading to the primary and secondary air chambers. The capacity of such openings is so great that any matter which might lightly adhere to the walls thereof would not interfere with uniformity in the volume of flow of the air as determined by the pressure developed by the blower, fan or other force feed device 13.

By feeding primary and secondary air in substantially constant volume and at a substantially uniform pressure, and controlling the direction of its flow in the manner above described, a low, outwardly flared, cupped flame closely adjacent the side walls of the combustion chamber of a furnace is secured, and this flame is sufficiently remote from the crown of said combustion chamber to prevent overheating of this crown.

In actual practice, the burner of the invention has been found to give highly satisfactory results, both as to the effective combustion of the mixture and economy in the operation of the burner.

The indirect flow of both the primary and the secondary air, that is, outwardly in relation to the vertical axis of the burner, upwardly with a spiral or circular trend, then inwardly with relation to the axis of the burner, and with a spiral trend along the inclined surfaces of the rings 18—19 and 25—29—31 respectively, is an essential characteristic of the invention, as are those characteristics by which foreign substances are excluded from the path of the flowing air, and any oil precipitated will be instantly converted into a combustible mixture with much the same action as that characteristic of the operation of a surface combustion furnace.

It is not my intention to limit the invention to the precise details of construction shown in the drawings, it being obvious that such may be varied without departing from the spirit and scope of the invention.

Having described the invention, what I claim as new and desire to have protected by Letters Patent is:

1. An oil burner embodying therein two coaxial walls forming a primary air chamber, the inner of said walls having an air input cham-

ber within same and obliquely extending openings connecting said chambers, a top closure for said input chamber having a nozzle opening therethrough, a top ring projecting inwardly from said outer wall to above said inner wall, said ring having an upwardly and outwardly extending inner surface co-axial inner and outer walls about said primary air chamber forming a secondary air chamber, the inner wall of which is spaced from the outer wall of said primary air chamber to form an air input channel, said last named inner wall having obliquely extending openings therethrough connecting said channel and said secondary air chamber, a top ring for said secondary air chamber extending toward but spaced from the top ring of the primary air chamber, and refractory material carried by the top ring of said secondary air chamber, said refractory material having an outwardly and upwardly inclined inner surface, a vertically extending oil jet nozzle positioned below the top ring of said primary air chamber, ignition means, means whereby air is delivered to said primary air input chamber and said secondary air input channel, and means whereby oil is delivered to said nozzle.

2. An oil burner embodying therein two coaxial walls forming a primary air chamber, the inner of said walls having an air input chamber within same and obliquely extending openings connecting said chambers, a top closure for said input chamber having a nozzle opening therethrough, a top ring projecting inwardly from said outer wall to above said inner wall, said ring having an upwardly extending hollow cylindrical portion having a substantially vertical outside perimeter, said ring and its upwardly extending portion having an upwardly and outwardly extending inner surface, co-axial inner and outer walls about said primary air chamber forming a secondary air chamber, the inner wall of which is spaced from the outer wall of said primary air chamber to form an air input channel, said last named inner wall having obliquely extending openings therethrough connecting said channel and said secondary air chamber, a top ring for said secondary air chamber extending toward but spaced from the upwardly extending portion of the top ring of the primary air chamber, and refractory material carried by the top ring of said secondary air chamber, said refractory material having an outwardly and upwardly inclined inner surface, a vertically extending oil jet nozzle positioned below the top ring of said primary air chamber, ignition means, means whereby air is delivered to said primary air input chamber and said secondary air input channel, and means whereby oil is delivered to said nozzle.

3. An oil burner embodying therein two coaxial walls forming a primary air chamber, the inner of said walls having an air input chamber within same and obliquely extending openings connecting said chambers, a top closure for said input chamber having a nozzle opening therethrough, a top ring projecting inwardly from said outer wall to above said inner wall, said ring having an upwardly and outwardly extending inner surface co-axial inner and outer walls about said primary air chamber forming a secondary air chamber, the inner wall of which is spaced from the outer wall of said primary air chamber to form an air input channel, said last named inner wall having obliquely extending openings therethrough connecting said channel and said secondary air chamber, a top ring for said secondary air chamber extending toward but spaced from the top ring of the primary air chamber, and refractory material carried by the top ring of said secondary air chamber, said refractory material having an outwardly and upwardly inclined inner surface, a vertically extending oil jet nozzle extending through the opening in, and beyond the top closure for said input chamber, and being positioned below the top ring of said primary air chamber, ignition means, means whereby air is delivered to said primary air input chamber and said secondary air input channel, and means whereby oil is delivered to said nozzle.

4. An oil burner embodying therein two coaxial walls forming a primary air chamber, the inner of said walls having an air input chamber within same and obliquely extending openings connecting said chambers, a top closure for said input chamber having a nozzle opening therethrough, a top ring projecting inwardly from said outer wall to above said inner wall, said ring having an upwardly and outwardly extending inner surface, co-axial inner and outer walls about said primary air chamber forming a secondary air chamber, the inner wall of which is spaced from the outer wall of said primary air chamber to form an air input channel, said last named inner wall having obliquely extending openings therethrough connecting said channel and said secondary air chamber, a top ring for said secondary air chamber extending toward but spaced from the top ring of the primary air chamber, and refractory material carried by the top ring of said secondary air chamber, said refractory material having an outwardly and upwardly inclined inner surface, a vertically extending oil jet nozzle extending through the opening in, and beyond the top closure for said input chamber, and being positioned below the top ring of said primary air chamber, an upwardly dished plate above said closure plate and about said nozzle, ignition means, means whereby air is delivered to said primary air input chamber and said secondary air input channel, and means whereby oil is delivered to said nozzle.

5. An oil burner embodying therein two coaxial walls forming a primary air chamber, the inner of said walls having an air input chamber within same and obliquely extending openings connecting said chambers, a top closure for said input chamber having a nozzle opening therethrough, a top ring projecting inwardly from said outer wall to above said inner wall, said ring having an upwardly and outwardly extending inner surface co-axial inner and outer walls about said primary air chamber forming a secondary air chamber, the inner wall of which is spaced from the outer wall of said primary air chamber to form an air input channel, said last named inner wall having obliquely extending openings therethrough connecting said channel and said secondary air chamber, a top ring for said secondary air chamber extending toward but spaced from the top ring of the primary air chamber, and refractory material carried by the top ring of said secondary air chamber, said refractory material having an outwardly and upwardly inclined inner surface, a vertically extending oil jet nozzle positioned below the top ring of said primary air chamber, ignition means, an air duct having an enlarged portion upon which the burner proper rests, and into which said primary air input chamber and said sec-

ondary air input channel open, and a feed pipe through which oil is delivered under pressure to said nozzle.

6. An oil burner embodying therein a vertically extending jet nozzle, an air supply duct, means for delivering air thereto, means forming about said jet nozzle a primary air chamber having a cylindrical outer wall, an inwardly directed top having an unobstructed circular opening therethrough spaced above said nozzle, said last named means having therein obliquely extending openings connecting said air duct and said primary air chamber, whereby primary air has an outward, upward and inward flow through said chamber with a whirling movement, means about said primary air chamber forming a secondary air chamber having a cylindrical outer wall and an inwardly directed top having an opening therethrough adjacent the opening in the top of said primary air chamber, a block of refractory material upon the top of said secondary air chamber, said means about said primary air chamber having obliquely extending openings connecting said duct and said secondary air chamber, the inner walls of the openings in the tops of said primary air chamber and said secondary air chamber and the inner wall of said refractory material, being upwardly and outwardly inclined, whereby the primary and secondary air and the oil is so directed as to cause an upwardly and outwardly directed hollow flame adjacent said refractory block, and said refractory block is so heated that any oil falling thereupon is volatilized, ignition means, and means delivering oil under pressure to said jet nozzle.

WILLIAM J. DEBLER.