

Oct. 29, 1940.

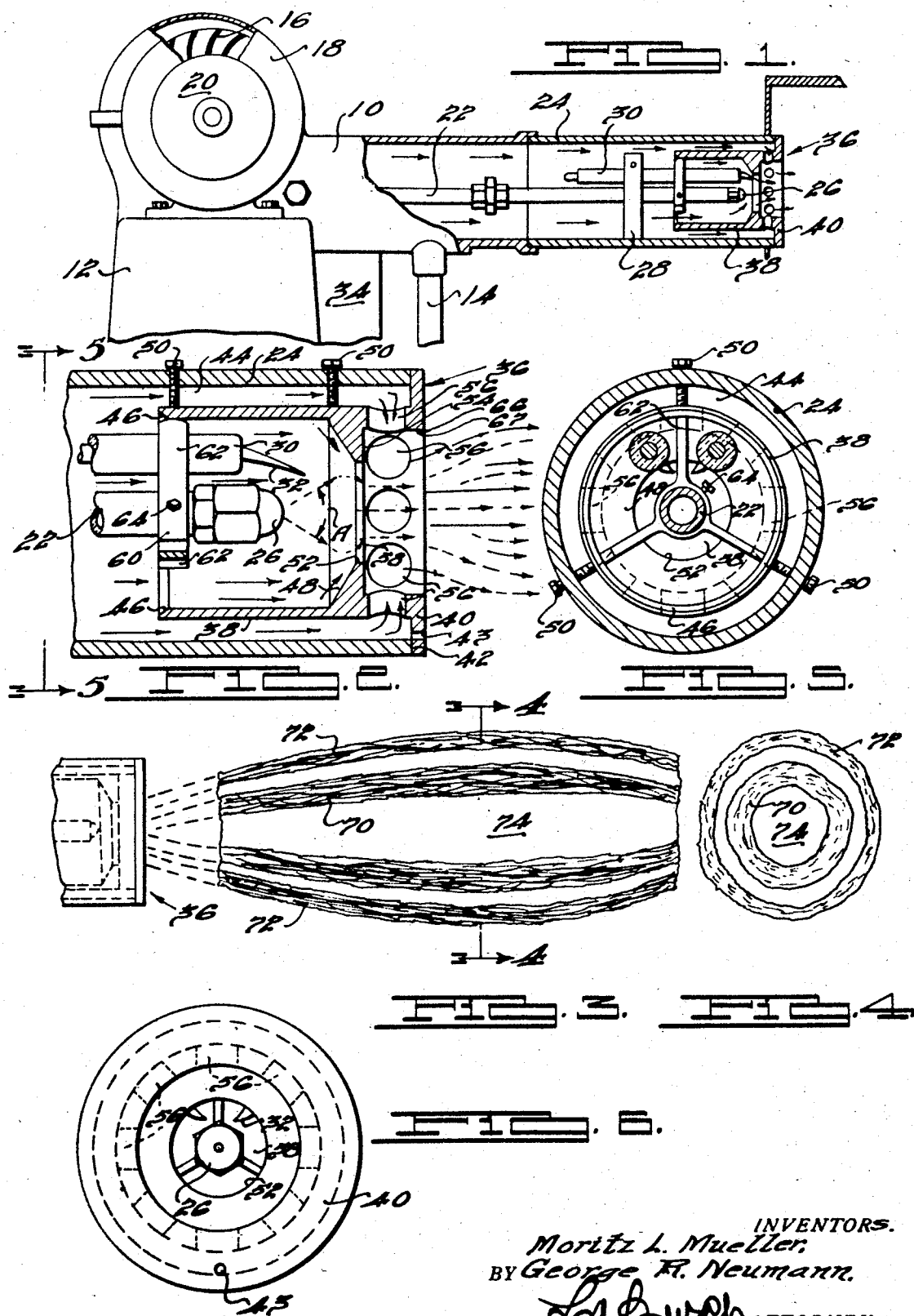
M. L. MUELLER ET AL

2,219,696

ART OF COMBUSTION

Filed Dec. 27, 1937

2 Sheets-Sheet 1



INVENTORS.
Moritz L. Mueller,
BY George R. Neumann.
Ed. L. Swick ATTORNEY

Oct. 29, 1940.

M. L. MUELLER ET AL

2,219,696

ART OF COMBUSTION

Filed Dec. 27, 1937

2 Sheets-Sheet 2

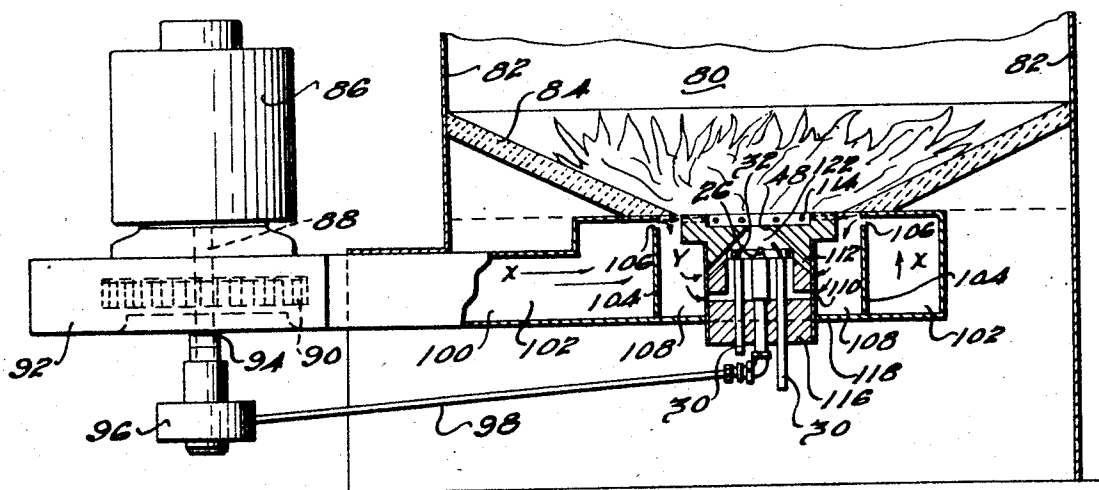


FIG. 7.

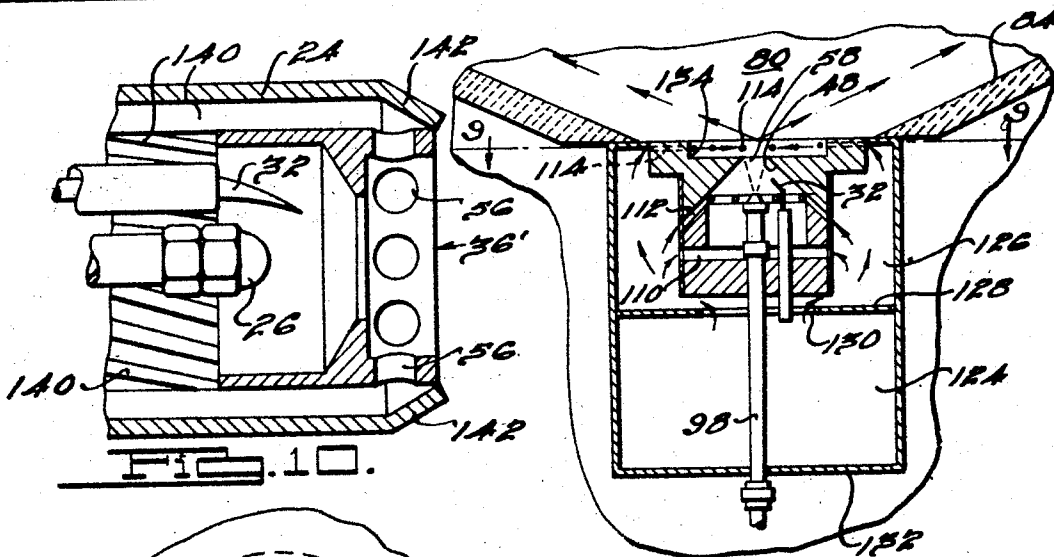


FIG. 10.

FIG. 8.

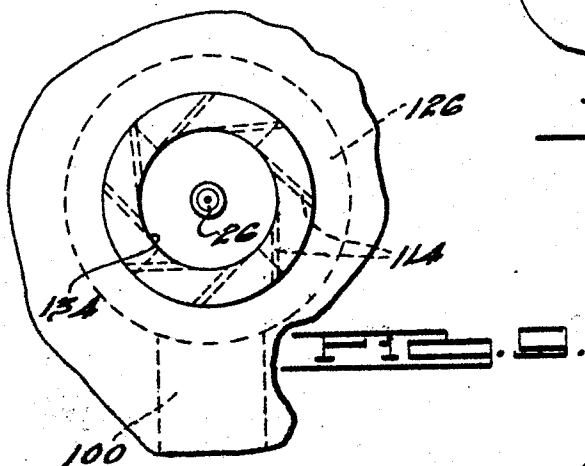


FIG. 9.

INVENTORS.
Moritz L. Mueller,
George F. Neumann.
BY *John Burph* ATTORNEY

UNITED STATES PATENT OFFICE

2,219,696

ART OF COMBUSTION

Moritz L. Mueller, Grosse Pointe, and George R. Neumann, St. Clair Shores, Mich., assignors to Borg-Warner Corporation, Chicago, Ill., a corporation of Illinois

Application December 27, 1937, Serial No. 181,752

1 Claim. (Cl. 158—76)

This invention relates in general to the art of combustion, with particular reference to an apparatus and method for burning fluid hydrocarbons. Such fluid hydrocarbons will hereinafter be described as oil or fuel oil although it is to be understood that gaseous or other fluid hydrocarbons may fall within the scope of the description.

Heretofore, apparatus which has employed pressure for atomizing fuel oil by spraying it through a fine nozzle has depended for the most part upon releasing the sprayed oil fog into a combustion chamber and upon the directing of a stream of air into the combustion chamber as a sheath around the oil fog to secure proper mixing or comingling of the particles of oil and air. Such apparatus has relied upon means for directing the air in such a manner that the sheath or envelope of air projected into the combustion chamber will coincide with and fit over the cone of oil fog issuing from the nozzle tip. It has been recognized that this is a very delicate adjustment and that slight inaccuracy of the nozzle, slight displacement of one part relative to another, and differences in the quality of fuel oil, which may be delivered by the local fuel dealer, will result in an upsetting of this adjustment and an according loss in efficiency of the combustion apparatus.

Such prior combustion apparatus has also been at great pains to produce agitation or whirling movement of the air projected into the combustion chamber in order that the cone of oil and the sheath of air may be more thoroughly mixed. Attempts have also been made to give the oil and air whirling movements in reverse directions in order to assist in this mixing. All such constructions attempt to mix oil and air in the combustion chamber after the pressure has been released from both of these substances and after their velocity has become relatively small and to this end have required the use of special combustion chambers for each burner or changes to be made in the burner to fit it for operation in various shapes of combustion chambers.

The requirements for precision in adjustment and the delicacy of such adjustments have made such equipment undesirable for domestic or small commercial installations where there is no skilled operator on hand to keep constant check on the condition of the apparatus. As a result, the majority of such installations are constantly running below their maximum efficiency, and such lack of efficiency is reflected in higher fuel bills which the consumer is required to pay.

In order to overcome these difficulties and to increase the efficiency of the combustion apparatus in general, the present invention provides means for mixing fuel and air within a space wherein the pressure is above that in a combustion chamber to which the mixture is released. This mixing apparatus has been so devised that fluctuations in quality of the fuel oil will not adversely affect the efficiency of the combustion apparatus. It has also been found that a wide variety of angles of oil nozzle tips may be employed in connection with this burner without any alteration in the fire characteristics.

With these purposes in mind, it is an object of the invention to provide means for mixing a sprayed oil fog and air within a pressure area prior to releasing the mixture to a combustion chamber.

A further object of the invention is to provide a new method of burning combustible fluids with extremely high efficiency.

An additional object of the invention is to provide a head for insertion in present day oil burning apparatus which will provide means for realizing the advantages outlined above.

It is a still further object of the invention to supply means for controlling the shape of the fire independent of any particular shape of combustion chamber.

It is a further object of the invention to provide an oil burner head which is simple, sturdy, readily and cheaply manufactured and which effectuates the foregoing objects and realize the advantages set forth hereinafter.

To this end, apparatus embodying the invention will be seen to reside in an oil burning apparatus of the pressure atomizing gun type. Such apparatus usually consists of a blower which is operated by an electric motor and which discharges a blast of air along a draft tube. In most installations, the draft tube carries, besides the air, a fuel pipe which is supplied with fuel oil under pressure by means of a pump actuated by the blower motor, and a pair of electrodes for igniting the fuel and air. In most instances, the draft tube is provided intermediate its length with a baffle which causes the air to take a path adjacent the inside diameter of the tube and results in the high pressure space in the draft tube being located at the blower side of the baffle. As a result of the use of this baffle, air which flows past the oil nozzle is of somewhat reduced pressure and can not serve effectively to entrain the oil. Because of this low pressure, various expedients have been resorted to at the combustion

chamber end of a burner in an attempt to give the air stream a definite shape upon its release into the combustion chamber.

In adapting such an oil burner for the use of the head of the present invention, the instrumentalities for shaping the air stream are removed from the combustion chamber end of the burner and there is substituted therefor a cylindrical head. The pressure baffle, which is located intermediate the ends of the draft tube, is removed so as to extend the space under high pressure within the draft tube forwardly to a point within the newly inserted burner head. With such a construction, the air flowing past the burner nozzle is of the full pressure delivered by the fan and has an accordingly great ability to entrain the oil issuing from the nozzle.

The oil being sprayed by the oil nozzle takes the shape of a right cone which has its apex at the oil nozzle aperture. Air which is being fed past the nozzle is deflected just forwardly thereof into a conical path which has its apex out beyond or forwardly of the oil fog apex, these two apices being oppositely directed and lying upon a line which forms the common altitude of the cones.

The angle of the oil nozzle upon which the conical formation of the fuel fog depends, may be such as to form a cone, the cross section of which may be either smaller or larger or the same size as the aperture formed at the termination of the conical air directing portion of the head at the point of passage of the fog through this aperture. The arrangement of the cones of the oil fog and of the air stream is such that the two meet one another with the elements of their conical surfaces extending transversely to one another while the air is still under pressure, thus producing a thorough penetration of the air into the oil and the oil into the air and a complete mixing and comingling of the two fluids.

With the oil fog and air meeting one another at high velocities, it becomes apparent that they will be ejected into the combustion chamber at a very high speed and that this speed may possibly be in excess of the rate of flame propagation within the combustion chamber. In order to retard this flow of the mixture, the present invention provides a means for producing a retarding effect upon the mixture by supplying supplementary air entirely around the same. Such supplementary air also serves to produce a secondary mixing and to supply additional air for mixture with the oil for completion of the combustion of all oil particles at all points throughout the flame propagated by the burner, as well as provide a stabilizing effect to hold the flame in free floating position.

In the drawings, in which similar reference characters are employed to designate similar parts and of which there are two (2) sheets:

Fig. 1 is a side elevational view of an oil burning apparatus of the pressure atomizing gun type, parts being broken away in order more clearly to illustrate the invention;

Fig. 2 is a vertical sectional view of a portion of the oil burner, showing the head and its cooperating parts in greater detail;

Fig. 3 is a diagrammatic view of a flame such as would be propagated by the oil burning instrumentalities shown in Figs. 1 and 2;

Fig. 4 is a vertical sectional view through the flame shown in Fig. 3, taken substantially upon a plane as indicated by the line 4-4 of Fig. 3, and looking in the direction of the arrows;

Fig. 5 is a vertical sectional view through the oil burner taken substantially upon a plane as indicated by the line 5-5 of Fig. 2 and looking in the direction of the arrows;

Fig. 6 is a right end elevational view of the part of the oil burner shown in Fig. 2.

Fig. 7 is a side elevational view of a different form of oil burner and a furnace showing the oil burner of the present invention as installed in a conventional furnace or boiler, parts being broken away more clearly to illustrate the invention;

Fig. 8 is a vertical sectional view of a slightly different form of oil burner using the same type of head as is disclosed in Fig. 7 and taken substantially upon a plane as indicated by the line 8-8 of Fig. 9;

Fig. 9 is a horizontal sectional view of the oil burning apparatus shown in Fig. 8 taken substantially upon a plane as indicated by the line 9-9 of Fig. 8 and looking in the direction of the arrows; and,

Fig. 10 is a vertical sectional view through the burner tip of an oil burner showing a slightly different form of head.

The oil burner which embodies the invention will be seen to comprise a burner body 10 which is supported upon a pedestal 12 and legs 14 from the floor of the basement or apartment in which the heating equipment is located. The body 10 is formed toward its rear end with a shell 18 for enclosing a blower 16 of the sirocco type which is adapted to be driven by a motor illustrated diagrammatically at 20. The motor shaft may also be connected to and drive the shaft of an oil pump (not shown) which supplies oil under pressure to a fuel pipe 22 extending through a draft tube 24 to supply oil to a nozzle 26. The fan pulls air into the shell 18 and discharges it along the draft tube 24.

Toward its forward end the fuel pipe 22 is supported by means of a tripod 28 which engages the inside diameter of the draft tube at three spaced points. Tripod 28 may also support a pair of electrodes 30 which comprise conductors having tips 32 located adjacent the oil nozzle, such conductors being sheathed in porcelain rearwardly of such tips 32 and being connected by any suitable conductors (not shown) to a transformer 34 which may be secured to the base 12 for supplying a high potential across the electrodes for igniting the fuel and air upon initiation of combustion.

The draft tube 24, which is cylindrical, receives in its forward end a burner head indicated generally at 36. The burner head 36 comprises a cylindrical portion 38 and has its forward or flame presented portion terminating in a flange 40 which may abut against the end of the draft tube 24 at 42. An aperture 43 may be provided in flange 40 for draining liquids which may be deposited inside tube 24. The cylindrical portion of the head 36 has an outside diameter somewhat less than the inside diameter of the draft tube 24 and is arranged concentrically with respect to the draft tube 24 to provide an annular air passage 44 extending completely around the cylindrical portion 38 of the head 36. The cylindrical member 38 is hollow and has its inside surface chamfered as at 46 at its rear edge. The inside surface of the cylindrical portion 38 terminates toward the forward end of the head 36 in a conical portion 48 which serves to direct air flowing from left to right, as viewed in Fig. 2, toward the coinciding axes of the draft tube 24 and head 36. The head 36 may be centered with respect to the

draft tube 24 and permanently held thus located by means of spaced set screws 50 threaded into the draft tube 24 and engaging the outer surface of the cylindrical portion 38 of the burner head 36.

The conical portion 48 of the burner head 36 terminates in a short cylindrical portion 52 forming an aperture through which the air flows to entrain the oil. Forwardly of the cylindrical portion 52, the burner head is provided with a flat annular surface 54 and with a series of apertures 56 which extend radially through the cylindrical portion 38 of the head 36. The apertures 56 are uniformly spaced around the periphery of the head and provide a means for supplying air to the oil and air mixture issuing from the main aperture 58 defined by the short cylindrical surface 52, in which the conical portion 48 of the head terminates. As previously explained, these supplementary air supplying passages result in a retarding of the velocity of the flame. It has been found that a decrease in the total area of the apertures 56 with respect to the area of the aperture 58 will result in the flame propagated by the burner becoming longer and in its standing at a distance further removed from the burner head after the flame has been established and ignition by means of the electrodes 32 has been discontinued.

The apertures 56 also serve to prevent eddy currents in the mixture of oil and air from wiping the flat face 54 of the burner. It has been found that if apertures 56 have too little area with respect to the orifice 58, they still will not prevent this wiping of the mixture upon the flat face 54. Such an action on the part of the mixture of oil and air is undesirable, since it is apt to leave deposits of oil upon this face, which in time would become partially burned and would carbonize this face of the burner, requiring it to be frequently cleaned. By enlarging the orifices 56 the face 54 is scoured with air and carbon deposits thereupon are prevented.

The oil nozzle 26 is centered with respect to the circular aperture 58 by means of a tripod, the central portion 60 of which surrounds and supports the fuel pipe 22 and the legs 62 of which engage the inside surface of the cylindrical portion 38 of the head 36. The oil nozzle 26 may be adjusted rearwardly or forwardly with respect to the aperture 58 by loosening a set screw 64 threaded into the central hub 60 of the tripod. This adjustment, made in conjunction with a consideration of the angle A, formed by the oil sprayed from the nozzle, determines the position which the cone of oil issuing from the nozzle will take with respect to the conical surface 48, which directs the air stream against the oil stream. Various tips may be used on the fuel nozzle having different angularities, varying from thirty degrees to ninety degrees and varying in the capacity or quantity of fuel which they will feed per hour. It has been found that it is relatively unimportant just what angle of fuel cone is employed, as long as the air which is supplied to the central mixing point has sufficient velocity to deflect this oil cone and prevent particles of oil from impinging upon the conical surface 48 or the cylindrical surface 52. With the air pressures which are usually available in domestic installations it has been found that the angle of the oil cone and the distance of the tip 26 rearwardly of aperture 58 may be such that, were no air flowing through the draft tube, the oil might impinge slightly upon the conical surface 48. With air

flowing through the draft tube at a pressure of about 0.30 inch of water, the air stream will act to compress and deflect the oil fog to prevent its striking the conical surface 48 or the cylindrical surface 52 of the aperture 58. Higher air pressures may be employed, ranging upward to 4.0 inches of water.

The oil will flow from the pressure atomizing nozzle 26, as indicated by the dotted line arrows in Fig. 2, in such a manner that it would impinge upon the edges of the orifice 58 were it not for the presence of the stream of air, as indicated by the full line arrows in Fig. 2, which serves to condense or compress the oil fog where it reaches a point adjacent the orifice 58. After passing through the orifice 58, the arrows indicating the oil and air are seen to remain in their compressed state until after they have passed the combustion chamber end or mouth of the burner, at which point they begin to expand. Just after leaving the orifice 58, the stream of oil and air is joined by the supplementary air, which flows through the apertures 56, as indicated by the full line arrows in Fig. 2.

It will be noted that the cone of oil fog is expanding as it passes through the orifice 58, whereas the cone formed by the air stream is contracting and that the paths of particles located in the two streams at their point of contact are directed transversely to one another, thus producing a thorough penetration of each particle of the air stream into the oil stream and a corresponding thorough penetration of each particle of the oil fog into the air stream. The visible effect of this meeting of the two streams is that the oil stream, which is the only portion which may be seen, is somewhat compressed and turbulent as it passes into aperture 58 and as it issues therefrom, becomes more turbulent and expands slightly.

The apertures 56 inject air transversely of the mixture path and radially into the mixture of oil and air as it issues from the mouth of the orifice 58 and tend further to increase the turbulence of the mixture at this point. The air supplied by apertures 56 also tends to constrict the air and oil mixture and prevent its expansion in so rapid a fashion that it would strike the inner corners 66 of the flanged portion 40 of the burner head 36 or its associated cylindrical portion 67. Although this air is used to increase the turbulence at the mouth of the orifice 58, a portion of it is deflected and follows along the exterior of the fluids issuing from the burner mouth to form a sheet which entirely surrounds the flame and which is available during the progress of the combustion fluids through the combustion chamber for the completion of combustion.

The angle of the apex of the conical surface 48 determines to some extent the shape of the fire. When this angle is relatively great, that is, when it approaches 180°, the fire will become very short and of relatively great diameter. As this conical angle is decreased, the flame becomes relatively long and thin.

The orifices 56 may be varied to cause a deflection of the flame in any desired direction. For example, if it is desired to raise the flame from the floor of the combustion chamber and have it stand in a more elevated position with respect to the mouth of the burner than would be the case when using the head as shown in Fig. 2, it is only necessary to enlarge the orifices 56 upon the lower side of the head 36 so as to increase the amount of air flowing through such lower orifices, the amount of air flowing through the upper

orifices 56 remaining the same. This enlargement of the lower orifices results in the flame being deflected upwardly. It will be recognized that the flame can thus be deflected in any desired direction, simply by increasing the size of the orifices 56 upon that side of the head which lies opposite to the desired direction of deflection.

Upon starting, the electrodes 32 are energized to cause a spark to travel between them, and this spark serves to ignite a portion of the oil and air within the burner head, such ignited fuel being carried out into the combustion chamber by the oncoming air to establish ignition of the main flame. During this stage of combustion, the flame will be burning directly from the mouth of the burner, but after the ignition has been cut off, usually about ninety seconds after initiation of burner operation, the flame will be self-propagating and will stand about two or three inches from the combustion chamber end or mouth of the burner, thus reducing the possibility of carbon depositing on the burner parts.

The flame thus established, after cessation of the electric ignition, takes a shape somewhat as shown in Fig. 3. This flame appears to be a somewhat cylindrical mass of fire which is swelled slightly toward its forward end, and, upon inspection, is seen to comprise an inner hollow cylindrical portion 70 of very brightly burning carbon particles which forms the main portion of the flame and an outer hollow cylindrical portion 72 somewhat more nebulous than the inner portion 70 and not quite so bright. In the hollow interior 74 of the inner portion and between the cylindrical portions 70 and 72, there may be a few tag ends of fire, but the flame in the main is confined to these two paths. The flame is found upon inspection to be of a uniform dark yellow or light orange color from one end to the other, thus indicating that its carbon dioxide content is all uniformly high and that combustion is taking place in a uniformly efficient manner.

This uniformity of the flame tends to substantiate the theory that the air supplied from the ports 56 is useful as secondary air to complete combustion throughout the flame as well as to increase the turbulence of the air and oil mixture at its point of issuance from the orifice 58. In the usual flame propagated by the pressure atomizing gun type of burner, the ends of the flame are somewhat ragged and the color of the flame varies considerably from one end to the other, having a bright yellow color at the end nearest the mouth of the burner, a dark yellow or a light orange color in its central portion, and a smoky dark orange color at its ends. These colors are interpreted as follows:

Color:	CO ₂ content (Per cent)
Bright yellow.....	4-5
Dark yellow or light orange.....	12-13
Smoky or dark orange.....	14-15

A uniformly high carbon dioxide content is indicative of very efficient combustion and tests of flue gas taken on products of combustion generated by a burner of this type yield readings on CO₂ content ranging from 12% to 14%, while the CO content is zero and the O₂ content approximately 4% or 2%, respectively.

In Figs. 7 to 9, there is shown a burner employing the head of this invention which is arranged to supply a mixture of fuel and air to a vertically extending combustion chamber, such a combustion chamber being of the type usually

found in domestic installations which are desired to be converted from solid fuel consuming to oil consuming heating plants.

Furnaces of this type usually embody a cylindrical or rectangular combustion chamber 80, the walls 82 of which serve as heat transfer surfaces for transmitting the heat generated within the combustion chamber to a fluid heating medium lying upon the opposite side of the walls 82. The grates (not shown) which are usually present in solid fuel combustion apparatus, are removed and a floor 84 of refractory material having an upper conical surface is built up in the bottom of the furnace combustion chamber 80.

The operating instrumentalities of the burner are seen to comprise the same parts as does the burner disclosed in Fig. 1, and include a motor 86 which is arranged with its shaft 88 in a vertical position and operatively connected to a fan 90 which rotates within a housing 92. A flexible coupling 94 connects the end of shaft 88 upon that side of the fan 90 opposite to the motor 86 to an oil pump adapted during operation to withdraw fuel oil from a tank and supply it under pressure to a fuel feed line 98. The fan 90 supplies air under pressure through a draft tube 100 to a pressure or plenum chamber 102 extending annularly about the head of the burner and centered with respect to the central aperture in the refractory material floor 84 of the combustion chamber 80.

A cylindrical baffle 104 extending around the burner head prevents the air moving along the draft tube 100 from being blown directly against one side of the burner head. To limit the flow of air the upper end of the cylindrical baffle 104 is spaced as at 106 from the upper end of the plenum chamber 102 and air may flow only as indicated by the arrows X in Fig. 7 through the space 106 and into an inside air chamber 108. The air, which has thus been forced to flow through the space 106 has converted its velocity head into pressure head upon reaching the chamber 108 and since all parts of this chamber are under an equal pressure, the air will flow evenly through three sets of apertures 110, 112 and 114, as indicated by the arrows Y in Fig. 7, such apertures being provided in a burner head 116 which has its upper end positioned in the aperture formed in the bottom portion of the refractory material floor 84. The burner head 116 and the bottom wall 118 of the air chamber are fitted to one another so as to provide an air-tight joint at the point where the head 116 passes through the wall 118. The air passing through the apertures 110 is available to wipe the surface of the oil nozzle 26 which is inserted through the bottom of the head 116 into the central cavity 122 thereof along lines which form extensions of the elements of conical surface 48 corresponding to the surface 48 as appears more clearly in Fig. 2. Air may also pass through the apertures 114 which correspond to the apertures 56 (Fig. 2) and perform the same function as the apertures 56. These apertures 114 may be arranged to extend tangentially with respect to the cylindrical surface of the expansion space adjacent the discharge orifice 58 of the burner head and may be so directed as to give the air either a clockwise or counterclockwise rotation. The apertures 114 might also be directed radially as are the apertures 56 of Fig. 2.

Electrodes 32 are provided for initiating ignition of the oil and their operation is discontinued after combustion has been established, similarly

to the electrodes described in connection with Figs. 1 to 6.

In Figs. 8 and 9 a slightly different form of air supplying means is shown, the draft tube 100 thereof being arranged in a lower plane than is the draft tube 100 shown in Fig. 7, being positioned to discharge air into a plenum chamber 124 which lies directly below the air chamber 126, corresponding to the air chamber 108 in Fig. 7, and being separated therefrom by a disc baffle 128 centrally apertured at 130 to provide a passage for air from the chamber 124 to the chamber 126 as shown by the arrows Z in Fig. 8. The fuel feed pipe 98 is sealed to the bottom wall 132 of the plenum chamber 124 at the point where it passes through the wall 132 to prevent air from leaking through the joint.

Fig. 9 illustrates more clearly the tangential arrangement of the air jets 114 with respect to the cylindrical surface 134 of the expansion space.

In Fig. 10 the head of the invention is disclosed as applied to a burner having a draft tube 24 provided on its inside surface with fins 140 originally intended for the purpose of deflecting air in a spiral path. The mouth of the burner is provided with an inwardly curled edge 142 which in the original burner served as a means for forming a cone of air for surrounding the cone of fuel oil within the combustion chamber. A head 36', similar to the head 36 of Fig. 2 but minus the out-turned flange 40 thereof, may be positioned within the mouth of the burner with its outer face flush with the outer edge of the inside periphery of the curled edge 142. The inwardly curled edge 142 thus serves to deflect air for passage through the supplemental air supplying orifices 56 and the burner head 36' is supported upon the spiral fins 140 which line the inside of the draft tube 24. Set screws (not shown) may be provided for supporting and maintaining the head 36' in its proper position. An oil nozzle 26 and electrodes 32 may be employed, as in the construction of Fig. 2.

With the constructions shown in Figs. 7 to 9, it is possible to adapt the burner of the present invention for use in a wide variety of types of heating apparatus as it is possible, by varying the size of the apertures 114, to increase or decrease the angle which the flame may have with respect to the vertical axis of the burner. This increase or decrease of the angle will also vary the flame speed and the distance which the flame will travel and may be arranged to result in impingement of the products of combustion upon the walls 82 of the combustion chamber which form a heat transfer surface, and also result in a thorough wiping of the products of combustion against the combustion-chamber side of the walls 82 as they travel upwardly before being exhausted through the flue.

It will be understood that the fuel combustion apparatus including the head, electrodes, spray nozzle and a portion of the draft tube might be employed in connection with a furnace which employs an exhaust fan in the stack and relies upon the use of such exhaust fan to draw air through the draft tube. For the purposes of this invention, it is immaterial whether the flow of air is caused by a positive pressure or by a pressure

created by a vacuum, the only requirement being that a pressure drop exist between the inside of the draft tube and the combustion chamber.

While the supplemental apertures 56 have been described as conducting air at right angles to its path of movement through the draft tube, these apertures might also be arranged so as to direct air slightly rearwardly or in the direction of the oil nozzle 26, thus causing the air to take a path which forms an acute angle with respect to a path of the air through the draft tube and burner head. It has been found that the acute angular disposal of the orifices 56 as above described will also serve to retard the speed of the mixture and to stabilize the flame which is hovering in space off the end of the burner. It has also been found that if the apertures 56 are so directed as to increase the speed of the mixture flowing from the mouth of the burner that the flame becomes unstable and the speed of the mixture increases beyond the rate of flame propagation and causes the flame to be extinguished. When the supplemental air feeding apertures are tangentially arranged, as in Figs. 7 through 9, they create a vortex upon the flat annular faces of the burner, thus tending to pull the mixture issuing from the burner mouth outwardly and to increase its angle. The resulting fire is very flat and spreading, which is ideal for the type of combustion chamber shown in Figs. 7 to 9.

It will thus be seen that the combustion apparatus carries into effect the objects of the invention as previously set forth and enables a domestic consumer to take full advantage of the high efficiencies made available by this burner without requiring the services of a skilled operator and constant supervision of its operation.

While the invention has been described with some detail, it is to be understood that the description is for the purpose of illustration only and is not definitive of the limits of the inventive idea. The right is reserved to make such changes in the details of construction and arrangement of parts as will fall within the purview of the attached claim which we make.

We claim:

Combustion apparatus comprising a draft tube adapted to be supplied with air under pressure from any suitable source, a cylindrical member smaller than the inside dimension of said draft tube and positioned within the mouth of said draft tube, a flange upon one end of said cylindrical member for engaging the end of said draft tube, said cylindrical member being hollow and having a restricted orifice defining the small end of a frustrum of a cone, a fuel discharge nozzle positioned within said hollow member to discharge a cone of oil fog in the direction of said orifice, the outer surface of said cylindrical member being spaced from the inner surface of said draft tube to form an air passage therebetween, said cylindrical member being provided with a plurality of spaced orifices extending there-through at right angles to the central axis of the cylindrical member between said flange and said restricted orifice and adjacent the surface surrounding said restricted orifice.

MORITZ L. MUELLER.
GEORGE R. NEUMANN.