Sept. 28, 1943. R. W. BECKETT 2,330,190

COMBUSTION METHOD FOR OIL BURNERS

Original Filed Feb. 4, 1938 3 Sheets-Sheet 1

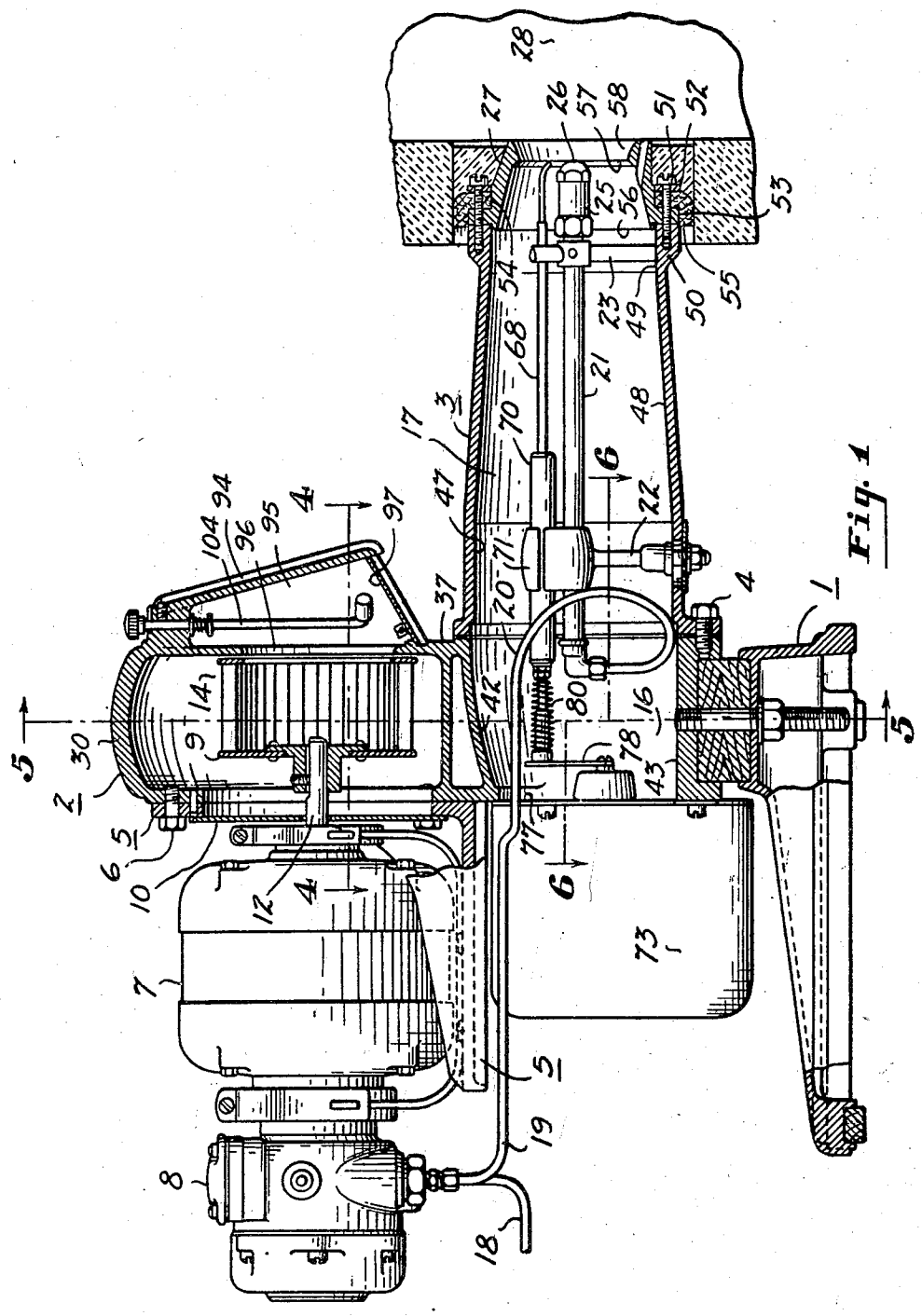


Fig. 1

INVENTOR
REGINALD W. BECKETT
BY
Evans & McCoy
ATTORNEYS

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Original Filed Feb. 4, 1938 3 Sheets-Sheet 2

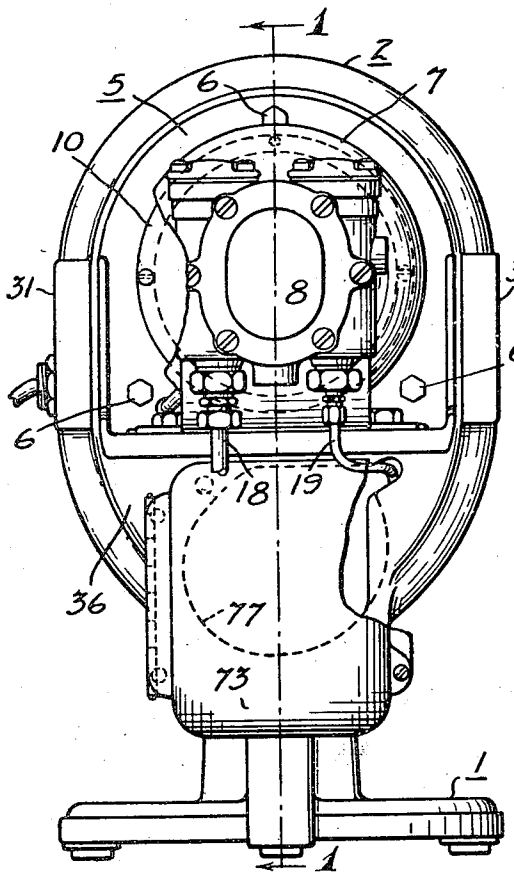


Fig. 2

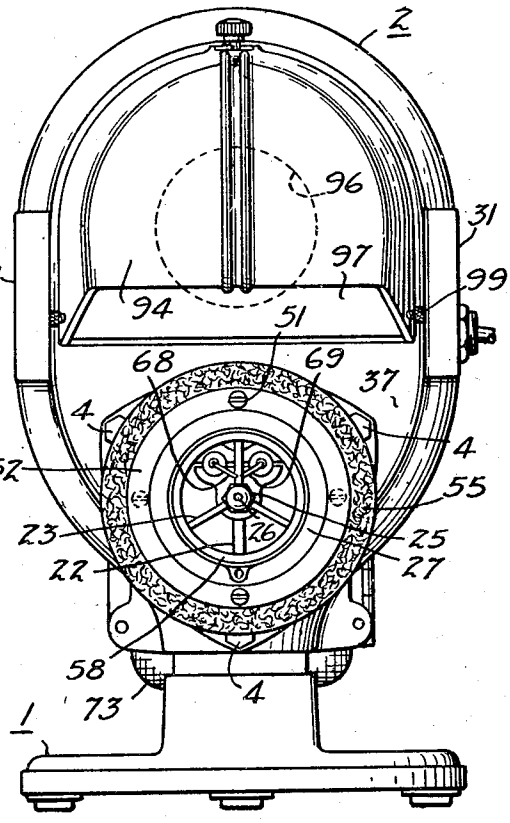


Fig. 3

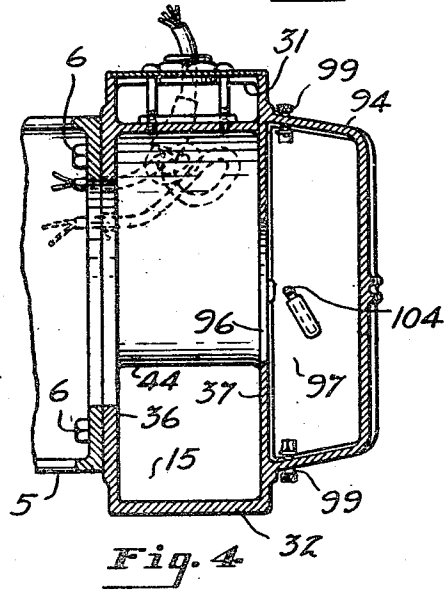


Fig. 4

INVENTOR
REGINALD W. BECKETT
BY
Evans + McCoy
ATTORNEYS

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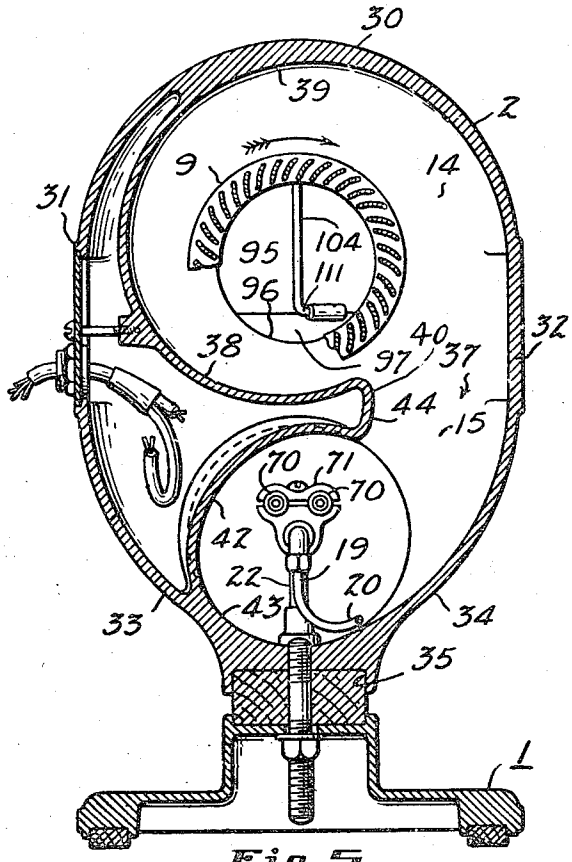


Fig. 5

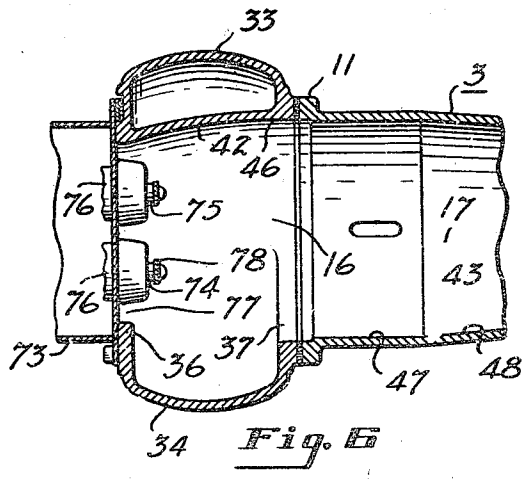


Fig. 6

INVENTOR
REGINALD W. BECKETT
BY
Evans & McCoy
ATTORNEYS

UNITED STATES PATENT OFFICE

2,330,190

COMBUSTION METHOD FOR OIL BURNERS

Reginald W. Beckett, Elyria, Ohio

Original application February 4, 1938, Serial No. 188,731. Divided and this application February 5, 1940, Serial No. 317,246

4 Claims. (Cl. 158—117.5)

This invention relates to combustion methods, and more particularly to an improved method of burning fuel in oil or other liquid fuel burners of the gun type in which a blast or current of combustion air is forced past and around a nozzle ejecting fuel under high pressure and into a furnace or other combustion chamber. The present application is a division of my co-pending patent application Serial No. 188,731, filed February 4, 1938, and now matured into Patent No. 2,310,274, February 9, 1943.

It is an object of the invention to provide an improved method of combustion in which a spiral motion is imparted to the combustion air and the air is given an increased turbulence or agitation in the region of the fuel ejecting nozzle so that an improved mixing of the fuel and air is produced and an atomized mist of highly combustible fuel is projected from the mouth of the burner.

Another object is to provide a generally improved combustion method which is economical and may be performed or utilized in a burner of relatively simple design and construction and one which is inexpensive to manufacture. Other objects and advantages of the invention will become apparent from the following detailed description of the method and a suitable burner or apparatus for carrying out the method made in connection with the accompanying drawings, in which:

Figure 1 is a side elevational view partly in section and with parts removed showing a burner in position for operation according to the method of the present invention in a conventional furnace and taken substantially on the line 1—1 of Fig. 2;

Fig. 2 is a rear elevational view of the burner with parts broken away;

Fig. 3 is a front elevational view of the burner;

Fig. 4 is a fragmentary sectional view taken substantially on the line 4—4 of Fig. 1;

Fig. 5 is a transverse vertical sectional view with parts removed taken substantially on the line 5—5 of Fig. 1; and

Fig. 6 is a fragmentary detail view in section taken substantially on the line 6—6 of Fig. 1;

Referring to the drawings by numerals of reference, which indicate like parts throughout the several views, the burner illustrated comprises a pedestal or base, indicated generally by the numeral 1, which is surmounted by and supports a main body portion or housing, indicated generally by the numeral 2. A horizontally disposed air or blast tube 3 is secured to the lower portion of the housing 2 at one end thereof by cap screws or studs 4 which extend through a radially directed flange 11 formed at the inlet end of the air tube. On the upper portion of the housing 2 at the end thereof opposite the blast tube 3 a supporting member or bracket 5 is removably secured by cap screws or studs 6.

The bracket 5 carries a removable unit which comprises all the movable parts of the burner including motor 7, fuel pump and pressure regulator 8, blower 9 of the sirocco type, and cover plate 10. The blower 9 is actuated and supported by shaft 12 of the motor 7 which also actuates the fuel pump. The circular cover plate 10 has a running or clearance fit on the shaft 12 between the motor 7 and blower 9.

The blower 9 is received in a chamber 14 formed in the upper portion of the housing 2 and forces air downwardly through a throat 15 tangentially into inlet end 16 of combustion air passage way 17 extending longitudinally through the bottom of the housing 2 and the air tube 3.

The fuel pump and pressure regulating device 8 draw liquid fuel through supply conduit 18 and force it under relatively high pressure through fuel pressure conduit 19 having a flexible loop 20 into fuel pipe 21 supported by bracket 22 and spider 23 in the air tube 3. A vaporizing or spray nozzle 25 is secured on the end of the fuel pipe 21 at the discharge end of the air tube 3 so that its outlet orifice 26 is disposed substantially in the plane of the smallest cross-sectional area portion of a burner head 27, to be later described. Air forced through the passage-way 17 by the blower 9 and moving in a helical path commingles with the oil spray emerging from the nozzle orifice 26 to form a mist of finely dispersed oil particles which burn in combustion chamber 28 of the heating unit such as a domestic furnace.

The housing 2 is symmetric in external appearance and of generally ovate form as viewed from either end. It is carried in an upright position on the base 1, being of a materially greater height than width and of a materially greater width than length. The housing is of substantially uniform length from top to bottom and has a top wall 30 of generally rounded form merging into relatively straight vertical side walls 31 and 32. Inwardly curving or rounded bottom walls 33 and 34 extend downwardly as continuations of the side walls 31 and 32 and terminate in a downwardly directed socket 35, to be later described. Rear end wall 36 carries the bracket 5

which supports the removable motor unit, and front end wall 37 carries the air tube 3 as mentioned above.

The blower chamber 14 (Fig. 5) is of the form commonly employed with rotary blowers of the sirocco type having axially extending blades, and is partially defined by a curved internal wall or partition 38 which extends between the end walls 36 and 37 of the housing 2 from a point 39 where it is formed into the top wall 30 of the housing at substantially the center thereof downwardly to the left in a circular fashion and then to the right, as viewed in Fig. 5. The lower end of the wall 38 extends beyond the middle of the housing and to cut off 40 of the throat 15. The radial space between the peripheral margin of the rotary blower 9 and the walls of the chamber 14 progressively increases from the cutoff 40 in a clockwise direction around the rotational axis of the blower substantially to the throat 15. This increase in the free radial cross-sectional area of the housing available for the flow of air is in the direction of rotation of the blower rotor 9, indicated by the arrow of Fig. 5.

In the bottom of the housing 2 is formed the inlet end 16 of the passage 17, as previously mentioned. Air moving through the throat 15 in a downward direction is directed tangentially into the passage portion 16 by the curved bottom wall 34 of the housing, the inside surface of which gradually approaches the passage 16 and is tangent thereto at substantially the bottom of the housing.

One side of the inlet end 16 of the passage, opposite the throat 15, is defined by an internal wall or partition 42 which starts substantially at the bottom center of the housing 2 where it is connected to the lower part of the bottom wall 33, as indicated at 43, and is then curved upwardly to the left and then to the right in a clockwise direction following the general curvature of the passage 17 in the tube 3. The upper end of the partition 42 and the lower end of the partition 38 are joined by a short, vertically disposed partition 44 which partially defines the throat 15. The partition 42 is curved or sloped longitudinally of the inlet portion 16 of the air passage as shown in Figs. 1 and 6. This curvature is progressively increased from the lower portion 43 to the top portion where the partition 42 joins the vertical partition 44. The margin 45 of the partition 42, adjacent the end wall 36 of the housing 2, progressively approaches the axis of the air passage 17, while the margin 46 of the partition 42, adjacent the end wall 37 of the housing, remains substantially flush with the internal wall of the air tube 3. Air entering the inlet 16 of the air passage 17 tangentially through the throat 15 is directed in a helical path to flow through the tube 3. The opening in the front end wall 37 of the housing 2, which is covered by the air tube 3, is of substantially the same effective cross-sectional shape and area as the corresponding end of the air passage in the tube 3 so that the walls of the inlet portion 16 are substantially flush with the walls of the air tube 3. No portion of the inlet end 16 of the air passage 17, which is formed in the housing 2, is of greater effective cross-sectional area than the portion of the passage 17 which is formed in the tube 3. Preferably, there is a progressive decrease in the effective cross-sectional area inlet portion 16 from the plane of abutment between the flange 11 of the tube 3 and the wall 37 to the rear wall 36 as appears in Figs. 1 and 6.

Tube 3 is substantially circular in cross-section throughout its length and has a portion 47 of cylindrical form and uniform diameter adjacent the housing 2 which merges into a tapering portion 48 which extends toward the discharge end of the tube where a second cylindrical portion 49 of uniform internal diameter and relatively short axial length is formed. The walls of the tube 3 are relatively thick and of heavy section at the discharge end thereof, preferably being in the form of an integral, thick-sectioned, annular collar 50 which reinforces the tube end and receives the screws which hold the head 27. A circular, radially directed flange 53 is integrally formed about the large diameter end of the head 27 and circumferentially abuts against the annular collar or thickened section 50 on the discharge end of the tube 3. A pair of screws 63 extend through suitable drill holes in the flange 53 and are threadedly secured in the collar 50 to clamp the head 27 in heat exchanging circumferential contact with the collar.

Another pair of screws 51 extend through an annular holding ring 52, disposed about the head 27, through the flange 53 and are threadedly received in the annular thickened collar portion 50 at the discharge end of the tube 3. The ring 52 and flange 53 preferably have substantially the same outside diameter and the ring is axially movable over an external cylindrical portion 54 of the head 27 which extends forwardly from the base of the flange 53. Between the ring 52 and flange 53, and seating on the cylindrical portion 54 of the head, is an annular ring 55 of fireproof fibrous material such as asbestos. This ring is clamped between the holding ring 52 and flange 53 by the screws 51 which also hold the head 27 to the tube 3.

Combustion air forced through the passage 17 in a spiral path is gradually accelerated in velocity by the general tapering form of the tube 3 which decreases in cross-sectional area towards the discharge end. The head 27 is formed to present a substantially continuous circular shoulder 56 to the advancing air and effects an agitation thereof which is beneficial in forming a suitable combustible mixture with the fuel oil. This shoulder 56 is adjacent the small diameter cylindrical portion 49 of the passageway 17 in which is located the spider 23. From the shoulder 56 the head 27 is tapered and the internal walls thereof converge to provide a progressively decreasing, substantially circular cross-sectional area in the direction of air flow. At substantially the region of smallest cross-sectional area the head 27 is formed with a shoulder 57 which further turbulates or agitates the moving air. From the shoulder 57 to the extreme end of the head 27 there is an outwardly tapering outlet or mouth 58.

A pair of ignition electrodes 68 and 69 are disposed longitudinally through the passageway 17 slightly above and on opposite sides of the oil pipe 21. These electrodes are mounted in porcelain insulators 70 held in a clamp 71 on the top of the bracket 22. The forward ends of the electrodes 68 and 69 are directed toward one another in the region of the orifice 26 of the nozzle 25 so that a spark across the electrodes ignites the atomized fuel.

A transformer, carried in a box 73 disposed against the rear end wall 36 of the housing, furnishes high tension current to the electrodes 68 and 69. Conductors 74 and 75 enclosed by insulators 76 extend into the inlet end 16 of the air passageway 17 from the transformer box 73

through an opening 77 formed in the rear wall 36 of the housing which is normally covered by the transformer box 73. Each of the conductors is provided with a spring-like brush 78 formed of suitable sheet metal such as bronze or brass and which extends upwardly and at right angles across the axes of the electrodes 68 and 69.

Electrical contact is made between the brushes 78 and the electrodes by means of contact sleeves slidably received on the electrodes and urged toward the brushes 78 by helical compression springs 80.

Air is drawn into the burner by the blower 9 through a downwardly directed inlet opening in a hood 94 formed on the front wall 37 of the housing 2. An air chamber 95 in the hood 94 communicates with the blower chamber 14 through a circular opening 96 formed in the front wall 37 and concentric with the shaft 12 of the blower and motor.

An air gate 97 is mounted off center on reduced diameter pin ends of adjustable pivot screws 99 which are threadedly carried in aligned holes through the side walls of the hood 94. The amount that the air gate will open under the influence of air pressure can be varied or adjusted by rotation of the rod 104 which moves the foot 111 to various positions. By means of the rod 104 the opening of the gate 97 which regulates the quantity of air forced through the passageway 17 by the blower 9 can be adjusted while the burner is in operation to give the most efficient and desirable type of flame in the combustion chamber 28.

The inlet end of the air passageway through the combustion air tube which is formed in the housing of the burner is of no greater cross-sectional area than the inlet end of the air tube so that air forced tangentially into the inlet end of the passageway 17 from the blower chamber 14 and throat 15 is substantially immediately given a spiral or helical path by the sloping or inclined wall 42.

During operation of the burner, combustion air, directed tangentially into the inlet end 16 of the air passageway 17 by the curved wall 34 of the throat 15, moves in a curved path which develops into a spiral path as the air travels forwardly through the tube 3. On account of the taper of the passageway 17 in the portion 48 of the air tube the spirally moving column of air is gradually accelerated so that its velocity is greater as it enters the head 27 than when leaving the cylindrical portion 47 of the tube.

The increased taper of the conical internal walls of the head 27 between the shoulders 56 and 57 with respect to the taper of the portion 48 of the air tube, further accelerates the combustion air in the region of the nozzle 25 so that the maximum velocity of the column of spirally moving air is substantially in the plane of the orifice 26 of the nozzle. Liquid fuel oil forced by the pump through the conduit 19 and pipe 21 is projected under high pressure from the orifice 26 of the nozzle 25 in the form of finely divided particles or droplets into the rapidly rotating stream or vortex of air surrounding and moving past the nozzle.

The spirally moving air column in the air tube 3 has a greater velocity at the radially outward portions thereof than at the center, and as the air enters the head 27 the radially outermost or peripheral portions of the air stream are deflected by the circumferential shoulder 56 in the passageway 17 and directed to flow transversely across the helical air column in advance of the nozzle 25 to entrain particles of the sprayed fuel oil. At substantially the region of smallest cross-sectional area and adjacent the extreme outlet end of the passage 17 the circumferential or annular shoulder 57 deflects the outermost part of the spirally advancing air column to flow transversely across such column and entrain particles of fuel oil projected from the nozzle 25. Outwardly of the burner mouth 58 the spirally moving air stream expands radially in the combustion chamber 28. The central part of the air stream is highly agitated or in a state of great turbulence effected by the cross currents influenced by the shoulders 56 and 57 and the outer portion of the air stream continues to move spirally. Fuel oil sprayed from the orifice 26 forms a rich mixture in the highly agitated central portion of the combustion air. Combustion is initiated in this rich mixture and is completed in the outer shell of relatively leaner mixture which is rotating in a spiral fashion. A spark plays across the tip ends of the electrodes 68 and 69 in the region of the nozzle orifice 26 substantially continuously and insures ignition of the combustible mixture in the highly agitated central portion of the air stream. If desired, the spark may be discontinued after ignition has been obtained and the burner is in operation.

The method of burning the liquid fuel carried out by the burner of the present invention is particularly successful in overcoming difficulties previously encountered in burners which were operated intermittently, such as domestic oil burners. One such difficulty is the tendency for smoky combustion during the heating up of the firebox. Another such difficulty is the pulsating or throbbing encountered when a burner is set in operation after a period of inactivity. The cause or causes of such pulsations are not thoroughly understood but it has been found that the burner described above, operating in accordance with the method outlined, substantially overcomes the objectionable pulsating effects so that entirely satisfactory intermittent operation can be had. It is believed that the increased agitation or turbulence and the cross currents immediately in advance of the nozzle orifice, in combination with the spirally advancing air column which is accelerated in its path toward the burner head and during its passage therethrough, are instrumental in effecting the improved operation.

Other modes of utilizing the principles of the invention may be resorted to, change being made, as desired, in the particular construction and arrangement of parts shown and described, it being understood that numerous modifications and alterations are contemplated in the method and that the disclosure of specific apparatus herein is given for purposes of explanation and illustration only.

What I claim is:

1. The method of producing and burning a combustible mixture of air and liquid fuel which comprises advancing air spirally in a generally circular sectioned column of greater length than diameter, accelerating the advancing air over the major portion of the length of the column to a deflecting zone extending circumferentially around the column intermediate the ends of the latter, deflecting a portion of the air at said zone to flow transversely across the column toward the center thereof, accelerating the air beyond the zone at a faster rate than in advance of the

zone to another deflecting zone extending circumferentially around the column, deflecting a portion of the air at said last mentioned zone to flow transversely across the column toward the center thereof, projecting the fuel in finely divided form into and in the same direction as the advancing air to mix therewith at said last mentioned zone, and igniting the mixture.

2. The method of producing and burning a combustible mixture of air and liquid fuel which comprises continuously projecting the fuel from an orifice in finely divided particles, continuously advancing air spirally in a circular column toward and around and in the same direction as the projected fuel, continuously intercepting and inwardly deflecting the outermost portion only of the spirally advancing air column in a first zone extending circumferentially around the column and in advance of the orifice to flow transversely across the column toward the center thereof, continuously intercepting and inwardly deflecting another outermost portion only of the spirally advancing air in a second zone extending circumferentially around the column and beyond said first zone to flow transversely across the column toward the center thereof and to entrain and mix with the projected fuel, and igniting the mixture.

3. The method of producing and burning a combustible mixture of air and liquid fuel which comprises continuously projecting the fuel from an orifice in finely divided particles, continuously rotating a mass of air in the form of a generally circular column, continuously introducing air tangentially into the rotating mass at one end of the latter and continuously releasing air from the other end of the column toward and around and in the same general direction as the projected fuel, continuously deflecting the tangentially introduced air toward the said other end to cause the same to flow toward said other end of the column with a spiral advancing movement of the rotating mass of air, continuously inwardly deflecting the outermost portion only of the spirally advancing air in a relatively short zone extending circumferentially around the column and adjacent the plane of the orifice transversely across the column toward the path of the projected fuel and to entrain and mix with the latter, and igniting the mixture.

4. The method of producing and burning a combustible mixture of air and liquid fuel which comprises continuously projecting the fuel from an orifice in finely divided particles, continuously rotating a mass of air in the form of a generally circular column, continuously introducing air tangentially into the rotating mass at one end of the latter and continuously releasing air from the other end of the column toward and around and in the same general direction as the projected fuel, continuously deflecting the tangentially introduced air toward the said other end to cause the same to flow toward said other end of the column with a spiral advancing movement of the rotating mass of air, continuously inwardly deflecting the outermost portion only of the spirally advancing air in a relatively short first zone extending circumferentially around the column and in advance of the plane of the orifice transversely across the column, continuously inwardly deflecting another outermost portion only of the advancing air in a second zone extending circumferentially around the column and beyond said first zone transversely across the column toward the path of the projected fuel and to entrain and mix with the latter, and igniting the mixture.

REGINALD W. BECKETT.