July 18, 1950 J. A. LOGAN ET AL 2,516,063

PRESSURE ATOMIZING OIL BURNER WITH A BUILT-IN COMBUSTION CHAMBER

Filed Aug. 19, 1948 3 Sheets-Sheet 1

Fig. 1.

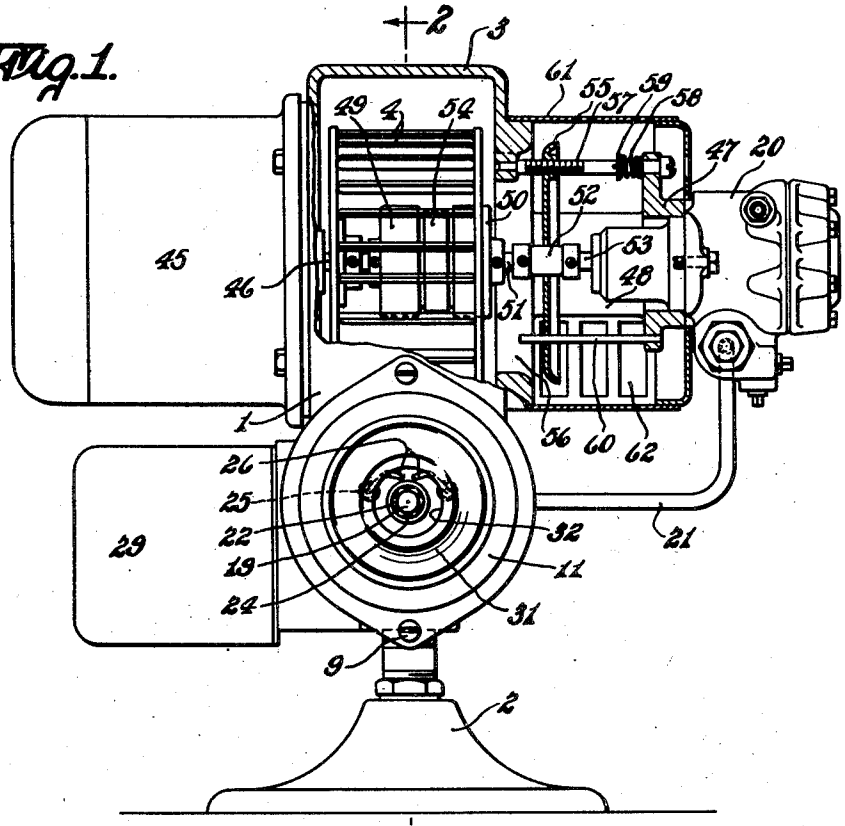
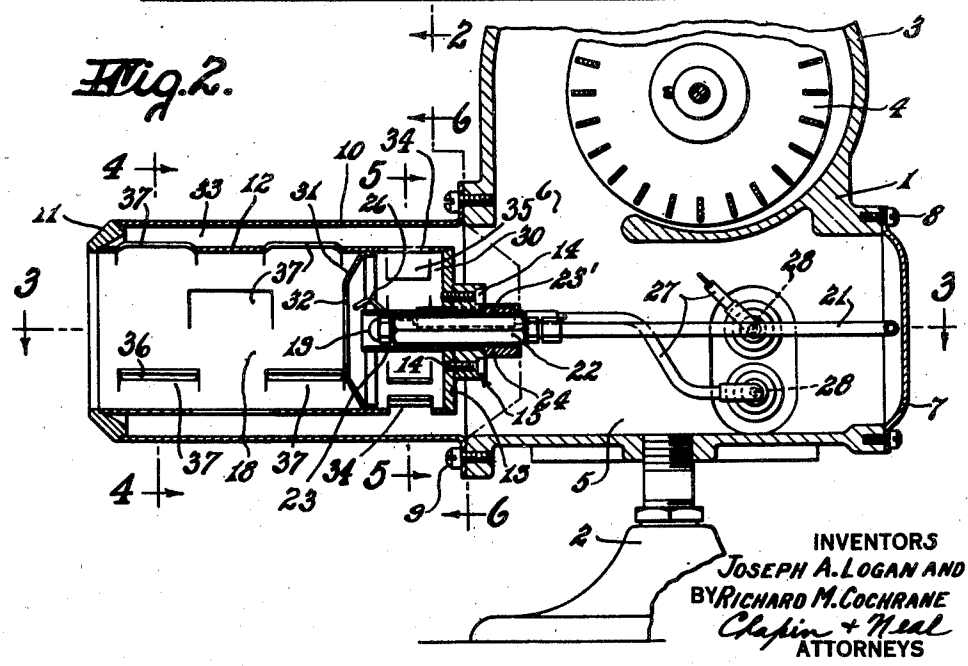


Fig. 2.



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Fig. 3.

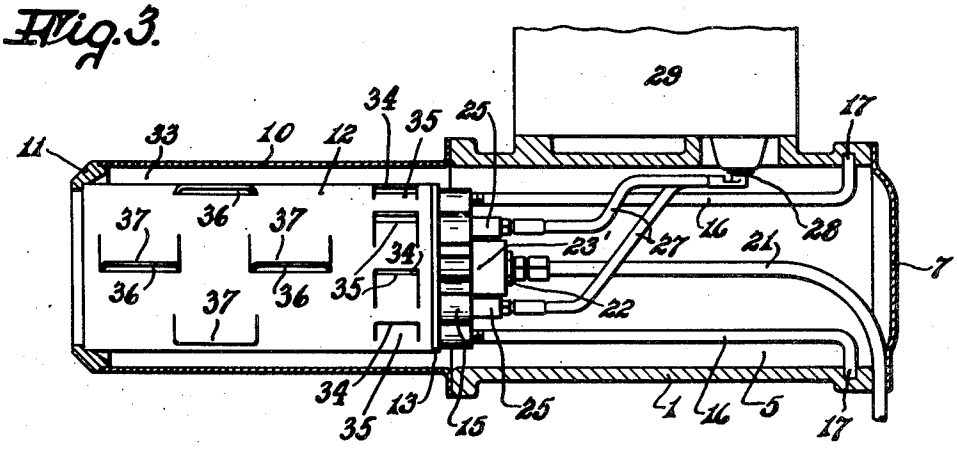


Fig. 4.

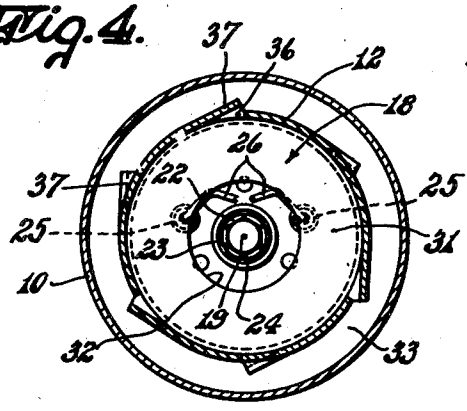


Fig. 5.

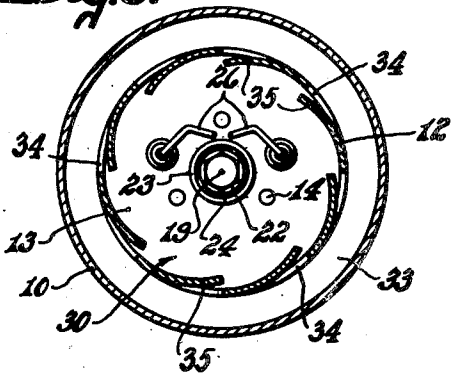
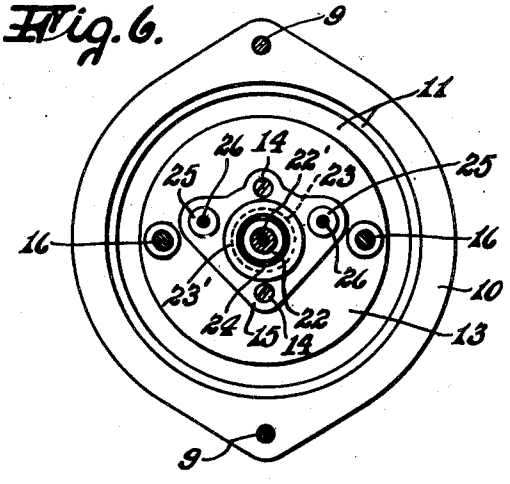


Fig. 6.



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Fig. 7.

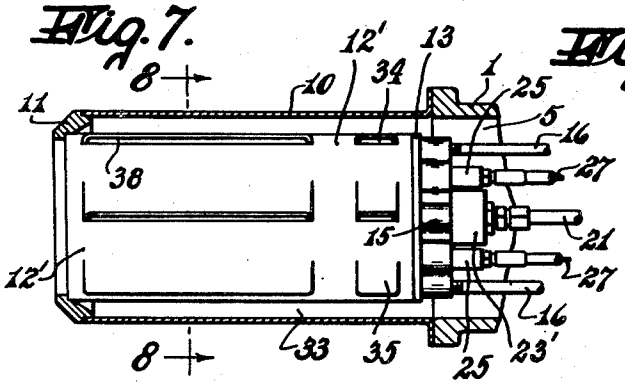


Fig. 8.

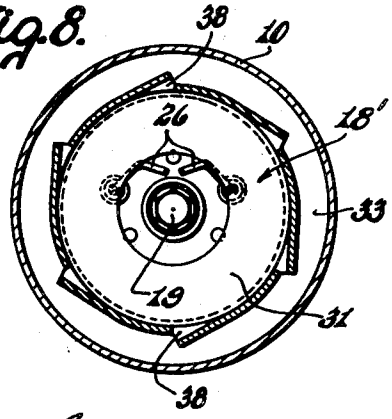


Fig. 9.

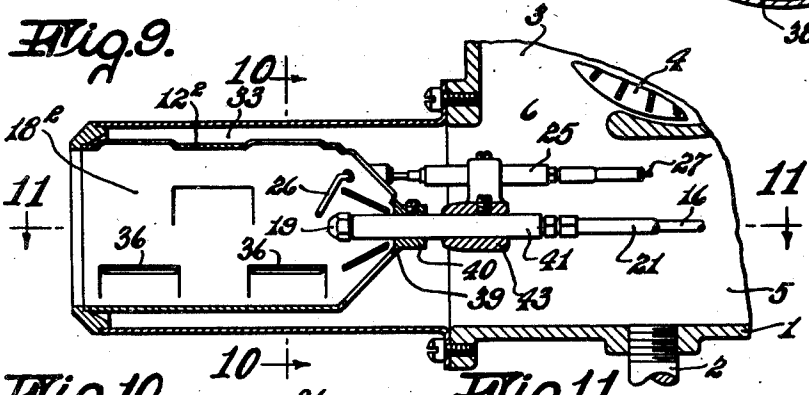


Fig. 10.

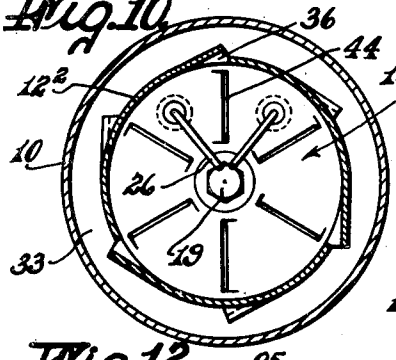


Fig. 11.

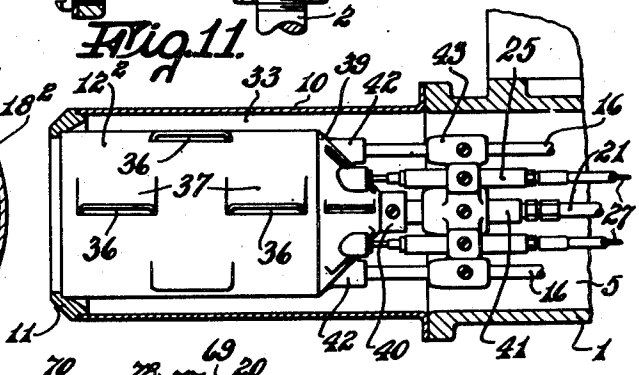
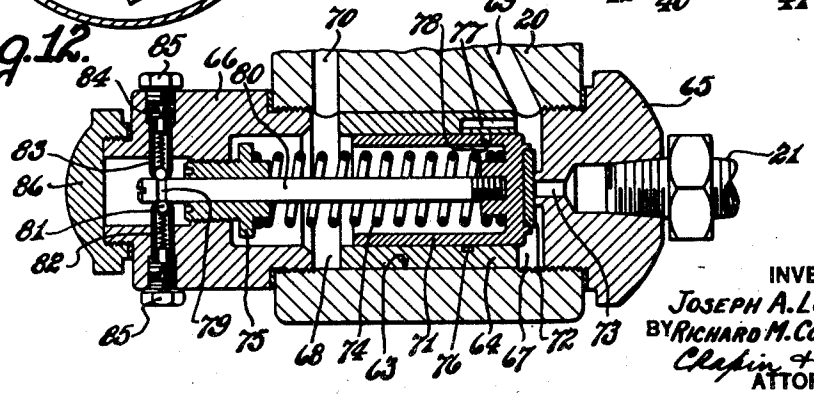


Fig. 12.



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Patented July 18, 1950 2,516,063

UNITED STATES PATENT OFFICE

2,516,063

PRESSURE ATOMIZING OIL BURNER WITH A BUILT-IN COMBUSTION CHAMBER

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Application August 19, 1948, Serial No. 45,066

4 Claims. (Cl. 158—76)

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This invention relates to an improved oil burner of the pressure atomizing type adapted for household service, as for example for heating the house or for heating the domestic hot water supply.

The main purpose of the invention is to improve the efficiency of the pressure-atomizing type of burner, particularly with respect to its operation under circumstances which will be explained in detail later on, when the preferred example is explained. Generally considered, the idea is to provide the burner structure including fan, oil pump, atomizing nozzle, and air tube elements common in the gun type burner, but to add a combustion chamber built out of sight inside the air tube element, and provide added elements and arrangements providing in their combination for an improved mode of operation. The improved operation is caused by the way the oil and air are controlled for mixing and burning in the built-in combustion chamber.

One form of gun type burner having a built-in combustion chamber is shown in the Logan Patent No. 2,411,048, dated November 12, 1946. Such burner has some points in common with the present invention, as a comparison will show, but the points of difference are significant as will be brought out with respect to features of operation.

An illustrative example of the invention, with some variations in detail, is shown in the accompanying drawings, in which:

Fig. 1 is a front elevational view of an oil burner embodying the invention, certain parts of the fan housing being broken away to show interior construction;

Fig. 2 is a fragmentary sectional elevational view taken on line 2—2 of Fig. 1;

Fig. 3 is a sectional plan view taken on the line 3—3 of Fig. 2;

Figs. 4, 5 and 6 are cross sectional views taken on the lines 4—4, 5—5, and 6—6, respectively of Fig. 2;

Fig. 7 is a fragmentary sectional view, taken similarly to Fig. 3 and showing a modification in the construction of the combustion-chamber;

Fig. 8 is a cross-sectional view taken on the line 8—8 of Fig. 7;

Fig. 9 is a fragmentary sectional elevational view, taken similarly to Fig. 2 and showing

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another modification in the construction of the combustion-chamber;

Fig. 10 is a cross sectional view taken on the line 10—10 of Fig. 9;

Fig. 11 is a sectional plan view taken on the line 11—11 of Fig. 9; and

Fig. 12 is a large scale cross sectional view of a pressure regulating valve especially adapted for use in the oil feeding system of the burner.

Referring to these drawings and first to Fig. 2 thereof, the burner includes a hollow casting 1, suitably supported, as by a pedestal 2, from the floor and providing in its upper portion a housing 3 for a fan 4 and in its lower portion a horizontally-disposed cylindrical passage 5, which receives air from fan 4 through the opening 6. The rear end of passage 5 is closed by a cover 7, secured to casting 1 by screws 8. Secured at its flanged inner end to casting 1 by screws 9 and mounted co-axially of and as an extension of passage 5 is an air tube 10. Suitably fixed in the outer end of tube 10 is an annular ring 11, having a seat to receive with a sliding fit the outer end of a tube 12, located within and co-axially of air tube 10. The outer end of tube 12 is open. Its inner end is closed by a circular disk 13, suitably fixed thereto. Fixed to this disk by screws 14 is a member 15. The disk also has two hubs to which are fixed, one in each, two rods 16 (Fig. 3). These rods extend rearwardly in the passage 5 in spaced parallel relation, one near each side of the passage, and their rear ends are outturned as at 17 and engaged, one in each, of two recesses formed at diametrically-opposite points in the peripheral wall of passage 5. The tube 12 is thus supported at its front end by ring 11 and at its rear end by rods 16. By removing cover 7, access is had to the ends 17 of these rods so that such ends may be pulled out of the recesses, in which they are engaged, and then pulled rearwardly to draw out the tube 12 and all the parts mounted thereon, for inspection, adjustment or repair. The tube 12 may be replaced by pushing it inwardly through passage 5 into air tube 10 until its outer end engages in ring 11, then engaging the ends 17 in their recesses and then replacing cover 7.

The inner tube 12 (Fig. 2) forms within it a combustion chamber 18, into which all the air for combustion is introduced to mix with a spray

of atomized oil, emitted from a pressure-atomizing nozzle 19, located co-axially of the tube and chamber. This nozzle is supplied with oil at suitable pressure by a pump 20 (Fig. 1) through a pipe 21 (Figs. 1 and 2), which enters the rear end of passage 5 (Fig. 2) and extends forwardly therein for connection to the rear end of the nozzle support 22. The latter has a passage 22' (Fig. 6) therethrough, allowing continuous communication between pipe 21 and the nozzle 19 carried by the front end of the support. This nozzle support 22 is of hexagonal cross sectional shape (Figs. 4, 5 and 6) and is held frictionally in a tube 23, which in turn is held frictionally in the member 15 and has an enlarged head 23' at its inner end. Six passages 24 are left between support 22 and tube 23 to connect air supply passage 5 to the combustion chamber 18 and allow streams of air to flow parallel to the axis of the nozzle and chamber 18. The support 15 also has fixed therein a pair of insulators 25 (Fig. 3) supporting, one in each, ignition electrodes 26 (Fig. 1), located to ignite the spray emitted from nozzle 19. These electrodes are connected by wires 27 (Fig. 3) to the high tension terminals 28 of an ignition transformer, contained within a casing 29, fixed to casting 1. The nozzle and electrodes can be removed separately from the combustion chamber by removing screws 14, which allows member 15 to be separated from disk 13 and removed with the nozzle and electrodes which it supports. The head 23', when engaged with the member 15 as shown, locates the tube 23 properly inside tube 12. The nozzle 19 is properly located in tube 23 when the inner end of its support 22 lies flush with the inner end of head 23'.

The combustion chamber 18 occupies the greater part of the interior of the tube 12. However, the rear portion 30 of this tube is separated from the rest by a partition 31 of frusto-conical form and having a large central opening 32, through which atomized oil and some air are admitted to the combustion chamber. Most of the air for combustion is admitted through the periphery of tube 12 from a jacket 33 which is formed between the tubes 10 and 12, is closed at its front end by ring 11 and is open at its rear end to the air supply passage 5. Near the inner end of tube 12 are a circular series (eight as shown) of angularly-spaced inlet openings 34 in the form of slots, which extend parallel with the axis of tube 12 and which allow air from jacket 33 to enter the chamber 30. These openings 34 are best shown in Fig. 5. They are formed by punching inwardly portions 35 of the tube to form air-directing vanes. Air, forced into these slots 34 and directed by the vanes 35, is caused to whirl around the chamber 30. As these whirling streams advance in chamber 30, they engage the frusto-conical partition 31 and are forced inwardly to meet the oil spray at locations near the nozzle 19 and then pass outwardly through opening 32 into the combustion chamber 18.

Air is supplied to the combustion chamber 18 through slots 36 in the peripheral wall of tube 12. These slots are arranged in three longitudinally-spaced circular series, each series comprising a plurality, as three, of angularly-spaced slots which partially overlap the slots of the adjacent series. The slots in one series are shown as staggered with relation to the slots in the adjacent series, as will be clear from Figs. 2 and 4. Each slot 36 is formed, by punching out vane parts 37 to lie tangentially, or substantially so with respect to the internal periphery of tube 12. The air from jacket 33 is thus fed through the peripheral wall of combustion chamber 18 in a plurality of whirling streams. The streams of each series partially overlap the streams from the adjacent series and cover substantially the entire length of the chamber. These streams sweep substantially the entire area of chamber 18. They travel around the flame and supply the air necessary to complete combustion. The burning mixture rotates around the combustion chamber as it moves toward the outlet end. This rotating mixture creates a vortex. The creation of the vortex would ordinarily result in the production of a partial vacuum in the space around the nozzle, as a result of which there would be a tendency for the flame to move toward the nozzle. The longitudinally-directed streams of air, issuing from the several passages 24, prevent the formation of such partial vacuum and counteract said tendency, acting to keep the flame away from the nozzle to avoid carbon deposits thereon. The revolving streams of air in the inner chamber 30 also help to move the flame away from the nozzle as such streams pass opening 32 of disk 31. Such last-named streams sweep past the ignition electrodes 26 as they pass to opening 32 and help keep them free of carbon deposits. They also serve to feed air to the oil spray at and near the location where ignition occurs and these streams, moving inwardly as they approach the opening 32 in ring 31, will blow the spark, which is produced between the electrodes, into the spray. By rotating the air around the flame, the latter is materially shortened. Most of the combustion occurs within the chamber 18, for example, no more than a quarter of the length of the flame in the usual operation extends outside the combustion chamber. The streams of air sweep the inner wall of the combustion chamber, tending to keep the oil or flame from impinging thereon and, by so doing, preventing the transfer of heat by conduction from the flame to tube 12 and thereby keeping the temperature of the wall of the chamber within reasonable limits. This wall will still be hot enough in normal operation to vaporize the oil.

The arrangement of air-feeding slots may be varied within substantial limits although the form shown in Figs. 2, 3 and 4 is now believed to be the best and is at present preferred. In Fig. 7, a tubular member 12' is constructed like the member 12 with the exception that the slots 38 leading into the combustion chamber each extend substantially from one end to the other of this chamber. As shown in Fig. 8, there is a circular series of six slots 38, angularly-spaced one from the other. The member 12' has also a series of slots 34, leading, as formerly, into the inner chamber 30, in which the nozzle 19 is located.

In Fig. 9 there is shown a tubular member 12^2, having like the member 12, three sets of slots 36, each set being axially-spaced one from another and consisting of a circular series of angularly-spaced longitudinally-extending slots. The difference here is in the construction of the rear wall of the combustion chamber 18^2 and the omission of the annular partition ring 31. The rear wall 39 is of frusto-conical form, terminating in a central, hollow cylindrical hub 40, in which the cylindrical support 41 for nozzle 19 is mounted and fixed as indicated. The wall 39 (Fig. 11) also has two diametrically-opposed hubs 42 on its outer periphery in which are fixed the described supporting rods 16. Fixed to these

rods, is a cross piece 43 in which is mounted the nozzle support 41 and the insulators 25. The electrodes 26 pass through and are suitably insulated from the rear wall. The frusto-conical inner wall 39 (Figs. 9 and 10) is provided with a series of angularly-spaced slots 44. These radiate from hub 40 and are so formed as to admit air in streams which whirl around the rear end of the chamber and the electrodes and nozzle 19 and, moving forwardly, tend to keep the oil away from the nozzle and the electrodes.

The fan 4 and pump 20 (Fig. 1) are driven by an electric motor 45, fixed as indicated to one side wall of the fan housing with its rotor shaft 46 extending into the interior of the casing to receive fan 4, which is fixed thereto as indicated. The oil pump is supported from a member 47 connected by arms 48 to the housing 3. The pump is preferably driven from shaft 46 through the intermediary of a time delay clutch. An example of one suitable clutch will be found in Logan Patent No. 1,985,934, dated January 1, 1935. An improved form of clutch is disclosed in the Theodore J. Mesh Patent No. 2,485,211, dated October 18, 1949. This improved form of clutch is the form at present preferred. The driving and driven clutch drums of this improved clutch are shown at 49 and 50 as respectively fixed to the motor shaft 46 and a driven shaft 51, which is connected by a flexible coupling 52 to the shaft 53 of pump 20. The carrier for the centrifugal weights is shown at 54. This type of clutch can be adjusted to delay the start of the pump for substantial intervals after the fan has started, say several seconds, and is arranged to prevent the pump starting until the fan has acquired full speed. The purpose is to establish the full flow of air at the desired velocity before any oil is emitted from the nozzle 19.

Fig. 1 shows the precision adjustment for the air flow. A shutter 55 is movable toward or away from the inlet opening 56 in the fan housing 3 by means of a screw 57. This screw has its inner end rotatably mounted in an end wall of housing 3 and its outer end rotatably mounted in member 47. A spring 58 on the screw acts between member 47 and a washer 59, held by a pin to the screw, to hold the head of the screw against the outer face of member 47. The latter has fixed thereto one end of a rod 60, the other end of which passes through the shutter and prevents it from rotating, when screw 57 is turned. The shutter is encompassed by a sheet metal casing 61 having slots 62 of sufficient aggregate area to admit all the air that will ever be needed for operation of the burner.

The pressure-regulating means for controlling the pressure of the oil supplied by pump 20 to atomizing nozzle 19 is in this case built into the casing of the pump itself. The construction is shown in Fig. 12. In the lower part of the pump casing is a cylindrical bore 63, in the central portion of which is fixed a sleeve 64. The ends of bore 63 are closed by plugs 65 and 66, threaded into the bore and terminating with their inner ends axially-spaced from the adjacent ends of sleeve 64, forming spaces 67 and 68. A passage 69 leads from the discharge side of pump 20 to space 67. The space 68 is connected by a passage 70 to the intake side of the pump. Slidably mounted in sleeve 64 is a hollow piston 71, having fixed to one end thereof a valve 72, adapted to engage a seat on plug 65 and close the outlet port 73, which leads to the nozzle feed pipe 21. A spring 74, acting between an adjustable abutment 75 threaded into plug 66 and the piston 71, yieldingly holds valve 72 on its seat to close the outlet 73. Pressure of the pumped oil acts on the piston 71 against the force of spring 74, and an additional force to be described, in a direction such as to move valve 72 from its seat. The sleeve 64 has formed in its internal peripheral wall a circumferential groove 76, which is connected by a passage 77 to the pressure space 67. A hole 78 is provided through the peripheral wall of piston 71, which, when valve 72 is closed, is closed by the internal peripheral wall of sleeve 64. After the valve 72 has opened and the pressure has built up to a predetermined degree, the piston 71 will be moved rearwardly until the hole 78 in the piston registers with groove 76. Oil from the pressure side of the pump and space 67 can then pass into the hollow piston and thence to space 68 and passage 70 to the suction side of pump 20. Oil will be thus by-passed to keep the pressure of the pumped oil from exceeding a predetermined minimum, say for example 50 pounds per square inch. The structure thus far described, is that of a conventional pressure-regulating valve.

This conventional structure is preferably modified by the addition of means for placing an additional load on the valve in order to make it necessary to produce a higher pressure on the valve to open it than is thereafter necessary to keep the valve open. It is for example desired to make the pressure necessary to open valve 72 considerably higher than the pressure at which by-passing of oil takes place through the piston valve described, whereas in the conventional arrangement the burner outlet valve, corresponding to 72, would open at a pressure lower than that at which by-passing of oil takes place. One way of securing the additional loading on valve 72 is to provide a circumferential groove 79 in a stem 80 fixed to piston 71, and to provide a plurality of spring-pressed balls 81 to engage in this groove, when valve 72 is closed. Each ball 81 and its spring 82 may be arranged in a tube 83, fixed radially in plug 66. The seat 84 for each spring 82 is threaded into an opening in plug 66 to secure adjustment of the force of the spring and the outer end of such opening is normally closed by a removable plug 85. A removable plug 86 allows access for adjusting the seat 75 to vary the force of spring 74.

The springs 82, pressing the balls 81 into the groove 79, provide resistance to initial opening movement of valve 72, in addition to that provided by spring 74. This additional resistance, however, is removed after the valve has opened and moved a short distance away from its seat. As long as the balls 81 are engaged in the groove 79, there is an additional resistance to the valve-opening movement. However, when the balls are completely disengaged from the groove, as they will be after the valve moves away from its seat a distance equal to half the width of the groove, this additional resistance will for all practical purposes be removed because the balls will then ride freely on the smooth peripheral surface of stem 80 without presenting any substantial resistance to movement of the valve. The practical effect of this arrangement is that, on starting of the burner, the oil may be atomized initially at a substantially higher pressure than that for which the valve spring 74 is set and this effect may be utilized to advantage in this particular burner as will be later described.

It is to be noted that the regulating valve described may be converted to operate in the conventional way, if necessary or desired. The stem

88 may be removed with a screw driver after cover 86 is removed, and this will free the valve 72 of the additional loading means.

The pressure-regulating valve with the additional loading means therefor is separately shown and claimed in the Joseph A. Logan Patent No. 2,451,681, dated October 19, 1948.

The pump 20 may be of any suitable type and an example of one suitable type will be found in Wahlmark Patent No. 2,309,683, dated February 2, 1943. This patent also shows the pressure regulating valve structure (without the additional valve-loading means) and the relationship of it to the pump structure.

In the operation of the burner of this invention, where a pressure atomizing nozzle, such as 19, is operated at substantially less than its rated oil pressure to secure a rate of flow much less than that for which the nozzle is rated, it is desirable to utilize the described additional loading means for the pressure-regulating valve 72. This will enable better atomization to be secured because of the higher pressure used and the burner can be started up better and more quickly in this way. Assume as one example, that the nozzle 19 is rated at one gallon an hour, when operated at 100 pounds per square inch pressure, and that it is to be operated at 50 pounds pressure in order to secure a low rate of flow, of say .66 gallon per hour. The burner will start up at this low pressure but it takes an appreciable time, several seconds, because the oil is not well atomized at this low pressure. Eventually, some of the oil will be vaporized by the arc between the ignition electrodes and this burning oil will vaporize more oil and full combustion will eventually ensue. The combustion, following the starting interval, is excellent—the burner of Figs. 1 to 6 operating at 12% CO_2, with 50 pounds per square inch oil pressure and .66 gallon per hour oil consumption. The starting conditions present the greatest difficulty. Therefore, it is of advantage to use the higher oil pressure for a short interval at the start because better atomization of oil by the nozzle is obtained with the higher pressure and ignition will occur quickly and combustion at the start will be cleaner and better.

It is also desirable to use some form of time delay clutch to delay the flow of oil until air is flowing into the combustion chamber 18 through the various slots and passages at the proper rate. The particular form of improved clutch shown in said Mesh patent is preferred because it can be made to give a delay of several seconds after the motor 45 and fan 4 have acquired full speed before the oil pump 20 is driven. Thus, ample time is afforded for the establishment of air flow, at the full rate intended, in the combustion chamber 18 before any oil is emitted from nozzle 19. With this arrangement smoky combustion at the start is avoided.

When normal air flow is established, there are streams of air that rotate around the inner peripheral wall of combustion chamber 18, which sweep substantially the entire area of such wall from one end to the other. These air streams tend to rotate with them the oil that is sprayed into them, creating a vortex. Looking from the outer end of the combustion chamber when the burner is in operation, an annular mass of flame is seen rotating in a counterclockwise direction. Also, an annular space may be seen between the rotating flame and the inner wall of the combustion chamber, showing that the rotating air streams keep the flame from direct contact with the peripheral wall of the combustion chamber.

It is not clear that this last-named space extends back for the entire length of the combustion chamber but it does extend back a substantial distance. It is reasonable that some of the oil from nozzle 19 strikes the inner peripheral wall of the combustion chamber, near the partition 31, and is vaporized by the hot wall but except for this location, the whirling air streams keep the flame spaced from sleeve 12. In any event these whirling air streams keep the temperature of the sleeve within reasonable limits. The air, being fed to the oil in whirling streams, has the effect of materially shortening the flame. Actually close to three quarters of the flame can be confined within the combustion chamber 18.

With the combustible mixture whirling in the combustion chamber, there would be a tendency to create a partial vacuum around and near the nozzle, due to the vortex and the oil spray near the nozzle might be forced back onto it and carbonize. To counteract this tendency, the six small longitudinal streams of air sweep by the nozzle 19 within tube 23 and force the oil spray away from the nozzle to keep it clean. The whirling streams of air admitted to chamber 30 also help in this connection, as well as to keep the oil off the ignition electrodes and supply air where needed near the nozzle.

While the burner is especially characterized by providing for good combustion from a pressure atomizing nozzle, when operated at a pressure much less than that at which it can be efficiently operated in the conventional gun type burner, the burner of this invention will also afford excellent combustion when the nozzle is operated at its rated pressure. With full rated flow, say for example 1 gallon per hour, from the nozzle, the resulting flame does not appear to extend much beyond the outer end of the combustion chamber, most of the combustion occurring within the combustion chamber as before.

The invention thus provides an improved domestic oil burner of the pressure atomizing type, having incorporated into its structure a combustion chamber, in which the air and oil may be effectively mixed and burned under controlled conditions to secure efficient combustion, even when the atomizing nozzle is operated at a pressure much less than that at which good atomization takes place, with a short flame contained for the most part within the combustion chamber.

We claim:

1. In an oil burner, an air tube having an air inlet in its inner end and an opening in its outer end, a tubular member having a peripheral wall, an inner end wall and an open outer end, said member being telescoped into said air tube with its outer end adjacent the outer end of said tube and fitting said opening, the peripheral wall of said member being spaced from the peripheral wall of the tube to form an annular air jacket, which completely surrounds the peripheral wall of said member, is closed at its outer end and communicates with said inlet at its inner end, the inner end wall of said member being exposed to the air flow in said tube; an annular ring fixed to the internal peripheral wall of said member at a location nearer the inner end wall than its outer end and partitioning the same into inner and outer chambers communicating with each other through the central opening in said ring, said outer chamber constituting a combustion chamber, a pressure-atomizing nozzle positioned in and substantially coaxially of said inner chamber to discharge a spray of atomized oil through said opening into the outer chamber, and ignition elec-

trodes positioned in said inner chamber, the peripheral wall of said member having a circular series of angularly-spaced longitudinally-extending slots opening tangentially into said inner chamber to direct whirling streams of air around such chamber and thence forwardly to mix with the oil spray near the nozzle and pass out through said central opening into the combustion chamber, the peripheral wall of said member having a circular series of angularly-spaced and longitudinally-extending slots opening tangentially into said combustion chamber, whereby the air for combustion is whirled around the combustion chamber and around the flame, said slots being located to direct whirling streams of air into the combustion chamber through said peripheral wall substantially from end to end thereof for sweeping the entire inner surface of said peripheral wall, said whirling streams of air acting to shorten the flame and confine it for the most part within the limits of the combustion chamber.

2. In an oil burner, an air tube having an air inlet in its inner end and an opening in its outer end, a tubular member having a peripheral wall, an inner end wall and an open outer end, said member forming within it a combustion chamber and being telescoped into said air tube with its outer end adjacent the outer end of said tube and fitting said opening; the peripheral wall of said member being spaced from the peripheral wall of the tube to form an annular air jacket, which completely surrounds the peripheral wall of said member, is closed at its outer end and communicates with said inlet at its inner end; the inner end wall of said member being exposed to the air flow in said tube, a cylindrical tube fixed in said end wall and projecting into said chamber in co-axial relation therewith, a support of polygonal cross section fitted into said tube, a pressure-atomizing nozzle fixed on the inner end of said support, there being between said support and tube a plurality of passages parallel with the axis of the tube, to emit air in longitudinal streams which surround said nozzle, the peripheral wall of said member having a circular series of angularly-spaced and longitudinally-extending slots opening tangentially into said chamber, whereby the air for combustion is whirled around the combustion chamber and around the flame, said slots being located to direct whirling streams of air into the combustion chamber through said peripheral wall substantially from end to end thereof for sweeping the entire inner surface of said peripheral wall, said whirling streams of air acting to shorten the flame and confine it for the most part within the limits of the combustion chamber.

3. In an oil burner, an air tube having an air inlet in its inner end and an opening in its outer end, a tubular member having a peripheral wall, an inner end wall and an open outer end, said member being telescoped into said air tube with its outer end adjacent the outer end of said tube and fitting said opening; the peripheral wall of said member being spaced from the peripheral wall of the tube to form an annular air jacket, which completely surrounds the peripheral wall of said member, is closed at its outer end and communicates with said inlet at its inner end; the inner end wall of said member being exposed to the air flow in said tube; a cylindrical tube fixed in said end wall and projecting into said chamber in co-axial relation therewith, a support of polygonal cross section fitted into said tube, a pressure-atomizing nozzle fixed to the inner end of said support, there being between said support and tube a plurality of passages parallel with the axis of the tube, to emit air in longitudinal streams which surround said nozzle, an annular ring fixed to the internal peripheral wall of said member at a location nearer the inner end wall than its outer end and partitioning the same into inner and outer chambers communicating with each other through the central opening in said ring, said outer chamber constituting a combustion chamber, said nozzle being positioned in and substantially co-axially of said inner chamber to discharge a spray of atomized oil through said opening into the combustion chamber, and ignition electrodes positioned in said rear chamber, the peripheral wall of said member having a circular series of angularly-spaced longitudinally-extending slots opening tangentially into said inner chamber to direct whirling streams of air around the chamber and thence forwardly to mix with the oil spray near the nozzle and pass out through said central opening into the combustion chamber, the peripheral wall of said member having a circular series of angularly-spaced and longitudinally-extending slots opening tangentially into said combustion chamber, whereby the air for combustion is whirled around the combustion chamber and around the flame, said slots being located to direct whirling streams of air into the combustion chamber through said peripheral wall substantially from end to end thereof for sweeping the entire inner surface of said peripheral wall, said whirling streams of air acting to shorten the flame and confine it for the most part within the limits of the combustion chamber.

4. In an oil burner, an air tube having an air inlet in its inner end and an opening in its outer end; a tubular member having a peripheral wall, an inner end wall and an open outer end; said member being telescoped in said air tube with its outer end adjacent the outer end of said tube and fitting said opening; the peripheral wall of said member being spaced from the peripheral wall of said tube to form an annular air jacket, which completely surrounds the peripheral wall of said member, is closed at its outer end and communicates at its inner end with the inlet of said tube; an annular disk mounted within and across the tubular member near its inner end and dividing the space within said member into inner and outer chambers, a pressure-atomizing nozzle mounted in the inner chamber with its orifice coaxial of and slightly back of the central opening in said disk to emit through said central opening into the outer chamber and generally lengthwise thereof a spray of atomized oil, ignition electrodes mounted in said inner chamber adjacent said nozzle, the peripheral wall of said tubular member having therein a circular series of angularly-spaced longitudinally-extending slots therethrough connecting said jacket to said inner chamber and opening tangentially into such chamber to direct whirling streams of air around it and thence forwardly to mix with the oil spray near the nozzle and pass out through the central opening in said disk into the outer chamber, the peripheral wall of said member having a plurality of sets of slots therethrough connecting said jacket to the outer chamber, each set comprising a circular series of angularly-spaced and longitudinally-extending slots, the slots in each series being angularly staggered with respect to the slots in the adjacent set, each slot opening through the peripheral wall of said member substantially tangentially to its inner surface, whereby the air for combustion is whirled around the outer chamber and around the flame, said slots

being located to direct whirling streams of air into the outer chamber substantially from end to end thereof for sweeping the entire inner surface of said peripheral wall, said whirling streams of air acting to shorten the flame and confine it for the most part within the limits of the outer chamber.

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