

May 5, 1953

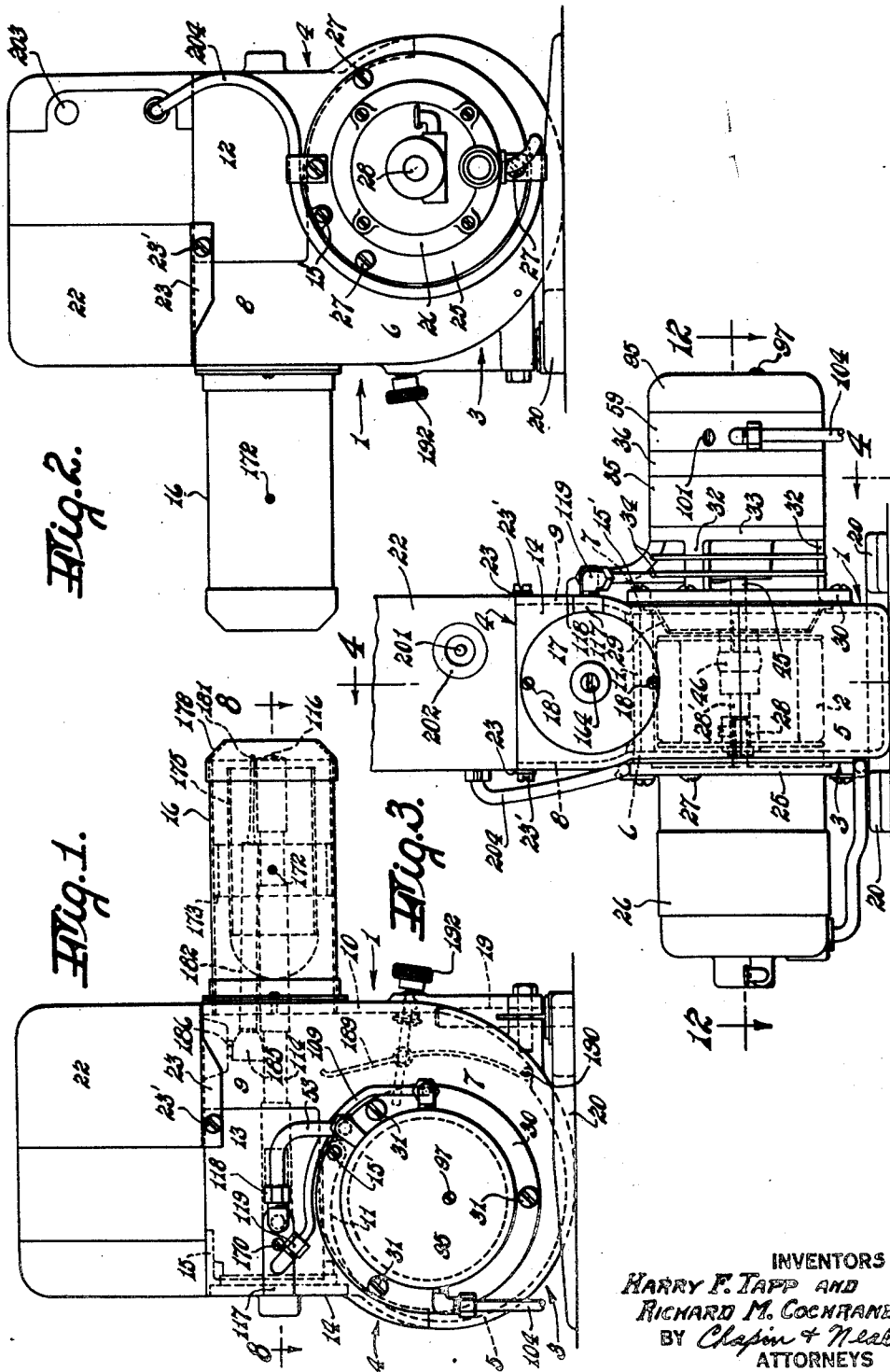
H. F. TAPP ET AL

2,637,375

FUEL SUPPLY CONTROL FOR AIR-ATOMIZING OIL BURNERS

Original Filed Sept. 2, 1950

4 Sheets-Sheet 1



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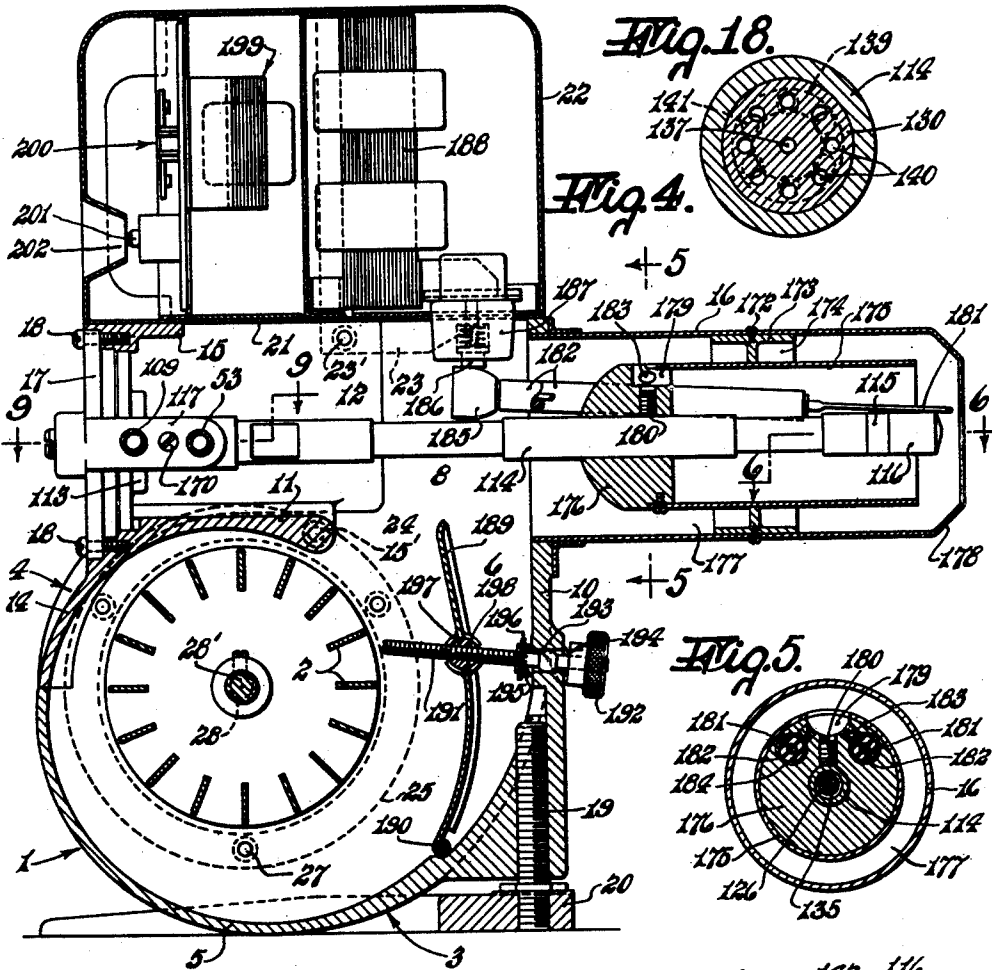


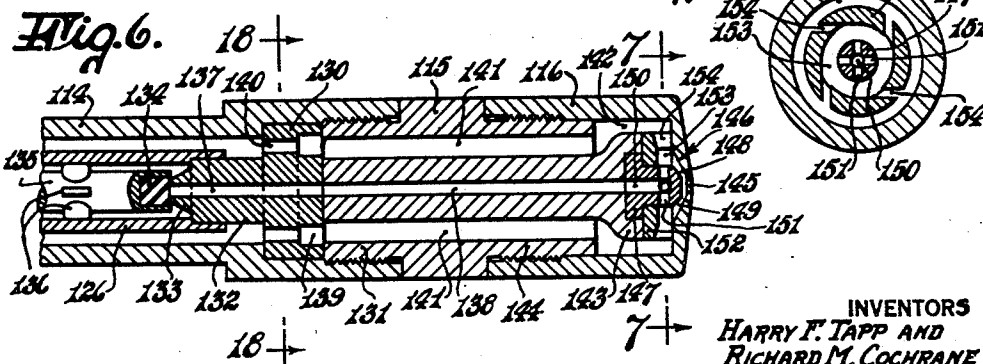
Fig. 18.

Fig. 4.

Fig. 5.

Fig. 7.

Fig. 6.



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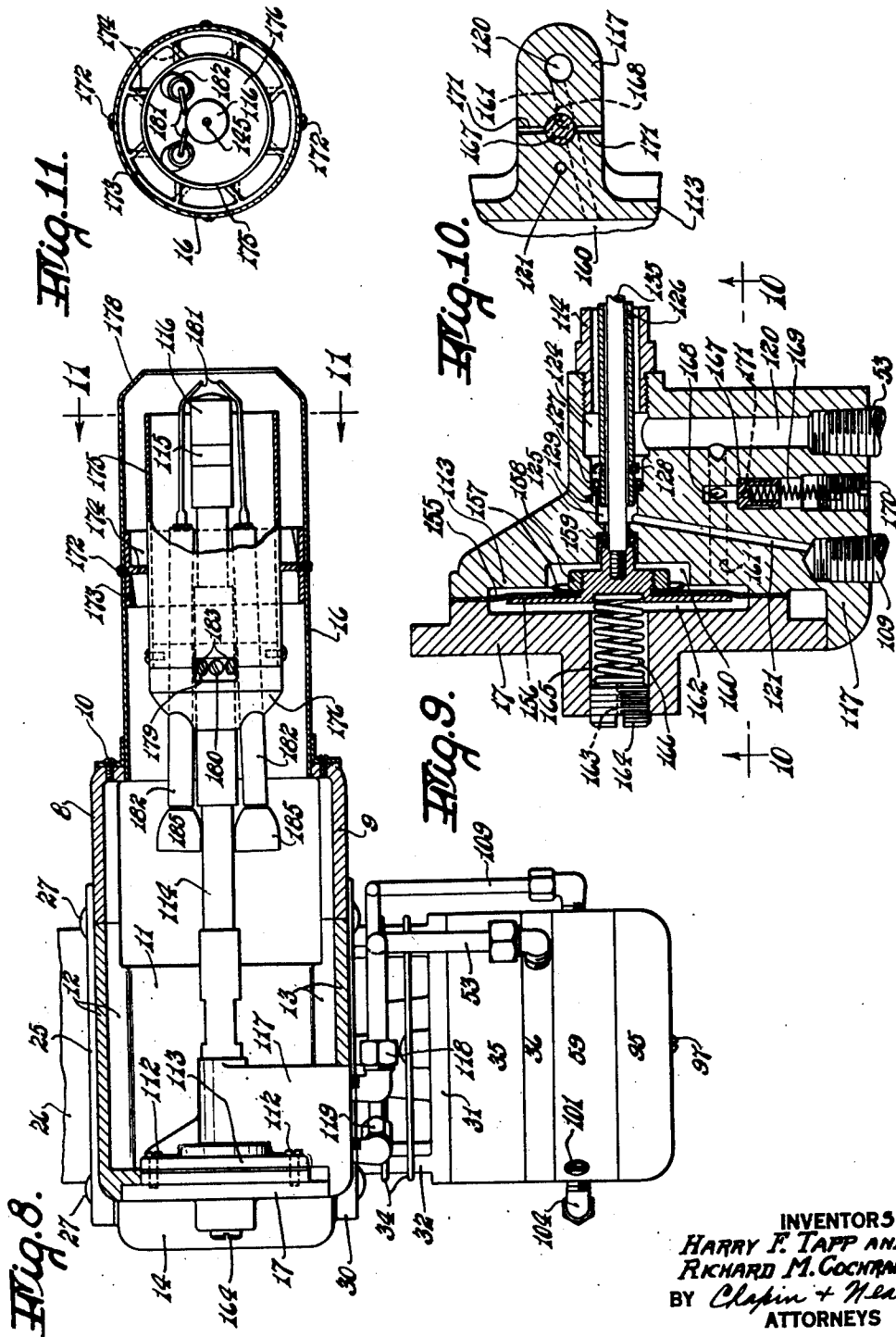
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Fig. 12.

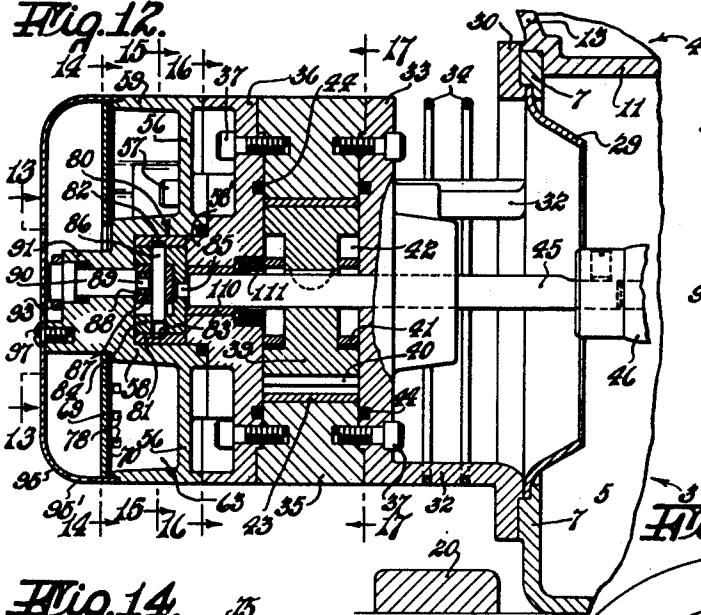


Fig. 13.

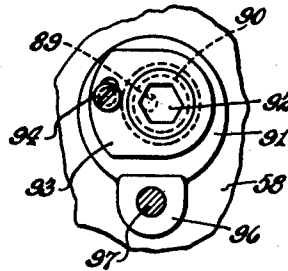


Fig. 15.

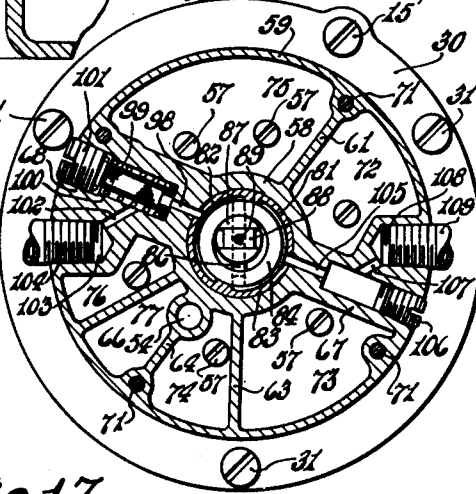


Fig. 14.

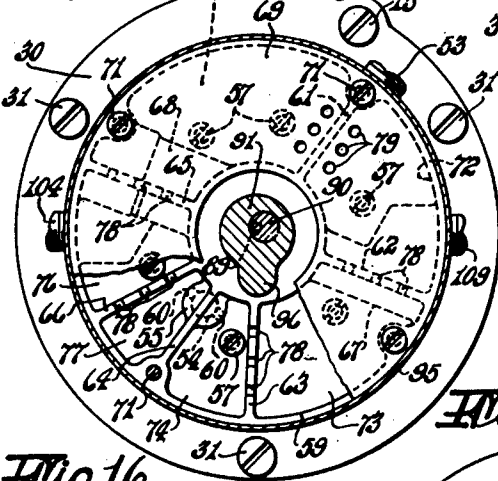
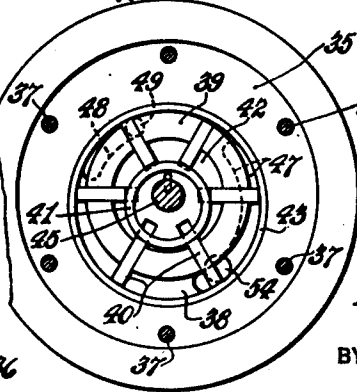
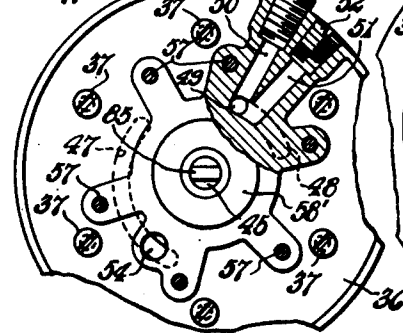


Fig. 17.

Fig. 16.



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UNITED STATES PATENT OFFICE

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FUEL SUPPLY CONTROL FOR AIR-
ATOMIZING OIL BURNERS

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Original application September 2, 1950, Serial No. 182,952. Divided and this application September 19, 1951, Serial No. 247,272

2 Claims. (Cl. 158—42.2)

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This invention relates to an improved oil burner of the so-called air-atomizing type.

This application is a division of our application Serial No. 182,952, filed September 2, 1950, and entitled Air-Atomizing Oil Burner.

The invention has for its general object the provision of a burner, which will burn fuel oils of various grades, including heavier grades, such as No. 5 fuel oil, for example, under conditions that can be controlled with precision to yield efficient and clean combustion, and which may be used to fire very small furnaces, such for example as have heretofore been fired by pot type burners, and even the small fire boxes of stoves and kitchen ranges.

The burner utilizes an air-atomizing type of nozzle to enable low firing rates to be secured with nozzle passages and orifices, which are large enough to avoid clogging, and to enable effective atomization to be effected at relatively low pressures. Oil, primary air and secondary air are respectively supplied by a pump, compressor and fan, all driven by an electric motor, usually under automatic thermostat control and the rate of flow of oil and primary and secondary air to the nozzle is regulable with precision as is the pressure of the oil and primary air supply, so that combustion conditions can be accurately controlled.

The invention has for other objects to provide in a burner features of construction which enable manufacture at relatively low cost and at the same time provide for efficient and controlled combustion, and to provide features involving improved construction and arrangement of parts that provide for convenience of assembly and also of disassembly, when required for easy servicing in the field.

These objects will best be understood from the detailed description of one illustrative example of the invention in the accompanying drawings, in which:

Figs. 1 and 2 are small scale elevational views showing opposite sides of an oil burner embodying the invention;

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

Fig. 4 is a sectional elevational view, taken on the line 4—4 of Fig. 3 and drawn to a larger scale;

Fig. 5 is a fragmentary cross-sectional view taken on the line 5—5 of Fig. 4;

Fig. 6 is an enlarged fragmentary sectional view taken on the line 6—6 of Fig. 4, showing the atomizing nozzle and the supply conduits for oil and primary air;

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Fig. 7 is an enlarged cross sectional view taken on the line 7—7 of Fig. 6;

Fig. 8 is a sectional plan view taken on the line 8—8 of Fig. 1;

Fig. 9 is a full-size fragmentary sectional plan view taken on the line 9—9 of Fig. 4;

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

Fig. 11 is a cross-sectional view taken on the line 11—11 of Fig. 8;

Fig. 12 is a fragmentary sectional elevational view taken on the line 12—12 of Fig. 3;

Figs. 13, 14, 15, 16 and 17 are cross-sectional views taken on the lines 13—13, 14—14, 15—15, 16—16 and 17—17 of Fig. 12; and

Fig. 18 is a cross-sectional view taken on the line 18—18 of Fig. 6.

Referring to these drawings: the burner includes a central casing (Fig. 1), designated generally as 1 and affording in its lower portion a housing for the fan 2, which supplies secondary air to the burner. This casing, as shown in Figs. 1, 2, 3 and 4, is made up of two sections 3 and 4, which are so constructed that they may be made by die casting. The larger section 3 has a curved bottom wall 5, forming part of the volute for the fan, two flat parallel upstanding side walls 6 and 7 with relatively narrow rectangular upward extensions 8 and 9, respectively, which bulge outwardly slightly, and a front wall 10 which is tangential to the end of larger radius of the volute wall 5 and which upstands at right angles to the side walls 6 and 7 and their respective extensions 8 and 9. The other end of the curved wall 5 terminates in a horizontal plane passing through the axis of revolution of fan 2. That portion of each side wall 6 and 7, which is disposed below said plane, has a curved margin integrally connected to the curved wall 5. Each side wall is further bounded by a short horizontal edge, disposed in said plane and extending inwardly a short distance from the end of smaller radius of wall 5; a curved edge, which is a 90° arc concentric with the axis of fan 2 and extending from said horizontal edge; a horizontal edge tangent to the upper end of the curved edge and which is substantially equal to the radius of the fan; a vertical edge forming the inner edge of extension 8 or 9, a horizontal edge forming the top of such extension and a vertical edge united to the front wall 10. The smaller section 4 has a curved wall 11 (Figs. 1 and 4), which extends from said plane and the last-named end of wall 5 upwardly, over and across toward wall 10 and completes the

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volute of the fan housing; integral, spaced, side walls 12 and 13 (Figs. 1, 2 and 8); a connecting end or rear wall 14, which parallels the front wall 10; and a narrow top wall 15. The side walls 12 and 13 serve as continuations of the side walls 6 and 7, and their extensions 8 and 9, respectively, and each has a short radial and horizontal edge; a curved edge; and a longer horizontal edge to rest upon and abut the corresponding edges of section 3, together with a vertical edge to abut the rear edge of the extensions 8 or 9, as the case may be, of the adjacent side wall. The sections 3 and 4 are held together by two screws 15' which pass one through side wall 6 and one through side wall 7 and thread into the wall 11.

The front and rear walls 10 and 14 of the casing (Figs. 4 and 8), have coaxial cylindrical openings therein. In the opening in wall 10 the rear end of an air supply tube 16 is suitably fixed as indicated in Fig. 8. The opening in wall 14 is closed by a circular disk 17, suitably fixed to such wall, as by screws 18 (Fig. 4). This casing 1 is supported from the floor in any suitable way, as by a short standard 19 (Figs. 1 and 4), fixed at its upper end in the lower front part of section 3 of the casing and adjustably secured at its lower end in the cross bar portion of a U-shaped foot piece 20, which rests on the floor. The upper end of the casing 1 is closed in any suitable way, as in the example shown, by the bottom wall 21 of a box 22, which houses certain electrical equipment as will later appear and which has two downwardly extending parts 23 overlapping the side walls of the casing and secured by screws 23', one to side wall 12 and the other to side wall 13. The inner end of wall 14 (Fig. 4) of the casing section 4 is spaced from wall 10 to form the outlet 24 of the fan, which outlet communicates with the upper portion of the interior of casing 1 and with air tube 16. The side walls 6 and 7 of the casing have large circular openings therein, that on wall 6 (Fig. 4) being larger than the outside diameter of fan rotor 2 and that in wall 7 (Figs. 3 and 12) forming the inlet to the fan housing. The opening in wall 6 (Figs. 2, 3 and 4) is closed by the end flange 25 of an electric motor 26, which drives the fan 2 and an air compressor and oil pump to be later described. Flange 25 is secured by screws 27 to wall 6. The motor has its drive shaft 28 (Fig. 3) extending into casing 1 and secured in the hollow end of a stud 28', fixed to the hub of fan 2, as indicated. The opening in wall 7 (Figs. 3 and 12) forms the inlet to the fan. A deflector 29 of frustoconical shape has an outer annular flange, which rests in a seat in side wall 7 and is clamped between the latter and an annular ring 30 by screws 31. This ring 30 is integrally connected by a series of horizontal arms 32 to a circular end plate 33 of the air compressor and serves to support both the compressor and the oil pump. There is a space between the plate 33 and ring 30 for the admission of air to the deflector 29 which directs the air axially to fan rotor 2. A shield, comprising a plurality of wire rings 34, mounted in axially spaced relation in the gap between the ring and end plate, is provided, and these rings are suitably secured to the arms 32.

The air compressor (Fig. 12) includes a central body 35 clamped between the end plate 33 and an end plate 36 by screws 37. The body 35 has a cylindrical chamber 38 (Fig. 17) extending through it and located eccentrically thereof.

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In this chamber 38 is a rotor 39 having a plurality of angularly-spaced radially-slidable vanes 40, the inner ends of which ride on rings 41, disposed one in each of two recesses 42 formed in the ends of the rotor. The chamber 38 may have a liner 43 of suitable oil-impregnated material. An O-ring 44 (Fig. 12) is mounted in a circular groove in each end plate 33 and 36 to press against the adjacent end face of body 35. These rings 44 prevent leakage between the end plates and body of the compressor. The rotor 39 is fixed as indicated to a drive shaft 45, which is rotatably mounted in suitable bearings, one in each of the end plates, and projects beyond the end plate 33 and into the fan housing where it is connected by a suitable flexible coupling 46 (Fig. 3) to the outer end of the described stud 28' and thus to motor shaft 28. The inlet and outlet ports of the compressor are shown in Fig. 17 at 47 and 48, respectively. They are arcuate grooves formed in the inner face of the end plate 36. The outlet port 48 is connected by a horizontal passage 49 (Fig. 16) to two radial passages 50 and 51 formed in end plate 36. The outer end of passage 51 is normally closed by a plug 52 and is adapted for connection to a pressure gauge when the plug is removed. The outer end of passage 50 is adapted for connection by a pipe 53 to the primary air supply passage of the atomizing nozzle as will later be described in detail. The inlet port 47 is connected to one end of a passage 54 which extends horizontally through end plate 36 (Fig. 16) and part way into a boss 55 (Fig. 14) formed on an abutting plate 56, which as shown in Fig. 12 is secured by screws 57 to end plate 36. Plate 56 has projecting from it an inner boss 58 housing the oil pump and an outer annular marginal rim 59. The boss 55 described merges with boss 58 and has radial holes 60 connecting hole 54 to the space between the boss 58 and flange 59.

A muffler of the labyrinth type is provided on the intake side of the compressor. The space between the described hub 58 and rim 59 (Fig. 14) is subdivided by a series of angularly-spaced baffles, 61, 62, 63, 64, 65 and 66 which extend radially from the hub to the rim and which project longitudinally from plate 56 to the same extent as rim 59 and boss 58 (see Fig. 12). The baffles 62 and 65 (Fig. 14) are formed, on radial bosses 67 and 68, respectively, on plate 56. A thin plate 69 (Fig. 12), having on its inner face a layer of suitable sound-deadening material 70, abuts the outer end faces of the rim 59, the boss 58 and all the baffles and is secured by four screws 71 (Fig. 14). The baffles thus subdivide the space between rim 59 and hub 58 and between plates 55 and 69 into a series of compartments 72, 73, 74, 75, 76, and 77. The baffles 62 and 63 and the baffles 65 and 66 have a plurality of notches 78 in their outer end faces but the baffles 61 and 64 are imperforate. Air inlet openings 79 (Fig. 14) are provided in plate 69, to admit air to the chambers 72 and 75 on opposite sides of the imperforate baffle 61. Air from chamber 72 follows a clockwise path, passing through the openings 78 in baffle 62 into chamber 73, through the openings 78 in baffle 63 into chamber 74 and thence through the right hand radial hole 60 into horizontal hole 54 and thence into the inlet port 47 of the air compressor. Air from chamber 75 follows a counterclockwise path, passing through the openings 78 in baffle 65 into chamber 76, then through the openings 78 in baffle 66 into chamber 77 and thence through the left hand radial hole

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60 into the horizontal hole 54 and thence to the inlet port 47 of the air compressor.

The oil pump is shown in Figs. 12 and 15. It is of the variable-capacity type and is mounted in a cylindrical recess 80 in the boss 58, which recess is coaxial with shaft 45 and extends from its rear face toward but not through the front face of the boss. The end plate 36 of the air compressor has a portion 53' of its central and bearing-containing hub entering the aforesaid recess to close it on the air compressor side and the joint between the abutting faces of this boss and hub is suitably sealed as indicated. Into this recess is pressed a ring 81, having centrally in its inner face two grooves 82 and 83 (Fig. 15), which are separated by two diametrically opposed lands and which form the inlet and outlet ports of the oil pump. A cup-shaped rotor 84, rotatably fits within ring 81 and between the end walls of the recess 80. This rotor has a slot of non-circular shape in its end wall to receive a key 85 which is of similar shape (see also Fig. 16) and is formed on the outer end of shaft 45. Two cylinder-forming holes are provided through the annular part of the rotor in diametrically opposed relation to receive the ends of a piston 86. This piston is fixed centrally between its ends in a cylindrical piece 87 which fits within the cup-shaped rotor and may be moved to various positions of eccentricity relatively thereto. The piece 87 has a groove in its outer face to receive a slide 88. The latter has a hole therein to receive a pin 89 eccentrically located on the inner end of a shaft 90 which is mounted in hub 58 and a smaller hub 91, integrally connected thereto, to turn about an axis eccentric to shaft 45. Suitably fixed as by welding to the outer end of shaft 90, is a plate 93, having a curved slot therein, and this plate may be held in various positions of angular adjustment by a screw 94 which passes through the slot and threads into boss 91. By moving shaft 90 as by a tool inserted in the hexagonal depression 92 in the end of shaft 90 the pin 89 may be moved to vary the radial position of the piston 86 and thus the capacity of the pump. A cup-shaped pressed-metal cover 95 conceals the oil-pump-adjusting means described and is held to a lug 96 on boss 91 by a screw 97. The oil inlet for the pump is formed in the described boss 58 (Fig. 15). It includes a radial passage 98, having a counterbore, in which is received a filtering screen 99 having an open inner end surrounded by a flange that is pressed against a seat in the counterbore by means of a spring 100, acting against a plug 101, threaded in and closing the outer end of the counterbore. A passage 102 connects this counterbore to an inlet 103, into which is threaded one end of suction pipe 104 adapted for connection at its other end to an oil supply tank (not shown). The outlet port 83 is connected to a radial passage 105 having a counterbore, the threaded outer end of which is normally closed by a plug 106 that is removable to enable attachment of a pressure gauge, when desired. A diagonal passage 107 connects the last-named counterbore to an outlet 108 into which is threaded a pipe 109 for supplying oil to the nozzle of the burner.

It will be noted from Fig. 12 that the left hand bearing 110 of the air compressor adjoins the oil pump and is positioned to receive some of the pumped fuel oil and utilize such oil for lubricating purposes. A sealing ring 111 is provided on the right hand side of bearing 110 to tightly seal the bearing and prevent oil from the pump entering the compressor and to prevent air from the

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compressor from reaching the oil pump. The oil pump is used as a metering pump as well as a transfer pump to draw fuel from a low level supply tank and it is important for the latter purpose to provide the seal described to prevent loss of suction.

Referring next to Figs. 4 and 8, the disk 17 is secured, as by screws 112, to a casting 113. The latter supports one end of a tube 114, which extends coaxially through the described secondary air tube 16 and terminates near the forward end of such tube with an atomizing nozzle, the body and cap of which are designated 115 and 116 respectively. The casting 113 has a lateral extension 117 (Fig. 8) which extends into and fills a slot in the side wall 13 of the casing section 4 (see also Figs. 1 and 3) and into which the described air and oil pipes 53 and 109 are screwed. These pipes have unions 118 and 119, respectively, which are located near member 117 and which can be disconnected whenever it is desired to remove the assembly comprising disk 17, members 113 and 117, together with the tube 114 and the atomizing nozzle and other parts connected thereto, as will be later described in detail.

Referring next to Fig. 9, it will be seen that the member 113 and its lateral extension 117 have radial passages 120 and 121 which at their outer ends respectively connect with the air and oil supply pipes 53 and 109 and which at their inner ends respectively connect with annular chambers 124 and 125 formed in member 113 coaxially of tube 114. Within the tube 114, which at its outer end is screwed into member 113, is an oil supply tube 126. This tube carries an O-ring 127, which partitions the chambers 124 and 125. Tube 126 has fixed thereon a snap ring 128 which together with a shoulder 129 confine the O-ring to an axial position such as is effective to seal the oil chamber 125 from the air chamber 124. The air chamber 124 connects with the annular space between tubes 114 and 126 and the oil chamber 125 connects with the space within tube 126.

Referring next to Fig. 6, the forward end of air tube 114 is counterbored to receive and closely fit a disk 130. The nozzle body 115 has a threaded portion 131, which screws into the forward end of tube 114 and clamps the disk 130 between its end wall and the end wall of the counterbore. This disk has an integral and rearwardly extending hub 132, which tightly fits into the forward end of oil tube 126 and which has inside the tube a valve seat 133. The latter is adapted to be engaged by a valve 134 on the end of a rod 135 located within tube 126 and slidably supported from the inner periphery of the tube in any suitable way as by the radial projections 136 on the rod. An oil passage 137 extends axially through the disk 130, hub 132 and seat 133 to receive oil from tube 126, when valve 134 is moved to the left away from its seat. This oil passage 137 registers with a central passage 138 in the nozzle body 115. The disk 130 also has in its forward face an annular groove 139 and a plurality of holes 140 which extend from the bottom of the groove to the rear face of the disk and there communicate with the annular space between tube 14 and pipe 126 to receive primary air. The nozzle body 115 has extending longitudinally there-through a plurality of passages 141 arranged in angularly-spaced relation about the central oil passage 138. These air passages 141 communicate at their rear ends with annular groove 139 and at their forward ends with an annular chamber 142 formed within cap 116 and the forward

end 148 of the nozzle body which end is of reduced diameter. The cap 115 is threaded onto a part 144 of the nozzle body and its front wall has a central orifice 145 which leads from a conical recess 146, formed in the inner face of the front wall, to the outer face of such wall. The front end of the nozzle part 143 is counterbored to receive the inner flanged end of a cylindrical piece 147 which terminates with a frusto-conical end 148 projecting into the conical recess 146 in spaced relation therewith to form an annular whirl chamber 149 which converges to the orifice 145. The part 147 has an axial oil passage 150 which at one end communicates with oil passage 138 and which extends closely adjacent to but stops short of the front end of part 147. Here, the passage 150 communicates with the inner ends of a plurality of holes 151 which extend radially outward to the outer periphery of part 147. Encompassing the cylindrical part 147 is an annular ring 152, which is pressed into and held in abutment with the outer end face of the part 143 by the cap 116 and which in turn holds the inner flanged end of member 147 in its seat in the counterbore. This ring 152 has in its front face an annular groove 153 closed at the front by cap 115 and a plurality of angularly spaced slots 154 located tangentially of the groove 153 and connecting at their outer ends with the air chamber 142. The primary air enters tangentially into the chamber 153 at a plurality of angularly-spaced locations and meets the oil streams, issuing radially from holes 151, intercepting these oil streams at right angles and effecting an intimate mixture of fuel and air. This mixture, whirling in the chamber 153, advances into the conical whirl chamber 149 where it is caused to whirl at rapidly increasing velocity as it advances to the outlet orifice 145. This rapidly-rotating stream of mixed fuel and air is confined peripherally until it emerges from the orifice 145, where being released from peripheral confinement it flies apart by centrifugal force into a fog-like spray.

Referring again to Fig. 9, it will be noted that the members 17 and 113 have flat annular faces, between which is clamped the marginal portion of a circular diaphragm 155. The latter is centrally perforated to receive the threaded hub of a plate 156, which abuts one face of the diaphragm 155. An annular ring 157, engaging the opposite face of the diaphragm, receives the threaded hub of plate 156 and a nut 158, threaded on such hub draws the ring and plate together to clamp the diaphragm therebetween. The valve rod 135, above described, is fixed at its rear end as indicated in the hub of plate 156. An O-ring 159 on the valve rod prevents leakage of oil from chamber 125 into the chamber 160 which is formed in member 113 on the right side of the diaphragm. Chamber 160 is connected to air passage 120 by a passage 161 (see also Fig. 10). The chamber 162 on the other side of the diaphragm is connected to the atmosphere by a hole 163, formed in a plug 164, threaded into and closing the outer end of an axial passage 165 in disk 17, which passage communicates with chamber 162. A spring 166 acting between plug 164 and plate 156 tends to move valve rod 135 to the right and hold valve 134 to seat 133, thus preventing oil from entering the nozzle until sufficient air pressure has been built up by the compressor to force diaphragm 155 to the left against the force of the spring 166 to open the valve. The pressure, at which valve 134 opens, is variable by adjustment of screw 164, which is accessible from

outside the burner casing as shown in Fig. 3 for the purpose.

The air pressure is regulated by an adjustable relief valve 167 shown in Fig. 9. This valve is mounted for axial sliding movement in the counterbored outer end of a passage 168, formed in the extension 117 and paralleling air passage 120. The inner end of passage 168 intersects the passage 161 and receives air therefrom (see also Fig. 10). The seat for valve 167 is the shoulder at the intersection of passage 168 with its counterbore. The valve is held to this seat by a spring 169, having a seat in a plug 170 which is threaded into and closes the outer end of the counterbore. A vent passage 171 (see also Fig. 10) connects the counterbore at a point between the valve seat and plug 170 with the exterior of extension 117, opening into the air chamber in the upper part of the fan housing. The force exerted by spring 169 on valve 167 is variable by turning screw plug 170, which is accessible from outside the burner casing, as will be clear from Fig. 1, and enables the air pressure to be readily adjusted. As at present contemplated, the burner may operate with an air pressure between $1\frac{1}{2}$ and 4 p. s. i.

Secondary air is supplied by the fan through tube 16, as will be clear from Figs. 4 and 8. Fixed to the tube 16 at a point intermediate its ends, as by screws 172, is an annular ring 173, having projecting inwardly therefrom a circular series of helical vanes 174. The inner edges of these vanes engage the outer peripheral wall of a cylindrical tube 175 and support it in coaxial relation with tube 16. The front end of tube 175 is open and terminates adjacent and slightly to the rear of the atomizing nozzle. The rear end of tube 175 is closed by a plug 176, which is secured to the tube as indicated and which has a rounded rear end to divert the air stream issuing from the outlet 24 of the fan into the annular passage 177 between the tubes 16 and 175. As will be clear from Fig. 11, successive helical blades 174 in the series overlap so that all air traveling through the annular passage 177 is engaged by the blades and caused to whirl as it moves forward in such passage. The whirling air stream, emerging from passage 177 is deflected toward the central stream of fuel and air, which is emitted from the nozzle orifice 145, by means of a frusto conical air director 178 on the outlet end of tube 16. Substantially all the secondary air is whirled as described. There is a single small vent passage 179 (Figs. 4 and 5) formed in plug 176 for the purpose of preventing the formation of a vacuum in the interior of tube 175. Except for the insignificant amount of air entering tube 175 through this vent passage, all the secondary air supplied by fan 2 is whirled. The plug 176 has a central opening therethrough which receives and closely fits the described nozzle-carrying tube 114. A set screw 180, threaded in the plug 176, holds tube 114 in place. Thus, the vanes 174 support tube 175, the conduit for secondary air and the oil conduit together with the ignition electrodes.

The ignition electrodes are shown at 181 (Figs. 4, 8 and 11). They are mounted in insulators 182 which in turn extend through holes in plug 176. Each insulator is held in place by a set screw 183, threaded in plug 176 and acting against a thin split sleeve 184 (Fig. 5), which surrounds the electrodes. On the rear end of each electrode (Figs. 4 and 8) is a metal terminal 185 which progressively increases in diameter rearwardly to form a cam. These cam terminals 185 are engaged, one by each of two spring-pressed metallic plungers 186 (Fig. 4), mounted in an insu-

lator 187, which is fixed in bottom wall of casing 21 and carries the high tension terminals of an ignition transformer 188, which is mounted in the front half of the described box 22. These terminals suitably connect electrically, one with each of the spring-pressed plungers 186. It will be clear that, when the disk 17 is unfastened and pulled rearwardly it will carry with it the assembly of tubes for primary air and oil and the ignition electrodes and that the connection between the transformer and electrodes will be broken before the electrodes are withdrawn from the tube 16. This entire assembly can readily be removed from tube 16 for inspection, adjustment or repair and may as readily be replaced in the tube. As this assembly is replaced the cam terminals 185 engage and force upwardly the spring-pressed plungers 186, thus remaking the electrical connection between the high tension terminals of the transformer and the ignition electrodes. These electrodes are suitably located so as to produce an arc between them to ignite the spray of fuel mixture. Preferably, the tips of the electrodes are located above and out of the path of the fuel spray and the arc produced between these tips is blown into such path by the secondary air.

The rate of flow of the secondary air stream is varied by means of a damper 189 (Fig. 4), which is pivotally mounted at its lower end on a rod 190, suitably fixed at its ends in the side walls 6 and 7 and extending therebetween. This damper may be swung toward or away from the fan rotor 2 in order to vary the effective area of the outlet 24 of the fan. Conveniently, the damper may be moved by means of a screw 191 having a knurled head 192, which is located outside the housing and by means of which the screw may be turned. The front wall 10 of the fan housing has an opening, through which the shank of screw 191 passes. The peripheral wall of this opening closely fits a ball-like part 193 on the shank of the screw. On the outer face of wall 10 is a rounded part-cylindrical projection 194 which is engaged by an end face of the knurled head 192. A coil spring 195, acting between the inner face of wall 10 and a washer 196 fixed to the screw, draws the head 192 against the rounded part 194. The screw is thus able to swing up and down about ball 193 as a fulcrum, as may be necessary as the screw 191 is turned. The screw is threaded into a nut 197, held in place by curved prongs 198, formed on the damper, in a manner such as to allow the nut to turn relatively to the damper as required, when the damper is moved in and out by turning the screw.

The described box 22 may as indicated in Fig. 4, contain, in its rear compartment, some of the controls for the burner, such as the relay 199, the thermal safety switch 200 and the reset button 201 for the safety switch. This button is accessible through a hole 202 in the rear wall of casing 22 (see also Fig. 3). The wires enter this casing through an opening 203 (Fig. 2) and a cable 204 (Figs. 2 and 3) extends from controls inside the casing to the motor 26.

In operation, when the motor 26 is started, usually automatically, on a demand for heat, as by the well known thermostat control, the fan, air compressor and oil pump are simultaneously started up and driven but the emission of oil from the nozzle is delayed until conditions of air flow and pressure, suitable for good combustion, are established. The valve 134 prevents oil from entering the nozzle until the primary air has been placed under sufficient pressure to overcome the force of spring 166 and move the diaphragm 155

to open the valve. This helps in avoiding smoke during the starting interval of operation of the burner. Flow of primary air through the nozzle passages and out through the nozzle orifice and flow of secondary air in the annular passage 177 and out through the open end of tube 18 will be established before valve 134 opens. Hence, when the valve does open, the oil issuing in radial jets through passages 151 of the nozzle will be met and impinged by jets of primary air issuing tangentially through passages 154 into the chamber 153. In this chamber, the oil and air will be mixed and the mixture will be whirled at considerable velocity. The whirling oil and air mixture advances into the whirl chamber 149, where its velocity rapidly increases as it approaches the outlet orifice 145. As this rapidly-rotating oil and air mixture emerges from the orifice and is freed from peripheral confinement, it flies apart by centrifugal force into a cone-like spray of finely divided particles and fog-like form. The spray is met by a stream of secondary air, whirled by the turbulator vanes 174, and the mixture is ignited by a spark produced between the electrodes 181. The whirling of the secondary air produces a short and wide flame having much the shape of an umbrella, adapting it for use in small fire boxes. Combustion continues until the demand for heat is satisfied, when the motor 26 is stopped. As the motor decreases in speed, the pressure of the primary air will soon drop sufficiently to enable valve 134 to be closed by spring 166. The oil flow is very quickly and sharply cut off from the nozzle, preventing any dribbling therefrom. However, flow of primary air continues which purges the nozzle. The early closure of the oil valve, well ahead of the cessation of air flow, helps in avoiding smoke during the stopping interval of operation of the burner.

It is to be noted that the conditions contributing to combustion may all be accurately controlled. The oil pump is a metering pump, as well as a transfer pump, and provides for oil flow at a definite rate, which is variable by adjustment of the member 90. The desired rate of oil flow, once obtained by this adjustment, will be maintained. The supply of primary air from the positively-acting compressor is at a constant rate but this rate and the pressure of the primary air are adjustable by turning screw 170, which controls the force of spring 169 which holds valve 167 closed. By by-passing some of the air, forced by the compressor into the passages 120, 161, 168, and 171, the rate of flow of primary air and the pressure thereof may be varied. The air pressure at which the oil valve 134 will open is regulable by turning the screw 164 which varies the force of the spring 166 that holds the oil valve closed. The pressure of spring 166 must, of course, be somewhat less than the air pressure secured by adjustment of screw 170. The rate of flow of secondary air is adjustable by the swinging shutter 169 in the fan housing. All the adjustments are readily accessible from outside the burner housing, except for the adjustment which varies the rate of oil flow, and for considerations of safety it has been thought best to conceal this oil-flow adjustment from unskilled persons who possibly might tamper with it. However, to the service man the adjustment is readily accessible by removing the cover 95, after the one screw 97 which holds it in place has been removed.

As one illustrative example, to illustrate how small a fire the burner will produce, a burner constructed according to the disclosure satisfactorily fired a combustion chamber seven inches

long, five inches wide and ten inches high, using oil at the rate of .3 gallon per hour and at a pressure slightly less than 2.5 p. s. i., and primary air at a pressure of 2.5 p. s. i. The motor used was rated at one twentieth of a horse power.

The construction of the housing 1 in two sections enables these sections to be manufactured economically by die casting and also facilitates the assembly of parts within the fan housing and also servicing of the fan. With the upper section 4 removed and the motor 26 bolted to the lower section 3, the fan rotor 2 may be placed on shaft 28 in proper position and secured thereto. Then, the assembly of oil pump and compressor may be bolted to the lower section and the connection between the drive shaft 45 and coupling 46 may be made, working from above. Also, the shutter 189 may be assembled and connected to its adjusting screw. Then, the upper section 4 may be put in place and secured by the two screws 15'. The top of the housing is then closed by fastening the transformer and control box 22 to the top of the upper section 4 by means of two screws 23'. This leaves the opening in the end wall 14 of the housing and, through this opening, is passed the assembly of atomizing nozzle, electrodes, tube 175, primary air and oil pipes, the oil valve, oil-valve-actuating means, primary air regulating valve and closure disk. When this unit is pushed into the housing and tube 16, the tube 175 will engage the inner peripheral edges of the turbulator vanes 174, whereby the tube and nozzle will be supported in proper coaxial relation with tube 16. The connection between the ignition electrodes and the high tension terminals of the ignition transformer will be automatically made by the cams 185 engaging the spring-pressed plungers 186 during the last stage of inward movement of the unit. The closure disk 17 will finally fit into and close the opening in wall 14, after which the screws 10 are applied to fasten disk 17 in place and the assembly is complete.

It will be clear that the burner is readily disassembled for servicing. By removing screws 18 and disconnecting the air and oil pipes 53 and 189 at their unions 118 and 119, respectively, the disk 17 may be removed, carrying with it as one unit, the atomizing nozzle, ignition electrodes, tube 175, oil valve, oil and primary air pipes, oil-valve-actuating means and primary air regulating means. All these parts may be removed without disturbing their cooperative relationship. If the parts of this unit are disassembled, they may be replaced in the desired relationship before the unit is replaced and such relationship will be retained during the replacement of the unit. The connections between the ignition electrodes and transformer terminals are automatically broken and made as the described unit is respectively withdrawn and replaced. After the described unit has been withdrawn, the upper section 4 may be removed to give full access to the fan and fan housing for cleaning.

The invention thus provides an improved oil burner of the air-atomizing type, which is capable of manufacture at relatively low cost and yet provides for clean and efficient combustion under conditions that are accurately regulable, and which provides for convenient assembling and disassembling of parts and for convenient adjustment of flow rates and pressure of the air and oil.

What is claimed is:

1. In an air-atomizing oil burner, of the type wherein oil and primary air are respectively supplied through inner and outer coaxial pipes to an air-atomizing nozzle, fixed to the outer ends of said pipes and located in one end of an open-ended draft tube through which secondary air is supplied to mix with the atomized oil emitted from said nozzle and wherein the flow of oil to said nozzle is controlled by a valve located in the inner pipe near the nozzle and having a rod extending through such pipe and fixed to a diaphragm actuated in one direction by pressure of the primary air and in the other direction by a spring; a closure for the other end of said tube having a recess in its inner face, a member located within said tube having a recess in its outer face and to which member the inner ends of said pipes are connected, said closure and member being fixed together and clamping between them the marginal portion of said diaphragm, the inner portion of the diaphragm separating said recesses one from another, said spring being located in the recess in said closure, said member having a supply passage for primary air communicating with the inner end of said outer pipe and with the recess in said member and an oil supply passage communicating with the inner end of said inner pipe, and a spring-closed relief valve adapted to open on excess pressure of the primary air, said relief valve and its spring being mounted in said member, the latter having a passage connecting said air-supply passage to one side of said relief valve and a vent passage connecting the other side of said relief valve to the space within said draft tube.

2. An air-atomizing burner, as claimed in claim 1, having means accessible from outside said draft tube for adjusting the pressure of both valve springs the one independently of the other.

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