Fig. 1.

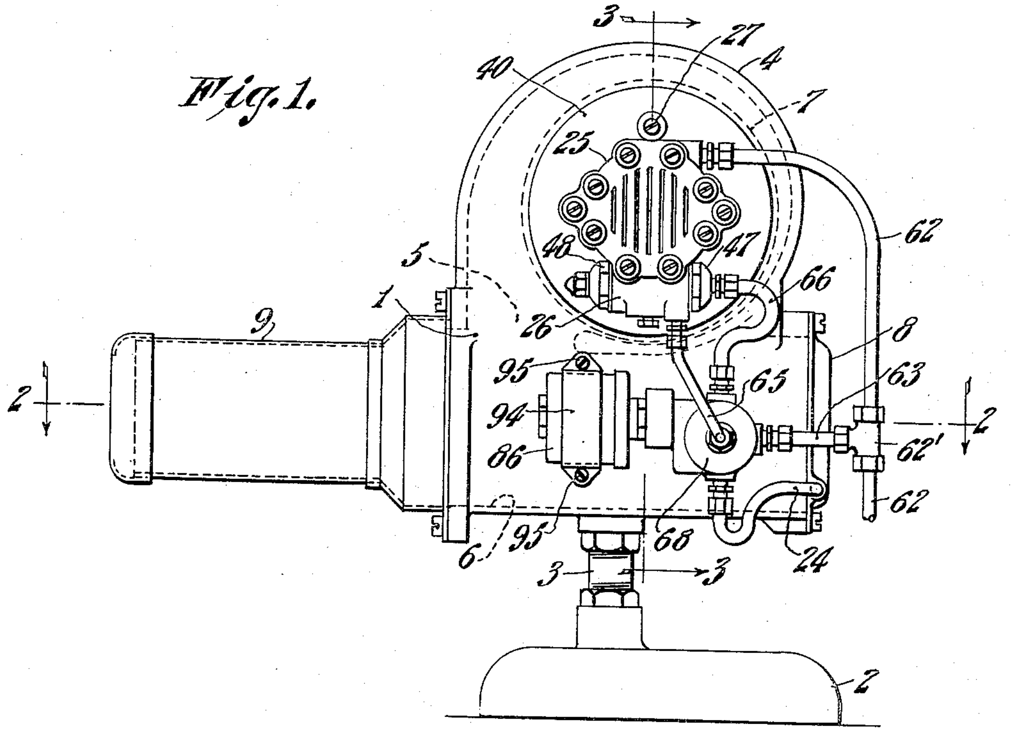

Fig. 2.

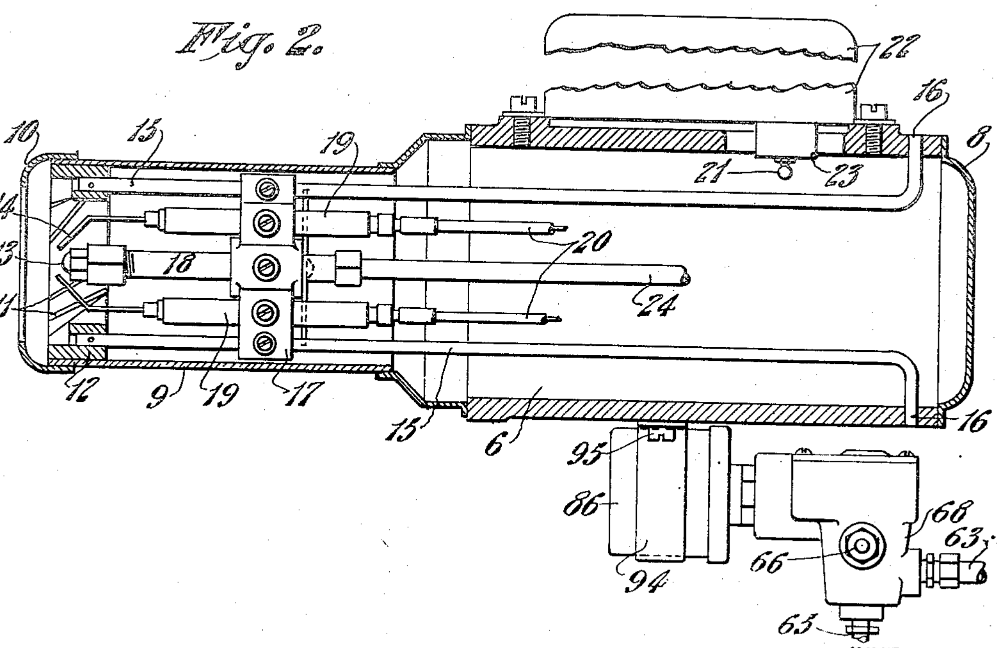

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Fig. 3.

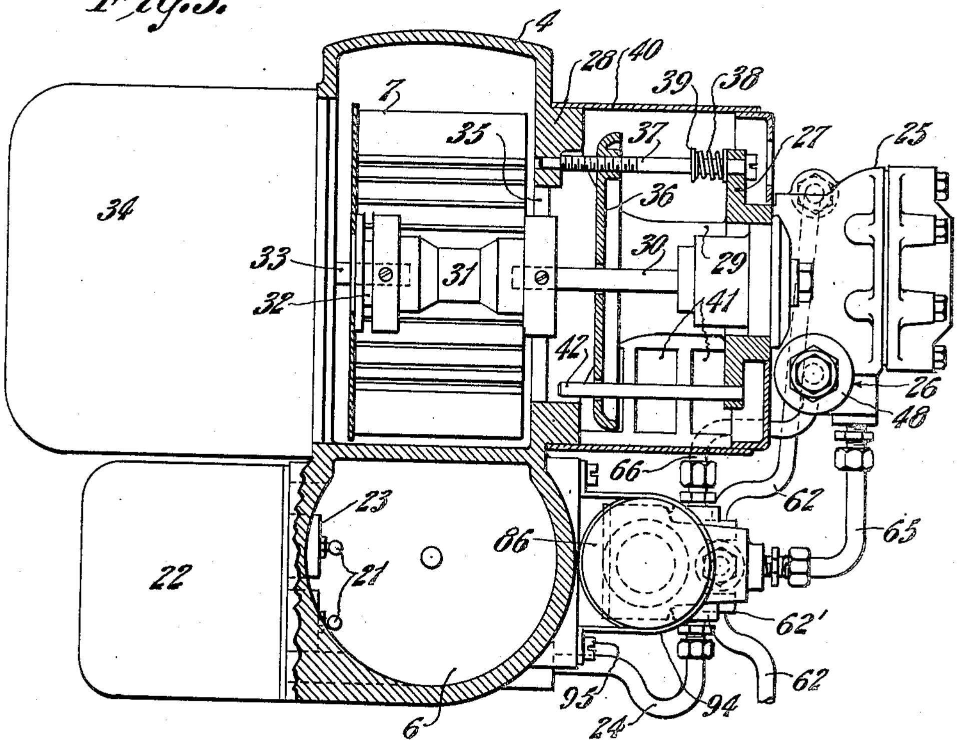
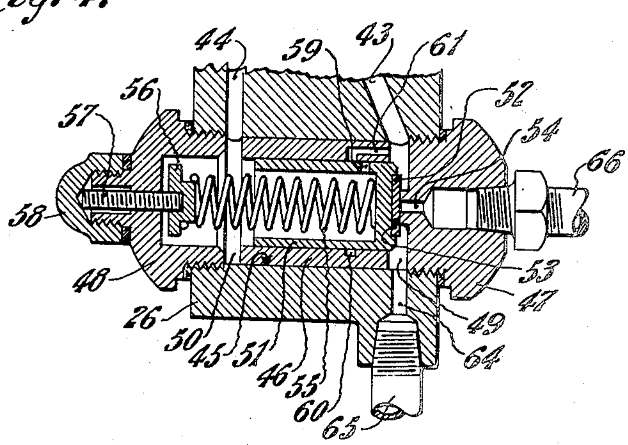


Fig. 4.



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Dec. 8, 1953

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2,661,795

TIME-CONTROLLED FUEL PUMP UNLOADING MEANS
FOR PRESSURE-ATOMIZING OIL BURNERS

Filed May 21, 1952

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Fig. 5.

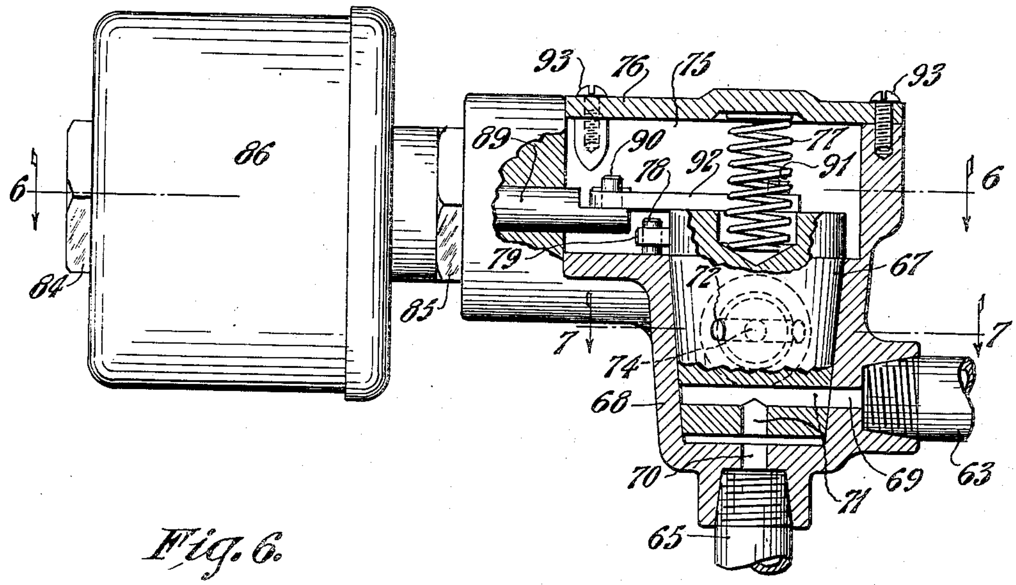

Fig. 6.

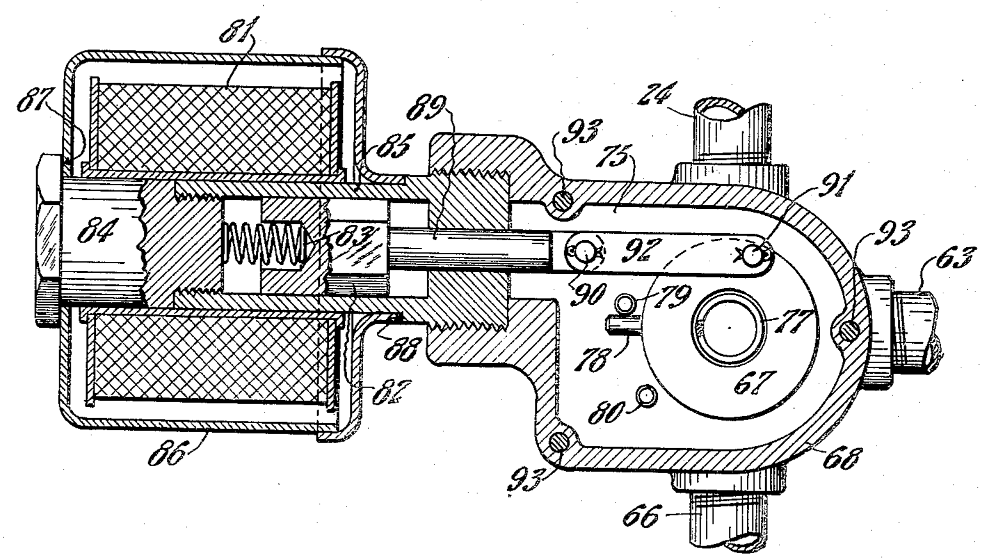

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Fig. 7.

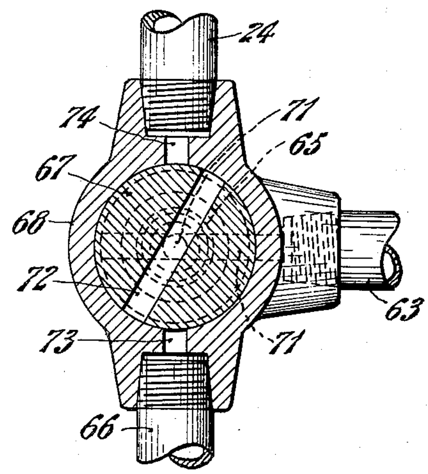
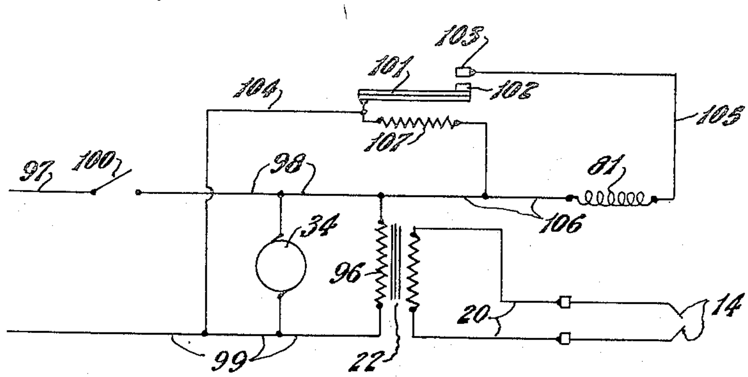


Fig. 8.



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UNITED STATES PATENT OFFICE

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TIME-CONTROLLED FUEL PUMP UNLOADING MEANS FOR PRESSURE-ATOMIZING OIL BURNERS

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Application May 21, 1952, Serial No. 289,058

1 Claim. (Cl. 158—28)

This invention relates to improvements in oil burners of the pressure-atomizing type, such as are adapted for house heating service and are started and stopped, usually by automatic thermostat control, many times each day during the heating season.

The ordinary burner of this type has an air-supply fan of a non-positively-acting type and an oil-supply pump of a positively-acting type, both driven by an electric motor and moving synchronously therewith at all times. A cut-off valve is interposed in the pipe between the pump and nozzle, opening only after the desired high atomizing pressure has been established. Such a burner has the disadvantage that efficient combustion, during the normal running interval of each cycle of operation of the burner, cannot be had without causing inefficient combustion and resulting smoky operation, during the starting and stopping intervals of the burner cycle, when the moving parts are respectively accelerating and decelerating. In the starting interval, the fan, being non-positive in action, does not have time to establish the normal rate of air flow past the atomizing nozzle before the oil pump, which is positive in action and usually has a pumping rate considerably in excess of that at which oil is consumed, has established full atomizing pressure, causing atomized oil to be emitted from the nozzle before air flow is available at a sufficient rate to result in good combustion. In the stopping interval, after the motor switch is opened, the fan and pump decelerate but the cut-off valve does not close immediately but only when the oil pressure drops below the predetermined value. Oil flow can continue for a short interval at atomizing pressure, while the rate of air flow is diminishing, thus providing an overrich mixture which causes smoky operation. The cut-off valve after closing does not always remain closed. There may be a momentary rise of pressure after the valve closes, causing opening of the same for an instant, followed by another closing of the valve and so forth, causing a chattering of the valve and emission of spurts of oil. To overcome smoky operation during the starting and stopping intervals, the air inlet shutter is adjusted to admit air at a greater rate but this, of course, means that air flow will be at a greater rate than is needed during the normal running interval, and this results in inefficient combustion.

This invention has for its object the provision of a new and better way to enable efficient combustion to be obtained during the normal running interval of each cycle of operation of the

burner and to prevent smoky combustion during the starting and stopping intervals of such cycle.

More particularly, the invention has for an object the provision of a by-pass around the pump, controlled by a valve which is open when the burner motor starts, and remains open for a certain time interval, at least long enough for the fan to attain full speed and preferably somewhat longer, and which opens simultaneously with the opening of the circuit to the burner motor, whereby the pump starts up unloaded and is prevented from building up sufficient pressure to open the cut-off valve until the full rate of air flow has been established and whereby the pump is unloaded simultaneously with the opening of the circuit to the motor so that an instantaneous cut-off of oil flow to the nozzle occurs before any deceleration of the motor fan and pump occurs.

The invention also has for an object the provision with a pump-unloading means of the kind described of an auxiliary cut-off valve located between the usual cut-off valve and the nozzle of the burner and closing and opening with the opening and closing, respectively, of the unloading valve, such auxiliary cut-off valve preferably being of a construction such as not to be adversely affected by high pressure and not subject to the chattering action described and preventing flow by gravity head through the pump to the nozzle, when the usual high-pressure cut-off valve leaks as it often does.

The invention will be disclosed with reference to the illustrative example of it shown in the accompanying drawings, in which,

Fig. 1 is an exterior elevational view of an oil burner embodying the invention;

Fig. 2 is a sectional plan view taken on the line 2—2 of Fig. 1;

Fig. 3 is a cross sectional view taken on the line 3—3 of Fig. 1;

Fig. 4 is a fragmentary sectional view showing the usual cut-off and by-pass valves provided for the fuel pump;

Fig. 5 is a top plan view partly in section showing the magnetically-operated unloading valve and auxiliary cut-off valve in the fuel feeding system of the burner;

Figs. 6 and 7 are sectional views taken on the lines 6—6 and 7—7, respectively, of Fig. 5; and

Fig. 8 is a wiring diagram showing a time switch for controlling the magnetically-operated valve and showing the relationship of the valve magnet with the motor that drives the oil-supply pump and air-supply fan of the burner.

Referring to these drawings; the burner includes a body casting 1 (Fig. 1), suitably supported, as by the floor plate 2 and standard 3. This body provides in its upper portion a fan housing 4, the outlet 5 of which opens into the front end of a horizontally-disposed cylindrical conduit 6, provided in the lower portion of the body. Mounted to rotate in this housing 4 is a fan 7. The rear end of conduit 6 is closed by a cover 8, which is mounted for easy removal, as indicated. Fixed to casing 1 is a tube 9, which, as shown in Fig. 2, is located coaxially, and forms a prolongation of the conduit 6, the rear end of the tube communicating with the front end of the conduit. The front end of tube 9 is adapted to be inserted through the wall of the combustion chamber. Tube 9 has fixed to its front end a suitable air director 10 and, inside the tube, near the front end thereof, is a turbulator, consisting of a circular series of angularly-spaced spiral vanes 11, fixed to an annular ring 12, which has sliding engagement with the interior peripheral wall of tube 9. An oil-atomizing nozzle 13, of the high-oil-pressure-atomizing type, is supported centrally of tube 9 near its front and outlet end. It will be seen that fan 7 will force air, which is drawn into its housing 4, in a manner to be later described, through the outlet 5 into conduit 6 and thence forwardly through such conduit and through tube 9, past the spiral vanes 11, which whirl the air stream, and then to air director 10, which directs the whirling air stream into the spray of atomized oil emitted from the nozzle 13. The mixture of air and oil, thus produced, is ignited by an electrical spark, produced between a pair of electrodes 14.

The nozzle 13 and electrodes 14 may be supported in any suitable manner. For example, a pair of rods 15 (Fig. 2) are fixed at one end to ring 12, at diametrically opposite points thereon, and extend rearwardly through tube 9 into conduit 6 and terminate with ends 16, which are bent outwardly at right angles and inserted in holes formed in the peripheral wall of the conduit. Fixed to and spanning these rods, is a cross piece 17, through which extends the oil-conducting tubular support 18 for nozzle 13. The cross piece 17 also has fixed therein two insulating tubes 19, in which the described electrodes 14 are supported. The nozzle support 18, and insulators 19 are adjustable in cross piece 17, as indicated. By removing cover 8, the ends 16 of rods 15 may be pulled out of their retaining holes and then the rods may be drawn rearwardly of conduit 6 to remove the nozzle 13, electrodes 14 and the turbulator 11, 12, all in assembled relation.

The electrodes 14 (Fig. 2) are adapted to be connected by wires 20 to the high tension terminals 21 of a suitable ignition transformer 22 (see also Fig. 3), which is fixed to and located outside body 1 with its high tension terminals 21 and insulators 23 projecting through an opening in the wall of conduit 6 into the interior thereof.

A flexible copper tube 24 (Fig. 2) is connected at one end to the oil-conducting nozzle support 18 and extends rearwardly through tube 9 and conduit 6, emerging therefrom through a passage in cover 8, as indicated in Fig. 1, for connection to the oil-supply means, to be described.

The fuel-feeding means for the pressure-atomizing nozzle 13 includes a suitable positively-acting pump, indicated generally at 25, the usual nozzle cut-off and pressure-regulating or by-pass valves, which in this case are mounted in an extension 26 of the pump casing, and a pump-unloading valve and auxiliary nozzle cut-off valve to be later described in detail. The pump with the cut-off and by-pass valves may, for example, be constructed as disclosed in Wahlmark Patent No. 2,309,683, to which reference is made for a more complete disclosure, if necessary or desired. This unit (Fig. 3) is bolted to the outer end face of a bracket 27, which is disposed in spaced parallel relation with one end wall 28 of the fan housing and is integrally connected thereto by two side arms 29. The pump unit is supported with its driving shaft 30 in substantially coaxial relation with the fan 7. Shaft 30 is connected by a flexible coupling 31 to the hub 32 of fan 7, which is fixed to the shaft 33 of an electric motor 34 secured as indicated to one side of the fan housing.

The driving elements for the oil pump (Fig. 3) extend out of the fan housing through a large hole 35 which forms the air inlet to fan 7. Cooperating with this inlet is a shutter 36, which is movable to adjust the effective area of the fan inlet and thus the rate at which air is supplied to the oil spray produced by nozzle 13. This shutter has a central opening through which shaft 30 passes. The shutter has threaded engagement with an adjusting screw 37, which is rotatably supported at its inner end in wall 28 and at its outer end in bracket 27. A spring 38, acting between this bracket and a collar 39 on the screw, forces the latter to the left and holds a shoulder on the screw engaged with wall 28. This spring also tends to prevent accidental rotation of the screw. A casing 40 encases the shutter, screw and clutch and is provided with air inlet slots 41 of adequate aggregate area. The shutter is prevented from rotating by a rod 42, with which it is slidably engaged, this rod being fixed at its outer end in bracket 27.

The usual provisions for regulation of oil pressure are shown in Fig. 4. The passages 43 and 44 respectively connect the outlet and inlet sides of the oil pump to a cylindrical bore 45 at longitudinally spaced locations. Fixed in this bore between such locations is a sleeve 46. The ends of bore 45 are closed by plugs 47 and 48, each having its inner end spaced from the adjacent end of sleeve 46, thereby forming chambers 49 and 50, respectively communicating with outlet and inlet passages 43 and 44. Slidably mounted in sleeve 48 is a hollow piston 51, having fixed to its outer and closed end a valve 52, adapted to engage a seat 53 on closure plug 47 and close off communication between chamber 49 and an outlet passage 54 in plug 47. A spring 55 acts between the closed end of piston 51 and a seat 56 to urge valve 52 into engagement with its seat 53, whereby outflow of oil to nozzle 13 is prevented. Seat 56 is adjustable by means of a screw 57, threaded into closure plug 48 and normally covered and concealed by a cap nut 58, which is threaded on a hollow hub on plug 48. The valve 52 will be opened by pressure of the oil on the outer end face of piston 51, when such pressure reaches a predetermined minimum value, which may for example be 95 p. s. i. When the pressure of the pumped oil reaches a somewhat higher predetermined pressure, say for example, 100 p. s. i., some oil will be by-passed back to the suction side of the pump in order to maintain the pressure of the oil supplied to nozzle 13 substantially constant. A hole 59 in the peripheral wall of piston 51 will move into communication with a circumferential groove 60 in the interior peripheral wall of sleeve 46, when the oil pressure rises to the second predetermined value, and some oil from chamber 49 can then flow through a passage 61 in sleeve 46 into groove 60 and thence through hole 59 to the interior of piston 51, which constantly communicates with chamber 50 and thus with the inlet side of the oil pump.

The inlet of the pump is connected to a suction pipe 62, which as shown in Fig. 1 includes, intermediate its ends, a T 62′, the side branch of which is connected by a pipe 63 to the unloading valve to be described. The described outlet chamber 49 has a second outlet 64 which is connected by a pipe 65 to the unloading valve. The outlet 54, controlled by the usual nozzle cut-off valve 52, is connected by a pipe 66 to the inlet of the auxiliary nozzle cut-off valve to be described and the outlet of the latter is connected to the described nozzle supply pipe 24.

The unloading valve and auxiliary nozzle cut-off valve will next be described with reference to Figs. 5, 6 and 7. These valves are combined in a single tapered plug 67, which is mounted in a casing 68 to turn about its axis through a small angle. Casing 68 has two ports 69 and 70 therein, which are respectively connected by the described pipes 63 and 65 to the inlet and outlet of the fuel pump. These two parts are connected, when valve plug 67 is in the illustrated and rest position, by a passage 71 in the plug. The latter, at a different level is provided with a diametrical passage 72, which is adapted when the plug is moved to the other of its extreme positions, to interconnect two ports 73 and 74 in the casing 68, which ports are respectively connected by the pipes 66 and 24 to the outlet of the usual nozzle cut-off valve 52 and to the atomizing nozzle 13. The casing 68 is extended beyond the large end of plug 67 to form a chamber 75 having a removable wall or cover 76 through which access is had for the assembly of parts. A spring 77 acts between cover 76 and the adjacent end of plug 67 to press the latter into close engagement with its seat in the casing. The turning movement of the valve plug 67 is limited by the abutment of a pin 78 on the plug with either of two stop pins 79 or 80, fixed to the casing. When pin 78 abuts stop 79, as shown, the valve plug 67 is positioned so that the ports 69 and 70 are connected by the valve passage 71, whereby the inlet and outlet sides of the fuel pump are interconnected to unload the pump; also the valve passage 72 is positioned as shown in Fig. 7 to prevent communication between the ports 73 and 74 whereby to prevent flow of oil to nozzle 13. When the valve plug is turned until pin 78 abuts stop 80, one end of the passage 71 will be moved out of communication with port 69 to block off communication between the inlet and outlet sides of the fuel pump and enable it to build up pressure to open the usual cut-off valve 52 and by-pass valve 59; also the passage 72 will be so positioned as to interconnect ports 73 and 74 and allow oil to flow to the atomizing nozzle 13.

For turning the valve plug 67 a solenoid 81 is provided operable, when energized, to move its plunger 82 against the force of a spring 83 and turn the valve plug 67 counterclockwise, until pin 78 abuts stop 80. When the solenoid is deenergized, the spring 83 turns the valve plug clockwise back into the illustrated position. In the particular example shown, the solenoid encompasses two cylindrical members 84 and 85, which are connected end to end by screw threads at a location between the ends of the solenoid. The member 84 is of magnetic material and the member 85 is of non-magnetic material. The solenoid is encased by a two part casing 86 of magnetic material, the two parts of which are clamped between shoulders 87 and 88 on the members 84 and 85. The outer end of member 85 is screw threaded into a tapped hole in a side wall of the described chamber 75. The plunger 82 is of hexagonal cross sectional shape and has a cylindrical extension 89 which passes through the last-named end of member 85 into chamber 75, where it terminates with a flattened part having an upstanding pin 90. The end face of valve plug 67 that lies in chamber 75 has a similar upstanding pin 91 which is connected to pin 90 by a link 92. In assembling the parts, the valve plug 67 is first inserted into its casing 68; then member 85 is screwed into the side outlet of the casing with the extension 89 projecting into chamber 75; then the extension is turned, if necessary, to position pin 90 properly for connection to pin 91; then link 92 is applied to connect these two pins and is held in place as indicated; then spring 77 is placed in its seat in the valve plug; and the cover 76 is applied and fastened in place by the screws 93.

The solenoid-controlled valve described is mounted in any suitable way on the burner, as for example as indicated in Figs. 1, 2 and 3, by means of a clamp 94 and screws 95 which hold the casing 86 to the lower part of body casing 1.

The energization of solenoid 81 is made to occur a predetermined time after the burner motor 34 is energized and continues until this motor is deenergized. An exemplary means for effecting these results is shown diagrammatically in Fig. 8. The burner motor 34 and the primary 96 of transformer 22 are connected in parallel in a circuit comprising wires 97, 98 and 99 and a control switch 100 of any suitable form and usually actuated by a thermostat. No attempt has been made to show the details of the motor control and the various safety devices commonly employed therewith. The diagram is intended merely to show the relationship between the burner motor 34 and the valve-actuating solenoid 81. The latter is arranged in a circuit from the wires 98 and 99 which circuit is controlled by a time switch, herein exemplified by a bimetallic member 101 having a contact 102 adapted to be moved, when member 101 is sufficiently heated, into engagement with a stationary contact 103. The member 101 is connected by a wire 104 to wire 99; the contact 103 is connected by a wire 105 to one terminal of solenoid 81; and the other terminal of the latter is connected by a wire 106 to wire 98. An electric heating coil 107 is provided for heating the thermostat member 101 and has its terminals connected to wires 104 and 106 and thus in parallel with the burner motor 34 to be energized whenever the motor is energized. This heating device is arranged to actuate the member 101 to cause engagement of the contacts 102 and 103 in a predetermined time, say for example, five seconds, which time is long enough to enable the burner fan 7 to attain full speed and establish normal air flow past the atomizing nozzle 13.

In operation, when the switch 100 is closed to start the burner motor 34 and energize the ignition transformer 22, the solenoid 81 is not immediately energized and the valve plug 67 occupies the position illustrated, whereby the inlet and outlet sides of the fuel pump are interconnected and communication between the ports 73 and 74 is prevented to cut off flow to the atomizing nozzle 13, independently of the usual cut-off valve 52.

The pump is therefore initially unloaded and can be accelerated rapidly, even by a small motor having low starting torque. After the motor has operated for the desired time, which preferably should be long enough for the fan 7 to attain full speed and to get the air flowing past the atomizing nozzle 13 at the normal rate, the switch 102—103 will be closed to cause energization of the solenoid 81 and movement of the valve plug 67 into its other position, in which flow to nozzle 13 is permitted and the pump unloading by-pass, comprising pipe 63, port 69, valve passage 71, port 70 and pipe 65, is closed. The fuel pump 25 rapidly builds up oil pressure until the cut-off valve 52 opens and allows oil to flow to the nozzle 13 to be atomized thereby and mixed with the air stream, which may be and preferably is moving at the full rate established to secure good combustion. Operation of the burner continues until switch 100 is opened, whereupon the burner motor 34 and solenoid 81 are simultaneously deenergized. This results in an instantaneous cutting off of oil flow to the nozzle 13 by the auxiliary cut-off valve at the very start of the deceleration interval and before the pump 25 has decreased in speed enough to cause closure of the usual cut-off valve 52. It also causes unloading of the oil pump 25. While the unloading of the pump should cause quick closure of the usual cut-off valve 52, this valve does not always close tightly. It is subjected to high pressure and likely to become leaky after it has been in use for some time. If this usual cut-off valve does leak, fuel can sometimes flow by gravity head through the gears of the oil pump to the nozzle 13, issuing in unatomized condition as drip. The auxiliary cut-off valve can be made to fit tightly and is not adversely influenced by high pressure and less likely to become leaky after long use. The auxiliary cut-off valve provides insurance against oil flow to the nozzle at unwanted times.

The invention therefore provides means for preventing the flow of any oil during any part of the acceleration and deceleration intervals of operation of a pressure-atomizing oil burner. Oil can be admitted only after the fan has acquired full speed and has had time to establish air flow at the full rate past the atomizing nozzle. Such rate of air flow can therefore be made that which is necessary for the most efficient combustion without any possibility of smoky operation during the intervals in the cycle of operation of the burner when the fan is accelerating or decelerating.

What is claimed is:

In an oil burner having a pressure-atomizing nozzle, an oil-supply pump, an air-supply fan, an electric motor for driving the pump and fan, and a pressure-regulating valve connected to the outlet of the pump and closing the same until the pump has built up a predetermined high atomizing pressure; a second valve comprising a casing having first and second pairs of ports and an element movable in said casing between first and second positions and having first and second valve passages to respectively control said first and second pairs of ports, a conduit connecting the first-named valve to one port of the first pair, a conduit connecting the other port of the first pair to said nozzle, conduits connecting the ports of the second pair one to the inlet and one to the outlet side of said pump, said element when in its first position having its second valve passage positioned to interconnect the second pair of ports and its first valve passage positioned to prevent communication between the first pair of ports and when in its second position having its first valve passage positioned to connect the first pair of ports and its second valve passage positioned to prevent communication between the second pair of ports, biasing means for holding the valve element in its first position, electrical means for moving the valve element against its biasing means from its first to its second position, an electrical circuit for said motor, an electrical circuit for said electrical means connected to the first-named circuit, and a switch for controlling the second circuit, said switch being open when the motor is deenergized, and actuating means for said switch initiated simultaneously with the energization of said motor and operable in a predetermined time interval to close said switch and cause energization of said electrical means.

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