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Ashton

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[54] **SLINGER UP OIL BURNER APPARATUS**

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[52] **U.S. Cl.** **431/168,** 239/214

[51] **Int. Cl.** **F23d 11/04**

[58] **Field of Search** 431/6, 3, 168, 162, 185, 431/187, 62; 239/214, 214.25

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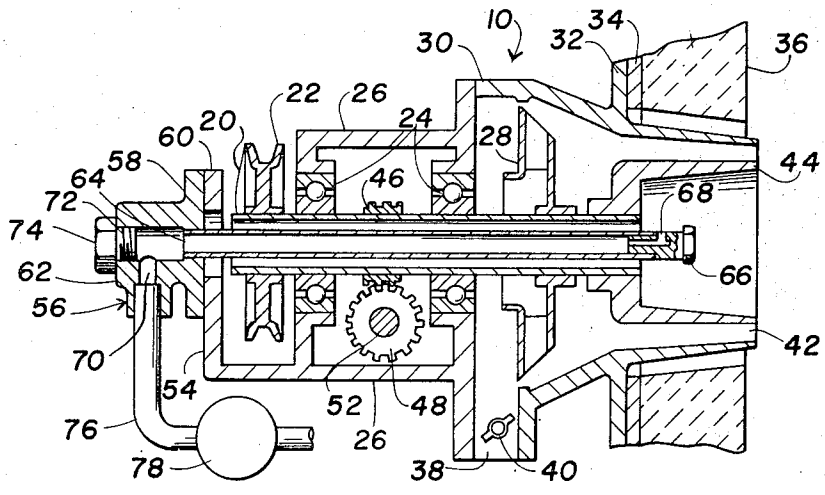
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Assistant Examiner—William C. Anderson
Attorney, Agent, or Firm—Murray Schaffer

[57] **ABSTRACT**

An oil burner having a main controller of the conventional form and a supply of a first fuel is independently supplied with a second more easily ignited fuel and fuel flow timing and regulating means, modulating the delivery of the second fuel to the burner during selected portions of the combustion cycle. The supply of the more easily ignitable oil significantly lessens the pollutants resulting from combustion, by providing a hotter, more complete burning than can be obtained by the heavier oil.

10 Claims, 8 Drawing Figures



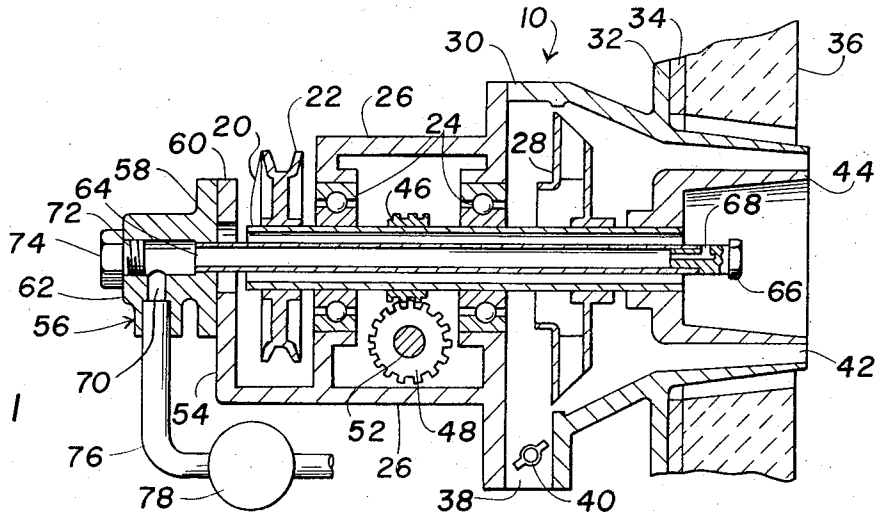


FIG. 1

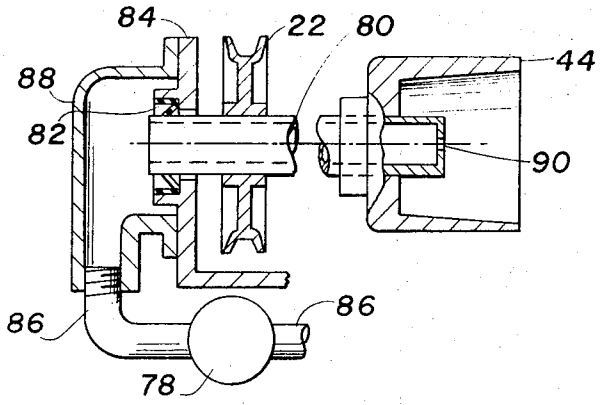


FIG. 2

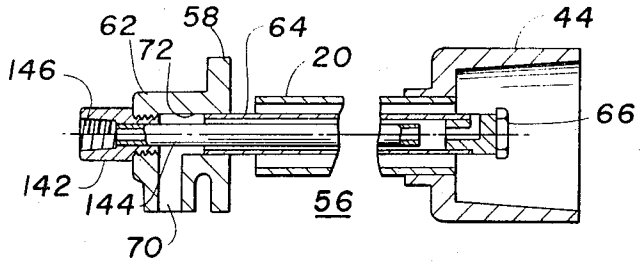


FIG. 4

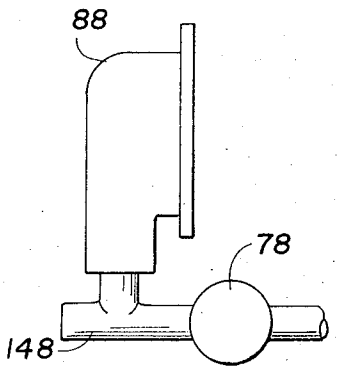


FIG. 5

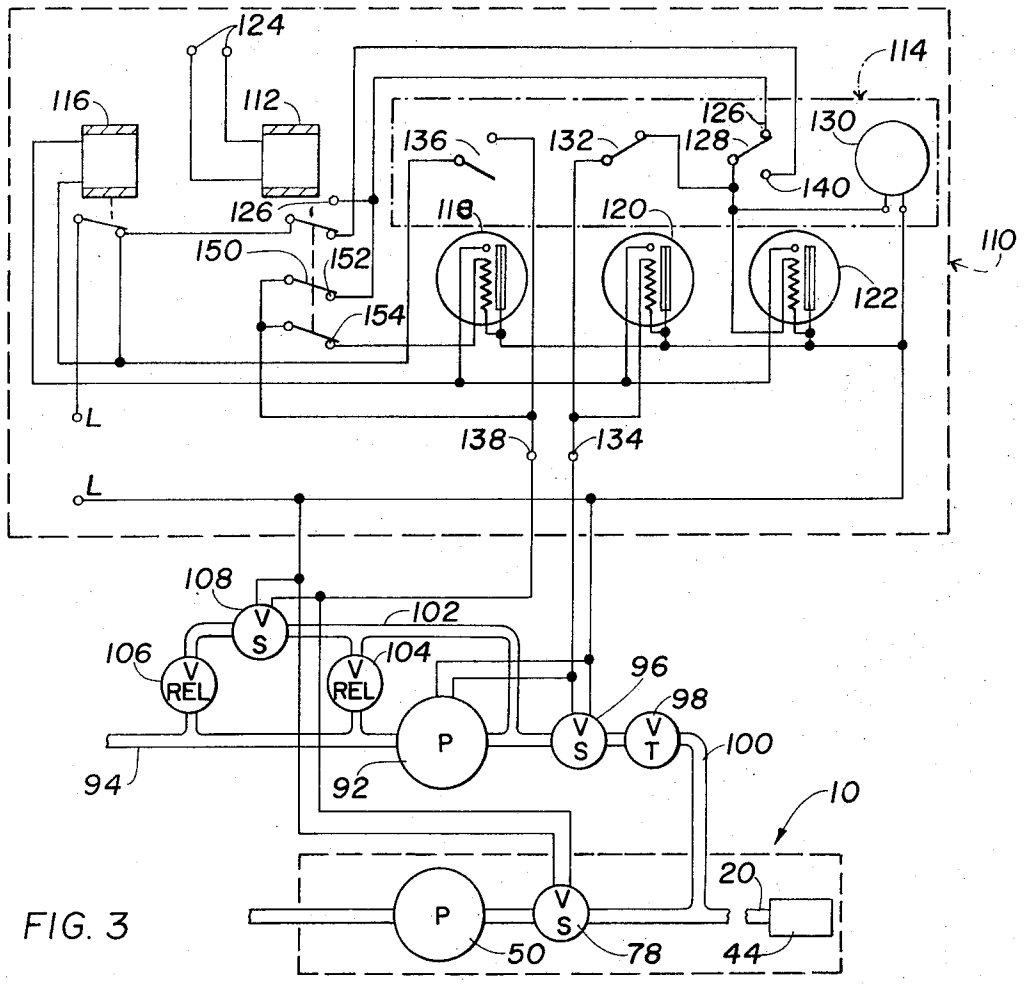

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FIG. 3

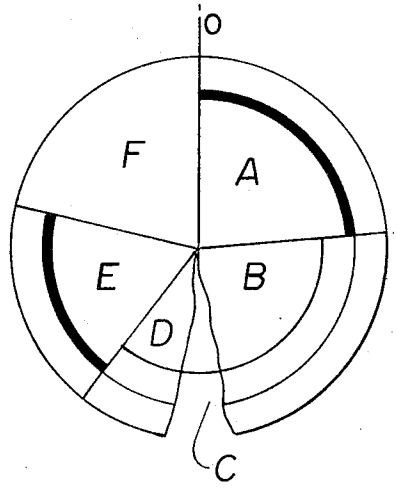

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FIG. 6

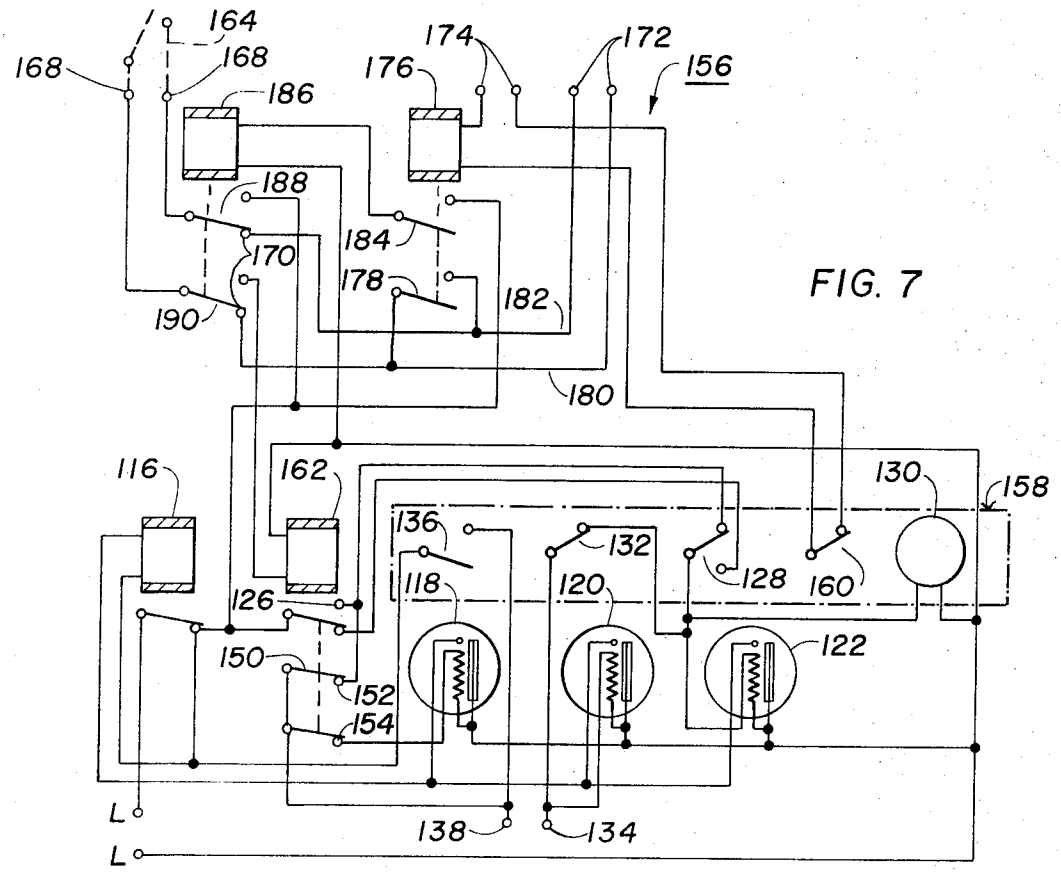

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FIG. 7

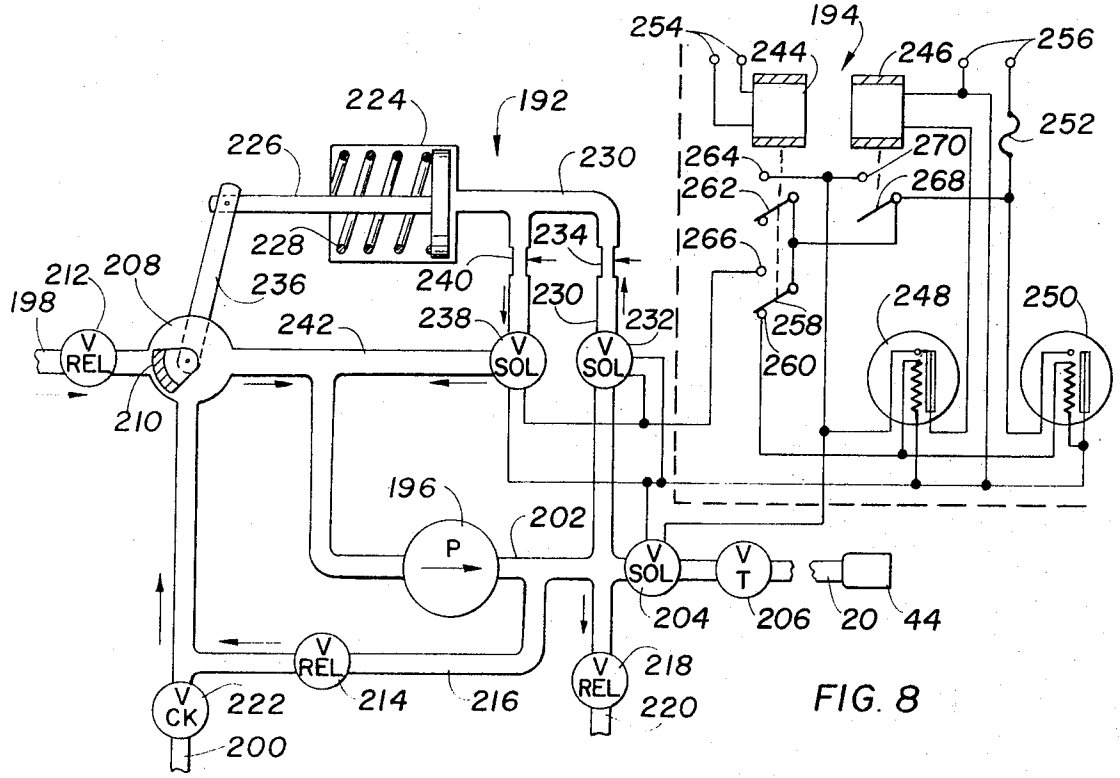

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FIG. 8

SLINGER UP OIL BURNER APPARATUS

BACKGROUND OF INVENTION

This invention relates to improvements in oil burners and is particularly concerned with facilitating the ignition of heavy fuel oils such as bunker C and No. 6 oil which are burned by them. It also relates to certain modifications in fuel flow which simplify burner maintenance.

The range of types and sizes of oil burners using heavy fuels is very wide and this disclosure will, in the interest of brevity, be chiefly concerned with the application of the invention to so called "rotary" oil burners. Such burners are commonly applied to boilers and kilns, etc., and vary in size from those burning 2 or 3 G.P.H. (gallons per hour) to others burning 200 or more G.P.H.. They usually embody a hollow shaft through which oil fuel is fed to the interior of a rapidly rotating member, such as a slinger cup, carried at one end of the said shaft and located in the combustion chamber or fire box. The oil is so fed and thrown and more or less broken into small particles or droplets by centrifugal force and passage through the ambient air, that is chiefly furnished by a blower mounted on the cup shaft and discharging axially and radially thereof. This constitutes the air of combustion and carries the oil drops with it as it moves along the fire box toward the exit fuel flue.

Combustion of the oil is usually started by an electrically ignited gas flame that is directed into the path of the radially and axially moving oil drops. The gas flame is shut off after a stable oil flame has been established. The velocity of the air traversing through the fire box is enhanced as its temperature is increased by combustion. The air flow velocity and pattern are critical to proper combustion and are arranged so that the oil drops are consumed while air suspended before impingement on the fire box walls. Initiation of combustion is very important to satisfactory burner operation. The lower velocity of relatively cold air at start up fails to keep oil from the fire box walls; the well known difficulty of igniting heavy oil and the disturbance of the gas flame by the air draft all combine to delay ignition for an unpredictable period after being called for by the controls. Oil is of course being fed and thrown on to the fire box wall throughout the delay. When ignition finally does take place the pre-fed oil is also ignited and being in excess, relative to the air supply generated smoke and soot; further, if the fire box is hot, the excess oil may create a flash-back into the burner room. While the abnormal fuel-air condition is of relatively short duration at each "turn-on" the cumulative effects are most objectionable. The soot fouls the boiler flues, etc. and together with the smoke causes very serious air pollution problems. Flash-back carries the polluting material into the burner room and also deposits a very tenacious film on all adjacent surfaces.

The above mentioned conditions cause a serious economic loss and an atmospheric pollution problem of no mean proportion. Additionally there is a persistent tendency for some of the heavy oil to form a tarry deposit that is carbonized by residual heat during shut down, on the wall and lip of the slinger cup and causes an erratic pattern of oil distribution necessitating not infrequent cleaning of the cup to correct a secondary cause of oil being thrown on to the fire box walls and erratic ignition.

It is an object of the present invention to:

a. afford clean and prompt fuel ignition in oil burners at the precise time called for by the control mechanism whereby smoke, soot and flash-back are lessened and, preferrably, entirely avoided,

b. afford a very readily adjustable means of reducing the initial oil flow to a quantity below the burner's normal minimum, to prevent violent flame flare at the outset of the burning cycle, and

c. so modify oil feed conditions that the slinger cup is left clean and "coking" is avoided for relatively very lengthy periods.

These objects, others and numerous advantages will be seen in the following disclosure of the present invention.

SUMMARY OF INVENTION

According to the present invention the method and apparatus provides an oil burner having a main controller and a supply of a first fuel to which is independently supplied a second more easily ignited fuel. The burner is provided with flow timing and regulating means modulating the delivery of the second fuel during selected portions of the combustion cycle. The supply of the more easily ignitable oil significantly lessens the pollutants resulting from combustion, by providing a hotter, more complete burning than can be obtained by the heavier oil itself during those perios of the combustion cycle when incomplete combustion is possible.

Preferably, the easier burning fuel is a light grade oil such as No. 2 or kerosene, and it is supplied during the initial stages of the combustion cycle, and when desired, in advance of the delivery of the heavy oil. Similarly, the lighter oil may be employed at the terminal portion of the cycle, whereby it can be used to purge at least part of the burner and rid the same of any residual unburned heavy oil.

According to the present invention there is also provided apparatus for constructing new and/or modifying existing burners with devices for carrying out the inventive steps. The apparatus comprises an independent source of a second fuel, and means to regulate its flow relative to the primary fuel.

Preferably, the apparatus includes control means for regulating the flow of the secondary fuel, both as to time and volume. Such controls are automatic and adjustable over a wide range so as to obtain a broad degree of operational control.

It is intended that the secondary fuel be used largely at either the initial or pre-burning stage or the terminal or after burning stage of the combustion of heavy oils. Consequently, timing devices are employed to effect such operation. In this manner the pollutant arising from poor combustion of cheap, heavy oil is reduced to almost nil.

Full details of the present invention are given in the following description and are shown in the attached drawings.

BRIEF DESCRIPTION OF DRAWINGS

How the foregoing and other objects not specifically mentioned may be attained will be made clear by study of the drawings of which:

FIG. 1 is a longitudinal sectional view of a known type of oil burner,

FIG. 2 is a fragmentary sectional view of burner part comprising a modification of parts shown in FIG. 1,

FIG. 3 is a schematic diagram showing an oil burner and its connections with a preferred embodiment of the invention,

FIG. 4 is a fragmentary longitudinal sectional view of the fuel feeding parts shown in FIG. 1 and including a part of the disclosed embodiment,

FIG. 5 is a fragmentary view of a modified inlet tubing of FIG. 2,

FIG. 6 is a diagram indicating a preferred pattern of fuel flow timing,

FIG. 7 is a schematic drawing of a modified form of a part of FIG. 3; and

FIG. 8 is a schematic drawing of an oil burner having an embodiment of the invention as an integral part.

DESCRIPTION OF INVENTION

As is well known, the heavy oil (usually No. 6) used in industrial oil burners is not easily ignited. In view of the difficulties caused thereby this invention contemplates the use of a more easily ignited substitute (say No. 2 oil) at start-up. The substitute may be used in place of the heavy oil, as a dilutent thereof or most conveniently, in both functions. The substitution is preferably of short duration, usually much less than one-minute, in view of the cost differential in favor of heavy oil. However, it may be desirable in the case of a cold fire box, to use the substitute either diluted or alone until the fire box attains a predetermined temperature before going to the normal heavy oil. This condition comes within the scope of the invention.

As the invention is readily practiced in conjunction with existing burners, i.e.: as an accessory thereto, FIGS. 1 and 2 are presented and explained as representing some of such burners to afford clear background information. It is also practical for the invention to be embodied integrally in a burner, which may be generally similar to those above mentioned, as will be later disclosed.

FIG. 1 is generally representative of a rotary oil burner **10**, of well known type having a hollow horizontal shaft **20**, carrying a driving pulley **22** and being supported on suitable bearings **24** in a gear case **26** whereon may be mounted an electric motor and belt organization (not shown) suited for driving said shaft through said pulley. A shrouded centrifugal air blower **28** is mounted on said shaft within a housing **30** secured to case **26**; the said housing has a radially extending flange **32** by which the burner may be secured to a fire box end plate **34** that usually has a refractory liner **36.** The housing **30** also embodies an air intake **38** having a butterfly damper **40**, it further embodies a discharge duct **42** placed co-axially of shaft **20** and surrounding an oil slinger cup **44** which is secured to the said shaft and the whole is arranged so that air from said blower is discharged in an annular pattern around said cup. Worm gear **46** is secured to shaft **20** within the case **26** and meshes with a gear **48** for driving an oil pump **50** (not shown in FIG. 1) through shaft **52.** The left-hand end of shaft **20** terminates adjacent to a bracket **54** that comprises part of case **26**; it is fashioned to firmly support a fuel feeding structure **56** by means of mating flanges **58** and **60.** The said structure **56** comprises a hollow head casting **62** wherein is secured a rigid steel tube **64** located co-axially of said shaft **20** and passing therethrough without contact. The said tube is closed at its right hand end by a so called nozzle **66** having an orifice **68** through which oil may be discharged into cup **44.** The head casting **62** has an inlet port **70** and it further has an opening **72** substantially coaxial with tube **64** which is closed by a threaded plug **74.**

In operation oil is delivered by the pump **50,** through a tube **76** to port **70** whence it passes along tube **64,** through orifice **68** and into the interior of the rapidly rotating cup **44.** Oil flow is controlled in ON and OFF fashion by a conventional electrical solenoid valve **78,** which is ON, or open, when energized. Oil discharged into cup **44** is thrown over the lip thereof by centrifugal force and is normally broken into a mist by radial dispersion and its passage through the air in preparation for combustion which is initiated by a gas flame directed into the path of the dispersing oil. All of which is common knowledge among those versed in the art.

FIG. 2 illustrates a minor modification in the mode of feeding oil to the slinger cup **44.** Here the hollow shaft **80** passes through a rotary seal **82** in bracket **84** which is in general an equivalent of bracket **54,** described earlier. Oil is fed to said shaft through tube **86** and solenoid valve **78** and is discharged into an elbow **88** that surrounds seal **82** and has oil tight contact with bracket **84.** Oil flows from the elbow **88** through hollow shaft **80** and into cup **44** via a nozzle **90** at the right hand end of the said shaft. Operation is similar to the earlier described mode. There are other variants in the way oil is fed to cup **44** or an equivalent thereof but as they have no serious import relative to the use of the invention, they are not described here.

The above described burners usually have a main controller (not shown) brought into operation when a thermostat or other device closes an electric circuit to call for heat. When this occurs, the main controller then in sequence switches on the burner motor which also drives the fuel pump **50,** lights the gas jet pilot and after a time lag, called a "pre-purge" energizes solenoid valve **78** allowing fuel to flow to cup **44** for burning. Oil quantity is controlled by mechanisms, not here of interest, to afford an initial low firing rate and after a short time to increase the firing rate to maximum. The burner runs during "BURN" until heat demand is satisfied whereon the thermostat or its equivalent opens its circuit to the main controller which then de-energizes solenoid valve **78** shutting off fuel but allows the burner motor to run for a short period (called "post-purge") usually of 30 to 45 seconds duration to clear the cup **44** of any oil remainder and finally shuts down. However, oil may later dribble from the hollow shaft and because of residual heat in the fire box some is carbonized on cup **44**; some may also drip to the lower side of duct **42** where it carbonizes and distorts the air passages therethrough.

When combining a burner of the class described with the present light oil feeding devices the electric leads from the above mentioned main controller are disconnected from solenoid valve **78** and taken to subcontroller **110** (to be described later) so that it and not the said solenoid valve is dominated by the main controller. The current so diverted serves as a signal to initiate operation of the subcontroller **110,** it is hereafter termed "signal" or "signal current." Note that all solenoid valves here involved are ON or open when energized and OFF or shut when de-energized.

FIG. 3 shows schematically the oil burner **10,** the light oil supply means and the subcontroller **110** which embodies the electrical controls. The burner has heavy

oil pump **50**, hollow shaft **20**, slinger cup **44** and the solenoid valve **78** controlling heavy oil delivery from pump **50** as earlier described. The light oil supply means comprise motor-pump unit **92** for drawing light fuel through pipe **94** and delivering it via solenoid valve **96** and throttle valve **98** to pipe **100** which is connected within the burner organization to hollow shaft **20** as later explained. Solenoid valve **96** is desirable but not essential and is connected in parallel to unit **92** to give a sharp oil cut-off when de-energized. The said means also comprises a by-pass line **102** around pump unit **92** in which line are pressure relief valves **104** and **106** together with the solenoid valve **108** connected in parallel with valve **78**. With solenoid valve **108** de-energized, valve **104** holds pump delivery pressure to throttle valve **98** at a desired uniform valve but when valve **108** is energized the valve **106**, set to open at a lower pressure than valve **104** will govern the pressure at said throttle valve. This makes two fuel flow rates available for one setting of valve **98**. Subcontroller **110** is preferrably a unitary structure comprising the components shown within the large broken line rectangle. It includes a 3PDT relay **112**, energizable by signal current from the main control box; a conventional 60 second cycle motor driven timer **114** shown within the chain line rectangle and having three switches operated by cams (not shown); a SP.ST manual re-set normally closed relay **116** whose coil is connected to three paralleled normally open thermally responsive delay action switches **118**, **120** and **122** commonly known as delay relays, any one of which, if it "closes," will trip relay **116**, breaking line current and de-energizing pump **92**, solenoid valves **78**, **96** and **108**, shut off all fuel to the burner. The drawing shows the subcontroller de-energized and ready to start a burning cycle on receipt of a signal from the main controller.

The subcontroller **110** is connected to "Line" as indicated. When relay **112** is energized by signal current from the main controller which enters via terminals **124**, line current goes through contact **126** and switch **128** to timer motor **130** and, through switch **132** to the subcontroller's pump terminal **134** and thence to pump **92** and solenoid valve **96**, causing light oil to flow at a pressure determined by relief valve **104** through throttle valve **98** and pipe **100** to the burner which as indicated by the delivery of the signal, has completed its pre-purge and is ready to be lit by the usual gas flame. After a suitable pause, during which the light oil flame is established, the timer closes switch **136** sending current to terminal **138** and on to solenoid valve **78** which opens to allow heavy fuel to flow from pump **50** to be burned. Solenoid valve **108** opens at the same time as valve **78** and thereby reduces the light oil pressure. This dual pressure arrangement allows a relatively large flow of light oil at first and then when light and heavy oils are combined, the flow is still not excessive. After the flame of the combined oils has become established, the timer changes the condition of switch **128** so that its blade engages contact **140** and opens the connection with contact **126**, thereby de-energizing the timer motor **130**, pump unit **92** and solenoid valve **96** which shuts off the light oil and leaves the burner on BURN with its normal fuel. When the heat demand has been satisfied, the thermostat or its equivalent opens its circuit to the main controller, whereon signal current is cut off and relay **112** reverts to the state shown in FIG. **3**, directing line current through contact **140** to timer motor **130**, pump unit **92** and solenoid valve **96** causing the timer to again start running and light oil to be furnished to the burner at its lower pressure. After a very brief period, usually about 2 or 3 seconds, the timer opens switch **136** which de-energizes solenoid valves **78** and **108** whereby heavy fuel is shut off from the burner and the light oil pressure is raised to its higher value. This condition, (post burn flush) continues long enough, usually about 5 to 8 seconds, when switch **132** is opened and light oil shut off. This period is long enough for the heavy oil to be flushed from the slinger cup, leaving only the light oil, if any, on its surfaces at the end of the post purge period. The light oil being (a) volatile and (b) of very low viscosity, leaves the cup clean and eliminates practically all carbonization. The post burn flush also leaves the approaches to the slinger cup clear of heavy oil so that at the start of the next operating cycle there is no hesitation in the appearance of the light oil. How the light oil delivery pipe **100** is connected within the burner organization is made clear by FIGS. **4** and **5**. FIG. **4** shows the fuel feeding structure of FIG. **1**, but having solid threaded plug **74** replaced by a hollow plug **142** wherein is secured tube **144** that passes inside tube **64** to a point adjacent nozzle **66**. Plug **142** has a threaded port **146** to which pipe **100** of FIG. **3** may be connected without interference with the heavy oil supply connection. FIG. **5** shows the elbow **88** and solenoid valve **78** of FIG. **2** without change but tube **86** has been replaced by a tee fitting **148** that affords access, down stream of the valve **78**, to the interior of elbow **88** and whereto pipe **100** may be connected to deliver light oil.

FIG. **6** is a diagram covering the sequence of events incident to a burning cycle and without relating to the pre-purge and post-purge periods. The disc represents the timer's (**114**) running period plus the indefinite BURN period. The sectors represent:

A. Light oil alone at the higher pressure (wide line)

B. Heavy oil plus light oil at lower pressure (narrow line)

C. BURN with heavy oil alone. Timer shut off by switch **128**

D. Heavy oil plus light oil at lower pressure

E. Light oil alone at the higher pressure (post burn flush)

F. All fuel off. Timer coasting to end of its cycle when switches **128** and **132** will revert to conditions shown in FIG. **3** and timer will stop.

Time values are not rigid and may be adjusted to suit individual installations. They may average A. 3–5 seconds, B. 2–4 seconds, C. indefinite, D. 2–3 seconds, E. 4–8 seconds, F. balance of timer's cycle.

Subcontroller **110** embodies certain safety arrangements. During period B switch **136** is closed and switch **128** is in the condition shown in FIG. **3**; should the signal go off at this time relay **122** will take the condition illustrated and current will pass, from the line leading to valves **78** and **108**, to relay blade **150**, contact **152** and so through switch **128** to the timer causing it to complete its cycle and shut off all fuel while so doing. Without the relay action described, control over the heavy oil flow would be lost as the timer would be stopped with switch **128** in the illustrated condition and nothing available to restart it. The combination of the lower pole of relay **112** with delay action switch **118** affords further protection against a run-away fire. Relay

112 is energized during periods A, B and C and contact 154 is inert so that delay switch 118 is held inactive during the indefinitely long BURN time. However, the heater of said delay switch is in circuit with valves 78 and 108 when relay 112 is in signal off position; if said valves are then energized beyond the designed delay of switch 118 which is in excess of period D, the said switch's contacts will close, trip relay 116 and cause complete shut down. Delay switch 120 having its heater in parallel with pump 92, is timed for the pump to run through periods A, B, D and E but if it is in circuit appreciably longer it will close its contacts, trip relay 116 and cause shut down. Delay switch 122 is in parallel with the timer motor 130 and if the latter is energized, for any reason, appreciably beyond its normal cycle time, the said switch will energize relay 116 and cause complete shut down. The following delay times appear satisfactory; switch 118, 20 seconds; switch 120, 30 seconds and switch 122, 75 seconds.

As indicated above, periods D and E trespass on the burner's post purge time as apportioned by the main controller without harm, as the flushing action aids the purge's cup cleaning function. But, if the amount of oil in the burner's passages is too large to be displaced by light oil in the time available, it becomes necessary to creat a time-lapse between thermostat opening and signal cut-off to allow the desired displacement. This is done by modified subcontroller 156 as shown in FIG. 7 which shows it unenergized. Here, instead of going directly to the main controller, the thermostat lines go to it via the subcontroller 156 where receipt of a signal from the main controller causes the following events:

a. the thermostat lines are bridged by a relay so as to make the main controller insensitive to the thermostat.
b. the thermostat is reconnected within the subcontroller so as to dominate the latter's functions.
c. an additional switch in the timer holds period E as long as desired and then restores the thermostat's regular functions whereon the main controller initiates post purge and shut-down in the usual way.

Certain parts used in subcontroller 110 are used here without change in identity or function. Timer 158 is like timer 114 but for a fourth switch 160. Relay 162 is identical in all ways including functions with relay 112 except for its coil being energized by line instead of signal current. Considering operations: when the thermostat (or other heat demander) closes, the following happens:

1. a circuit is closed from the thermostat 164, via terminals 168 contacts 170 terminals 172 and thence to main controller which
2. puts burner through its normal start-up sequence to end of pre-purge when
3. signal current received via terminals 174 from main controller energizes relay 176 so that blade 178 bridges or "shorts" lines 180 and 182 making main controller insensitive to thermostat and
4. blade 184 closes a line circuit through coil of relay 186 whereon
5. blades 188 and 190 separate the thermostat from lines 180 and 182 and
6. connect it to the coil of relay 162 making the latter responsive to said thermostat and to be energized by line current so that
7. relay 162, functioning just like relay 112, starts the timer 158 which
8. goes through the same pump and solenoid valve switching and self stopping functions as earlier described and
9. the burner operates exactly as with subcontroller 112 until,
10. thermostat opens for shut-down, thereby de-energizing relay 162 and, as in the case of relay 112
11. the timer restarts, initiating period D, which is followed by period E but
12. lines 180 and 182 are still bridged and main controller insensitive so that post-purge can not be started and timer may be set to run long enough to entirely free burner of heavy fuel after which
13. switch 160 opens to break signal current to relay 176 which when de-energized will
14. open bridge across lines 180 and 182 and de-energize relay 186 which
15. will reconnect the now open thermostat to lines 180 – 182 to main controller that will
16. start the normal post-purge sequence while the
17. timer completes its cycle during which switch 160 is reclosed and which is ended by switches 128 and 132 reassuming the position shown, ready for a new operating cycle, to be started when called for by the thermostat.

It should be here noted that the timer values given for delay switches 120 and 122 will have to be reviewed where they are used with subcontroller 156; new values will depend on the duration of the post burn flush. The subcontroller just described may also be used where the main controller is not arranged to allow a conventional post-purge, so as to provide the highly desirable flushing actions described.

Practicing the present invention requires (a) a source of light or easily ignited fuel, (b) means to regulate its flow in conjunction with the normal or heavy fuel and, (c) the means to control, timewise, the sequence of certain events involving (a) and (b). The foregoing disclosure is of a preferred structure but many variations are practical. For instance, instead of using solenoid valves, one could use mechanical valves actuated by the cams of a sufficiently rugged timer; the pump unit (92 herein) might embody a reducing gear and so comprise the timer; the pump unit might be replaced by a gravity head or a pressurized tank. Solenoid valve 108 could be eliminated when furnace conditions permit and another modifcation would be the use of a modulating mixing valve to govern the transition from one fuel to another.

The foregoing describes an organization that may readily be added to an existing burner. It is, however, practical to embody the invention integrally within a burner. Such a case is described below with a reference to FIG. 8. In this case the construction shown comprises the burner 192, which lies to the left of the broken line and is under the control of a main controller (not shown) as above described re FIGS. 1 and 2. It also comprises a subcontroller 194, that lies to the right of the broken line and is responsive to a "signal" from the main controller. No attempt has been made to show such other items as ignition parts, viscosity valves, high and low fire controls, driving motors, etc. as they are not of direct concern and are well understood in the art. The burner 192 comprises a pump 196 having a ca-

pacity in excess of burner usage and similar to the earlier mentioned pump **50.** The pump **196,** is arranged to draw a first, or heavy oil through pipe **198** or to draw a second or light and more easily ignited oil through pipe **200,** either oil being received from any convenient source, not shown. Oil is delivered by the said pump through pipe **202,** normally closed solenoid valve **204** and hollow shaft **20** to slinger cup **44** as earlier described; a throttle valve **206** is preferrably located down stream of said solenoid valve, as shown. A selector valve **208** is interposed at the junction of pipes **198** and **200.** As shown in the drawing, the former pipe is closed by valve "shutter" **210** while pipe **200** communicates with said pump making light oil available to it, but if the said shutter is turned CCW it will close pipe **200** and open pipe **198** to make heavy oil available to the pump. An adjustable relief valve **212** may be located as shown to afford greater resistance to the flow of heavy oil than is offered to the flow of light oil through pipe **200.** This arrangement aids in the maintaining of desired proportions of the mix of fuels while the said valve shutter is being moved from its one position to its other; it is also assures little leakage of heavy oil past the shutter **210** when it is in the position shown. An adjustable relief valve **214** is located in pipe **216** which is teed into pipe **200** and forms a bye-pass loop around pump **196** that is open when shutter is in the position shown. Another adjustable relief valve **218** is located in pipe **220** whereby heavy oil may be returned to its source when shutter **210** is moved to open pipe **198** and close pipe **200.** Valve **214** is set to open at lower pressure than valve **218** so that with the parts m the position shown light oil may be pumped and held at a lower pressure while being bye-passed around the said pump than would obtain if heavy oil were being pumped and pipe **200** closed by selector valve **208;** a check valve **222** prevents heavy oil at its relatively high pressure from opening valve **214** and flowing down pipe **200** in reverse to normal direction. In brief, when light oil is being pumped the excess over burner consumption is recirculated at relatively low pressure and when heavy oil is being pumped at a relatively high pressure, the excess is returned to the heavy oil source. This dual pressure affords two oil flow rates at any setting of throttle valve **206.**

The dash-pot cylinder **224** has a piston and rod assembly **226** which may be moved to the left, from the position shown and against the urging of spring **228** by oil pressure transmitted from pipe **202** through pipe **230,** normally closed solenoid valve **232,** adjustable restriction **234** to the cylinder **224.** Valve arm **236** is secured to selector valve shutter **210** at one end and its other end is suitably connected to the said piston rod which, when moved to the left from the position shown partially rotates the said shutter to open pipe **198** while closing pipe **220.** During such valve movement both pipes are open to the suction of pump of pump **196** and there is no interruption in oil flow; it is then that the flow resistance of valve **212** determines the oil mixture. This makes it possible to avoid any large proportion of heavy oil in the fluid in cylinder **224** and to maintain a fairly uniform viscosity and attain a reasonably constant dash-pot timing action which can be varied by restrictions **234** and **240.** Piston and rod assembly **226** may be returned from the left ward position, to that shown in the drawing, by spring **228** if solenoid valve **232** is closed and normally open solenoid valve **238** is permitted to open when oil in the said cylinder will flow through adjustable restriction **240** and on into pipe **242** leading to the suction side of pump **196.** Such restoration of piston and rod to the position shown in the drawing will also restore valve **208** to the position shown, where light oil is available to the said pump. Note that solenoid valve **232** has to be energized to be close while solenoid valve **238** has to be energized to be open.

The subcontroller **194** is preferrably a single unit; it comprises a DPDT relay **244** energizable by signal current for switching purposes, a SPST relay **246** that cooperates with a normally closed thermally responsive delay switch **248** to hold solenoid valve **204** open for a predetermined time after the signal has gone OFF, thus affording the highly desirable post-burn Flush Period previously described. Another delay switch **250** that is normally open serves, in case of need, to short circuit line fuze **252** and so affords a safety function. The drawing shows the device deenergized. When heat is required, the main controller switches on the burner motor (not shown) which drives pump **196,** ignites the gas pilot flame, and after pre-purge, sends signal current to terminals **254.** Terminals **256** receive line current from the burner motor or other convenient source switched ON and OFF by the main controller. Switch **248** is preferrably arranged to open after being in circuit about 10 – 15 seconds while switch **250** preferably closes after being in circuit about 60 seconds. When a burner operating cycle starts, line current passes through fuze **252,** relay blade **258,** contact **260** and the heater of switch **248** which will open in due time, but without effect as it has no function until after the burn period. Following the normal pre-purge period the main controller will send signal current and energize relay **244** when the following events will take place:

a. relay blade **262** engages contact **264** and line current will open solenoid valve **204** whereon light oil, which is available on account of selector valve **208** being in the position shown, passes through throttle valve **206** and on in the usual manner via hollow shaft **20** to cup **44** to be burned while, simultaneously,

b. relay blade **258** engages contact **266** and current opens normally closed solenoid valve **232** while closing normally opens solenoid valve **238;** this admits oil under pressure to cylinder **224** while isolating it from the suction side of pump **196,** whereon piston and rod assembly **226** starts moving to the left at a rate decided by restriction **234** to gradually change the condition of selector valve **208** from the light oil position shown to the other positions, not shown, where only heavy oil is delivered as earlier explained, and the BURN period starts. At the same time

c. blade **258** has left contact **260** and delay switch **248** recloses after a few seconds. The said switch is in parallel with solenoid valve **204** and current is free to pass through the coil of relay **246** which causes blade **268** to engage contact **270** to close a second circuit to said solenoid valve, thus feeding it from the control of relay **244.**

d. As above stated, BURN is in process, piston and rod **226** are at their extreme leftward position, selector valve **208** is directing heavy oil to pump **196** to be burned and the heater of delay switch **248** is in open circuit while the switch's contacts are

closed. But, as soon as heat demand is satisfied, the main controller terminates the signal and

e. relay **244** is de-energized, blade **258** leaves contact **266,** this de-energizes solenoid valve **232** and shuts pipe **230** from pipe **202**; it also de-energizes normally open solenoid valve **238** which puts pipe **230** in communication with pipe **242,** unsealing cylinder **224** and allowing spring **228** to return piston and rod **226** and selector valve **208** to the positions shown, cutting off heavy oil and restoring light oil flow to the burner which now enters the Post-burn Flush Period: at the same time

f. blade **258** re-engages contact **260** causing heating of delay switch **248,** while blade **262** has left contact **264,** leaving solenoid valve **204** energized solely through relay **246.** After its predetermined interval the said delay switch's contacts open and break the line circuit through the coil of relay **246** which then opens its circuit to solenoid valve **204,** all fuel is cut off from cup **44** and the flame goes out. The burner then completes its post-purge Period and shuts down.

The normally open delay switch **250** has its contacts connected across the line so that if they close, fuze **252** will be opened by the resulting short circuit. Its heater circuit is in parallel with that of delay switch **248** but its delay setting is much longer than that of the latter and in normal usage its contacts never close, but if switch **248** fails to respond when energized after BURN, switch **250** will close and cause an emergency shut-down. It may be pointed out at this time that the delay setting of switch **250** is such that it will not close during the pre-purge period even though switch **248,** with its short delay, goes to "contact open" condition.

If desired, a normally open delay action switch may be placed in the line to soleoid valves **232** and **238** to replace restriction **234** and **240** to control the duration of the light oil burning period before hydraulic action initiates the movement of selector valve **208** from the position shown. To affect this, the delay switch's heater would be connected from contact **266** to the return line at any convenient point while its contacts would be interposed between the said contact **266** and the said solenoid valves. Duration of the light oil burning period would depend on the selection of a commercially available switch. These have delay ranges running from 1 second to over 1 minute.

What is claimed:

1. The combination comprising rotary type oil burner having an oil slinger cup for dispersal of fuel into a combustible mist, an orifice opening into the interior of said cup for normally burning a first fuel and having a main operating controller for regulating the normal combustion cycle of said burner, a source of a second fuel more easily ignited than said first fuel, and fuel flow timing and regulating means arranged and adapted for modulation of the delivery of said second fuel to the orifice of said burner independently of said first fuel and in part in seriatim therewith during selected portions of any combustion cycle whereby the quantity of soot and air pollutants resulting from said combustion of said first fuel is at least lessened by the improved combustion of said second fuel.

2. The combination according to claim **1,** wherein said timing and regulating means is arranged to feed said second fuel during the initial portion of said combustion cycle.

3. The combination according to claim **1,** wherein said timing and regulating means is arranged to feed said second fuel during the terminal portion of said combustion cycle.

4. The combination according to claim **1,** wherein said timing and regulating means includes means for adjusting the volume of said second fuel as it is fed to said burner relative to said first fuel.

5. An oil burner of the class described having a non-rotating passage for delivering fuel oil through an ejection orifice, a rotary slinger cup open to said orifice for the delivery of fuel to a fire-box, a tube inserted within said passage having one end accessible for connection to a source of fuel other than that used as a fuel-in-chief and having its other end within said passage adjacent said orifice whereby the orifice of said passage may expeditiously be cleared of said fuel-in-chief, said tube being appreciably smaller in cross section than the cross section of said passage so as to afford a way for the flow of said fuel-in-chief.

6. Apparatus for operative connection to a burner having a rotary slinger cup provided with a nozzle orifice opening into the interior thereof for heavy oil, said burner having an operating controller and comprising conduit means through which a relatively light oil may flow from a receptacle to said burner upstream of said orifice, first means to start and stop said flow, second means arranged and adapted to afford a control for connection to a valve component of said burner for starting and stopping the flow of heavy oil therethrough and timing means for interconnection with and responsive at least in part to said controller, said timer being arranged and adpated for operational connection to said first and second means to operatively control the flow of said oils to said burner for combustion in designed sequence to comingle for at least some period consequent upon a change from one oil to the other.

7. The apparatus according to claim **6** which further includes means arranged and adapted to afford a plurality of rates of flow of said light oil to said burner.

8. Apparatus for operating an oil burner having a rotary slinger cup provided with a nozzle orifice opening into the interior thereof and a controller for regulating the operation thereof, a source of a first fuel oil, an independent source of a second fuel oil, and means for conducting the flow of oils to the orifice of said burner comprising first electrically operated means for starting and stopping the flow of said first fuel to said burner, a second electrically operated means for starting and stopping the flow of said second fuel to said burner, a third electrically operated means arranged and adapted to afford a plurality of rates to the flow of said second fuel to said burner, an electric timing means interconnected with and responsive, at least in part, to said controller and arranged and adapted to control the flow of electric current to said first, second and third electrically operated means in a desired sequence whereby said fuels may be burned by said burner in a predetermined arrangement.

9. The apparatus according to claim **8** wherein said electric timing means embodies part of a circuit between the closable contacts of a heat demand responsive structure and said controller, said timing means being receptive to signal current and on receipt of such signal current, renders said controller insensitive to

said structure, closes electric circuits through a plurality of relay contacts and thereby sets in motion a motorized switching organization which affords said fuel flow timing and regulating functions, and affords a predetermined time delay between the opening of said closable contacts when such heat demand has been satisfied and the transmission of the information thereof to said controller whereby said burner is afforded a post-burn flush period that is separate from its normal post purge period.

10. The combination comprising an oil burner having a rotary slinger cup provided with a nozzle orifice opening into the interior thereof suited for burning in a regulated combustion cycle a first fuel and having a source thereof and a second fuel also having a source thereof and fuel flow regulating means arranged and adapted to regulate the delivery to the orifice of said burner of each of said fuels independently of the other, said regulating means being further arranged and adapted to afford such delivery in a predetermined sequential program during selected portions of a combustion cycle whereby the quantity of soot and of air pollutants resulting from combustion characteristics of said second fuel.

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