Dec. 28, 1954 P. S. DICKEY ET AL 2,698,141

CONTROLLING APPARATUS

Original Filed April 26, 1946 3 Sheets-Sheet 1

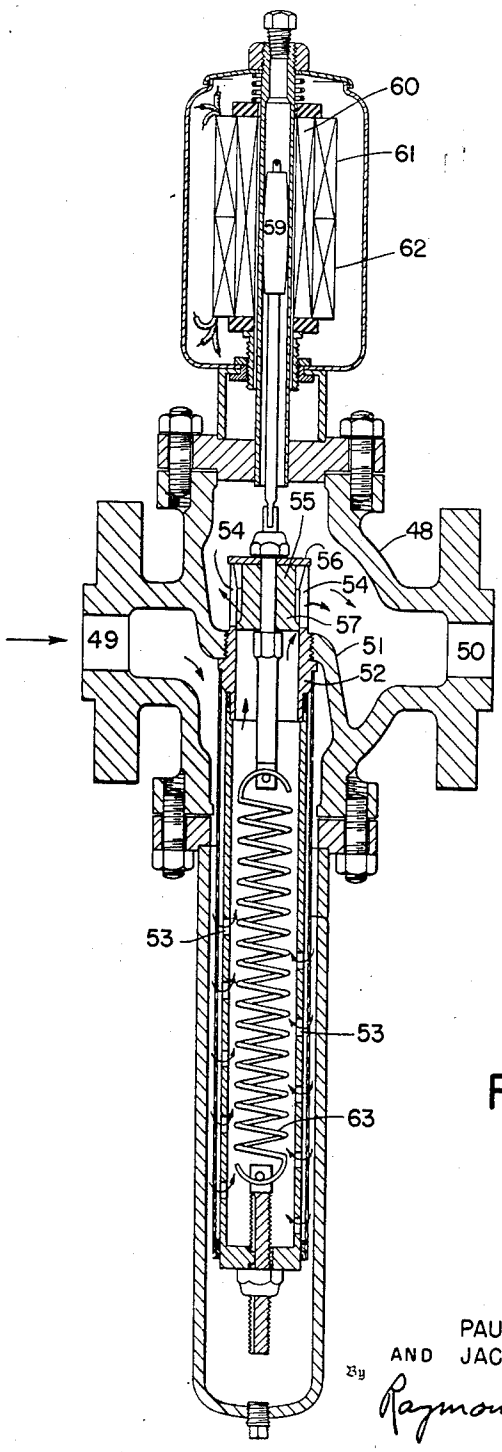


FIG. 1

Inventors
PAUL S. DICKEY
AND JACK F. SHANNON
By Raymond W. Jenkins
Their Attorney

Dec. 28, 1954 P. S. DICKEY ET AL 2,698,141

CONTROLLING APPARATUS

Original Filed April 26, 1946 3 Sheets-Sheet 2

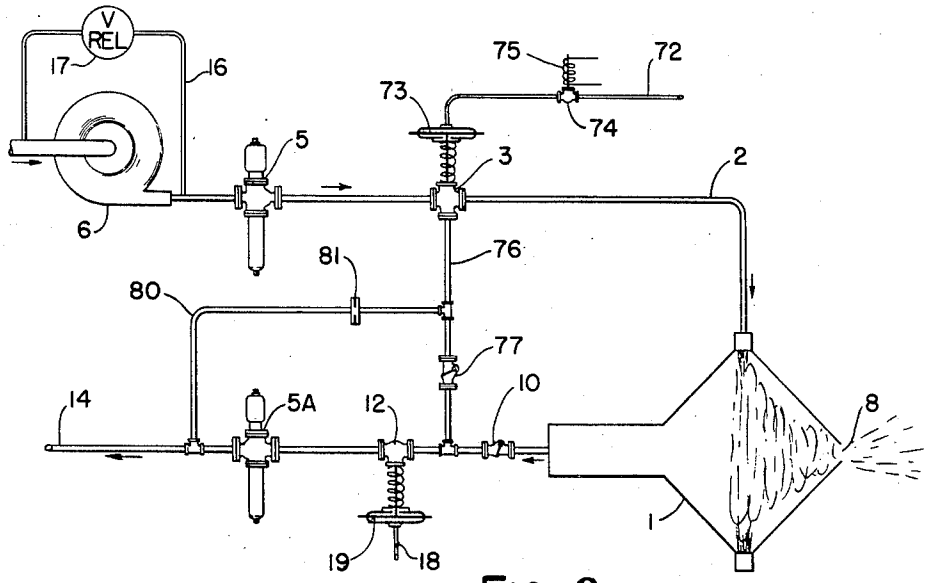


FIG. 2

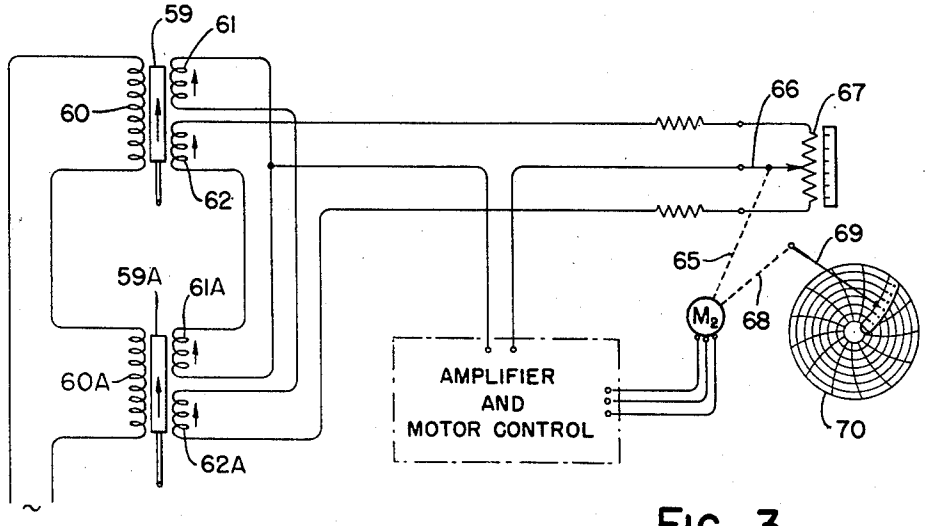


FIG. 3

Inventors

AND PAUL S. DICKEY
JACK F. SHANNON

By Raymond W. Jumkins
Their Attorney

Dec. 28, 1954 P. S. DICKEY ET AL 2,698,141

CONTROLLING APPARATUS

Original Filed April 26, 1946 3 Sheets-Sheet 3

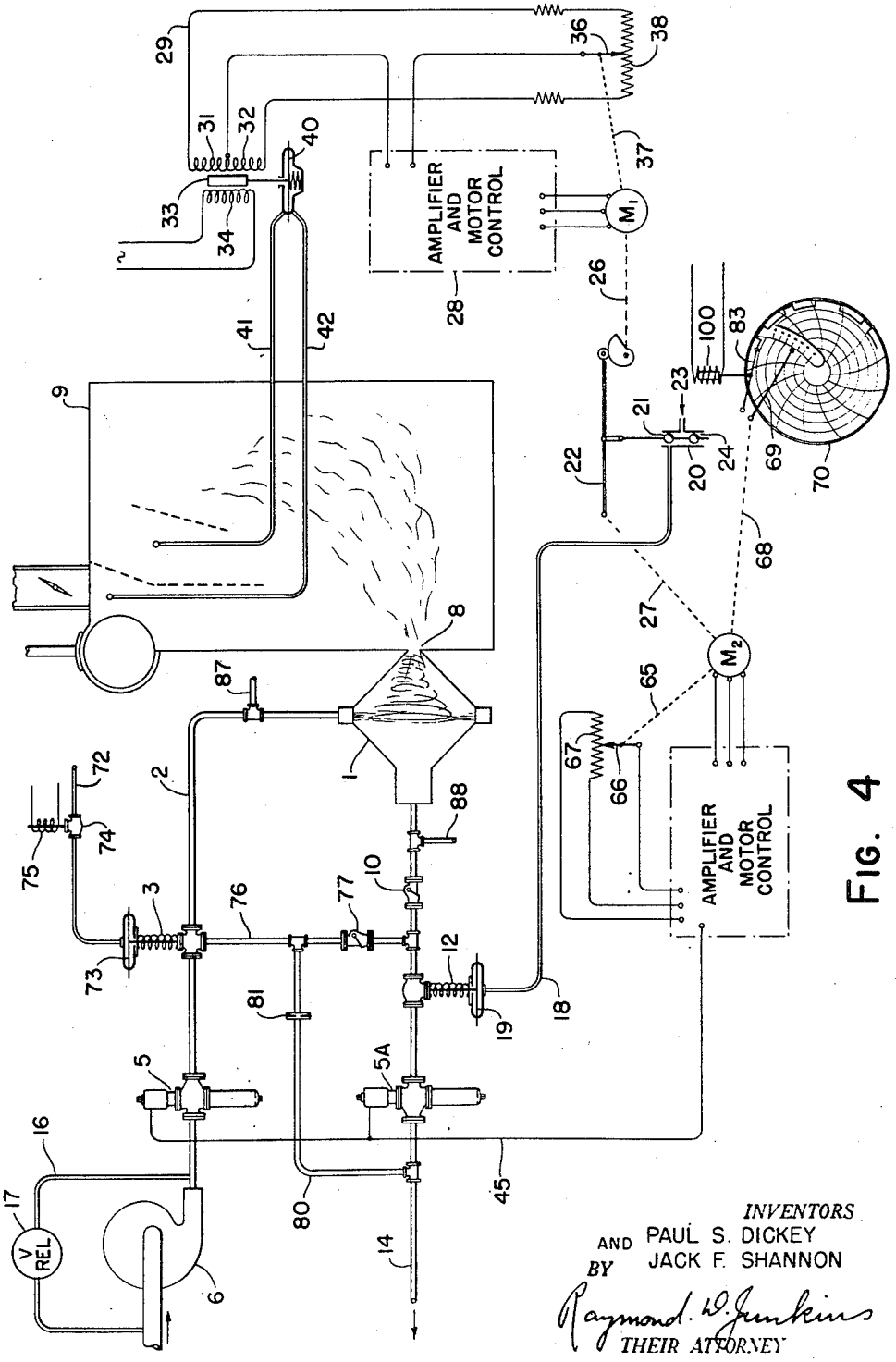


FIG. 4

INVENTORS
PAUL S. DICKEY
AND JACK F. SHANNON
BY Raymond W. Jenkins
THEIR ATTORNEY

United States Patent Office

2,698,141

Patented Dec. 28, 1954

2,698,141

CONTROLLING APPARATUS

Paul S. Dickey, East Cleveland, and Jack F. Shannon, Euclid, Ohio, assignors to Bailey Meter Company, a corporation of Delaware

Original application April 26, 1946, Serial No. 665,108. Divided and this application June 28, 1952, Serial No. 296,172

4 Claims. (Cl. 236—15)

Our invention relates to fluid control systems, and more particularly to flow measuring and control systems for recirculating oil burner installations.

An object of our invention is to provide an improved system which operates automatically to regulate the supply of fuel, such as oil, from a burner to a furnace. Another object is to provide an improved recirculating oil system for the burner of a furnace. Another object is to provide for a furnace an improved recirculating oil system having means for supplying oil to a burner at a fixed rate and for regulating the flow of oil from the burner to a return line in inverse proportion to the flow of air through the furnace. Yet another object is to provide in an improved system for a recirculating burner installation, means for supplying fuel from the burner to a furnace in proportion to the flow of air therethrough, and means operating automatically when it becomes desirable to extinguish the flame in the furnace, to deliver the oil in a predetermined manner through conduits by-passing the burner. Yet another object is to provide improved means for indicating the flow of oil in a recirculating burner installation. Another object is to provide an improved recirculating burner installation having means responsive to the flow of air through a furnace and to the difference in flow between fuel supply and return lines for controlling the distribution of fuel from the burner to the furnace and the return line. Other objects will appear in the course of the following description.

This application is a division of our pending application Ser. No. 665,108 (now abandoned) filed April 26, 1946, as a continuation-in-part of our application S. N. 555,258, filed September 22, 1944, and now Patent No. 2,459,689 dated January 18, 1949.

In the accompanying drawings in which there is shown for purposes of illustration one form which our invention may assume in practice:

Fig. 1 is an enlarged vertical sectional view of a flow meter which is adapted for use in our improved control system.

Fig. 2 is a diagram of the piping and fluid control means included in our control system.

Fig. 3 is a wiring diagram for electrical control apparatus used in the control system shown in Fig. 2.

Fig. 4 shows diagrammatically our complete control system.

It will be understood that the parts in each of the figures of the drawing are not shown to scale. In Figs. 2 and 4 a fuel oil burner **1**, shown to greatly enlarged scale relative to the rest of the system, has oil supplied thereto through a pipe **2** connected through a 3-way valve **3** and a flow meter or device **5** which operates in direct proportion to the flow of oil therethrough, to the discharge of a fuel pump **6** which is driven by suitable means, not shown, and operates to supply fuel oil to the system at a constant rate. The burner has a port **8** through which a portion of the oil is discharged to be burned in a furnace **9**, shown in Fig. 4. The rest of the oil supplied to the burner is discharged past a check valve **10**, a diaphragm-actuated valve **12** and a flow responsive device or meter **5A** to a return pipe **14** leading to a fuel tank, not shown, or to the intake side of the pump **6**. The oil is supplied to the burner under normal operating conditions at a pressure of approximately 1000 p. s. i., and, to prevent the pressure from exceeding this value at any time, there is provided across the pump a by-pass **16** containing a pressure regulating valve **17**.

By regulating the valve **12** to restrict in varying amounts

the flow of oil from the burner to the return line **14**, it will be seen that the amount of oil discharged from the burner through the port **8** to be consumed in the furnace will be correspondingly varied. For regulating the valve **12** we have provided a system which is responsive to changes in the flow of air through the furnace and to changes in the difference between the flow of oil from the pump discharge and the flow through the return line **14**. This regulating system includes a conduit **18** communicating at one end with a diaphragm **19** for the valve **12**, and communicating at its other end with a valve casing **20** containing a valve member **21** which is operatively connected to the mid portion of a lever **22**. The valve member operates to control the connection of the conduit **18** with a fluid supply conduit **23** and a fluid discharge conduit **24**. In a neutral position of the valve member, the conduit **18** is cut off from both the fluid supply and discharge conduits. When the valve member is moved upwardly in Fig. 4 from its neutral position, the conduit **18** is connected to the supply conduit **23**, and a lowering of the valve member from its neutral position results in a connection of the conduit **18** to the discharge conduit.

The lever **22** is operatively connected at its opposite ends by any suitable means **26** and **27** to motors M1 and M2 which operate to move the lever and position the valve member **21**. The motor M1 is energized by an amplifier and motor control device **28**, which is connected into a bridge circuit generally designated **29**. Windings **31** and **32** are connected into the bridge circuit and are energized varying amounts depending upon the position of a core piece **33** in a magnetic field produced by the energizing of a winding **34** from any suitable source of electrical power. Any change in the energization of the windings **31** and **32** produces an unbalance in the bridge circuit and effects an operation of the motor M1. A contact arm **36** is operatively connected to the motor by suitable means **37** so that it is moved by the motor along a slide-wire resistance **38** in a direction to effect a rebalancing of the bridge circuit. The core piece **33** is connected to a diaphragm **40** which has its opposite sides connected through pipes **41** and **42** to different points in the air stream through the furnace. The points in the air stream are selected so as to subject the opposite sides of the diaphragm to pressure differences which are adequate to move the core piece **33** as the flow of air changes. The connection between the motor M1 and the lever **22** is such that an operation of the motor resulting from an increase in the rate of air flow through the furnace produces a positioning of the valve member **21** to supply fluid from the conduit **23** through the conduit **18** to the diaphragm **19** for moving the valve **12** toward its closed position. It will be seen that a reduction in the flow of oil past the valve **12** to the return line **14** will result in a flow of a larger portion of the oil from the burner to the furnace.

It is desired that the change in the flow of oil from the burner to the furnace be in proportion to the change in the flow of air through the furnace. To obtain this it is necessary that some means be provided for moving the valve member **21** to its neutral position as soon as the valve **12** has been adjusted to produce the proper flow of oil to the furnace, otherwise the flow of fluid relative to the diaphragm **19** will continue until the valve **12** is either closed or moved to its full open position. To move the valve member **21** to its neutral position when the desired flow is reached, there is provided a circuit, generally designated **45**, which is connected to the meters **5** and **5A** and energizes the motor M2 to cause its operation in one direction or the other as the difference in flow through the meters increases or decreases.

The meters **5** and **5A** are alike, and, as shown in Fig. 1, include a casing **48** having intake and discharge ports **49** and **50** separated by a partition **51**. A cylindrical member **52** carried by the partition has its interior connected by ports **53** and slots **54** to the intake and discharge ports, respectively. A plunger **55** has a portion **56** engageable with the upper end of the member **52**, and a portion **57** extending into the member so that it is acted upon by the fluid flowing into the latter from the intake

port. A core piece 59 is carried by the plunger 55 and is positionable by the latter relative to windings 60, 61 and 62. The plunger is moved upwardly against the action of a spring 63 in proportion to the flow of fluid through the casing.

The circuit 45, shown more fully in Fig. 3, comprises the windings 60, 61 and 62 of the meter 5 connected with the windings 60A, 61A and 62A of the meter 5A in a bridge circuit in such a way as to unbalance the circuit in proportion to changes in the difference of the flow through the meters. When the circuit is unbalanced, the motor M2 rotates in one direction or the other and operates through suitable connections 65 to move a contact arm 66 along a slide-wire resistance 67 and effect a rebalancing of the bridge circuit. The motor M2 is also connected by suitable means 68 to a recording arm 69 of a meter 70 for positioning the arm to record the differences in the flow through the meters 5 and 5A. The connections 27 between the motor M2 and the lever 22 are such that the valve member 21 is moved to its neutral position when the circuit 45 becomes balanced. The general circuit of Fig. 3 is fully disclosed in the Hornfeck Patent 2,406,221, and further description of the same herein is not deemed necessary.

It will be seen that with the system so far described the fuel oil will be supplied by the pump 6 at a constant rate to the burner 1 where a part of the oil will pass through the opening 8 to the furnace to be burned, and the remainder will escape past the valve 12 to the return line 14. The electrical control circuit will operate in response to the flow of air through the furnace and to the difference in flow through the meters 5 and 5A for positioning the valve 12 to effect the desired distribution of oil from the burner to the furnace and the return line. It will be appreciated that the difference in flow through the meters 5 and 5A is the amount of oil that is consumed by the furnace, and that the meter arm 69 records this amount.

If the flame should go out in the furnace for some reason, or if it should be desired that the flame be extinguished because of high steam pressure, high superheat temperature, low rate of superheat steam flow, high furnace circuit temperature, low inert water pressure or failure of auxiliaries, such as water pumps, etc., then it is necessary that the flow of oil to the burner but cut off. To accomplish this we have provided a conduit 72 for conducting fluid from a source of supply to a diaphragm 73 which is operatively connected to the valve 3. A valve 74 controls the flow of fluid through the conduit 72 and is adapted to be moved to its open position on the energizing of a solenoid winding 75. The winding 75 is connected into a suitable circuit which is energized when any of the conditions which it is desired to protect against exist.

On the supply of fluid to the diaphragm 73, the valve 3 is positioned to cut off the flow of oil to the burner and to direct the flow to a conduit 76 communicating past a check valve 77 with the return line between the check valve 10 and the valve 12. If all of the oil discharged by the pump was conducted through this conduit to the return line, the flow through the meters 5 and 5A would be the same and the valve 12 would be wide open. However, the flow of air through the furnace when it is shut down would be greatly reduced but would still be of a substantial amount. As the control system for the valve 12 operates, as explained above, to produce a difference in flow through the meters 5 and 5A proportional to the air flow through the furnace, the valve 12 moves toward its closed position in an attempt to produce a flow difference through the meters proportional to the substantial flow of air in the furnace. The closing of the valve would, of course, produce no difference in flow between the two devices since there would be no burner through which the oil could discharge. The valve 12, under these conditions, would close completely and cut off all flow of oil from the pump to the system. When the emergency conditions ceased to exist, the valve 3 would operate to supply full volume of oil to the burner initially and, since the valve 12 would not immediately open to pass some of the oil to the return line, an undesirable excess quantity of oil would be discharged to the furnace.

In order that the valve 12 may be positioned to maintain a difference in the flow through the meters 5 and 5A proportional to the air flow in the furnace when the supply of oil to the burner is cut off, we have provided a conduit 80 containing a flow resistor 81 and connected from the conduit 76 to the return line 14 across the meter 5A, the valve 12 and the check valve 77. The conduit 80 and the resistor 81 are adjusted to offer a resistance to the flow of oil equal to the resistance offered to the flow from the burner through the port 8. It will be seen that the by-pass makes it possible to obtain a difference in flow through the meters 5 and 5A proportional to the air flow through the furnace when the valve 3 operates to cut off the flow to the burner and to direct all of the flow to the conduit 76. The difference is approximately the same as it should be if the flow was suddenly switched to the burner. The valve 12 is in such a position that it would pass a large portion of the oil from the burner to the return line, and the smaller portion of the oil passed to the furnace would be insufficient to flood the latter during its period of starting.

In order that a record may be had showing the actual amount of oil burned in the furnace, there is provided with the meter 70 a recording arm 83 connected to a plunger which is actuated by a solenoid winding 100 connected in parallel with the winding 75. When fuel is burning in the furnace, the arm 83 makes a circular path near the outer edge of the chart, and, when the furnace is shut down, the arm is swung a slight amount to make a circular path of different radius. The oil flow recorded by the arm 69 during the period when the arm 83 indicated that the furnace was operating, would show the total amount of oil consumed in the furnace.

The control system shown may be used for regulating flow to a plurality of burners simultaneously, and, to indicate the connection of other burners in the system, we have shown conduits 87 and 88 connected to the system at the supply and discharge sides of the burner 1 for conducting fuel relative to the supply and discharge of another burner, not shown.

While there is specifically described in this application one form which our invention may assume in practice, it will be understood that this form is shown for purposes of illustration and that our invention may be modified and embodied in various other forms without departing from its spirit or the scope of the appended claims.

What we claim as new, and desire to secure by Letters Patent of the United States, is:

1. A burner system for a furnace comprising, in combination, a burner, a pump for discharging a constant volume of fuel, means normally operative to deliver all of the fuel from said pump to said burner, a return line for conducting a portion of the fuel away from said burner, flow responsive means connected to said delivery means and said return line, means for regulating the flow through said return line, means responsive to the changes in the rate of air flow through said furnace and to said flow responsive means for controlling said regulating means, and means for by-passing fuel around said burner when abnormal conditions exist in the furnace, said by-pass means including parallel conduits connecting said delivery means to said return line at opposite sides of said flow responsive means connected therein, one of said parallel conduits offering a resistance to the flow of fuel equal to the resistance of fuel flow from said burner to the furnace.

2. An oil burner system in combination, an oil burner, pressure means supplying oil under pressure to said burner, a return conduit from the burner, a regulator in said return conduit regulating the discharge rate of oil from the burner, by-passing means for the burner, means actuating said by-pass means, said by-pass means including two lines each connected to said return conduit at different points along the return conduit, one of said lines having a fixed resistance to flow, and a flow responsive device in said return conduit located between said line connections to said return conduit, whereby the fixed resistance in one of said lines allows for the passage of oil in the other of said lines through the flow responsive device at the same rate when the burner is by-passed as when the burner is operating.

3. A burner system for a furnace including in combination, a burner, a pump for discharging a constant volume of fuel, means normally operative to deliver all of the fuel of said pump through said burner, a return line for conducting a portion of the fuel away from said burner, means for regulating the flow through the said return line, means responsive to the flow of air through the furnace and to the difference in flow between said fuel delivery

means and said return line for controlling said regulating means, means operative automatically to by-pass fuel around said burner when abnormal conditions exist in the furnace, said by-pass means including two lines connected with said return line with one of said lines offering a resistance to the flow of fuel equal to the resistance in flow of fuel through a burner tip, and said regulating means in the return line located between said two lines.

4. An oil burner system in combination, an oil burner, pressure means supplying oil under pressure to said burner, a fluid responsive device to the rate of flow of oil to the burner, a return conduit from the burner, a fluid pressure responsive valve in said return conduit regulating the discharge of oil from the burner, a fluid responsive device in said return conduit sensitive to the rate of flow of the oil return from the burner, means adapted to by-pass the burners with the same rate of oil flow, and parallel paths to which the by-pass connects, one of said

paths including the return meter, the other of said paths having a fixed resistance flow and connected to opposite sides of the return meter, the fixed resistance of such value that the return meter registers approximately the same when the burner is by-passed as when it is operating, whereby the amount of fuel fluid available to the burner is continuously in phase with the burner fluid demand.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,862,690	MacRae et al.	June 14, 1932
2,165,182	Luhrs	July 4, 1939
2,177,823	Donaldson	Oct. 31, 1939
2,265,961	Ziebolz	Dec. 9, 1941
2,334,679	Mason et al.	Nov. 16, 1943