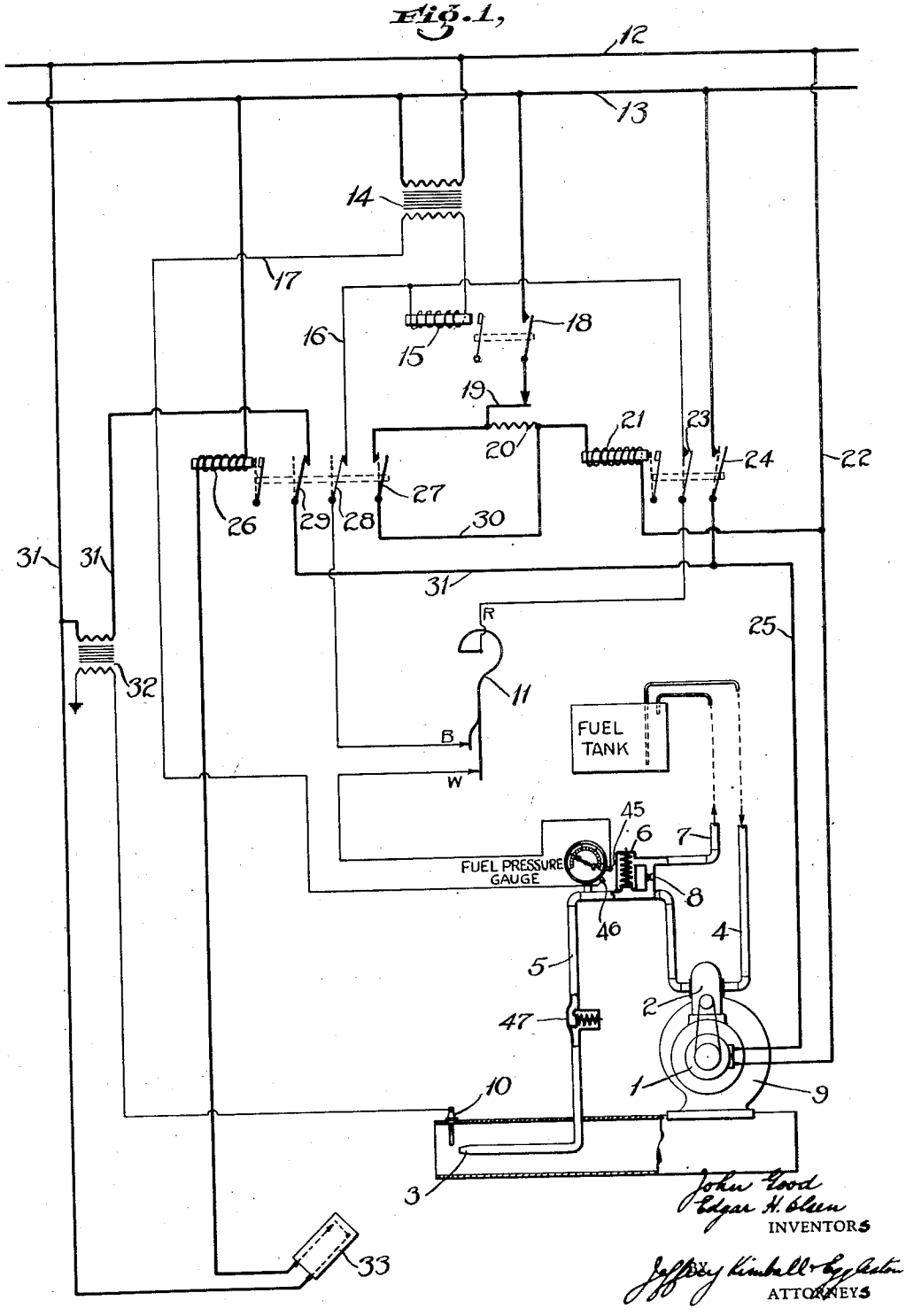
Aug. 25, 1931. J. GOOD ET AL 1,820,612

LIQUID PUMPING APPARATUS

Filed April 21, 1928 3 Sheets-Sheet 1

Fig. 1.



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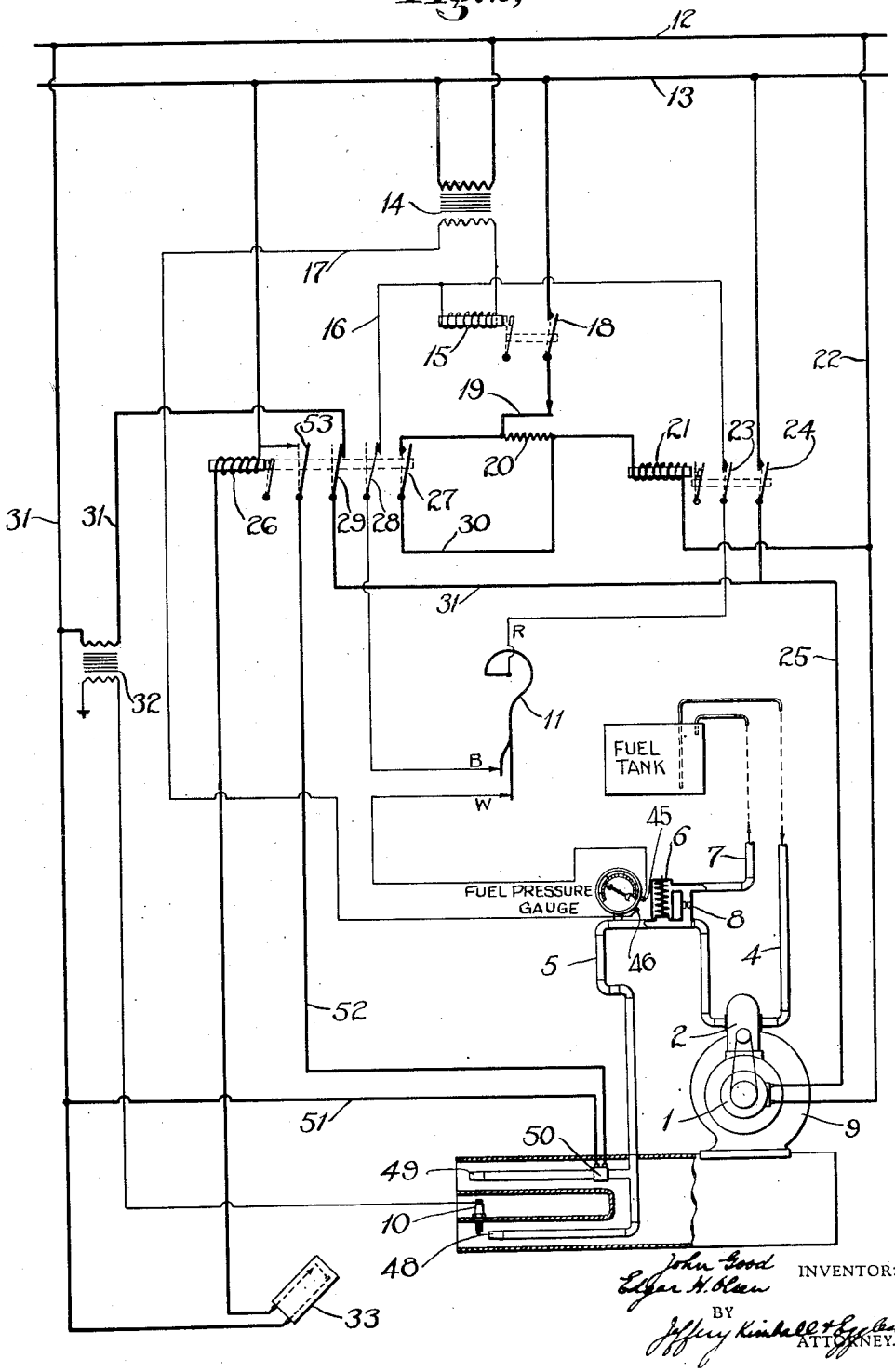
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Fig. 2.



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LIQUID PUMPING APPARATUS

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Fig. 3.

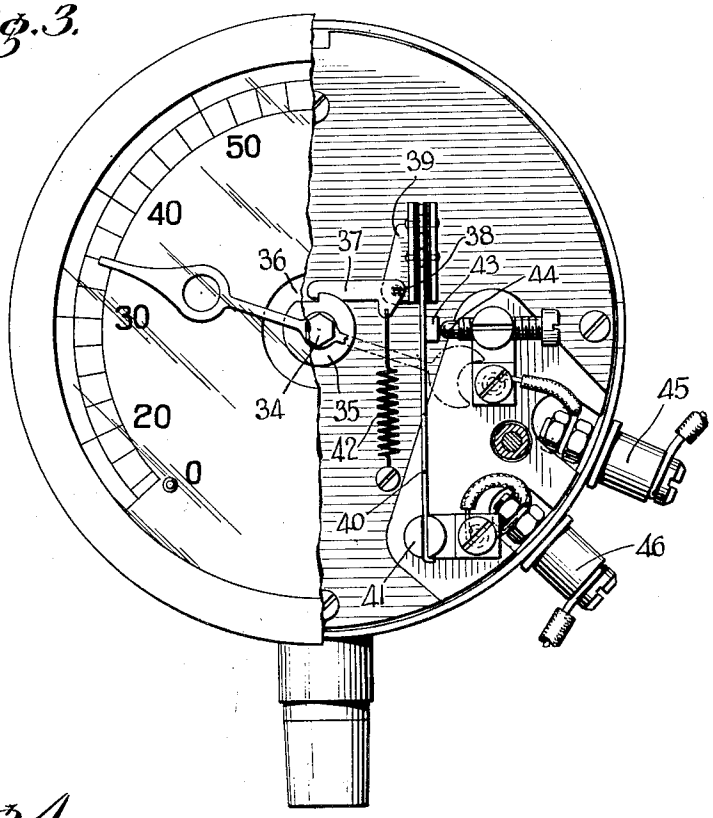
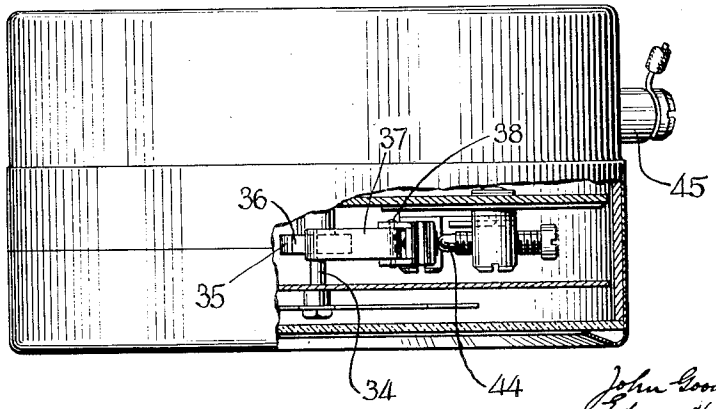


Fig. 4.



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UNITED STATES PATENT OFFICE

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LIQUID PUMPING APPARATUS

Application filed April 21, 1928. Serial No. 271,743.

The object of the invention is the elimination of certain objections and dangerous conditions which obtain in the pumping systems of automatic oil burners as a result of air leakage.

By reason of the fact that the oil supply tanks are more or less remote from the burner, the oil line usually includes numerous connections, perhaps a vacuum feed tank, valves and the like, any of which are likely to leak. The suction of the pump during periods of burner activity and the falling back of the oil when the pump stops, draws air into the system through any such connections which may be loose and through any other sources of leakage. Particularly after a stand-by period, there is frequently sufficient air in the system to interfere with normal operation of the burner, and, even though the fuel pipe adjacent the nozzle may contain sufficient oil to start the burner in operation, air subsequently delivered to the nozzle may cause the extinguishment of the flame.

The present invention consists in the provision of means whereby the apparatus will rid itself of any such air under conditions of complete safety, and more particularly by means of the arrangements and in accordance with the mode of operation exemplified in the accompanying drawings.

Fig. 1 illustrates diagrammatically an oil burner control circuit having the invention applied;

Fig. 2 the application of the invention to a control system for an oil burner of the general type disclosed in the prior and copending application of John Good, Ser. No. 128,755, filed August 12, 1926; and

Figs. 3 and 4 elevation and plan views, broken away, of a pressure gauge, illustrating the application of the invention thereto.

The particular type of burner forms no part of the present invention but in the form of Fig. 1 includes a burner motor 1 which drives a fuel pump 2 having connection with the "tank" or source of supply and the burner nozzle 3 through pipes 4 and 5 respectively. A relief valve 6 is connected with a return line 7 to control the delivery pressure and nozzle output in the usual manner. Pipe 8 represents a restricted by-pass around the relief valve, more fully explained below. The return line 7 is connected with the top of the supply tank. The combustion air may be supplied by a motor driven blower 9, or otherwise. Ignition of the fuel is effected by any suitable means, such as an expanding pilot light, a hot wire igniter or a spark plug, such as 10, or otherwise.

The control system of Fig. 1, in great measure, is standard on numerous oil burners, the various elements being primarily subject to the control of a low voltage room thermostat 11. The letters R, W and B indicate the so-called red, white and blue lines. For the sake of clearness, the mains 12 and 13 and all high voltage circuits are indicated by heavy lines.

A transformer 14 supplies energy to a low voltage pilot relay 15 which is directly controlled, when the apparatus is at rest by the blue and white lines, marked 16 and 17.

The pilot relay controls a switch 18 to make or break a high voltage circuit from main 13, through thermostatic element 19, heater 20, main relay 21, and line 22 back to the main 12.

Relay 21 controls a low voltage switch 23 in the red line and high voltage motor switch 24, the circuit for the latter being completed through lines 25 and 22.

A second main relay, 26, controls three circuit switches marked 27, 28 and 29, 27 being open and 28 and 29 closed when the machine is at rest, so that when relay 26 is energized it closes switch 27 and opens switches 28 and 29. Switch 27 controls a circuit 30 which constitutes a shunt for heater 20. Switch 28 is in the blue line and switch 29 controls the igniter. The latter being shown as spark

plug 10, its operation is by a high voltage circuit 31 in parallel with the motor circuit and a spark coil 32 in turn connected to the spark plug.

Relay 26 is controlled by any suitable device which responds to normal burner operation and for purposes of illustration we have shown a so-called protectostat 33 which is a thermostatic switch operated by radiant heat. It is located in such a position that it is operated by the burner flame. A stack or other control would obviously serve the purpose equally well.

As thus far described, the operation of the system is as follows:

The room thermostat, when cold, moves to the position shown, closing the pilot relay circuit and hence switch 18. The latter completes the circuit of heater 20 and relay 21, which by the closure of switch 24, energizes the motor and igniter circuits.

Under normal conditions, fuel is delivered to nozzle 3 and ignited by the spark plug but if for any reason ignition does not occur, heater 20 causes thermostatic element 19 to bend downwards and break the circuit of relay 21 thus bringing the apparatus to rest. The time limit imposed by the heater and element 19 is variable, but is usually set for about two minutes.

Assuming that the conditions are normal and that ignition does occur, protectostat 33 responds to the flame to close the circuit of relay 26. Thereupon switch 29 is opened to break the igniter circuit, switch 27 is closed to shunt heater 20 and switch 28 is opened to transfer control of the apparatus as a whole to the now closed red line switch 23. As will be understood, if the room thermostat opens at any time thereafter, for however short a period, the red line is broken, the pilot relay de-energized and the apparatus brought to rest. Thereupon, provided the room thermostat is still calling for heat, the above described cycle is repeated.

If at any time during the operation of the apparatus sufficient air passes through the nozzle to cause extinguishment of the flame, it will now be apparent that the apparatus will continue to run in its then condition until the protectostat opens. Until this occurs, air and oil, or, if the extinguishment was caused merely by an air bubble, oil will be pumped into the combustion space. Since the igniter is not then active, the oil accumulates and in many instances ignites later, either from a hot part of the combustion space or from renewed activity of the igniter, with destructive violence. The delay in the renewal of igniter activity is caused by the time necessarily taken by the protectostat 33, or other safety control, to move to its safe position and even though this may be no more than a few seconds, sufficient oil can accumulate in that time to be dangerous.

As a means of avoiding this contingency our invention contemplates automatic means which respond instantly to the presence of air in the system, and act to prevent any dangerous condition from this cause. These means are made effective through the pressure change which is incident to the presence of air. On the suction side of the pump the presence of air causes a diminished suction or pressure increase, and on the pressure side of the pump, a corresponding pressure drop. In the preferred form of the invention we utilize the pressure change on the pressure side of the system and, for convenience, we employ the pressure gauge, which is usually found on the pressure side, as part of the means for producing the effect referred to, although as will be apparent, said means can be organized independently of any such gauge and in any desired location.

In the form of the invention shown in Figs. 3 and 4, the gauge shaft 34 is provided with a collar 35 rigidly secured thereto and notched as at 36 to receive a latch finger 37; the latter is pivoted at 38 on the insulating block 39, itself secured to the end of a spring blade 40 suitably mounted in the block 41. A spring, such as 42, serves to keep the finger 37 in contact with the collar 35. The blade 40 carries a contact 43 which normally engages an adjustable contact 44, the latter being connected with binding post 45. Similarly the block 41 is connected with binding post 46. By this means the two posts 45 and 46 are normally connected by way of block 41, blade 40 and contacts 43 and 44. Under increasing fuel pressure, the gauge shaft 34 rotates in a clockwise direction and, as will be apparent, the finger 37 simply rides on the collar 35 without effect on blade 40, but as the pressure falls, say as a result of air in the system, and the collar rotates in the reverse direction, the notch 36 will engage the latch finger and draw the blade toward the left and separate contacts 43, 44. As the pressure continues to fall the periphery of the collar operates as a cam to release the finger 37 and so permit the blade to close the contacts. This results in a momentary interruption of the circuit through said contacts.

Referring to Fig. 1 it will be seen that the circuit thus interrupted by the gauge switch is the white line circuit, which includes also the room thermostat.

It will be apparent therefore that as soon as the oil pressure drops sufficiently to cause the opening of the gauge switch, the white line is broken and the pilot relay 15 thereby de-energized. When this occurs, relay 21 is also de-energized, by the opening of switch 18, and the motor switch 24 is opened to stop the motor. The de-energization of relay 21 also opens the red line switch 23, so that even though the gauge switch causes only a temporary break in the white line, its subsequent

reclosure is ineffective to start the motor, blue line switch 28 being held open by relay 26.

As above explained, the time which elapses before relay 26 is de-energized depends upon the type of safety device used. As soon as such device or protectostat does open, the apparatus is immediately restored to its starting position, i. e., heater shunt 30 opened, blue line switch 28 closed and igniter switch 29 closed, so that the igniter is operative. Thereupon, assuming the room thermostat is still calling for heat, the machine starts up again on its normal cycle.

Oil burners of this general type are usually provided with a spring loaded discharge valve 47 in the oil delivery line, to determine a minimum working pressure at which the fuel is delivered or the machine is designed to run and it is preferable to adjust the gauge switch so that it operates in the neighborhood of this predetermined pressure, or just before the same is reached.

When the machine starts up again, if enough air is still present to prevent the development of sufficient pressure to open valve 47, it is expelled by way of by-pass 8, the passageway through which is so restricted as to offer considerable resistance to the passage of oil but to permit ready escape of the air. When the air is eliminated and the normal fuel supply restored, the pressure builds up in line 5 and opens valve 47 and the operation continues as above described.

In any event and regardless of the presence of a valve, such as 47, and regardless of the presence of air or the quantity of air, the gauge switch responds immediately to the impairment of the fuel supply to render the machine entirely safe.

In Fig. 2 the invention is applied to a novel control system particularly suited for use in connection with an oil burner such as described in application Ser. No. 128,755, above referred to. In this type of burner air and fuel are delivered to the combustion space initially in non-explosive proportions. After ignition, the igniter is rendered inactive and the mixture proportions are conformed to normal combustion requirements. As a convenient means of carrying out this method of operation, two fuel nozzles 48 and 49 are provided which together supply sufficient fuel for normal combustion. Nozzle 48 operates and is controlled exactly as in nozzle 3 of Fig 1, except of course, that it supplies a smaller quantity of fuel. Nozzle 49, however, is shut off from the fuel supply when the apparatus is at rest by an electro-magnetic valve 50. This valve is adapted to be energized, and so opened, by a high voltage circuit including lines 51, 52 and switch 53. The latter is made a part of the switch series 27, 28 and 29 controlled by relay 26 and is so organized that it closes when the relay is energized and opens when the relay circuit is broken. The other parts of the control system will be recognized as the same as shown in Fig. 1.

When the room thermostat 11 calls for heat, relays 15 and 21 operate as above described and oil is delivered by way of nozzle 48 and ignited by spark plug 10. When protectostat 33 closes the circuit of relay 26, not only are switches 27, 28 and 29 operated but also switch 53 is closed to energize and open valve 50, whereupon oil is delivered by way of nozzle 49 and ignited by the flame of nozzle 48.

If for any reason the flame is extinguished, protectostat 33 opens the circuit of relay 26 which causes switches 27, 28 and 29 to operate as above described and also causes switch 53 to open and valve 50 to close, shutting off the oil supply by way of nozzle 49. In this respect it will be noted that even though the motor and pump continue in operation the oil delivered by way of nozzle 48 does not, in conjunction with the full air supply from blower 9, produce an explosive mixture in the combustion space. As in the form of Fig. 1 however, the safety condition of the burner is dependent upon the operation of protectostat 33 or its equivalent and hence the same dangerous condition is apt to arise before the protectostat operates.

The gauge switch is shown connected as in the previous form and its operation is in all respects similar to that already described.

The arrangements above described are representative of a general class of burner control systems in which a so-called condition of safety is brought about by the operation of one or more combustion responsive devices, such as the protectostat, but, as pointed out, a dangerous condition is apt to arise even before such devices can operate. Not only does the present invention avoid such condition but in the form illustrated the systems as a whole are so organized with respect to the gauge, or equivalent switch, that the latter serves as an automatic check on the said combustion responsive devices. As soon as the fuel supply is impaired, the gauge switch serves as a master control, regardless of the position of the other parts of the apparatus, and renders further operation of the burner entirely dependent upon the functioning of the protectostat or similar device, so that if the latter fails burner operation is suspended until the defect is remedied.

Although illustrated only in its preferred form and in combination with two particular burner control systems it will be apparent that the invention is capable of application to other control systems and of embodiment in numerous forms to suit the conditions in hand.

We claim:

1. In a control system for oil burners hav-

ing an oil line, a motor operated pump for effecting passage of oil therethrough and an ignition device, the combination of a room thermostat, a motor controlling circuit responsive to the closure thereof, a second circuit, also controlled by the room thermostat, switch means for transferring the control of the motor to said second circuit, combustion responsive means for operating said switch means, said switch means rendering the ignition device inactive, a switch in said second circuit and automatic means responsive to pressure variation in the oil line and operative to open said switch.

2. In a control system of the kind described, the combination of an oil line, a pump associated therewith, a motor for driving the pump, a control circuit for the motor, a switch in said circuit adapted to be closed during normal operation, and pressure responsive means connected to the oil line and directly responsive to pressure variation therein, said means arranged to open said switch in response to abnormal pressure drop in said line.

3. In a control system of the kind described, the combination of an oil line, a pump associated therewith, a motor for driving the pump, a control circuit for the motor, and pressure responsive means connected to the oil line and directly responsive to pressure variation therein, said means arranged for momentarily breaking the circuit in response to abnormal pressure drop in said line.

4. In a burner the combination of a source of supply, an oil line and a pump, a return line from the delivery side of the pump to said supply source, a restriction in said return line dimensioned to resist the passage of oil but permit ready escape of air, a motor for operating said pump, a pressure responsive device connected to the oil line, an igniter, a motor switch arranged for operation by said device to stop the motor in response to abnormal pressure variation, and means for coincidently re-starting the motor and energizing said igniter, said means acting automatically and subsequently to the stoppage of the motor by said device.

5. In a burner, the combination of a source of supply, an oil line and a pump, a motor for operating the latter, an igniter, combustion controlled means for rendering the same inactive or active according to the condition of the burner, a device connected to said oil line and directly responsive to pressure variation therein, a switch operated by said device to stop the motor in response to abnormal pressure variation and means for restarting the motor including a switch controlled by said first-mentioned means.

6. In a burner, the combination of a source of supply, an oil line and a pump, a motor for operating the latter, an igniter, a device connected to said oil line and directly responsive to pressure variation therein, a switch operated by said device to stop the motor in response to abnormal pressure variation, an igniter switch, a motor starting switch and means responsive to combustion failure for coincidently closing both said last mentioned switches.

7. In an oil burner system, the combination of a pump and oil line supplied thereby, a motor for operating the pump, a device connected to said oil line and directly responsive to pressure variation therein, a motor switch controlled by said device and adapted to be opened, to stop the motor, in response to abnormal pressure variation in said line, a normally active igniter, means for rendering the same inactive following the starting of the burner, said means adapted to coincidently render active the igniter and close said switch to re-start the motor in response to failure of combustion.

8. The combination of a pump and line supplied thereby, a motor for operating the pump, a member connected to said line and directly responsive to pressure increase and decrease therein, a motor-controlling switch associated with said member including means for holding the switch closed throughout movement of said member in one direction, said member arranged to open said switch at a predetermined point in its movement in the other direction, corresponding to a predetermined pressure in said line, and said means acting to re-close the switch upon continued movement of the member in said other direction.

9. In a control system of the kind described, the combination of an oil line pump associated therewith, a motor for driving the pump, a control circuit for the motor, a switch in said circuit adapted to be closed during normal operation, pressure responsive means connected to the oil line and directly responsive to pressure variation therein, said means arranged to open said switch in response to abnormal pressure drop in said line, and combustion controlled means active after each operation of said pressure responsive means to re-start the motor.

10. In a burner control system, the combination of an oil delivery line, a normally open safety switch, means for closing and opening the same, respectively, during burner operation and in response to failure of combustion, a device connected to said line and directly responsive to pressure variation therein, and means actuated by said device to stop the oil delivery in response to abnormal pressure drop in said line, said last mentioned means acting to prevent further delivery until said safety switch opens.

11. In a burner control system, the combination of an oil delivery line, a normally open safety switch, means for closing and

opening the same, respectively, during burner operation and in response to failure of combustion, a device connected to said line and directly responsive to pressure variation therein, and means actuated by said device to reduce the oil delivery in response to abnormal pressure drop in said line, said last mentioned means acting to maintain said reduced delivery until said safety switch opens.

In testimony whereof, we have signed this specification.

JOHN GOOD.
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