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BURNER PRIMARY CONTROL

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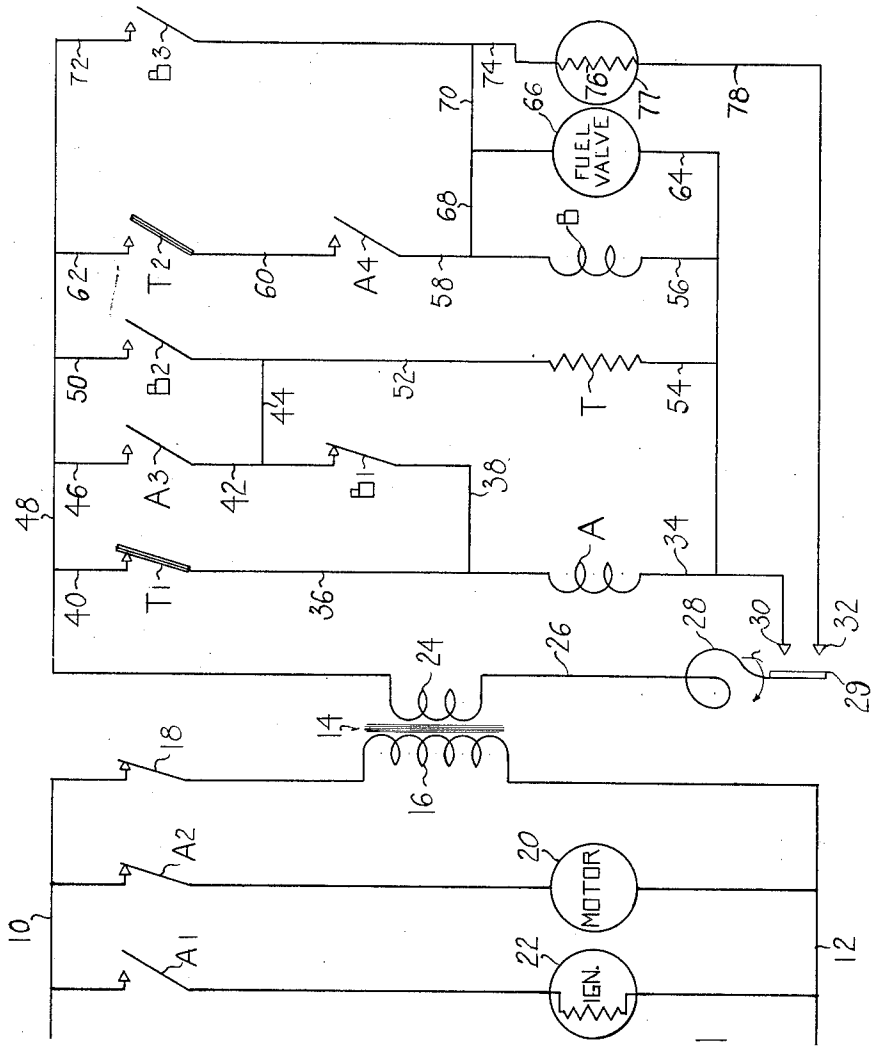


FIG. 1

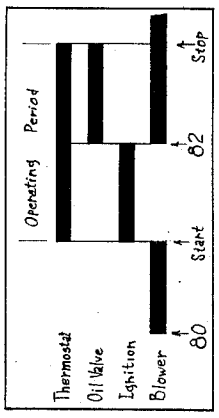


FIG. 2

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BURNER PRIMARY CONTROL

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8 Claims. (Cl. 158—28)

This invention concerns a control circuit and components for the operation of a fuel burner system.

More particularly it concerns a novel circuit arrangement that provides optimum control of the burner system utilizing a minimum number of components and is especially adaptable to the control of a vaporizing or pot-type burner.

Safety regulations and requirements for efficient operation have necessitated a corresponding increase in the complexity and multiplicity of parts in conventional burner control systems. It is an object of this invention to provide a control system that contains all the safety features and provides cyclic operation to ensure timed sequential actuation of the control components without adding numerous components.

One of the objects of this invention is to provide sequential operation in a control system wherein the ignition means is deenergized immediately upon energization of the fuel supply means to prevent the ignition from being energized while the fuel is burning. This feature is desirable to lengthen the effective life of the ignition means.

Another object of the invention is to provide sequential operation in a control system wherein the blower supplying combustion air is maintained in operation at all times except during the ignition period. This feature is desirable to provide purge or evacuation periods prior to and after fuel burning operation, and to prevent blower interference during the ignition of the fuel.

A further object of the invention is to provide sequential operation under the guidance of a timer to ensure positive and definitive functioning of the components during a timed period.

These and further objects will be explained in the following description and more particularly pointed out in the appended claims.

In the drawing, Figure 1 shows a circuit diagram illustrating the electrical relationship between the control components; and Figure 2 shows a simple graph illustrating the control sequence of operation of the major burner components.

Referring now to Figure 1, a source of electrical supply (not shown), such as the conventional 110 volt domestic power source, has connected thereto a hot line **10** and a ground line **12**. A transformer **14** and more particularly its primary **16** is connected across the lines **10** and **12**. A normally closed limit switch **18** is interposed in series with the primary **16** and is operative to open the circuit upon the attainment of an undesirable high temperature in the burner or as a result of some other unsafe condition.

In parallel circuit with primary **16** and across the lines **10** and **12** is connected a blower motor **20** for supplying combustion air to the fuel burner. A relay switch A2, shown in normally closed position, controls the operation of motor **20**.

Also, in parallel circuit with primary **16** and with motor **20** is an ignition means **22** controlled by a normally open relay switch A1. The ignition means **22** may consist of an

electric hot wire type of ignitor which obtains incandescence after electrical energization thereof and maintains incandenscence for a period after electrical deenergization thereof, sufficient to ignite the fuel.

The previously described elements are located in the high voltage circuit (110 volt) of the control system. The following elements to be described are located in the low voltage secondary circuit. The use of a low voltage secondary is well known in the art and permits the use of more economical components without sacrificing safety and operating characteristics. The secondary **24** of transformer **14** is connected by wire **26** to a conventional type room thermostat **28**. The thermostat **28** operates to close a circuit between wire **26** and thermostat contact **30** upon a temperature drop below a set value. Contact **30** is subsequently described as the low fire contact because it completes a circuit to a fuel supply valve to provide a low metered flow of fuel to the burner to maintain a low fire condition during the ordinary operating cycle. A high fire thermostat contact **32** is provided which upon failure of the thermostat **28** to be satisfied on low fire will be engaged by the thermostat arm **29** to perform a high fire function. The high fire function will be later described in connection with its co-operating circuit.

A wire **34** connects contact **30** with a relay coil A. Relay coil A is connected by wire **36** to a bimetallic timer switch T1 and by wire **38** to a relay switch B1. The switches T1 and B1 are shown in their normally closed contact position. Note, that the position of all the switches as shown in the drawing represent the system in the standby position prior to a call for heat from the thermostat **28**. The other side of switch T1 is connected by wire **40** to a wire **48** which is connected to one side of transformer secondary **24**. The other side of switch B1 is connected by wire **42** to a normally open relay switch A3 and by wire **44** to a normally open relay switch B2. Switch A3 is connected by wire **46** to the wire **48** and transformer secondary **24**. Switch B2 is connected by wire **50** to the wire **48** and secondary **24** and by wire **52** to a timer heater T. The timer heater T is connected by wire **54** with contact **30**.

A wire **56** connects contact **30** with a second relay coil B. The other side of relay coil B is connected by wire **58** to a normally open relay switch A4. Relay switch A4 is an optional component and its specific purpose will be later described. A wire **60** connects switch A4 with a normally open bimetallic timer switch T2 which is connected to wire **48** by a wire **62**.

A wire **64** connects contact **30** with a fuel valve actuator **66** which may take the form of an actuating coil of a solenoid valve. A wire **68** conects the other side of valve **66** with switch A4, and wire **70** connects valve **66** with a normally open relay switch B3. Switch B3 is also connected by wire 72 to wire 48 and by wire **74** to a bimetal heater **76**. The heater **76** is connected by wire **78** to the high fire thermostat contact 32.

The relay coils A and B are composite units with their switches A1, A2, A3, A4, and B1, B2, B3, respectively, to form conventional relays which may be mounted on the primary control in a manner well known in the art. The switches A1, A3, A4, B2, and B3 are shown in the open contact position and switches A2, and B1 are shown in the closed contact position which are their positions at the point **80** or standby position of the operating cycle of Figure 2.

The timer heater T and bimetallic switches T1 and T2 form a timer unit whereby the switch T1 is in the closed contact position and switch T2 is in the open contact position, as shown, when the heater T is de-energized. Upon energization of heater T, the heat is transmitted to the

bimetals of the respective switches T1 and T2 and they are moved to their opposite positions after a timed interval of heating. Upon de-energization of heater T, the bimetals will flex back to their cold positions, as shown, after a timed interval of cooling.

The fuel valve actuator **66** has a solenoid coil which when energized moves a valve to a fuel flow position. A metering valve **77** may be located in the fuel supply line ahead of the main valve **66** to meter a definite quantity of fuel to the burner. Under ordinary heating conditions this amount of metered fuel will be sufficient to satisfy the thermostat demand. However, under extreme temperature demand conditions the thermostat will not be satisfied by the limited flow of fuel and the room or enclosure temperature will drop even though the heating system is operating and the thermostat arm **29** remains in engagement with contact **30**. Under these latter conditions the thermostat arm **29** will engage the high fire contact **32**. This action completes a circuit for energizing the bimetal heater **76** which acts upon the metering valve **77**, heretofore mentioned, to increase the flow of fuel to the burner. This latter position constitutes the high fire position of the control system. Both the low and high fire positions can be made adjustable to permit various degrees of fuel flow operation. The thermostat **28** can be adjusted to vary the temperatures at which the low and high fire positions are obtained.

Operation

The operation of the fuel burner system as applied particularly to a pot-type oil burner will now be described. With particular reference to Figure 2, which indicates by the heavy dark areas the energization of various functional components, the control system is assumed to be at the position **80**, which represents any position prior to starting. The time lengths between the positions on the graph are merely indicative of the relationship which may exist under one particular setting and may be correspondingly adjusted for different time intervals according to particular requirements. However, the relationship between the components and their positions of energization or deenergization is critical and important for any position or unit of time.

The moment of starting is indicated at "start" and is effected by the closing of thermostat **28** and arm **29** with contact **30** upon a demand for heat. This completes a circuit for the energization of relay coil A through the closed timer switch T1 and the energization of timer heater T through switches T1 and B1. The energization of relay coil A effects the closing of switches A1, A3, A4 and the opening of switch A2. The closing of switch A1 energizes the ignitor **20**, which may be a hot wire type of ignitor that reaches incandescence after a short time period of heating occasioned by the passage of electrical current therethrough. The opening of switch A2 deenergizes the blower motor **18** which has been effecting a purging or evacuation of unburned fuel remaining from the previous operating cycle. The closing of switch A3 completes a holding circuit, in conjunction with closed relay switch B1, around the time switch T1, to maintain energization of relay coil A and timer heater T. The closing of switch A4 does not immediately effect the completion of a circuit but acts to prepare a circuit for subsequent completion by another switch.

The energization of timer heater T starts a timing period for the system by means of the bimetallic switches T1 and T2 which are subsequently moved to their opposite positions in response to heat. The movement of switches T1 and T2 to their hot positions opens switch T1 and closes switch T2 which correponds to the position **82** of Figure 2. Thus, the time period between "start" and position **82** is determined by the length of time required for heater T to effect the switching action of bimetallic switches T1 and T2. This latter period may be adjustable by varying the resistance of heater T

to give different time periods according to individual requirements. The closure of switch T2 completes a dual circuit; the circuit through previously closed switch A4 to the relay coil B, and the circuit to the fuel valve actuator **66**. Operation of the fuel valve actuator **66** permits the flow of oil or other fuel to the burner where it is ignited by action of the ignitor **20** (previously energized). Note, that de-energization of the ignitor **20** is effected at this point (**82**) because the energized relay coil B opens switch B1 which breaks the circuit to the relay coil A (switch T1 opened by action of timer heater T) and thereby opens the switches A1, A3, and A4. Even with switch A1 in the open position, the ignitor **20** is sufficiently hot enough to provide fuel ignition for a period after de-energization thereof.

The energization of relay coil B closes switches B2 and B3 resulting in the completion of two holding circuits; switch B2 maintains the timer heater T energized after switch A3 opens, and switch B3 maintains the fuel valve actuator **66** energized after switch A4 opens. The de-energization of relay coil A closes switch A2 which completes the circuit for the blower motor **18** and combustion air is supplied to the burner to aid the fuel burning process. The de-energization of relay coil A also opens switches A3 and A4 which places the system under the control of relay B.

The operation of the burner is now complete and will continue until the thermostat **28** is satisfied or an unsafe condition results in safety shut-down. The latter condition may be provided for by the use of a dump bucket type safety control (not shown but well known in the art) which operates to shut down the system upon a failure of combustion or over-supply of fuel. The limit control **18** is also provided to shut down the system in the event of over-heating, etc. These controls are ancillary and form no part of the present invention.

In the event that insufficient heat is being supplied during the running period of the cycle (between positions **82** and "stop") the thermostat **28** and its arm **29** move into engagement with the high fire contact **32**. This action completes a circuit for the bimetal heater **76** which after a short heating period affects metering valve **77** in the fuel supply line to increase the volume and flow of fuel to the main fuel valve (operated by **66**) and the burner. For example, the thermostat **28** may be adjusted so that a drop of 2½ degrees below the demand setting (indicating a failure of the low fire system to satisfy the heat demand) results in engagement of thermostat arm **29** with contact **32** as well as with contact **30**. Upon completion or satisfaction of the heat demand, either in the low fire or high fire positions, the thermostat arm **29** breaks with contact **30** and of course contact **32** if it was previously engaged thereto. This action de-energizes the entire transformer secondary circuit and therefore relay coil B. The de-energization of relay coil B places the secondary circuit back in its standby or "stop" position with one exception. The system cannot immediately re-start in the event of a short off period because the timer heater T has just been de-energized. This means that for a timed period of cooling, the timer switches T1 and T2 remain in their hot position, i. e. switch T1 is open and switch T2 is closed. With switch T1 in the open position and relay switches A3 and B2 already in their open positions the starting relay coil A cannot be energized. Thus a forced time period is created after each operating cycle which prevents immediate recycling of the system and allows a purge period to be effected by the blower **18** during the cooling time of timer heater T.

Certain safety features of the invention will now be pointed out. In the event the electric power supplied to the system fails for any reason during the operating cycle, and the power failure is of short duration, i. e., for a time period less than the cooling time of heater T, the following safety feature results. The cessation of power de-energizes the system and the relay coils A and B return

their switches to the positions shown in the drawing. However, the thermostat arm **29** remains in engagement with contact **30** and the timer switches T1 and T2 are in their hot positions in contradistinction to their positions shown in the drawing, so that with re-occurrence of power the system would supply fuel to the burner without ignition, if it were not for relay switch A4. Relay switch A4 prevents the re-energization of relay coil B upon the occurrence of power failure of short duration. This condition may be further explained by assuming a circuit without switch A4. With the above conditions prevailing and the re-occurrence of power, the closed hot timer switch T2 would allow the energization of relay coil B and actuator **66** with the subsequent delivery of oil or fuel to the burner. The relay coil A remains de-energized because the open, hot timer switch T1 prevents energization thereof. Thus the ignitor **22** remains de-energized and having been in the cold position for some time is ineffective to ignite the delivered fuel. This condition would be, of course, quite dangerous and switch A4 is added to prevent the system from cycling in this manner, in that it requires the system to re-cycle from the beginning after the timer heater T has cooled sufficiently to return its switches to their cold positions.

Another safety feature is obtained by the use of timer heater T, the switches operated by it and switch A4. In the event that the thermostat **28** has just completed an operating cycle and someone turns it to a higher setting while timer heater T has insufficient time to cool, the resulting dangerous condition would be obviated because switch A4 in the open position would prevent immediate fuel delivery and the system would have to "wait" for the timer heater T to cool in order to re-cycle. This condition is equivalent to a short power failure.

Fuel delivery by actuator **66** is also prevented in the event of failure of the following components, timer heater T, relay coil A, and transformer **14**. This is a further safety feature.

Other possible safety features are evident and the invention is intended to be limited only by the scope of the appended claims.

What is claimed is:

1. In a fuel burner control system, a pair of terminals connectible to a source of electrical power; means for burning fuel including fuel supply means and an electrically operated blower motor for controlling combustion air; a first normally closed switch controlling said motor; a first series circuit coupled to said terminals comprising serially said first switch and said motor; said fuel supply means including an electrically operated control valve actuator; a heat retentive electrical ignitor for effecting ignition of said fuel after deenergization of said ignitor; a second normally open switch controlling said ignitor; a second series circuit coupled to said terminals comprising serially said second switch and said ignitor; a timer comprising an electrically operated actuator and timing switches operatively associated therewith for providing timed operation of said blower, ignitor and actuator; a temperature responsive element having switching means operatively associated therewith for initiating operation of the control system; a relay coil for operating said first and second switches and having a third normally open switch operatively associated therewith; a third series circuit coupled to said terminals comprising serially said switching means, said coil and a first normally closed one of said timing switches; a normally closed control switch; a fourth series circuit coupled to said terminals comprising serially said switching means, said timer actuator, said normally closed control switch, and said first normally closed one of said timing switches; a fifth series circuit coupled to said terminals comprising serially said switching means, said valve actuator, said third normally open switch and a second normally open one of said timing switches; a normally open control switch; a sixth series circuit coupled to said terminals comprising serially said switching means, said timer actuator, and said normally open switch; said relay coil and timer actuator being controlled by said temperature responsive element in response to a demand for heat to close said second switch energizing said ignitor and to open said first switch deenergizing said motor after a period of purging of the system; means automatically effective to operate said normally open control switch and said normally closed control switch upon operation of said second one of said timing switches; said second one of said timing switches upon closing after a predetermined time period effecting operation of said valve actuator and simultaneously deenergizing said relay coil to deenergize said ignitor and reenergize said blower.

2. In a fuel burner control system, a pair of terminals connectible to a source of electrical power; means for burning fuel including fuel supply means and an electrically operated fuel valve actuator controlling flow of fuel; a timer including an electrically operated actuator and timing switches operatively associated therewith for energizing said valve actuator; a heat retentive electrical ignitor capable of ignition for a period after electrical deenergization thereof for effecting ignition of said fuel; a first normally open switch controlling said ignitor; a first series circuit coupled to said terminals comprising serially said switch and said ignitor; a relay coil for operating said switch and having a second switch operatively associated therewith; a temperature responsive element having switching means operatively associated therewith for energizing said relay coil and said timer actuator in response to a demand for heat; a second series circuit coupled to said terminals comprising serially said switching means, said relay coil, and a first normally closed one of said timing switches; a third series circuit coupled to said terminals comprising serially said switching means, said valve actuator, a second normally open one of said timing switches, and said second switch; a normally closed control switch; a fourth series circuit coupled to said terminals comprising serially said switching means, said timer actuator, said normally closed control switch, and said first one of said timing switches; said relay coil closing said first switch to energize said ignitor; a normally open control switch, a fifth series circuit coupled to said terminals comprising serially said switching means, said timer actuator, and said normally open control switch; means automatically effective to operate said normally open control switch and said normally closed control switch upon operation of said second one of said timing switches; said timer actuator operating said second one of said timing switches to energize said valve actuator after a timed period to supply fuel to the burner and to energize said automatic means to simultaneously deenergize said relay coil to deenergize said ignitor.

3. In a fuel burner control system, a pair of terminals connectible to a source of electrical power; means for burning fuel including fuel supply means and an electrical blower motor for controlling combustion air; a first normally closed switch; a first series circuit coupled to said terminals comprising serially said first switch and said motor; said fuel supply means including a control valve actuator; a heat retentive electrical ignitor capable of ignition for a period after electrical deenergization thereof for effecting ignition of said fuel; a second normally open switch controlling said ignitor; a second series circuit coupled to said terminals comprising serially said second switch and said ignitor; a relay coil for operating said first and second switches and having a third switch operatively associated therewith, a temperature responsive element including switching means for energizing said relay coil in response to a demand for heat; timing means including an electrical timing actuator and timing switches operatively associated therewith controlled by said temperature responsive element providing timed operation of said blower, ignitor and valve actuator; a

third series circuit coupled to said terminals comprising serially said switching means, said relay coil, and a first normally closed one of said timing switches; a normally closed control switch; a fourth series circuit coupled to said terminals comprising serially said switching means, said timing actuator, said normally closed control switch, and said first one of said timing switches; a fifth series circuit coupled to said terminals comprising serially said switching means, said valve actuator, a second one of said timing switches, and said third switch; a normally open control switch, a sixth series circuit coupled to said terminals comprising serially said switching means, said timer actuator and said normally open control switch; means automatically effective to operate said normally open control switch and said normally closed control switch upon operation of said timing switches; said relay coil upon energization thereof closing said second switch to energize said ignitor and opening said first switch to deenergize said blower motor, and said second of said timing switches effecting operation of said valve actuator after a time period sufficient to obtain ignition of said fuel.

4. In a fuel burner control system, a heat responsive element including first switching means operatively associated therewith; means for burning fuel including fuel supply means and an electrical blower for controlling combustion air; electrical fuel igniting means; a relay coil having second switching means operatively associated therewith for alternatively energizing said motor and deenergizing said igniting means; electrical timing means having an electrical actuator and a normally closed timing switch operatively associated therewith; a first energizing circuit for said coil comprising serially said first switching means, said coil and said normally closed timing switch; a normally closed control switch; a second energizing circuit for said actuator comprising serially said first switching means, said actuator, said normally closed control switch and said timing switch; a normally open control switch; and a third energizing circuit for said actuator comprising serially said first switch means, said actuator, and said normally open control switch; and means automatically effective to operate said normally open control switch and said normally closed control switch upon operation of said timing switch.

5. An arrangement as set forth in claim 4 wherein said fuel supply means includes an electrically operated valve actuator; said relay coil having other switching means operatively associated therewith; said timing means having a normally open timing switch; and an energizing circuit for said control valve actuator comprising serially said first switching means, said other switching means and said normally open timing switch.

6. In a fuel burner control system, means for burning fuel including fuel supply means and an electrical blower motor for controlling combustion, electrical fuel igniting means; a relay coil having first switching means operatively associated therewith and arranged to normally energize said motor and to normally deenergize said igniting means; heat responsive means having second switching means operatively associated therewith; electrical time delay means having an actuator and an associated timing switch for instituting a time delay; a normally closed control switch; first circuit means for energizing said actuator through said second switching means and said normally closed control switch and said timing switch to initiate said time delay; second circuit means for energizing said coil through said second switching means and said timing switch to effect deenergization of said motor and energization of said igniting means during the interval of said time delay; a normally open control switch; third circuit means for energizing said actuator through said second switch means, and said normally open control switch; and means automatically effective upon operation of said timing switch for operating said normally open control switch and said normally closed control switch.

7. An arrangement as set forth in claim 6 wherein said fuel supply means includes an electrically operated control valve actuator; said relay coil having other switching means operatively associated therewith; said time delay means having an additional timing switch operatively associated therewith; and an energizing circuit for said valve actuator including serially said second switching means, said other switching means and said additional timing switch.

8. In a fuel burner control system, means for burning fuel including fuel supply means and an electrical blower motor for controlling combustion; electrical fuel igniting means; a relay coil having first switching means operatively associated therewith and arranged to normally energize said motor and to normally deenergize said igniting means; heat responsive means having second switching means operatively associated therewith; electrical time delay means having an actuator and an associated timing switch for instituting a time delay; a normally closed control switch; first circuit means for energizing said actuator through said second switching means and said normally closed control switch, and said timing switch, to initiate said time delay; second circuit means for energizing said coil through said second switching means and said timing switch to effect deenergization of said motor and energization of said igniting means during the interval of said time delay; a normally open control switch; third circuit means for energizing said actuator through said second switching means, and said normally open control switch; means automatically effective upon operation of said timing switch for operating said normally open control switch and said normally closed control switch; said fuel supply means including an electrically operated control valve actuator; said relay coil having other switching means operatively associated therewith; said time delay means having an additional timing switch operatively associated therewith; an energizing circuit for said valve actuator including serially said second switching means, said other switching means, and said additional timing switch; said means automatically effective to operate said normally open and said normally closed control switches including a second relay coil with said control switches being operated by said second relay coil; and said second relay coil being connected in parallel with said valve actuator.

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