Feb. 18, 1969 J. R. WILLSON 3,428,041

HEATING CONTROL SYSTEM WITH TIME DELAY RELAY

Filed June 6, 1967 Sheet 1 of 2

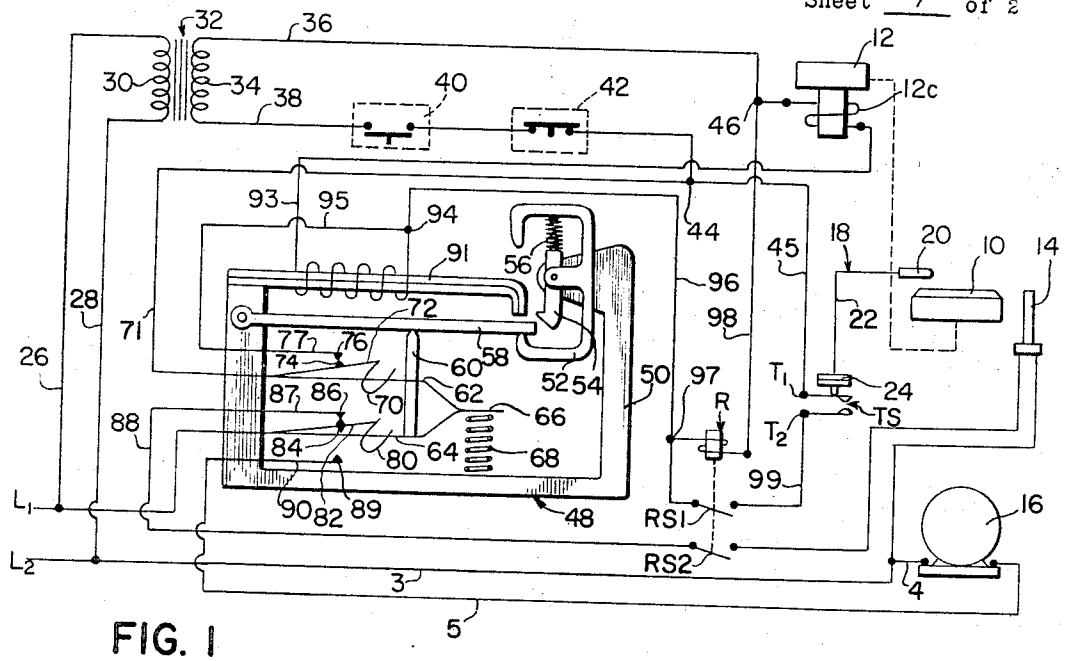

FIG. 1

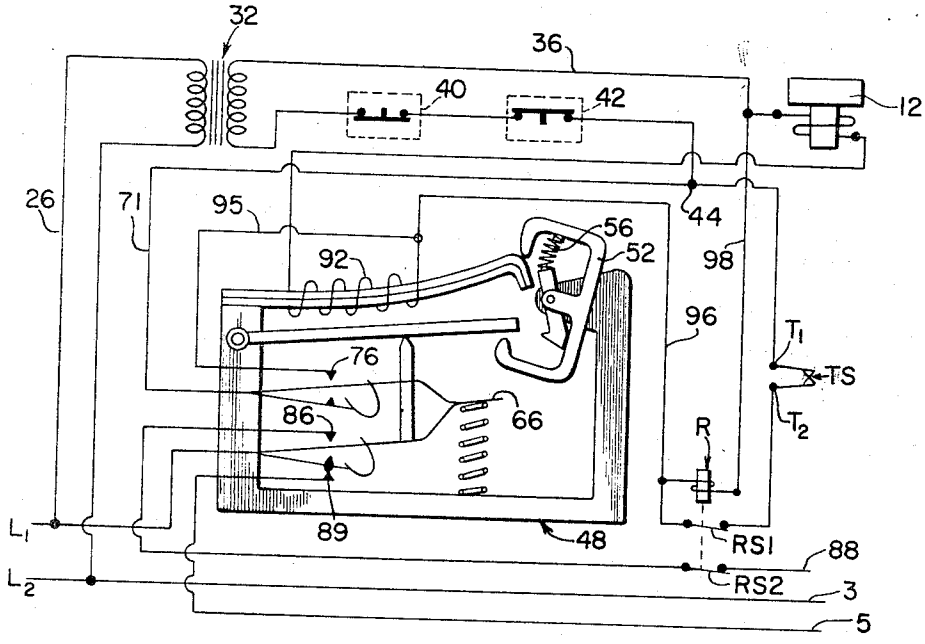

FIG. 2

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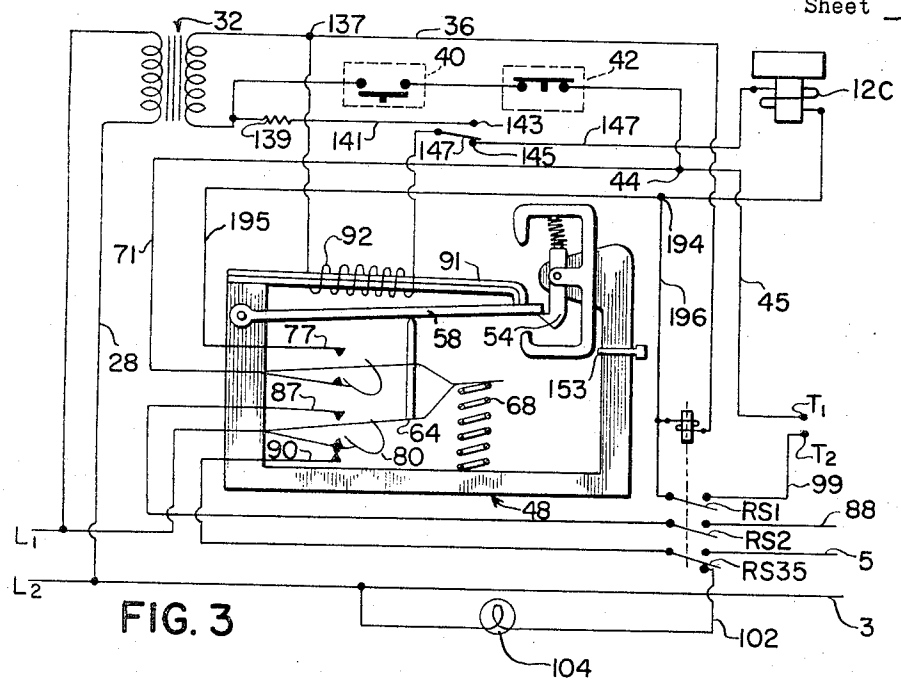

FIG. 3

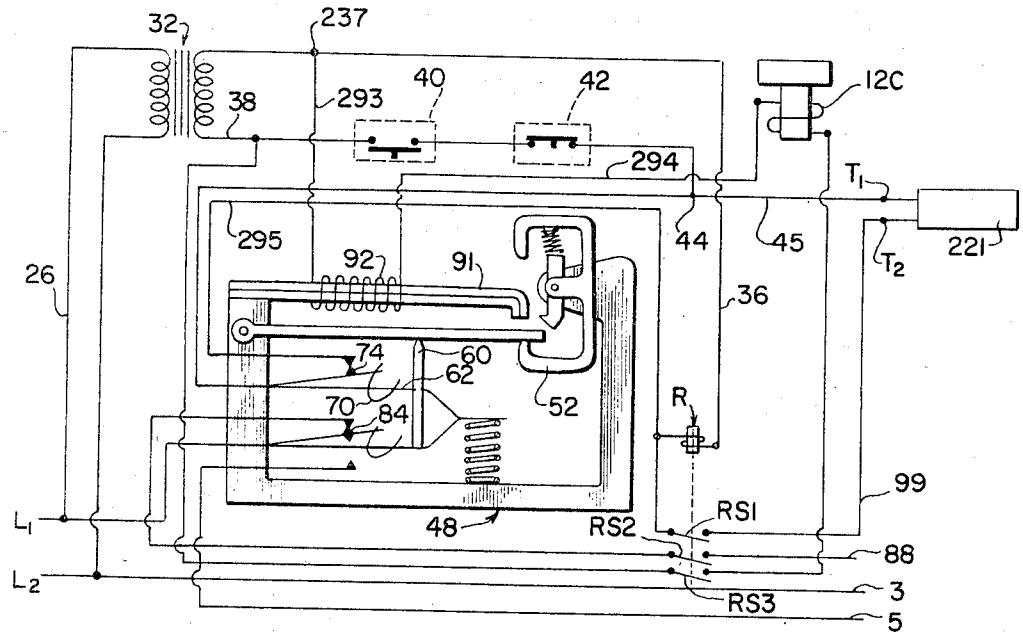

FIG. 4

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HEATING CONTROL SYSTEM WITH TIME DELAY RELAY

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Int. Cl. F24h 3/02; F23n

ABSTRACT OF THE DISCLOSURE

A forced air heating control system including a time delay relay having a bimetal strip and a mechanical latching member which cooperate to open and close circuits to a heater fan and an electric igniter.

Background of the invention

The invention relates to a heating control system and mor particularly to time delay control relays and relay circuits for forced air heating systems.

In order to maintain an adequate heat level in an area from a remote heater installation, it has been found that the electrical circuit for the circulating fan of a forced air heating system can be suitably opened or closed by a time delay relay operable in response to the on-off temperature control of the area being heated. Many of these heater installations such as roof top units, also generally require electric ignition systems for dependable operation. In these systems it is desirable to have an automatic ignition device with flame proving means which may be operable in response to the same on-off temperature control that initiates the starting and stopping of the fan.

Summary of the invention

The invention is generally characterized in that a time delay relay which is in the electrical circuit for the circulating fan of a forced air heating system is also in electrical circuit with the furnace igniter and a flame sensing element. A single time delay relay including a bimetallic strip and a mechanical latching member cooperate to connect a fan and an igniter in electrical circuit when a room thermostat calls for heat but provides temporary protection to spurious electrical or flame interruptions and lock-up protection to the system if the furnace fails to ignite.

Some important advantages of this invention are that it provides lock-up to a safe position when hazardous conditions are present while permitting continuous electrical ignition and fan starting when momentary electrical or flame interruptions occur. The use of a single time delay relay in the heating control circuit insures automatic furnace, fan and electric igniting start and stop operations in response to a thermostatic control switch while at the same time providing maximum safety features.

It is, therefore, an object of the present invention to provide a novel heating control circuit for automatically starting a fan and allowing electric ignition of the furnace in response to the operation of a remote control switch, and in addition, to provide a novel time delay relay for controlling the switching of electrical control circuits in a forced air heating installation.

Brief description of the drawings

FIG. 1 is a circuit diagram of an embodiment of the invention illustrating the heating control system in an off position;

FIG. 2 is a circuit diagram of the embodiment of FIG. 1 illustrating the system in an on position;

FIG. 3 is a circuit diagram similar to FIG. 1 with additional components and illustrating the system in a lock-up position; and

FIG.4 is a circuit diagram of another embodiment of the invention.

Description of the preferred embodiments

As is illustrated in FIG. 1, a forced air heating system includes a main burner **10** being supplied with a flow of fuel under the control of a solenoid operated valve **12** and being ignited by an electric igniter **14**; an electric circulating fan **16** forces air heated by burner **10** to a space that is to be temperature controlled. A flame responsive assembly, indicated generally at **18**, includes a thermal bulb **20** disposed to sense the flame at the burner **10**, a capillary tube **22** and a contractable and expansible bellows or power element **24**; the bulb **20**, capillary tube **22** and power element **24** constitutes a closed system filled with a thermally responsive fluid, such as mercury, whereby the presence of a flame at the burner **10** effects an expansion of the power element **24** for a purpose to be described hereinafter.

An electric circuit for controlling the heating system is supplied over power leads L_1 and L_2 from any suitable power source, which are connected by conductors **26** and **28**, respectively, to the primary winding **30** of a transformer **32**. Assuming a 110 volt source at leads L_1 and L_2, the transformer **32** is stepped down to 24 volts at its secondary winding **34** that has conductors **36** and **38**. A conventional space thermostat **40**, suitably located in the space being temperature controlled, and a conventional high limit switch **42**, suitably located in the plenum chamber of the furnace embodying the burner **10**, are serially connected in the conductor **38** which extends at a common junction **44**, while the conductor **36** extends to a common junction **46**. A conductor **45** extends from the common junction **44** to the terminal T_1 connected to a thermal switch TS that is operated between open and closed positions by the power element **24**.

A time delay relay, indicated generally at **48**, includes a generally U-shaped frame **50**, one end of which pivotally carries an E-shaped lifter **52** and a latch bar **54** on a common pivotal axis. The latch **54** is transversely disposed to the center leg of the lifter **52** and a coil spring **56** is mounted in compression between the top of the latch **54** and the top leg of the lifter **52**. A lever arm **58** is pivotally mounted adjacent the opposite end of frame **50** so that its free end extends into the space defined by the E-shaped lifter. An operating rod **60** engages the undersurface of the lever arm **58** and is secured to spaced actuating blades **62** and **64** having free ends integrated at **66** which is biased by a coil spring **68** mounted in compression between the actuating blade end **66** and the bottom wall of frame **50**.

An overcenter U-shaped spring **70** is mounted between a cutout edge of actuating blade **62** and an edge of an actuated blade **72** which is formed as a tongue in the cutout portion of the actuating blade **62** and which is electrically connected to a conductor **71** extending to the common junction **44**. The specific details of the snap acting switch elements may take any suitable form, such as illustrated in U.S. Patents No. 2,237,705 and No. 2,458,518. The actuated blade **72** is made of a current conducting material and carries a contact **74** for movement into and out of engagement with a fixed contact **76** mounted on a fixed blade **77** also of current conducting material. The other actuating blade **64** is similar to blade **62** and includes the similar elements of overcenter spring **80**, actuated blade **82** but having a double faced contact **84** thereon for cooperation in one position with a fixed contact **86** on an upper fixed blade **87** and in an opposite position with a fixed contact **89** on a lower fixed blade **90**. A bimetal element **91** has one end secured to

the top of frame **50** on the end above the pivot mount for lever arm **58** and extends superimposed thereover with a transversely bent end portion disposed for engaging the free end of the lever arm **58**.

An electric heating coil **92** is wound around the bimetal **91** and has one end connected to a conductor **93** which is connected to the common junction **46** and includes a series connection with the solenoid coil **12***c* of the valve **12**. The other end of heating coil **92** is connected to a common junction **94** having one conductor **95** connected to the fixed blade **77** and another conductor **96** connected to a common junction **97**. A conductor **98** from the common junction **46** to the common junction **97** includes the coil of a relay R which has a pair of normally open switches RS1 and RS2. The relay switch RS1 is serially connected in a conductor **99** extending from the common junction **97** to the terminal T_2 connected to the thermal switch TS. The relay switch RS2 is serially connected in a conductor **88** extending from the fixed blade **87** to the igniter **14** and the other conductor **3** for the igniter **14** is directly connected to the lead line L_2. The circulating fan **16** has a pair of terminal posts, one of which is connected by a conductor **4** to the conductor **3** and the other of which is connected by a conductor **5** to the lower fixed blade **90**.

In the following description of a sequence of operation, it is to be understood that the heating system components including elements **10, 14, 16, 18, 20, 22** and **24** are also part of FIGS. 2, 3 and 4, but have not been shown thereon for the sake of brevity. FIG. 1 represents the various positions of the control components when the space thermostat **40** is open, i.e., contacts **76** and **86** are closed by switch arm blade contacts **74** and **84**, respectively; contact **89** is open so the circulating fan is deenergized; and, the relay switches RS1 and RS2 are open to the igniter **14** cannot be energized.

When space thermostat **40** calls for heat, it is closed as shown in FIG. 2 and completes a circuit traced as follows: from the secondary winding **34** of the transformer **32** through the conductor **38**, the closed spaced thermostat **40**, the normally closed limit switch **42**, common junction **44**, conductors **71**, blade **72**, contacts **74** and **76**, blade **77** and conductor **95** to common junction **94**; thence through a series connected network comprising the heater coil **92**, conductor **93**, control valve coil **12***c*, common junction **46** and conductor **36** to the other side of the transformer secondary **34**, with the coil of relay R being in a parallel circuit between the common junctions **94** and **46** by means of conductor **96**. Accordingly, the control valve **12** is opened so there is a flow of fuel to the burner **10**, which is ignited by the igniter **14** which is energized by a circuit traced from power line L_1 through blade **82**, contacts **84** and **86**, fixed blade **87**, conductor **88** and closed relay switch RS2, the igniter **14** and conductor **3** to the power line L_2.

At the same time, the energized heater coil **92** in the time delay relay **48** effects heating of the bimetal **91** which is caused to bend upwardly and eventually pivot the lifter **52** clockwise as viewed in FIG. 2. The bottom leg of lever **52** also commences the upward movement of the lever arm **58** whereby the operating rod **60** and the attached actuating blades **62** and **64** are aided in their upward movement by the coil spring **68**; during such movement blades **62** and **64** cause rotation of their respective overcenter springs **70** and **80** until they pass dead center positions, after which the movable switch blades **72** and **82** are moved with a snap action to their positions shown in FIG. 2 wherein contacts **76** and **86** are open and contacts **84** and **89** are closed. Closure of contacts **84** and **89** completes a circuit for the circulating fan traced from power line L through movable blade **82**, closed contacts **84** and **89**, fixed blade **90**, conductor **5**, terminals on the circulating fan **16**, conductor **4** and conductor **3** to the power line **5**. Thus, a short time after the burner **10** is ignited, the circulating fan **16** is energized to force the warm air through the heating system.

The opening of the contact **86** opens the circuit for the igniter **14** which is deenergized. However, the burner **10** continues to operate so that the flame sensor bulb **20** is heated and the resulting expansion of the power element **24** closes the thermal switch TS. The contact **76** is opened simultaneously with the opening of contact **86**, however, the heating coil **92** remains energized by another circut including the thermal switch TS. The bimetal **91** and heating coil **92** have a predetermined time delay characteristic which is greater than the time it takes for the closure of the thermal switch TS by the flame sensor assembly **18–24**; thus, the thermal switch TS closes before the bimetal **91** effects opening of control **76**. With normal operating conditions, the system will function automatically with the burner **10** being cycled thermostatically in response to operation of the space thermostat **40**.

When undesirable interruptions occur after ignition, the operation of the time delay relay provides the control system with several protective features. Such interruptions which might be likely to occur are those due to a power failure, a rapid opening of the thermostat contacts or by an opening of the flame sensor contacts after a flame failure. An interruption of this nature will cause relay R to return to its normal position, gas valve **12** to immediately close and time delay relay **48** to return to its normal position.

When this happens recycling occurs in the same way as when controlled by the space thermostat **40**.

If ignition does not occur, however, the flame switch TS will not close before the time delay relay **48** pulls in. Relay R is then released through the opening of switch **76** and the heater coil **92** is deenergized. With flame switch TS opened, bimetal **91** does not continue to bend far enough to clear the latch **54** and is brought into the lock-up position shown in FIG. 3.

In this position, even though bimetal **91** cools, switches **62** and **64** cannot transfer their contacts back to their normal position because of the latch **54**. Gas valve **12**, therefore, cannot open and the igniter **14** is prevented from being energized. To be released from the lock-up position, the bimetal **91** must either be heated sufficiently to clear the latch **54** or a manual release in the form of a push button **153** acts on the lifting member **52** may be provided.

An electrical reset for so heating the bimetal **91** is shown in FIG. 3 wherein an electrical switch **143, 145** and **147** is connected through a conductor **14** and a resistor **139** to the conductor **38** and thus remove the time delay relay **48** out of lock-up. A third relay switch RS35 is also shown in FIG. 3 which connects a lamp **104** and its conductor **102** to the conductor **3** in order to indicate lock-up conditions.

FIG. 4 shows a modified heating control system which may be employed with a thermistor type of flame sensor. With this embodiment the electrical load of the gas valve **12** and heater coil **92** are carried by relay switch RS3 to minimize the load on the thermistor **221**. Relay R operates switch RS3 and switches RS1 and RS2 in the thermistor path and conductor **88**, respectively. The system operation is similar in all other respects to that described in the embodiment of FIGS. 1 and 2.

In the event that the time delay relay **48** fails in the embodiments described, interruption of the main burner gas at the end of the delay period is provided by wiring the gas valve **12** in series with the time delay heater **92**. With this provision, any failure of the time delay relay heater, disconnected wires, or bimetal failure will result in a fail safe or lock-up position.

Inasmuch as many changes could be made in the above constructions and many more widely different embodiments of the present invention could be made without departing from the scope thereof, it is intended that all matter contained in the foregoing description or shown

in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In a heating control system, the combination including a fan motor for circulating air heated by a burner, an electric igniter for said burner, a thermostatic switch movable between on and off positions, and an electrical input circuit comprising:

a bimetal heating element,

a first time delay switch,

a second time delay switch,

a heating network for said bimetal heating element including said first time delay switch connected to said input circuit in response to said thermostatic switch being in its on position,

means including said second time delay switch connecting the igniter to the input circuit in response to said thermostatic switch being in its on position, and

means responsive to said bimetal element after a predetermined time delay for disconnecting said first time delay switch from the heating network and for switching the input circuit from the igniter to the fan motor with said second time delay switch.

2. The combination of claim 1 wherein said time delay switches have a normal position and an active position, means in said heating network for returning said time delay switches to their normal positions in response to spurious electrical or flame interruption signals, and means in said responsive means for preventing said switches from returning to their normal positions in response to a lock-up signal.

3. The apparatus of claim 1 wherein said heating network comprises a heating coil wound around said bimetal electrically connected between the thermostatic switch and said first time delay switch, a flame sensing circuit connected between the thermostat and said coil, said flame circuit closing an electrical current path to said coil in response to a flame signal, and said bimetal moving said responsive means to a recycle position in response to heating signals from both said time delay circuit and said flame sensing circuit.

4. The apparatus of claim 3 wherein said responsive means establishes a lock-up condition in response to heating signals only from said time delay circuit.

5. The apparatus of claim 3 wherein said responsive means includes a latching member for holding said first and second time delay switches in a lock-up position in response to a lock-up signal.

6. In a heating control system having a fan motor for circulating air heated by a burner and an electric igniter for said burner, the combination including

a thermostatic control switch,

an electrical current input circuit,

flame sensing means,

a third delay relay circuit comprising a relay heating switch and an electric igniter switch each having a normal position and an active position,

a bimetal strip,

an electrical heating element in the vicinity of said bimetal strip,

means actuable by said bimetal strip for moving said switches from their normal positions to their active positions after a predetermined time delay,

said heating switch in the normal position connecting the heating element in a first heating circuit with the thermostatic switch and said input circuit,

said ignition switch in the normal position connecting the igniter to said input circuit and in said active position connecting the fan motor to the input circuit,

relay means connected to said thermostatic switch for connecting a second heating circuit to said heating element, and

said first and second heating circuits during normal operation supplying sufficient heat to bend the bimetal for a period of time greater than said predetermined time for moving said actuable means to a recycle position.

7. The system of claim 6 further comprising means for returning said time delay switches to their normal positions for system recycling in response to spurious electrical or flame interruption signals.

8. The system of claim 6 further comprising means for locking said switches in their active positions in response to lock-up protection signals, and means for preventing system recycling in response to said lock-up signals.

References Cited

UNITED STATES PATENTS

2,160,592	5/1939	King	236—11
2,375,900	5/1945	De Lancey.	

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U.S. Cl. X.R.

236—11