Feb. 27, 1968 P. ROMANELLI 3,370,436

COMBINED GAS AND ELECTRIC CONTROL SYSTEM FOR REFRIGERATOR APPLIANCES

Filed Dec. 12, 1966 2 Sheets-Sheet 1

FIG. 1.

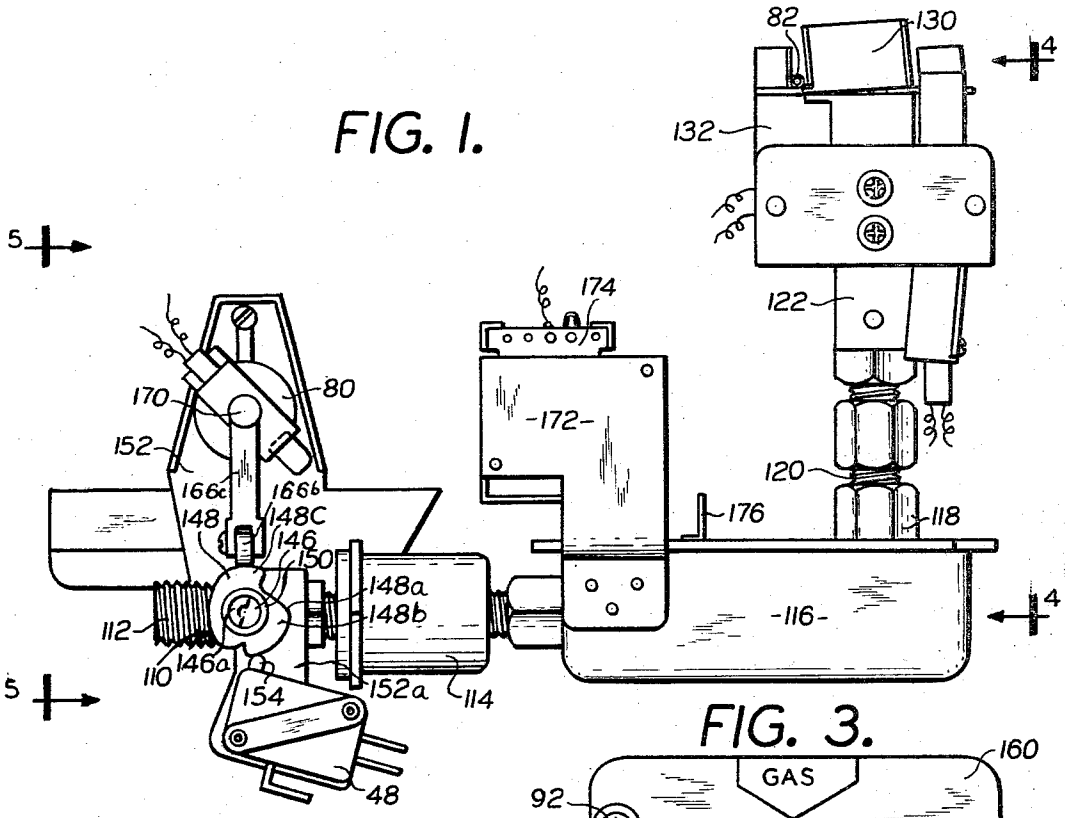
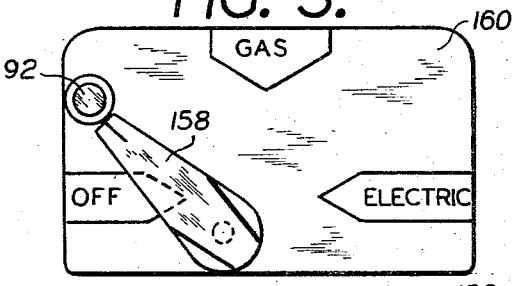


FIG. 3.



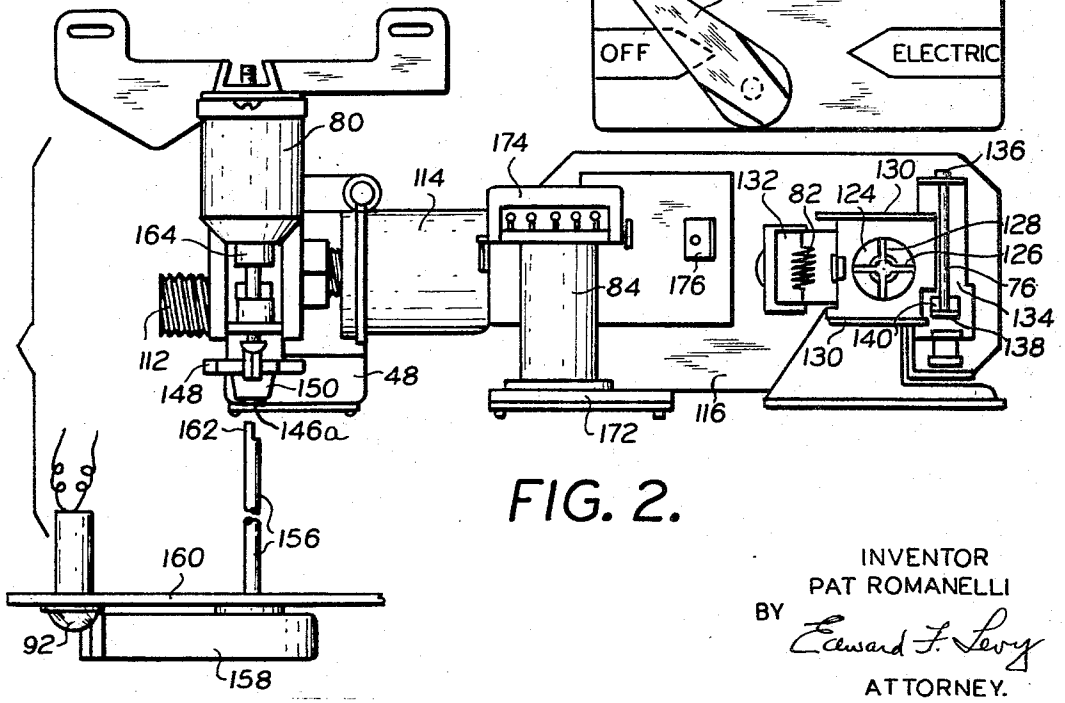


FIG. 2.

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FIG. 4.

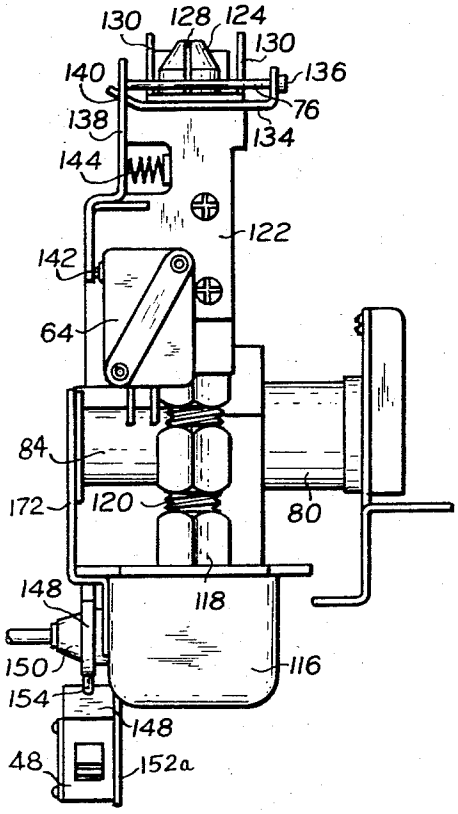


FIG. 5.

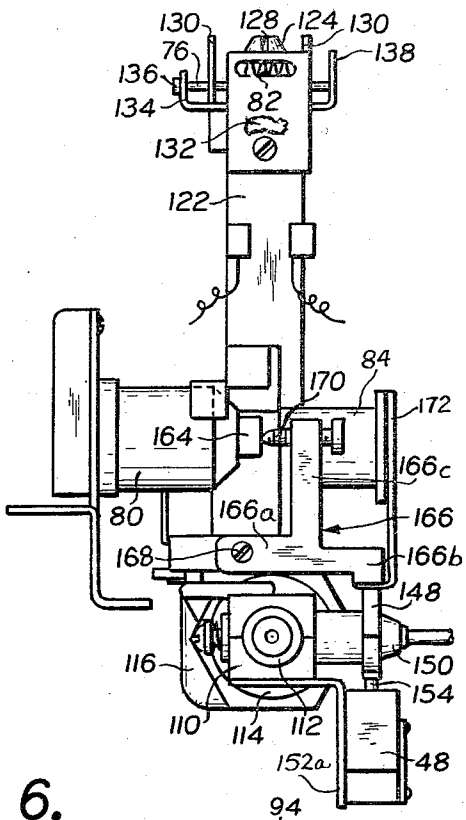
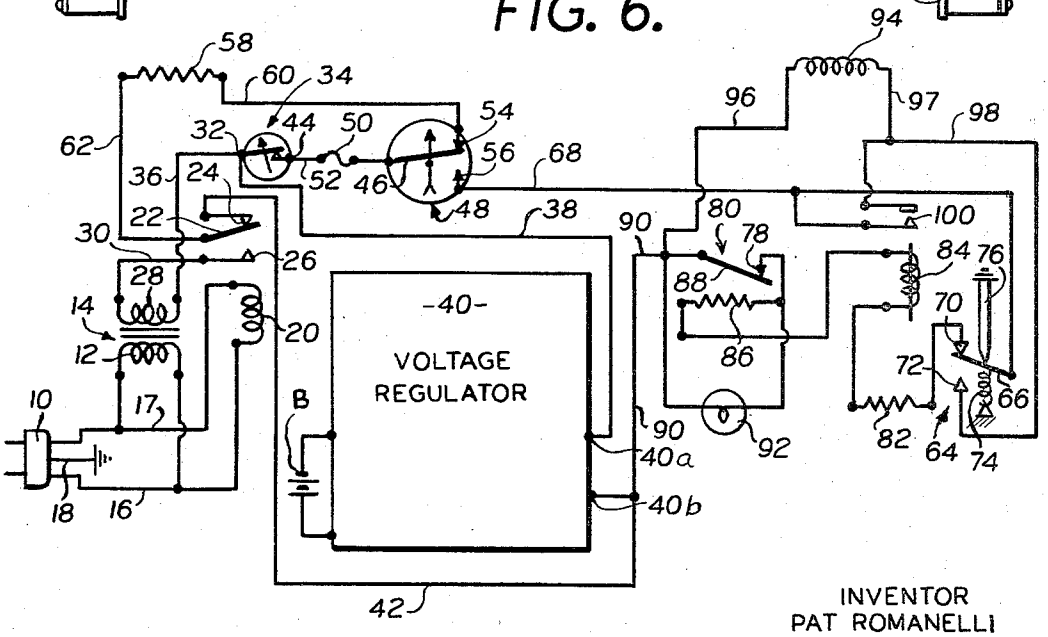


FIG. 6.



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United States Patent Office 3,370,436
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3,370,436

COMBINED GAS AND ELECTRIC CONTROL SYSTEM FOR REFRIGERATOR APPLIANCES

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Filed Dec. 12, 1966, Ser. No. 600,820
10 Claims. (Cl. 62—148)

This invention relates to improvements in control systems for gas operated and electrically operated appliances, and has particular application to a control system for a refrigerator or the like having both gas and electrical actuating means.

The invention is particularly directed to small semi-portable refrigerator units which are commonly used in automobile trailers or the like. A popular type of such refrigerator unit includes a refrigerating system which is selectively operable either by an electrical circuit or by a separate gas system at the option of the user. In such existing systems, the electrical circuit and gas system are entirely independent of each other, requiring two separate thermostats, one for the electrical circuit and one for the gas system.

A disadvantage of the existing gas-electric refrigerator systems resides in the fact that since the gas and electric systems are entirely independent, the gas sector must be manually ignited and controlled to produce a gas flame, and requires the use of a thermal mechanically-operated valve which must be pre-heated before it can be thermostatically modulated. These valves, while necessary to insure that no gas escapes while the refrigerator system is electrically operated, are a constant source of complaint. First, the valve must be preheated by applying a match flame to a zip tube or the like, requiring the zip tube valve button to be manually depressed and held for feeding gas thereto for a period of time while a bimetallic unit within the body flexes to permit gas flow. The valve, once open, will remain so as long as the flame is burning and its body is thus heated. If the valve body temperature decreases due to extinguishing of the flame or insufficient flame, the valve will shut down with a subsequent loss of refrigeration, and there is no indicating means to advise the user that the refrigerator is inoperative.

Since the aforementioned standard valve burners have a low heat output, they are very sensitive to drafts and gusts of wind which are prevalent where the trailer is being towed, and where the possibility of flame-out due to drafts and wind concussion from passing vehicles is increased. Thus, operation of existing gas-electric refrigerators tends to be faulty and uncertain at best.

It is an object of the present invention to provide an improved refrigeration system of the character described which eliminates the aforesaid problems and disadvantages by including a combined gas and electric actuating and control system which may be selectively operated so that the refrigeration unit is operated either by a gas heater or an electric heater, but in which the gas system is controlled by the electrical system for completely automatic ignition.

Another object of the invention is the provision of a refrigeration system of the character described which operates from a single battery, such as an automobile storage battery, for use in a portable or semi-portable refrigerator or the like adapted to be installed in trailers, portable homes, etc., but which is also adapted to be connected with a standard house line source.

Another object of the invention is the provision of a refrigeration system of the character described in which both the electrical actuating circuit and gas actuating system are controlled by a single electric thermostat, and only one gas connection is required, eliminating numerous

fittings and points of leakage, and avoiding duplications of parts.

Another object of the present invention is to provide a control system for a gas or electrically operable appliance, such as a refrigerator, which is compact in size, simple in operation and economical to produce.

A further object of the present invention is to provide a control system for a gas or electrically operated appliance which automatically ignites the gas and which is also adapted to shut off the flow of the gas in the event that ignition of the gas is not accomplished.

In accordance with the invention there is provided a refrigerator unit adapted to be operated through the application of heat by either an electric heater element, or a gas burner. The electric heater element is included in an electrical circuit which may be selectively connected to a battery power source or to an A.C. line source for energization of the heater element. The gas burner system is also controlled by a second electrical circuit operable by said battery and including portions of the first circuit. A selector switch manually operable from the exterior of the refrigerator unit is employed for selecting either heater element or the gas burner for energizing the refrigerator system, by completing the appropriate circuit. The second electrical circuit includes an electric ignition element located proximate to the mouth of the gas burner and energized upon completion of the second electrical circuit to ignite the gas flowing therethrough, and a solenoid-actuated valve for controlling the flow of gas through the burner. The second circuit also includes a heat-responsive element located in proximity to the burner mouth for deenergizing the ignition element when the gas emitted by the burner is ignited, in addition to a safety switch for opening the second circuit in the event that the gas is not ignited after a predetermined period. A single thermostat-controlled switch controls both the first and second circuits in accordance with the temperature achieved by the refrigerator system.

Other objects and features of the present invention will become more apparent from a consideration of the following description when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a front elevational view of a control system constructed according to the present invention;

FIG. 2 is a top plan view of the control system;

FIG. 3 is a front elevational view of the control panel of the system shown in FIG. 1;

FIG. 4 is an end view of the system shown in FIG. 1 as seen looking from the right;

FIG. 5 is an end view of the system shown in FIG. 1 as seen looking from the left; and

FIG. 6 is a schematic circuit wiring diagram of a control system constructed in accordance with the present invention.

As noted hereinabove, the system of the present invention is adapted to control a gas or electrically operated appliance. In the description which follows, reference will be made to the system of the present invention for use in conjunction with a refrigerator having an ammonia evaporated system which may be operated by gas power or by electrical power.

The elements comprising the control system of the present invention are illustrated in FIGS. 1–5, and the electrical connection between these elements are shown in the schematic circuit diagram of FIG. 6, to which reference is now made.

The electrical circuit includes a standard electric plug **10** which is connected to the primary winding **12** of a transformer **14** by leads **16, 17**. The plug **10** is adapted to be connected with a conventional house outlet to supply 110 volt alternating current to the circuit of the present

invention. The plug **10** may be of the three-prong type wherein one prong is connected to ground by a lead **18**. Also connected to the plug **10**, in parallel with the primary winding **12** is the winding of a relay **20**. The relay **20** includes a movable armature **22** which normally engages a contact **24** and which is adapted to engage a contact **26** when the relay winding is energized.

The transformer **14** is of the step-down type and includes a secondary winding **28**. In practice, the transformer **14** is adapted to convert the voltage applied to the primary winding **12** from 110 volts to 12 volts which appears across the secondary winding **28**.

One terminal of the secondary winding **28** is connected to the contact **26** by a lead **30**. The other terminal of the winding **28** is connected to a terminal **32** of a thermostat switch **34** by a lead **36**. Also connected to the terminal **32** by a lead **38** is one output terminal **40***a* of a voltage regulator **40**. The other output terminal **40***b* of the voltage regulator **40** is connected to the contact **24** by a lead **42**. The input terminals of the voltage regulator **40** are connected across a battery B which, in practice, is a 12 volt battery.

The thermostat switch **34** is a single-pole, single-throw switch adapted to be opened by a thermostat located in the freezer compartment when the temperature theerof drops to a preset level thereby to deenergize the heating elements of the present circuit.

The other terminal **44** of the switch **34** is connected to the arm **46** of a selector switch **48**, through a fuse **50**, by a lead **52**. The arm **46** of the switch **48** is selectively and manually operable to be connected with a contact **54** or a contact **56** to respectively place the circuit of the present invention in its electrical control mode or its gas control mode.

The contact **54** of selector switch **48** is connected to one terminal of an electrical heater element **58** by a lead **60**. The opposite terminal of heater element **58** is connected to the armature **22** of relay **20** by lead **62**. The heater element is associated with the refrigerating system of the refrigerator unit for independently supplying heat energy for the operation thereof. This is accomplished with the circuit portion heretofore described, when the selector switch **48** is set with the arm **46** engaging contact **54**.

With switch **48** set for electric operation, the heater element **58** will be energized by battery B, unless plug **10** is inserted into a 100 volt A.C. line, in which event the heater element **58** will automatically be energized by the live current and the battery B will be disconnected.

If the plug **10** is not inserted, and selector switch **48** is set for electric heat energization of the refrigerator system, that is with arm **46** engaging contact **54**, current flows from one terminal of battery B through voltage regulator **40**, lead **38**, thermostat switch **34**, fuse **50**, switch **48** and lead **60** to one terminal of heater element **58**, and from the other terminal of heater element **58** through lead **62**, arm **22** and contact **24**, and lead **42** through the voltage regulator **40** to the other terminal of battery B. Thus, the heater element **58** is supplied with 12 volt D.C. current by battery B, and the heat supplied by the energized heater element will cause operation of the associated refrigeration equipment. The thermostat switch **34** is controlled by a thermostat located in the refrigerator compartment, and when the temperature therein drops to a selected value, the switch **34** is opened to deenergize the heater element **58**.

In the event that a 110 volt A.C. house line is available, the plug **10** is connected to this house line, energizing relay winding **20** to cause arm **22** to disengage contact **24** and engage contact **26**. The heater element **58** is then energized by the secondary circuit of the transformer **14**, this circuit comprising lead **36**, thermostat switch **34**, fuse **50**, selector switch **48**, lead **60**, lead **62**, arm **22**, contact **26** and lead **30**. Thus, the transformer **14** supplies 12 volt A.C. current to heater element **58** for energization thereof. The thermostat switch **34** monitors the temperature in the freezing compartment in the same manner as when the electric heater element is battery operated.

The alternate circuit portion is adapted to ignite and control a gas burner, the flame of which is employed for operation of the refrigeration system in substitution for the electric heater element **58**.

The gas control portion of the circuit includes a single-pole double throw switch **64** having a movable arm **66** connected by lead **68** to the contact **56** of selector switch **48**. The arm **66** is movable to engage with either of contacts **70** or **72**, but is normally biased by spring **74** into engagement with contact **70**. The arm **66** may, however, be moved out of engagement with contact **70** and into engagement with contact **72** by expansion of a sensing probe **76** which is physically associated with said arm **66**.

The probe **76** is mounted in heat sensing proximity to the gas burner of the refrigerator and is made of a material which expands when heated by the flame emitted by the burner. The probe **76** therefore increases in length when heated beyond a predetermined limit and is operable to move arm **66** into engagement with contact **72** against the biasing force of spring **74**. However, when the flame is extinguished, the probe **76** contracts and the spring **74** again biases the arm **66** into engagement with contact **70**.

The contact **70** of switch **64** is connected to one contact **78** of a snap-acting bimetallic switch **80** through a series circuit comprising a glow coil **82** for igniting the gas, the winding of a relay **84**, and the heater coil **86** for the bimetallic switch **80**. Switch **80** is of conventional type including the stationary contact **78**, a bimetallic strip **88** normally in engagement with contact **78**, but which is adapted when heated by heater element **86** to a predetermined temperature, to snap out of engagement with contact **78**, thereby breaking the circuit to glow coil **82**. The switch **80** is adapted to be manually reset to the closed position by an external button. Thus, once switch **80** opens and cools, it will remain in open condition until the user manually closes the same.

The bimetallic strip **88** of switch **80** is connected to the output terminal **40***b* of the voltage regulator **40** by a lead **90**. A lamp **92** is connected across strip **88** and the contact **78** of switch **80**. When switch **80** is closed the lamp **92** is energized to signal that the gas portion of the system has been rendered inoperative.

The flow of gas to the burner head is controlled by a solenoid actuated valve operated by a solenoid winding **94** connected by lead **96** to the bimetallic strip **88**. Leads **97**, **98** connect the other end of solenoid winding **94** to the contact **72** of switch **64**. This same terminal of the solenoid winding **94** is adapted to be connected to the lead **68** through the normally open contacts **100** of relay **84**.

The gas control portion of the system is adapted to operate on twelve volt D.C. current and is therefore energized only by the battery B. When it is desired to energize the gas control portion of the present system, the selector switch **48** is operated to the gas control mode wherein the switch arm **46** engages the contact **56**. Thus, the glow coil **82** will be energized through the circuit comprising the energized lead **38**, thermostat switch **34**, fuse **50**, selector switch **48**, lead **68**, switch **64**, glow coil **82**, relay winding **84**, heater **86**, switch **80** and the return lead **90**. Additionally, the solenoid winding **94** will be energized through the circuit comprising the energized lead **68**, the closed contacts **100** of the energized relay **84**, and the leads **96** and **90**.

The current flowing through the solenoid winding **94** of the gas control valve actuated by said solenoid winding, will cause the valve to move to the open state thereby allowing the gas to flow through the burner head out of the mouth thereof. Additionally, the current flowing through the glow coil **82** will cause the temperature of the same to be raised until, finally, the ignition temperature of the gas is reached at which time the gas will ignite and begin to burn, thereby producing a flame. The

ignition of the gas will be detected by the probe **76** to thereby move the arm **66** of the switch **64** into engagement with the contact **72**, in the above-described manner. This action disconnects the glow coil **82** from the potential source but maintains the solenoid winding **94** of the solenoid actuated valve energized through the circuit comprising the energized lead **68**, switch **64**, lead **98**, the solenoid winding **94** and leads **96** and **90** back to the voltage regulator **40**. The heat produced by the burning gas will operate the associated refrigeration apparatus in a manner similar to that caused by the electric heater coil **58**.

When the temperature within the refrigerator compartment drops to the desired value, the thermostat switch **34** opens in the conventional manner thereby deenergizing the solenoid winding **94**. Accordingly, the solenoid actuated gas valve closes, thereby shutting off the flow of gas to the burner head and extinguishing the gas flame. This condition is again sensed by the probe **76** which contracts to remove the actuating force on the switch arm **66**, thereby allowing the spring **74** to bias the arm **66** into engagement with the contact **70**. Thus, the system of the present invention will be reset for another cycle of operation. Hence, when the thermostat switch **34** again closes, the system will initiate flow of the gas and energization of the glow coil **82** to again ignite the gas.

As a safety precaution, if the gas does not ignite when the glow coil **82** reaches the ignition temperature of the gas, the system will automatically be deenergized by the bimetallic switch **80**. The current flowing through the heater **86** of bimetallic switch **80** will cause the heater **86** to raise the temperature of the bimetallic strip **88**. When this temperature reaches a preselected value, the bimetallic strip **88** will snap away from the contact **78** thereby causing the glow coil **82** and the solenoid winding **94** to become deenergized. The circuit constants are selected so that the switch **80** will open after the temperature of the glow coil **82** has risen slightly above the ignition temperature of the gas.

It is noted that the switch **80** is bridged by the lamp **92**. Accordingly, when the switch **80** opens, current will flow through the lamp **92**, illuminating the same to indicate that the gas has failed to ignite and to warn the user to reset the switch **80**. However, the resistance of the lamp **92** is sufficiently high to limit the current flowing through the serially connected elements to a very low value. Accordingly, the relay winding **84** will fail to close the contacts **100**, thereby disconnecting the solenoid winding **94** from the energized lead **68** to shut off the flow of gas to the burner head. Moreover, the current through the glow coil **82** will be insufficient to cause appreciable heating of the same. Thus, the relay winding **84** and the glow coil **82** will be effectively deenergized.

The structural arrangement and configuration of the elements described above is shown in FIGS. 1–5, wherein it will be noted that the operating elements are interconnected to form a compact unit which may be readily mounted within the interior of a refrigerator.

The physical control unit includes a rotary gas shut-off valve **110** having a threaded nipple **112** adapted to be connected to a source of gas, which, in the case of a portable refrigerator unit, would be a container of gas under pressure. The valve **110** is connected to and communicates with a conventional gas filter **114**, which in turn is connected to and in communication with a solenoid-activated valve **116** controlled by the solenoid winding **94**. The outlet **118** of the valve **116** supports an upstanding conduit **120** upon which is mounted a gas burner **122** having a nozzle **124**. The gas outlet aperture of nozzle **124** is in the form of mutually perpendicular slots **126** and **128** so that the flame emitted by the nozzle is directed radially outward as well as forwardly. Opposed heat shields **130** are mounted at the top of the burner on either side of the nozzle **124** to confine the flame within the heating area.

Secured to one side of the body of gas burner **122** is an insulating block **132** mounting the glow coil **82** which is positioned proximate to the nozzle **124**. At the opposite side of the burner nozzle and proximate thereto the sensing probe **76** is mounted on a bracket **134** affixed to the burner body. As shown in FIGS. 2 and 4, one end of the probe **76** is affixed at **136** to the bracket **134**, and the other free end bears against the top end of a lever **138**. The lever **138** extends downwardly through a slot **140** in bracket **134** which acts as a fulcrum for pivotal movement of the lever. As shown in FIG. 4, the lower end of lever **138** is in engagement with the activating button **142** of the single pole double throw switch **64**, which is shown in its preferred form as a micro-switch. A spring **144**, mounted on bracket **134**, bears against the lever **138** below its fulcrum **140** and urges the lever out of pressing engagement with the button **142** so that the switch **64** is normally urged to the operating condition shown in FIG. 6. However, when the gas flame emitted by the burner nozzle impinges on the probe **76**, the latter elongates to pivot lever **138** to such an extent that the lever depresses the switch button **142**, and switch **64** completes the electrical circuit through the contact **72** shown in FIG. 6.

The gas shut-off valve **110** has a forwardly projecting cylindrical stem **146** which has a split end portion **146***a* of semi-cylindrical shape. A cam disc **148** is affixed to the stem **146**, the disc having an elongated cylindrical hub **150** which receives the split end **146***a* of the stem **146**. The cam disc **148** has a dwell portion **148***a*, a tapered rise portion **148***b*, and a rise portion **148***c* which function to shut off the gas supply and to reset the bimetal switch in a manner to be presently described.

Mounted on the gas shut-off valve **110** is a bracket **152** having a depending extension **152***a* upon which is mounted the selector switch **48** shown in FIG. 1 as a microswitch having a spring-biased actuating plunger **154** which is positioned to ride on the cam surface of the cam disc **148**.

The stem **146** of the shut-off valve **110** is adapted to be rotated by a shaft **156** which extends to the exterior of the refrigerator housing and upon the end of which is mounted an operating handle **158**. The handle **158** is located in registry with a control panel **160** affixed to the front surface of the refrigerator housing and is provided with indicia indicating three operative positions, respectively designated "OFF," "GAS" AND "ELECTRIC." Also mounted on control panel **160** is the lamp **92** which indicates that the bimetallic switch **80** has opened, as explained above.

The shaft **156** has a split end **162** which is inserted within the cylindrical hub **150** of cam disc **148** and thus is locked to and cooperates with the split end **146***a* of valve stem **146** so that when the shaft **156** is turned by operation of the handle **158**, the valve stem **146** is turned to operate gas shut-off valve **110** and also to rotate the affixed cam disc **148**. In the position shown in FIG. 3, the handle is turned counterclockwise so that it points to the "OFF" indicia on the control panel **160**. In this position, the gas shut-off valve **110** is closed so that no gas flows to the burner **122**. When the handle **158** is turned in a clockwise direction until it is upright and points to the "GAS" indicia on the control panel **160**, the valve **110** is opened to permit gas to flow to the burner, and if the handle is turned further clockwise until it points to the "ELECTRIC" indicia, the gas shut-off valve **110** is again closed.

Mounted on the bracket **152** is the housing of bimetallic switch **80** within which is contained the heater element **86**. The switch **80** has a projecting reset button **164** which must be depressed to reset the contained bimetallic element after the latter has snapped to a position to open the switch. The switch **80** is mounted on bracket **152** above cam disc **148**, with its reset button **164** engaged by the end of a lever **166**. As shown in FIG. 5, the lever **166** has a rearwardly-extending arm **166***a* mounted by pivot **168** on the bracket **152**, a forwardly-extending arm **166***b* which rides upon the surface of cam disc **148**, and an upstanding

arm 166c carrying an adjustable screw 170 which engages the reset button 164.

Mounted on the valve 116 is an upstanding bracket 172 which supports the relay 84. Terminal blocks 174 and 176 are provided respectively at the rear of relay 84 and on the top surface of valve 116 so that the proper electrical connections may be made to the various elements.

When it is desired to operate the refrigerator with electric heat, the operating handle 158 is turned clockwise from the position shown in FIG. 3 until it points to the "ELECTRIC" setting on panel 160. At this setting, the valve stem 146 and cam 148 are turned by handle 158 to a position in which the stem 146 closes the gas valve 110 to prevent flow of gas to the burner, and the deepest end of the dwell portion 148a of cam disc 148 allows plunger 154 of selector switch 48 to project to its fullest extent so that the switch arm 46 engages contact 54 (FIG. 6). The circuit through electrical heater coil 58 is thus closed, while the gas flame control circuit is opened. If the refrigerator is located in an area having 110 volt line outlets, the plug 10 is inserted into an outlet, the relay 20 then automatically disconnecting the battery B, and the refrigerator operating through electrical heat, powered by the 110 volt line source. Alternately, in the situation in which the refrigerator is in use in a trailer, boat or the like, where wind conditions would render a gas flame operation hazardous, and no line current is available, the unit is powered by the battery B which energizes the heater coil 58 whenever the selector switch 48 is at the "ELECTRIC" setting and the plug 10 is not inserted in a live socket.

The electrical heater coil 58 thus operates alone to power the refrigerator unit, being energized and deenergized as required, under control of the thermostat switch 34 activated by the thermostat-sensing means in the refrigerator compartment.

When it is desired to operate the refrigerator by gas flame, the operating handle 158 is turned to the "GAS" setting on control panel 160. The valve stem 146 is thus turned to open the gas valve 110, permitting flow of gas to the solenoid-actuated valve 116. At the same time, the cam disc 148 is turned to a position in which rise portion 148b engages plunger 154 of selector switch 48 to depress the latter and move selector switch arm 46 (FIG. 6) into engagement with contact 56, thereby connecting the gas control circuit to battery B.

Completion of the gas control circuit results in initial energization of the relay 84 which closes switch contacts 100 to connect solenoid winding 94 within the gas control circuit. Energization of the solenoid winding 94 opens the solenoid-actuated valve 116, permitting gas to flow therethrough to the burner 122. The glow coil 82 is also energized so that it will ignite the gas emerging from burner nozzle 124. The gas flame thus produced energizes the refrigerator unit of the assembly.

The head of the gas flame is directed toward the metal probe 76, causing the latter to gradually increase in length and pivot lever 138 so that the latter depresses the actuating button 142 of switch 64. The arm 66 (FIG. 6) of switch 64 is thereby moved out of engagement with contact 70 and into engagement with contact 72, thus deenergizing the glow coil 82 and the bimetal heater 86, but maintaining the solenoid winding 94 energized so that gas continues to flow.

If, when the gas system is turned on, the gas escaping from the burner nozzle is not ignited by the glow coil 82, within a reasonable time, the bimetallic switch 80 will operate in the manner previously described, to close the solenoid-actuated gas valve 116 and cut off the flow of gas to the burner nozzle. In addition, the signal lamp 92 on the control panel will be illuminated warning the user to reset the selector switch 80.

The "OFF" position of the operating handle 158 not only serves to deenergize the entire system, but also to reset the bimetallic switch 80 in case the latter has opened because of ignition failure. Thus, when the handle 158 is turned counter-clockwise to the "OFF" setting on control panel 160, the valve stem 146 is turned to close gas valve 110 and prevent feeding of gas therethrough. The intermediate part of dwell portion 148a of cam disc 148 is also turned into engagement with the plunger 154 of selector switch 48, holding said plunger in an intermediate or neutral position in which selector switch arm is spaced between contacts 54 and 56, and all electrical circuits are interrupted. At the same time, the rise portion 148c of cam disc 148 is turned to the position shown in FIG. 1 in which it engages the arm 166b of lever 166, causing the latter to pivot in such a manner that the screw 170 depresses the reset button 164 of bimetallic switch 80.

It will be observed that in the unit described herein, a single thermostat switch 34 is utilized to control both the gas control circuit and the electrical heater circuit. When the unit is switched to the electrical heater circuit, the thermostat switch 34 in the refrigerator compartment interrupts and completes the circuit to successively energize and deenergize the electrical heater coil 58 as required. On the other hand, when the unit is switched over to the gas-operated phase, the thermostat switch 34 will open the entire gas control circuit when the temperature within the refrigerator compartment has reached the desired limit. The solenoid winding 94 will therefore be completely deenergized, and the solenoid-actuated valve will be accordingly closed, shutting off the flow of gas to the burner 122 and extinguishing the flame. The probe 76 will now cool and contract, allowing spring 74 to bring switch arm 66 back into engagement with contact 72. The gas control circuit is thus again set in its initial starting condition. When the temperature in the refrigerator compartment subsequently rises, this will be sensed by the thermostat and the thermostat switch 34 will close, energizing the gas control circuit. Gas is thus again permitted to flow to the burner and the glow coil 82 is again energized to ignite the gas, in accordance with the starting operation previously described. The periodic extinguishment and ignition of the gas flame thus occurs automatically, without requiring supervision or manual operation on the part of the user.

There has thus been provided a highly versatile and efficient refrigeration control system which includes a minimum number of elements and is relatively simple in construction and operation. The system described herein is particularly adapted for use in a portable refrigerator which may be employed in automobile trailers, boats and the like. The refrigerator may be operated wholly by electricity supplied by a house line source where such is available. Where the trailer or boat is in motion, the refrigerator is then preferably operated efficiently by gas supplied from a pressurized container, with the gas flame controlled by an electrical circuit energized by the self-contained batteries. Should draft conditions in the moving vehicle extinguish the gas flame, the gas supply will automatically be shut off, and a warning signal given to the user. The unit can now be run entirely electrically from current supplied by the batteries, until the draft conditions are eliminated.

While a preferred embodiment of the invention has been shown and described herein, it will become apparent that numerous omissions, changes and additions may be made in such embodiment without departing from the spirit and scope of the present invention.

What I claim is:

1. In a refrigerator having a compartment cooled by a refrigerator system operable alternately by heat supplied from an electric heater element energized by a source of electrical power and a gas burner connected to a gas supply source through a gas supply line, the improvement comprising a control system for alternate and selective automatic operation of said electric heater element and gas burner, said control system comprising a gas control section and an electric control section, said electric control section including a first electrical circuit for connecting

said electric heater element to said source of electric power for energization of said heater element, said gas control section including a manually-operable valve and an electrically-operable valve in said gas supply line and individually operable to shut off the flow of gas to said burner, an electrically-energized ignition element positioned proximate to the mouth of said gas burner, a second electrical circuit for connecting said ignition element and said electrically-operable valve to said source of electrical power, whereby said electrically-operable valve is opened to permit gas to flow through said gas supply line to said burner and said ignition element is energized to ignite the gas flowing from the burner mouth, said control system also including manually-operable selector means having a first position in which it completes said first electrical circuit and opens said second electrical circuit, a second position in which it completes said second electrical circuit and opens said first electrical circuit, and a third position in which it opens both first and second electrical circuits, said selector means being operatively coupled to said manually-operable valve for opening the same when said selector means is brought to its second position, and closing the same when brought to its second and third positions.

2. A control system according to claim 1 which also includes single thermostat means responsive to temperature changes in said refrigerator compartment and connected in series with said first and second electrical circuits for deenergizing both said circuits in response to a temperature drop in said compartment below a selected level.

3. A control system according to claim 2 in which said first electrical circuit includes first means for connecting said circuit to an external source of electrical power and second means normally connecting said circuit to a self-contained source of electrical power, and a two-state device operable by the flow of current therethrough to disconnect said second means when said first means connects said circuit to said external power source.

4. A control system according to claim 2 in which said gas control section includes a heat-responsive element in proximity to said burner mouth and switch means in said second electrical circuit operatively connected with said heat-responsive element for actuation by the latter in response to the heat of ignited gas at the burner mouth, to deenergize said ignition element while maintaining said electrically-operable valve in open condition.

5. A control system according to claim 4 in which said gas control section includes safety means connected in said second electrical circuit in series with said ignition element and adapted to be heated by the flow of current therethrough and to open said second electrical circuit after said safety means has heated beyond a pre-selected time interval.

6. A control system according to claim 5 in which said safety means includes a snap-type bimetallic switch and an electrically-energized heater member therefor, said heater member being connected in series with said ignition element and being deenergized therewith by operation of said heat-responsive element.

7. A control system according to claim 6 in which said electrically-operable valve is a solenoid valve, and in which said second electrical circuit includes a first branch for maintaining said solenoid valve in open condition, said heat responsive element comprising a heat-expansive member and a control switch operative coupled thereto for movement upon heating of said heat-expansive member, from a first position in which it closes said first branch and opens said second branch, to a second position in which it closes said second branch and opens said first branch, said ignition element and said bimetallic switch heater member being connected in series in said second branch.

8. A control system according to claim 6 in which said bimetallic switch is a snap switch having an open position requiring manual resetting, and in which linkage means are provided between said selector means and said bimetallic switch for resetting the latter to closed position only when said selector means is brought to its third position.

9. A control system according to claim 8 in which said selector means includes a selector switch having an actuating member and a rotatable cam member engaging said actuating member, and in which said linkage means includes a lever engaging said cam member at one end, and operatively engaging said bimetallic switch at the other end thereof.

10. A control system according to claim 9 in which said cam member has a cam surface engaging said lever to reset said bimetallic switch and an opposing cam surface engaging said selector switch actuating member to open both first and second electrical circuits in the third position of said selector means.

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