Jan. 3, 1967 N. L. HULTGREN 3,295,334

HEAT OPERATED REFRIGERATOR OPERABLE ON GAS OR ELECTRICITY AND CONTROL MECHANISM THEREFOR

Filed Jan. 8, 1965 4 Sheets-Sheet 1

FIG. 1

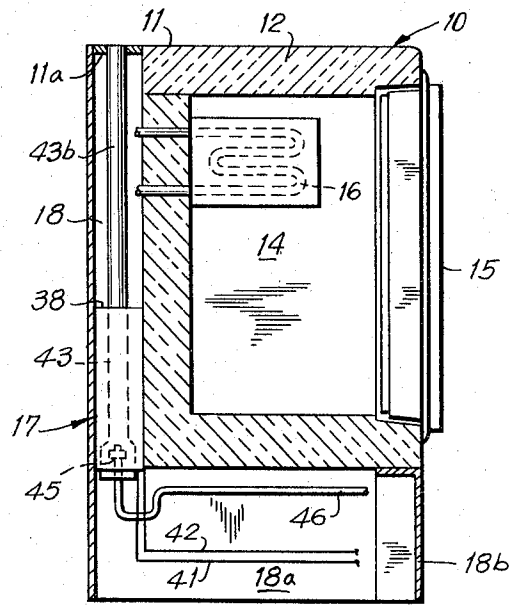

FIG. 3

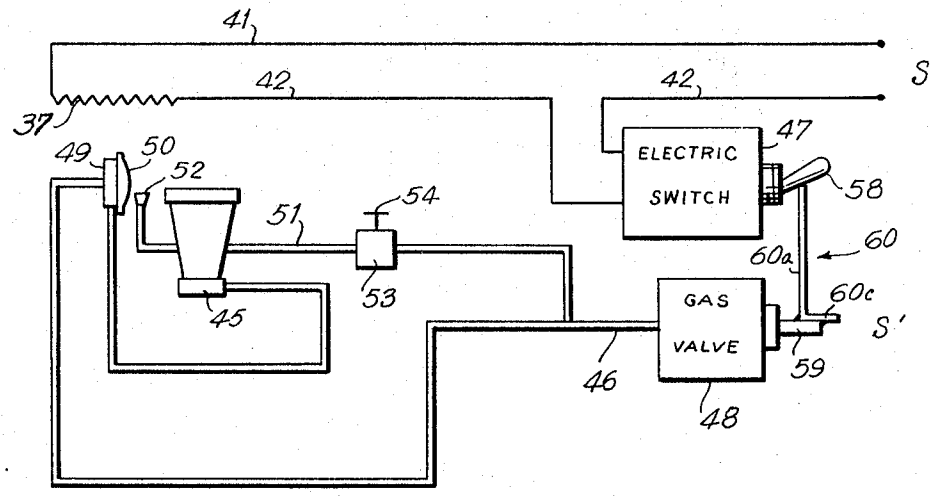

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FIG. 2

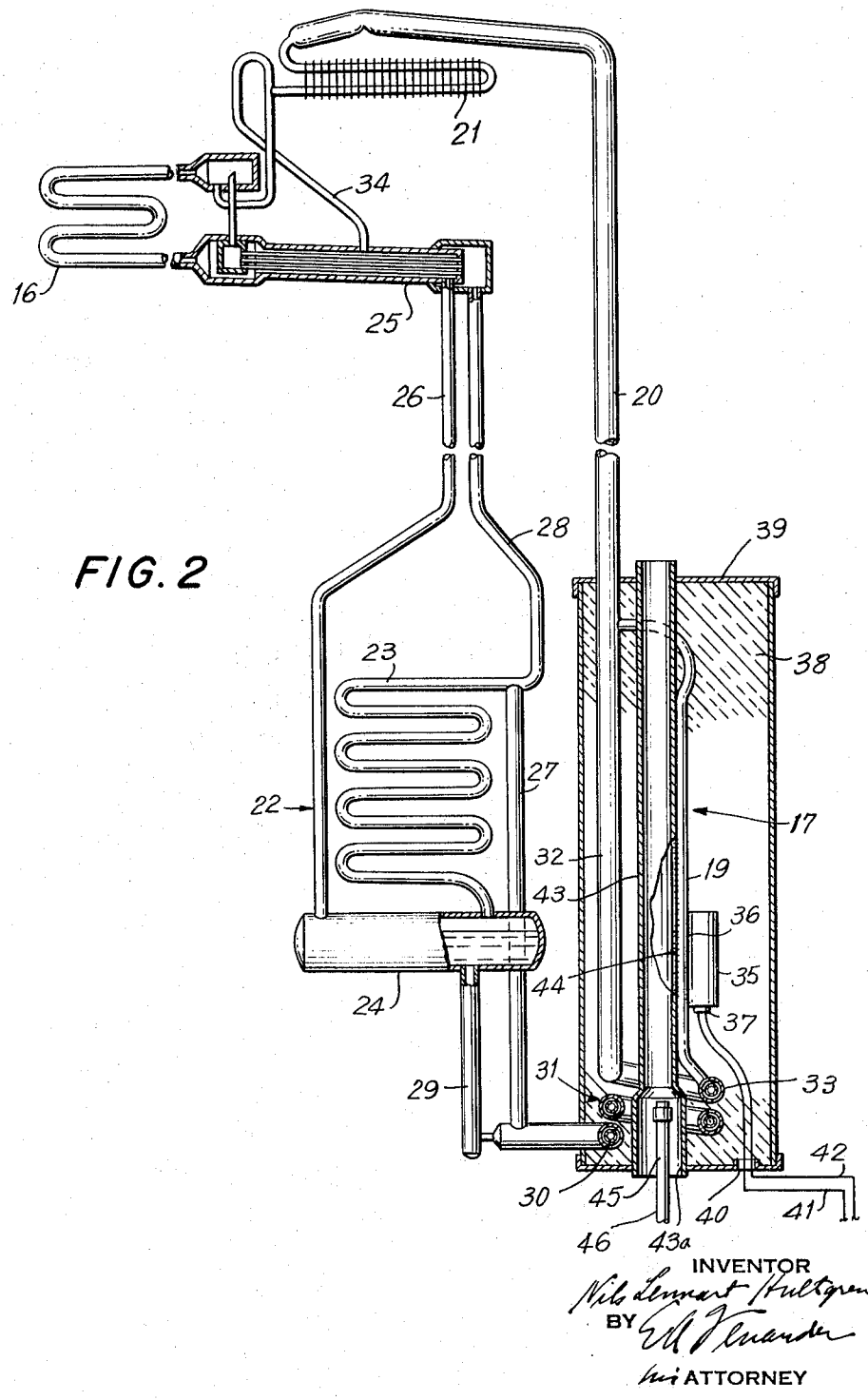

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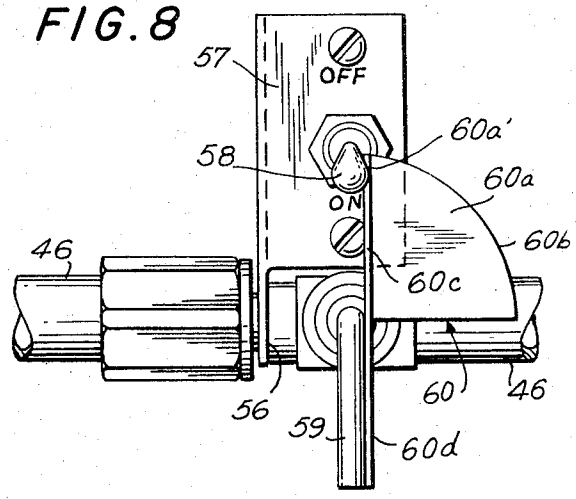
FIG. 8



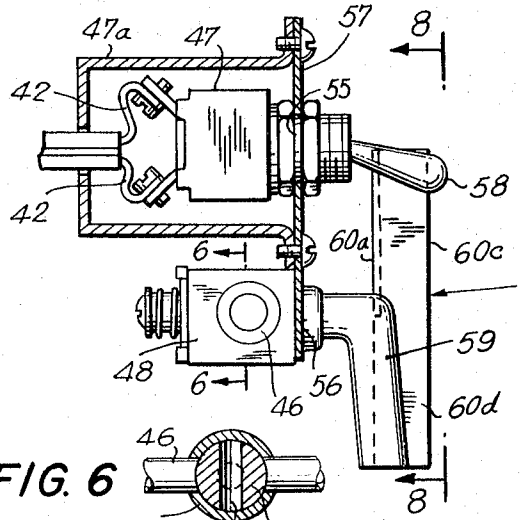
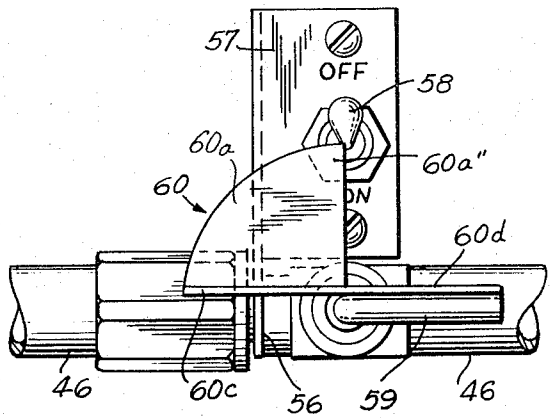


FIG. 5

FIG. 6

FIG. 7



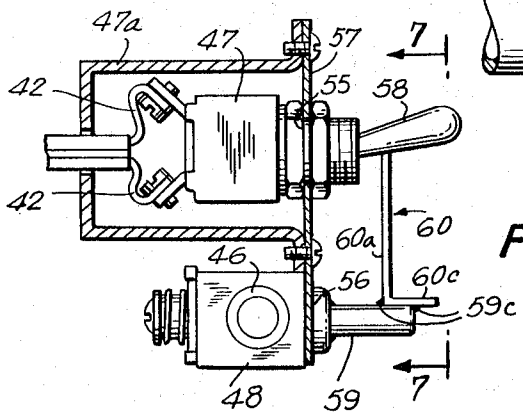


FIG. 4

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HEAT OPERATED REFRIGERATOR OPERABLE ON GAS OR ELECTRICITY AND CONTROL MECHANISM THEREFOR

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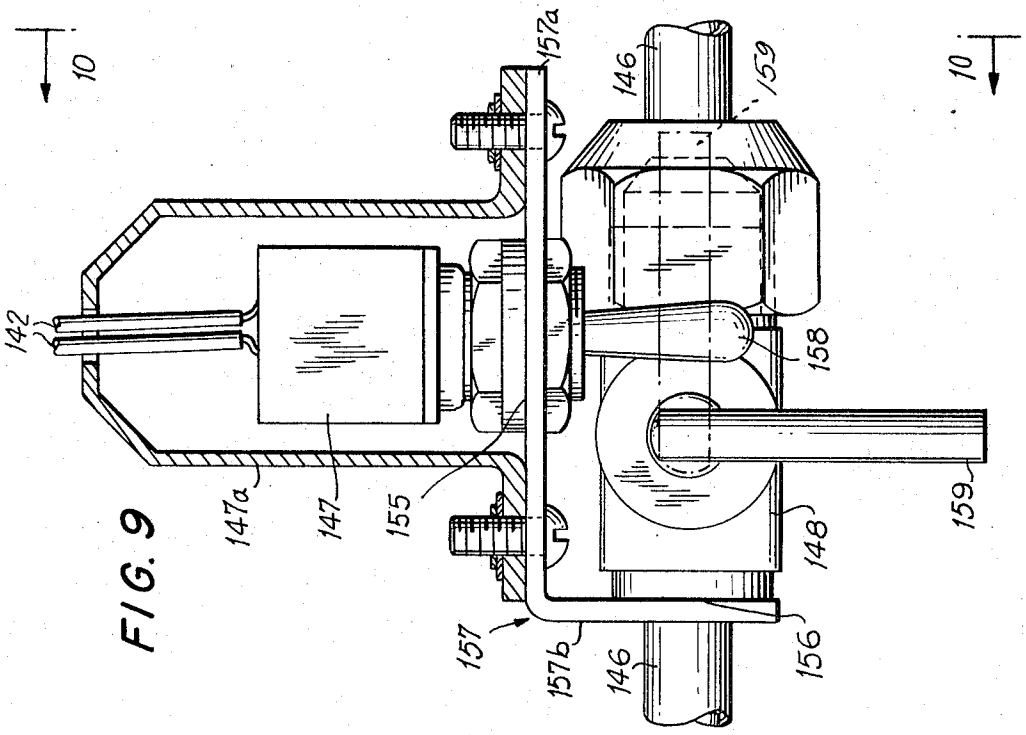

FIG. 9

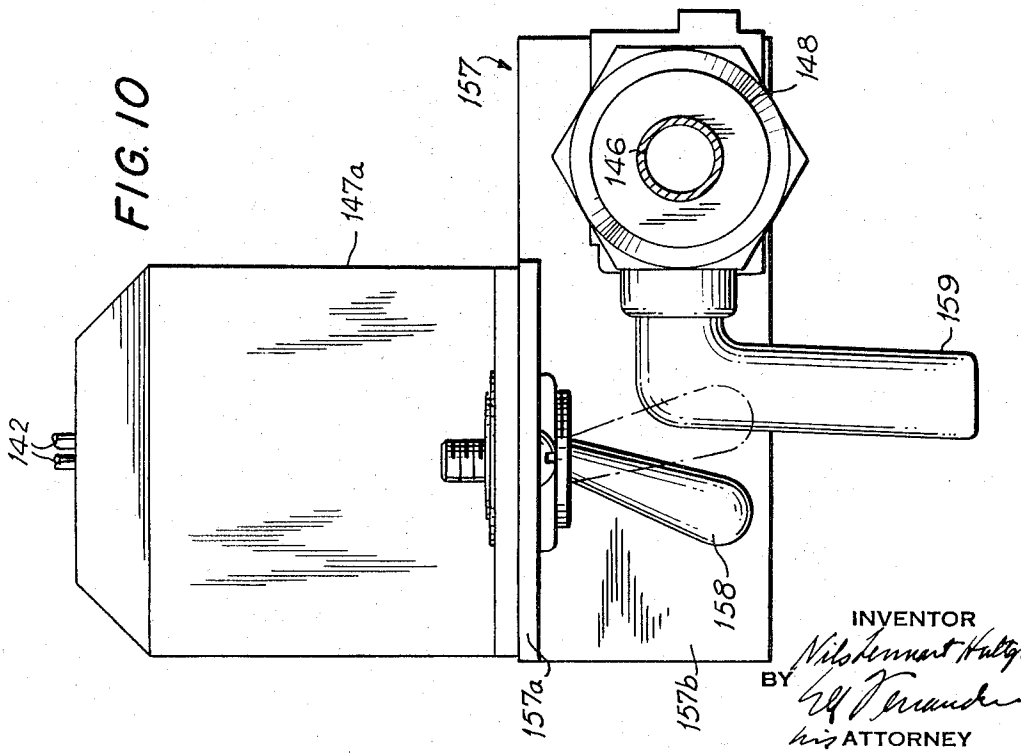

FIG. 10

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HEAT OPERATED REFRIGERATOR OPERABLE ON GAS OR ELECTRICITY AND CONTROL MECHANISM THEREFOR

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9 Claims. (Cl. 62—148)

My invention relates to heat operated refrigerators of the type alternatively employing gas and electricity as power sources and in which cooling is effected by a refrigeration unit having a heat receiving part.

It has already been proposed to provide specially constructed control mechanism to control the operation of heat operated refrigerators of this type for mobile homes like travel trailers, for example. In such specially constructed control mechanism a single control member is employed which is operatively associated with a gas valve and an electric switch and in one position of which the heat operated refrigerator is adapted to be operated by gas and in the other by electricity.

An object of my invention is to provide a heat operated refrigerator of this type having an improved control mechanism which is of simplified construction and requires a minimum number of parts for alternatively employing gas and electricity as power sources and prevents the refrigerator from being connected to either one of the power sources when the control mechanism is functioning to connect the refrigerator to the other of the power sources. I accomplish this by respectively providing in the electrical and gas supply lines an electrical switch and a gas valve having independent manually operable control members movable in paths of movement which interfere with one another in such manner that, when the switch is closed, the manually operable control member therefor physically blocks and prevents movement of the manually operable gas valve control member from its valve closed to its valve open position; and, when the gas valve is open, the manually operable control member therefor physically blocks and prevents movement of the manually operable electric switch control member from its switch open to its switch closed position.

Another object of my invention is to provide a heat operated refrigerator of this type having an improved control mechanism of simplified construction which can be readily assembled with inexpensive electrical switches and gas valves of conventional design.

Further objects and advantages of my invention will become apparent as the following description proceeds, and the features of novelty which characterize any invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In the drawing:

FIG. 1 is a vertical sectional view of a mobile home refrigerator provided with heating equipment embodying my invention;

FIG. 2 illustrates more or less diagrammatically heat operated refrigeration apparatus suitable for use in the refrigerator shown in FIG. 1;

FIG. 3 is a diagrammatic representation of circuits for controlling the heating of the heat receiving part of the refrigeration apparatus shown in FIGS. 1 and 2;

FIGS. 4 and 5 are side vertical views, partly in section, of parts shown in FIG. 3, movable control parts being illustrated in different positions in the two figures;

FIG. 6 is a fragmentary sectional view taken at line 6—6 of FIG. 5;

FIGS. 7 and 8 are front elevational views taken at lines 7—7 and 8—8, respectively, of FIGS. 4 and 5;

FIG. 9 is a top plan view, partly in section, of parts like those in FIGS. 4 to 8, illustrating a modification of my invention; and

FIG. 10 is a vertical view taken at line 10—10 of FIG. 9.

Referring to FIG. 1, I have shown my invention in connection with a mobile home refrigerator 10 comprising a cabinet 11 having thermally insulated walls 12 defining a storage compartment 14 into which access may be gained by a door 15 hinged to the front of the cabinet. Within the storage compartment 14 is disposed a cooling element or evaporator 16 of suitable heat operated refrigeration apparatus. Although I do not wish to be limited thereto, the heat operated refrigeration apparatus may be of a uniform pressure absorption type which is well known in the art. In refrigeration apparatus of this type, the cooling element 16 is connected to other parts, including a generator 17, which are mounted on the cabinet 11 and positioned in the vertically extending space 18 at the rear of the cabinet.

In heat operated refrigeration apparatus of this kind refrigerant vapor is expelled from absorption liquid in a vapor lift pipe 19 of the generator 17, as shown in FIG. 2. The expelled refrigerant vapor passes through a conduit 20 to a condenser 21. The refrigerant vapor is liquified in the condenser 21 and flows into the evaporator 16 in which the refrigerant evaporates and diffuses into an inert gas to produce a refrigerating effect. The resulting gas mixture of refrigerant and inert gas flows from the evaporator 16 to an absorber 22 which may be of an air-cooled type including a coil 23 and an absorber vessel 24 to which the lower end of the coil is connected, such gas mixture entering the absorber vessel 24 through a heat exchanger 25 and a conduit 26.

In the absorber 22 refrigerant is absorbed from the gas mixture into absorption liquid which is delivered thereto through a conduit 27, and the absorption liquid enriched in refrigerant passes into the absorber vessel 24. The inert gas is returned from the absorber 22 to the evaporator 16 in a path of flow including a conduit 28 and heat exchanger 25, and the enriched absorption liquid is conducted through a conduit 29 and inner pipe 30 of a liquid heat exchanger 31 to the generator 17.

The absorption liquid raised in vapor lift pipe 19 and from which refrigerant vapor has been expelled flows by gravity from a standpipe 32 through the outer pipe 33 of liquid heat exchanger 31 and conduit 27 into the upper part of absorber coil 23. A vent conduit 34 connects the lower end of the condenser 21 and the passage of the heat exchanger 25 through which the gas mixture flows from the evaporator 16.

Absorption solution enriched in refrigerant flows from the absorber vessel 24 through the liquid heat exchanger 31 into the lower end of vapor lift pipe 19 which is in thermal exchange relation at 36 with a heating tube 35. The heating tube 35 is arranged to be heated by an electrical heating element 37 disposed within the tube. Vapor generated in the vapor lift pipe 19 by heating effected by the heating tube 35 raises liquid therein by vapor lift action and flows from the upper end thereof through the upper part of standpipe 32 into conduit 20 and passes to the condenser 21, as previously explained.

The generator 17 in its entirety, together with a major portion of the liquid heat exchanger 31, are embedded in a body of insulation 38 retained in a metal shell or casing 39 having an opening 40 at the bottom thereof. The heating tube 35 is embedded in a part of the insulation 38 which is intermediate the ends thereof and spaced from the top and bottom ends of the shell 39. Electrical conductors 41 and 42 for the electrical heating element 37 pass through the bottom opening 40 of the shell 39 and extend through the insulation 38. The heating tube 35

snugly receives the heating element **37** which may comprise a cartridge housing an electrical wire or the like having a relatively high resistance that generates heat when connected to a source of electrical energy. It is usually the practice to provide a passage in the body of insulation **38** which extends to the exterior of the insulating body, so that the electrical heating element **37** may be readily inserted into and removed from the heating tube **35**.

As best shown in FIG. 2, the generator **17** is arranged to be operated at will by two independent sources of heat, each of which alone is capable of supplying heat at an adequate rate and at a sufficiently elevated temperature to the vapor lift pipe **19** to effect normal operation of the refrigeration apparatus under all conditions under which the apparatus is intended to be operated. This is accomplished by providing a second heating flue **43** which is in thermal exchange relation at **44** with the vapor lift pipe **19**. A fluid fuel burner **45** is arranged to be supported in an upright position within the bottom part **43***a* of the heating flue, so that the combustion gases will be used most effectively for heating the heating flue **43**. The burner **45** is connected to a source of supply of gaseous fuel by a pipe **46**.

The generator **17** constitutes the heat receiving part of the refrigeration apparatus. The lower end **43***a* of the heating flue **43** projects through an opening in the bottom of the shell **39** into the rear part of a space **18***a* below the storage compartment **14**. The space **18***a* is accessible through an opening **18***b* at the front of the cabinet **11** adapted to be closed by a removable closure member or hinged door (not shown). The heating flue **43** is provided with a riser or flue extension **43***b* which extends upwardly in the rear apparatus space **18** and is mounted in position in any suitable manner. The upper end of the riser **43***b* may be flush with an apertured member **11***a* so that natural circulation of air may take place in the rear apparatus space **18** to promote cooling of parts, such as the condenser **21** and absorber **23**, of the refrigeration apparatus.

When refrigeration apparatus like that illustrated in FIG. 2 is intended to be operated electrically, the electrical conductors **41** and **42** are connected to a suitable source of electrical supply. When the refrigeration apparatus of FIG. 2 is intended to be operated by a gaseous fuel, the burner **45** is connected to a source of supply of the fuel and ignited. When the electrical heating element **37** and burner **45** inadvertently are operated at the same time, the generator **17** is subjected to excessive heating which tends to shorten the life of the refrigeration apparatus. It is therefore desirable to protect the refrigeration apparatus so that, when the apparatus is connected to one of the sources of heat, the apparatus cannot be connected to the other source of heat.

Such a protective arrangement is diagrammatically shown in FIG. 3 in which the electrical heating element **37** is connected to a source S of electrical energy by the conductors **41** and **42**, a switch **47** being connected in the conductor **42**. The burner **45** is connected to a source S' of gaseous fuel by the conduit **46** in which is connected a manually operable valve **48**. The pipe **46** is also provided with a valve **49** having a thermal member **50** associated therewith which functions to keep valve **49** open when a flame is being maintained at the burner **45** and to close valve **49** when the burner flame is extinguished.

The burner **45** is provided with a lighter tube **51** into which gaseous fuel is diverted from the supply conduit **46**. The outer free end of the lighter tube **51** terminates at a discharge orifice **52** for maintaining a pilot flame at the vicinity of the thermal member **50**. In the lighter tube **51** is provided a valve **53** which is spring biased to its closed position and can be opened by manipulating a push button **54**. To start the burner **45** valve **48** may be opened and the push button **54** then pressed to open valve **53**, whereby gaseous fuel can flow through the lighter tube **51** and the fuel discharged from the orifice **52** can be ignited to provide a pilot flame which functions to heat the thermal member **50**. When the latter is heated sufficiently it in turn functions to open valve **49** and supply fuel to the burner **45** which is ignited by the pilot flame, whereupon the push button **54** may be released to close valve **53** and shut off the pilot flame.

During normal operation of the refrigeration apparatus when either the electrical heater **37** or the gaseous fuel burner **45** alone is functioning to supply heat to the vapor-expulsion unit **11**, the different parts of the unit are heated to elevated temperatures which are within a safe operating range which does not impair the life of the refrigeration apparatus. However, if both the electrical heater **37** and the gaseous fuel burner **45** were allowed to function at the same time for a prolonged interval of time to supply heat to the generator **17**, the different parts of the unit would be heated to abnormally high elevated temperatures and tend to shorten the life of the refrigeration apparatus.

In accordance with my invention, in order to insure that the different parts of the generator **17** always will be heated to elevated temperatures which are within a safe operating range, the heating equipment just described embodies means whereby, when either the electrical heater **37** or the gaseous fuel burner **45** is connected to supply heat to the generator **17**, the other cannot be rendered operable to supply heat to the refrigeration unit.

In the embodiment of the invention illustrated in FIGS. 4 to 8 the electric switch **47** and gas valve **48** are respectively mounted at **55** and **56** to a bracket **57** which may be mounted in any suitable manner (not shown) in the forward part of the space **18***a* of the cabinet **11**. The switch **47** is provided with a housing **47***a* and may be of a conventional type referred to as a "toggle switch" having an independent manually movable operating member or part **58** which snaps vertically between an upper "off" position and a lower "on" position, as illustrated in FIGS. 7 and 8.

The gas valve **48** may be of a conventional type having an independent manually movable operating member or arm **59** connected to a rotatable plug **59***a* having a passage **59***b* therethrough. The operating member **59** forms a unitary part of the rotatable element of the gas valve **48** and is manually movable between a vertical valve "closed" position shown in FIGS. 5 and 8 and a horizontal valve "open" position shown in FIGS. 4 and 7.

It will now be understood that the independent switch operating member **58** is manually movable in a vertical path of movement between its upper "open" or "off" position shown in FIGS. 4 and 7 and its lower "closed" or "on" position shown in FIGS. 5 and 8; and that the independent gas valve operating member **59** is manually movable in an angluar path of movement between its downwardly depending valve "closed" position shown in FIGS. 5 and 8 and its horizontal valve "open" position shown in FIGS. 4 and 7.

In accordance with my invention, the independent manually movable operating members **58** and **59** are movable in paths of movement which interfere with one another in such manner that the switch operating member **58** in its down or lower switch "closed" position will physically block movement of the gas valve operating member **59** from its vertical valve "closed" position toward its horizontal valve "open" position, and the gas valve operating member **59** in its horizontal valve "open" position will physically block downward movement of the switch operating member **58** from its upper switch "open" position toward its lower switch "closed" position. I accomplish this by fixing to the gas valve operating member **59** at **59***c* a plate **60** which is of the shape shown in FIGS. 7 and 8. As best shown in FIGS. 4, 7 and 8, the plate **60** includes a first portion which is L-shaped in section and has a long arm **60***a* thereof forming a quadrant of a circle with a curved peripheral edge **60***b* extending through an angle of 90°. The short arm **60***c* of the L-shaped first portion of the plate **60** is essentially

parallel to the gas valve operating arm **59** and in end-to-end relation therewith, as best shown in FIGS. 7 and 8.

The plate **60** includes a second portion **60***d* which constitutes an extension of the short arm **60***c* of the L-shaped first portion. The second portion **60***d* of the plate **60** is joined to the operating arm **59** and is coextensive therewith in the direction of its length. Essentially, the extension **60***d* of the plate **60** functions as a component or part of the independently movable gas valve operating member **59**, as best shown in FIG. 5.

Let us assume that the refrigerator **10** is connected to the electrical source of supply S and the switch **47** is closed and the independent switch operating arm **58** is in its lower "closed" or "on" position, as illustrated in FIGS. 5 and 8; and that the independent gas valve operating member **59** is in its vertical or valve "closed" position shown in FIGS. 5 and 8. Under these conditions, the switch operating member **58** is in the path of movement of the plate **60** and physically blocks and prevents movement of the plate in a counterclockwise direction in FIG. 8. Since the switch operating arm **58** is in the path of movement of the plate **60**, the gas valve operating arm **59** cannot be moved from its vertical valve "closed" position toward its horizontal valve "open" position.

Let us now assume that the refrigerator **10** is connected to the source of supply S' of gaseous fuel and the gas valve operating arm **59** is in its horizontal valve "open" position illustrated in FIGS. 4 and 7; and that the independent switch operating member **58** is in its upper or switch "open" or "off" position shown in FIGS. 4 and 7. Under these conditions, the plate **60** is in the path of movement of the switch operating member **58** and physically blocks and prevents downward movement of the independent switch operating member in the manner shown in FIGS. 4 and 7.

Each of the operating members **58** and **59**, which are independently movable about axes perpendicular to one another, are movable with respect to the other. Therefore, the independent operating members **58** and **59** can be manually moved to their switch "open" and valve "closed" positions at the same time to disconnect the refrigerator **10** from both the sources of supply of electricity and gaseous fuel.

In FIG. 8 the switch operating member **58** in its switch "on" or "closed" position interferes with the movement of the plate **60** at a zone **60***a'* at one end of the quadrant **60***a*. In FIG. 7 the plate **60** at a zone **60***a''* at the opposite end of the quadrant **60***a* interferes with the movement of the switch operating member **58**.

In FIGS. 9 and 10, I have shown another embodiment of my invention in which parts similar to those illustrated in FIGS. 4 to 8 are referred to by the same reference numerals to which "100" has been added. In FIGS. 9 and 10 the electric switch **147** within the housing **147***a* is fixed at **155** to the horizontal arm **157***a* of an L-shaped bracket **157**. The switch **147** is connected in a conductor **142** corresponding to the conductor **42** in FIG. 3. The switch **147** is of the "snap-acting" type and provided with an independent operating member **158** manually movable back and forth between the solid and dotted line positions illustrated in FIG. 10.

The gas valve **148** is fixed at **156** to the vertical arm **157***b* of the L-shaped bracket **157**. The gas valve **148** is provided with an apertured turnable plug similar to the plug **59***a* in FIG. 6 and connected in a pipe **146** corresponding to the pipe **46** in FIG. 3. The independent gas valve operating member **159** is manually movable between the solid and dotted line positions illustrated in FIG. 9.

Let us assume that the refrigerator **10** is connected to the electrical source of supply and the switch **147** is closed and the switch operating arm **158** is in the dotted line position in FIG. 10 which designates the switch "closed" or "on" position; and that the gas valve operating arm **159** is in its vertical solid line position in FIG. 10 which designates the valve "closed" position. Under these conditions, the switch operating arm **158** in dotted lines in FIG. 10 is in front of the gas valve operating arm **159** and in the path of movement of the gas valve operating arm and physically blocks and prevents movement of the arm **159** in a counterclockwise direction in FIG. 9.

Let us now assume that the refrigerator **10** is connected to the source of supply of gaseous fuel and the gas valve operating arm **159** is in the horizontal dotted line position in FIG. 9 which designates the gas valve "open" position; and that the switch operating arm **158** is in its solid line position in FIG. 10 which designates the switch "open" or "off" position. Under these conditions, the gas valve operating arm **159** in dotted lines in FIG. 9 is in back of the switch operating arm **158** and in the path of movement of the switch operating arm and physically blocks and prevents rearward movement of the operating arm **158** to its dotted line position in FIG. 10 and prevents the arm **158** from moving to its switch "closed" or "on" position.

Let us assume that the gas valve operating arm **159** is in its solid line vertical position in FIG. 9 and the switch operating arm **158** in FIG. 9 is moved rearward and in its switch "closed" position indicated in dotted lines in FIG. 10. Under these conditions, it will be observed that the gas valve operating arm **159** can be moved counterclockwise a short distance before it will strike the switch operating arm **158**. In this situation, the switch operating arm **158**, which is in its "closed" position, will physically block and prevents movement of the gas valve operating arm **159** after initial movement of the arm **159** from its vertical valve "closed" position toward its horizontal valve "open" position. However, the switch operating arm **158** still functions to physically block and prevents movement of the gas valve operating arm **159** under these assumed conditions while the arm **159** still is in a position in its path of movement to effect closing of the gas valve **159**.

With this construction anyone attempting to move the gas valve operating handle **159** from its vertical "closed" position toward its horizontal "open" position will be made aware at once that the switch operating arm **158** is in a switch "closed" position and must be shifted to its switch "open" position before the gas valve operating arm can be moved to its horizontal "open" position.

In view of the foregoing, it will now be understood that in the embodiment of FIGS. 4 to 8 and in the embodiment of FIGS. 9 and 10, it is always necessary to manually move one of the independently operable switch and gas valve operating arms **58** and **59** or **158** and **159** to its inoperative position before the other of the independently operable switch and gas valve operating arms can be moved to its operative position. This always will require two separate movements of the switch and gas valve operating arms to shift from gas to electric operation of the refrigerator **10** or vice versa.

While I have shown and described particular embodiments of the invention, it will be apparent that modifications may be made without departing from the spirit and scope thereof, as set forth in the claims.

I claim:

1. In combination with a refrigerating system of the type alternatively employing gas and electricity as power sources and in which cooling is effected by a refrigeration unit having a heat receiving part, of a gas burner heating means adapted to heat the heat receiving part, means for supplying gas energy to said burner heating means, electrical heating means adapted to heat the heat receiving part, means for conducting electrical energy to said electrical heating means, and control mechanism connected to said gas energy supply means and to said electrical energy conducting means and adapted to connect said gas energy supply means to its associated heating means and to disconnect said electrical energy conducting means from its associated heating means or to connect said

electrical energy conducting means to its associated heating means and disconnect said gas energy supply means from its associated heating means, said control mechanism comprising an electric switch which is coupled to said electrical energy conducting means and to said electrical heating means and includes a first independently movable part manually movable between switch closed and open positions for respectively completing and interrupting electrical continuity therethrough and a valve in said gas supply means having a rotatable plug with a passage therethrough and including a second independently movable part manually movable between valve open and closed positions for turning said plug for respectively flowing and obstructing flow of gas energy through said supply means, said first part being independently movable to a position in the path of movement of said second part and said second part being independently movable to a position in the path of movement of said first part, and said first part being independently movable to a switch closed position only when said second part is in a valve closed position and said second part being independently movable to a valve open position only when said first part is in a switch open position.

2. The combination set forth in claim **1** in which said first part in its switch closed position physically blocks and prevents movement of said second part from its valve closed to its valve open position and said second part in its valve open position physically blocks and prevents movement of said first part from its switch open to its switch closed position.

3. The combination set forth in claim **2** in which said first part is movable about a first axis between switch closed and open positions and said second part is movable about a second axis transverse to said first axis between valve open and closed positions, and said first and second parts respectively are movable to switch open and valve closed positions at the same time.

4. The combination set forth in claim **2** in which said first part is movable in a first path of movement between switch closed and open positions and said second part is movable in a second path of movement between valve open and closed positions, said first part in its switch closed position being in said second path of movement and physically blocking and preventing movement of said second part from its valve closed to its valve open position, said second part in its valve open position being in said first path of movement and physically blocking

and preventing movement of said first part from its switch open to its closed position, and said first and second parts respectively being movable at the same time to their switch open and valve closed positions.

5. The combination set forth in claim **4** in which said second part and the rotatable plug of said valve form a unitary member, said second part being operable to rotate said plug about a first axis between valve open and closed positions, and said first part being movable between switch closed and open positions about a second axis perpendicular to said first axis.

6. The combination set forth in claim **4** in which said first and second parts are respectively movable in said first and second paths of movement and interfere with one another at a zone, said first part being movable in its path of movement through said zone to close said switch only when said second part is in its valve closed position and said second part being movable through said zone to open said valve only when said first part is in its switch open position.

7. The combination set forth in claim **4** in which said second part of said valve has a longer path of movement than said first part of said switch and said second part in its valve closed position is closely adjacent to said first part in its switch open position.

8. The combination set forth in claim **7** in which said first part in its switch closed position physically blocks movement of said second part after initial movement of the latter from its valve closed position toward its valve open position, said first part functioning to physically block movement of said second part while said second part is still in a position in its path of movement which effects closing of said valve.

9. The combination set forth in claim **4** in which said second part of said valve includes a plate having a curved peripheral edge which functions to physically block and prevent movement of said first part when said valve is in its open position.

References Cited by the Examiner

UNITED STATES PATENTS

3,080,729	3/1963	Grubb	62—497
3,105,363	10/1963	Von Der Scher	62—148
3,177,677	4/1965	Boren et al.	62—148 X

LLOYD L. KING, *Primary Examiner.*

Disclaimer

3,295,334.—*Nils Lennart Hultgren*, Stockholm, Sweden. HEAT OPERATED REFRIGERATOR OPERABLE ON GAS OR ELECTRICITY AND CONTROL MECHANISM THEREFOR. Patent dated Jan. 3, 1967. Disclaimer filed May 21, 1971, by the assignee, *Aktiebolaget Electrolux.*

Hereby enters this disclaimer to claims 1 to 9, inclusive of said patent.

[*Official Gazette August 24, 1971.*]