

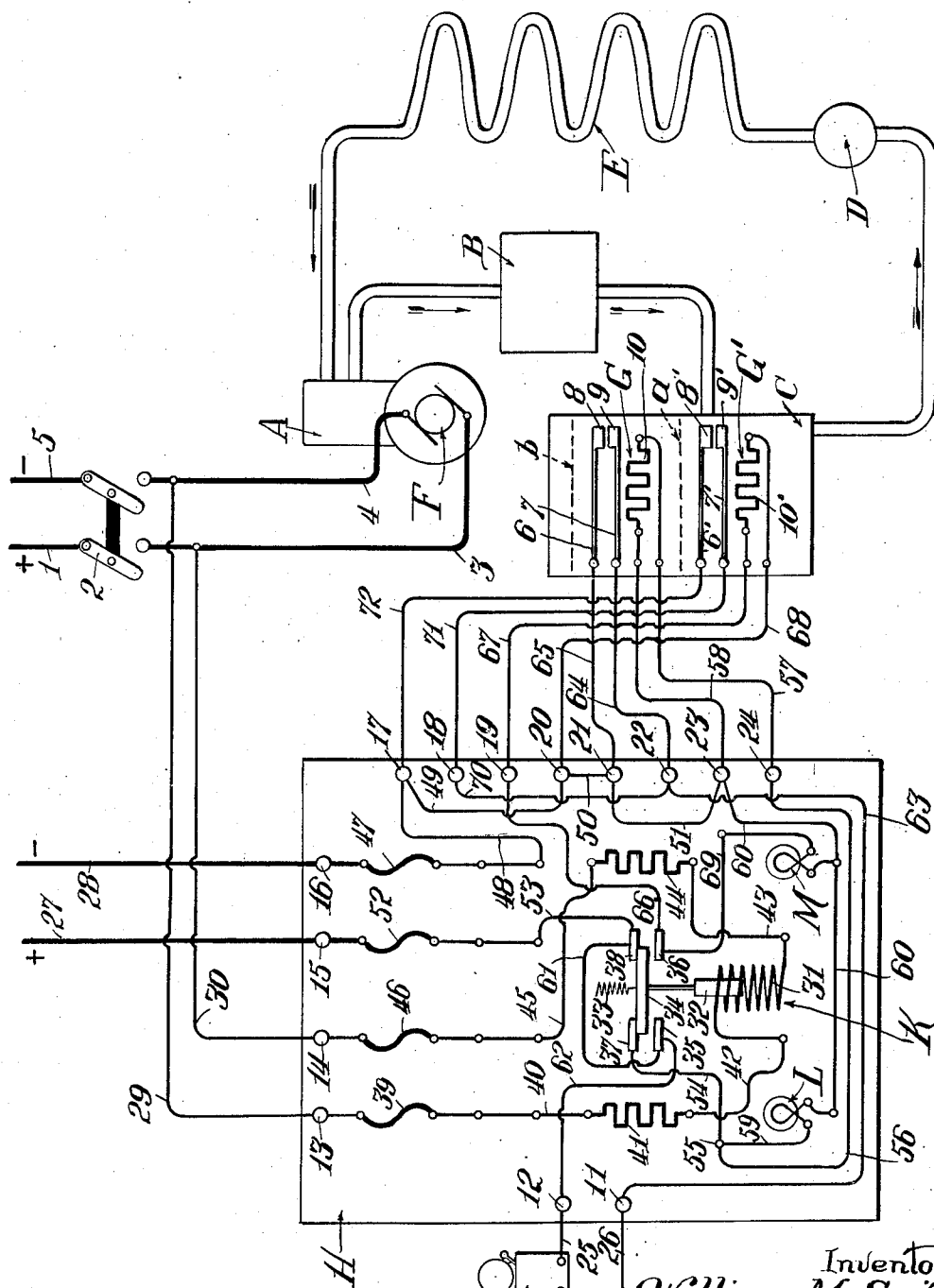
June 1, 1937.

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2,082,035

LEAK DETECTOR

Filed April 6, 1936



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UNITED STATES PATENT OFFICE

2,082,035

LEAK DETECTOR

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Application April 6, 1936, Serial No. 72,973

13 Claims. (Cl. 62-1)

This invention relates to a new and improved leak detector, and more particularly to an improved means for automatically giving an alarm to indicate the leakage of refrigerant from an automatic refrigerating system.

The refrigerant used in many refrigerating systems, particularly of the compression type, is poisonous or at least injurious to health, particularly if the refrigerant escapes in large quantities. The apparatus hereinafter disclosed is designed to give an alarm or signal whenever any material quantity of this refrigerant escapes from the system, so that the leaks may be stopped and serious damage avoided.

In a refrigerating system of the compression type, a tank or sump is positioned in the closed circulation system in advance of the condenser. Liquid refrigerant drains from the condenser into this tank and passes from this tank through the evaporator. A certain reserve supply of liquid refrigerant will remain in the tank at all times, although a large percentage of the refrigerant is in circulation throughout the other elements of the refrigerating system. When the refrigerating system is idle, that is when the compressor is stopped and the circulation of the refrigerant is substantially discontinued, a greater amount of the liquid refrigerant will accumulate in the tank and the liquid level will rise substantially to a normal upper predetermined level. When the compressor is in operation and the circulation of refrigerant is renewed, the normal amount of liquid refrigerant in the tank will be decreased and the liquid level in the tank will fall to a lower predetermined level. Thus there are two normal liquid levels in the tank, one when the refrigerating system is in operation and the other when the refrigerating system is not in operation. According to the present invention, two separate detector units are positioned in the tank, one of these units being associated with each of the two normal liquid levels. Either detector is adapted to cause the operation of a signal device when the liquid level falls substantially below the normal level with which that particular detector unit is associated. Means is provided for selectively rendering either one or the other of the detector units effective in accordance with whether the refrigerating system is idle or in operation. In this way a substantial leakage from the system will cause a warning to be given at any time, whether the refrigerating system is in operation or not.

The principal object of this invention is to provide an improved leak detecting apparatus of the type briefly described hereinabove and disclosed more in detail in the specifications which follow.

Another object is to provide an improved electrically-operated signal unit and control mechanism therefor to be associated with the sump tank of a refrigerating system.

Another object is to provide, in combination with a tank in which one liquid level is normal at certain times and another liquid level is normal at certain other times, a mechanism for giving a signal whenever the liquid level is lowered materially below the level that is normal at any given time.

Other objects and advantages of this invention will be more apparent from the following detail description of one suitable form of apparatus constructed and operating according to the principles of this invention.

The accompanying drawing is a diagrammatic view illustrating a typical refrigerating system, the signal mechanism, and the wiring connections therefor.

At the right of the figure is diagrammatically illustrated a refrigerating system of the compression type comprising a compressor A, a condenser B, a sump tank C, an expansion valve D, and an evaporator E, all of these units being connected in a closed circuit by the piping shown so that refrigerant will circulate through these units in well known manner, in the direction of the arrows. The compressor A is driven by motor F which is energized by means of the following circuit: From main 1 through switch 2, wire 3, motor F, wire 4, switch 2 and the other power main 5. The switch 2 may be opened or closed in any suitable manner. Usually this switch is operated thermostatically in accordance with temperature changes in the space being refrigerated. When the temperature in this space has been lowered to a predetermined point the switch 2 is opened to stop the action of the refrigerating system. When the temperature again rises to this point the switch is closed and motor F is again energized to cause operation of the compressor A and renew the circulation of the refrigerant.

When the compressor is in operation a larger percentage of the refrigerant will be in circulation through the system and the normal liquid level in sump C will be substantially as indicated at *a*. When the compressor is not in operation, more of the refrigerant will drain into

sump C and the normal liquid level will be higher as indicated at b.

A pair of similar detector units are indicated at G and G'. The unit G consists of a switch and a heating element therefor. The switch comprises a pair of supporting bars 6 and 7, one or both of which are of thermostatic material, these bars being fixedly mounted at one end and respectively carrying at their free ends the normally spaced apart contacts 8 and 9. When heat is applied to these bars they will warp toward one another so as to complete a circuit through the contacts 8 and 9. The electric heating element 10 is positioned adjacent the switch and when energized by suitable electric current the heat from this element is sufficient to bring the contacts 8 and 9 into engagement. However, when the heating element 10 is submerged in a liquid, such as the liquid refrigerant in tank C, this liquid will carry away or dissipate sufficient of the heat from the element 10 so that the heat transmitted to the supporting bars 6 and 7 of the switch is insufficient to bring contacts 8 and 9 into engagement with one another. The detector unit G' is of exactly similar construction and the elements of this unit are indicated by similar but primed reference characters.

The detector unit G is so positioned in the tank that the heating element 10 will be submerged a short distance below the upper liquid level b. As long as the liquid level remains at b, the heating element will be ineffective to close the switch, even though the heating element is energized, but as soon as the liquid level falls sufficiently to no longer cover the heating element 10, the heat from this unit will bring the contacts 8 and 9 together and close the circuit. In a similar manner the detector unit G' is so positioned that its heating element 10' is located just below the lower normal water level a.

At H is indicated a suitable panel board or box on which are suitably positioned the several terminals 11 to 24 inclusive. The switches and heating elements of the detector units G and G' are connected to the several terminals 17 to 24 inclusive as will be hereinafter described. A suitable signal or alarm mechanism J, for example an electric bell as here shown, is connected through wires 25 and 26 with the terminals 12 and 11 respectively. The mains 27 and 28 of a low voltage control circuit are connected respectively with the terminals 15 and 16. The wires 29 and 30 connect the respective wires 4 and 3 of the actuating circuit of motor F with the terminals 13 and 14.

On the panel board H is a relay mechanism indicated generally at K and comprising a solenoid coil 31 adapted when energized to draw down the core 32 against the resistance of a spring 33. When thus energized, the contact bar 34 will be pulled down so as to bridge the pair of fixed contacts 35 and 36. When the coil 31 is de-energized the spring 33 will draw contact bar 34 upwardly so as to bridge the second pair of fixed contacts 37 and 38. The relay coil is energized through the following circuit: From motor main 4 through wire 29, terminal 13, fuse 39, wire 40, resistance 41, wire 42, coil 31, wire 43, resistance 44, wire 45, fuse 46, terminal 14, and wire 30 to the other motor main 3. It will thus be seen that the relay coil 31 is connected in parallel with the motor F so that whenever switch 2 is closed to energize the motor F, the relay K will also be energized. Conversely, when the motor is stopped the relay coil will be deenergized.

The negative main 28 of the controlling circuit is connected through fuse 47 and wire 48 with terminal 17. Terminals 17 and 20 are connected by the jumper 49. Terminals 20 and 21 are connected by jumper 50. Terminals 21 and 23 are connected by jumper 51. It will thus be seen that terminals 17, 20, 21 and 23 are all connected with negative main 28. When the motor F is not running and relay K is in the position shown in the drawing, a circuit for energizing the heating element 10 of detector G is completed as follows: From positive main 27 through terminal 15, fuse 52, wire 53, relay contacts 38, 34 and 37, wire 54, terminal 55, wire 56, terminal 24, wire 57, heating element 10, wire 58, terminal 23 and thence to negative main 28. At the same time a branch or shunt circuit will be completed as follows: From terminal 55 through wire 59, signal light L, wire 60, terminal 23 and thence to the negative main. The light L will give a visible indication on the panel board that the motor F and the refrigerating system are not in operation.

With the circuits completed as just described, the heating element 10 will be continuously energized but since the refrigerating system is not in operation the refrigerant in sump tank C will be at the higher level b so as to cover the heating element 10. The liquid will thus dissipate the greater portion of the heat from element 10 and the thermostatically controlled contacts 8 and 9 will not be brought into engagement with one another. However, if under these conditions there should be a leak in the circuit so that the refrigerant level in tank C will drop sufficiently to uncover the heating element 10, then this heating element will be effective to heat the thermostatic bars 6 and 7 and bring the contacts 8 and 9 into engagement with one another. This will complete a circuit energizing the bell or other signal J, as follows: From positive main 27 through terminal 15, fuse 52, wire 53, contact 38, wire 61, contact 35, wire 62, terminal 12, wire 25, signal J, wire 26, terminal 11, wire 63, terminal 22, wire 64, bar 7, switch contacts 9 and 8, bar 6, wire 65, terminal 21, and thence to negative main 28. The signal J will then continuously give an alarm until the circuit is manually broken, or until the liquid level is restored to the upper level b so as to again submerge the heating element 10.

As has already been noted, when the motor F is again energized and the refrigerant is again actively circulated, the liquid level in tank C will normally drop to the level a even though there is no loss of refrigerant. If the heating element 10 were still energized the signal J would now be operated, but since the coil 31 of relay K is now energized the movable contact 34 will be moved down so as to break the energizing circuit for heating element 10 and signal light L and complete new circuits between the contacts 35 and 36. This will render the upper detector unit G ineffective but at the same time the lower detector unit G' will be made effective. The energizing circuit for heating element 10' of detector G' is as follows: From positive main 27 through terminal 15, fuse 52, wire 53, contact 38, wire 61, switch contacts 35, 34 and 36, wire 66, terminal 19, wire 67, heating element 10', wire 68, terminal 20 and thence to negative main 28. At the same time the signal light M will be energized through the shunt circuit extending from contact 36 through wire 69, light M, and wire 60, to terminal 23. This light will indicate that the motor F is running and the re-

frigerating system is in operation. If now the liquid level in tank C should fall sufficiently to uncover the heating element 10', the resultant heat applied to thermostatic bars 6' and 7' of detector G' will bring together the contacts 8' and 9' and complete a second energizing circuit for signal bell J which extends as before from positive main 27 through the signal J to terminal 22, jumper 70, terminal 18, wire 71, bar 7', contacts 9' and 8', bar 6', wire 72, terminal 17 and thence to negative main 28.

It will thus be seen that when it is normal for the liquid level to fall from the upper level b to the lower level a the signal J will not be operated, since this is no indication that there has been a loss of refrigerant. However if the level should fall further so as to uncover the heating element 10' it will be because there is no longer a normal quantity of refrigerant in the circulating system and in this case the signal J will be operated.

It will be apparent that this signal system is entirely automatic and indicates any substantial variation from the normal liquid level, even though this liquid level changes in accordance with the periodic on and off operation of the refrigerating system.

While this signal system is particularly adapted for use with a compression refrigerating system of the type here disclosed, it will be apparent that it might be used with other types of refrigerating systems, or with other liquid-holding tanks in which one liquid level is normal at one time, and another level is normal at another time.

I claim:

1. In combination with a tank adapted to hold liquid, there being an upper liquid level which is normal at certain times, and a lower liquid level which is normal at other times, a signal device, and means for automatically operating the signal whenever the liquid level falls a predetermined distance below the level that is normal at any given time, said predetermined distance being less than the difference between the two normal levels.

2. In combination with a tank adapted to hold liquid, there being an upper liquid level which is normal at certain times, and a lower liquid level which is normal at other times, a signal device, a pair of detector units positioned in the tank and each adapted to cause actuation of the signal when the level in the tank falls materially below a predetermined level, one of the detectors being associated with the normal upper level and the other with the normal lower level, and means for selectively rendering effective at any given time the detector that is associated with the particular level that is normal at that time.

3. In combination with a tank adapted to hold liquid, there being an upper liquid level which is normal at certain times, and a lower liquid level which is normal at other times, a signal device, an electric circuit for actuating the signal, a pair of similar detector units, each unit comprising a normally open thermostatically operated switch and an electric heating element adapted when energized to cause the switch to close unless the heating element is submerged in the liquid to dissipate the heat and thus permit the switch to remain open, one of these detectors being positioned with its heating element just below the normal upper liquid level in the tank and the other detector being positioned with its heating element just below the normal lower liquid level,

the two switches being connected in parallel in the signal operating circuit so that either may close the circuit, and means for energizing the upper heating element only when the upper liquid is normal and for energizing the lower heating element when the lower level is normal.

4. In combination with the sump tank of a refrigerating system, the liquid in this tank remaining at a normal high level when the refrigerating system is idle, this liquid level normally falling to a lower level when the system is in operation, a signal device, and means associated with the tank for causing the signal to operate when the system is idle and the liquid falls a predetermined distance below its normal upper level but less than the distance to the normal lower level, or when it falls a predetermined distance below its normal lower level when the system is in operation.

5. In combination with the sump tank of a refrigerating system, the liquid in this tank remaining at a normal high level when the refrigerating system is idle, this liquid level normally falling to a lower level when the system is in operation, a signal device, a pair of detector units positioned in the tank and each adapted to cause actuation of the signal when the liquid in the tank falls materially below a predetermined level, one of the detectors being associated with the normal upper liquid level and the other with the normal lower level, and means for selectively rendering the upper detector effective when the system is idle and the lower detector effective when the system is in operation.

6. In combination with the sump tank of a refrigerating system, the liquid in this tank remaining at a normal high level when the refrigerating system is idle, this liquid level normally falling to a lower level when the system is in operation, a signal device, an electric circuit for actuating the signal, a pair of similar detector units, each unit comprising a normally open thermostatically operated switch and an electric heating element adapted when energized to cause the switch to close unless the heating element is submerged in the liquid to dissipate the heat thus permitting the switch to remain open, one of these detectors being positioned with its heating element just below the normal upper liquid level in the tank and the other detector being positioned with its heating element just below the normal lower liquid level, the two switches being connected in parallel in the signal operating circuit so that either may close the circuit, and means for energizing the upper heating element only when the refrigerating system is idle and the lower heating element when the system is in operation.

7. In combination with the sump tank of a refrigerating system, the liquid in this tank remaining at a normal high level when the refrigerating system is idle, this liquid level normally falling to a lower level when the system is in operation, a signal device, an electric circuit for actuating the signal, a pair of similar detector units, each unit comprising a normally open thermostatically operated switch and an electric heating element adapted when energized to cause the switch to close unless the heating element is submerged in the liquid to dissipate the heat thus permitting the switch to remain open, one of these detectors being positioned with its heating element just below the normal upper liquid level in the tank and the other detector being positioned with its heating element just below the normal lower liquid level, the two switches being

connected in parallel in the signal operating circuit so that either may close the circuit, a relay, means for energizing the relay only when the refrigerating system is in operation, and relay-operated switch mechanism for energizing the lower heating unit when the system is in operation and the upper heating unit when the system is idle.

8. In combination with the sump tank of a refrigerating system, the liquid in this tank remaining at a normal high level when the refrigerating system is idle, this liquid level normally falling to a lower level when the system is in operation, a signal device, an electric circuit for actuating the signal, a pair of similar detector units, each unit comprising a normally open thermostatically operated switch and an electric heating element adapted when energized to cause the switch to close unless the heating element is submerged in the liquid to dissipate the heat thus permitting the switch to remain open, one of these detectors being positioned with its heating element just below the normal upper liquid level in the tank and the other detector being positioned with its heating element just below the normal lower liquid level, the two switches being connected in parallel in the signal operating circuit so that either may close the circuit, a control panel, a relay mounted on the panel, a pair of signal lights on the panel, means for energizing the relay only when the refrigerating system is in operation, and relay-operated switch mechanism on the panel for energizing the lower heating unit and one of the lights when the system is in operation and for energizing the other heating unit and the other light when the system is idle.

9. In combination with a refrigerating system including a compressor, a condenser, a sump tank for holding liquid refrigerant, an evaporator, and a motor for driving the compressor and causing the refrigerant to circulate, the liquid in the tank normally being at a predetermined high level when the compressor is idle and normally sinking to a predetermined lower level when the compressor is in operation, a signal device, and means associated with the tank for causing the signal to operate when the compressor is idle and the liquid falls a predetermined distance below the normal upper level in the tank and before it falls to the normal lower level, or when the liquid falls a predetermined distance below the normal lower level when the compressor is in operation.

10. In combination with a refrigerating system including a compressor, a condenser, a sump tank for holding liquid refrigerant, an evaporator, and a motor for driving the compressor and causing the refrigerant to circulate, the liquid in the tank normally being at a predetermined high level when the compressor is idle and normally sinking to a predetermined lower level when the compressor is in operation, a signal device, a pair of detector units positioned in the tank and each adapted to cause actuation of the signal when the liquid in the tank falls materially below a predetermined level, one of the detectors being associated with the normal upper liquid level and the other with the normal lower liquid level, and means for selectively rendering the upper detector effective when the compressor is idle and the lower detector effective when the compressor is in operation.

11. In combination with a refrigerating system including a compressor, a condenser, a sump

tank for holding liquid refrigerant, an evaporator, and a motor for driving the compressor and causing the refrigerant to circulate, the liquid in the tank normally being at a predetermined high level when the compressor is idle and normally sinking to a predetermined lower level when the compressor is in operation, a signal device, an electric actuating circuit for the signal, a pair of similar detector devices, each device comprising a normally open thermostatically operated switch and an electric heating element adapted when energized to cause the switch to close unless the heating element is submerged in the liquid to dissipate the heat thus permitting the switch to remain open, one of these detectors being positioned with its heating element just below the normal upper liquid level in the tank and the other detector being positioned with its heating element just below the normal lower liquid level, the two switches being connected in parallel in the signal operating circuit so that either may close the circuit, and means for energizing the upper heating element only when the compressor is idle, and the lower heating element when the compressor is in operation.

12. In combination with a refrigerating system including a compressor, a condenser, a sump tank for holding liquid refrigerant, an evaporator, and a motor for driving the compressor and causing the refrigerant to circulate, the liquid in the tank normally being at a predetermined high level when the compressor is idle and normally sinking to a predetermined lower level when the compressor is in operation, a signal device, an electric actuating circuit for the signal, a pair of similar detector devices, each device comprising a normally open thermostatically operated switch and an electric heating element adapted when energized to cause the switch to close unless the heating element is submerged in the liquid to dissipate the heat thus permitting the switch to remain open, one of these detectors being positioned with its heating element just below the normal upper liquid level in the tank and the other detector being positioned with its heating element just below the normal lower liquid level, the two switches being connected in parallel in the signal operating circuit so that either may close the circuit, a relay, a circuit for simultaneously energizing or deenergizing the motor and relay, and relay-operated switch mechanism for energizing the lower heating element when the motor is operating and the upper heating element when the motor is idle.

13. In combination with a refrigerating system including a compressor, a condenser, a sump tank for holding liquid refrigerant, an evaporator, and a motor for driving the compressor and causing the refrigerant to circulate, the liquid in the tank normally being at a predetermined high level when the compressor is idle and normally sinking to a predetermined lower level when the compressor is in operation, a signal device, an electric actuating circuit for the signal, a pair of similar detector devices, each device comprising a normally open thermostatically operated switch and an electric heating element adapted when energized to cause the switch to close unless the heating element is submerged in the liquid to dissipate the heat thus permitting the switch to remain open, one of these detectors being positioned with its heating element just below the normal upper liquid level in the tank and the other detector being positioned with its heating element just below the normal liquid

level, the two switches being connected in parallel in the signal operating circuit so that either may close the circuit, a control panel, a relay mounted on the panel, a pair of signal lights on the panel, a circuit for simultaneously energizing or deenergizing the motor and relay, and relay-

operated switch-mechanism on the panel for energizing the lower heating unit and one of the lights when the motor is operating, and for energizing the upper heating unit and the other light when the motor is idle.

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