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Stewart

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[54] **DUAL FUNCTION LOW PRESSURE CUTOUT FOR REFRIGERATION SYSTEM**

[75] Inventor: **Robert S. Stewart,** Staunton, Va.

[73] Assignee: **Westinghouse Electric Corporation,** Pittsburgh, Pa.

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[52] **U.S. Cl.** **62/203,** 62/209, 62/227, 62/229

[51] **Int. Cl.** **F25b 41/00**

[58] **Field of Search** 62/203, 204, 208, 209, 62/226, 227, 228, 229

[56] **References Cited**

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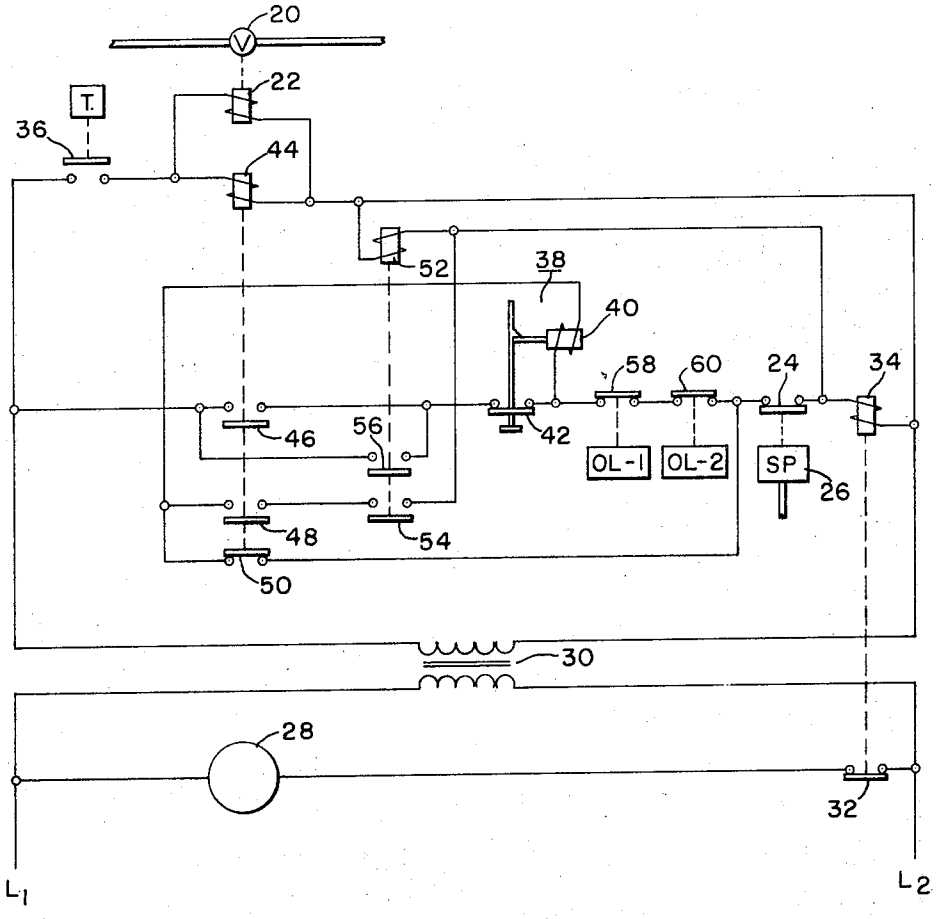
Primary Examiner—Meyer Perlin

Attorney, Agent, or Firm—E. C. Arenz

[57] **ABSTRACT**

A single low pressure cutout is provided in a control arrangement to provide normal low pressure protection during a cooling demand, and to shutdown the compressor after a pumpdown operation. The arrangement includes a lockout circuit and switch means which function to switch the low pressure cutout into the lockout circuit for normal low pressure protection, and out of it for the pumpdown operation.

6 Claims, 2 Drawing Figures



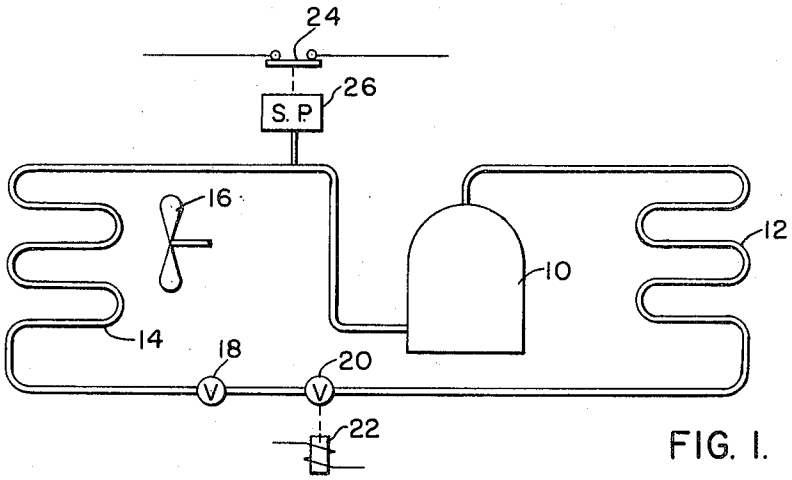

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FIG. 1.

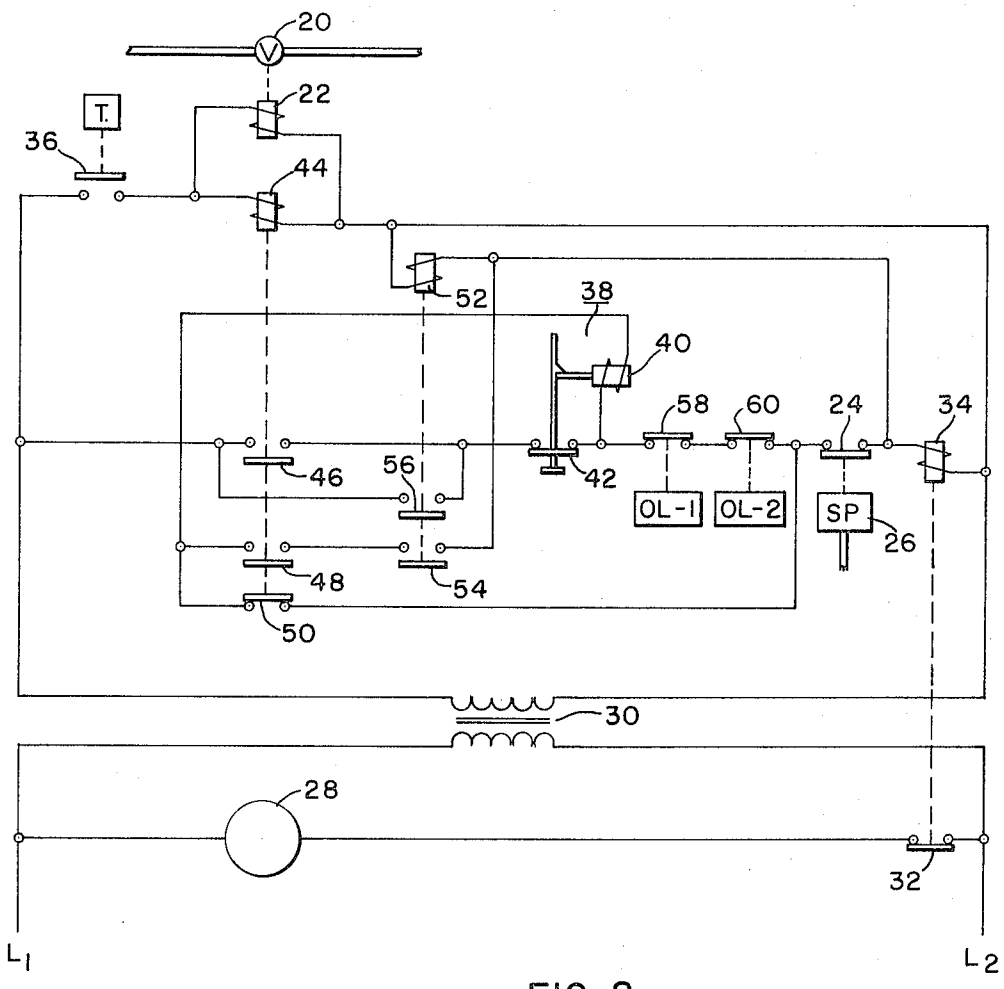
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FIG. 2.

DUAL FUNCTION LOW PRESSURE CUTOUT FOR REFRIGERATION SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention pertains to the art of control arrangements for refrigeration systems.

2. Description of the Prior Art

Of the patented prior art of which I am aware, the following U.S. Patents are considered to be exemplary of arrangements proposed to achieve at least part of that which I consider achieved by my invention: U.S. Pat. No. 3,377,816; 3,271,971; 2,475,069; 2,364,459.

As background for better understanding the invention and its advantages, the following information on conventionally used arrangements to obtain the two functions which my invention provide is considered apropos.

Normal low pressure protection of refrigeration systems of the type with which my invention is concerned is desired when the suction line pressure goes below a predetermined setting while a cooling demand exists, the low pressure typically being caused by some fault such as low refrigerant charge, or dirty evaporator filters, or low evaporator air flow, or indoor fan failure, for example. Such refrigeration system conditions may well result in icing of the evaporator and may result in equipment failure, or at the least unsatisfactory cooling, if permitted to continue. Hence, the low pressure cutout device used for normal low pressure protection is usually provided in a lockout circuit, that is, a circuit which requires a manual reset, if the circuit is energized.

As is well known, the purpose of a compressor pumpdown after the cooling demand is satisfied is to permit the compressor to clear itself of refrigerant before shutdown, and thereby preventing slugging on startup. This is conventionally done by closing the liquid line to the evaporator with a solenoid operated valve. The compressor continues to operate after the valve is closed until a predetermined low pressure is sensed by a low pressure cutout device which stops compressor operation. Since a pumpdown occurs on every cycle of the cooling demand thermostat, it requires a low pressure cutout device that automatically resets. A preferred setting for the low pressure cutout devices for both functions is, in my view, about 30 psig.

So far as I know, the conventional way to obtain the normal low pressure protection, while also permitting a pumpdown, is to use two different low pressure cutout devices, with one being arranged to provide a lockout if the low pressure occurs, and the other one resetting automatically. This also requires of course that the cutout device for normal low pressure protection be set at a substantially lower value, such as 5 psig compared to 30 psig, so as not to interfere with the pumpdown function. Since the setting of 5 psig on the normal low pressure protection will not protect against icing of the evaporator, typically an additional device such as a refrigerant thermostat associated with the evaporator coil is used to sense extreme cold conditions for stoppong the compressor. With this arrangement, the cutout device used for the normal low pressure protection is in fact only protecting for a loss of refrigerant charge.

SUMMARY OF THE INVENTION

In accordance with my invention, a single low pressure cutout device is provided in a control arrangement including a manually resettable circuit breaker in a lockout circuit, and switching means is provided to switch the low pressure cutout device into the lockout circuit for normal low pressure protection and out of the lockout circuit for the pumpdown operation. In my currently preferred operation, the lockout circuit includes one parallel branch including the tripping coil of the circuit breaker and another parallel branch including overload switch means, both of the parallel branches being in series with the circuit breaking contacts of the circuit breaker. The lockout circuit changing switch means is operable in accordance with operation of the cooling demand thermostat to connect the switch means of the low pressure cutout device in the parallel branch including the overload switch means in response to a demand for cooling so that a suction pressure below a given level will actuate the circuit breaker by energizing the tripping coil, and to connect the switch means of the low pressure cutout device in series with the other parallel branch in response to satisfaction of the cooling demand thermostat so that termination of compressor operation can occur following pumpdown without actuating the circuit breaker when the switch means of the low pressure cutout device operate to an open position.

DRAWING DESCRIPTION

FIG. 1 is a schematic representation of a refrigeration system of the type with which my control arrangement may be used; and

FIG. 2 is a schematic representation of one control arrangement according to the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The diagrammatically represented refrigeration system of FIG. 1 includes a compressor **10**, condenser **12**, evaporator **14** and fan **16** therefor and the connecting lines therebetween which include expansion valve **18** and suction line valve **20** therein as shown. Valve **20** is operated by solenoid **22** to a closed position at the appropriate time to provide for a pumpdown operation.

The low pressure cutout device includes a switch **24** operable in accordance with the suction pressure sensed in the suction line downstream from the suction valve **20** by the suction pressure sensing means designated **26.**

In the arrangement of FIG. **2,** opposite sides of a voltage source are indicated by lines L1 and L2. For purposes of explaining the invention, **28** indicates the compressor motor although it will be understood that for refrigeration systems of the larger sizes **28** can be indicative of the coil of a motor contactor for controlling the energization of a motor energized from a different voltage source. In that same connection, a transformer **30** is shown for stepping down the voltage for the major part of the control circuit. To energize the compressor motor, switch **32** must be closed by the cooling control relay coil **34.**

Referring to FIG. **2,** the other major parts of the control arrangement will now be described. The cooling demand thermostat including its switch **36** is open

when satisfied and closes when cooling is demanded. The circuit breaker generally designated **38** is of the manual reset type and includes a tripping coil **40** and the breaking contacts **42**, and is normally closed. A first control relay is provided which includes a coil **44** controlling normally open switch **46**, normally open switch **48**, and normally closed switch **50**. A second control relay is provided which includes coil **52** and normally open switches **54** and **56**. The circuit also includes switches **58** and **60** which are normally closed overload switches operated to open positions in response to one or another abnormal operating conditions as sensed by the devices carrying the legends OL-1 and OL-2.

For purposes of description of this invention, the lockout circuit portion of the control arrangement includes the breaker contact switch **42** in series with one branch parallel circuit including the tripping coil **40**, and another branch parallel circuit including the overload switches **58** and **60**. The low pressure cutout device switch **24** is connected in parallel with the tripping coil during normal cooling operation to provide a low suction pressure shutdown if such condition arises, and is connected in series with the two parallel branches of the lockout circuit to preclude tripping the circuit breaker during a pumpdown operation preceding compressor shutdown, which is then effected by opening of the cutout device switch **24**.

The switches controlled by the first control relay coil **44** perform the following functions. Switch **46** serves to complete part of the control circuit to permit initially energizing the compressor when the cutout device switch **24** closes during a normal startup. Switch **48** completes part of the one parallel branch of the lockout circuit after the cutout device switch **24** has closed during the normal startup. Switch **50** serves to connect the cutout device switch **24** in series with the two parallel branches of the lockout circuit when switch **50** is closed, and to isolate it from the one branch including the tripping coil **40** when it is opened.

The function of the switches of the second control relay controlled by coil **52** are as follows. Switch **56** completes what can be considered to be a holding circuit which permits continued compressor operation after a cooling demand has been satisfied and the pumpdown is occurring. Switch **54**, by remaining open during normal startup before the cutout device switch **24** closes, prevents the circuit breaker from tripping through the circuit which would be completed through switch **54** if closed at that time. However, switch **54** must close after the cutout device switch **24** closes to provide a complete branch circuit with the tripping coil **40**.

OPERATION

After a normal cooling operation and compressor shutdown following a suction pumpdown, the thermostat **36** is open, the coil **44** of the first control relay is deenergized, the suction line valve **20** is closed by its controlling solenoid **22** being deenergized, and the cutout device switch **24** is open in response to the pressure in the suction line being below the established pressure setting.

When cooling is demanded, the thermostat **36** closes, the coil **44** of the first control relay is energized so that its controlled switches **46** and **48** close and **50** opens, and the suction line valve **20** is opened by the energization of its solenoid **22**. Opening of the suction line valve **20** will relieve the low pressure in the suction line downstream of the valve **20**, if such a low pressure exists at that time, and the cutout device switch **24** will close. Thus a compressor energizing control circuit is established through the first control relay switch **46**, the closed circuit breaker breaking contacts **42**, the overload switches **58** and **60**, and the cutout device switch **24**. This results in energization of the cooling relay coil **34** and closure of its controlled switch **32** to complete the circuit in which the compressor motor, or operating coil **28** for a motor contactor, is located. Before the cutout device switch **24** closes, energization of the circuit breaker tripping coil **40** is prevented by switch **54** of the second control relay being open until the switch **24** closes.

After the cutout device switch **24** closes, the cutout device switch and the overload switches **58** and **60** are in a parallel circuit with the tripping coil **40** of the circuit breaker so that if any overload condition, or a low pressure condition in the suction line arises, causing any of these switches to open, the circuit breaker will be tripped by energization of its tripping coil. The parallel circuit in which the tripping coil is connected is established by the closure of the switch **54** of the second control relay following closure of the cutout device switch **24**, the earlier closed switch **48** of the first control relay, and the earlier opened switch **50** of the first control relay.

After the thermostat is satisfied so that its switch **36** opens, the first control relay is deenergized so that its control switches **46**, **48**, and **50** take the positions shown in FIG. **2**, the suction line valve **20** is closed by deenergization of its solenoid **22**, and the cutout device switch **24** remains closed until a suction pressure below the setting is detected by the suction pressure sensor **26**. By closing of the switch **50** of the first control relay, the cutout device switch **24** is now in series with the one branch including the overload switches **58** and **60**, and the other branch including the tripping coil **40**. Accordingly, the switch **24** is effectively outside the lockout circuit.

While the pumpdown operation occurs, the compressor remains energized through a completed control circuit including switch **56** of the second control relay, the circuit breaking contacts **42**, the two overload switches **58** and **60**, and the cutout device switch **24** which completes the circuit to both the second control relay coil **52** and the parallel cooling relay coil **34**. After the pumpdown has reduced the suction line pressure downstream from the valve **20** to below the setting of the cutout device, the switch **24** opens and the circuit is as it was first stated above following a normal cooling operation and shutdown.

It is noted that should any abnormal condition arise causing opening of either of the overload switches **58** or **60** during a pumpdown, the circuit breaker will be tripped to a position requiring manual reset.

It is considered that one of the salient advantages of the arrangement is that the suction line pressure setting for both pumpdown and for normal low pressure protection is the same. This is considered to be preferable to an arrangement in which the pumpdown pressure setting is substantially higher than the normal low pressure protection setting, which must be substantially lower where separate cutout devices are used for the two functions to avoid nuisance tripping of the circuit

breaker requiring manual reset during a normal pumpdown.

I claim:

1. In a control arrangement for a refrigeration system having a valve to permit a compressor pumpdown operation following satisfaction of cooling demand as sensed by a thermostat:

a manually resettable circuit breaker including normally closed breaking contacts and a tripping coil;

a circuit including one parallel branch in which said tripping coil is connected, and another parallel branch, said parallel branches being in series with said breaker contacts;

a cutout switch operable to an open and a closed position in response to suction line pressures respectively below and above an established setting; and

switch means for connecting said cutout switch in said another parallel branch to effect tripping of said breaker by energization of said tripping coil upon opening of said cutout switch while a cooling demand exists, and for connecting said cutout switch in series with said parallel branches upon satisfaction of said cooling demand to prevent tripping of said breaker while said compressor pumpdown operation occurs and until said cutout switch opens in response to completion of said pumpdown.

2. In a control arrangement for a refrigeration system having a valve to permit a compressor pumpdown operation following satisfaction of cooling demand as sensed by a thermostat:

a manually resettable circuit breaker including normally closed breaking contacts and a tripping coil;

a cutout switch operable to an open and a closed position in response to suction line pressures respectively below and above an established setting; and

switch means for connecting said cutout switch in parallel with said tripping coil while the cooling demand exists so that energization of said tripping coil will occur while said cooling demand exists upon opening of said cutout switch, and for connecting said cutout switch in series with both said tripping coil and a circuit in parallel with said tripping coil upon satisfaction of a cooling demand so that energization of said tripping coil is avoided when said cutout switch opens following compressor pumpdown.

3. In a control arrangement for a refrigeration system including a compressor, condenser, evaporator, connecting lines therebetween, a thermostat, and a valve for restricting refrigerant flow to said compressor following satisfaction of a cooling demand sensed by said thermostat:

a manually resettable circuit breaker having normally closed circuit breaking contacts and a tripping coil;

a low pressure cutout switch responsive to suction pressure downstream from said valve, said cutout switch being connected in series with relay means controlling energization of said compressor;

a circuit having one parallel branch including said tripping coil, and another parallel branch, said parallel branches being connected in series with said circuit breaker contacts; and

switch means operable in accordance with operation of said cooling demand thermostat for connecting said cutout switch means in said another parallel branch in response to a demand for cooling, so that opening of said cutout switch in response to a suction pressure below a given level will open said breaking contacts by energizing said tripping coil, and for connecting said cutout switch means in series with said parallel branches in response to satisfaction of said thermostat so that opening of said cutout switch and termination of compressor operation will occur following pumpdown without opening said circuit breaking contacts.

4. In a control arrangement according to claim 3 including:

a solenoid for opening said suction line valve when energized;

a relay coil for operating said switch means;

said solenoid and said relay coil are connected in parallel with each other and in series with said thermostat.

5. In a control arrangement according to claim 3 wherein:

said another parallel branch includes overload switch means.

6. A control arrangement for a refrigeration system including a compressor, condenser, evaporator, connecting lines therebetween, and a solenoid operated valve for restricting refrigerant flow to said compressor, comprising:

a thermostat;

a control power source;

a manually resettable circuit breaker having normally closed circuit breaking contacts and a tripping coil;

a low pressure cutout switch responsive to suction line pressure downstream from said valve;

overload switch means;

a cooling relay including a coil and switch means for effecting energization of said compressor when said coil is energized;

a first control relay including a coil and first and second normally open switches and a third normally closed switch;

a second control relay including a coil and first and second normally open switches;

one circuit across said source including said thermostat connected in series with said solenoid and said first control relay coil in a first parallel circuit;

another circuit across said power source from one side thereof to the other, including;

a second parallel circuit including in parallel said first switches of said first and second control relays, said second parallel circuit being connected in series with said breaking contacts,

a third parallel circuit in series with said breaking contacts including, in series in one branch said tripping coil and said second switches of said first and second control relays, and in series in the other branch said overload switch means and said cutout switch,

a third parallel circuit in series with said second parallel circuit, said third parallel circuit including said second relay coil in parallel with said cooling relay coil,

said third normally closed switch of said first control relay being connected between the two branches of

said third parallel circuit, with one side of said third switch being connected between said overload switch means and said cutout switch, and the other side of said third switch being connected between said tripping coil and said second switch of said first control relay;

whereby energization of said first control relay coil in accordance with closing and opening of said thermostat results in connecting of said cutout switch in and out of parallel with said tripping coil so that said low pressure cutout switch provide normal low suction pressure protection while the cooling demand exists, while permitting a compressor pump-down after a cooling demand is satisfied.

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