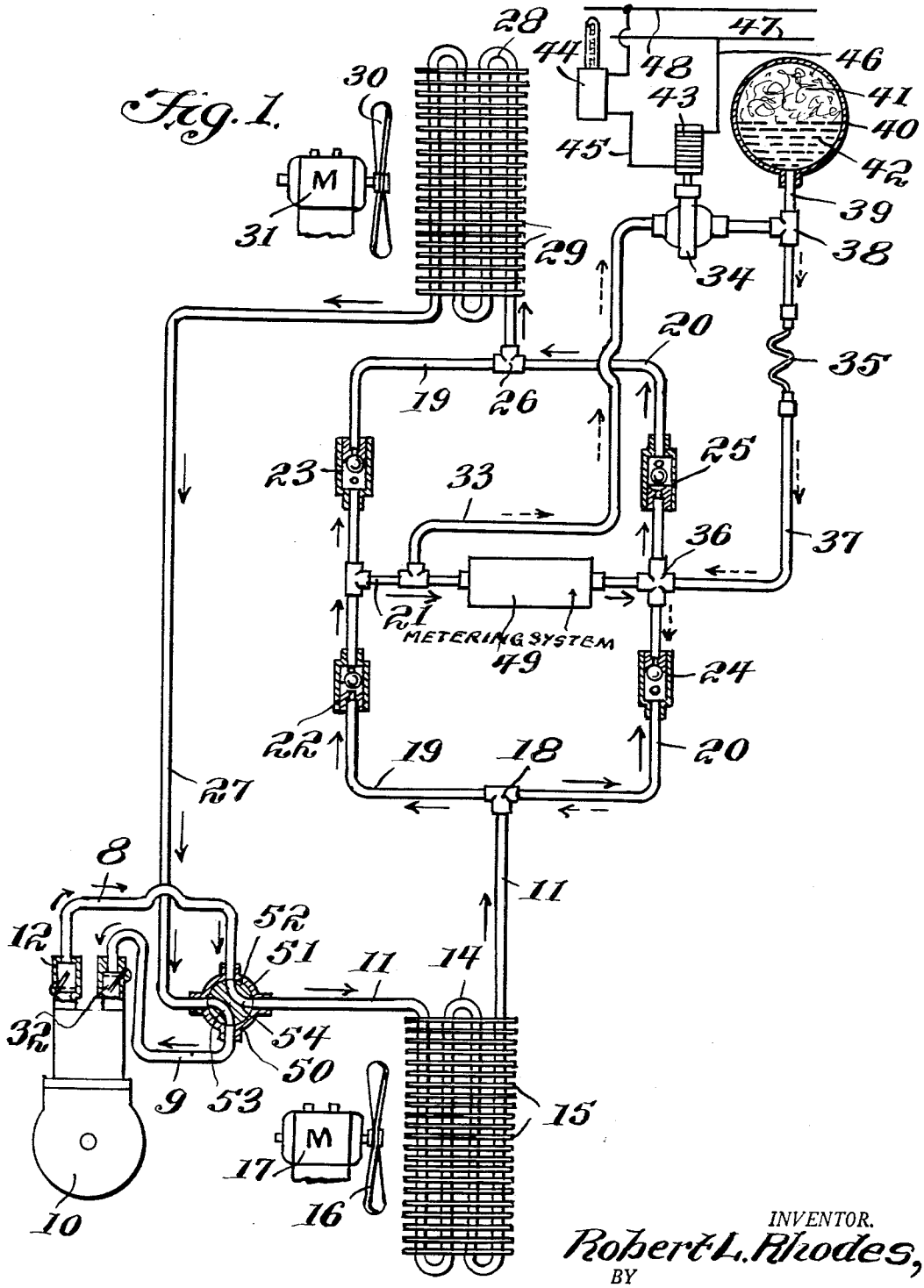
Aug. 16, 1955 R. L. RHODES 2,715,317

AUTOMATIC LOAD CONTROL FOR A REVERSIBLE HEAT PUMP AND AIR CONDITIONER

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Fig. 1.



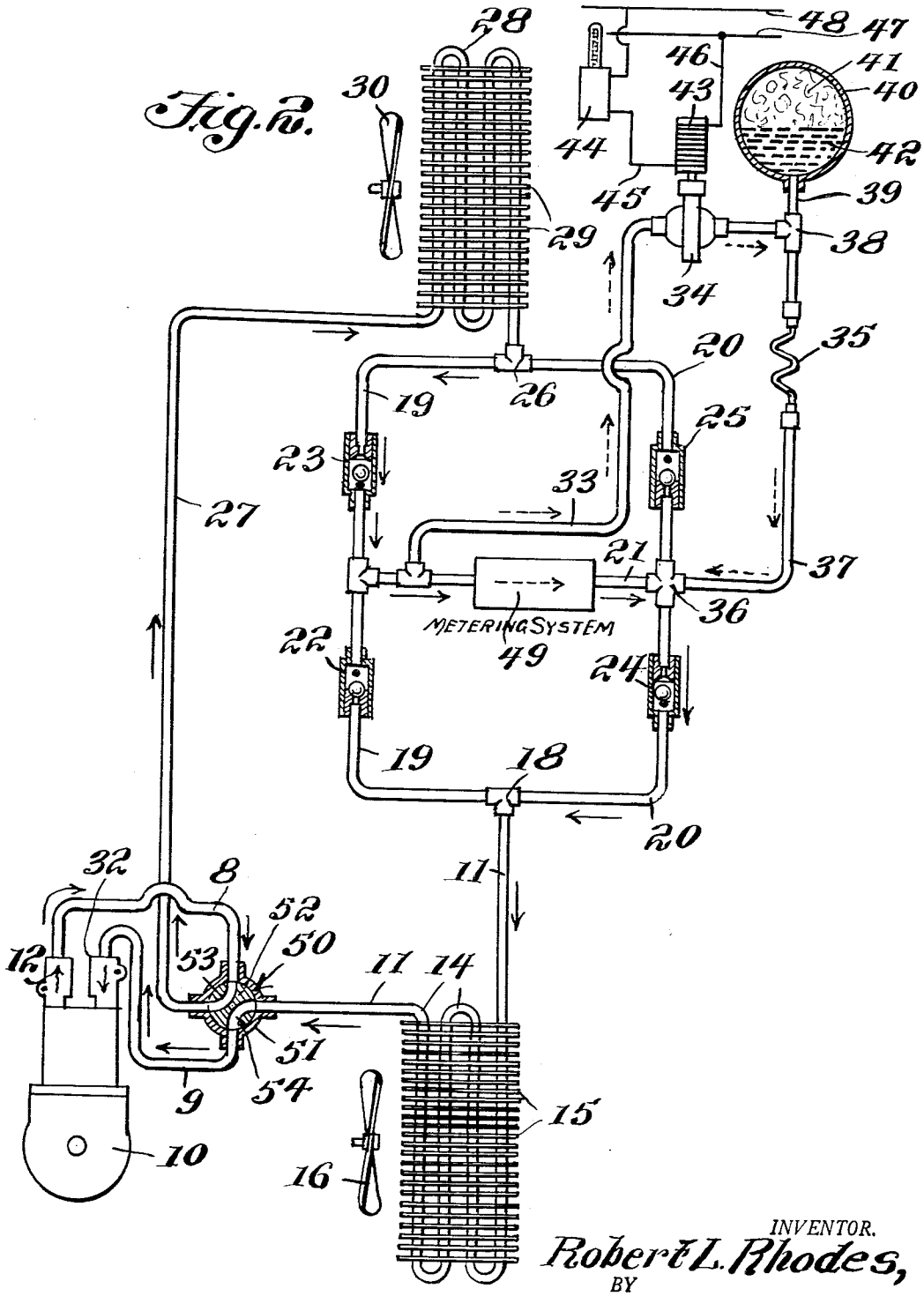
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Fig. 2.



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AUTOMATIC LOAD CONTROL FOR A REVERSIBLE HEAT PUMP AND AIR CONDITIONER

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5 Claims. (Cl. 62—3)

This invention relates to a heat pump or air conditioner, and more particularly to a control system for a heat pump or air conditioning assembly.

The object of the invention is to provide a load control system whereby the output of the heat pump or air conditioner can be limited by decreasing the amount of refrigerant in the system.

Another object of the invention is to provide an automatic load control for a reversible heat pump which will provide unidirectional refrigerant flow through a metering system and whereby the effective refrigerant charge in the system will be varied automatically to compensate for temperature variations to thereby insure high output over all design temperature conditions.

A further object of the invention is to provide an automatic load control for a reversible heat pump or air conditioner which is extremely simple and inexpensive to manufacture.

Other objects and advantages will be apparent during the course of the following description.

In the accompanying drawings, forming a part of this application, and in which like numerals are used to designate like parts throughout the same:

Figure 1 is a schematic showing of the automatic load control of the present invention.

Figure 2 is a view similar to Figure 1 but showing the valve shifted to a different position.

Referring in detail to the drawings, the numeral **10** designates a refrigeration compressor of conventional construction, and extending from the compressor **10** is a first conduit **8** which serves to convey the refrigerant from the compressor **10**. The conduit **8** may have a check valve **12** arranged therein. A portion of a conduit **11** is shaped to define a coil **14** which may have fins **15** thereon, and a fan **16** is driven by a motor **17**. A T-fitting **18** serves to connect the conduit **11** to second and third conduits **19** and **20**. The second conduit **19** has a pair of oppositely acting or oppositely opening check valves **22** and **23** arranged therein, while the other or third conduit **20** also has a pair of oppositely acting check valves **24** and **25** interposed therein. A branch line or conduit **21** interconnects the pair of conduits **19** and **20** together.

A fourth conduit **27** is connected to a T-fitting **26** which communicates with the conduits **19** and **20** and the fourth conduit **27** may have a coil formation **28** therein. The coil formation **28** may include fins **29** and arranged contiguous thereto is a blower or fan **30** which is operated by a motor **31** of conventional construction. The short conduit **9** may be provided with a check valve **32** adjacent the compressor **10**.

Extending from the branch line **21** is a fifth conduit **33** which has a solenoid operated valve **34** therein. A sixth conduit **37** is arranged in engagement with a fitting **36**, and the sixth conduit **37** has a flow restrictor **35** arranged therein. A line or conduit **39** leads from a fitting **38** to a tank or receiver **40** and the tank **40** may have gaseous or vapor refrigerant **41** therein and liquid refrigerant **42** below the vapor **41**.

The valve **34** may be opened and closed by means of a solenoid **43** which can be connected to a switch **44** by means of a wire **45**. A wire **46** also connects the solenoid **43** to a power line **47**, and one of the wires **48** of the power input is connected to the switch **44**.

A metering system **49** is arranged in the branch line **21**. A valve mechanism **50** is arranged in engagement with the conduits **11** and **27**, and the valve **50** includes a stationary casing **51** that has a movable core **52** rotatably arranged therein. The core **52** includes a pair of curved passageways **53** and **54** that are mounted for movement into and out of registry with the sections of the conduits **11** and **27**.

The conduits **27** and **11** lead to the valve **50**. Also extending from the valve **50** are conduits or lines **8** and **9** which are connected to the compressor **10** through the medium of the check valves **12** and **32**.

From the foregoing it is apparent that there has been provided an automatic load control for reversible heat pumps which will provide unidirectional refrigerant flow through the flow metering system such as strainers, driers, high side floats, or other devices requiring unidirectional flow. The present invention will also automatically vary the effective refrigerant charge in the system to compensate for temperature variations and will insure high output over all design temperature conditions. The assembly may also be used to decrease the output of the machine if the compressor cycling is not desired for temperature and humidity control. The unidirectional flow is obtained through the use of the four check valves **22**, **23**, **24** and **25**. With the valve **50** set as shown in Figure 1, the valves **22** and **25** permit the flow of refrigerant through the system while the valves **23** and **24** block the flow around the control. In the second condition as shown in Figure 2, when the four way valve **50** is turned as indicated, then the valves **23** and **24** permit the flow through the metering system **49**, while the valves **22** and **25** prevent the fluid from bypassing the metering system **49**.

The control switch **44** may be pressure, temperature, or electrically actuated and the switch **44**, solenoid valve **34**, receiver tank **40** and flow restrictor **35** are used for controlling the effective fluid in the system. Thus, when a decrease in output is required, the control switch **44** energizes the solenoid **43** and this permits fluid to flow from the high pressure side of the metering system into the receiver **40**. The receiver must be located near the outside coil **28** so that its temperature and pressure will be lower than the high pressure side of the flow metering system and higher than the low pressure side of the metering system. The restrictor **35** permits refrigerant to slowly return to the low pressure side of the machine and again build up the output by increasing the effective charge in the system after the output has been sufficiently reduced to allow the control switch **44** to open. When sufficient refrigerant is returned to the system from the receiver **40**, the cycle will be repeated.

The system of output control of the present invention is also effective if the high pressure is taken from the refrigerant compressor outlet and the restrictor **35** is connected to the compressor inlet.

The present invention is not a new type of heat pump, but is a better load control system for heat pumps and air conditioning equipment. Broadly the present invention is such that the output of an air conditioner can be limited by decreasing the amount of refrigerant in the system and the automatic control of the amount of refrigerant in the system therefore controls the output. The receiver **40** contains a supply of refrigerant partially liquid **42**, and part in the vapor state which is indicated by the numeral **41** and this refrigerant is fed into the system through the restrictor **35** or withdrawn from the system through the solenoid valve **34** as required for control.

Since the receiver **40** is located in outside air the pressure, due to temperature in the receiver **40**, will always be lower than the high pressure side of the system metering device **49** and higher than the low pressure side so that flow will always be in the direction indicated.

Since the solenoid valve **34** is connected to the high pressure side of the system metering device, there will be no reverse flow of fluid through the metering device. The four check valves **22, 23, 24** and **25** insure that there will be unidirectional flow through the metering device **49**. The control switch **44** may be eliminated when a suitable electrical temperature or pressure control valve is available to replace the solenoid valve **34**. It is to be understood that any suitable type of four-way valve can be used for the valve **50** and although the drawings illustrate a rotary valve **50**, other types can also be used. The check valves **12** and **32** are positioned inside of the compressor **10** and form part of the compressor.

The high pressure side of the system includes all conduits and components through which the refrigerant flows, between the compressor outlet and the metering system **49**. The low pressure side of the system includes all conduits and components through which the refrigerant flows, between the metering system **49** and the inlet of the compressor **10**.

The metering system or device **49** is a restriction to the flow of refrigerant necessary to maintain a pressure differential sufficient to cause the refrigerant to condense to the liquid state in the high pressure, high temperature side of the system and to vaporize in the low pressure, low temperature side of the system. There are several metering devices of conventional construction which may be used with the present invention and as for example a capillary tube type can be used if a high temperature is to be maintained by the high side coil, and this also permits subcooling of the liquid in the high side coil and can be used in heat exchange relation with the conduit **9** for added subcooling. The capillary tube is a relatively long tube of small diameter which is of a size so that fluid friction will maintain the required pressure difference between the high and low pressure sides of the system.

A float operated valve may be used for passing liquid from the high to the low pressure side of the system as fast as it is condensed. The high side float may give higher efficiency as it permits the machine to operate against the lowest possible high side pressure if cooling is the primary use of the machine. Any suitable type of metering device **49** can be used in the present invention. The arrows shown by the conduits or lines show the direction of refrigerant flow in the system and are used as an aid in tracing the cycle. The flow restrictor **35** prevents excessive fluid from bypassing the metering device **49** when the solenoid valve **34** is open, and the restrictor **35** also determines the time required to recharge the system to the overload point and the frequency of operation of the control.

In Figure 1 the heating cycle refrigerant movement is illustrated. Thus, the compressor **10** reduces the vapor pressure in the coil **28** through conduit **27**, four-way valve **50** and conduit **9**. This causes the liquid refrigerant in coil **28** to vaporize at a low temperature and absorb heat from the outside air. This vapor flowing to the compressor **10** through the aforementioned components is compressed to a high pressure and consequent high temperature. This high temperature vapor flows through conduit **8**, four-way valve **50**, and conduit **11** into coil **14** in the area to be heated. As the temperature of the vapor is reduced in the coil **14** it condenses to liquid and gives up the heat of vaporization which it absorbed in the coil **28**, plus the heat of compression. The liquid refrigerant then flows from the coil **15** through the conduit **11**, T-fitting **18**, conduit **19**, check valve **22**, and conduit **21** to the metering system **49** and flow around the metering system is blocked by the check valves **23** and **24**. The metering system consists of any component requiring unidirectional flow (strainer, drier, etc.) and a pressure reducing device (high side float, capillary tube or the like). Flow through the metering system reduces the pressure on the liquid and lowers the vaporizing temperature. The liquid flows through the conduit **20**, check valve **25**, T-fitting **26**, and conduit **27** to the outside coil **28**. The liquid absorbs the heat of vaporization in the coil **28** from the outside air and the cycle is continuously repeated.

Referring to Figures 1 and 2 there is illustrated the refrigerant movement for automatic load control action. Thus, when conditions require that the output of the machine be reduced, the control switch **44** energizes the solenoid **43**, which opens the valve **34**. This permits fluid to flow through the conduit **33**, valve **34**, T-fitting **38** and conduit **39** into the receiver tank **40**, the restrictor **35** preventing excessive flow through the conduit **37**. The resulting reduction of fluid in the coil **14** or coil **28**, depending upon what type of metering device is used, lowers the output of the machine. When the reduction of output is no longer required the control switch **44** allows the solenoid valve **34** to close. Fluid again slowly returns to the system from the receiver **40** through the conduit **39**, T-fitting **38**, conduit **37**, restrictor **35** and fitting **36**. This returning fluid again builds up in coil **14** or **28** until the overload condition again exists and the cycle is repeated.

The cooling cycle as illustrated in Figure 2 and the action of the machine on the cooling cycle of Figure 2 is similar to the action of Figure 1, except that Figure 1 shows the heating cycle and except for the following differences. The four-way valve **50** is thrown to direct the high pressure (hot) vapor from the compressor **10** to the outside coil **28** and the cold low pressure vapor from the inside coil **14** to the compressor **10**. This reverses the direction of fluid flow through the system except where unidirectional flow is provided by the four check valves **22, 23, 24** and **25**. Fluid now flows through the check valves **23** and **24** while valves **22** and **25** block flow around the controls.

The advantages of the system of the present invention are that there will be provided an efficient and economical method of providing unidirectional fluid flow for a strainer, drier, liquid receiver, and/or other components which require unidirectional flow when used in a reversible heat pump. Further, there is provided a method of automatically varying the effective refrigerant charge in a system for the purpose of controlling the output of the machine, and there is also provided a method of using a liquid receiver in a system that uses a high side float or capillary tube expansion device to supply make up fluid for small refrigerant leaks. The present invention also provides a method of limiting the power required for the compressor, the high side pressure, or the high side temperature, depending upon how the control switch is activated. Furthermore, the present invention can be used to reduce the output of the machine instead of cycling the compressor on and off for humidity control or other conditions where cycling the compressor is undesirable.

I claim:

1. In combination, a refrigerant compressor, a valve mechanism connected to said compressor, a first conduit extending from said valve mechanism, a portion of said first conduit being shaped to define a coil, a first T-fitting connected to said first conduit, a second and third conduit connected to said T-fitting, a pair of oppositely opening check spaced apart valves interposed in each of said second and third conduits, a branch line interconnecting said second and third conduits together and joined to said second and third conduit at the space intermediate the respective pairs of valves and having a metering device therein, a second T-fitting connected to the junction of said second and third conduits, a fourth conduit extending from said second T-fitting to said valve mechanism, a portion of said fourth conduit defining a coil, a fifth conduit connected to said branch line at a point

intermediate the second conduit and said metering device, a sixth conduit connected to said branch line at the opposite side of the metering device from said fifth conduit and said sixth conduit being also in communication with said third conduit, and a tank communicating with said fifth and sixth conduits.

2. The structure as defined in claim 1, and further including a valve arranged in said fifth conduit.

3. The structure as defined in claim 1, and further including a valve arranged in said fifth conduit, and a solenoid and switch for controlling said last named valve.

4. The structure as defined in claim 1, and further including a flow restrictor arranged in said sixth conduit.

5. In combination, a refrigerant compressor, a valve mechanism connected to said compressor, a first conduit extending from said valve mechanism, a portion of said first conduit being shaped to define a coil, a first fitting connected to said first conduit, a second and third conduit connected to said fitting, a pair of spaced apart valves interposed in each of said second and third conduits, a branch line interconnecting said second and third conduits together and joined to said second and third conduit at the space intermediate the respective pairs of valves and having a metering device therein, a second fitting connected to the junction of said second and third conduits, a fourth conduit extending from said second fitting to said valve mechanism, a portion of said fourth conduit defining a coil, a fifth conduit connected to said branch line at a point intermediate the second conduit and said metering device, a sixth conduit connected to said branch line at the opposite side of the metering device from said fifth conduit and said sixth conduit being also in communication with said third conduit, and a tank communicating with said fifth and sixth conduits.

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