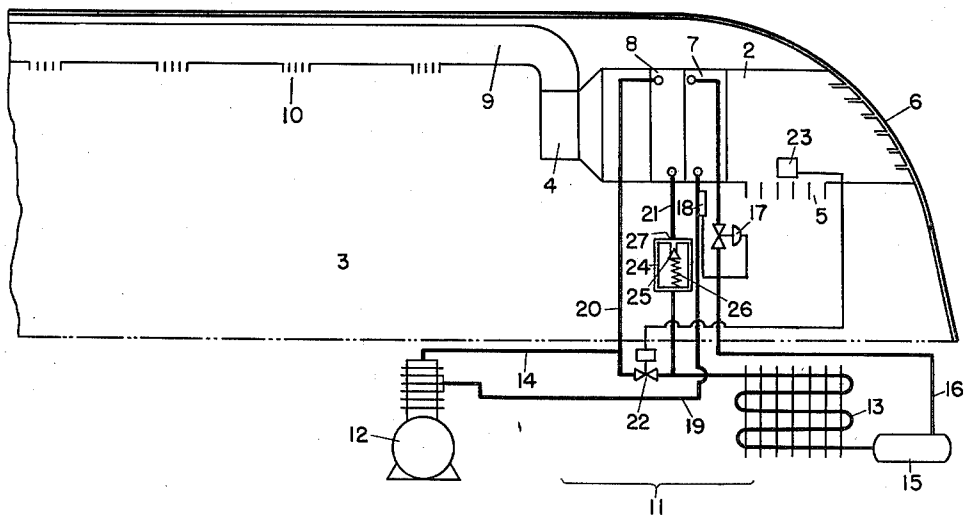
July 18, 1950 J. SWINBURNE 2,515,842

SYSTEM FOR PROVIDING REHEAT IN BUS AIR CONDITIONING

Filed July 16, 1947

FIG.1



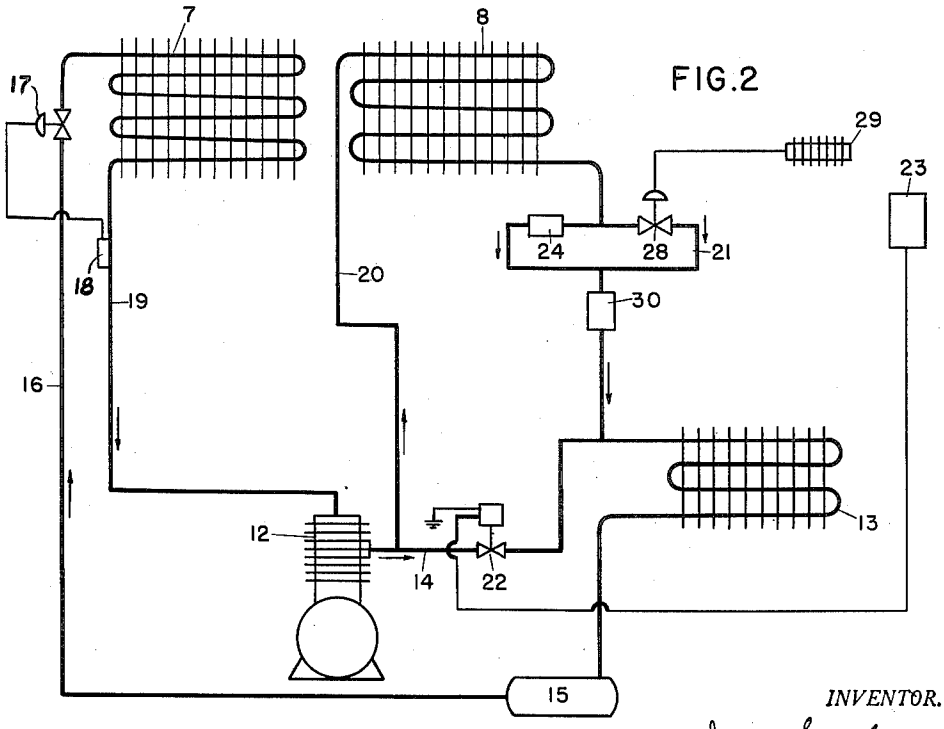


FIG.2

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Patented July 18, 1950 2,515,842

UNITED STATES PATENT OFFICE

2,515,842

SYSTEM FOR PROVIDING REHEAT IN BUS AIR CONDITIONING

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Application July 16, 1947, Serial No. 761,324

8 Claims. (Cl. 62—6)

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This invention relates to a system for providing reheat in air conditioning and more particularly to an air conditioning system in which hot gaseous refrigerant from the compressor is utilized to reheat a stream of dehumidified cooled air.

In bus air conditioning, for example, a problem exists in the control of the temperature of the interior of the bus under conditions of low sensible heat load and high latent heat load which frequently occur during night operation when the exterior relative humidity is high and the exterior dry bulb temperature is low. Such conditions are aggravated by high passenger load at the same time, thus leading to uncomfortable conditions within the space being treated.

The chief object of the present invention is to provide a simple and economical system for reheating dehumidified, cooled air by means of hot gaseous refrigerant from the compressor thereby increasing the sensible heat of such air to provide comfortable conditions within the area being treated.

An object is to provide an air conditioning system including suitable control members responsive to a change in temperature in an area being conditioned to regulate the flow of hot compressor gas in heat exchange relation with conditioned air for supply to such area.

A further object is to provide a system of reheating cooled air in which a solenoid valve in response to a change in temperature in an area being conditioned halts the direct flow of hot gas from the compressor to the condenser of the refrigeration system and directs such gas through a coil in heat exchange relation with cooled air for supply to the area being conditioned, flow of hot gas through the coil being regulated by a second valve which maintains a pressure materially greater than condenser pressure in such coil when it is utilized for reheat purposes. Other objects of my invention will be readily perceived from the following description.

This invention relates to a system for providing reheat in bus air conditioning in which hot gaseous refrigerant from the compressor is employed to reheat a stream of cooled air. The system includes a compressor, a condenser, a line connecting the compressor and the condenser, and an evaporator disposed in heat exchange relation with air to be conditioned. The evaporator is connected to the compressor and to the condenser to permit refrigerant to be supplied thereto and returned to the compressor. An expansion valve or other suitable means regulates supply of refrigerant to the evaporator. A coil is disposed in

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the path of air directed through the evaporator and is adapted to receive hot gaseous refrigerant from the compressor, the refrigerant passing therethrough and then to the condenser. A solenoid valve is provided in the line connecting the compressor and the condenser. When the valve is closed, direct passage of refrigerant from the compressor to the condenser is prevented, the refrigerant from the compressor passing to the coil. A second valve is provided in the line connecting the coil and the condenser to regulate passage of refrigerant from the coil to the condenser and to maintain a pressure materially greater than condenser pressure in the coil when it is utilized to reheat air directed through the evaporator.

The attached drawing illustrates a preferred embodiment of the present invention, in which

Figure 1 is a diagrammatic view of an air conditioning system for buses including the reheat system of the present invention; and

Figure 2 is a diagrammatic view of a modified refrigeration system for use in air conditioning.

Referring to the drawing, there is shown an air conditioning system satisfactory for use in vehicles such as buses. Such system includes a casing 2, preferably, disposed in the area 3 to be conditioned and a fan 4 adapted to draw return air from area 3 through louvres 5 and outside air through louvres 6 in any desired proportion within casing 2. The fan 4 draws such air through an evaporator 7 to dehumidify and cool the same and through reheat coil 8 as hereinafter explained. Fan 4 urges the conditioned air through duct 9, the air in duct 9 passing through openings 10 therein to the area being conditioned.

Evaporator 7 forms part of a refrigeration system designated generally at 11, the remaining elements of the system preferably being disposed in a suitable housing (not shown) placed beneath the body of the vehicle being conditioned. Refrigeration system 11 includes a compressor 12 connected to a condenser 13 by discharge line 14. Condenser 13 is connected to receiver 15. Receiver 15 is connected to evaporator 7 by liquid line 16. An expansion valve 17 is disposed in line 16 to regulate the passage of refrigerant to evaporator 7; valve 17 is controlled by means of a thermal sensitive bulb 18 placed adjacent suction line 19 connecting evaporator 7 and compressor 12.

Reheat coil 8 is disposed adjacent evaporator 7 in casing 2 in the path of air drawn through the evaporator. Coil 8 is connected to compressor 12 by line 20 which joins line 14 and is adapted to receive hot gaseous refrigerant from

the compressor. Line 21 connects coil 8 with condenser 13.

A solenoid valve 22 is disposed in line 14 between the condenser 13 and the juncture of line 20 with line 14. Valve 22 may be actuated by a suitable thermostat 23 responsive to a change in temperature such as a predetermined decrease in temperature in the area being conditioned. Preferably, thermostat 23 is placed adjacent louvres 5 in the path of air drawn from area 3 being conditioned. During normal operation of the system, valve 22 is held in open position by thermostat 23 to permit uninterrupted direct flow of refrigerant from compressor 12 to condenser 13; upon a predetermined change in temperature in the area being conditioned, valve 22 is permitted to close thus causing refrigerant to flow from compressor 12 to coil 8.

A spring-loaded check or relief valve 24 is disposed in line 21. Valve member 25 of valve 24 is yieldably urged by spring 26 against port 27 to retain the valve in closed position. Spring 26 is designed to maintain materially greater pressure in coil 8 when it is utilized for reheat purposes, than the pressure in condenser 13. When solenoid valve 22 is closed, pressure in coil 8 increases to a point sufficient to urge valve member 25 away from port 27 against the resistance of spring 26 permitting flow of refrigerant to condenser 3. Valve 24 may be adjusted by means of spring 26 to open at a pressure, for example, of about 50 pounds per square inch greater than the pressure maintained in condenser 3.

Assume the system is in operation and that the temperature of the area being conditioned has decreased to the predetermined point. In response to such change in temperature, thermostat 23 closes solenoid valve 22 thus directing hot gaseous refrigerant from compressor 12 to coil 8. Pressure in coil 8 increases to force valve 24 to open against the resistance of spring 26, permitting passage of refrigerant to condenser 13. The hot gaseous refrigerant in heat exchange relation with the air cooled by evaporator 7 reheats such air before it is supplied to area 3 being conditioned. permitting comfortable conditions to be maintained in the area and pre-cooling the refrigerant before it is passed to condenser 13. When the temperature of area 3 has increased to the desired point, thermostat 23 reflects such change and moves solenoid valve 22 to an open position permitting the hot gaseous refrigerant to flow direct to condenser 13 from compressor 12 without bypassing through coil 8.

The operation so described provides an on-and-off reheat cycle for air being conditioned. If desired, the reheat cycle may be made continuous and modulating by employing the modified system shown in Figure 2.

Referring to Figure 2, a modulating valve 28 may be placed in line 21, valve 28 being actuated by a thermal responsive bulb 29 disposed in the stream of air directed to evaporator 7 or in any other suitable place where it may accurately reflect the need for reheating or increasing the sensible heat of the conditioned air. When solenoid valve 22 is open there is not reheat. When solenoid valve 22 closes, the amount of reheat is determined by the degree of opening of valve 28. Valve 28 may be selected to open upon a predetermined increase in temperature and to close upon a predetermined decrease in temperature. Assuming valve 28 is fully open, pressure

and temperature in reheat coil 8 is at a minimum, preventing any great addition of sensible heat to the conditioned air. When valve 28 moves toward a closed position, gradually restricting passage of refrigerant between reheat coil 8 and condenser 13, the pressure and temperature within reheat coil 8 rises thus increasing the sensible heat imparted to the cooled air. If desired, relief valve 24 may be retained in parallel with valve 28 as a safety measure if valve 28 should fail.

When reheat is not desired, reheat coil 8 is made inoperative. A relief valve 30 may be disposed in line 21 to stop the continuous passage of hot gaseous refrigerant through reheat coil 8. Valve 30 may be selected to open under a minor pressure difference of say five pounds and will serve to trap liquid refrigerant in coil 8 to prevent reheating when solenoid valve 22 is open.

The present invention provides simple and economical equipment permitting hot gaseous refrigerant to be utilized to increase the sensible heat of cooled air. The equipment so provided may be readily incorporated in existing systems of air conditioning and is of particular value for use in bus air conditioning systems. Comfortable conditions are maintained in an area being conditioned by raising the sensible heat of conditioned air supplied to such area without substantial increase in cost of operation or necessitating a large initial investment in additional equipment.

The use of a greater pressure in the reheat coil than in the condenser results in a reheat coil of smaller size to decrease initial equipment cost. This feature is of great value in transportation air conditioning where space is at a premium and light weight is essential.

While I have described a preferred embodiment of my invention, it will be understood my invention is not limited thereto since it may be otherwise embodied within the scope of the following claims.

I claim:

1. In a system for providing reheat in bus air conditioning, the combination of a compressor, a condenser, a line connecting the compressor and the condenser, a heat exchange member adapted to be placed in heat exchange relation with air to be cooled, said member being connected to the compressor and the condenser to permit refrigerant to be supplied thereto and returned to the compressor after its passage through said member, means for regulating the supply of refrigerant to said member, a second heat exchange member adapted to be placed in the path of air directed through the first heat exchange member, the second heat exchange member being adapted to receive hot gaseous refrigerant from the compressor, refrigerant after passage through the second member being directed to the condenser, a valve member in said line, means to actuate the valve in response to a change in temperature in the area being cooled to close the line connecting the compressor and the condenser thereby directing hot gaseous refrigerant to the second heat exchange member, and a yieldable second valve member to prevent passage of refrigerant from the second heat exchange member to the condenser to maintain a pressure materially greater than condenser pressure in the second heat exchange member when it is utilized to reheat air directed through the first heat exchange member.

2. A system according to claim 1 in which the first valve member comprises a solenoid valve adapted to move to open and closed positions; the actuating means therefor including a thermostat responsive to a predetermined change in temperature in the area being cooled to actuate the solenoid valve.

3. A system according to claim 2 in which the second valve includes a valve member adapted to close a port therein, and a spring urging the valve member to close the port thereby preventing passage of refrigerant through the valve, an increase in pressure in the second heat exchange member above a predetermined point tending to urge the valve member away from the port against the resistance of the spring, said valve member being again urged by the spring to close the port when pressure in the second heat exchange member has decreased to the predetermined point whereby materially greater pressure exists in the second heat exchange member when it is utilized to reheat air than exists in the condenser.

4. In a system of air conditioning for use in buses and the like, the combination of a duct through which conditioned air is forwarded to the area to be conditioned, an evaporator disposed in the duct for dehumidifying and cooling air directed therethrough, a coil disposed in the duct adjacent the evaporator for heating air after its passage through the evaporator, fan means for passing air in heat exchange relation with the evaporator and coil and for forwarding the conditioned air to the area being conditioned, a compressor, a condenser, a first line connecting the compressor and the condenser, refrigerant being supplied to the evaporator from the condenser and returned from the evaporator to the compressor, a second line connecting the coil with the compressor, a third line connecting the coil and the condenser, a solenoid valve in said first line adapted to move open and closed positions to permit and to prevent direct flow of refrigerant between the compressor and the condenser, closing of said valve forcing hot gaseous refrigerant to flow from the compressor to said coil, means for actuating said valve in response to the temperature of the area being conditioned, and a second valve disposed in the third line yieldably closing said line to passage of refrigerant from the coil to the condenser and serving to maintain a materially greater pressure in the coil when it is utilized to heat air directed through the evaporator than exists in the condenser.

5. In a refrigeration system, the combination of a compressor, a condenser, a line connecting the compressor and the condenser, an evaporator disposed in heat exchange relation with air to be conditioned, the evaporator being connected to the compressor and the condenser to permit refrigerant to be supplied thereto and returned to the compressor after its passage therethrough, a coil disposed in the path of air directed through the evaporator adapted to receive hot gaseous refrigerant from the compressor, a second line connecting the coil and the condenser, a solenoid valve in the first line, means to actuate said valve

in response to a change in temperature in the area being conditioned to close the first line thereby directing hot gaseous refrigerant from the compressor to the coil, and a second valve disclosed in the second line yieldably closing said line to the passage of refrigerant from the coil to the compressor, said valve maintaining a pressure materially greater than condenser pressure in the coil when it is utilized to reheat air directed through the evaporator.

6. A system according to claim 5 in which the second valve includes a valve member adapted to close a port therein, and a spring yieldably urging the valve member to close the port thereby preventing passage of refrigerant through the valve, an increase in pressure in the coil above a predetermined point tending to urge the valve member away from the port against the resistance of the spring, said valve member being again urged by the spring to close the port when pressure in the coil had decreased to the predetermined point whereby materially greater pressure exists in the coil when it is utilized to reheat air than exists in the condenser.

7. In a refrigeration system, the combination of a compressor, a condenser, a line connecting the compressor and the condenser, an evaporator disposed in heat exchange relation with air to be conditioned, said evaporator being connected to the compressor and the condenser to permit refrigerant to be supplied thereto and returned to the compressor after passage through the evaporator, means for regulating the supply of refrigerant to the evaporator, a coil disposed in the path of air directed through the evaporator adapted to receive hot gaseous refrigerant from the compressor, a second line connecting the coil and the condenser, a solenoid valve in the first line, means to actuate the solenoid valve in response to a change in temperature in the area being conditioned to close the first line thereby directing hot gaseous refrigerant to the coil, and a modulating control valve disposed in the second line responsive to a change in temperature of air directed to the evaporator and coil to govern passage of refrigerant from the coil to the condenser and to maintain a pressure materially greater than condenser pressure in the coil when it is utilized to reheat air directed through the evaporator.

8. A system to claim 7 in which a relief valve is disposed in the second line between the control valve and the condenser, said valve being responsive to a predetermined change in pressure in the coil to discontinue passage of refrigerant from the coil to the condenser when the solenoid valve is in an open position.

JAMES SWINBURNE.

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Certificate of Correction

Patent No. 2,515,842 July 18, 1950

JAMES SWINBURNE

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 3, line 69, for the words "not reheat" read *no reheat*; column 6, lines 4 and 5, for "disclosed" read *disposed*;

and that the said Letters Patent should be read as corrected above, so that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 10th day of October, A. D. 1950.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.