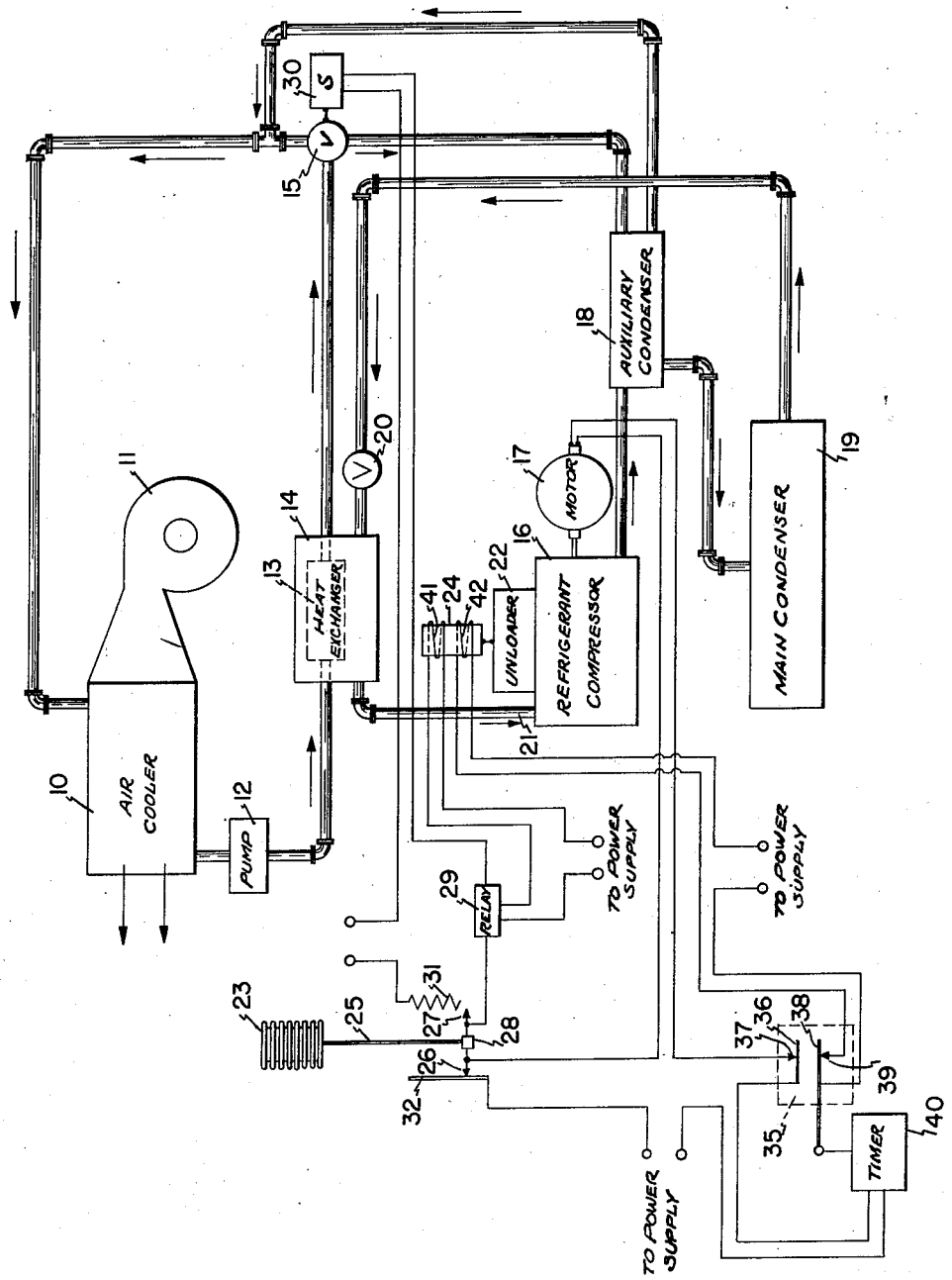
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AIR CONDITIONING REFRIGERATION SYSTEM

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INVENTORS
WILLIAM A. MINKLER &
ELDON H. LUSK
BY
Robert T. Palmer
ATTORNEY

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AIR CONDITIONING REFRIGERATION SYSTEM

William A. Minkler, Elmhurst, Ill., and Eldon H. Lusk, East Paterson, N. J., assignors to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

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This invention relates to refrigeration systems, and relates more particularly to air-conditioning systems which include refrigeration systems for cooling the air.

It is the conventional practice in air-conditioning systems, in which the air is cooled through the use of refrigerant compressors, to unload the compressors as the loads decrease, down to minimum fractional capacities. For load reductions below the minimum capacities, the compressors are stopped. This results not only in fluctuations in the temperature and the humidity in the conditioned space, but the frequent stops and starts cause excessive wear of the compressors and of the motors driving same.

This invention overcomes the disadvantages of the prior systems by maintaining a refrigerant compressor in constant operation down to a zero load condition; by partially unloading the compressor upon a fall in load below capacity load; and then upon a further fall in load, using heat from a condenser of the system for heating a cooling fluid supplied to the air cooler.

In one embodiment of the invention, an indirect air-cooling system has a water chiller which supplies chilled water to the air cooler. The compressor is operated continuously and, upon a predetermined reduction in load in the conditioned space, the compressor is unloaded to 50% of its capacity. Upon a further reduction in the load in the conditioned space, a portion of the water from the water chiller is heated in an auxiliary condenser whereby the temperature of the chilled water supplied to the air cooler is raised sufficiently to compensate for the reduction in load below the 50% level. Thus, the temperature and the humidity in the conditioned space are maintained constant by the continuous operation of the compressor, and the wear resulting from the starting and stopping of the compressor is avoided. The system is efficient since the heating of the chilled water is balanced by the cooling of the condenser.

An object of the invention is to eliminate the wear of refrigerant equipment resulting from the starting and stopping of refrigerant compressors under load controls.

Another object of the invention is to provide uniform conditions in an air-cooled space by operating a refrigerant compressor used for cooling the air, continuously.

The invention will now be described with reference to the drawing which is a diagrammatic view of an air-conditioning system using an indirect refrigeration system for cooling the air.

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The air cooler 10, which may be a conventional air washer or finned-tube cooler, is connected to a conventional fan 11 which moves the air to be cooled through the cooler 10 and discharges it into the conditioned space.

The pump 12 circulates water through the air cooler 10, the heat exchanger 13 in the water chiller 14, and the three-way valve 15.

The compressor 16, driven by the electric motor 17, supplies refrigerant vapor through the auxiliary condenser 18, the main condenser 19, and the expansion valve 20, into the water chiller 14 around the heat exchanger 13, the refrigerant being returned through the pipe 21 to the suction side of the compressor.

The compressor has the unloader 22 which is actuated by the solenoid 24 to unload the compressor to 50% capacity when the solenoid is energized.

The solenoid 24 has two energizing windings 41 and 42, the winding 41 being connected to energize the solenoid under control of the thermostat 23, the winding 42 being connected to energize the solenoid when the system is first started up, as will be described.

The thermostat 23 is of the bellows type and has the plunger 25 carrying at its lower end the contacts 26 and 27 which are electrically separated by the insulator 28. The contact 27 is connected in series with the energizing winding of the relay 29, the solenoid 30, which adjusts the valve 15, a power supply source, which is not illustrated, and the resistor 31 when the contact 27 is in contact with the resistor.

The contacts of the relay 29 are connected in series with the power supply source, and the energizing winding 41 of the solenoid 24, when the contact 27 touches the resistor 31.

The winding 42 of the solenoid 24 is connected in series with the power supply source, the armature 38 and the contact 39 of the switch 35 when the switch is closed to start the compressor.

The contact strip 32, the contact 26, the power supply source, the compressor motor 17, the timer 40, and the contact 37, and the armature 36 of the starter switch 35, are connected in series when the starter switch is closed.

The armature 38 of the switch 35, touches its contact 39 when the switch is closed, and is moved by the timer 40 away from its contact 39 a predetermined time interval after the switch is closed, for energizing the solenoid winding 42 so that the unloader 22 will unload the compressor, unless the solenoid winding 41 is energized at that time by the thermostat 23.

To start the system, the starter switch 35 would be closed causing, through the contact of the armature 36 with the contact 37, the motor 17 to start the compressor, and causing, through the contact of the armature 38 with the contact 39, the solenoid winding 42 to be energized so it actuates the unloader 22 for unloading the compressor. By starting the compressor partially unloaded, the power required for starting is reduced, and wear on the compressor and its driving motor is reduced.

After a predetermined time interval which may, by way of example, be two minutes, the timer 40 would move the armature 38 away from the contact 39 so as to deenergize the solenoid winding 42. The solenoid 24 would then adjust the unloader 22 to load the compressor 100%, unless at that time the thermostat 23 will have caused the solenoid winding 41 to be energized.

Ordinarily, when the system is first started up, the thermostat 23 will not have moved the contact 27 against the resistor 31, so that after the timer 40 has acted to cause the compressor to be 100% loaded, the compressor will continue to operate at full capacity until the load in the conditioned space has been substantially reduced, at which time the bellows of the thermostat will contract sufficiently to move the contact 37 against the resistor 31.

This would cause the relay 29 to be energized so that it would close the circuit from the power supply to the winding 41 of the solenoid 24 of the unloader 22, causing the solenoid to be energized and to unload the compressor to 50% capacity.

At the same time, the solenoid 30 would be energized causing it to adjust the valve 15 so that a portion of the chilled water from the water chiller 14 would be circulated through the condenser 18, the condenser heating the water sufficiently to make up for the reduction in the load in the conditioned space.

By way of example, the thermostat may move the contact 27 against the resistor 31 when the temperature in the conditioned space falls below 76° F.

As the load in the conditioned space continues to decrease, the bellows 24 would expand further so as to move the contact 27 further along the resistor 31 so as to reduce the value of the electric resistance in the circuit of the solenoid 30, causing the solenoid to become more strongly energized so as to adjust the valve 15 to permit more chilled water to circulate through the condenser 18. Thus, every reduction in load below the first reduction is compensated for by an increase in the amount of heat added to the air chilling water, so that the conditions in the conditioned space are maintained uniform, and the compressor is maintained continuously in operation.

When the temperature in the conditioned space rises, say to 77° F., so that the load in the conditioned space is such that the compressor would be called upon to operate at full capacity, the thermostat 23 will have moved the contact 27 away from the resistor 31, so that the valve 15 would be so adjusted that no chilled water would be circulated through the condenser 18.

During the contraction of the thermostat bellows caused by load reductions, the contact 26 will slide along the strip 32 causing the compressor to remain continuously in operation throughout the entire load range. At zero load, when there would be no need for cooling, the contact 26 would move below the strip 32, thus opening the circuit of the motor 17 and stopping the compressor.

While one embodiment of the invention has been described for the purpose of illustration, it should be understood that the invention is not limited to the exact apparatus and the arrangement of apparatus illustrated, as modifications thereof may be suggested by those skilled in the art without departure from the essence of the invention.

What is claimed is:

1. A refrigeration system comprising a refrigerant compressor, a condenser, and a water chiller connected in a refrigerant circuit; a cooler; means including a valve connecting said water chiller and said cooler in a water circuit when said valve is adjusted to one position, and connecting said water chiller, said condenser, and said cooler in a water circuit when said valve is adjusted to a second position; and means responsive to a reduction in the load on said cooler for adjusting said valve to said second position.

2. A refrigeration system comprising a refrigerant compressor, a condenser, and a water chiller connected in a refrigerant circuit; a cooler; means including a valve connecting said water chiller and said cooler in a water circuit when said valve is adjusted to one position, and connecting said water chiller, said condenser, and said cooler in a water circuit when said valve is adjusted to a second position; an unloader for said compressor; and means responsive to a reduction in the load on said cooler for adjusting said valve to said second position, and for actuating said unloader for partially unloading said compressor.

3. A refrigeration system comprising a refrigerant compressor, a main condenser, an auxiliary condenser, and a water chiller connected in a refrigerant circuit; a cooler connected to said water chiller for receiving water therefrom; an unloader for said compressor; and means responsive to a reduction in the load on said cooler for actuating said unloader for partially unloading said compressor, and for routing the chilled water from said chiller in heat exchange relationship with said auxiliary condenser.

4. A refrigeration system comprising a refrigerant compressor, a main condenser, an auxiliary condenser, and a water chiller connected in a refrigerant circuit; a cooler; means including a valve connecting said water chiller and said cooler in a water circuit when said valve is adjusted to one position, and connecting said water chiller, said auxiliary condenser, and said cooler in a water circuit when said valve is adjusted to a second position; and means responsive to a reduction in the load on said cooler for adjusting said valve to said second position.

5. A refrigeration system comprising a refrigerant compressor, a main condenser, an auxiliary condenser, and a water chiller connected in a refrigerant circuit; a cooler; means including a valve connecting said water chiller and said cooler in a water circuit when said valve is adjusted to one position, and connecting said water chiller, said auxiliary condenser, and said cooler in a water circuit when said valve is adjusted to a second position; an unloader for said compressor; and means responsive to a reduction in the load on said cooler for adjusting said valve to said second position, and for actuating said unloader for partially unloading said compressor.

6. A refrigeration system comprising a refrigerant compressor, a condenser, and a water chiller connected in a refrigerant circuit; a cooler; means including a valve connecting said water chiller and said cooler in a water circuit when said valve is adjusted to one position, and connecting said water chiller, said condenser, and said cooler in a water circuit when said valve is adjusted to a second position; means responsive to a reduction in the load on said cooler for adjusting said valve to said second position, and means responsive to further reductions in the load on said cooler for adjusting said valve for varying the volume of water circulated through said condenser conformably with the reduction in load.

7. A refrigeration system comprising a refrigerant compressor, a condenser, and a water chiller connected in a refrigerant circuit; a cooler; means including a valve connecting said water chiller and said cooler in a water circuit when said valve is adjusted to one position, and connecting said water chiller, said condenser, and said cooler in a water circuit when said valve is adjusted to a second position; an unloader for said compressor; means responsive to a reduction in the load in the space served by said cooler for actuating said unloader for partially unloading said compressor and for adjusting said valve to said second position, and means responsive to further reductions in said load for adjusting said valve for varying the volume of water circulated through said condenser condenser conformably with the reduction in load.

8. A refrigeration system comprising a refrigerant compressor, a main condenser, an auxiliary condenser, and a water chiller connected in a refrigerant circuit; a cooler; means including a valve connecting said water chiller and said cooler in a water circuit when said valve is adjusted to one position, and connecting said water chiller, said auxiliary condenser, and said cooler in a water circuit when said valve is adjusted to a second position; and means responsive to a reduction in the load on said cooler for adjusting said valve to said second position, and means responsive to further reductions in said load for adjusting said valve for varying the volume of water circulated through said condenser conformably with the reduction in load.

9. A refrigeration system comprising a refrigerant compressor, a main condenser, an auxiliary condenser, and a water chiller connected in a refrigerant circuit; a cooler; means including a valve connecting said water chiller and said cooler in a water circuit when said valve is adjusted to one position, and connecting said water chiller, said auxiliary condenser, and said cooler in a water circuit when said valve is adjusted to a second position; an unloader for said compressor; and means responsive to a reduction in the load on said cooler for adjusting said valve to said second position, and for actuating said unloader for partially unloading said compressor, and means responsive to further reductions in said load for adjusting said valve for varying the volume of water circulated through said condenser conformably with the reduction in load.

WILLIAM A. MINKLER.
ELDON H. LUSK.

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