Thus, discharge pressure is constantly applied to the unloader piston while the compressor is operating, and for unloading, the pilot valve is closed for preventing gas leaking by the unloader piston from returning to the suction side of the compressor, while, for loading, the pilot valve is opened for permitting the gas leaking by the unloader piston, to return to the suction side of the compressor.

An object of my invention is to simplify and to reduce the cost of unloader mechanisms for compressors.

My invention will now be described with reference to the drawings, of which:

Fig. 1 is a diagrammatic view of a refrigeration system embodying my invention;

Fig. 2 is an enlarged detail view, partially in section, of one of the unloader mechanisms of Fig. 1, and

Fig. 3 is a sectional view of one of the solenoid-operated control valves used in the system of Fig. 1.

Referring first to Fig. 1, a six cylinder refrigerant compressor 10 driven by the electric motor 11, supplies compressed refrigerant through the tube 12 to the water cooled condenser 13. The condensed refrigerant is supplied through the tube 14 and expansion valve 15 to the air cooling evaporator 16, the expanded refrigerant being returned through the tube 17 to the suction side of the compressor.

The six cylinders of the compressor are divided into three pairs, each pair having a common cylinder head H1, H2 and H3 respectively. Each of the cylinder heads H1 and H2 has a pair of similar control cylinders 19, one for each compressor cylinder of each head H1 and H2.

One of the compressor cylinders of the head H3 has a similar control cylinder 19. The other compressor cylinder of the head H3 has no control cylinder since this compressor cylinder is never unloaded.

Each control cylinder 19 contains a piston 20 having a recessed upper portion in which is fitted a coiled spring 21. The upper end of the spring 21 contacts the upper end of the interior of the cylinder 19, and its lower end contacts the piston 20, the function of the spring being to bias the piston downwardly to its normal unloaded position illustrated by Fig. 2. The piston 20 is loosely fitted in the cylinder 19 so that there is a relatively slight leakage of gas past it.

The piston 20 has fitted into its lower end the upper end of the plunger 22, the lower end of which is fitted into a circular plate 23 which rests upon the bar 24 having the small rods 25 which extend through circular holes in the valve plate 26, and contact the suction valve reeds 27 holding them in open position in which the compressed gas flows past the reeds into the suction chamber 29. Such a bar and its reed contacting rods are usually termed a "comb."

The relatively small coiled springs 28 extend between the bottom side of the bar 24 and the top side of the valve plate 26 and, normally, are compressed by the pressure of the plunger 22 against the bar. When the rod 22 is lifted by the piston 20, the springs 28 lift the bar 24, removing the pressure of the rods 25 from the valve reeds permitting the latter to close to loading position.

While the valve reeds 27, which are of spring metal, and are, therefore, resilient, could be permitted to lift the bar 24 when the pressure of the plunger 22 is removed, it has been found that improvement in performance is obtained by using the springs 28, and chattering of the reeds is eliminated.

Compressed gas is taken from the discharge tube 12 and supplied through the tubes 30 and 31 and the fittings 32 to the undersides of the unloader pistons 20. The control cylinders 19 of the compressor heads H1 and H2, above their pistons 20, have the outlet fittings 34
which are connected by the tubes 35 to the inlets of the two-way valve pilot valves V1 and V2 which are actuated by the electric solenoids S1 and S2 respectively. The outlet tubes 38 connects the outlet of the cylinder 19 of the compressor head H3 and the outlets of the valves V1 and V2 with the suction side of the compressor.

The solenoids S1 and S2 have one side of their energizing windings connected together and through the wire 49 to one of the electric lines L1. The other sides of the energizing windings are connected by the wires 41 and 42 respectively, to the contacts 43 and 44 respectively, of the thermostat T, the armature of which is connected to the other electric line L2. The contact 46 of the thermostat is connected to one side of the energizing winding of the relay 47, which, when energized, closes its contacts 48 connecting the motor 11 to the electric lines.

The thermostat T is responsive to a load condition, which, for example, may be the temperature of the air within a room cooled by the evaporator 16.

Operation

When the temperature of the room cooled by the evaporator reaches a point where cooling is required, the armature 45 of the thermostat T will touch the contact 46, energizing the relay 47 which then closes its contacts 48 causing the motor 11 to start and to start the compressor.

At this time all of the cylinders of the compressor are unloaded except one cylinder of the head H3 which has no control cylinder, and which, therefore, is loaded at all times.

When the compressor has reached its normal operating speed, the discharge pressure from the compressor cylinder of the head H3 which is loaded at all times, will have built up sufficiently to lift the piston 20 of the control cylinder 19 of the other compressor cylinder of the head H3, permitting its associated suction valve reeds to close so that the latter cylinder becomes loaded shortly after the compressor has started.

At this time since the solenoids S1 and S2 are deenergized, and the pilot valves V1 and V2 are closed so that the four compressor cylinders of the heads H1 and H2 are unloaded.

If the temperature of the air within the room cooled by the evaporator 16 rises further, the thermostat T will move its armature 45 against the contact 44 causing the solenoids S1 to become energized and to open the valve V2. This permits the pistons 20 of the control cylinders 19 of the head H2 to be moved upwardly by the discharge pressure and to load the compressor cylinders of the head H2.

If the temperature of the air within the room continues to rise, the thermostat T will move its armature 45 against the contact 43 causing the solenoid S1 to become energized and to open the valve V1. This permits the pistons 20 of the control cylinders 19 of the head H1 to be moved upwardly by the discharge pressure, and to load the compressor cylinders of the head H1.

Upon a decrease in the temperature of the air within the room, the controls will operate in reverse order, the thermostat acting first to unload the compressor cylinders of the head H1, second, if the temperature continues to fall, to unload the compressor cylinders of the head H2, and third, if the temperature continues to fall, to stop 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 system illustrated, since modifications thereof may be suggested by those skilled in the art, without departure from the essence of the invention.

What I claim as my invention, is:

1. An unloader mechanism for a compressor having a cylinder, comprising valve means at the suction side of the cylinder for permitting, when open, gas compressed within said cylinder to pass to the suction side of the compressor, a control cylinder, a loosely fitted piston slidable in said control cylinder, means including a spring for causing said piston to hold said piston means normally closed, means connected to the discharge side of said compressor and to said control cylinder for supplying compressed gas against one side of said piston for moving said piston against the action of said spring for permitting said valve means to close, means including a control valve connecting the interior of said control cylinder at the other side of said piston, with said suction side of said compressor for permitting, when said control valve is open, gas leaking past said piston to flow to said suction side of said compressor, and means for closing said control valve for preventing the gas supplied against said one side of said piston from moving said piston against the action of said spring.

2. An unloader mechanism for a compressor having a cylinder, comprising means including resilient valve reeds at the suction side of said cylinder, which, in open position permit gas compressed within said cylinder to pass to the suction side of said compressor, a control cylinder, a loosely fitted piston slidable in said control cylinder, means including a spring for causing said piston to hold said piston normally closed, means connected to the discharge side of said compressor and to said control cylinder for supplying compressed gas against one side of said piston for moving said piston against the action of said spring for permitting said reeds to move to closed position, means including a control valve connecting the interior of said control cylinder at the other side of said piston with said suction sides of said compressor for permitting when said reeds are in open position, gas leaking by said piston to flow to said suction side of said compressor, and means for closing said control valve for preventing the gas supplied against said one side of said piston from moving said piston against the action of said spring.

3. An unloader mechanism for a cylinder of a compressor, comprising valve means at the suction side of the cylinder for permitting, when open, gas compressed within said cylinder to pass to the suction side of said compressor, a control cylinder having a head with an outlet opening, a loosely fitted piston slidable in said control cylinder, a bias spring between one side of said piston and said head of said control cylinder, means including a plunger connecting said piston with said valve means, said spring forcing said plunger against said valve means for maintaining it normally closed, means connected to the discharge side of said compressor and to said control cylinder for supplying compressed gas against the other side of said piston for moving said plunger against the action of said spring away from said valve means for permitting said valve means to close, means including a control valve connecting said outlet opening with said suction side of said compressor for permitting, when said control valve is open, gas leaking past said piston to flow to said suction side of said compressor, and means for closing said control valve for preventing the gas supplied against said other side of said piston from moving said piston against the action of said spring.

4. An unloader mechanism for a cylinder of a compressor, comprising resilient suction valve reeds at the suction side of said cylinder, which in open position, permit gas compressed within said cylinder to pass to the suction side of said compressor, a control cylinder having a head with an outlet opening, a loosely fitted piston slidable in said control cylinder, a bias spring between said head of said control cylinder and the adjacent side of said piston, means including a plunger connected to said piston, rods contacting said reeds, said spring and said piston for holding said reeds normally in open position, means connected to the discharge side of said compressor and to said control cylinder for supplying compressed gas against the other side of said piston for moving said piston against the action of said spring for permitting...
5. An unloader mechanism for a cylinder of a compressor, comprising a valve plate at the suction side of said cylinder, said plate having a plurality of spaced-apart openings therethrough, a plurality of suction valve reeds, one for each of said openings, at the inner side of said plate, a valve bar at the other side of said plate, said bar having a plurality of rods attached thereto which extend through said openings against said reeds, a control cylinder mounted on the head of said cylinder and having its interior connected to the interior of said cylinder, said control cylinder having a head with an outlet opening therein, a loosely fitted piston slidably in said control cylinder, a coiled spring between the outer side of said piston and said head of said control cylinder, means including a plunger attached to said piston for contacting said bar, said spring through said piston, said plunger and said bar maintaining said reeds normally in open position, means connected to the discharge side of said compressor and to said control cylinder for supplying compressed gas against the inner side of said piston, means including a control valve connecting said outlet opening with said suction side of said compressor for permitting when said control valve is open, gas leaking past said piston to flow to said suction side of said compressor, and means for closing said control valve for preventing the gas leaking past said piston from flowing to said suction side of said compressor.

6. An unloading mechanism as claimed in claim 5 in which a plurality of coiled springs extend between said bar and said plate for biasing said bar away from said plate.

7. An unloader mechanism for a cylinder of a compressor comprising suction valve means at the suction side of the cylinder for permitting, when open, gas compressed within the cylinder to pass to the suction side of the compressor, a control cylinder, a loosely fitted piston in said control cylinder, means including spring means for causing said piston to hold said valve means normally open, means connected to the discharge side of said compressor and to said control cylinder for supplying compressed gas against one side of said piston for moving said piston against the action of said spring means for permitting said valve means to close during the compression strokes of the piston in said first mentioned cylinder, and means connecting said control cylinder at the other side of said piston with said suction side of said compressor.

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