A control device for regulating the capacity of a reciprocating compressor employed in a refrigeration unit includes a solenoid disposed within the outer walls of the compressor. The solenoid has first and second operating positions and is selectively placed therein in response to normal operating conditions within the refrigeration unit. A cable device is suitably connected to the solenoid and includes fork members pivotally mounted thereon. The cable device moves in response to movement of the solenoid, the fork members thereby being rotated to either load or unload a suction valve regulating the passage of gas into a cylinder of the compressor.

1 Claim, 4 Drawing Figures
CAPACITY CONTROL DEVICE FOR RECIPROCATING COMPRESSOR

BACKGROUND OF THE INVENTION

This invention relates to control devices for regulating the capacity of reciprocating compressors.

Generally, fluid compressors are designed to operate at a relatively constant speed. Thus, when the load on the system in which a compressor is employed varies, inefficient operation of the compressor will result unless the capacity of the compressor can be likewise varied. There are many known devices suitable for use on multi-cylinder compressors for regulating the capacity thereof.

Generally, the control devices herebefore available suffer from a common failing; they are all relatively expensive to manufacture and are generally complex, thereby requiring highly skilled personnel to correct any malfunctions that may develop at the compressor's installation site.

A highly efficient, but relatively expensive and complex capacity control device is illustrated in U.S. Pat. No. 3,119,550. The device therein disclosed employs a solenoid to regulate the bleeding of gas to control the position of a piston to selectively bypass gas from the discharge manifold to the suction manifold of a cylinder of a compressor.

Hereofore, relatively simple devices have been available to unload a cylinder of a compressor upon the startup of such compressor to thereby minimize the size of the motor required to drive the compressor. A prior art device for unloading a compressor upon startup is illustrated in U.S. Pat. No. 2,274,338. However, as noted above, the device disclosed in the foregoing patent has a limited function; the device only unloads the cylinder of a compressor upon startup, but does not effect operation of the compressor during normal operating conditions.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a relatively simple, yet efficient control device for reciprocating compressors, operable to vary the capacity of the compressor during normal operating conditions thereof.

It is a further object of this invention to provide a capacity control device employing a relatively uncomplicated, but efficient mechanism to regulate the position of the suction valve of a compressor cylinder to selectively unload or load the cylinder in response to variations in the load on a refrigeration unit employing the compressor.

These and other objects of the present invention are obtained by utilizing a solenoid suitably positioned within the outer walls of the compressor body. Means to sense operating conditions within the refrigeration unit are operable to selectively place the solenoid in first or second operating positions. Additional means are operably connected to the solenoid and the suction valve to place the suction valve in a loaded state when the solenoid is placed in its first operating position in response to predetermined conditions within the refrigeration unit, the last mentioned means being further operable to place the suction in an unloaded state when the solenoid valve is placed in its second operating position.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional, somewhat schematic, view of a compressor employed in a refrigeration unit;

FIG. 2 is a perspective view of a portion of the compressor, particularly illustrating the instant invention;

FIG. 3 is a sectional view taken along lines 3--3 of FIG. 4; and

FIG. 4 is a horizontal sectional view taken along the lines 4--4 of FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, and in particular to FIG. 1, thereof, there is disclosed a reciprocating compressor embodying the instant invention. In referring to the drawings, like numerals shall refer to like parts.

FIG. 1 illustrates a longitudinal sectional view of a typical reciprocating compressor 10. Compressor 10, to be more fully explained in detail hereinafter, is employed in a refrigeration unit which includes a condenser 35, thermostatic expansion valve 36, and an evaporator 40, connected together to form a refrigeration unit. As is known to those familiar in the art, high pressure refrigerant gas is discharged from the cylinders of compressor 10 and flows to condenser 35. The high pressure refrigerant gas is condensed in condenser 35 by passing in heat transfer relation with a relatively cold heat exchange medium, for example, air routed thereover via fan 37. The condensed refrigerant liquid passes through thermostatic expansion valve 36 and thence into evaporator 40 where it is vaporized by absorbing heat from a medium to be cooled, for example, air to be delivered into an occupied space and routed over evaporator 40 by operation of fan 38. Typically, fans 37 and 38 are connected to a single motor 39. The vaporized gas then passes from evaporator 40 into the suction side of compressor 10. The foregoing illustrates a typical refrigeration unit of a type employed in air conditioning system, or commercial and industrial refrigeration applications.

Compressor 10 includes an outer wall 11 having a cylinder head 11' suitably connected thereto. The compressor is illustrated as having two cylinders, but any number of multiple cylinder combinations may be employed.

Each of the cylinders 12 has a piston 13 reciprocally disposed therein. Pistons 13 are connected via connecting rods 15 to an eccentric portion 16 of a crankshaft 14. Crankshaft 14 further includes a counterweight 17. As is known to those skilled in the art, rotation of the crankshaft will cause the pistons to reciprocate in the cylinders to compress gas therein to a desired pressure.

Compressor 10 further includes a suction manifold 18 and a discharge manifold 19. Discharge manifold 19 is suitably connected via conduit 31 to condenser 35. Suction manifold 18 is suitably connected via suction conduit 32 to evaporator 40.

Gas from suction manifold 18 flows under the control of suction valve 20 into each of the cylinders of the compressor. Valves 20 are maintained on their seats by springs 21, suitably constrained within suction guides 21'. The compressed gas is delivered from the cylinders of the compressor under the control of discharge valves 22. Discharge pressure lifts the valves off their seats so as to permit the gas to flow from the cylinders into dis-
charge manifold 19. Springs 23 suitably constrained within discharge guides 24 operate to maintain discharge valves 22 on their seats until the desired discharge pressure has been obtained within cylinders 12. The foregoing description illustrates a typical reciprocating compressor of a type known to those skilled in the art.

As noted hereinbefore, the load on the refrigeration unit in which the compressor is employed may vary. Since the compressor is designed to operate at a relatively constant speed, inefficient operation of the compressor will result unless the capacity of the compressor may be varied in accordance with changes in the load on the refrigeration unit. In addition, undesirable overheating of areas served by the refrigeration unit may also occur.

The capacity control device in accordance with the present invention is illustrated in FIGS. 2, 3 and 4. The device includes a solenoid 27 suitably supported on a bracket 26. Bracket 26 is preferably connected to an inner surface of wall 11 so solenoid 27 is disposed within crankcase 34 of the compressor. A cable 29 is suitably connected to a portion of solenoid 27. The other end of cable 29 is connected to one end of spring 28. The other end of spring 28 is attached to bracket 26. Pivotedly connected to cable 29 are fork members 25. Fork members 25 provide a force on the lower surface of suction valve 20, in opposition to the force supplied by springs 21, whereby valve 20 may be lifted off its seat. Fork members 25 are moved into contact with the undersurface of valve 20 to lift the valve off its seat when it is desired to unload the cylinder of the compressor.

Solenoid 27 has first and second operating positions. When in its first operating position, solenoid 27 moves cable 29 so that members 25 are maintained in their solid line position as illustrated in FIGS. 2 and 3. When members 25 are in such position, they are maintained out of contact with the undersurface of valve 20 to thereby have no effect on its operation. Valve 20 will thereby be operated solely in response to pressure conditions within suction manifold 18 and cylinder 12. For illustrative purposes, solenoid 27 is in its first operating position when switch 33 is open to thereby deenergize the solenoid. The cylinder is then in a loaded state.

When the load on the refrigeration unit is reduced, switch 33 is closed to thereby energize solenoid 27 to place same in its second operating position. Switch 33 is connected to a suitable device which functions to sense the load on the system. Such device may be a thermostat sensing the temperature of the air prior to its passing in heat transfer relation with the refrigerant flowing through the evaporator. Other suitable devices may be satisfactorily employed to operate switch 33.

The return force of spring 29 causes cable 29 to rotate, thereby causing members 25 to pivot and assume the dotted line positions shown in FIGS. 2 and 3. When members 25 are in their dotted line positions, they are in contact with the lower surface of valve 20. The members supply a force which overcomes the force supplied by springs 21 to lift and maintain valve 20 off of its seat. When valve 20 is maintained in such position, discharge pressure cannot be obtained in the cylinder controlled thereby. Such cylinder is thereby placed in an unloaded state. Members 25 are maintained in contact with valve 20 to maintain the cylinder in its unloaded state until the load on the refrigeration unit again increases to thereby open switch 33 and return solenoid 27 to its first operating position.

The control device herein disclosed effectively loads a cylinder of a compressor during normal operating conditions so the capacity of the compressor may be varied in accordance with changes in load on the unit in which the compressor is employed.

While a preferred embodiment of the invention has been disclosed, the invention should not be limited thereto, but may be otherwise embodied within the scope of the following claims.

I claim:

1. A device for varying the capacity of a reciprocating compressor employed in a refrigeration unit, the device being operable during normal operating conditions of said unit, comprising:
   a. a suction valve for regulating the passage of refrigerant gas into a cylinder of said compressor;
   b. a solenoid disposed within the outer walls of the compressor;
   c. means to sense operating conditions within the refrigeration unit, and being further operable to selectively place said solenoid in first and second operating positions; and
   d. means operably connected to said solenoid and said suction valve to place said suction valve in an unloaded state when said solenoid is placed in its first operating position in response to predetermined conditions within said refrigeration unit, said means being further operable to place said suction valve in a loaded state when said solenoid is placed in its second operating position, said means comprising a cable member connected at one end to said solenoid and at its other end to a spring member, said cable being positioned about the periphery of said cylinder; and fork members pivotally connected to said cable member, movement of said solenoid causing said fork members to rotate to selectively load or unload said suction valve.

* * * * *

2. A device for varying the capacity of a reciprocating compressor employed in a refrigeration unit, the device being operable during normal operating conditions of said unit, comprising:
   a. a suction valve for regulating the passage of refrigerant gas into a cylinder of said compressor;
   b. a solenoid disposed within the outer walls of the compressor;
   c. means to sense operating conditions within the refrigeration unit, and being further operable to selectively place said solenoid in first and second operating positions; and
   d. means operably connected to said solenoid and said suction valve to place said suction valve in a loaded state when said solenoid is placed in its first operating position in response to predetermined conditions within said refrigeration unit, said means being further operable to place said suction valve in a loaded state when said solenoid is placed in its second operating position, said means comprising a cable member connected at one end to said solenoid and at its other end to a spring member, said cable being positioned about the periphery of said cylinder; and fork members pivotally connected to said cable member, movement of said solenoid causing said fork members to rotate to selectively load or unload said suction valve.

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