United States Patent [19]

Le Blanc

[11] **3,844,686**

[45] **Oct. 29, 1974**

[54] **CAPACITY CONTROL DEVICE FOR RECIPROCATING COMPRESSOR**

[75] Inventor: **Jack J. Le Blanc,** Clay, N.Y.

[73] Assignee: **Carrier Corporation,** Syracuse, N.Y.

[22] Filed: **June 4, 1973**

[21] Appl. No.: **366,924**

[52] **U.S. Cl.** **417/298**

[51] **Int. Cl.** **F04b 49/00**

[58] **Field of Search** 417/298, 26, 28

[56] **References Cited**

UNITED STATES PATENTS

2,245,053	6/1941	Sanders, Jr.	417/28 X
2,339,191	1/1944	Raymond	417/298
2,681,177	6/1954	Hartwell	417/298 X
2,730,296	1/1956	Hartwell	417/298
3,303,988	2/1967	Weatherhead	417/298

FOREIGN PATENTS OR APPLICATIONS

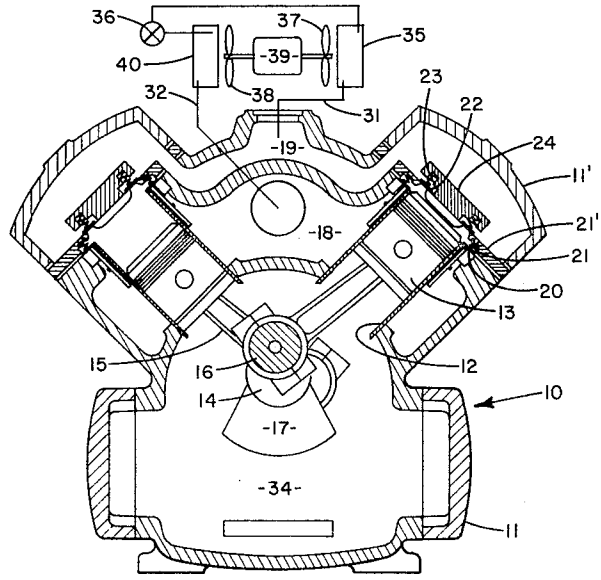
602,771	8/1960	Canada	417/298

Primary Examiner—Carlton R. Croyle
Assistant Examiner—Richard Sher
Attorney, Agent, or Firm—J. Raymond Curtin; Barry E. Deutsch

[57] ABSTRACT

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



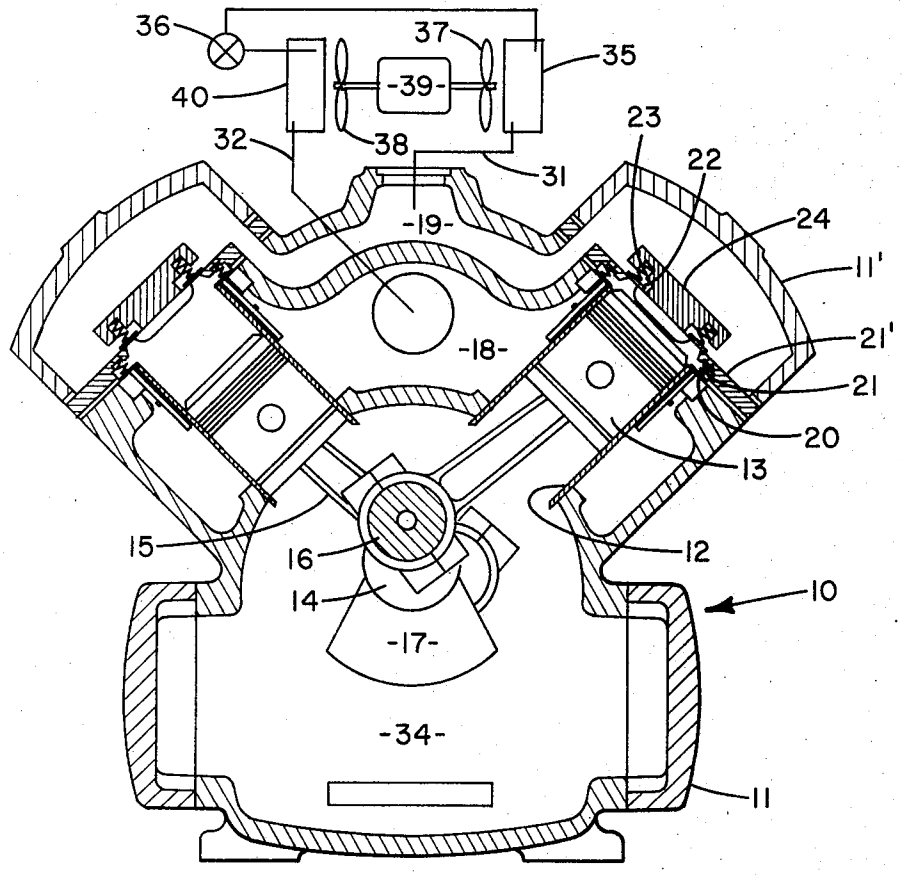


FIG. 1

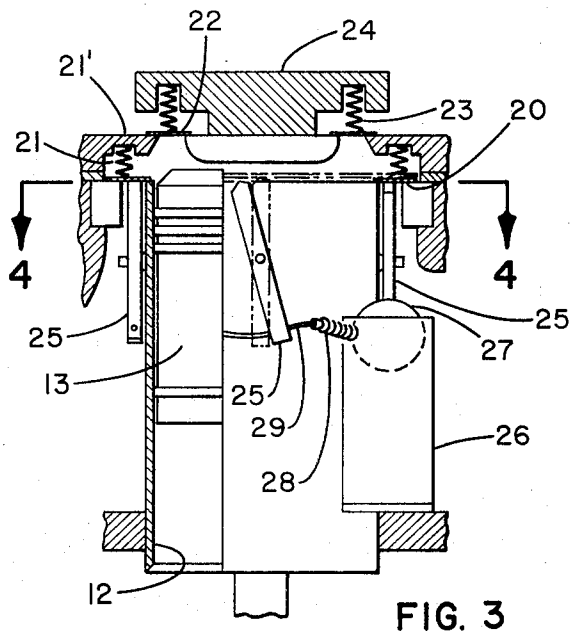


FIG. 3

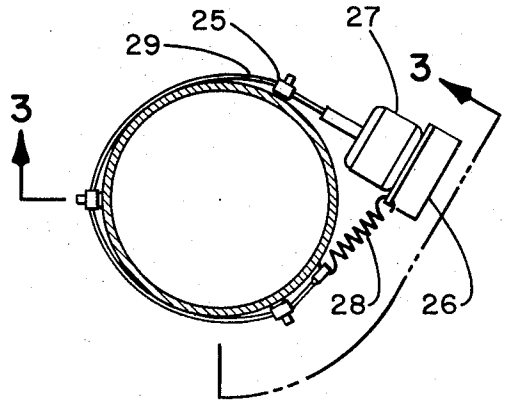


FIG. 4

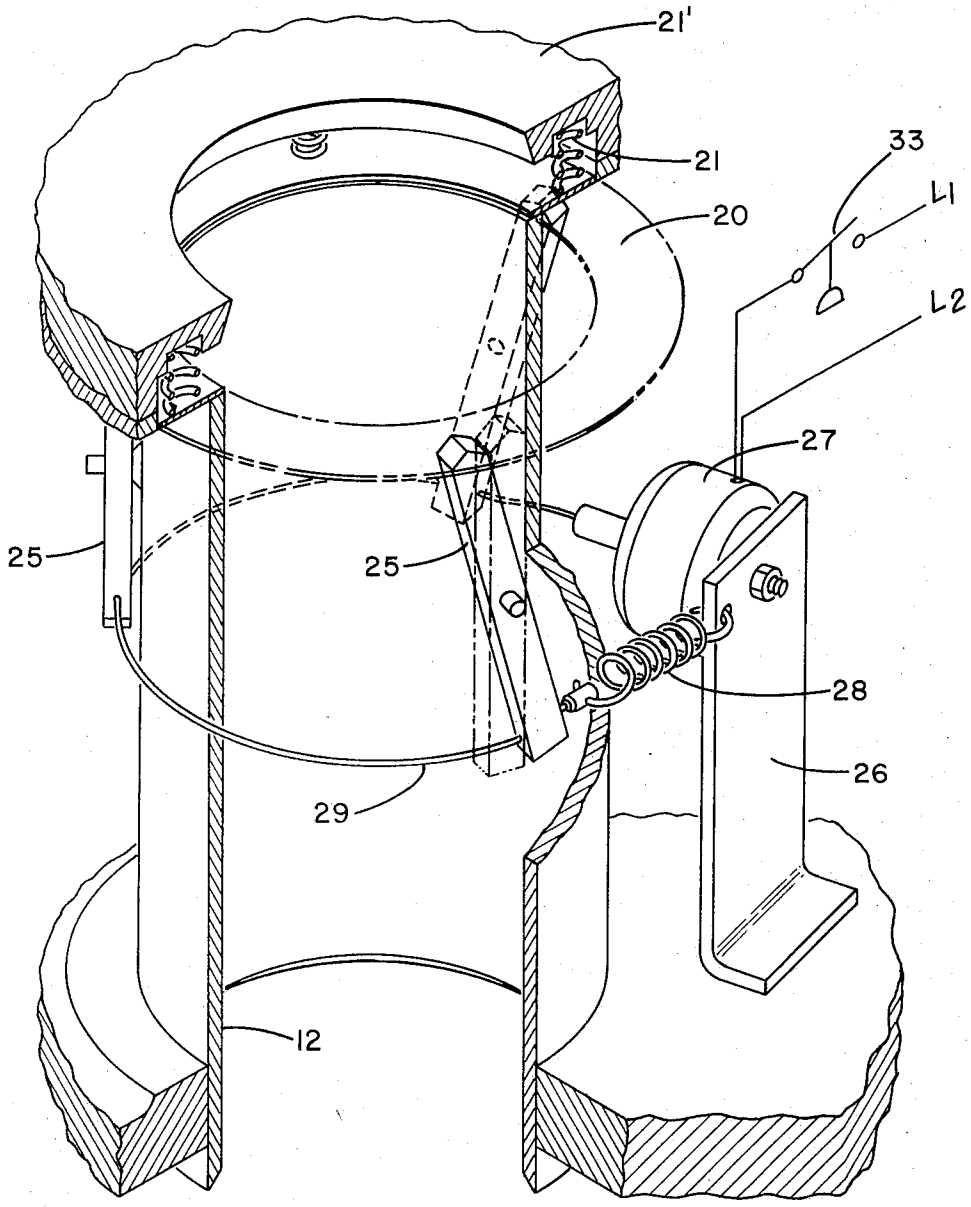


FIG. 2

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 heretofore 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.

Heretofore, 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 is 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 overcooling 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.** Pivotally 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 **28** 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.

* * * * *