Oct. 6, 1959 K. M. GERTEIS 2,907,348

IMPROVED VALVE MEMBER

Original Filed Feb. 26, 1954

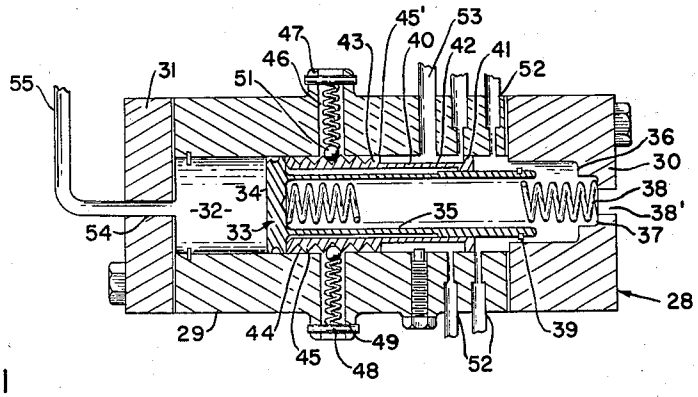


FIG. 1

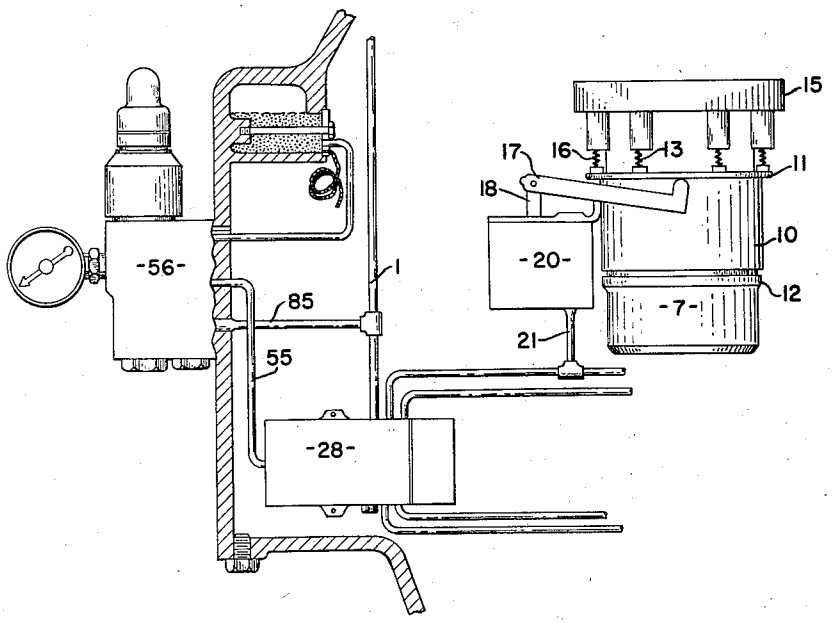


FIG. 2

INVENTOR.
KARL M. GERTEIS

BY Herman Seid

ATTORNEY

United States Patent Office

2,907,348

Patented Oct. 6, 1959

2,907,348

IMPROVED VALVE MEMBER

Karl M. Gerteis, Syracuse, N.Y., assignor to Carrier Corporation, Syracuse, N.Y., a corporation of Delaware

Original application February 26, 1954, Serial No. 412,793, now Patent No. 2,836,345, dated May 27, 1958. Divided and this application August 1, 1957, Serial No. 675,648

1 Claim. (Cl. 137—622)

This application is a division of my co-pending application, Serial No. 412,793, filed February 26, 1954, now issued as U.S. Patent 2,836,345.

This invention relates generally to reciprocating compressors and more particularly to an improved device for automatically controlling the capacity of the compressor in relation to the demand made upon the compressor. Still more particularly this invention relates to an improved valve mechanism which may be incorporated in a fluid circuit having utility in a capacity control system for a reciprocating compressor.

The chief object of the invention is the provision of an improved control valve for use in a capacity control system for a reciprocating compressor of the kind which alternately inactivates or activates cylinders in the compressor and which includes an unique construction preventing rapid cycling of the cylinders in response to load variations. This condition occurs when, for example, the reduction in load is sufficient to cause a cylinder to unload but the reduced output of the compressor is insufficient to meet the reduced load requirement.

Other objects and features of this invention will be apparent upon a consideration of the ensuing specification and drawings wherein:

Figure 1 is a sectional view of the control valve illustrating the invention;

Figure 2 is a diagrammatic view illustrating the manner in which the individual elements, one of which is the valve forming the subject of this invention, of an improved capacity control system are related.

Briefly, the capacity control system, in which the control valve forming the instant invention is useful, includes one or more cylinder unloading elements, depending on the number of cylinders present, in communication with a common control valve having a spring urged piston movable in a passage in such manner as to permit the application of oil pressure to certain of the unloader elements. Movement of the piston in the passage is dependent upon an unbalanced force between the spring and a source of oil, the pressure of which is under the influence of a regulating valve, which in turn is subject to the load on the compressor as evidenced by the suction pressure to which the compressor is subjected. The oil under the influence of the regulating valve is a part of the lubrication system of the compressor.

As pointed out above, the operation of the control valve is dependent in part upon the demand upon the compressor and causes the individual cylinders to load or unload in accordance therewith. Changes in the load upon a refrigeration system having a compressor equipped with a capacity control system of the type here described, as reflected by the pressure in the suction line, tend to be small in comparison with the change in capacity of the compressor when, for illustration, one of two operating cylinders is unloaded. It will be appreciated that the capacity of the compressor may be reduced by 50% at this point. The compressor tends to balance against the load so that the unloaded cylinder is rapidly loaded again,

resulting in an action known as cycling. Rapid cycling often causes undue wear on the parts involved and should be avoided or at least minimized. To accomplish the elimination of rapid cycling, this invention includes an improved control valve, incorporating a lost motion feature which necessitates a relatively large suction pressure change before the capacity control system changes from unloading to loading or vice versa after operating through a pattern that includes either successively loading or unloading, while permitting a relatively small differential to occur for the purpose of functioning in the latter manner. In other words, when the capacity control system operates to change from loading to unloading or vice versa, a relatively large differential in suction pressure is necessary before the change occurs.

Referring to the attached drawings, there is illustrated in Figure 2 a capacity control system for a compressor having a plurality of cylinders, and a crankcase. Disposed within the crankcase is oil sump accommodating lubricant for the operating mechanism of the compressor including a crankshaft, pistons, and connecting rods, all of which are elements of a conventional compressor used, for illustration, in a refrigeration system which forms no essential part of the invention but which, it will be understood, are present to form an operable compressor.

It will be appreciated that efficient operation of the compressor necessitates varying the output of the compressor in accordance with the demand made thereon. One convenient method of varying the output of the compressor involves equipping certain of the cylinders with an unloader element as of the type illustrated in Figure 2. The unloader mechanism, disclosed, is utilized to place the suction valves, not shown, of the cylinder 7 in inoperative position and includes a lifter sleeve 10, surrounding the cylinder, provided with an outwardly extending flange 11. The sleeve is adapted to move in a reciprocatory manner about the outer surface of the cylinder from a lower limit as indicated by band 12 embracing the cylinder.

Disposed radially about the flange 11 and in engagement with the upper surface thereof are a plurality of lifter pins 13 which operate to lift the suction valve from its seat in valve plate 15 in response to the upward movement of the sleeve 170. Loading springs 16 surround the lower portions of the pins 13 and serve to maintain the bottoms of the pins in engagement with the flange 11 on the sleeve 10.

Movement of the sleeve 10 is provided by a power element comprising a forked lever 17 having the end portions in engagement with the underside of flange 11 and which is pivoted at its other end to a vertical rod member 18. The latter member is secured at its other end to a piston, not shown, which moves within casing 20 in response to oil pressure introduced therein through line 21 in the manner to be later described. Spring mechanism, not shown, opposes the action of the oil flowing in line 21. An appropriate relief opening, not shown, is provided in casing 20 to accommodate oil which may seep between the piston and the wall of the casing. Thus, it may be seen that the power unloading element is so constructed and arranged as to cause the lifting pins 13 to move the suction valves from their seats when there is inadequate oil pressure to overcome the action of the spring in the casing. When adequate oil pressure is supplied to the power element, the piston is forced upwardly against the action of the spring, pivoting lever 17 to permit sleeve 10 to move downwardly and allowing springs 16 to move lifting pins 13 downward so that the suction valves assume their normal position under the influence of conventional positioning springs in the valve plate 15.

In Figure 1, a control valve 28 forming the subject of this invention is illustrated which permits oil pressure

to be introduced into the various power unloaders in a sequence depending upon the load imposed upon the compressor. Control valve **28** comprises a casing **29** having a first end member **30** and a second end member **31**. The casing **29** is provided with a cylindrical bore **32** extending therethrough which accommodates a movable piston **33** having a head **34** and a hollow elongated shank **35**, having its unattached end open, depending therefrom. Bore **32** is in communication with a socket **36** positioned within end member **30** and which is provided with a portion of reduced diameter **37**, constituting a spring seat. One end of a spring member **38** is positioned against seat **37** and the other end of the spring **38** is in engagement with the under side of the head **34** so as to normally urge piston **33** to the left of the control valve as viewed in Figure 3. Opening **38'** serves to vent oil to the crankcase when the piston moves to the right, acting as an escape outlet. The piston **34** is also provided, on the shank portion proximate the unattached end, with an annular ring member **39** which in effect forms a radial projection about the shank. Mounted with the bore **32** so as to surround the shank **35** of piston **33** is a bobbin **40**, having a first enlarged end portion **41** providing a sealing engagement with the sides of the casing which define bore **32**, an intermediate portion **42** of reduced diameter and, an end portion **43**, including a sealing surface **45'**, the exterior surface of which is formed by a series of alternately spaced grooves and ridges or lands **44** and **45**.

Casing **29** has further provided therein radial bores **46** extending from bore **32** through the side of the casing and through a boss **47** located on the external surface of the casing. A pin **48** projects through aligned openings **49** provided in the boss **47**. Seated against pin **48** is a spring member having the outer end thereof in engagement with a spherical ball **51**, the parts being so designed and constructed that the balls **51** are normally urged inwardly of the casing into engagement with the grooves **44** on bobbin **40**. Also positioned in casing **29** is a radial opening **53** in communication with the main supply line of the lubrication system. The casing **29** is further provided with a series of radial openings **52** through which oil from the lubrication system of the compressor passes en route to the individual unloading elements mentioned above. Cover **31** has provided therein an opening **54** for the reception of line **55** connected to the regulating valve of the system in a manner to be more completely described.

In the compressor capacity control system chosen to illustrate the control valve of this invention there is provided a regulating mechanism **56** which serves to govern the pressure of oil applied to the piston head **34** through line **55** in accordance with an operating characteristic of the compressor or machine served by the capacity control system. It will be understood that the pressure of the oil flowing in line **55**, as determined by the operation of the regulating mechanism **56** bears a direct relation to the position of piston **33** in control valve **28** thus determining the number of lines **52** in communication with main oil supply line **53**.

The regulating mechanism **56** is not a part of this invention. Accordingly only a brief description of it will be necessary to appreciate the system illustrated to describe control valve **28**. Regulating mechanism similar to member **56** is described in detail in United States Patents 2,626,099, and 2,836,345, as well as co-pending application, Serial Number 675,726, filed August 1, 1957, in the name of Karl M. Gerteis and assigned to the assignee of this invention.

The regulating mechanism serves to vary the pressure applied to the piston **33** through line **55** by venting a portion of the main oil supply delivered to the regulating mechanism **56** through branch line **85**. The amount of oil so vented is in direct relation to a variable characteristic of the machine served by the capacity control system. Thus regulating mechanism **56** is provided with means, not shown, for adjusting the size of a vent in response to the suction pressure in a compressor equipped with the capacity control system.

In order to more adequately describe my invention, the operation of the system including the valve **28** as a component thereof will be explained. When the compressor is started, the power unloader elements, because of a lack of oil pressure, are arranged with the sleeve **10** in its uppermost position and pins **13** holding the suction valves in inoperative position so that the output of the unloaded cylinders is zero. In a relatively short period of time, the pump of the lubrication system, deriving its power from the compressor prime mover, forces oil through the lubrication system, which includes main line **1**, from where it moves to the regulating valve. Oil is also delivered from the main line **1** through line **53** to the control valve **28**. Due to the absence of oil in line **55**, the piston **33**, together with bobbin **40**, are positioned within the control valve in such a manner as to prevent passage of the oil from line **53** through any of the openings **52**. The action of spring **38** moves the piston **33** to the left of the valve, as shown in Figure 3, and the annular ring **39** engages flange **41** of the bobbin, so that the flange **41** is positioned within the opening **32** between opening formed by the line **53** and the closest opening **52**.

Eventually the oil pressure in the compressor will rise to a value sufficient to apply a substantial pressure in line **55**. As long as the suction pressure in the compressor indicates a need for compression the oil pressure in line **55** will continue to rise. Once the oil pressure in line **55** exceeds the force produced by spring **38** in valve **28** movement of the piston to the right, as viewed in Figure 1, occurs. However before the bobbin **40** moves, the piston must travel a distance sufficient to permit engagement between the underside of piston head **34** and the left hand end of bobbin **40**. Continued movement beyond this point enables communication to be established between one pair of lines **52** and supply **53** through valve **28**.

At least two of the cylinders in the compressor are activated. If the pumping capacity of the machine, under these circumstances, satisfies the demand on the machine as indicated by the suction pressure in the machine, control valve **28** permits the capacity control system to maintain the arrangement described. In the event the suction pressure in the machine drops indicating a reduced pumping capacity requirement, the novel control valve automatically operates through the lost motion feature to be described, to inactivate the unloaders being served by the lines **52** previously placed in communication with supply line **53**. It accomplishes this as the pressure in line **55** drops as a result of the condition sensed by the regulating mechanism **56**. In other words, regulating mechanism **56** vents an amount of oil flowing through it so that the line pressure in line **55** drops. Spring **38** in control valve **28** forces the piston **33** to the left as viewed in Figure 1. With the arrangement shown, a lost motion action sufficient to effect delay of movement of bobbin **40** occurs for the reason it is necessary that piston **33** travel a distance to the left, under the action of spring **38**, sufficient to effect engagement of bobbin **40** by annular ring **39**. Then in the event the machine demand changes rapidly, movement of the valves by the lifter pins **13** is avoided and the condition known as "chattering" substantially eliminated.

I claim:

In valve mechanism for controlling flow of fluid from a main supply line to one or more service lines wherein operation of the valve is responsive to the action of a fluid source subject to pressure variations, the combination comprising a casing having a chamber therein, a first opening for flow of the fluid subject to pressure variations into the chamber, a second opening for connecting the fluid supply line to the chamber and a plurality of ports serving to place the supply line in communication, through the chamber with the service lines; a piston slid-

ably mounted in said casing, said piston having a head portion and a shank portion depending therefrom and spaced from the sides of the casing defining the chamber; resilient means urging the piston to a predetermined position within said casing chamber opposing action of the fluid under pressure variations; a ring member fixedly secured to and surrounding the shank portion of the piston at the end thereof remote from the head portion; and an annular member having enlarged end portions in engagement with the wall of the casing surrounding the shank portion of the piston but of a lesser axial length so that movement of the piston within the chamber in response to unbalanced forces between the resilient means and the fluid subject to pressure variations causes

the annular member to move by virtue of engagement with the head portion of the piston or with the ring member secured to the shank portion of the piston to vary the number of ports in the casing in communication with the fluid supply line.

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