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PUMP UNLOADER

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PUMP UNLOADER

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This invention relates to fluid compressors and more particularly to means for automatically unloading a fluid compressor.

It is an object of this invention to provide a fluid compressor with an unloader adapted to unload the compressor when the speed thereof is reduced to a predetermined value and to maintain the compressor unloaded while starting, until the speed has increased to a predetermined value, so as to permit the driving unit, which may be an electric motor or an internal combustion engine, or any preferred prime mover, to pick up speed before the work of compressing begins.

Another object of the invention is to provide a fluid compressor and unloading means which operates to unload the compressor when same is stopped, by opening communication from the compression chamber of the compressor to the atmosphere and which operates to maintain said communication open while starting, until the speed of the compressor is increased to a predetermined value, so that only a low starting torque is required of the driving unit.

A further object of the invention is to provide an unloader for a fluid compressor wherein the unloader valve is actuated by the fluid lubricant of the lubricating system and is responsive to variations in the pressure of the fluid lubricant, and wherein the pressure of the fluid lubricant is regulated by centrifugally controlled means, so that loading of the compressor is accomplished when the speed of the compressor attains a predetermined value.

Other objects and advantages will appear from the following more detailed description of the invention.

In the accompanying drawing, Fig. 1 is a diagrammatic view, mainly in section, of a fluid compressing apparatus embodying my invention; Fig. 2 is a sectional view taken on the line 2—2 of Fig. 1; and Fig. 3 is a fragmental sectional view showing the unloading means in a position for loading the compressor.

As shown in the drawing, the fluid compressing apparatus may comprise an air compressor 1, a storage reservoir 2, and a check valve device 3 interposed in the discharge pipe to prevent back flow from said storage reservoir through said discharge pipe.

The air compressor may comprise a crank case 4 having a crank chamber 5, a cylinder casing 6 having a compression chamber 7 containing a piston 8, and a cylinder cover 9 closing the compression chamber 7.

The piston 8 is connected, in the usual manner, by a connecting rod 10 to a crank pin 11 provided on the crank shaft 12, which is journaled in bearings 13 and 14 mounted in end plates 15 and 16 secured in any desired manner to the side walls of the crank case. A suitable gasket, such as 17, is clamped between each said end plate and the side walls of the crank case to provide a tight joint. The crank shaft 12 is adapted to be connected to a prime mover, such as an electric motor or an internal combustion engine.

The cylinder cover 9 contains an inlet chamber 39 from which air is drawn at atmospheric pressure past the inlet valve disc 40 into the compression chamber 7 upon the suction stroke of the piston 8. The inlet valve disc 40 is yieldingly retained upon its seat by means of a spring 41. The cylinder cover 9 also contains an outlet chamber 42 which is adapted to receive fluid under pressure compressed in the compression chamber 7 and forced past the discharge valve disc 43 which is yieldingly pressed to its seat by means of a spring 44.

The check valve device 3 may comprise a casing containing a valve disc 45 having at one side a chamber 46 connected by pipe 47 to the storage reservoir 2 and at the other side a chamber 48 connected by a pipe 49 with the outlet chamber 42 in the cylinder cover 9 of the compressor and also connected by a pipe 50 with the chamber 37 associated with the unloader valve 36, which will be referred to more in detail hereinafter. The valve disc 45 is yieldingly pressed to its seat by a spring 51 contained in the chamber 46 and is adapted to prevent back flow from the storage reservoir to chamber 37, for a reason which will be understood from the description hereinafter.

The fluid lubricating system of the compressor comprises a pump which may include a rotor 18 that is formed on the crank shaft 12 by enlarging a portion thereof, intermediate the bearing 13 and the crank pin 11, concentric with the axis of said shaft. The rotor is enclosed in a cylindrical chamber 19 which may be formed in an extended portion of the end plate 15, said chamber being disposed eccentrically with respect to the rotor 18.

The rotor 18 is provided with a through slot 20 disposed diametrically thereof in which are slidably received rotor blades 21 and 22 which are adapted, at their outer ends, to bear against the interior wall of the cylindrical chamber 19 and which are provided with bores 23 and 24,

respectively, extending axially of said blades from the inner ends thereof. Thus, with the blades assembled in the slot 20, the bores 23 and 24 are axially aligned and the open ends thereof face each other. A coil spring 25, secured at one end to a pin 26 carried by the blade 21 at the bottom of the bore 23 and secured at the other end to a pin 27 carried by the blade 22 at the bottom of the bore 24, is under initial tension therebetween and acts to maintain said blades in their innermost position, as will now be seen.

For limiting the sliding movement of the blades 21 and 22 inwardly, a stop pin 28 is provided which is screw-threaded into an opening in the rotor disposed radially thereof and at right angles to the axis of the slot 20, the pin 28 being preferably of such length that it extends across said slot. With the blades 20 and 21, the spring 25 and the pin 28 assembled in the rotor 18, said pin separates said blades, and the spring 25, being under initial tension between said blades, acts to hold the inner ends thereof in engagement with said pin, so that the blades are held in their innermost position, until the speed of the crank shaft has increased to such a value that the centrifugal force developed thereby and acting on the blades is sufficient to overcome the tension of the spring 25, as will be understood from the description herein-after.

The rotor chamber 19 is provided with an opening 30 which leads to an oil inlet passage 31 which communicates with a pipe 32 having one end extending into the fluid lubricant 33 at the bottom of the crank case 5. Said chamber is provided with an outlet port 34 which opens into a chamber 35 at one side of an unloader valve piston 36.

The unloader valve piston 36 is contained in the casing of the extended portion of the end plate 15 and has at one side the chamber 35 which, as above mentioned, is connected through the port 34 with the rotor chamber 19, and has at the other side a chamber 37 which is in continuous communication with the crank chamber 5 through the opening 38. The valve piston 36 controls communication from the pipe 50, which leads to the chamber 48 in the check valve device 3, to the chamber 37 and thereby controls communication from the outlet chamber 42 of the compressor to the crank chamber 5. The flow capacity of the opening 38 is restricted as compared with the capacity of the communication, including the pipe 50, from the outlet chamber 42 to the crank chamber 5.

A passage 52 leads from the outlet port 34 of the rotor chamber 19 to the bearing 13 for conducting fluid lubricant to said bearing and for conducting fluid lubricant from said bearing to the other crank shaft bearing 14 and to the connecting rod bearing on the crank pin 11, a drilled passage 53 is provided in the crank shaft 12, extending longitudinally thereof from the bearing 13 to the bearing 14 and having a branch leading to said connecting rod bearing.

A relief valve is interposed between the chamber 35 and the passage 31 and comprises a valve 54, subject on its seating side to the pressure of the fluid lubricant in said chamber and pressed to its seat by means of a spring 55.

When the compressor is idle, the blades 21 and 22 occupy the positions shown in Fig. 1, the tensioned spring 25 acting to hold the inner ends of said blades in engagement with the stop pin 28 and thereby out of engagement with the interior wall of the rotor chamber 19. When the com-

pressor is started and until a predetermined speed of rotation of the crank shaft is attained, the centrifugal force developed thereby and acting on the blades 21 and 22 is insufficient to cause said blades to move outwardly in the slot 20, against the tension of the spring 25, into engagement with the interior wall of the rotor chamber 19 and there is, therefore, no fluid lubricant pressure acting in chamber 35 at the left of the unloader valve piston 36. Atmospheric air drawn into the compression chamber 7 of the compressor past the inlet valve disc 40 is discharged past the discharge valve 43 into pipe 49 and is forced thence through chamber 48 in the check valve device 3 and pipe 50. There being no fluid lubricant pressure acting in chamber 35 when the compressor is initially started, if the valve piston 36 is not already in its open position, it will be moved inwardly to that position by the pressure of the fluid discharged into the pipe 50, this movement being effected promptly and positively, due to the fact that the unseating of the valve piston exposes the full area thereof to the pressure of said fluid and also to the fact that the opening 38, being restricted, permits a rapid build up of fluid pressure in chamber 37. With the valve piston 36 unseated, fluid discharged into pipe 50 flows therefrom to the atmosphere past said valve piston, through chamber 37, the opening 38, the crank chamber 5, the oil filling inlet 56, and openings 57 in the cover 58. With the compression chamber 7 of the compressor thus vented to the atmosphere on the compression stroke, the compressor is unloaded and it therefore quickly picks up speed. During this time, back flow of fluid under pressure from the storage reservoir 2 through the check valve device 3 is prevented by the valve disc 45 which is held seated by the pressure of the reservoir fluid in chamber 46.

When the speed of rotation of the crank shaft 12 has increased to a predetermined value, the centrifugal force acting on the blades 21 and 22 overcomes the tension of the spring 25 and said blades are moved outwardly within the slot 20 under the action of said force into engagement with the interior wall of the rotor chamber 19. Due to the well known action of the blades, fluid lubricant is pumped from the body of fluid lubricant 33 into chamber 35 through the pipe 32, passage 31, inlet opening 30, chamber 19, and outlet passage 34. The fluid lubricant pressure in chamber 35 increases until the valve piston 36 is moved rightwardly thereby, to its seated position against the pressure of the fluid delivered into chamber 37 from the compression chamber 7. The vent connection of the compression chamber is thus cut off and the pressure of the fluid discharged from said chamber into the pipe 49, and thence into the chamber 48 of the check valve device 3, will increase until the valve disc 45 is unseated thereby, and flows thence through pipe 47 into the storage reservoir 2. Thus, the loading of the compressor is effected only after the crank shaft attains a predetermined speed of rotation.

Fluid lubricant delivered to the passage 34 is also forced therefrom through passage 52 to the crank shaft bearing 13 and from thence into passage 53 in the crank shaft 12, from whence it is forced to the bearing of the connecting rod 10 on the crank pin 11 and to the bearing 14.

When the pressure of the fluid lubricant delivered by the pump to chamber 35 exceeds a predetermined degree, the relief valve 54 will be unseated thereby against the action of the spring 55 and fluid lubricant will then flow from said

chamber to the passage 31, thereby preventing the building up of excessive pressure in the fluid lubricant circulating system.

When the compressor is stopped and the speed of the crank shaft has fallen to a predetermined degree, the tension of the spring 25 will overcome the centrifugal force acting on the blades 21 and 22 and said blades will be moved inwardly within the slot 20 out of engagement with the interior wall of the rotor chamber 19 and into engagement with the stop pin 28. With the blades thus retracted, the fluid lubricant pump becomes ineffective. The pressure of the fluid lubricant in chamber 35 acting to hold the valve piston 36 seated being thus relieved, fluid under pressure in pipe 50 will unseat said valve piston, causing the compression chamber 7 of the compressor to be vented to the atmosphere in the manner hereinbefore described. Thus, the compressor is unloaded when brought to rest, and it is apparent that upon initial starting of the compressor, the only load on the compressor, so long as the fluid lubricant pump remains ineffective, will be the compression of the fluid at atmospheric pressure within the compression chamber 7.

The speed of rotation of the crank shaft 12 at which the compressor is loaded is determined by the initial tension of the spring 25, and thus the compressor may be loaded at any desired speed of operation.

The loading of the compressor being dependent upon the pressure of the fluid lubricant while the compressor is operating, it is obvious that in event of failure of the fluid lubricant pump or leaks in the lubricating system, such as would cause an abnormal fall in fluid lubricant pressure, the pressure acting in chamber 35 on the unloader valve piston 36 falls correspondingly, so that fluid under pressure in the pipe 50 will unseat said valve piston and thereby unload the compressor.

From the foregoing, it is apparent that an unloading mechanism for a fluid compressor has been provided which is controlled by the pressure of the fluid lubricant of the lubricating system and which is responsive to the speed of the compressor.

While one illustrative embodiment of the invention has been described in detail, it is not my intention to limit its scope to that embodiment or otherwise than by the terms of the appended claims.

Having now described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. A control mechanism for a fluid compressor comprising a fluid pump operative to supply fluid under pressure, and a valve for controlling a communication through which fluid compressed by said compressor is discharged, said valve being subject to the opposing pressures of the fluid discharged by said pump and fluid compressed by said compressor into said communication and being adapted to be operated by the fluid discharged by said pump to close said communication and thereby load said compressor and adapted to be operated upon the relief of fluid under pressure discharged by said pump to open said communication and thereby unload said compressor, said pump being rendered ineffective to supply fluid under pressure to said valve, so as to effect unloading of said compressor, when the speed of said compressor is less than a predetermined speed.

2. A control mechanism for a fluid compressor comprising a fluid pump operative to supply fluid under pressure, and a valve for controlling a communication through which fluid compressed by said compressor is discharged, said valve being subject to the opposing pressures of the fluid discharged by said pump and fluid compressed by said compressor into said communication and being adapted to be operated by the fluid discharged by said pump to close said communication and thereby load said compressor and adapted to be operated upon the relief of fluid under pressure discharged by said pump to open said communication and thereby unload said compressor, said pump being rendered operative by the action of centrifugal force to supply fluid under pressure to said valve for loading said compressor when the speed of the compressor exceeds a predetermined speed and being rendered inoperative, by the action of centripetal force, to supply fluid under pressure to said valve, and thereby effect unloading of said compressor, when the speed of said compressor is less than said predetermined speed.

3. The combination in a fluid compressor comprising a casing having a crank case chamber containing a supply of fluid lubricant, a crank shaft rotatable in said crank case chamber, means operative by fluid lubricant pressure for effecting the loading of said compressor, and means for supplying fluid lubricant under pressure to said loading means, comprising a pump having a casing provided with a rotor chamber, a rotor element rotatably mounted in said chamber eccentrically thereof and operated by said crank shaft and having a plurality of radial slots therein, a member slidably mounted in each of said slots and movable, by the action of centrifugal force, into engagement with the interior wall of said rotor chamber for supplying fluid lubricant under pressure from said crank case chamber to said loading means when the speed of said crank shaft exceeds a predetermined speed, and means for rendering said members ineffective when the speed of said crank shaft is less than said predetermined speed.

4. The combination in a fluid compressor comprising a casing having a crank case chamber containing a supply of fluid lubricant, a crank shaft rotatable in said crank case chamber, means operative by fluid lubricant pressure for effecting the loading of said compressor, and means for supplying fluid lubricant under pressure to said loading means, comprising a pump having a casing provided with a rotor chamber, a rotor element rotatably mounted in said chamber eccentrically thereof and operated by said crank shaft and having a plurality of radial slots therein, a member slidably mounted in each of said slots and movable by the action of centrifugal force, into engagement with the interior wall of said rotor chamber for supplying fluid lubricant under pressure from said crank case chamber to said loading means when the speed of said crank shaft exceeds a predetermined speed, and yielding means acting on said members whereby said members are maintained out of engagement with the interior wall of said rotor chamber against the action of centrifugal force when the speed of said crank shaft is less than said predetermined speed.

5. In combination, a reservoir, a control chamber, a fluid compressor having a compression chamber, the compressor being adapted to com-

press fluid under pressure into said control chamber and having valve means adapted to prevent back flow of fluid from the control chamber to said compression chamber, valve means operative to permit fluid to be supplied from said control chamber to said reservoir and to prevent back flow of fluid from the reservoir to said con-

trol chamber, a lubricating system for supplying lubricant under pressure to portions of the compressor, and means responsive to the pressure of the lubricant in said system for controlling the release of fluid from said control chamber.

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