

May 24, 1960

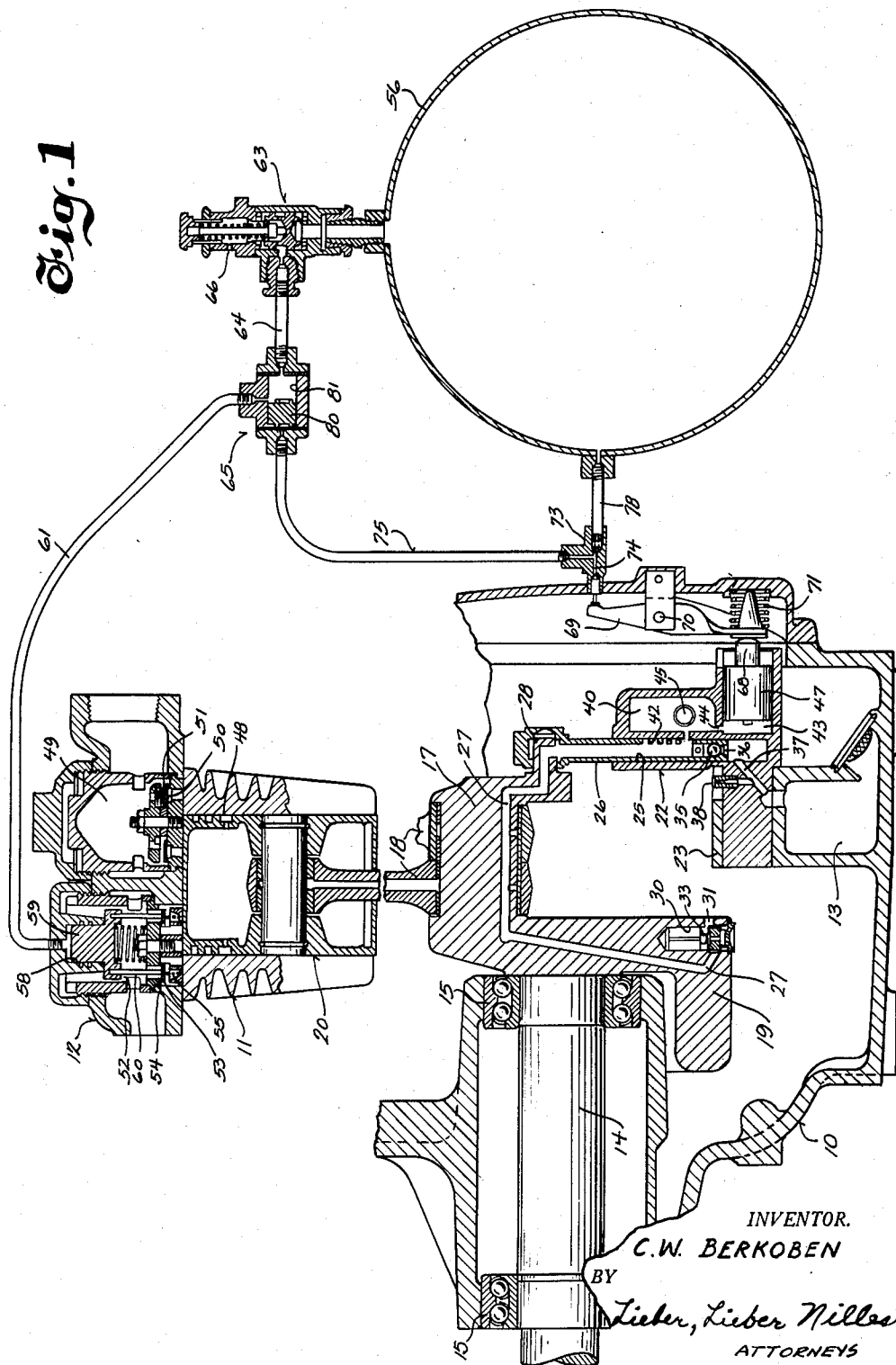
C. W. BERKOBEN
COMPRESSOR CONTROL SYSTEM

2,937,801

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2 Sheets-Sheet 1

Fig. 1



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Fig. 2

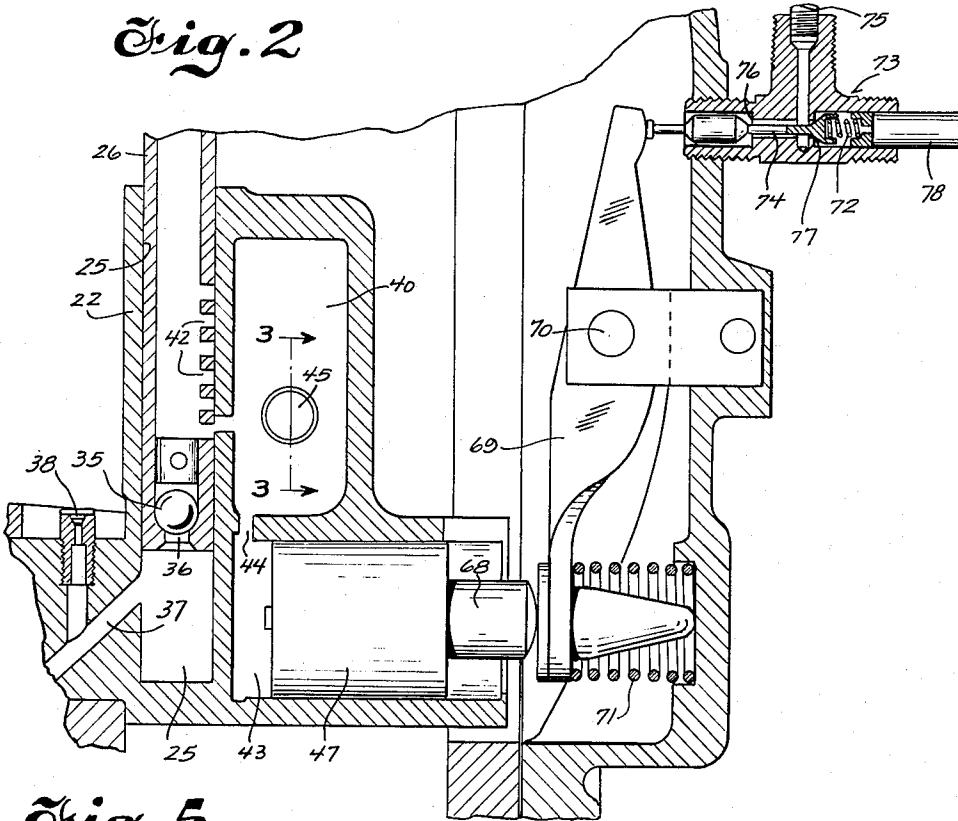


Fig. 5

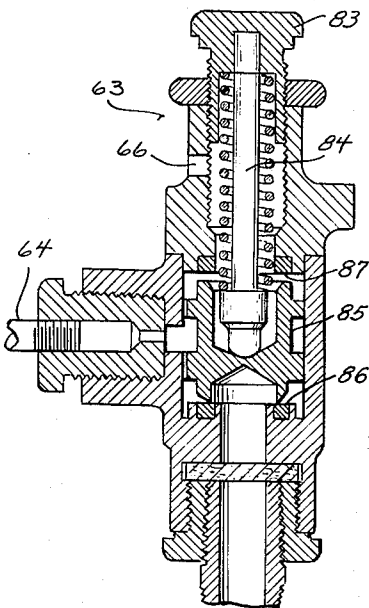


Fig. 3

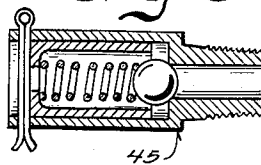


Fig. 4

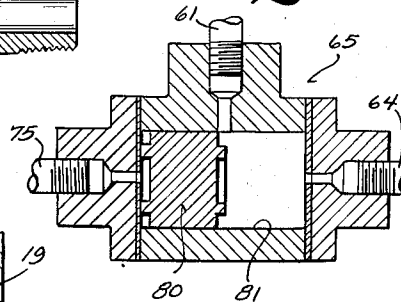
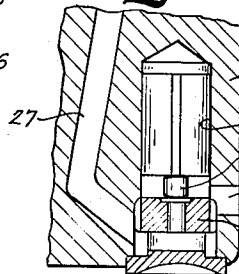


Fig. 6



INVENTOR.

C. W. BERKOBEN

BY

Lieber, Lieber & Nilles
ATTORNEYS

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COMPRESSOR CONTROL SYSTEM

Charles W. Berkoben, Hales Corners, Wis., assignor to Westinghouse Air Brake Company, Wilmerding, Pa., a corporation of Pennsylvania

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2 Claims. (Cl. 230—7)

This invention relates generally to compressors and more particularly to a control system therefor which provides load-unload control, insures low starting torque and provides protection for the unit when the oil pressure is below a predetermined minimum.

Control systems of this general character have been used successfully but have heretofore been rather complicated in construction, particularly their valve mechanisms, and have required considerable maintenance and repair. These systems have provided loadless starting means which are actuated by lack of pressure in the lubrication system.

In accordance with the present invention, a compressor control system has been provided in which service problems have been minimized and which is dependable in operation.

The invention provides means which holds the air intake valve of the compressor cylinder open when pressure over a predetermined amount is in the air receiver. In addition, the arrangement is such that, when the compressor is started, the air intake valve of the cylinder will remain open, if the air receiver is pressurized, until the compressor is up to sufficient speed for the motor to handle the compressing load. If the air receiver is not pressurized when the compressor starts, the compressor will, of course, have no load imposed thereon and the low starting torque feature provided by this invention will not be necessary.

Furthermore, in the event of low oil pressure, for example, due to a low supply of oil or excessive bearing clearance, the invention provides means for preventing the cylinder air intake valve from closing and thereby maintaining the compressor in an unloaded condition.

It is an object of this invention to provide a loadless starting system for a compressor, which system is operated by the pressure in the air receiver.

These and other objects and advantages will appear hereinafter as this disclosure progresses, reference being had to the accompanying drawings, in which:

Figure 1 is a longitudinal sectional view through a compressor-receiver unit made in accordance with the present invention, certain parts being broken away or removed for clarity of the drawings;

Figure 2 is an enlarged, fragmentary, sectional view showing part of the unit shown in Figure 1;

Figure 3 is a sectional view taken on line 3—3 of Figure 2, but on an enlarged scale, of the pressure relief valve in the air dome;

Figure 4 is an enlarged, sectional view of the three-way shuttle valve shown in Figure 1;

Figure 5 is an enlarged, sectional view of the unloader pilot valve of Figure 1; and

Figure 6 is an enlarged, sectional view of the centrifugally actuated regulating valve.

Referring more specifically to the drawings, the invention has been shown as applied to a Y compressor, that is, a compressor having two compressing cylinders arranged in Y formation—only one cylinder is shown, however.

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The compressor comprises a sectional casing having a crank case 10, a cylinder section 11 and a cylinder head section 12. The crank case 10 is provided with an oil reservoir 13 in the bottom thereof.

A crankshaft 14 is rotatably mounted in anti-friction bearings 15 in the case 10 and is driven by any form of motor device, such as an internal combustion-engine or electric motor. A crank arm 17, having a pair of connecting rods 18 journaled thereon, and a counterweight 19 are made integral with the crankshaft 14. A piston 20 is connected in the usual manner to each connecting rod 18 for reciprocation thereby.

The fluid lubricating system of the compressor includes a pump cylinder casing 22 journaled for oscillation in a fixed bearing 23 that is integral with crank case 10 and which casing contains a compression chamber 25. The interior of hollow pump plunger 26 is in communication at its upper end with a lubricant passage 27 which extends through crank pin 28, crank arm 17 and into the counterweight arm 19. The positive type pump forces oil up to the crank pin bearings and through drilled connecting rods to wrist pin bearings.

The counterweight arm is provided with a valve chamber 30 having an outlet 31 to the crankcase and contains a bleed valve 32 which is closed by the piston 33 when the latter is moved to the closed position by centrifugal force when the crankshaft rotates. Therefore, the pump 26 cannot build up oil pressure until and unless the crankshaft is rotating at a sufficient speed. Piston 33 also serves to unload the oil system when the compressor stops.

The pump plunger 26 is reciprocated in its chamber 25 as the crankshaft is rotated. A ball check valve 35 is adapted to close a port 36 in the end of the plunger during the suction stroke of the plunger and is adapted to be forced from the closed position, shown in Figures 1 and 2, during the downward compression stroke of the plunger, to permit fluid within chamber 25 to be forced inside the plunger. An inlet passage 37 establishes communication from the reservoir chamber 13 to the compression chamber 25 and is closed by the plunger upon initial movement of the plunger in its downward or compression stroke.

In order to even out pulsations from this plunger type pump an air snifter orifice 38 is provided through which air is drawn into and mixed with oil being drawn into the pump inlet. The air dome 40 is designed to contain air and oil and acts to reduce pulsations in oil pressure and thereby contributes to better operation of the unloading device, to be described, and provides more uniform lubrication for the bearings. Ports 42 permit passage of fluid to the unloading device via the air dome 40 which communicates with the cylindrical chamber 43 via passage 44.

The air dome contains a pressure relief valve 45 (Figs. 2 and 3) which is threadably engaged in the casing and extends outwardly from the dome.

The pump cylinder casing 22 includes the chamber 43 in which the plunger 47 is reciprocally mounted for operation of the unloading device to be described. Chamber 43 is supplied with fluid lubricant under pressure from dome 40 and as the pump plunger 26 reciprocates, fluid under pressure is forced to act on plunger 47, the pressure of the lubricant being determined by the centrifugally controlled valve 33.

In reference to Figure 1, the cylinder valve head 12 contains an outlet chamber 49 which receives air under pressure compressed in the chamber 48 by piston 20 and which is forced past the discharge valve disc 50 which is yieldingly pressed against its valve seat by spring 51. The discharged air is then conducted to the air receiver

56, to be described. The valve head 12 is also provided with an inlet chamber 52 from which air is drawn at atmospheric pressure in the case of a single compressor or from the low pressure cylinder via an intercooler if two-stage compression is employed. The air is drawn past the inlet valve 53 into the compression chamber 48, upon the suction stroke of piston 20. The inlet valve disc 53 is yieldingly retained on its seat 54 by spring 55.

The load-unload control operates as follows. A conventional suction valve unloading device is provided for actuating valve disc 53 and includes a cylinder 58 and piston 59, the latter of which is connected by rods 60 to the disc. A conduit 61 is in communication with cylinder 58 and when air pressure in the receiver 56 reaches a predetermined value, the conventional unloader pilot 63 allows receiver pressure to enter conduit 64, pass through the shuttle valve 65, to be described, and into conduit 61, causing the conventional suction valve unloading device to hold open the suction valve disc 53. As a result, the compressor will operate unloaded (running continuously though not compressing air) until the receiver pressure drops to a predetermined value. The unloader pilot 63 then permits the receiver pressure in conduits 64 and 61 to escape to atmosphere through orifice 66 thereby allowing the suction valve 53 to close and the compressor to again compress air.

Referring again to Figures 1 and 2, the unloader plunger 47 has a stem 68 that engages the lower end of lever 69 and rotates the lever about its pivot point 70 in a counterclockwise direction when pressure of the fluid acting on the plunger 47 is sufficient to overcome the tension of spring 71. Rotation of lever 69 in a counterclockwise direction causes spring 72 in the three-way plunger control valve 73 to urge the double valve element 74 to the left, as shown in Figure 2, where pressure in conduit 75 is permitted to bleed past valve seat 76 and into the crank case chamber 13. When in this position the valve 74 is seated at 77 to block receiver pressure from passing from conduit 78 to conduit 75. When pressure on the unloader piston 47 drops, the spring 71 urges lever 69 to the clockwise position, which in turn moves the valve element 74 to the right. As a result, receiver pressure from conduit 78 enters conduit 75 and goes to the three-way shuttle valve 65.

This shuttle valve connects either conduit 64 to 61 or conduit 75 to 61 and is operated by differential air pressure moving the shuttle piston 80 to either end of the cylinder 81.

The low starting torque feature of this unloading system is necessary only when the receiver is pressurized.

When the receiver is at zero pressure, the compressor starts working at low torque requirements and therefore imposes only a light load on the driving motor (not shown). Under these circumstances the low starting torque feature of this unloading system is not necessary.

When the compressor is starting against receiver pressure, however, the system insures low starting torque on the compressor as follows. When the compressor is at rest and the receiver is pressurized, the suction valve 53 is open by the unloader device because of the pressure in conduit 61. Pressure in conduit 61 is the result of pressure from the receiver passing through conduit 78, valve 73 (which is held open by spring 71), conduit 75, valve 65 and into conduit 61. Assuming that the unloader pilot has been manually closed by rotation of its handle 83 to move stem 84 and valve 85 downwardly away from its seat 87 and against seat 86 (an operation which is unnecessary but which may occur), the shuttle piston will normally be to the right (Fig. 4) when the compressor is idle because vent 66 in the unloader pilot 63 allows pressure in conduit 64 to bleed to atmosphere. If the unloader pilot has been thus closed, it should be manually opened to restore normal operating conditions and to safeguard against over pressurizing the receiver upon restarting the compressor. However, unless the

pressure in the receiver goes above a predetermined value, valve 85 remains closed due to the action of the spring surrounding the stem 84. Even if the compressor was stopped with the unloader pilot open and it remained open when the compressor is restarted, then the compressor will still start unloaded anyway. This is because pressure remains in conduit 64 which is opened to conduit 61 by valve 65. In either event, the compressor will start unloaded and remain that way until valve 73 is actuated by pressure in chamber 43 causing piston 47 to move the lever counterclockwise. Spring 72 then causes the valve 74 to block conduit 75 from conduit 78 and permits the pressure in conduit 75 to bleed into the crankcase.

In order for valve 73 to be so actuated the crankshaft must be rotating sufficiently fast to cause centrifugal force to close the bleed valve 33 (Fig. 6) and thereby permit pressure to build up behind piston 47.

Therefore, the compressor suction valve will be closed after the compressor has reached sufficient speed for the driving motor to handle the compressing load.

The centrifugal valve 33 also permits unloading of the oil system when the compressor stops thus permitting piston 47 to move to the left. When the motor stops, the compressor slows down, permitting the centrifugally actuated valve 33 to open and thereby immediately dropping the oil pressure. The suction valve unloader then unloads the compressor by opening the suction valve.

The low oil pressure protection is provided by this control system as follows. If for some reason, such as low oil level or excessive bearing clearance, the oil pressure in chamber 43 cannot be built up sufficiently high to move piston 47 to the right against the spring 71, then the lever 69 will not move the valve 74 to permit the pressure conduit 75 to bleed into the crankcase so as to close the suction valve 53 and thereby load the compressor.

As a result, the loss or lack of pressure in the receiver will lead to operator investigating the cause thereof and remedying the cause. The compressor will be unharmed because of its unloaded condition and fully automatic protection against low oil level is provided.

Various modes of carrying out the invention are contemplated as being within the scope of the following claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention.

I claim:

1. In a compressor, the combination comprising, a compressor block having a cylinder therein, a crankshaft journaled in said block, a piston in said cylinder and connected to said crankshaft, an intake valve for the cylinder of the compressor block, a compressed air conduit extending from said intake valve, a control valve in said compressed air conduit, a lubricating pump actuated by said crankshaft, a speed-responsive valve in said crankshaft for unloading said pump when said crankshaft is rotating below a predetermined speed, means including a spring-biased lever engageable with said control valve and shiftable by said pump to permit said control valve to shift and bleed said compressed air conduit and thereby close said intake valve and cause the compressor to load, said lever being spring-biased to shift said control valve to a conduit pressurizing position, an air receiver in communication with said control valve and operative to pressurize said conduit when said lever shifts said valve, a three-way valve in said conduit, and an unloader valve in communication with said receiver and with said three-way valve, said three-way valve either acting to connect said receiver and intake valve when said control valve moves to said conduit pressurizing position or acting to connect said intake valve to said unloader valve when said control valve is moved to a conduit bleeding position.

2. In a compressor of the type having a compression cylinder, a rotatable crankshaft, a piston in said cyl-

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inder and connected to said crankshaft, an intake valve for said cylinder, a compressed air conduit extending from said intake valve for retaining said intake valve in an open position in which said compressor is unloaded by compressed air from said conduit, a three-way plunger control valve in said compressed air conduit, a lubricating pump actuated by said crankshaft, a speed-responsive valve in said crankshaft and in communication with said pump for causing said pump to discharge to atmosphere when said crankshaft is rotating below a predetermined speed, means including a lever engageable with said control valve and shiftable by said pump to permit said control valve to shift to a conduit bleeding position and permit said intake valve to close and thereby the compressor to load, said lever being spring-biased to shift said control valve to a conduit pressurizing position, an air receiver in communication with said control valve

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and operative to pressurize said conduit when said spring-biased lever shifts said valve, a three-way shuttle valve in said conduit, and an unloader valve in communication with said receiver and with said shuttle valve, said shuttle valve connecting said receiver to said intake valve either via said control valve when the latter is moved by said lever to said conduit pressurizing position or via said unloader valve when said control valve shifts to said bleeding position.

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