

June 6, 1944.

E. MORRISON

2,350,518

COMPRESSOR

Filed Oct. 23, 1942

2 Sheets-Sheet 1

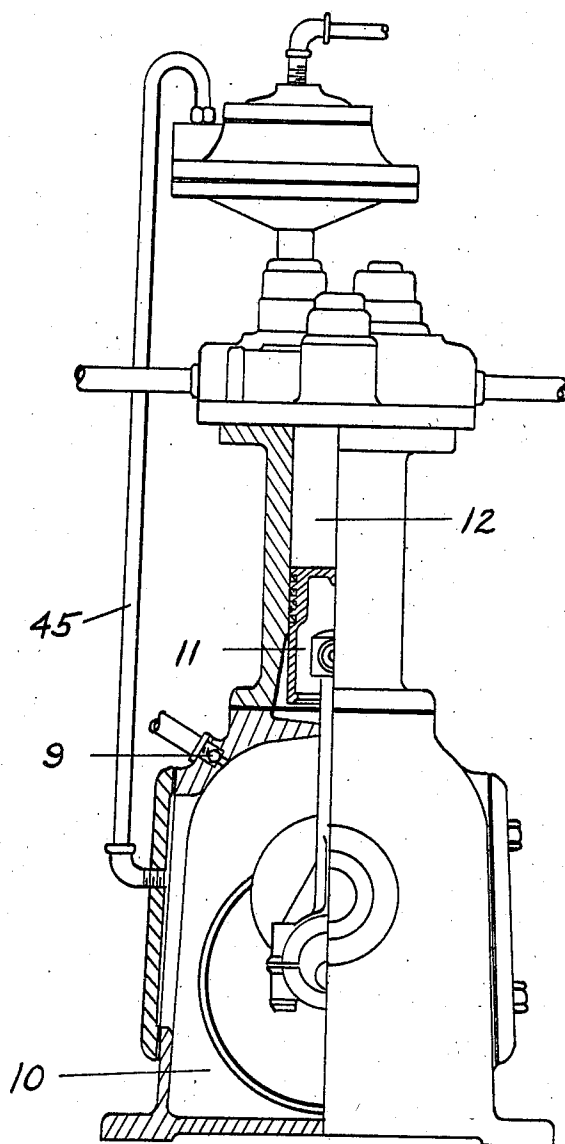


Fig. 1

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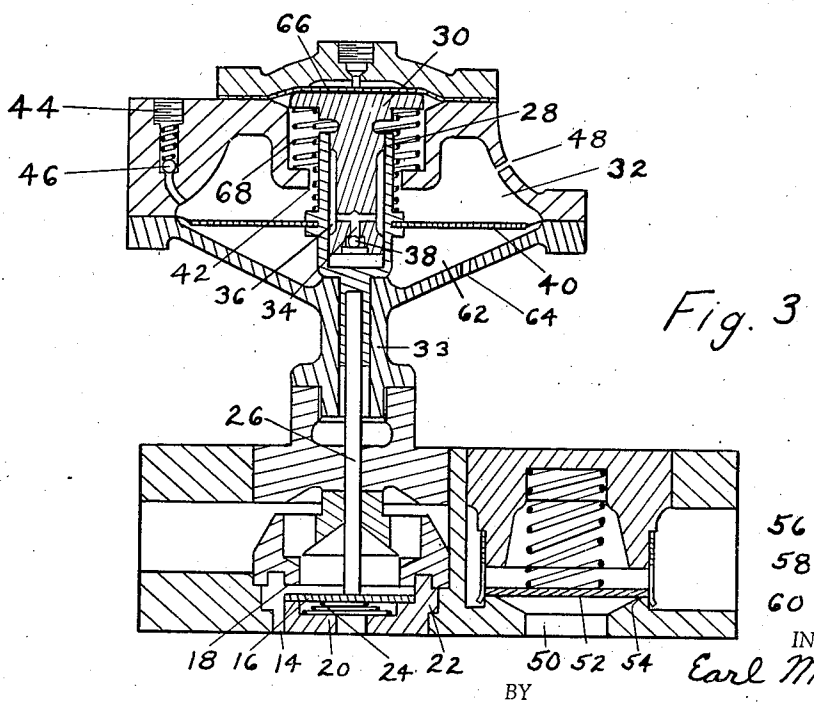
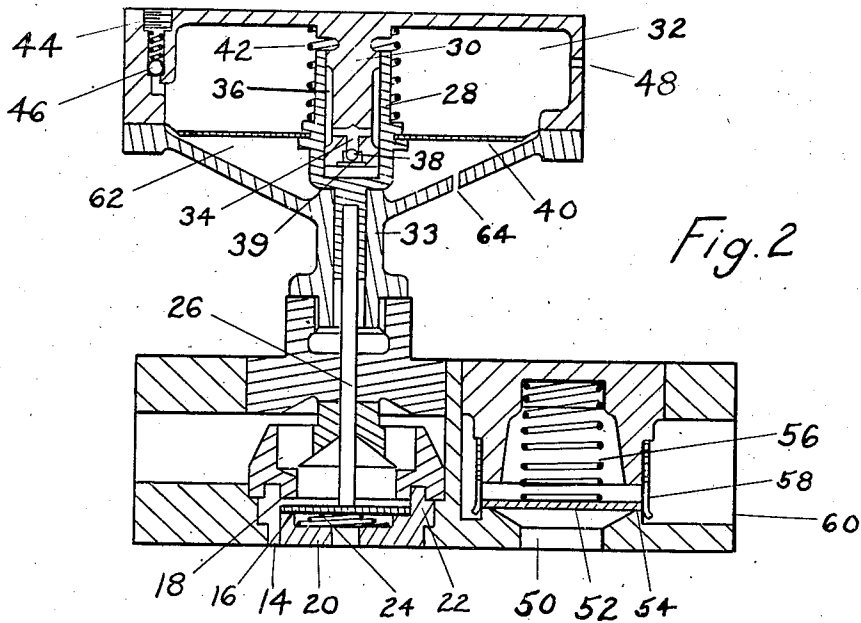
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2,350,518

COMPRESSOR

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Application October 23, 1942, Serial No. 463,299

10 Claims. (Cl. 230—24)

This invention relates to improvements in compressors. More particularly this invention relates to improvements in unloaders for compressors.

It is an object of the present invention to provide an improved unloader for compressors.

Ordinarily compressors are connected to and associated with a source of power, such as an electric motor or an internal combustion engine. This source of power is used to start and run the compressor.

In many cases, the source of power is so related to the compressor that the two start and stop simultaneously. Such a relation is desirable because it obviates the necessity of having a clutch to connect the compressor and the source of power. However, such a relation impresses the full starting torque of the source of power on the compressor, and this torque sometimes may be injurious. Particularly is this true, where the piston of the compressor starts compressing the gas or air in the cylinder. In such cases the sudden impressing of the starting torque of the source of power onto the compressor may cause a break-down of the crank-shaft or other parts of the compressor. The danger of break-downs from this cause can be minimized greatly by providing means to unload the compressor for starting. Where this is done, the piston moves freely in the cylinder until the compressor and the source of power reach operating speed. The compressor can then be loaded safely without danger of break-downs. It is, therefore, an object of the present invention to provide an unloader for compressors that unloads the compressor for starting.

An unloader is desirable for other reasons as well. Where a compressor that is not equipped with an unloader is started, the source of power must exert a force that is large enough to compress the gas or air in the cylinder of the compressor and to overcome the inertia and the friction of the source of power and the compressor. This force is often considerably larger than that required to keep the compressor and source of power running after it has been started. As a result, the source of power must be larger than the running needs of the compressor require. The provision of an unloader permits the compressor to start without any compression of the gas or air until the compressor is running at normal speed. Where a compressor is equipped with an unloader, the source of power need only, in starting, overcome the inertia and friction of the source of power and the compressor. After the

compressor has gotten up to speed, the unloader gradually permits it to compress the gas or air. In this way an unloader permits the use of a source of power that is designed to approximate the running needs of the compressor. Such a source of power is considerably smaller and less expensive than the one required where the compressor does not have an unloader.

Unloaders are further desirable because they not only permit the use of a smaller source of power, they reduce the wear experienced in starting the compressor. When a compressor starts, it has an insufficient supply of lubrication on the rubbing surfaces. If the load is heavy the wear is much greater than it is when the load is light. As a result, a loaded compressor is subject to more wear than an unloaded compressor.

Various attempts have been made to unload compressors, and some of these attempts have been fairly satisfactory. The unloader provided by the present invention is more advantageous and desirable than any of the unloaders heretofore used. It is simple, compact and certain of operation. This unloader is arranged to hold the intake valve of the compressor off of its seat until the compressor gets up to speed. Such an arrangement obviates the provision of an additional opening in the cylinder and utilizes the large valve opening that is not likely to clog up.

It is, therefore, an object of the present invention to provide an improved unloader for compressors that actuates the inlet valve of the compressor to unload the compressor.

Unloaders for compressors sometimes are mechanically actuated by centrifugally operated devices. While these devices can operate satisfactorily, they must have rubbing surfaces. Such surfaces are subject to wear and such wear may be injurious and may absorb power. The present invention obviates any such wear by providing a pressure responsive means that is actuable to unload the compressor. It is, therefore, an object of the present invention to provide a pressure responsive means that is actuable to unload the compressor.

A compressor preferably operates between given limits and many compressor systems are provided with mechanisms that determine the pressure range of the system. Many of these mechanisms are complicated and are expensive. The means commonly used is a pressure actuated electrical switch that acts to stop the actuation of the compressor. Such a means requires the use of additional equipment and the use of additional labor in assembling the system. The ad-

ditional equipment and the additional steps in the assembly, increase the cost of the system and are therefore objectionable. The invention obviates this objection by providing an unloader that acts upon the inlet valve of the compressor to unload the compressor whenever the pressure reaches a predetermined value. Such an unloader requires very little additional equipment or steps in assembling the system. It is an object of the present invention to provide an unloader that acts upon the inlet valve of a compressor to unload the compressor whenever the pressure in the compression system reaches a predetermined level.

Other objects and advantages of the invention will become apparent to those skilled in the art from an examination of the drawings and accompanying description.

In the drawings and accompanying description, two preferred embodiments of the invention are shown and described, but it is to be understood that the drawings and accompanying description do not limit the invention and the invention will be defined by the appended claims.

In the drawings,

Fig. 1 is a partial cross-sectional, front elevational view of a compressor in which the invention has been incorporated.

Fig. 2 is a cross-sectional view of a portion of one form of unloader provided by the invention, and

Fig. 3 is a cross-sectional view of another form of unloader provided by the invention.

Referring to the drawings in detail, a single cylinder compressor of the usual type is shown having a crank-case 10, piston 11, and cylinder 12. The application of the invention to a single cylinder compressor is illustrated for reasons of simplicity and clarity, but this invention is applicable to multi-cylinder compressors as well. The crank-case 10 is provided with a ball check valve 9 that communicates with the atmosphere external to the crank-case 10. Where desired, this valve 9 can be made to communicate with the intake of the compressor. Such an arrangement would provide a quieter operation for the compressor. The ball check valve 9 permits air to flow out of the crankcase 10 but prevents the flow of air into the crank-case.

Positioned at the top of the cylinder is the structure, in which the unloader provided by the invention is incorporated. Two different unloader structures have been shown, and that shown in Fig. 2 consists of the valve opening 14 that is closable by the valve 16 when it engages valve seat 18. When the valve 16 is in the position shown in Fig. 2, it is not in engagement with seat 18, and air or gas may flow into or out of the cylinder 12 through the valve opening 14. The valve 16 used in this embodiment of the invention is a flat circular disc, that is confined by a cup-like retainer member 20 which is incorporated in the valve structure. The retainer member 20 has a number of projections 22 spaced around its outer periphery that support the member. These projections are circumferentially spaced to permit the ready flow of gas past the periphery of the valve 16 whenever the valve is not engaging its seat 18. The retainer 20 has an opening, in the center thereof beneath the valve 16, to permit unhampered movement of that valve. This opening prevents the creation of a reduced pressure between the valve 16 and the retainer 20 that might hamper free action of valve 16. This

particular valve retainer has been found to be very serviceable, but any suitable valve and retainer may be used.

A spring 24 is positioned beneath the valve 16 and tends to force the valve into engagement with the seat 18. Positioned above the valve 16 is a rod 26 that is secured to and movable with a cylinder 28. The cylinder 28 slidably engages a piston 30 that is a downwardly extending projection on the inside of the top of the vacuum chamber 32 and also slidably engages the sleeve-like portion 33. The end of the piston 30 has a passage 34 through it. The passageway 34 connects the space between the end of the piston 30 and the end of cylinder 28, with a space 36 between the wall of the cylinder 28 and the recessed face of the piston 30. This passageway has a ball 38 that assists in controlling the flow of liquid through the passageway. The ball is held in position by the retainer 39. The cylinder 28 is secured to and movable with a pressure-responsive diaphragm 40 that forms the bottom of vacuum chamber 32 and forms the top of atmospheric chamber 62. A spring 42 acts on and biases the cylinder 28 and the diaphragm 40 downwardly. An opening 44 is provided in the wall of the vacuum chamber that is connected by tube 45 with the crank-case 10 of the compressor. Positioned in this opening 44 is a ball check 46 that permits air to flow out of the chamber 32 but prevents the flow of air into the chamber 32. The chamber 32 is also provided with another opening. This opening communicates with the atmosphere external to the vacuum chamber and is denoted by the numeral 48.

The outlet valve opening of the cylinder is denoted by the numeral 50. Positioned above the valve opening 50 is the valve 52 that engages valve seat 54 under the biasing action of spring 56. A retainer member 58 is provided that engages and guides the valve 52. This retainer has large recesses in one end thereof that permit the compressed air or gas to flow therethrough and out of the exhaust port 60 when the valve 52 is off its seat. The chamber 62 below the pressure responsive diaphragm communicates with the atmosphere through the opening 64.

The operation of this unloader is as follows: This biasing action of the spring 42 will force cylinder 28 and rod 26 down whenever the compressor is not running. The spring 42 is stronger than spring 24 and will maintain valve 16 off of its seat. When the compressor is idle therefore, the inlet valve 16 will be held off its seat 18. When the compressor starts, the piston 11 will move down in cylinder 12. This movement simultaneously draws air or gas into the cylinder 12 and forces air out of the crank-case 10 through the ball check valve 9. When the piston 11 moves up, it will force the air or gas in the cylinder 12 to go back out through the inlet valve 14; and it will create a reduced pressure in the crank-case 10, because part of the air originally occupying the crank-case was forced out through ball-check valve 9. The atmosphere in the crank-case 10 communicates with the atmosphere in the vacuum chamber 32 through conduit 45. As the crank shaft continues to rotate, the piston 11 will move up and down and maintain a reduced pressure in the crank-case and therefore in the vacuum chamber 32.

This reduced pressure will cooperate with the atmospheric pressure in chamber 62 to exert a force on pressure-responsive diaphragm 40 that will overcome the biasing action of spring 42.

When this occurs the pressure-responsive diaphragm 40 will move up and pull cylinder 28 and rod 26 up and out of contact with the inlet valve 16. The valve 16 will then be free to move under the influence of the spring 24 and the reduced pressure created by the movement of the piston 11. When the piston 11 moves down, the valve 16 will be pulled into open position against the biasing action of spring 24 and air or gas will flow through the valve opening 14. When the piston 11 moves up, the valve 16 will close under the action of spring 24 and will force the contents of the cylinder to flow through the exhaust opening 50, past valve 52 and out exhaust port 60.

As long as the compressor is operating, a reduced pressure will be maintained in the vacuum chamber 32 and the valve will open and close alternately. When the compressor is stopped, air will flow through the small opening 48 in the wall of the vacuum chamber and will permit the pressure to rise to the atmospheric level. When this occurs, the pressure on each side of the diaphragm 40 will be the same and the spring 42 will move the rod 26 against valve 16 until the valve is held off of its seat. The opening 48 is made quite small so a partial pressure can be maintained in the chamber 32 whenever the compressor is operating.

The rate at which the pressure-responsive diaphragm 40 moves under the force exerted by the spring 42 is determined by the piston 30 and cylinder 28 which act as a dashpot. A portion of the cylinder 28 is filled with oil of a suitable viscosity; and whenever the cylinder 28 moves downward, this oil must flow between the periphery of the piston 30 and the inner periphery of cylinder 28. The oil is selected to suit the average temperature of the place where the compressor is used and to provide the desired rate of movement of the piston 30. When the cylinder 28 moves to unload the compressor, it can move quickly because the oil can move past the ball check valve 38. This provides a quick unloading of the compressor, and provides a gradual loading of the compressor. This is a highly desirable arrangement.

A slightly different form of unloader is shown in Fig. 3. This unloader will not only unload the compressor when it is idle, it will unload the compressor whenever the pressure in the system rises to a predetermined level. This form of unloader differs from the form shown in Fig. 2 only in the construction of the vacuum chamber, and the rest of the elements are the same and perform the same function. The piston 30 in Fig. 2 is stationary, while the piston 30 in Fig. 3 is secured to and movable with a pressure-responsive diaphragm 66. This diaphragm 66 is biased upwardly by the action of spring 68. A chamber is formed above the diaphragm 66 that may be placed in communication with the pressure in the system by a pressure unloader of the usual kind, whenever the pressure in the system rises above a predetermined level. This pressure forces the piston 30 and cylinder 28 and rod 26 down until the rod holds valve 16 off its seat. Where this is the case, the compressor is unloaded, because any air or gas that is drawn into the cylinder through the inlet valve opening will be expelled through the same opening.

The operation of this second form of unloader is quite similar to the operation of the first form. When the compressor is at rest the spring 42 will force the cylinder 28 and the rod 26 down until the force exerted by spring 24 is over-

come, and the valve 16 is held off of its seat 18. When the compressor starts, a reduced pressure will be created in the crankcase 10 and, therefore, in the vacuum chamber 32. This reduced pressure in the vacuum chamber 32 will cooperate with the atmospheric pressure in chamber 62 to move the pressure responsive diaphragm 40 upward. The upward movement of the diaphragm causes an upward movement of the cylinder 28 and rod 26 that moves the rod 26 out of engagement with valve 16. The valve 16 will then be free to open and close under the influence of spring 24 and the reduced pressure created by piston 11. As long as the compressor operates, and the pressure in the system remains below a predetermined level, the valve 16 will be permitted to open and close alternately. If, however, the pressure in the system rises above a predetermined level, a pressure unloader of the usual type, not shown, will operate to permit part of the compressed air or gas in the system to enter the chamber above the pressure-responsive diaphragm 70. This compressed air or gas will exert a force on the diaphragm 70 that is strong enough to overcome the biasing action of spring 68 and spring 24, and will force rod 26 down until the valve 16 is held off its seat. Any air or gas that is drawn into the cylinder through inlet port 23 will then be exhausted through the same port until the pressure in the system falls below the predetermined level.

This form of the invention not only protects the compressor and the source of power from excessive loads on starting, but it helps maintain a predetermined range of pressure in the compressor system. By use of this invention an unloader may be provided that cooperates with and acts upon the inlet valve of the compressor and unloads the compressor when it stops, and unloads the compressor whenever the pressure rises above a predetermined level.

Whereas the drawings and accompanying description have shown and described two preferred forms of the invention, it is obvious to those skilled in the art that various changes may be made in the form of the invention without affecting the scope of the invention.

What I claim is:

1. An unloader for compressors comprising an inlet valve, a valve actuator that is spring biased to engage the valve and hold it open, a pressure responsive diaphragm secured to and movable with said valve actuator, said diaphragm being positioned in a chamber and having one side thereof communicating with the atmosphere external of said chamber and having the other side thereof in communication with the crank-case of said compressor, said crank case being provided with valve means operable to cause a reduced pressure in said crank-case upon operation of said compressor, and a second pressure responsive diaphragm positioned in a second chamber, said second chamber having a portion thereof in communication with the high side of the compression system and a valve openable to permit pressure to be exerted in said chamber that will overcome the force exerted on said first diaphragm and cause the valve to be held off of its seat.

2. An unloader for compressors that is operable to control the actuation of the inlet valve of said compressor and comprises a valve actuating device resiliently biased to move said valve off of its seat and thereby unload said

compressor, a pressure responsive diaphragm associated and movable with said device and a second pressure responsive diaphragm associated and movable with said device, said first pressure responsive diaphragm being positioned in a chamber and having atmospheric pressure on both sides thereof when the compressor is idle and having atmospheric pressure on one side and reduced pressure on the other side whenever said compressor is operating, said second pressure responsive diaphragm being positioned in a chamber that is connected to the high pressure side of said compressor by a normally closed conduit that is openable when the pressure in the compression system rises to a predetermined level, said first pressure responsive diaphragm being arranged to bias said device for movement to loading position, and said second pressure responsive diaphragm being arranged to move said device to unloading position whenever the pressure in said system rises to a predetermined level.

3. An unloader for compressors comprising an inlet valve for a compressor, a valve actuating device that is spring biased to engage said valve and hold it open, a pressure responsive means that is associated and movable with said actuating device and is adapted to overcome the bias of said spring and permit said valve to close, hydraulic means associated with said actuating device that retards movement of said device toward said valve, and a second pressure responsive means that is actuable to cooperate with said spring to overcome the force exerted on said actuating device by said first pressure responsive means and thereby hold said valve open, means associated with the crankcase of said compressor that maintains a reduced pressure in said crankcase whenever said compressor is operating, and means responsive to predetermined pressures in the compression system, of which said compressor is a part, that is adapted to actuate said second pressure responsive means, said first pressure responsive means having one surface thereof in communication with the atmosphere external of said unloader and having the other surface thereof in communication with the crankcase of said compressor, said unloader being arranged to hold said inlet valve open until said compressor is started, to thereafter slowly permit said valve to close, and to again hold said valve open if the compressor stops or the pressure exceeds a predetermined value.

4. An unloader for compressors comprising an inlet valve for a compressor, a valve actuating device that is spring biased to engage said valve and hold it open, pressure responsive means actuable to overcome the bias of said spring and move said valve actuating device out of engagement with said valve and thereby permit said valve to close, means associated with said compressor that is adapted to cause actuation of said pressure responsive means whenever said compressor is operating, hydraulic means associated with said valve actuating device that is adapted to retard movement of said valve actuating device toward said valve, and a second pressure responsive means that is adapted to cooperate with said spring to overcome the force exerted by the first pressure responsive means and to move said valve actuating device until it engages said valve and holds it open whenever the pressure in the compression system rises to a predetermined level.

5. An unloader for compressors that is operable to control the actuation of the inlet valve of a compressor, and comprises a valve actuating device that is spring-biased to engage said valve and hold it off its seat, a pressure responsive diaphragm associated and movable with said device, said diaphragm having one surface thereof in communication with the atmosphere external of said compressor and having its other surface in communication with the crankcase of said compressor, hydraulic means associated with said valve actuating device that retards movement of said device toward said valve, said unloader being arranged so said diaphragm has atmospheric pressure on both sides thereof when the compressor is idle and has atmospheric pressure on one side thereof and reduced pressure on the other side thereof whenever said compressor is operating, said atmospheric pressure and said reduced pressure providing a force on said valve actuating device that overcomes the bias of said spring and moves said device until said valve is free to seat itself.

6. An unloader for compressors that is operable to control the actuation of the inlet valve of a compressor and comprises a valve actuating device that is spring-biased to engage said valve and hold it off its seat, a pressure responsive diaphragm associated and movable with said device, a chamber for said diaphragm, a relatively small opening maintaining said chamber in communication with the atmosphere external of said compressor, a second opening and a conduit that maintain said chamber in communication with the crankcase of said compressor, said compressor being arranged so the pressure in said crankcase is sub-atmospheric whenever said compressor is operating, said small and said second openings and said conduit cooperating to maintain atmospheric pressure in said crankcase whenever said compressor is idle, a piston and cylinder that are filled with hydraulic fluid, said piston and said cylinder being formed and dimensioned so said fluid must move slowly past the piston whenever said piston moves into said cylinder, said piston and cylinder being associated with said valve actuating device so said piston moves into said cylinder whenever said valve actuating device is moved toward said valve whereby said piston and cylinder are arranged to retard movement of said valve actuating device toward said valve.

7. An unloader for compressors comprising a relatively light disc that constitutes the inlet valve of a compressor, a valve actuating device that is movable into and out of engagement with said valve, spring means biasing said device for movement into engagement with said valve to hold said valve off of its seat and prevent loading of said compressor, a chamber, a pressure responsive diaphragm positioned in said chamber, said pressure responsive diaphragm being associated and movable with said valve actuating device, a relatively small opening in said chamber that places said chamber in communication with the atmosphere external of said compressor, a second opening in said chamber that places said chamber in communication with the crankcase of said compressor through the medium of a conduit, said crankcase having valve means associated therewith that permits air to flow out of said crankcase but prevents entry of air into said crankcase and thereby maintains sub-atmospheric pressures in said crankcase whenever

said compressor is operating, said unloader being arranged so the spring moves said valve actuating device to hold said valve off of its seat whenever the compressor is idle and so the pressure responsive means is adapted to overcome the bias of the spring and move said device to permit said valve to seat whenever the compressor is operating.

8. An unloader for compressors comprising a relatively light disc that constitutes the inlet valve of a compressor, a valve actuating device that is movable into and out of engagement with said valve, spring means biasing said device for movement into engagement with said valve to hold said valve off of its seat and prevent loading of said compressor, a chamber, a pressure responsive diaphragm positioned in said chamber, said pressure responsive diaphragm being associated and movable with said valve actuating device, a relatively small opening in said chamber that places said chamber in communication with the atmosphere external of said compressor, a second opening in said chamber that places said chamber in communication with the crankcase of said compressor through the medium of a conduit, said crankcase having valve means associated therewith that permits air to flow out of said crankcase but prevents entry of air into said crankcase and thereby maintains sub-atmospheric pressures in said crankcase whenever said compressor is operating, a piston and cylinder that are filled with hydraulic fluid and are associated with said valve actuating device, said piston having a check valve therein that prevents quick movement of said fluid past said piston whenever said piston moves into said cylinder and thereby prevent quick movement of said valve actuating device away from said valve but permits quick movement of said fluid past said piston when said piston moves out of said cylinder and thereby permits quick movement of said device toward said valve, said unloader being arranged so the spring moves said valve actuating device to hold said valve off of its seat whenever the compressor is idle and so the pressure responsive means is adapted to overcome the bias of the spring and move said device to permit said valve to seat whenever the compressor is operating and being arranged to unload the compressor quickly but to load the compressor slowly.

9. An unloader for compressors that is operable to control the actuation of the inlet valve

of a compressor, and comprises a valve actuating device that is spring-biased to engage said valve and hold it off its seat, a pressure responsive diaphragm associated and movable with said device, said diaphragm having one surface thereof in communication with the atmosphere external of said compressor and having its other surface in communication with a reduced pressure area of said compressor during operation, hydraulic means associated with said valve actuating device that retards movement of said device toward said valve, said unloader being arranged so said diaphragm has atmospheric pressure on both sides thereof when the compressor is idle and has atmospheric pressure on one side thereof and reduced pressure on the other side thereof whenever said compressor is operating, said atmospheric pressure and said reduced pressure providing a force on said valve actuating device that overcomes the bias of said spring and moves said device until said valve is free to seat itself.

10. An unloader for compressors comprising an inlet valve for a compressor, a valve actuating device that is spring biased to engage said valve and hold it open, a pressure responsive means that is associated and movable with said actuating device and is adapted to overcome the bias of said spring and permit said valve to close, hydraulic means associated with said actuating device that retards movement of said device toward said valve, and a second pressure responsive means that is actuable to cooperate with said spring to overcome the force exerted on said actuating device by said first pressure responsive means and thereby hold said valve open, means associated with said compressor to maintain a reduced pressure area whenever said compressor is operating, and means responsive to predetermined pressures in the compression system, of which said compressor is a part, that is adapted to actuate said second pressure responsive means, said first pressure responsive means having one surface thereof in communication with the atmosphere external of said unloader and having the other surface thereof in communication with said reduced pressure area said unloader being arranged to hold said inlet valve open until said compressor is started, to thereafter slowly permit said valve to close, and to again hold said valve open if the compressor stop or the pressure exceeds a predetermined value.

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