March 3, 1942. B. W. MANTLE 2,275,303

AUTOMATIC UNLOADER FOR COMPRESSORS

Filed March 20, 1940

Fig. 1.

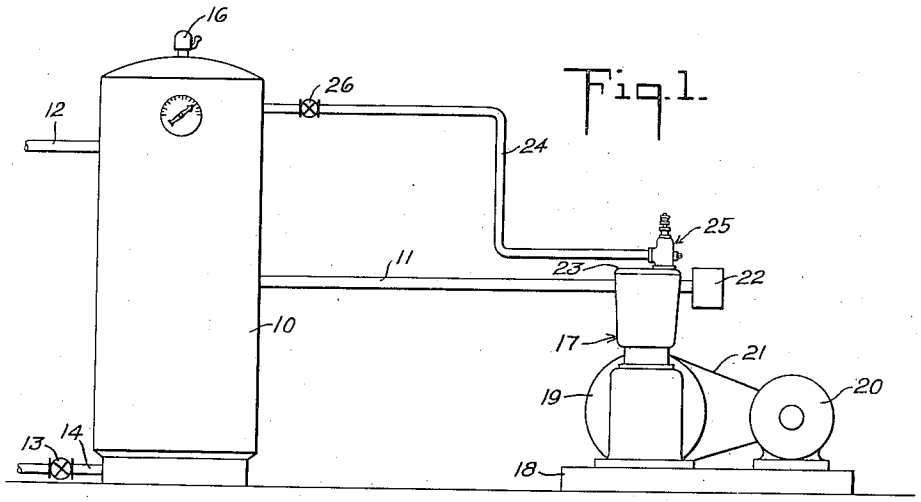
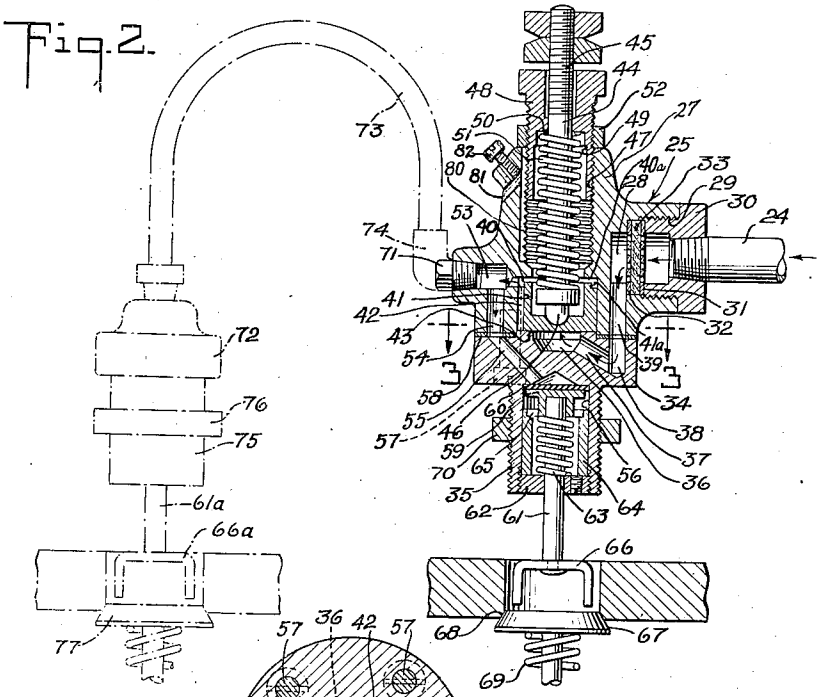


Fig. 2.



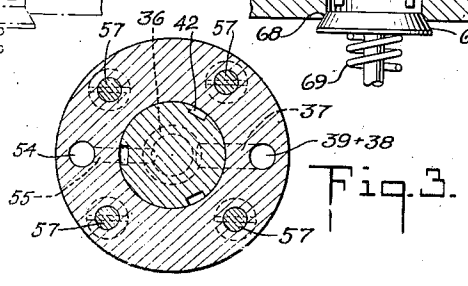


Fig. 3.

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AUTOMATIC UNLOADER FOR COMPRESSORS

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Application March 20, 1940, Serial No. 324,902

5 Claims. (Cl. 230—31)

This invention relates to improvements in automatic unloaders for compressors, and has for an object the provision of a settable pressure controlled unloading device which will automatically unload the compressor when the discharge pressure rises to a predetermined value and will reload the compressor when this value is reduced to a second predetermined lower value. The device includes a movable member which is adapted to unseat the inlet valve or valves of the compressor and thereby unload the compressor.

A further object of the invention is the provision of a settable pressure controlled unloading device including plunger means and a member connected to said plunger means and adapted to engage and unseat the inlet valve of a compressor. The device is mounted on the compressor and said means is positioned in line with the inlet valve. Further, the device may be adjusted so that the plunger may only effect a predetermined movement of the valve in unseating it.

Still another object of the invention is the provision of an unloading device of the character described, having a tapped connection to the cylinder of the plunger, whereby the pressure to which the plunger is subjected, when the unloader functions may be also applied to a piston device associated with the other inlet valve, in cases where a two cylinder compressor is employed. The piston device consists of a valve unseater connected to a piston. The piston operates in a cylinder which receives pressure from the unloader device each time the latter controls. A typical example of a piston device is shown and described in Figures 4 and 5 of my co-pending application Serial Number 297,215, filed September 30, 1939.

Referring to the drawing:

Figure 1 is an elevation of an air system including a tank, a motor, and a compressor equipped with my new and improved automatic unloader;

Figure 2 is a cross-sectional elevation of the device and a portion of the cylinder of the compressor on which the unloader is mounted, and also showing an arrangement for controlling the second inlet valve in case a two cylinder compressor is employed; and

Figure 3 is a sectional view taken along the line 3—3 of Figure 2.

Referring to Figure 1, the air compressor outfit includes an air storage tank 10 having a discharge pipe 11 from the compressor connected thereto, a feed pipe 12 for leading the air to the point or points of use. The tank 10 also has a blow-off valve 13 connected to the bottom of the tank through a nipple 14, a pressure gage 15 and a safety valve 16.

The compressor, generally designated by the numeral 17 is mounted on a base 18 and carries a flywheel 19 which is driven by a motor 20, also mounted on the base through the medium of a belt 21. The discharge port of the compressor is connected to the pipe 11 and the inlet port is provided with a suitable strainer or air filter 22. The cylinder head 23 has mounted thereon an automatic unloader generally designated by the numeral 25 and details of which will be described in connection with Figures 2 and 3. A pipe 24 is connected between the unloader 25 and the tank 10 and includes a valve 26 for shutting off air pressure between the tank and the unloader.

The unloader, generally designated by the numeral 25 and shown in detail in Figures 2 and 3, includes a body portion 27. A chamber 28 is formed in the body. A threaded hole 29 communicates with the chamber 28 and is fitted with a threaded bushing 30 carrying a strainer formed of perforated disks 31 and 32 with suitable permeable material 33 therebetween. A pipe such as the pipe 24 is connected to the bushing 30 for leading air under pressure into the body of the valve. The valve body 27 has an extension comprised of a disk-like portion 34 and a threaded shank 35. A chamber 36 is formed in the portion 34 and has a slanting passage 37 leading therefrom and communicating with the vertical passage 38. The vertical passage 38 communicates with a vertical passage 39 in the valve body which in turn communicates with the chamber 28. The body 27 also has a chamber 40 formed therein and a piston 41 forms a working fit in the chamber 40 and is provided with one or more vertical grooves 42, the purpose of which will presently be described.

The piston 41 is normally seated on the surface 43 about the chamber 36. A rod 44 having threads 45 formed in its upper portion carries on its lower end an engaging member 46. The engaging member is provided with a hemispherical end which engages a hemispherical depression in the head of the piston 41, thereby providing a minimum frictional engagement of the piston by the member 46, and minimizing any tendency of the piston to "cock" sidewise. A threaded hole 47 extends downwardly into the body 27 and communicates with the piston chamber 40. A threaded bushing 48 is threaded into the hole 47 and forms a bearing for the rod 44. The bushing 48 has a counterbored portion 49 which terminates in the surface 50. A spring 51 is positioned on the rod 44 between the engaging end 46 and the surface 50 and the tension of this spring is varied by screwing the bushing 48 in or out, until a desired setting is obtained, after which the bushing may be fixed by means of the lock nut 52.

The body 27 has a smaller chamber 53 formed therein and communicating with the upper por-

tion of the chamber 40. The skirt of the piston 41 is undercut as shown at 41a so that when the piston is all the way up in the chamber 40, an annular space defined by the cutaway portion 41a is in communication with the chamber 53. The one or more vertical grooves formed in the piston would at that time communicate with the annular portion (as these vertical grooves run out into the undercut portion 41a).

A vertical passage 54 formed in the body 27 also communicates with the chamber 53, and an angular passage 55 communicates with the passage 54 and with the upper portion of a chamber 56 formed in the threaded shank 35.

The bossed portion 34 is secured to the body 27 by means of screws 57 with a suitable sealing gasket 58 therebetween.

The chamber 56 forms a cylinder for a piston 59 which is in turn provided with a suitable packing washer 60. The piston 59 is carried on the upper end of a rod 61. A retaining bushing 62 is threaded into the bottom portion of the cylinder 56 and a hole therein forms a guide bearing for the rod 61. A spring 63 has one end bearing against the bushing 62 and the other against the piston 59 and tends to urge the piston and the rod 61 upwardly. A bushing 64 in the cylinder 56 is provided for limiting the downward travel of the piston 59. The upper end of the bushing 64 is counterbored at 65. The counterbore forms a stop for the piston 59 and is of such depth that when the piston engages the bottom of the counterbore 65, the packing 60 contacts and forms a seal with the upper end of the bushing 64 and prevents air from escaping around the rod 61 when the piston has been moved downwardly.

The lower end of the rod 61 has secured thereto a yoke 66 which is provided for engaging an inlet valve such as the valve 67 and forcing it off of its seat 68 against the urge of the inlet valve spring 69.

In mounting the unloader on the head of a cylinder in the manner shown in Figure 1, a threaded hole is provided in the cylinder head in line with the inlet valve and threaded to match the threads formed on the exterior surface of shank 35. The unloader is screwed down until the proper clearance is provided between the inlet valve 67 and the yoke 66. When the piston is in its normal position, having obtained this adjustment, the lock nut 70 is screwed down against the cylinder head and the unloader is thereby locked in position thereon to retain the proper adjustment.

A threaded hole in the body 27 communicates with the chamber 53 and may be provided with a closure plug 71.

Operation

Assuming that the pressure to be maintained on the tank is from between 80 and 90 pounds, and assuming that the tension of the spring 51 is such that when 90 pounds is reached in the tank the piston 41 will raise, it will be noted that the area of the piston subjected to the tank pressure is substantially less than the entire area of the head of the piston. However, as soon as sufficient pressure has been applied to this small area (90 pounds tank pressure as assumed above) the piston raises and since the 90 pounds per square inch is applied to more square inches of area (the area of the piston which was previously covering up or in contact with the surface 43) the air pressure forces the piston up until the skirt of the piston effects a seal with the cylinder head surface 40a, and holds the piston in this relation until the air pressure reduces to the low limit as herein explained. When the piston leaves the surface 43, air passes via the one or more vertical grooves 42 to the upper portion of the chamber 40 and thence to the chamber 53 and via the passages 54 and 55. Air pressure acts against the piston 59 and moves the same downwardly until it is brought to rest within the counterbore 65 and the packing 60 effects a seal with the upper end of bushing 64. The rod 61 which is secured to the piston 59 is by this action moved downwardly the same distance the piston moves, and the yoke 66 on the lower end thereof engages the inlet valve 67 and holds it off of its seat, thereby preventing the compressor from pumping air.

As soon as the air pressure on the head of the piston 41 has reduced to a point where the spring 51 urges the piston back down on its seat 43 (above it has been assumed that this pressure is 80 pounds per square inch) the pressure on the head of the piston 59 is cut off and leaks down by passing out around the bearing in the bushing 48 for the rod 44. The spring 63 urges the piston 59 to the top of the cylinder 56 and thereby raises the yoke 66 off of the inlet valve 67, allowing it to again be seated so that the compressor can operate to pump air.

By removing the plug 71 the devices external to the unloader may be controlled by pressure in unison with the operation of the unloader. One example of such use is shown in dot-dash lines which illustrate an auxiliary piston type unloader 72 connected to the chamber 53 by means of a pipe 73 and an elbow 74. The auxiliary unloader 72 has a threaded portion 75 which is screwed into the cylinder head in the same manner as the portion 35 was for the unloader and the suitable adjustment is retained by means of the lock nut 76.

This auxiliary unloader is for controlling the second inlet valve of a two cylinder compressor, the second inlet valve being designated by the numeral 77 and the yoke 66a is carried on a rod 61a connected to the piston in the device. In such an arrangement, the tank pressure leaves the piston 41 in the manner previously described and permits pressure to pass into the chamber 53. This pressure is imparted to the piston 59 via the passages 54 and 55 as described above and is imparted to a similar piston in the auxiliary unloader 72 via the elbow 74 in the pipe 73, causing the inlet valve 67 and the inlet valve 77 to be lifted off of their seats so that neither cylinder of the compressor can pump air.

The auxiliary piston type unloader such as 72 herein, is described and shown in detail in Figure 5 of copending application Serial Number 297,215, filed September 30, 1939.

A clearance groove 80 may be formed in the threaded hole 47, and an angular hole 81 leading in from the outside air communicates with the groove 80. A tapped hole angular with respect to the hole 81 is provided with a screw 82 by means of which the hole 81 may be restricted to permit the air, within the threaded hole 47 and in the counterbore 49 in bushing 48, to escape within a definite time limit. This arrangement may be called a bleeder, and permits the device to operate with a snappy action.

A further arrangement contemplates the omission of the passage 55, the cylinder 56, the piston 59, its packing 60, the spring 63, the piston

rod 61 and the engaging yoke 66. By omitting these parts the bossed portion 34 only contains the chamber 36 and the passages 37 and 38, the latter of which communicates wtih the passage 39 and when the air pressure to which 24 is connected reaches a predetermined high pressure, the piston 41 raises and permits air to pass into the chamber 53 and thence out via pipe 73 to an auxiliary unloader 72. This permits the mounting of the device at some point remote from the cylinder head, with the result that less heat is conducted to the device and the oil in the same which passes through with the air is not carbonized.

With this modified arrangement, as many auxiliary unloaders as there are cylinders in the compressor can be connected to and controlled by the device. For example the fitting 74 can be a T shaped fitting in cases where a two cylinder compressor is employed and one unloader 72 associated with one inlet valve may be connected to one side of the T and the second auxiliary unloader 72 may be associated with the second inlet valve, and may be connected to the other side of the T, in which event the device will control the two auxiliary valves in unison by air passing into the chamber 53 and via the T and connecting pipes to the auxiliary unloaders.

Compared to diaphragm types of devices, it is believed that the device herein shown and described is simpler in construction, cheaper to manufacture, and will operate with less wear and tear on the mechanism controlled thereby.

It must be understood that it is not necessary that the auxiliary unloaders be controlled by a master or automatic valve being operated by air delivered by the same compressor. In other words, a master valve subjected to air pressure from one source may control auxiliary unloaders on other compressors feeding air to another source.

Although a simple embodiment of the invention is herein shown and described by way of example, it is obvious that many changes may be made in the arrangement shown without departing from the spirit of the invention as set forth in the annexed claims.

What is claimed is:

1. In combination with a compressor having an inlet valve, a discharge valve and means connected to said compressor to receive the discharge therefrom, an unloading device including a body mounted on the head of said compressor in alignment with said inlet valve, an engaging member reciprocably carried by said body and normally positioned adjacent to said inlet valve, said member being adapted to unseat said inlet valve and said body being adjustable on said head whereby any desired clearance between said engaging member and said inlet valve may be obtained, a cavity in said body, a cylinder bore in said body communicating with said cavity, a piston in said cylinder, means for impressing the pressure of said discharge upon said cavity, adjustable spring means urging said piston to the end of said cylinder communicating with said cavity, pressure responsive means in said body connected to said engaging member, and a passage in said body having one end communicating with said pressure responsive means and its other end terminating in said cylinder, whereby when a predetermined pressure, in accordance with the adjustment of said spring means, is impressed upon the head said piston causing said piston to move and impart said pressure upon said pressure responsive means, the unseating of said inlet valve by said engaging member is effected.

2. In a device of the character described, a body, a cylinder within said body, a cavity in said body, a wall between said cavity and said cylinder, an opening in said wall smaller in diameter than the diameter of said cylinder forming an annular seating face which the head of said piston normally contacts, a piston in said cylinder having its head seating on the surface of said wall and leaving exposed to said cavity an area defined by said opening and smaller than the entire area of said head, spring means urging said piston against said wall, said spring means being adjustable and being adapted to be set to a point where a predetermined pressure against said exposed area of the piston will cause said piston to move against the urge of said spring means, means for imposing pressure on said cavity, whereby when said predetermined pressure is reached, said piston will move and subject the entire area of its head to said pressure, thereby making it necessary that said pressure be substantially reduced before said spring means can cause said piston to re-establish contact with said wall, a passage in said body adapted to be placed into communication with said cavity when said piston is moved by said predetermined pressure in said cavity, and means communicating with said passage and controlled by pressure from said cavity.

3. The invention according to claim 2 in which the piston in said first cylinder has at least one groove extending longitudinally in the surface of its outer diameter from its head toward the extremity of its skirt to facilitate the passage of air from said cavity to said second cylinder the instant the head of said piston is moved out of contact with said wall.

4. In combination with a compressor having an inlet valve, a discharge valve and means connected to said compressor to receive the discharge therefrom, an auxiliary unloading device including a body adjustably mounted on the head of said compressor in alignment with said inlet valve, an engaging member reciprocably carried by said body and normally positioned adjacent to said inlet valve, said member being adapted to unseat said inlet valve, a cylinder bore in said body, a piston in said cylinder, said body being adapted to be adjusted on the head of said compressor for obtaining any desired clearance between said engaging member and said inlet valve, an unloader member for controlling the operation of said auxiliary unloader including a body member having a chamber formed therein, means for impressing the pressure of said discharge upon said chamber, pressure responsive valve means within said body and subjected to said pressure, settable means holding said pressure responsive valve member on its seat against said pressure, a passage in said body placed in communication with said pressure when said piston is unseated, and means for leading said pressure from said passage to said auxiliary unloader.

5. A device according to claim 2 in which said spring means is positioned within a longitudinal cavity in said body, in which a passage leads from said longitudinal cavity to the atmosphere, and in which adjustable means is provided for constricting the opening of said last passage, thereby permitting the air to escape from said longitudinal cavity at a desired rate.

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