July 1, 1930. H. B. HALVORSEN 1,769,667

COMPRESSOR UNLOADING MEANS

Filed Feb. 25, 1924 2 Sheets-Sheet 1

Fig. 1.

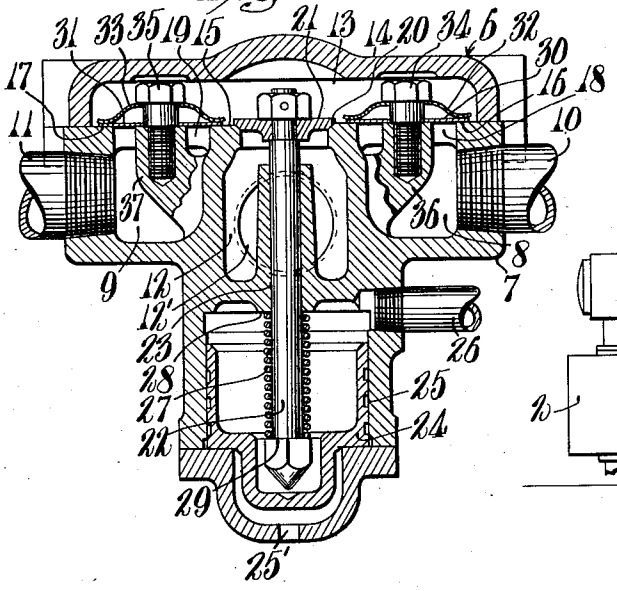


Fig. 2.

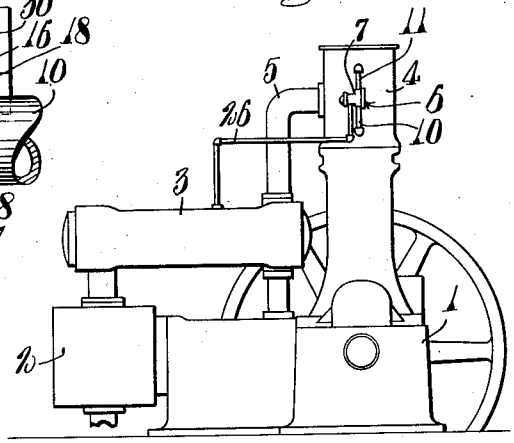


Fig. 3.

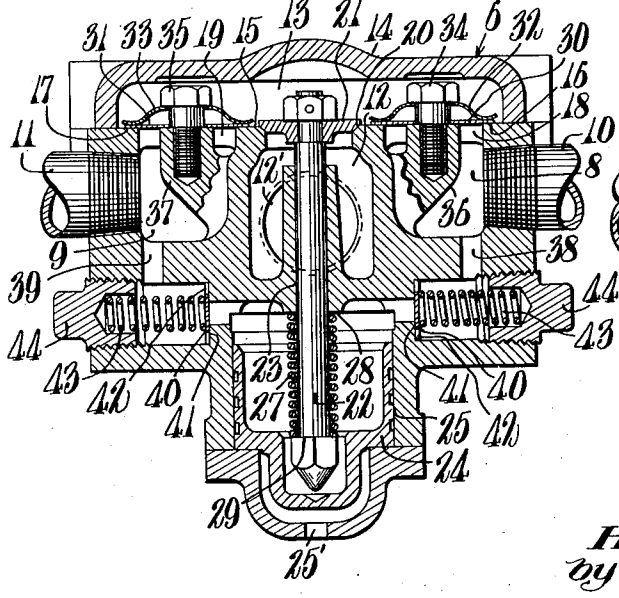
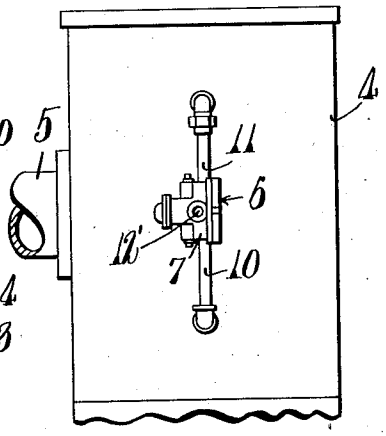


Fig. 4.



Inventor:
Halbert B. Halvorsen.
by
Drake & Co.
atty.

July 1, 1930. H. B. HALVORSEN 1,769,667

COMPRESSOR UNLOADING MEANS

Filed Feb. 25, 1924 2 Sheets-Sheet 2

Fig. 5.

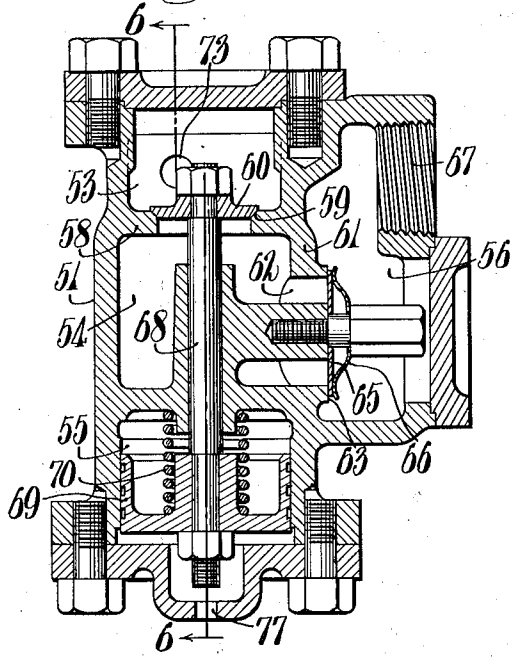


Fig. 6.

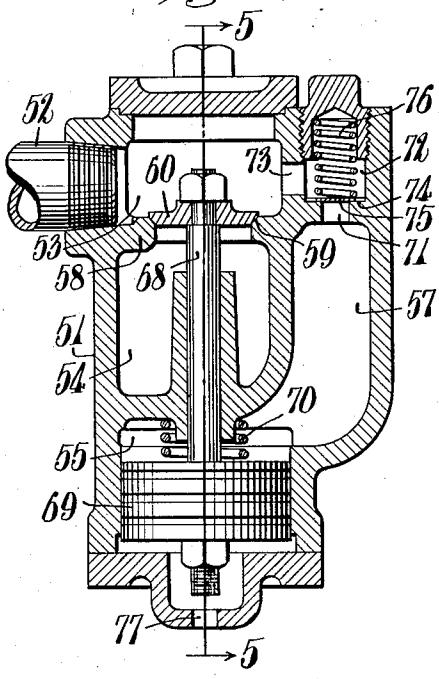


Fig. 7.

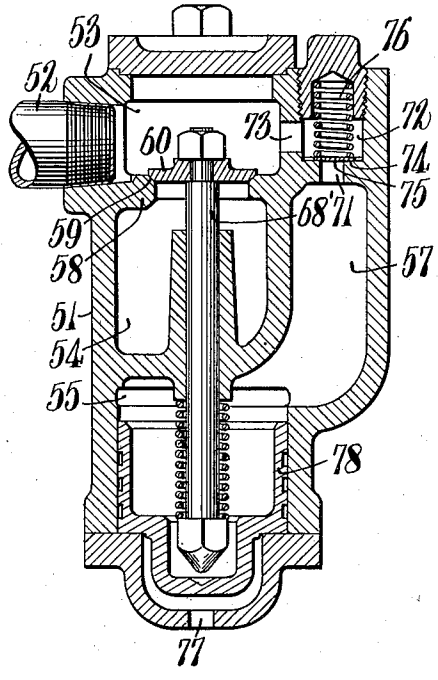
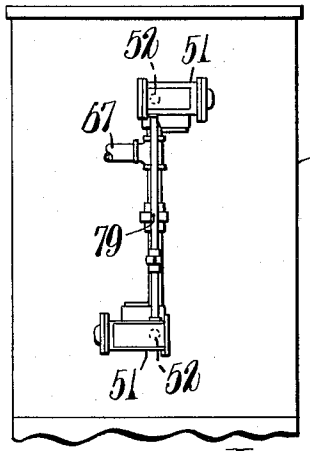


Fig. 8.



Inventor:
Halbert B. Halvorsen.
by Horace L. Locke
atty.

Patented July 1, 1930 1,769,667

UNITED STATES PATENT OFFICE

HALBERT B. HALVORSEN, OF MICHIGAN CITY, INDIANA, ASSIGNOR TO SULLIVAN MACHINERY COMPANY, A CORPORATION OF MASSACHUSETTS

COMPRESSOR-UNLOADING MEANS

Application filed February 25, 1924. Serial No. 694,927.

My invention relates to compressor unloading means.

An object of my invention is to provide an improved compressor unloading means and more especially an improved compressor unloading means of the auxiliary unloader type adapted to be used with a compressor having an intake type unloader and having for its particular function the avoidance of the compression of any air which may leak past the intake unloader valve when the compressor is turning over unloaded from a partial vacuum to receiver pressure and so the development of excessive temperatures. Other objects and advantages of my improved construction will however appear in the course of the following specification and appended claims.

In the accompanying drawings I have shown for purposes of illustration several forms which my invention may assume in practice.

In these drawings,—

Fig. 1 is a central section through one illustrative form of my invention.

Fig. 2 is a view of a compressor provided with this illustrative form of my invention.

Fig. 3 is a view of a somewhat similar modification in central section.

Fig. 4 is a fragmentary view on an enlarged scale illustrating the connection of this last mentioned modification to the high pressure cylinder of a compressor.

Fig. 5 is a central sectional view on the line 5—5 of Fig. 6 through a further modification.

Fig. 6 is a central sectional view through the mechanism of Fig. 5 taken on a plane corresponding to the section line 6—6 of Fig. 5.

Fig. 7 is a sectional view similar to that of Fig. 6 showing a further modification.

Fig. 8 is an elevational view of the high pressure cylinder of a compressor, illustrating the application of the forms of my invention shown in Figs. 5, 6 and 7 thereto.

It will be understood that in the event that there is any leakage past the intake closure valve in a compound compressor, there will be very undesirable consequences in the high pressure cylinder unless some special auxiliary means is provided therefor, for the high pressure cylinder will pump down the pressure in the intercooler to a partial vacuum notwithstanding any ordinary leakage and so, if such means is not provided, the high pressure piston will compress air from a partial vacuum up to full receiver pressure and a very high temperature will be developed due to the number of compressions that take place. For the purpose of preventing any such undesirable results, I have disclosed the several different forms referred to above, each of which constitutes means for venting the ends of the high pressure cylinder of a compound compressor when the latter is running unloaded and as soon as the pressure in the high pressure cylinder becomes a little above atmospheric pressure.

In Fig. 2 there is shown a compressor provided with one of the illustrative forms of my invention, the same being generally designated 1 and comprising a low pressure cylinder 2 discharging to an intercooler 3, with which a high pressure cylinder 4 is connected by a pipe 5. Mounted upon the high pressure cylinder 4 is an unloading mechanism generally designated 6 and including a casing 7 having chambers 8, 9 which are connected by pipes 10, 11 respectively with the counterbores or other suitable points at the lower and upper ends of the cylinder 4. Between the chambers 8 and 9 is a third chamber 12 which communicates with the atmosphere through a passage 12′, and there is arranged within the casing 7 and in a space 13 between a cover member 14 and the main body of the casing, a valve seat surface 15 which provides valve seats 16 and 17 respectively surrounding a series of ports 18 and 19 opening from the chambers 8 and 9 into chamber 13. Midway between the valve seats 16 and 17 there is arranged a seat 20 for a poppet type valve 21 which is carried upon a stem 22 guided as at 23 and adapted to be moved by a piston 24 reciprocable in a cylinder 25 arranged coaxial with the valve stem. This cylinder 25 is vented to the atmosphere by means of a

port 25′ and is connected at a point above the piston 24 with the intercooler by means of a connection 26. A spring 27 surrounds the stem 22 and acts between an abutment 28 on the casing 7 and a shoulder 29 at the lower end of the stem and the piston 24 on moving upwardly is adapted to engage the lower extremity of the stem and raise it and with it the valve 21. Arranged upon the valve seats 16 and 17 are annular valves 30 and 31 which are held seated normally by light transversely flexed springs 32, 33 while the latter are held in position by machine screws 34 and 35 threaded into bosses 36 and 37 respectively projecting into the chambers 8 and 9.

The mode of operation of this form of my invention will be already apparent, but it may be summarized as follows: Assuming that the intake closure valve with which the low pressure cylinder 2 is provided is closed so that the compressor has ceased to pump any fluid into the intercooler except such as may leak by the intake closure valve, it will be evident that the high pressure cylinder 4 will soon produce a partial vacuum in the intercooler 3 and as quickly as this happens the piston 24 will be moved upward against the pressure of the spring 27 by the atmospheric pressure acting upon its lower side with the result that the valve 21 will be unseated and the chamber 13 will be placed in free communication with the atmosphere through the passage 12′. Thereafter, as soon as there is any compression of the air which may leak past the intake closure valve to even a small degree above atmospheric pressure, the valve 30 or the valve 31 will be unseated at such time as this pressure is reached and will discharge the air to the atmosphere. As a result, it will be evident that the number of compressions which can take place is decidedly reduced and the danger of burning of the lubricant and injury to the parts by high temperatures is totally prevented.

The form of my invention shown in Figs. 3 and 4 differs from that shown in Figs. 1 and 2 only in that the changes in pressure in the high pressure cylinder proper are relied upon to effect the operation of the atmospheric vent means. The structure, with the exception of the means for effecting upward movement of the piston which controls the atmospheric vent valve, is identical with the parts previously described and accordingly it is unnecessary to restate any part of this structure. It will be observed that instead of employing the connection 26 to the intercooler there is provided a connection from each of the chambers 8 and 9 to the space above the piston 24, these connections being respectively designated 38, 39 and being controlled by simple plate valves of thin flexible material 40 cooperating with seats 41 to prevent the passage of pressure from the chambers 8 and 9 to the space above the piston 24, while permitting the pressure above this piston to be vented when the valves are unseated. These valves are provided with a central imperforate portion and a plurality of projecting guiding portions 42 which serve to center them while permitting the passage of fluid past the valves when the latter are unseated. Springs 43 are provided to maintain the valves 40 normally seated, these being held in position by plugs 44.

Now considering the mode of operation of this form of my invention it will be observed that upon the closure of the intake controlling valve the pressure in the intercooler will speedily be pumped down to less than atmospheric pressure and accordingly the movements of the high pressure piston will produce a partial vacuum at the end of the cylinder away from which the piston is moving at any given moment. When the pressure is thus reduced it is obvious that it will be correspondingly reduced in the chambers 8 and 9 and accordingly the pressure above the piston 24 will force the valves 40 off their seats and pass into the low pressure spaces at the ends of the compressor high pressure cylinder. As soon as the pressure above the piston 24 is sufficiently reduced the latter will move upwardly and engage the stem 22 with the result that the valve 21 will be unseated. Thereafter, since there will be a partial vacuum during each suction stroke, the piston will be maintained in raised position until the compressor is reloaded notwithstanding the fact that there may be pressures at the end of the compression strokes sufficiently high to momentarily unseat the valves 30 and 31. During the unloaded running of the compressor, it will be evident that any pressure which may tend to be built up within either end of the compressor cylinder will be vented to the atmosphere very soon after it attains a pressure equal to atmospheric pressure and there will therefore be no possibility of an undesirable range of compression which would result were these vent means not provided. When the compressor is reloaded there will no longer be any tendency for fluid to flow from above the piston 24 to the opposite ends of the cylinder and as the piston 24 is not a perfectly tight fit for its cylinder, the leakage through the port 25′ past the piston will speedily allow the spring 27 to force the piston downward and to close the valve 21. It is of course possible that there may be some leakage around the stem 22 also which would aid in this effect.

In Figs. 5, 6 and 8, a still further form of my improved construction is illustrated, while in Fig. 7 the structure is substantially the same as that in the figures just men-

tioned, but there is a small change which will be noted. In these species of my invention it will be observed that a relief valve is arranged at each end of the high pressure compressor cylinder, these relief valves comprising casings 51, which casings are supported by the pipes 52 which connect certain chambers within the casings with the counterbores or other similar parts of the compressor high pressure cylinder. Within the casings 51 there are arranged three alined chambers, respectively 53, 54, 55, a discharge chamber 56 and a passage or communication chamber 57. The chamber 53 which is connected by the pipe 52 with one end of the high pressure cylinder is spaced by a septum 58 from the chamber 54, this septum providing a valve seat 59 with which a valve 60 cooperates. The chamber 54 is separated by a septum 61 from the discharge chamber 56, and passages 62 opening through a valve seat 63 in the chamber 56 serve to conduct fluid from the chamber 54 into the chamber 56. Suitable spring closed annular valves 65 yieldingly held closed by transversely flexed springs 66 normally close the communication between chambers 54 and 56. Atmospheric dicharge passages 67 lead from the chambers 56. The valves 60 are connected by stems 68 with pistons 69 which are reciprocable in the chambers 55, these pistons being normally held in the position shown in Fig. 5 with the valve 60 seated upon its seat 59 by springs 70. The space within the chamber 55 above the piston communicates by way of the passage 57, a port 71, a valve chamber 72, and the port 73 with the space 53. Within the valve chamber 72 is a valve seat 74 with which a plate valve 75 of the type previously described cooperates, which valve is normally maintained seated by the spring 76 and serves to permit flow from, but not towards, the chamber 55.

From the description given it will be at once apparent how this mechanism operates, when it is observed that there is an opening 77 admitting atmospheric pressure to the lower side of the piston 69. Assume that the compressor is unloaded and that a partial vaccuum is drawn in one end of the high pressure cylinder during one stroke of the piston. This will cause the valve 75 to be unseated by the pressure in the passage 57 and chamber 55 and if the compressor continues to run unloaded, the pressure above each piston 69 will be reduced to such an extent that the pistons will move upwardly while the valves 75 will maintain the pressure less than atmospheric in the passage 57. Accordingly upon the discharge strokes, it will at once result that the pressure in the chamber should it exceed atmospheric will be free to pass the valve 60 and enter the chamber 54 whence it may pass through ports 62, valves 65 and so to the atmosphere through the opening 67. Each end of the cylinder herein provides its own unloading mechanism. The valve 65 prevents back flow of air into the cylinder.

As to the form of this mechanism shown in Fig. 7 it differs from that shown in Fig. 5 only in that instead of a piston 78 being connected directly to the stem 68′, an arrangement such as is shown in the form of Figs. 1 to 4 is provided and the piston has free movement relative to the stem. The general mode of operation is, however, identical with the form shown in Figs. 5, 6 and 7. Here also it will be observed that the movement of the piston to effect the closure of the valve 60 is accomplished by reason of leakage past the pistons or along the stems 68 or 68′.

In connection with Figs. 5, 6, 7 and 8 it may be noted the chambers 57 of the mechanisms at the opposite ends of the high pressure cylinder may be connected by a pipe connection 79 (see Fig. 8), this being done for the purpose of effecting the unloading at the opposite ends of the cylinder uniformly.

It will be understood that the relative dimensions of the valves 21 or 60 and of their respective pistons 24, 69 and 78 must be selected so that the product of the effective area of the pistons multiplied by the difference between atmospheric pressure and the sub-atmospheric pressure produced as a result of unloading of the low pressure cylinder will exceed the product of the pressures acting during loaded operation upon the valves 21 or 60 multiplied by the effective area of those valves. The present drawings are illustrative of positional relations, and changes appropriate to the conditions of operation are to be made in accordance with the foregoing principle.

In all the forms of my invention it will be observed that means is provided of very simple construction which automatically takes care of the condition which may grow out of a leaky intake closure valve and which results in a really complete unloading of the compressor and the prevention of any possible injury due to high temperatures.

While I have in this application specifically described several forms which my invention may assume in practice, it will be understood that these forms of the same are shown for purposes of illustration and that the invention may be modified and embodied in various other forms without departing from its spirit or the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent is:

1. An unloading mechanism comprising a casing provided with a chamber which has an outlet to the atmosphere, a valve opening against fluid pressure in said chamber for controlling said outlet, a member controlling

the outlet valve, means for normally maintaining said outlet valve closed, and means for subjecting said member to subatmospheric pressure to effect movement thereof to open the outlet valve including check valve controlled passages adapted for connection to the opposite ends of a cylinder.

2. In a compressor unloading mechanism comprising a casing having a chamber adapted for communication with one end of a compressor cylinder, a chamber in constant communication with the atmosphere, a chamber intermediate said first and second mentioned chambers, a check valve opening toward the second mentioned chamber controlling communication between said second and third mentioned chambers, a valve controlling communication between said first and third mentioned chambers, a fourth chamber, a piston therein operative to effect opening of said second mentioned valve, and a check valved connection between said piston containing chamber and said first mentioned chamber.

3. In an unloading mechanism comprising a casing having a chamber provided with an atmospheric vent, chambers at the opposite sides of said first mentioned chamber adapted for connection with the opposite ends of a compressor cylinder, a chamber communicable with all three of said previously mentioned chambers, check valves opening toward said last mentioned chamber controlling the communication therewith of said second mentioned chambers, a valve controlling communication between said fourth chamber and said first chamber, and means operative to open said valve.

4. In an unloading mechanism comprising a casing having a chamber provided with an atmospheric vent, chambers at the opposite sides of said first mentioned chamber adapted for connection with the opposite ends of a compressor cylinder, a chamber communicable with all three of said previously mentioned chambers, check valves opening toward said last mentioned chamber controlling the communication therewith of said second mentioned chambers, a valve controlling communication between said fourth chamber and said first chamber, and means for controlling the position of said valve including a piston constantly subjected on one side to atmospheric pressure, a spring adapted to resist movement thereof and to act on the opposite side thereof, and means intermittently subjecting said last mentioned side to pressure greater than and less than atmospheric.

5. In an unloading mechanism comprising a casing having a chamber provided with an atmospheric vent, chambers at the opposite sides of said first mentioned chamber adapted for connection with the opposite ends of a compressor cylinder, a chamber communicable with all three of said previously mentioned chambers, check valves opening toward said last mentioned chamber controlling the communication therewith of said second mentioned chambers, a valve controlling communication between said fourth chamber and said first chamber, and means for controlling the position of said valve including a piston constantly subjected on one side to atmospheric pressure, a spring adapted to oppose movement of said piston, and means for intermittently subjecting the opposite side of said piston to pressures equal to and less than atmospheric.

6. In an unloading mechanism comprising a casing having a chamber provided with an atmospheric vent, chambers at the opposite sides of said first mentioned chamber adapted for connection with the opposite ends of a compressor cylinder, a chamber communicable with all three of said previously mentioned chambers, check valves opening toward said last mentioned chamber controlling the communication therewith of said second mentioned chambers, a valve controlling communication between said fourth chamber and said first chamber, and means operative to open said valve including a fifth chamber, a piston therein subjected constantly on one side to atmospheric pressure and alternately subjected on its other side to pressures equal to and less than atmospheric and also including check valved connections between said second mentioned chambers and said fifth chamber.

7. An unloading mechanism, adapted for connection to a compressor cylinder, comprising valve means adapted to effect an unloading controlling function for a compressor, means whereby said valve is always maintained in an open position while the compressor is unloaded to permit fluid in a connected compressor to be discharged to atmosphere, and a plurality of valves for preventing back flow of fluid to the compressor while unloaded.

8. A compressor unloading mechanism comprising a casing having separate valves for preventing back flow of fluid to the opposite ends of a compressor cylinder with which said casing is adapted for connection, valve means therein for controlling discharge to the atmosphere from said ends, and vacuum responsive means therein for actuating said latter valve means.

9. A compressor unloading mechanism comprising chamber forming means adapted for communication with a compressor cylinder, means therein for controlling discharge of fluid to the atmosphere from the cylinder to which it is connected and to effect unloading thereof, said latter means including a plurality of valves opening in-

wardly of said chamber forming means, one of said plurality of valves being a check valve adapted to trap fluid pumped into said chamber forming means from said cylinder.

10. A compressor unloading mechanism comprising chamber forming means adapted for communication with a compressor cylinder and adapted to be subjected to pressure existing in the cylinder with which it has communication, means for controlling the unloading of said compressor including a plurality of valves opening inwardly of said chamber forming means, one of said plurality of valves being a check valve for interrupting return flow from said chamber forming means to said cylinder.

11. A compressor unloading mechanism comprising chamber forming means adapted for communication with a compressor cylinder and adapted to be subjected to pressure existing in the cylinder with which it has communication, means for controlling the unloading of said compressor including a plurality of valves opening inwardly of said chamber forming means, and means whereby one of said valves is adapted to be seated while the other is open.

12. A compressor unloading mechanism comprising a casing having a chamber adapted for communication through a check valve controlled passage with a compressor cylinder and through a port to the atmosphere, a valve opening against fluid pressure in said chamber for controlling said port, a member controlling said latter valve, means for normally maintaining said latter valve closed, and means for subjecting said member to sub-atmospheric pressure to effect movement thereof to open said latter valve.

13. A compressor unloading mechanism comprising a casing having a chamber adapted for communication through a check valve controlled passage with a compressor cylinder and through a port to the atmosphere, a valve opening against fluid pressure in said chamber for controlling said port, a member controlling said latter valve, means for maintaining said latter valve closed, and means for subjecting said member to sub-atmospheric pressure produced by said compressor cylinder to effect movement thereof to open said latter valve when said compressor is unloaded.

14. A compressor unloading mechanism comprising a casing having a chamber adapted for communication with both ends of a compressor cylinder, a check valve adapted to interrupt return flow to each end of said cylinder from said chamber, said chamber having a valve controlled discharge to the atmosphere, said latter valve opening against fluid pressure in said chamber, a member controlling said latter valve, means for maintaining said latter valve closed, and means for subjecting said member to sub-atmospheric pressure produced by said compressor cylinder to effect movement thereof to open said latter valve.

In testimony whereof I affix my signature.

HALBERT B. HALVORSEN.