United States Patent

Krechel

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[54] **UNLOADER VALVE ASSEMBLY**

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[52] **U.S. Cl.** **137/117,** 137/119, 137/628, 137/115, 137/505.25

[51] **Int. Cl.**.....**F16k 17/10**

[58] **Field of Search**.....137/117, 115, 116, 116.3, 116.5, 137/102, 119, 628, 505.25

[56] **References Cited**

UNITED STATES PATENTS

3,324,873	6/1967	Trombatore	137/116.3
3,358,705	12/1967	Krechel	137/628
3,446,233	5/1969	Herold	137/119
3,519,011	7/1970	Pannanen	137/102
3,604,446	9/1971	Brooks	137/119

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[57] **ABSTRACT**

An unloader valve for air compressors or the like comprising a valve body having a passage therethrough, an exhaust port through the valve body wall from an intermediate portion of the passage constituting a chamber to the exterior of the body and a main valve member and an auxiliary valve member which are axially slidable in the passage between a retracted position and an advanced position. The main valve member has an axial passage therethrough and the auxiliary valve member extends into the main valve axial passage to block the flow of air therethrough when the valve members are in their retracted positions. The main valve has a first portion axially movable within the chamber for blocking the exhaust port when the main valve member is in its advanced position and unblocking the exhaust port when it is in its retracted position and a second portion engageable with the outlet end of the valve body passage for closing the latter when the main valve is in its retracted position. A transfer port is provided for communication between the main valve axial passage and the exhaust port when the latter is unblocked to unload the compressor.

15 Claims, 4 Drawing Figures

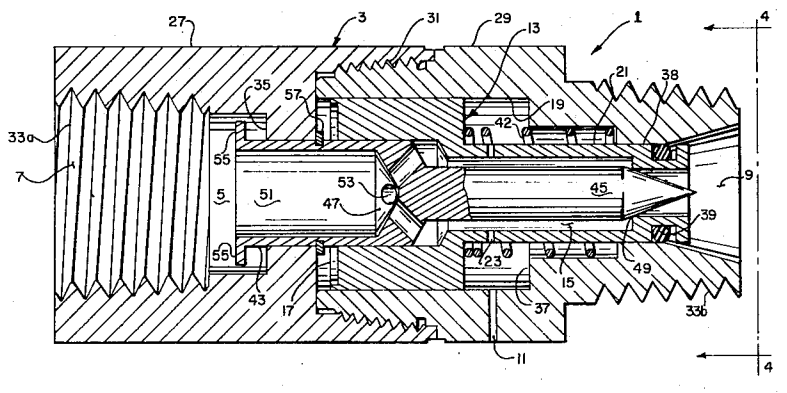


FIG. 1

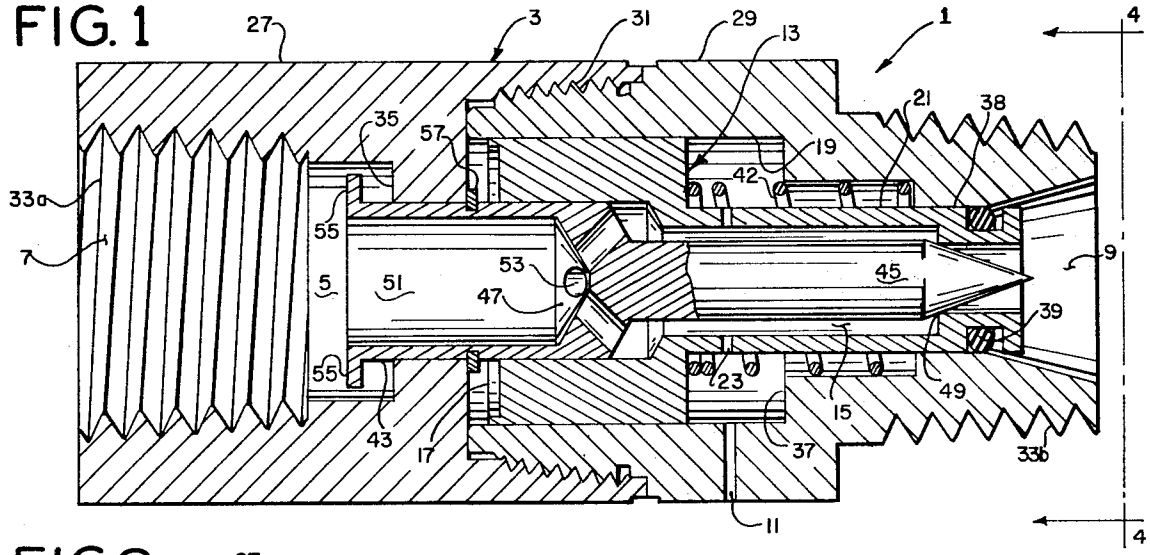


FIG. 2

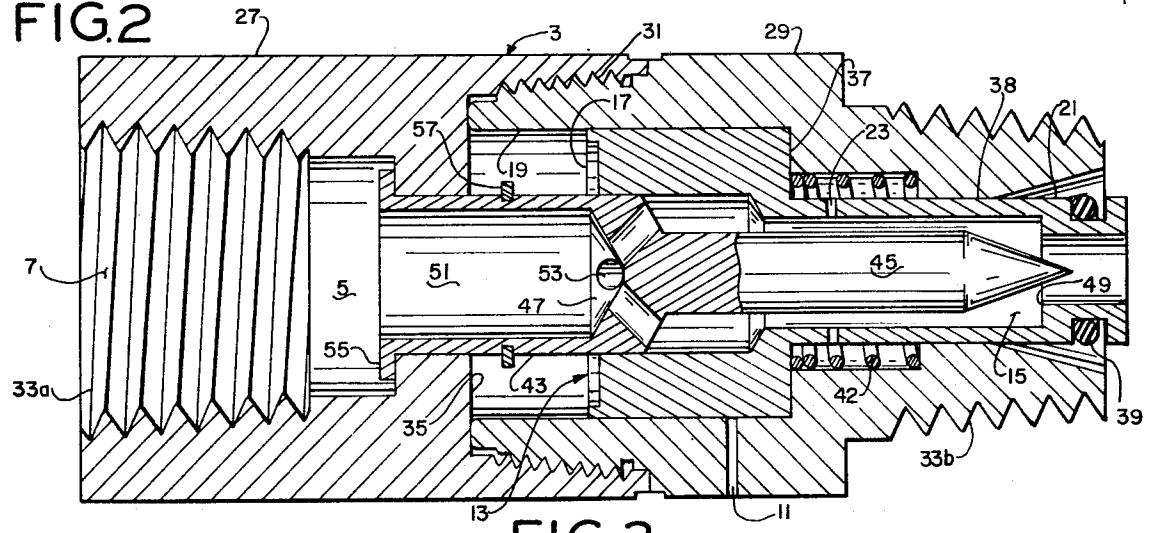
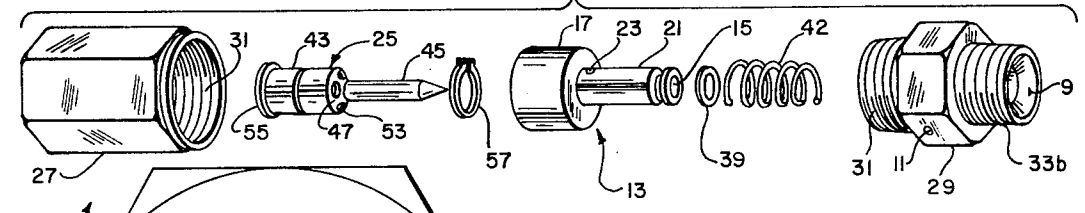


FIG. 3



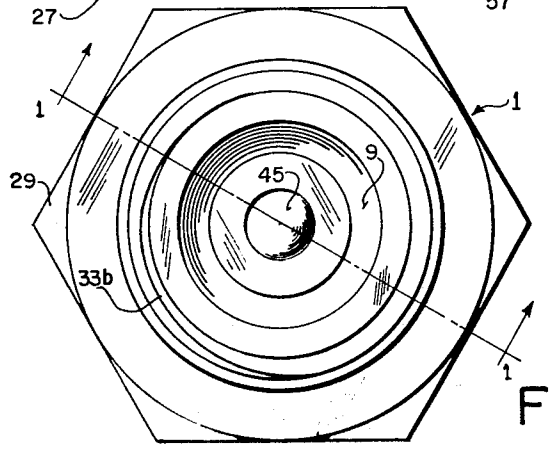


FIG. 4

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UNLOADER VALVE ASSEMBLY

BACKGROUND OF THE INVENTION

This invention relates to valve assemblies, and more particularly to an unloader valve for use with air compressors, pumps, and the like.

Generally, an air compressor may have its outlet port connected directly to an external pneumatic load (e.g., a storage tank) so that upon starting the compressor must overcome the external pneumatic load as well as any internal starting load. The total starting load on the compressor may be reduced by providing an unloader valve in the pneumatic circuit for reducing the pneumatic load at the compressor outlet so the only load which the compressor must overcome upon starting is its internal starting load. A check valve is usually used in conjunction with an unloader valve to prevent backflow through the unloader valve to the compressor. Unloader valves having a check valve combined therewith are now in general use, such a valve being disclosed in my U.S. Pat. No. 3,358,705. These unloader valves, however, were not intended to be used in conjunction with extremely small compressors, e.g., diaphragm pumps having flow rates less than approximately 1.5 cubic feet per minute (CFM). It was found that with such an unloader valve in its advanced position, i.e., with the bleeder port **11** (referring to the above-mentioned patent) uncovered, the entire output of these small compressors could be vented to the atmosphere via bleeder port **11** without causing a sufficient differential pressure on the upstream side of the unloader valve to shift the valve **15** to cover the bleeder port and to permit air to flow through the unloader valve to the pneumatic load. If the flow rate from the compressor was sufficient to cause a small differential pressure, the valve **15** would shift to an intermediate position between its fully advanced and fully retracted positions in which the seat **55** is clear of check valve seat **9** and sleeve **13** has not been sufficiently moved to block bleeder port **11** thereby permitting the flow from the compressor to be vented to the atmosphere via the bleeder port and to flow downstream from the unloader valve via ports **19** and through the gap between valve **15** and check valve seat **9**. With the unloader valve in this intermediate position, the compressor cannot become fully loaded and the desired operating pressure at the pneumatic load cannot be achieved. It has been found that with an unloader valve such as shown in the above-mentioned patent, dirt, oil, varnish, etc., may accumulate adjacent the ports **19** in valve **15** after several thousand hours of operation partially blocking the flow therethrough if the unloader valve selected is not the proper valve for the pneumatic circuit in which it is included and if the air flowing in the circuit is extremely dirty due to improper operation of the compressor.

SUMMARY OF THE INVENTION

Among the several objects of this invention may be noted the provision of a combined unloader-check valve assembly which is responsive to extremely small flow rates to load the compressor and responsive to blocking of the flow downstream from the unloader valve to unload the compressor; the provision of such a valve having axial flow therethrough to prevent oil, dirt, varnish, etc., from accumulating and blocking the flow; the provision of such a valve in which substantially no flow will occur therethrough until the exhaust port has been blocked; and the provision of such a valve which has relatively few parts and a minimum of close tolerances, and which is of relatively simple construction and low cost.

In general, an unloader valve of this invention for air compressors or the like comprises a valve body having a longitudinal passage therethrough from one end thereof, constituting its inlet end, to the other end thereof, constituting its outlet end, an intermediate portion of the passage constituting a chamber, and an exhaust port extending from the chamber to the exterior of the valve body. A main valve member is axially slidable in the passage between a retracted position and an advanced position relative to the outlet end of the valve body, with the main valve member having an axial passage therethrough from one end thereof to the other, a first portion thereon axially movable in the chamber for blocking the exhaust port when the main valve member is in its advanced position and unblocking the exhaust port when the main valve member is in its retracted position, a second portion in the valve body passage adjacent its outlet end for closing the latter, and a transfer port providing for communication between the axial passage therein and the chamber in the valve body passage. Auxiliary valve means are provided for the axial passage in the main valve member for blocking the flow of air therethrough at a point between the outlet end of the main valve passage and the transfer port when the main valve member is in its retracted position, and continuing to block the flow of air through the main valve passage until the main valve member in moving to its advanced position blocks the bleeder port, and then opening the main valve member passage.

Other objects and features will be in part apparent and in part pointed out hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a longitudinal cross-section taken on line **1—1** of FIG. **4** of an unloader check valve assembly of this invention showing the valve assembly in its retracted position;

FIG. **2** is a view similar to FIG. **1** showing the valve assembly in its advanced position;

FIG. **3** is an exploded perspective view on a smaller scale of the valve assembly; and

FIG. **4** is an end view taken from the outlet end of the valve assembly.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, an unloader valve **1** of this invention is shown to comprise a valve body, generally indicated at **3**, having a passage **5** therethrough from one end thereof constituting its inlet end **7**, to the other end thereof constituting its outlet end **9**. The valve body has an exhaust port **11** (a bleeder port) extending from the passage **5** to the exterior of the valve body. A main valve member generally indicated at **13** is axially slidable in passage **5** between a retracted position (as shown in FIG. **1**) and an advanced position (as shown

in FIG. 2) relative to the outlet end 9 of the valve body. The main valve member has an axial passage 15 therethrough from one end thereof to the other, a first portion thereon, indicated at 17, axially movable in an intermediate portion 19 of the passage 5 constituting a chamber for blocking and unblocking the exhaust port 11 when the main valve member 13 is in its advanced position and unblocking the exhaust port when the main valve member is in its retracted position, and a second portion 21 in the valve body passage adjacent the outlet end 9 for closing the latter. The main valve member 13 further has a transfer port 23 through the second portion 21 of the main valve for providing communication between the axial passage 15 therein and the chamber 19. A needle valve member generally indicated at 25 is provided within the main valve member passage 15 and constitutes auxiliary valve means for blocking the flow of air through the main valve member passage at a point between the outlet end of this last-mentioned passage and the transfer port 23 when the main valve member is in its retracted position, and continuing to block the flow of air through the passage until the main valve member, in moving to its advanced position, blocks the exhaust port 11 and then opening the main valve member passage.

More particularly, valve body 3 includes two body sections or fittings, an inlet section 27 and an outlet section 29. These body pieces are threaded together as indicated at 31 to constitute the valve body 3. The outer ends of each of these sections are provided with threads 33*a* and 33*b* suitable for connecting the unloader valve assembly into a pneumatic circuit. The section 27 has an internal annular flange 35 defining the inlet end of chamber 19 and the section 29 has a shoulder 37 defining the outlet end of the chamber. The latter constitutes a dampening chamber (as will appear), and the exhaust port 11 extends through the wall of piece 29 adjacent the outlet end of chamber 19.

As shown in FIG. 3, main valve 13 has a cylindric head constituting the first portion 17 disposed toward the inlet end of the valve body and a stem constituting the second portion 21 extending toward the outlet end of the valve body. The stem 21 has a sliding sealing fit in passage 5 adjacent its outlet end. The latter is flared as indicated at 38 to provide a conical check valve seat for an O-ring seal 39 carried in an annular groove adjacent the outlet end of the main valve stem 21. The O-ring 39 acts as a check valve to block the backflow of air from a pneumatic load downstream from the unloader valve to the compressor when the main valve member 13 is in its retracted position. The latter is biased toward its retracted position by a coil compression spring 42 which surrounds the stem 21 of the main valve and bears against the outlet side of the head 17. Spring 42 also functions to retard the movement of the main valve member toward outlet end 9 of the valve body.

Needle valve 25 has a head 43 and a needle valve stem 45 extending downstream from the head. The cross section of the valve stem 45 is substantially smaller than the cross section of the head 43 and a conical transition section 47 is provided therebetween. The head 43 is slidable within the inlet portion of the main valve passage 15 and the needle valve stem 45 extends farther into the main valve passage 15 and is engageable with a needle valve seat 49 in the main valve passage between the transfer port 23 and the outlet end of the main valve member to block the flow of air therethrough when the main valve member is in its retracted position. The main valve passage 15 is substantially larger in cross section than the cross section of the needle valve stem 45 to permit air to flow through the main valve passage when the needle valve is open. A recess 51 is provided in head 43 at its inlet end and ports 53 extend through the transition section 47 adjacent the needle valve stem providing for communication between the inlet end 7 of the valve body passage 5 and the main valve passage 15 via recess 51 and ports 53.

The needle valve head 43 is slidable relative to the valve body in the central opening defined by flange 35 between the retracted position shown in FIG. 1 and the advanced position shown in FIG. 2. A flange 55 at the inlet end of head 43 engages the inlet side of flange 35 to limit the movement of the needle valve member 25 toward the outlet end of the valve body, and a snap ring 57, releasably secured to the head 43 in an annular groove therearound, limits movement of the needle valve member toward the inlet end of the valve body member beyond its retracted position. The snap ring 57 is spaced apart from the flange 55 a distance greater than the thickness of flange 35 to permit limited axial movement of the needle valve relative to the flange 35 between its retracted position and advanced position.

In operation, with an unloader valve 1 of this invention connected in a pneumatic circuit between an air compressor and a pneumatic load, and with the air compressor stopped and unloaded, the valve parts will be in their respective retracted positions as shown in FIG. 1, i.e., the main valve member 13 and the needle valve member 25 are to the left with the O-ring seal 39 engaging the check valve seat 38, with the head 17 of the main valve member 13 unblocking the exhaust port 11 permitting communication between the valve body passage 5 and atmosphere 50 that the valve assembly upstream of the O-ring seal 39 and the air compressor outlet are at atmospheric pressure, and with the needle valve stem 45 engaging the valve seat 49 in the main valve passage 15 blocking the flow of air therethrough. Thus, when the unloaded air compressor is started, it need only overcome its internal starting loads.

When the compressor starts, air enters the valve assembly through its inlet end 7, passes through needle valve member 25 via recess 51 and ports 53 into main valve passage 15, out transfer ports 23 and through exhaust port 11 to atmosphere. As the speed of the compressor increases, the flow rate of air delivered to the unloader valve also increases, and when this flow rate exceeds the capacity of exhaust port 11 (acting as a bleeder port) to vent air to the atmosphere, an increase in differential pressure between inlet end 7 and outlet end 9 of the valve assembly results, which in turn causes main valve member 13 and needle valve member 25 to move from their respective retracted positions against the bias of spring 42 to their advanced positions. As the main valve member and needle valve member begin to move from their retracted positions, O-ring 39 is displaced from valve seat 38 and needle valve stem 45 remains seated on valve seat 47 until head 17 of the main valve member blocks exhaust port

11 and until flange 55 on needle valve head 43 engages the inlet side of flange 35, restraining the needle valve from further downstream movement. With exhaust port 11 blocked, continued flow from the compressor will increase the differential pressure causing main valve member 13 to further move toward its advanced position thereby displacing valve seat 49 away from needle valve stem 45, opening main valve passage 15 and permitting air to flow therethrough. The above-described valve assembly parts will remain in their respective advanced positions of FIG. 2 so long as the compressor delivers sufficient flow of air to overcome the force of spring 42.

If an unloader valve is used in conjunction with a reciprocating compressor, for example, the unloader valve is subjected to a surge of air on each compression stroke of the compressor. These surges of air cause fluctuations in the differential pressure across the unloader valve which forces the main valve member 13 to move back and forth within passage 5 in response thereto. With the unloader valve of this invention, this compressor-induced vibratory movement of the main valve member is dampened by the compression of the air within the chamber 19 acting as a dashpot cylinder as the main valve head 17 axially reciprocates therewithin as a dashpot piston. This compression of air results in a dashpot effect which substantially dampens the vibrational movement of the main valve member in response to rapid air flow fluctuations and reduces the wear of the main valve. The dampening characteristics of this valve assembly are particularly adapted to damp out relatively high speed flow fluctuations such as are present in a diaphragm-type air pump.

When the compressor is stopped and there is no flow in the pneumatic circuit, main valve 13 and needle valve 23 are axially shifted from their respective advanced positions of FIG. 2 to their respective retracted positions of FIG. 1 by spring 42. Thus, the air upstream from valve seat 38 in the valve body is vented to atmosphere via exhaust port 11 to unload the compressor, and the air downstream from the unloader valve assembly is blocked from flowing back to the compressor outlet and to exhaust or bleeder port 11 by O-ring check valve seal 39 engaging valve seat 38.

The unloader valve assembly of this invention may also be used in conjunction with small, continuously operated compressors (e.g., compressors having output flow rates less than 1.5 CFM) to unload the compressor when substantially no air is flowing through the pneumatic circuit. With the main valve 13 and the needle valve 25 in their retracted positions of FIG. 1 and with no air flowing through the pneumatic circuit, the air from the outlet of the continuously operated compressor is vented to atmosphere via exhaust port 11, thereby allowing the compressor to operate under a greatly reduced load except when air is consumed by the pneumatic load, thus increasing the service life of the compressor. The diameter of port 11 is sufficiently large (e.g., 0.025 inch) to permit the entire output of these small compressors to vent to atmosphere and to permit easy drilling of the port, and yet sufficiently small to create a restriction so that there is a slight increase in pressure at the compressor outlet (i.e., to act as a bleed). When air pressure downstream from the outlet end 9 of the valve body is reduced, the differential pressure across the valve assembly causes main valve member 13 and needle valve member 25 to move from their retracted positions to their advanced positions as heretofore described, thus permitting air to pass through the valve assembly to the pneumatic load.

On increase of pressure downstream from the valve assembly, the spring 42 will move the main valve 13 and needle valve member 25 from their respective advanced positions (FIG. 2) back to their retracted positions (FIG. 1) when the flow through the valve is not sufficient to maintain the main valve member 13 and the needle valve member 25 in their respective advanced positions against the bias of spring 42. As the head 17 of the main valve unblocks exhaust port 11, the compressor outlet is again placed in communication with atmosphere allowing the continuously operating compressor to idle in a substantially unloaded condition.

With valve members 13 and 25 in their advanced positions (FIG. 2), substantially all air passing through valve assembly 1 flows through recess 51 and ports 53 into passage 15, around needle valve stem 45, and through needle valve seat 49 to the outlet end 9. This axial flow washes away any oil, dirt or varnish that may tend to accumulate on these parts thereby keeping the valve assembly substantially free of such accumulations. Furthermore, the air flows substantially straight through the valve assembly of this invention, resulting in a smaller pressure drop across the valve assembly than in other comparable unloader valves, and hence reduced loss of pressure.

While the invention has primarily been described for use with a compressed air system, it will be understood that the assembly is suitable for use in other fluid systems (gas or liquid). The valve assembly may be incorporated in a compressor structure or may be a separate article of manufacture.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. an unloader valve assembly for air compressors or the like comprising a valve body having a longitudinal passage therethrough from one end thereof, constituting its inlet end, to the other end thereof, constituting its outlet end, an intermediate portion of said passage constituting a chamber, said body having an exhaust port extending from said chamber to the exterior of said body, a main valve member axially slidable in said passage between a retracted position and an advanced position relative to the outlet end of said body, said main valve member having an axial passage therethrough from one end thereof to the other, a first portion thereon axially movable in said chamber for blocking said exhaust port when said main valve member is in its said advanced position and unblocking said exhaust port when said main valve member is in its said retracted position, and a second portion in the valve body passage adjacent its outlet end for closing

the latter, said main valve member further having a transfer port providing for communication between the axial passage therein and said chamber, and auxiliary valve means for said mean valve passage, said auxiliary valve means blocking flow of air through said main valve passage at a point between the outlet end of said main valve passage and said transfer port when the main valve member is in its said retracted position, and continuing to block flow of air through said main valve passage until the main valve member, in moving to its advanced position, blocks said exhaust port, and then opening said main valve passage.

2. An unloader valve assembly as set forth in claim 1 wherein said auxiliary valve means comprises a valve seat in said main valve member passage adjacent the outlet end thereof and an auxiliary valve member extending axially through said main valve member passage engageable at its end toward the outlet end of this passage with said seat when the main valve member is retracted.

3. An unloader valve assembly as set forth in claim 2 wherein said auxiliary valve member is axially slidable in the valve body passage an in the main valve member passage between a retracted position and an advanced position relative to the outlet end of the valve body, and being engageable with said main valve passage seat when both it and the main valve member are retracted, and open off the seat when both it and the main valve are advanced.

4. An unloader valve assembly as set forth in claim 3 wherein both the main and auxiliary valve members are movable between their retracted and advanced positions by differential air pressure at the inlet and outlet ends of the valve body.

5. An unloader valve assembly as set forth in claim 4 having interengageable means on the auxiliary valve member and said valve body for limiting the axial movement of the auxiliary valve member.

6. An unloader valve assembly as set forth in claim 1 having resilient means for biasing said main valve member to its retracted position.

7. An unloader valve assembly as set forth in claim 6 wherein said main valve is subject to axial vibrational movement in response to fluctuations in fluid flow through the valve and wherein said first portion of the said main valve member is slidable as a piston in said chamber for dampening said axial vibrational movement.

8. An unloader valve assembly as set forth in claim 3 wherein said auxiliary valve member is a needle valve having a head which is slidable within the main valve member at its inlet end, and a stem extending axially from said head within said main valve member passage engageable with said valve seat therewithin when the main valve member is retracted.

9. An unloader valve assembly as set forth in claim 8 wherein said needle valve head has a recess therewithin in communication with the inlet end of said valve body and a port providing for communication between said inlet end and said main valve passage.

10. An unloader valve assembly for air compressors or the like comprising a valve body having a longitudinal passage therethrough from one end thereof, constituting its inlet end, to the other end thereof, constituting its outlet end, said valve body comprising an inlet section having an internal flange intermediate its ends and an outlet section threaded in said inlet section from the outlet end of the inlet section, said outlet section being formed to define a chamber at its inlet end, said internal flange defining one end of said chamber, said outlet section having a shoulder intermediate its ends defining the other end of said chamber, said valve body having an exhaust port extending from said chamber to the exterior of said body, a main valve member axially slidable in said passage between a retracted position and an advanced position relative to the outlet end of said valve body, said main valve member having an axial passage therethrough from one end thereof to the other, a first portion thereon axially movable in said chamber for blocking said exhaust port when said main valve member is in its said advanced position and unblocking said exhaust port when said main valve member is in its retracted position, a second portion in the valve body passage adjacent its outlet end for closing the latter, and a transfer port providing for communication between the axial passage therein and said chamber, and said valve assembly further having auxiliary valve means for said axial passage in said main valve member, said auxiliary valve means blocking flow of air through said main valve passage at a point between the outlet end of said axial passage and said transfer port when the main valve member is in its retracted position, and continuing to block flow of air through said main valve passage until the main valve member, in moving to its advanced position, blocks said exhaust port, and then opening said main passage.

11. An unloader valve assembly as set forth in claim 10 wherein said main valve member second portion has a sliding sealing fit with a portion of said valve body adjacent its outlet end, the last-said portion of said valve body constituting a check valve seat, and said main valve member second portion has a seal secured thereto engageable with said check valve seat when said main valve member is in its retracted position for blocking the backflow of air through the unloader valve assembly.

12. An unloader valve assembly as set forth in claim 11 wherein said valve body passage downstream from said check valve seat is flared.

13. An unloader valve assembly as set forth in claim 10 wherein said auxiliary valve means comprises a valve seat within said main valve passage and a needle valve member, the latter having a head and a needle valve stem extending axially from said head within said main valve passage, said needle valve member being carried by said internal flange for axial sliding movement relative thereto and for axial sliding movement in the main valve passage between a retracted position and an advanced position relative to the outlet end of the valve body, said needle stem engaging said valve seat in said main valve passage when said needle valve member and said main valve member are in their respective retracted positions, said needle valve member being movable with said main valve member with said needle valve stem remaining seated on said main valve passage valve seat until said exhaust port is blocked, and then said main valve member being movable relative to said needle valve member to displace said main valve passage valve seat away from the needle valve stem to permit air to flow therethrough.

14. An unloader valve assembly as set forth in claim 13 having interengageable means on said needle valve and said valve body for limiting the axial movement of said needle valve member relative to said main valve member.

15. An unloader valve assembly as set forth in claim 14 wherein said interengageable means comprises a flange adjacent the inlet end of said needle valve member head engageable with said internal flange to limit the downstream movement of said needle valve member and a removable ring secured to said head downstream from the flange, said ring being engageable with said internal flange to limit the upstream movement of said needle valve member.

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