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AIR COMPRESSOR

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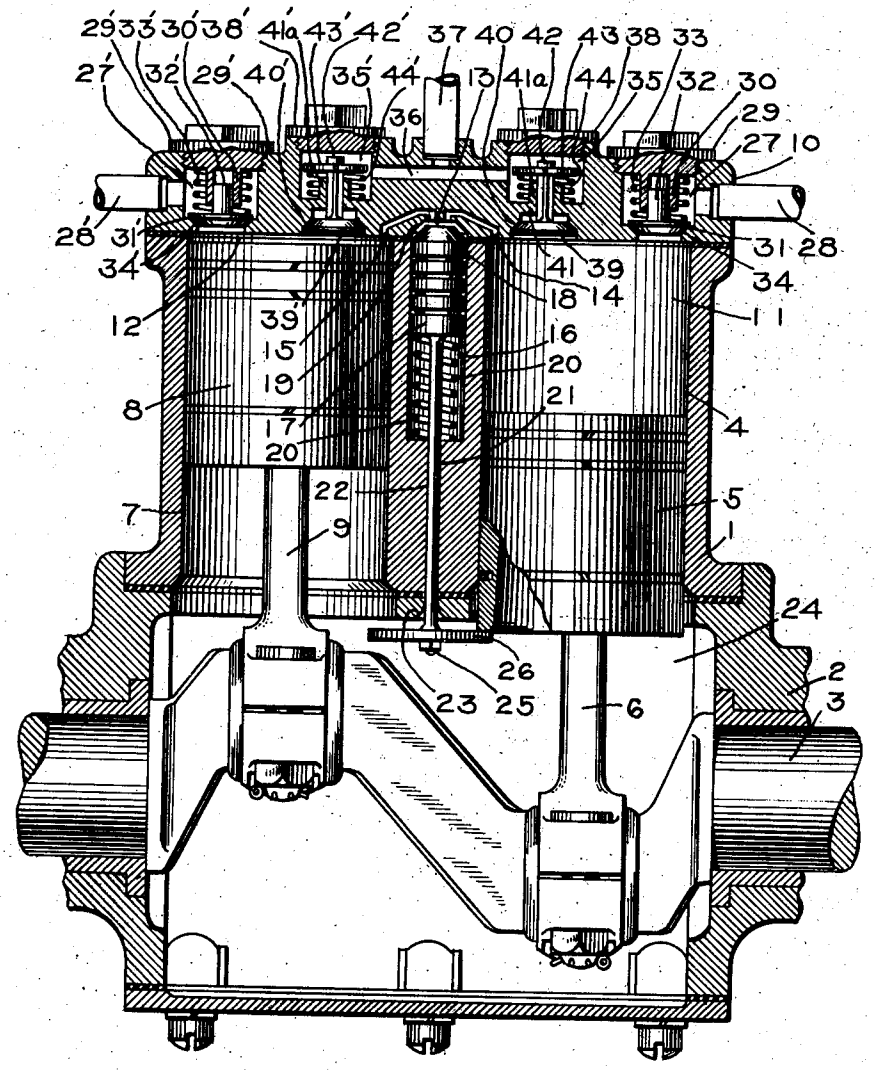

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AIR COMPRESSOR

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10 Claims. (Cl. 230—184)

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This invention relates to fluid compressors and more particularly to the reciprocating piston type.

In compressors of the conventional type, it has been found necessary to have a certain amount of dead space for clearance between the piston and the cylinder head and in the valve chambers. This space retains a quantity of fluid at a pressure substantially above the fluid pressure of a storage reservoir or receiver, which fluid must expand during the intake stroke until the pressure in the cylinder is substantially below atmospheric pressure before the inlet valve will open to supply fluid to the cylinder for the inlet stroke. This condition results in lowered volumetric efficiency because of the unproductive piston movement and the diminished quantity of fluid delivered by the compressor to the receiver.

It is an object of this invention, therefore, to provide an improved compressor of the reciprocating piston type so designed that the inlet and discharge valves will be positioned promptly for the intake movement of each piston and thereby to increase the volumetric efficiency of the compressor.

Another object is to provide a compressor having a plurality of fluid compressing cylinders in which one cylinder will be supercharged with a certain amount of fluid under pressure from another cylinder before the beginning of the intake stroke of the piston in the first mentioned cylinder.

In the accompanying drawing the single figure is a vertical sectional view of a fluid compressor constructed in accordance with this invention.

As shown in the drawing, the compressor may comprise a casing, designated by the numeral 1, having secured to the bottom surface thereof in a suitable manner a crankcase 2 in which there is rotatably mounted the usual driven crankshaft 3. The right-hand end of the casing 1, as illustrated, is provided with a cylinder 4 in which a piston 5 is slidably mounted to be reciprocated by the crankshaft 3 through the medium of the connecting rod 6. The left-hand end of the casing 1 is provided with a cylinder 7 in which a piston 8 is similarly mounted and reciprocated likewise through the medium of a connecting rod 9.

Secured to the top surface of the casing 1 by bolts or other suitable means is a cylinder head 10 which provides valve controlled inlet and discharge passages for the fluid compressed in a manner hereinafter more fully described. A fluid compressing chamber 11 is thus defined at the right hand end of the casing by a portion of the

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bottom surface of the head 10, the wall of the cylinder 4 and the top surface of the piston 5. In a similar manner a fluid compressing chamber 12 is defined at the left hand end of the casing by another portion of the bottom surface of the head 10, the wall of the cylinder 7 and the top surface of the piston 8.

Formed in the bottom face of the cylinder head 10 and located between the two portions just mentioned is a recess 13 which communicates with the compressing chamber 11 by way of a valve controlled passage 14 in the head and with the compressing chamber 12 by way of a valve controlled passage 15 in the head. This recess is open at the bottom to a vertical bore 16 formed in the wall between the cylinders 4 and 7 of the casing 1.

Slidably mounted in the bore 16 is a piston valve member 17, the upper end of which is provided with a frusto-conically shaped valve 18. This valve is arranged to engage a corresponding valve seat 19 which defines a portion of the recess 13 and to thereby close communication between passages 14 and 15. Interposed between and operatively engaging the bottom of the bore 16 and the lower end of the valve member 17 is a helical spring 20 which constantly exerts an upwardly directed force on the valve member.

The lower end of the valve member 17 is provided with an actuating stem 21 which is slidably carried in a vertical bore 22 in the casing 1 and extends through bore 23 in the crankcase 2 into the crankcase chamber 24. Secured to the lower end of the stem 21 by a nut 25 is a cross-member 26 which projects into the paths of travel of both pistons so as to be engaged and moved downwardly by either piston against the opposing pressure of spring 20.

At the extreme right-hand end of the cylinder head 10 there is formed a discharge chamber 27 which extends vertically through the head and is in constant open communication with a fluid discharge pipe 28. This chamber is closed at the top by a hollow nut member 29 which has screw-threaded engagement with the cylinder head 10. The nut member is provided with a vertically cylindrical sleeve portion 30 which extends into the chamber 27 and which serves as a guide and a stop for the discharge valve 31. This valve, preferably of the tapered poppet type is operably mounted in the chamber 27 and controls communication between compressing chamber 11 and chamber 27.

Projecting from the upper surface of the valve 31 is a vertical guide stem 32 which is slid-

ably guided in the sleeve portion 30 of the nut member 27. Interposed between and operatively engaging the nut member 27 and the back surface of the valve 31 is a helical spring 33 which, when the piston 5 substantially completes its upward stroke, urges the valve downward into sealing engagement with an annular tapered seat 34 formed in the bottom of the chamber 27 as illustrated, to interrupt the flow of fluid under pressure from the compressing chamber 11.

To the left of the chamber 27 there is formed in the cylinder head 10 an inlet chamber 35 which is in constant communication with a fluid inlet passage 36 which is in open communication with an inlet pipe 37. This chamber is closed at the top by a nut member 38 which has screw-threaded engagement with the head 10. The communication between the bottom of the chamber 35 and the compressing chamber 11 may be closed, as illustrated, by a valve 39, preferably of the poppet type, which is arranged to seat on a valve seat 40 formed in the lower side of the head 10.

Above the valve 39 the head 10 is provided with a wall 41 which defines the bottom of the chamber 35 and which is provided with an upwardly extending sleeve portion 41a in which there is slidably mounted the guide stem 42 of the valve 39.

The stem 42 is preferably formed integrally with the valve 39 and is fluted to permit the passage of fluid through the sleeve portion 41. Pinned to the upper end of the stem is a spring seat 43, upon which an upwardly directed force is exerted by a spring 44 interposed between the spring seat and the upper surface of the wall 41a, thereby urging the valve 39 into sealing engagement with the valve seat 40.

Attention is here directed to the fact that the members employed for imparting resiliency to the movement of the valves are disposed in the cylinder head and not in the compressing chamber, thereby keeping the necessary clearance space between the piston and the head at a minimum and thereby adding to the volumetric efficiency of the compressor.

At the left-hand end of the compressor, the head 10 is provided with an inlet and discharge valve construction for cooperating with cylinder 7 similar to that described above for cylinder 4.

At the extreme left-hand end of the cylinder head 10, for controlling the flow of fluid to and from the compression chamber 12, there is provided a discharge valve mechanism and an inlet valve mechanism, each of which is identical with the corresponding mechanism mounted in the right-hand end of the cylinder head. In view of the similarity, the several parts of these mechanisms will be indicated by the same reference numerals as applied to the mechanisms at the right hand end of the casing with the exception that the prime sign is added.

In operation, when the crank shaft 3 is turned by any suitable source of power, pistons 5 and 8 will be actuated by the connecting rods 6 and 9, respectively. Each piston completes an inlet and a discharge stroke for each revolution of the crankshaft.

In the accompanying drawing, piston 8 is shown in its upper dead center position and piston 5 is shown in its lower dead center position. The piston 5 in this position acts through the medium of the member 26 and stem 21 of the valve member to hold valve 18 out of engagement with valve seat 19. Upon movement of the valve 18 to its

unseated position fluid under pressure may flow from compressing chamber 12 to compressing chamber 11 by way of passage 15, recess 13 and passage 14 for reasons which will hereinafter more fully appear. With the piston positioned as just described the inlet and discharge valves will be in their seating positions as shown.

Upon rotation of the crank shaft 3, connecting rod 6 and thereby piston 5 will be moved upwardly. In response to the upward travel of the piston the compressed spring 20 will act to move the valve member 17 upwardly until valve 18 again engages valve seat 19 and closes communication between chambers 11 and 12.

It is preferred that the piston movement required to permit the valve member 17 to seat be relatively small so that there will be little reverse fluid flow after the pressures of fluid in the two compressing chambers have equalized.

The piston 5 as it moves upwardly compresses the fluid in the chamber 11 until the upwardly directed force exerted by the fluid on the discharge valve 31 unseats the valve against the combined downwardly directed force exerted by the spring 33 and the fluid pressure which may be in the discharge pipe 28. With valve 31 unseated, fluid will flow from chamber 11 into discharge chamber 27 and thence into discharge pipe 28 and a suitable fluid receiver, not shown. Fluid under pressure will continue to flow in this manner until the piston 5 nearly reaches the end of its upward stroke when, with the fluid pressures in the discharge pipe 28 and the chamber 5 substantially equal, the force of the spring 33 will prevail and the valve 31 will again be seated.

At the same time as piston 5 is making its upward stroke, piston 8 will be making its downward stroke. At the start of the stroke the inlet and discharge valves are positioned as shown in the accompanying drawing. After a slight downward movement of the piston, pressure of fluid in chamber 12 will be sufficiently below atmosphere to allow the pressure of fluid in the inlet chamber 35' to move valve 39' against the pressure of spring 44' and away from the valve seat 40'. Fluid will flow through inlet pipe 37 and passage 36 to inlet chamber 35' and thence past the valve seat 40' to compressing chamber 12. The pressure of inflowing fluid will hold valve 39' unseated until the piston 8 nears the end of its downward movement. As the piston nears the end of its stroke the valve will again be seated by spring 44'.

Shortly after the inlet valve is seated, the bottom of the piston 8 will engage the cross-member 26 and move it downward which will likewise move the valve member 17 downward thereby moving the valve 18 away from valve seat 19.

The discharge valve 31 will also have been seated before the piston 8 engages the cross-member 26. Fluid under pressure will now flow from compressing chamber 11 to compressing chamber 12 by way of passage 14, recess 13, and passage 15.

The piston 8 will now be at bottom dead center while the piston 5 will be at top dead center. The valves will be in the position as illustrated.

The same operation will follow as previously described except that the function performed by piston 5 will now be performed by piston 8 and vice versa.

At the completion of each compression stroke or inlet stroke, valve member 17 will operate to open communication between the two compressing chambers. Thus the pressure of fluid in a

compression chamber is reduced before the beginning of an inlet stroke of its piston and is increased before the beginning of a compression stroke.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a fluid compressor of the type comprising two pistons and means connected to said pistons for actuating first one and then the other to compress fluid, in combination, a communication for permitting fluid to flow between the pressure sides of said pistons, a valve for opening and closing said communication, means for effecting the operation of said valve to open said communication as an incident to either piston reaching substantially the end of its inlet stroke, and means for effecting the operation of the valve to close said communication at all other times.

2. In a fluid compressor of the type comprising two pistons and means connected to said pistons for actuating first one and then the other to compress fluid, in combination, a communication for permitting fluid to flow between the pressure sides of said pistons, a valve for opening and closing said communication, resilient means for actuating said valve to close said communication, and means operative by either of said pistons at substantially the end of its inlet stroke to actuate said valve to open said communication.

3. In a fluid compressor of the type comprising two pistons, and means connected to said pistons and operable to actuate first one and then the other to compress fluid, in combination, a communication connecting the pressure sides of the two pistons, valve means controlling said communication, and means conditionable upon the movement of either piston to substantially the end of its inlet stroke to actuate said valve means to open said communication, and means operative to actuate said valve means to close said communication at all other times.

4. A fluid compressor comprising two pistons, means connected to said pistons to actuate first one and then the other of said pistons to compress fluid, a communication connecting the chambers on the pressure sides of the two pistons, valve means controlling said communication, means for actuating said valve means to close said communication, and means operative by each piston at substantially the end of its inlet stroke to actuate said valve means to open said communication.

5. A fluid compressor comprising two pistons, means connected to said pistons to actuate first one and then the other of said pistons to compress fluid, a communication connecting the chambers on the pressure sides of the two pistons, valve means controlling said communication, means conditionable upon movement of either piston to substantially the end of its inlet stroke to actuate said valve means to open said communication, and means operative to actuate said valve means to close said communication at all other times.

6. A fluid compressor of the type arranged to draw fluid into one chamber for compression

therein while fluid is being compressed in another chamber and comprising two fluid compressing chambers and two pistons for reciprocating in the respective chambers, in combination, means for supercharging each of said chambers with fluid under pressure, the supercharging means comprising means rendering the supercharging means ineffective until either piston is substantially at the end of its inlet stroke and operative by the piston as it approaches the end of its inlet stroke to render said supercharging means effective.

7. A fluid compressor of the type arranged to draw fluid into one chamber for compression while fluid is being compressed in another chamber and comprising two pistons for reciprocating in the respective chambers, in combination, means for preloading the pressure side of a piston, completing its inlet stroke, with fluid under pressure from the pressure side of a piston completing its compression stroke, and means actuable by either piston at substantially the end of its inlet stroke to render said preloading means operative, and means separate from said piston for actuating the second mentioned means to render the preloading means ineffective.

8. A fluid compressor of the type arranged to draw fluid into one chamber for compression while fluid is being compressed in another chamber and comprising two pistons for reciprocating in the respective chambers, in combination, means for preloading the pressure side of a piston, completing its inlet stroke, with fluid under pressure from the pressure side of a piston completing its compression stroke, and means conditionable upon the movement of either piston to substantially the end of its stroke for rendering said preloading means operative.

9. A fluid compressor of the type arranged to draw fluid into a chamber for compression therein while fluid is being compressed in another chamber and comprising two fluid compressing chambers and two reciprocating pistons for compressing fluid in said chambers, in combination, means for venting fluid under pressure from one chamber, valve means operative to start and stop said venting action, means conditionable upon the movement of either piston to substantially the end of its inlet stroke to actuate said valve means to start said venting action, and means operative to actuate said valve means to suspend said venting action at all other times.

10. In a fluid compressor of the type comprising two pistons and actuating means connected to said pistons for compressing fluid with first one piston and then the other, in combination, a passage in open communication with the pressure side of one of said pistons, a passage in open communication with the pressure side of the other of said pistons a communication for permitting fluid to flow from one of said passages to the other, valve means for controlling said communication, resilient means actuating said valve means to close said communication, and means operable by either of said pistons at substantially the end of its inlet stroke to cause said valve means to open said communication.

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