Jan. 5, 1926. 1,568,776

D. F. SMITH

COMPRESSOR

Original Filed Sept. 28, 1918 3 Sheets-Sheet 1

Fig. 1.

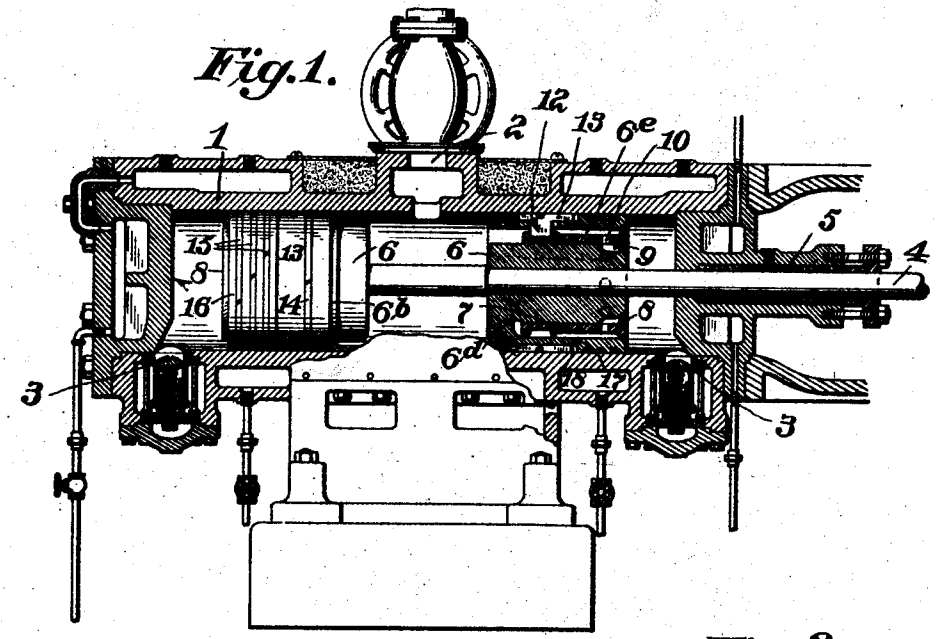


Fig. 2.

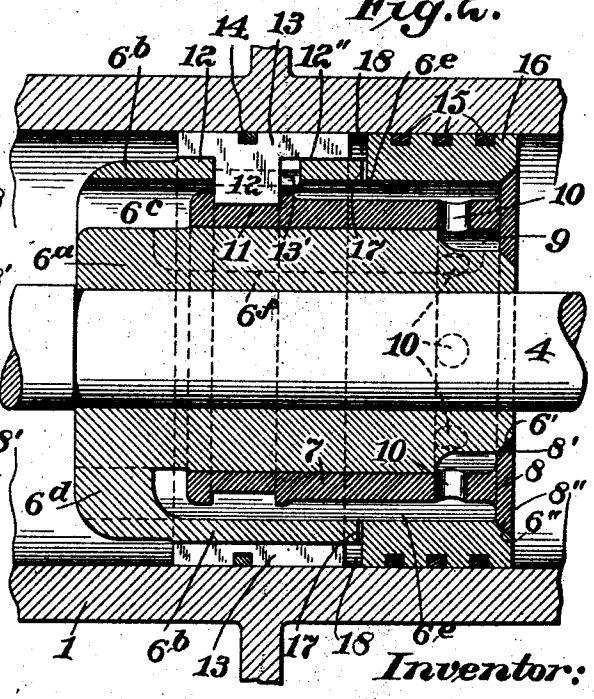
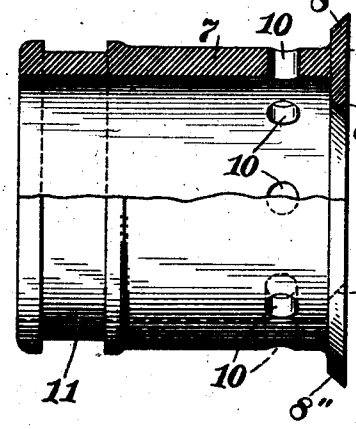


Fig. 3.



Inventor:

David Franklin Smith,

by Spear Middleton, Donaldson & Spear

Atty's.

Jan. 5, 1926. 1,568,776

D. F. SMITH

COMPRESSOR

Original Filed Sept. 28, 1918 3 Sheets-Sheet 2

Fig. 4.

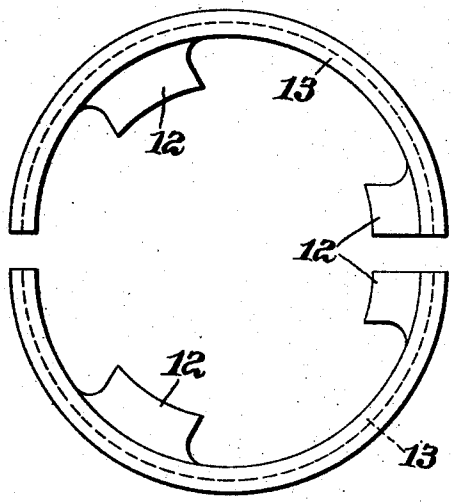


Fig. 5.

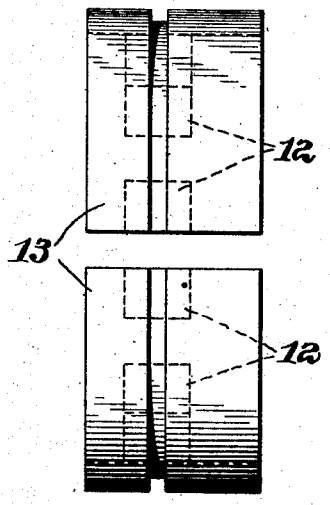


Fig. 7.

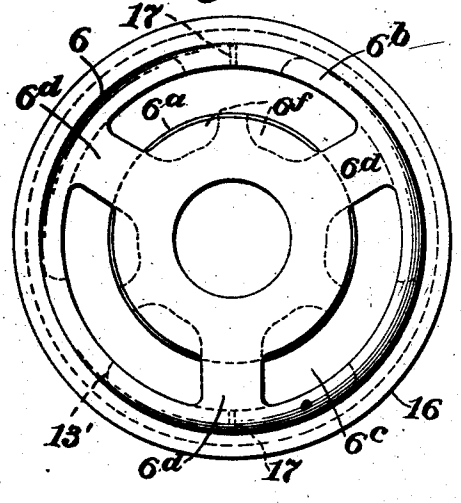


Fig. 6.

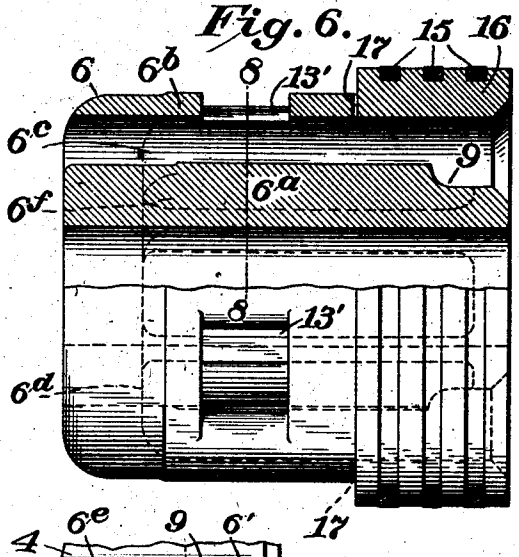


Fig. 8.

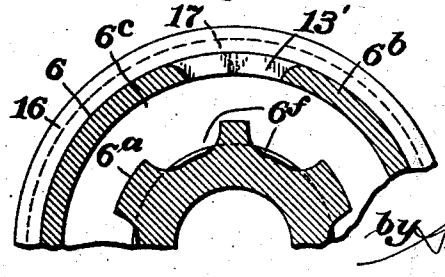
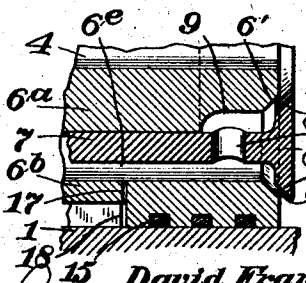


Fig. 9.



Inventor:
David Franklin Smith,
by Spear, Middleton, Donnan & Spear
Atty's.

Jan. 5, 1926. 1,568,776

D. F. SMITH

COMPRESSOR

Original Filed Sept. 28, 1918 3 Sheets-Sheet 3

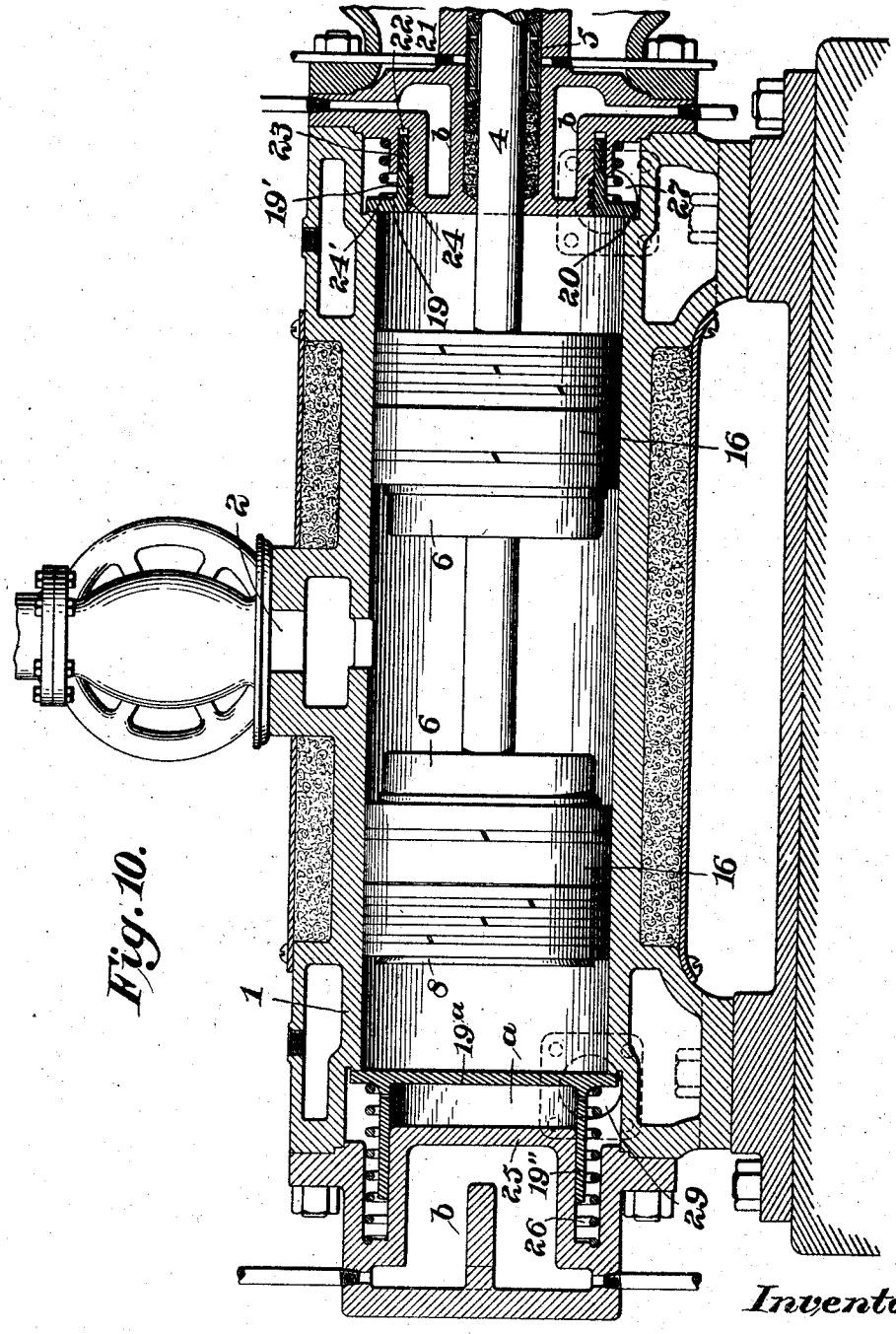


Fig. 10.

Inventor:
David Franklin Smith,
by Spear, Middleton, Donaldson & Spear
Attys.

Patented Jan. 5, 1926. 1,568,776

UNITED STATES PATENT OFFICE.

DAVID FRANKLIN SMITH, OF WASHINGTON, DISTRICT OF COLUMBIA.

COMPRESSOR.

Application filed September 28, 1918, Serial No. 256,117. Renewed June 18, 1925.

To all whom it may concern:

Be it known that I, DAVID FRANKLIN SMITH, a citizen of the United States, and resident of Washington, District of Columbia, have invented certain new and useful Improvements in Compressors, of which the following is a specification.

My invention is an improvement in compressors for air or gas and is applicable in various situations, such, for instance, as in refrigerating plants.

One object is to secure high efficiency by providing a valve organization for the compressor pistons or heads, which will be sensitive and positive in operation, and in which a maximum volume of air or gas will be taken into the cylinder through the valve mechanism at each opening action of the valves of the head or piston.

Other objects of the invention will be clear from the following description:

The invention consists in the features and combination and arrangement of parts hereinafter described, and particularly pointed out in the claims.

In the accompanying drawings;

Figure 1 is a sectional view taken longitudinally through a compressor embodying my invention.

Figure 2 is a detail of a portion of the cylinder with the compressor head or piston and valve mechanism in section.

Figure 3 is a part section and part side elevation of the valve member.

Figure 4 is an end view of a sectional ring member associated with the valve to control the operation thereof.

Figure 5 is a side elevation of the parts shown in Figure 4.

Figure 6 is a part sectional view and part side elevation of the compressor head or piston.

Figure 7 is a view of Figure 6 looking from the left thereof.

Figure 8 is a cross sectional view of Figure 6 on the line 8—8 thereof.

Figure 9 is a detail sectional view of a portion of the compressor head, and valve showing the valve in open position.

Figure 10 is a sectional view showing the preferred form of my invention in which improved discharge valves are employed.

In these drawings 1 indicates the cylinder having an inlet 2 at its central portion for the air or gas and outlet valves 3 near the ends thereof for the discharge of the compressed air or gas. The piston rod 4 passes through a suitable stuffing box 5 and is connected with the compressor heads or pistons 6, which are located spaced apart as shown in Figure 1, so as to receive between them the incoming supply of air or gas. These pistons or compressor heads carry valves, one of which is shown in detail in Figure 3 as consisting of a cylindrical body portion 7, and a valve ring or head 8 carried thereby at one end thereof, this valve ring 8 having its inner and outer edges at 8′, 8″ bevelled to seat itself on a correspondingly formed seat of annular form indicated at 6′, 6″ at one end of each piston head.

The cylindrical body portion of the annular valve member is slidably mounted on the main body portion of the head 6 indicated at 6^a, this being the inner portion of said head. This head is of special construction in that it consists of the inner body portion 6^a and an outer ring shaped or cylindric portion 6^b separated from the inner body portion by a space 6^c. The outer cylindric portion 6^b is connected with the inner body portion 6^a of the head by webs or arms 6^d shown at the lower part of Figs. 1 and 2 and in Figure 7. The cylindrical body portion of the valve member is adapted to reciprocate in this space 6^c, the inner body portion of the head being machined to receive the valve with a close sliding fit. The space 6^c is of such width that a channel 6^e is left between the outer surface of the cylindric body of the valve and the inner side of the outer shell 6^b of the compressor head, so that gas or air is free to flow from the inner end of the compressor head through the passage 6^e to reach the valve ring 8. Passages are also formed at 6^f in the main body part 6^a of the compressor head, so that air or gas is free to pass along these channels on the inner side of the valve cylinder or body, so as to reach the space 9 formed at the end of the body 6^a of the head or piston, this chamber being provided by reducing the diameter of the body portion 6^a at this point, the chamber 9 being of annular form. This chamber 9 communicates with the passage 6^e by ports 10 formed through the body of the valve. The valve body is provided with an annular groove 11

near its inner end, which receives lugs 12 extending inwardly from a divided ring 13, this ring having an outside diameter equal to the inside diameter of the cylinder 1 and adapted to slide on the interior of said cylinder. The projections 11 extend through openings 13′ in the shell 6^b of the piston or compressor head, these openings 13′ being longer than the length of the projections 12, as indicated in Figure 2. The ring 13 is of such a width as to overlie the outer surface of the shell 6^b of the piston head as indicated at 12′, 12″, in Figure 2. This ring member is provided with the packing ring 14, and packing rings 15 are provided in the head or enlarged portion 16 of the piston, it being understood that the extension or shell 6^b of the piston is of smaller exterior diameter than the end portion 16 of the compressor piston, thus providing a space between it and the interior of the main cylinder in which the ring 13 is adapted to lie and work. The ring 13 exercises a retarding influence on the valve member to which it is connected as described, this retarding influence being due to the frictional resistance between the exterior of the ring 13 and the inner face of the main cylinder, so that as the compressor head shown in Figure 2 moves towards the left the valve member will lag in respect to the movement of the compressor head and the valve ring 8 will raise from its seat to allow the charge of air or gas to pass through the passages 6^e and 6^f into the compression space at the right of the compressor head, and on the stroke of the compressor head to the right the valve member 8 will close upon its seat and compression will take place and the compressed fluid will pass out through the discharge valve 3.

In order to prevent air or gas from being trapped in the space at the right of the ring 13 in Figure 2 I provide ports 17 extending from the space 18 through the shell 6^b to communicate with the passage 6^e.

Figure 9 shows the open position of the valve while the compressor head is moving leftward. When the stroke is reversed and the head moves towards the right the valve will lag in respect to the movement of the head by reason of the frictional resistance offered by the ring 13 bearing in the main cylinder of the compressor and this together with the resistance of the volume of air or gas in the compression space will cause a quick seating of the valve resulting in high efficiency of the compression stroke, due to the large volume of air or gas trapped in the compression space.

It will be seen that I get a large opening of the valve, it being annular in form and located close to the outer cylindric surface of the head or piston. In other words the ring shaped valve is made of as large a diameter as possible and the area of opening presented to the passage of the air or gas insures a maximum volume in each charge passing into the compression space.

It will be observed that there is no spring employed in connection with my valve organization and therefore no spring pressure to be overcome, and the suction is not relied upon in opening the valve. The valve will begin to open immediately upon the beginning of the suction stroke, due to the retarding effect of the ring 13, which causes the valve to lag and hence the valve will open without requiring rise of the suction to a certain degree.

The ring 13 is split, as before stated, and it is easily applied to connect up the valve member with the piston or compressor head by inserting the valve into the annular cavity in the head and then placing the sections of the ring shaped member 13 in position with its projections 12 extending through the openings in the piston and into the annular groove 11 in the valve. The packing ring 14 holds the sections of the ring 13 in place when the parts are assembled ready to be placed in the cylinder 1. The openings 13′ are of such length as to allow the ring 13 and valve to lag when the piston changes its stroke, the valve being picked up by the end walls of the openings 13′ striking the projections 12.

The openings 10 allow the air or gas pressure to pass from inside to outside of the shell of the valve to escape at the valve seats 6′, 6″ equally.

It will be observed that no bolts are employed in holding the parts together and the parts are assembled and dismounted in a simple manner.

The preferred form of my invention is shown in Fig. 10 in which the same form of piston and suction valve mechanism as above described is employed but the discharge valves are different. Both of these discharge valves 19, 19^a, are of a form to secure a maximum area of discharge opening with a minimum amount of movement of the valve. At the head end of the cylinder, through which the piston rod passes, the discharge valve is of ring form and is of an external diameter slightly greater than the interior bore of the cylinder. It finds a seat against the annular shoulder 20 on the cylinder wall, the bore of the cylinder beyond this shoulder being enlarged in respect to the portion in which the piston travels. This valve has a sleeve portion 19′ which surrounds and slides on the inwardly projecting extension 21 of the head of the cylinder and within an annular recess 22 of said head packing being arranged at 23—24 on opposite sides of the sleeve. This discharge valve is backed by a spring 24′ tending to hold it to its seat.

The discharge valve 19ª is in the form of a disc with a sleeve extension 19″ slidably embracing the projection 25 of the other head of the cylinder. A space *a* normally exists between the valve and said extension 25, and this valve is backed by a spring 26. The space *a* is provided in order that in case of breakage of the piston rod the piston, if it strikes the valve 19ª, will not result in damage by breaking the head, the space *a* being sufficient to allow the shock to be absorbed by the spring 26.

The stroke of the piston with my form of discharge valves may be equal substantially to the length of the cylinder chamber, only the slightest clearance being provided at the end of the piston's stroke.

There are no pockets or spaces between valves or within the cylinder for gas to be compressed and follow back and thus reduce capacity.

The valves will allow the discharge of the full volume of the cylinder. The valves, because of their large size and the large area of the opening afforded thereby, when the valves are off of their seats, need open but a minimum distance, and this contributes to quiet running of the compressor.

The final outlets for the gas are indicated at 27 and 29.

A space is provided at *b* for cooling, and expanded ammonia may be introduced to circulate through this space.

By reason of the large area of the valve the compressor or the working parts will not be damaged should liquid get into the cylinder by accident because ample area of discharge opening will be afforded for the evacuation of any liquid.

The cylinder extension 25, Fig. 10, is cooled internally and the sleeve 19″ of the discharge valve 19ª works on the outer side of this extension so that the expansion of the sleeve under heat will be away from its working contact with the outer side of this cooled extension and the valve will be prevented from sticking.

Referring to Fig. 2, the space 18 between the head of the piston and the ring 13 provides a cushion to prevent shock being transmitted to the parts which might result in breakage, for instance, to the piston rod. This breakage is due to crystallization which results from the vibration under shock but with the provision of the cushion at 18 this is avoided. It will be seen that this cushion is effective in both the opening and closing movements of the valve 8. In one direction the ring 13 works against fluid confined in the space 18 and in the other direction a suction effect is present and retards the movement of the ring 13 and the valve 8.

Hammering of the valve is thus prevented.

By reason of the employment of the valves in the piston and in the cylinder of ring or disc form and of large diameter the apparatus will work with liquid as well as with gas.

What I claim is:

1. In combination with a cylinder, a piston having a central body portion with an outer shell spaced apart from the body portion and connected therewith, a valve having a cylindric body portion sliding on the body portion of the piston and arranged in the annular recess between the body portion and shell, said valve having an annular head to seat itself against annular seats on the shell and body portion of the piston, substantially as described.

2. In combination with a cylinder, a piston having a central body portion with an outer shell spaced apart from the body portion and connected therewith, a valve having a cylindric body portion sliding on the body portion of the piston and arranged in the annular recess between the body portion and shell, said valve having an annular head to seat itself against annular seats on the shell and body portion of the piston, the recess in which the annular valve body works forming a passage for the air or gas on the exterior of the valve and the said body portion of the piston having channels formed therein for the passage of the gas or air on the interior of the valve, substantially as described.

3. In combination a cylinder, a piston, an annular valve member slidable on a portion of the piston and means for controlling the movements of the valve in respect to the piston comprising a member connected with the valve and bearing on the interior of the cylinder, said controlling member extending through an opening or openings in the piston, substantially as described.

4. In combination a cylinder, a piston, an annular valve member slidable on a portion of the piston, and means for controlling the movements of the valve in respect to the piston comprising a member connected with the valve and bearing on the interior of the cylinder, said controlling member being formed in sections, substantially as described.

5. In combination a cylinder, a piston having a shell with openings therein, a valve within the shell, controlling means for the valve slidably engaging the interior of the cylinder, said shell having an opening, the said controlling means which has frictional sliding contact with the cylinder wall having a portion extending through the opening and connected with the valve, substantially as described.

6. In combination a cylinder and piston, a valve slidable in relation to the piston and arranged within a portion thereof, said portion being perforated, and a valve

retarding member bearing on the wall of the cylinder and having a portion of less extent than the perforation of the piston extending through said perforation and connected with the valve, so that the valve will be picked up by the piston after the latter has performed a part of its stroke, substantially as described.

7. In combination a cylinder, a piston having a head and a shell-like body portion, a valve within the shell, said shell having openings, and a member between the shell and the wall of the cylinder having sliding frictional contact with the latter, said member being formed in sections and having portions extending through the openings in the shell and connecting with the valve, substantially as described.

8. In combination a cylinder, a piston, a valve within the piston, a split ring between the piston and cylinder, a packing ring holding the parts of the split ring together, said piston having openings and said split ring having portions extending through the openings and engaging the valve, said openings allowing the valve to lag but causing the picking up of the valve, by their walls engaging the portions of the split ring extending through them, substantially as described.

9. In combination a cylinder, a piston therein having a head at one end, a reduced body portion consisting of a shell and an inner part connected by means at one end leaving an annular recess between the parts to one side of the arms, the said inner part of the piston having channels extending longitudinally, an annular valve having a body portion sliding on the inner part of the piston but leaving the recess and channels open to supply gas or air to the valve seat, a split ring surrounding the reduced shell of the piston, and bearing frictionally upon the inner wall of the cylinder, said split ring having portions extending through openings in the shell and fitting in recesses in the valve, substantially as described.

10. In combination a cylinder, a piston having passage ways longitudinally through it with a seat at one end, an annular valve having a portion adapted to seat to close or open the passageway, retarding means for the valve arranged exterior to the piston and between it and the cylinder and bearing on the latter, said piston having an opening and the said exterior retarding means being connected with the valve through the said opening, substantially as described.

11. In combination a cylinder having enlarged ends forming shoulders providing seats for discharge valves, coaxially arranged with the cylinder, cylinder heads each having an extension forming on its outer side a seat for one of the discharge valves, discharge valves, one of said valves being of disc form and one of ring form, a double piston, means for introducing the fluid into the cylinder between the pistons, ring valves carried by the pistons and of substantially the full diameter thereof, the disc discharge valve being normally spaced apart from the end of the cylinder extension, a spring on the outer side of each cylinder head extension bearing on the valve, and a piston rod passing through the ring-shaped discharge valve and the cylinder head extension on which said ring valve slides, substantially as described.

12. In a compressor the combination of a cylinder and piston, a ring-shaped discharge valve at the end of the cylinder, said cylinder having a shoulder against which the ring valve seats itself, and having a head within extension provided with an annular recess, said ring-shaped valve having a sleeve portion slidable in the annular recess, packing on both sides of the said sleeve portion and a spring in rear of the ring-shaped valve, substantially as described.

13. In combination in a compressor, a cylinder, a piston, a ring-shaped valve carried by the piston within the end thereof and having a portion extending within the piston and a fluid cushion controlling the action of the valve, said cushion comprising a space between the cylinder and piston, and a member connected with the valve and operating in the said space.

14. In combination in a compressor, a cylinder, a piston, a valve carried by the piston, and a member connected with the valve and forming a piston-like member and a dash pot space in which the said piston-like member operates to control the valve against hammering, substantially as described.

15. In combination a cylinder, a piston, having a head with a portion of reduced diameter, to one side of said head leaving a space between the reduced portion and the cylinder wall, a valve carried by the piston and a member connected with the valve, said member bearing on the cylinder and having a piston-like action in the said space to cushion the action of the valve, and a small port leading from said space and communicates with the interior of the cylinder, substantially as described.

16. In combination a cylinder having an enlargement of its bore near its end providing a shoulder directed outwardly, a head for said cylinder having an extension coaxial with the axis of the cylinder, a piston, a piston rod passing through the extension, a stuffing box for the piston rod in the said extension, said extension having an annular recess, a ring-shaped valve having a sleeve portion working on the out-side of the ex-

tension and in the annular recess, packing for said sleeve portion within the recess and on the extension, and a spring bearing on the valve and on the head outside of said sleeve portion, said head extension being hollow, and means for circulating a cooling medium through the said extension, substantially as described.

17. In combination in a compressor, a cylinder, a piston having a portion of reduced diameter providing a space between the same and the wall of the cylinder, a ring-shaped valve at one end of the piston, said piston having an annular seat for both the outer and inner edges of the ring-shaped valve and having also an interior portion spaced apart from the exterior portion or shell, said shell and interior portion being connected together at one end of the piston, said valve having a cylindrical extension slidably mounted on the inner portion of the piston with passages on the outer side and inner side of said valve extension and within the piston, a member connected with the valve extension extending through an opening in the shell of the piston and working in the space between the reduced portion of the piston and the cylinder wall to cushion the action of the ring valve, substantially as described.

18. In combination in a compressor, a cylinder, a piston having a rear portion of reduced diameter providing a space between it and the cylinder wall, said piston comprising an outer shell portion and an inner portion spaced apart therefrom, a piston rod connected with the inner portion, a ring-shaped valve seated at its outer and inner edges upon the shell portion and inner portion of the piston and having a cylindrical extension slidable upon the inner portion of the piston, said piston also having a free space for the passage of the fluid between its shell and cylindric extension of the ring-shaped valve, and having channels in its inner portion connected with the inner valve seat and having also a lateral opening through its reduced diameter portion, a member working in the space between the reduced diameter portion and the cylinder wall and connected through said lateral opening with the cylindric extension of the ring-shaped valve, said member bearing on the cylinder wall and acting with the said space to cushion the action of the ring-shaped valve, substantially as described.

19. In combination in a compressor, a cylinder, a piston having a rear portion of reduced diameter providing a space between it and the cylinder wall, said piston comprising an outer shell portion and an inner portion spaced apart therefrom, a piston rod connected with the inner portion, a ring-shaped valve seated at its outer and inner edges upon the shell portion and inner portion of the piston and having a cylindrical extension slidable upon the inner portion of the piston, said piston also having a free space for the passage of the fluid between its shell and cylindric extension of the ring-shaped valve, and having channels in its inner portion connected with the inner valve seat and having also a lateral opening through its reduced diameter portion, a member working in the space between the reduced diameter portion and the cylinder wall and connected through said lateral opening with the cylindric extension of the ring-shaped valve, said member bearing on the cylinder wall and acting with the said space to cushion the action of the ring-shaped valve, the shell portion and inner portion of the piston being connected together at one end of the piston and the said member being formed in sections and held within a groove of the cylindric portion of the ring-shaped valve, substantially as described.

In testimony whereof I affix my signature.

DAVID FRANKLIN SMITH.