B. RATHMELL.

AIR OR GAS COMPRESSOR.

APPLICATION FILED MAR. 28, 1908.

1,001,301.

Patented Aug. 22, 1911.

4 SHEETS—SHEET 1.

FIG. 1.

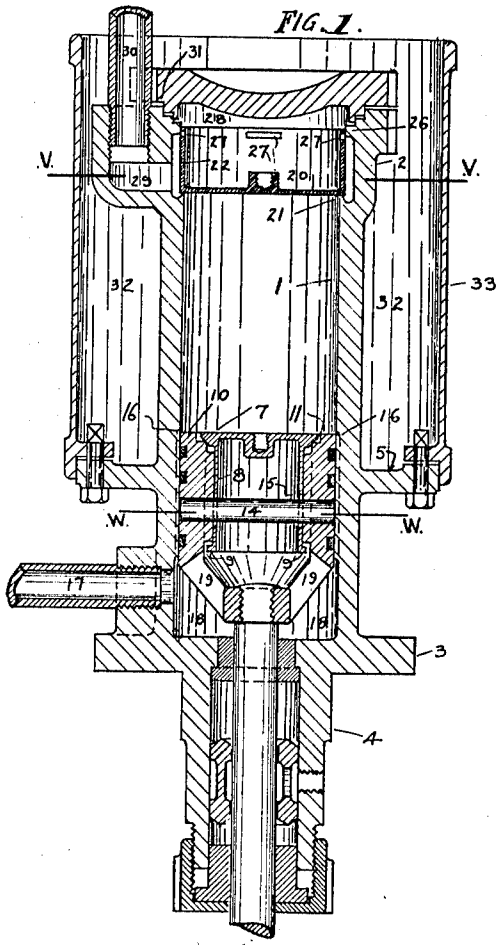


FIG. 3.

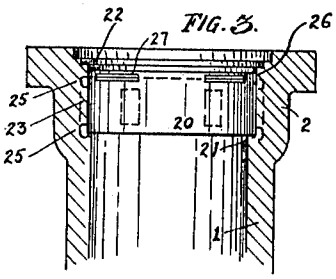


FIG. 4.

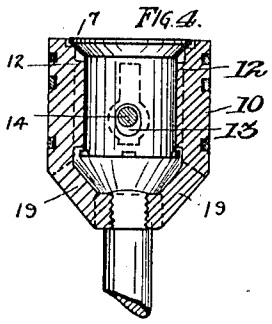


FIG. 5.

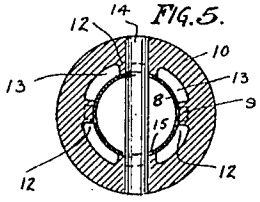
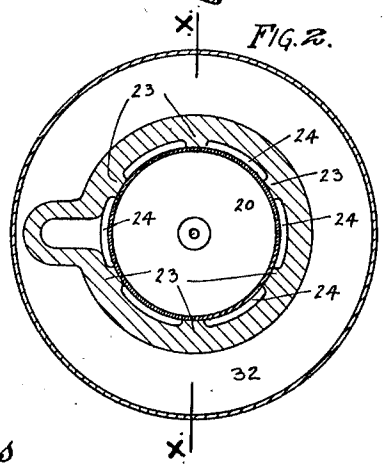


FIG. 2.



Witnesses
John H. Walker
Walter Beresford

Inventor
Bernard Rathmell

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4 SHEETS—SHEET 2.

FIG. 6.

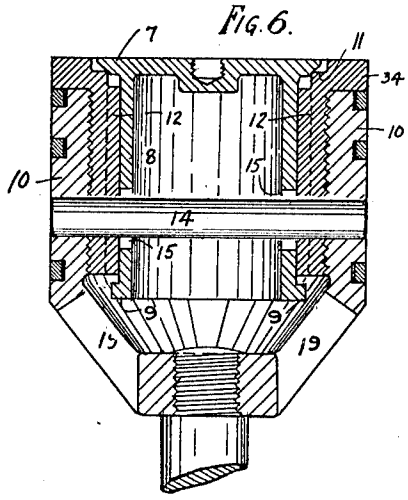


FIG. 8.

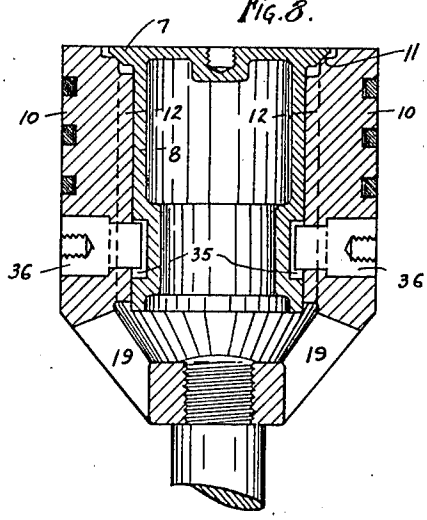


FIG. 7.

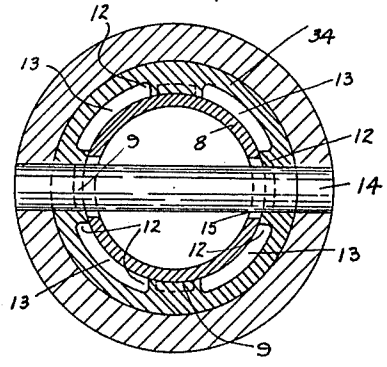


FIG. 9.

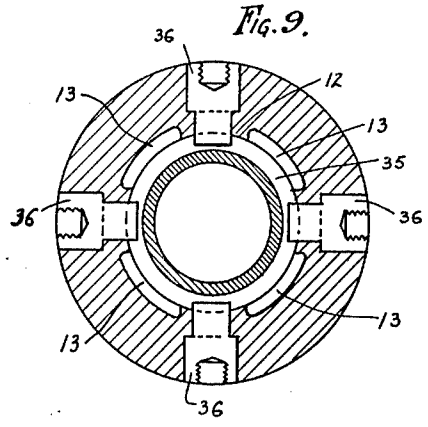
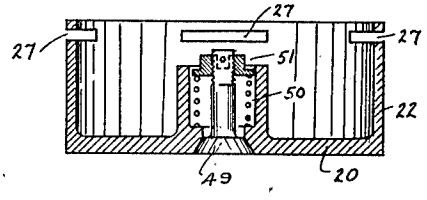


FIG. 13.



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4 SHEETS—SHEET 3.

FIG. 10.

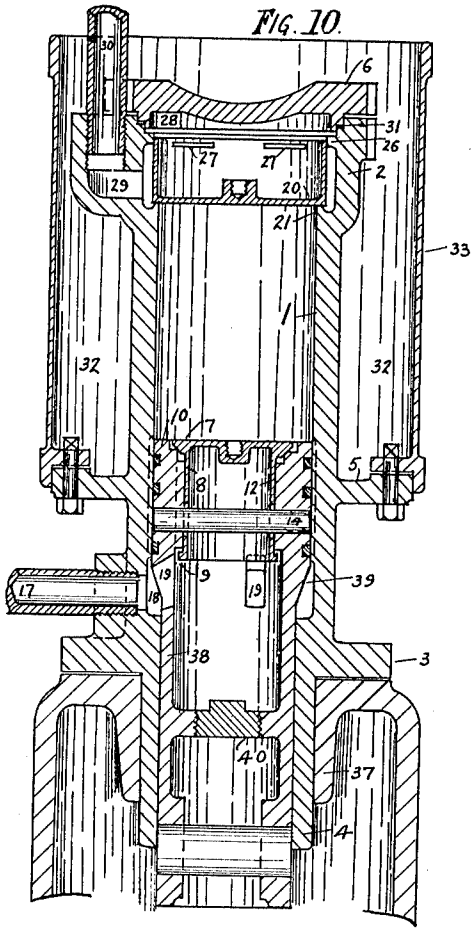


FIG. 11.

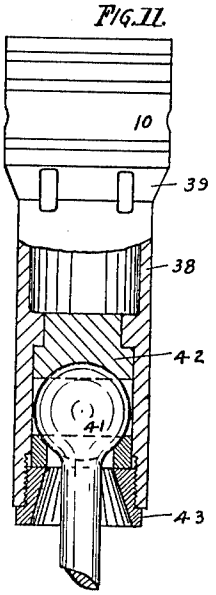
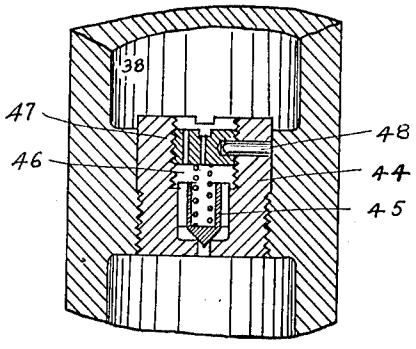


FIG. 12.



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4 SHEETS—SHEET 4.

Fig. 14

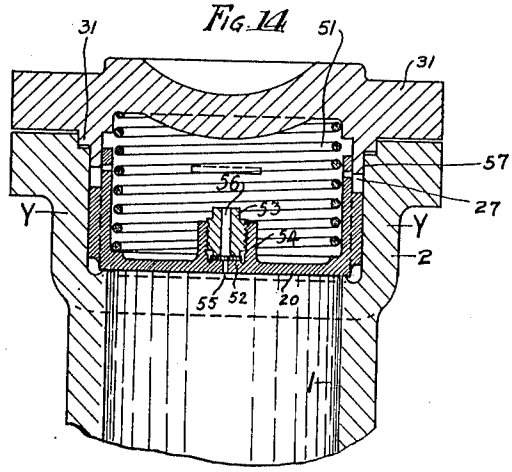


Fig. 16

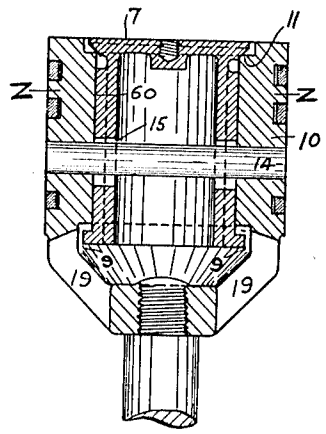


Fig. 15

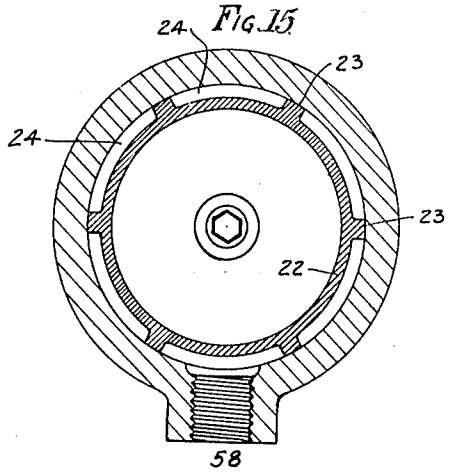
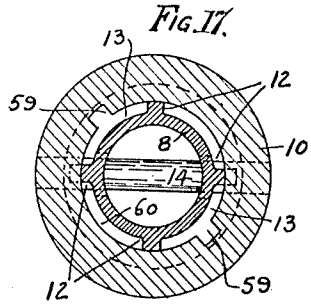


Fig. 17.



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UNITED STATES PATENT OFFICE.

BERNARD RATHMELL, OF LIVERPOOL, ENGLAND.

AIR OR GAS COMPRESSOR.

1,001,301. Specification of Letters Patent. Patented Aug. 22, 1911.

Application filed March 28, 1908. Serial No. 423,952.

To all whom it may concern:

Be it known that I, BERNARD RATHMELL, a subject of the King of England, and a resident of 10 Victoria street, Liverpool, in the county of Lancaster, England, engineer, have invented certain new and useful Improvements in and Relating to Air or Gas Compressors, of which the following is a specification.

My invention relates to compressors for air and other gases, more particularly of the vertical single acting type, such as are used for refrigerating and ice making purposes; of the kind in which the suction valve is provided with a cylindrical extension adapted to operate in guides contained within a piston: and also of the kind in which the discharge valve covers the full diameter of the cylinder bore.

My invention has for its main object to so construct both suction and delivery valves that the employment of pieces attached to the valves is obviated.

I thus effect simplification of manufacture of such compressors, reduction of liability to stoppage or breakdown during operation: and also render the machine capable of being worked at high speeds.

In a compressor, according to my invention, the suction valve is in one piece, and is placed inside the piston. The valve head has a cylindrical extension which slides within radial wings or fins within the piston, which fins act as guides to keep the valve central with its seat. The valve is prevented from leaving its guides by a pin or pins placed in the piston and kept in position by the compressor cylinder walls; a gas passage is formed outside the cylindrical extension on the valve; the seating and radial guiding wings for the valve may be in one with the piston body, or alternatively disposed on a special seating fitted within the piston, such seating being locked in position by the same pin or pins which are used to retain the valve in its guides; the piston is hollow and holes are provided for the passage of gas to the suction valve. Further, according to this invention, the delivery valve is made in one piece and of the full diameter of the compressor bore, a seating being provided for it on the metal of the cylinder walls; said valve is provided with a cylindrical extension which slides in guides in the cylindrical head of the compressor, such head being of greater diameter than the compressor proper, the extreme part of the cylindrical extension on the valve enters a corresponding part of the compressor's head or cover, and suitable slots are arranged to provide for cushioning when the valve lifts. A spring or springs may be placed within the cylindrical valve to bear against the compressor cover; gas passages are provided outside the cylindrical extension on the valve. I prefer to inclose the working part of the compressor cylinder, and the compressor delivery or discharge head in a water jacket.

In single acting compressors, I provide an opening at the inner or suction end of the bore through which the suction or incoming air or gas is admitted to the suction side of the hollow piston; grooves, or other suitable means may be provided for opening the compressor bore to the suction gas direct at the end of the stroke.

A machine made according to my invention may have one or more compressors worked from the same crank shaft; in a machine having more than one compressor a bearing is preferably provided between each crank. Further, in a small compressor the connecting rod which operates it may be made with the small or cross head end of spherical shape, this spherical end bears against a metal shoe on the compression stroke, and is kept in position by a bell mouthed piece through which the connecting rod passes.

It may be here stated that I am well aware that ball joints are known and used in various apparatus, other than machines of the type herein described.

In a machine of the inclosed type, according to this invention, the piston is of trunk pattern, and is made of two diameters, the larger diameter part is the piston proper, which is hollow; and the part of smaller diameter is extended for the connecting rod attachment, and slides in a guide of corresponding diameter made solid with the compressor cylinder; inlet gas ports to the hollow piston are placed at the shoulder formed by the change of diameters; this disposition of the gas ports in the shouldered part of the piston accelerates the speed of the gas passing into the piston on the suction stroke. Between the inlet gas ports at the piston shoulder and the point at which the con-

necting rod is attached, a solid partition is placed, so that the hollow piston is not open direct to the crank casing inside which the connecting rod works.

The crank casing or frame of an inclosed machine may be connected through a non-return or relief valve to the suction side of the machine. In such a machine the crank or cranks work through an oil bath, and the crank shaft passes through a bearing and gland; means are provided for ascertaining the oil level, and for filling in oil when required. The compressor cylinder is flanged and bolted to the frame of the machine. It is accurately centered by a bored guide on the frame into which an extension of the cylinder fits.

Drawings illustrating my invention are annexed hereto, in which:—

Figure 1 is a sectional elevation of a compressor, piston and valves, suitable for a machine of the open type (that is operated by connecting rod, cross head, and piston rod). Fig. 2 is a sectional plan through the compressor head taken as on line V—V, Fig. 1. Fig. 3 is a vertical section through the compressor head taken as on line X—X Fig. 2 but showing the discharge valve in elevation. Fig. 4 is a vertical cross section through the piston, but showing the suction or inlet valve in elevation. Fig. 5 is a sectional plan through the piston on line W—W Fig. 1. Fig. 6 is a section of a piston and valve according to my invention, with the suction valve seating and guides disposed on a separate piece screwed into the piston body. Fig. 7 is a sectional plan of Fig. 6 through center of retaining pin. Fig. 8 is a section of a piston and valve, according to my invention, in which two or more short retaining pins are used instead of one long pin. Fig. 9 is a sectional plan of Fig. 8 through centers of retaining pins. Fig. 10 is a vertical section of a compressor, trunk piston, and valves, according to my invention, suitable for machine of inclosed type. Fig. 11 is a trunk piston adapted to be operated by a connecting rod with a spherical cross head end. Fig. 12 shows a relief valve fitted to the crank casing of an inclosed machine; and Fig. 13 shows a safety valve fitted inside the compressor discharge valve. Fig. 14 is a section through compressor head showing guiding fins disposed outside valve extension instead of inside compressor head; also shows a spring or discharge valve and a relief disk. Fig. 15 is a section through line Y—Y of Fig. 14. Fig. 16 is a section through a piston showing the guiding fins disposed on outside of suction valve extension instead of inside piston body. Fig. 17 is a section through line Z—Z of Fig. 15.

In the several figures of the drawings like characters of reference denote like or corresponding parts wherever they occur.

Referring now more particularly to Figs. 1 to 5:—1 is the compressor cylinder body, 2 the compressor discharge head, 3 a flange for attaching compressor to the frame of the machine; and 4 is a spigot or guide formed outside the stuffing box to insure the compressor being truly central with frame; 5 is a flange for carrying the water jacket casing, and inlet and outlet water connections. 1, 2, 3, 4, 5, are all in one piece and all concentric to the center line; this insures that all operative parts of the compressor are truly in line, and renders the machining of the compressor simple. 6 is the compressor cover, jointed and bolted to compressor head. The inlet or suction valve 7 has a cylindrical extension 8 as guide, at the bottom of which guide are lips or projections 9, which act as stops to limit the amount of valve lift; on the piston 10 is the valve seating 11, and also the guiding fins 12, 12 for the cylindrical guide 8 of the valve. Between the guiding fins 12, 12 and outside the guide 8 of the valve are the gas passages 13, 13. 14 is the retaining pin, which is made in length equal to the diameter of the piston, so that when the piston is in the cylinder this pin can not get out of place; pin 14 fits in the piston body at each end, and passes through holes 15 15 in the valve guide, which holes are made wider than the pin diameter to allow some rotary motion to the valve, and are of such depth that the top and bottom of same are clear of pin when the valve is seated, and also when the stops 9 of the valve are against the bottom end of the guiding fins 12, 12; the bottom ends of the fins 12, 12 are machined, so as to permit of the exact amount of valve lift required, and to provide a fair surface for the stops 9 to beat against; the pin 14 and width of the holes 15 are so arranged that, while some rotary motion is allowed, the valve cannot rotate far enough for the valve stops 9 to get clear from under the guiding fins 12, 12; if from any cause the valve stops 9 fail, the pin 14 constitutes a stop for limiting the valve lift, and prevents the valve from leaving the piston.

The suction valve disk or head 7, with the cylindrical guide 8 and projecting stops 9, 9 are all in one solid piece of metal, and no other pieces are screwed on or attached, thus any trouble from parts unscrewing or becoming loose is avoided; the valve seat may be made conical, flat or radial. The interior part of the guide 8 above the holes 15 is closed or left blank, so that some of the inlet gas flowing through the piston becomes trapped or baffled in this part and helps to lift the valve off its seat, and to keep it open throughout the suction stroke.

The disposition of the valve seating and the guiding fins integral therewith insures the one being in true alinement with the

other, and when the seating is placed direct on the piston body, it is possible to make the suction valve almost as large in diameter as the compressor cylinder bore; this gives large area, and ample gas passage through the valve, with small valve lift. Additional gas passages may be provided by placing grooves 16, 16, in the cylinder, so that when the piston is at the bottom, the compressor space is open direct to the inlet gas space; this would insure compressor cylinder being absolutely filled by gas at the full inlet pressure.

In operation the incoming or suction gas passes through inlet pipe 17 into the space 18, and through the ports 19, 19, in the lower part of the piston body, to the underside of the suction valve. The full bore of the compressor is covered by the discharge valve 20 which has a seating 21 on the end of the compressor cylinder. The valve 20 has a cylindrical guide 22 extending upward, and made solid with the valve; this guide slides between guiding fins in the compressor head; between the fins 23, 23 are the vertical gas passages 24, 24, while circumferential passages 25 25 are provided by cutting away parts of the guiding fins 23, 23; above the passages 25, 25 and the fins 23 is a solid ring of metal 26, into which the end of the cylindrical guide 22 enters, and which provides a cut off edge for the slots 27 27 in the guide 22. These slots are so arranged that when the valve lifts beyond a certain distance the slots 27 27 pass the bottom edge of the ring 26 and thus inclose the space 28, which then forms a dash pot or gas cushion, and brings the valve to rest by increased pressure on top; this action tends to prevent any excessive lift. A spring may also be placed on discharge valve if necessary somewhat as shown in Fig. 14 when a spiral spring 51 is adapted to bear against cover 6 on top of valve 20. By making the discharge valve of the full cylinder diameter, the piston may actually pass through the valve seating, if necessary, and the clearance at the end of the compression stroke is reduced to a minimum; ample gas passage is secured, and the valve lift can be very small. A further advantage is that the large valve gives such a free exit from the compressor that if, from any cause, liquefied gas gets into the cylinder, it can be discharged easily without danger of damaging the compressor cover. The valve 20 and guide 22 being solid with one another, there are no small parts to get loose or break; the valve seating and the guiding fins are on the same metal which insures accurate alinement; the seating may be flat, conical or radial. The discharge gas passes from the compressor head through the branch 29 to the pipe 30; 31 is the compressor cover joints; 32 is the water jacket space, and envelops the compressor cylinder, the discharge head, and branch, and the compressor cover; 33 is the water jacket casing, which is attached to the flange 5. Casing may be either open or closed at top.

Referring now to Figs. 6 and 7:—When, for any reason, it is desired to put in a separate valve seating on the piston body, the piston, valve, and valve seating piece, may be arranged as shown in these figures. 7 is the suction valve with cylindrical guide 8 and stops 9, 9. 12, 12 are the guiding fins and 11 the valve seating, both being disposed on the separate seating piece 34, which is screwed into the piston body 10; the seating piece 34 is screwed hard down on the piston body 10, and the retaining pin 14 passed through the two of them, and through the holes 15 in the valve guide; the pin 14 is a fit in the piston body, and in the seating piece and prevents the latter from slacking back; the holes 15 in the guide are larger than the diameter of the retaining pin—as before described—; the passages 13, 13, for the gas are between the guiding fins 12, 12 in the seating piece, and outside the cylindrical guide 8 of the valve.

Referring now to Figs. 8 and 9: An alternative arrangement is shown whereby the suction valve is left free to rotate. In this arrangement, the valve 7 has a cylindrical guide 8, but instead of the stops 9, it is provided with an annular recess —35— into which project the ends of two or more retaining pins 36, 36; these pins fit in the piston body, and are kept in place by the cylinder walls; and prevented from projecting into the valve recess too much by shoulders on the pins. The recess 35 is deeper than the diameter of the projecting ends of the pins, so that when the valve is on its seat, the top of the recess is clear of the top of the pins, and the distance between the bottoms of the pins and the bottom of the recess fixes the amount of valve lift. The pins 36 prevent the valve from leaving its guides, and at the same time leave it free to revolve. Passages 13, 13, for the gas are provided, as before. This arrangement may also be employed when a separate seating piece is screwed into the piston. Alternatively, in either suction valve the guiding fins may be placed on the exterior of the cylindrical valve extension, instead of on the interior of the piston, or the special seating piece; in which case the interior of the piston, or of the special seating piece, will be a plain bored guide to receive the valve guiding fins. Such a valve is shown in Figs. 16 and 17 where the valve head 7 has a cylindrical extension 8 on which are formed the ribs or fins 12 adapted to slide within the plain guide 60; two opposite fins have projections 9, 9, at these lower ends which act as stops

by coming against the under side of the solid guide 60; to allow for the insertion of these projecting stops 9, 9, two slots 59, 59, are formed in the guide 60; after valve guide is lowered into position through these slots, it is slightly turned to bring stops under solid part and pin 14 put into position. Further, in the compressor head the guiding fins for the valve may be placed on the exterior of the cylindrical extension of the valve, instead of on the compressor head, this latter being then bored plain, as shown in Figs. 14 and 15 where the valve 20 has cylindrical extension 22 on which are formed the guiding fins 23 which are cut away at top and bottom to give circumferential passage for gas. The slots 27 as before described engage with a cut off edge 57 formed on the compressor cover; gas passages 24, 24 are formed between the fins as before described. The outlet passage 58 may be led straight out.

Referring now to Figs. 10 and 11;—Fig. 10 shows a compressor cylinder and trunk piston for a machine of the inclosed type, that is, with the crank and connecting rod operating within an inclosed casing—generally in an oil bath. The inlet gas is taken to the compressor cylinder through the pipe 17 communicating with the suction space 18; the compressor cylinder has an extension 4 which acts internally as a guide for the piston trunk, and externally as a spigot in the corresponding sleeve 37 on the crank casing, to insure the compressor being central with same. The piston body 10 is made hollow for the suction valve, and is integral with a trunk 38 of smaller diameter, to which it is joined by a short taper piece 39; in the shoulder so formed are placed the inlet gas ports 19, 19. On the suction or down stroke the action of this descending shoulder is to force the gas from the annular space beneath it, and, between ports 19, 19, to the suction valve. The extended trunk is utilized for coupling up the connecting rod, and serves to prevent oil splashing into the compressor; small grooves are placed circumferentially on the exterior of the trunk to carry up some oil for the lubrication of trunk and cylinder; the interior of the piston trunk is closed at 40, so that there is no direct opening between crank casing and compressor cylinder bore.

Fig. 11 shows a method, suitable for small machines, of coupling up the connecting rod to the trunk piston. The connecting rod end 41 is made spherical in shape, and bears, during the compression stroke, on a shoe 42 fitted inside the trunk; the spherical end is kept up in place by a nut 43, this nut being kept from slacking back by a pin through the trunk metal. For a single acting compressor, this spherical end gives greater bearing surface on the compression stroke than can be obtained by the use of the ordinary gudgeon pin in a trunk piston. It should be noted that this spherical end can be similarly used in the cross head of small open type compressors.

In a machine of the inclosed type, I prefer to fit a relief valve to the crank casing, in order to prevent any accumulation of pressure, higher than the suction pressure, inside the crank casing. Fig. 12 shows a method of doing this:—Into the closed partition above the connecting rod end, a plug 44 is screwed and fastened; this plug carries a relief valve 45 with suitable guiding wings, the relief valve is held in position by a light spring 46 bearing against an adjustable nut 47, which is prevented from moving when once set by a pin 48, the said pin being unable to shift after the plug 44 is screwed into position; holes are left in nut 47 for gas escape. When the spherical ended connecting rod is fitted this relief valve will be placed in the bearing shoe 42 shown in Fig. 11. The action being that when any pressure accumulates in the crank casing materially higher than the suction pressure within the hollow piston, the valve 45 will be lifted and the pressure relieved.

In compressors, according to this invention, the possibility of accident, which arises if the machine is started with the discharge stop valve closed, is guarded against by placing a safety valve inside the compressor discharge valve, and this is shown in Fig. 13. In the solid discharge valve 20 a valve seat is machined, and a valve 49 placed therein; this valve is held to its seat by the spring 50 bearing against the nut 51, which is adjustable and can be set to give way under any suitable excess of pressure. Thus should the machine be started with the discharge conduit blocked, the pressure inside the cylinder head will rapidly rise until it reaches the limit at which the safety valve is set to open; when the valve opens this pressure relieves itself into the cylinder, and prevents the suction valve from being opened, and no more gas will be pumped. Alternatively, instead of a spring loaded valve, a diaphragm of thin metal may be placed over a small relief hole, the metal being of such a thickness that it will burst under the excess pressure. Such an arrangement is shown in Fig. 14 where 52 is a thin metal disk of known strength held in place over a small hole 55 in discharge valve by a screw plug 53 with a hole 56 bored through allowing gas pressure to come direct on disk: a boss 54 is formed on back of discharge valve and machined out for disk and screwed plug: the disk metal is soft enough to make a gas tight joint. This arrangement of placing the safety valve within the discharge valve avoids the necessity of fitting the pipe connections required when a relief valve is

fitted outside to blow off the discharge branch into the suction branch, or, on the other hand, avoids the loss of gas which is sustained when a relief valve is placed so as to blow off into the atmosphere.

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

1. In a compressor for compressing air or other gas; in combination, a piston in one piece, a valve seating, valve guides, and valve stops integral with said piston, a suction valve comprising a valve head, a hollow cylindrical extension adapted to work within said guides on the piston, and outward projections on the lower end of said cylindrical extension adapted to engage with said valve stops on the piston, said valve head, cylindrical extension, and stops being integral with each other, a safety retaining pin for said valve adapted to pass through said cylindrical extension on the valve and through said piston and be maintained in position by the cylinder wall, and means whereby said valve is permitted certain rotary motion and normally prevented from "knocking" against said pin.

2. In a compressor for compressing air or other gas; in combination, a piston in one piece, a valve seating, valve guides, and valve stops integral with said piston, a suction valve comprising a valve head, a hollow cylindrical extension adapted to work within said guides on the piston, and outward projections on the lower end of said cylindrical extension adapted to engage with said valve stops on the piston, said valve head, cylindrical extension, and stops, being integral with each other, a safety retaining pin for said valve adapted to pass through said cylindrical extension on the valve and through said piston and be maintained in position by the cylinder wall, means whereby said valve is permitted certain rotary motion and normally prevented from "knocking" against said pin, a discharge valve seating, guides, and inwardly projecting ring all integral with each other and disposed within the discharge chamber of the compressor, and a discharge valve having integral therewith a hollow cylindrical extension adapted to work in the said guides within the discharge chamber, said discharge valve being of not less diameter than the compressor bore.

3. In a compressor for compressing air or other gas, a compressor cylinder and gas discharge chamber having integral therewith a discharge valve seating of the full cylinder diameter, discharge valve guides and an inwardly projecting ring, a discharge valve of not less diameter than the diameter of the cylinder bore having integral therewith a hollow cylindrical extension adapted to work within the said guides, and ports in said cylindrical extension adapted to be closed by said inwardly projecting ring during the upward travel of said valve to form a dash-pot for the purpose specified.

4. In a compressor for compressing air or other gas, a suction valve comprising a valve head and a cylindrical guide extension disposed within a piston; fins whereby said valve is maintained central with its seat, the spaces between said fins being adapted to form gas passages; a pin passed through the piston and cylindrical valve guide; said pin being maintained in position by the cylinder walls; an extension on said cylinder; a piston trunk of lesser diameter than the piston proper and integral therewith adapted to work in said cylinder extension as a guide, and adapted for connection to an operating rod; gas ports in said trunk, and means whereby said piston trunk is closed near its lower end.

5. In a compressor for compressing air or other gas, a suction valve comprising a valve head, and a cylindrical guide extension disposed within a piston; fins whereby said valve is maintained central with its seat; the spaces between said fins being adapted to form gas passages; a pin passed through the piston and cylindrical valve guide, said pin being maintained in position by the compressor cylinder wall; an extension on said compressor cylinder; a piston trunk of lesser diameter than the piston proper and integral therewith, guided in said compressor cylinder extension and adapted for connection to an operating rod; gas ports in said trunk, and a relief valve disposed within said piston trunk and adapted to prevent any material accumulation of pressure, higher than suction pressure, in the crank casing.

6. In a compressor for compressing air or other gas, a suction valve comprising a valve head and a cylindrical guide extension; a sleeve, provided with a valve seating, secured to the piston, within which sleeve the said guide extension is disposed; means whereby said valve is maintained central with its seat; and a pin or pins passed through the piston, sleeve, and valve guide; said pin or pins being maintained in position by the cylinder wall.

7. In a compressor for compressing air or other gas, a suction valve, comprising a valve head, and a cylindrical guide extension disposed within the piston; fins integral with said piston, adapted to maintain said valve central with its seat; and a plurality of pins adapted to pass through said piston wall and enter an annular recess in said guide.

8. In a compressor for compressing air or other gas, a suction valve comprising a valve head and a cylindrical extension disposed within the piston; fins on said extension

adapted to bear against said piston, to maintain said valve central with its seat; projections on the lower part of said fins; slots provided in the piston, through which said projections are adapted to pass; and a pin passing through the piston and cylindrical extension on valve, such pin being maintained in position by the cylinder wall.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

BERNARD RATHMELL.

Witnesses:
JOHN HINDLEY WALKER,
WALTER BERESFORD.