Oct. 24, 1944. J. W. NEWTON ET AL 2,361,316

GAS COMPRESSOR

Filed Aug. 18, 1942 4 Sheets-Sheet 1

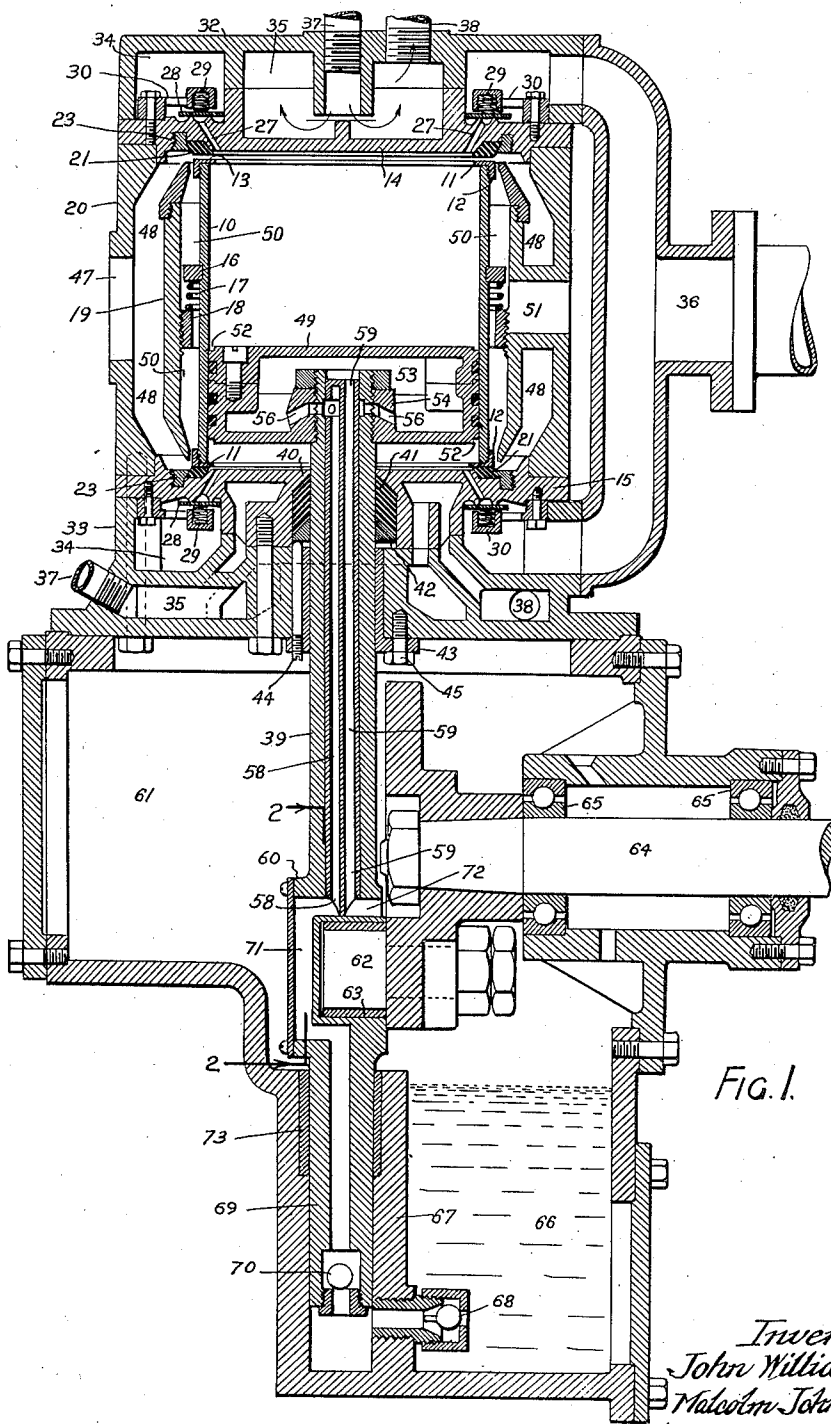


FIG. 1.

Inventors:-
John William Newton
Malcolm John Duff-Fyfe
by their Attorneys
Howson & Howson

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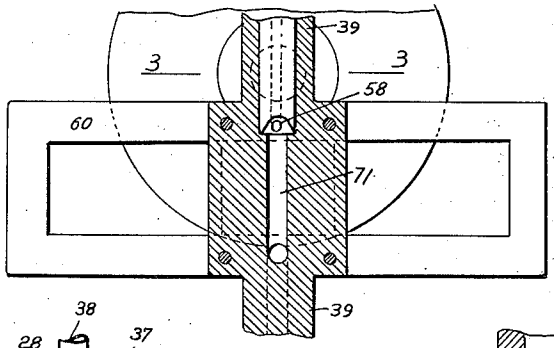


FIG. 2.

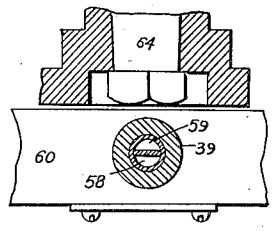


FIG. 3.

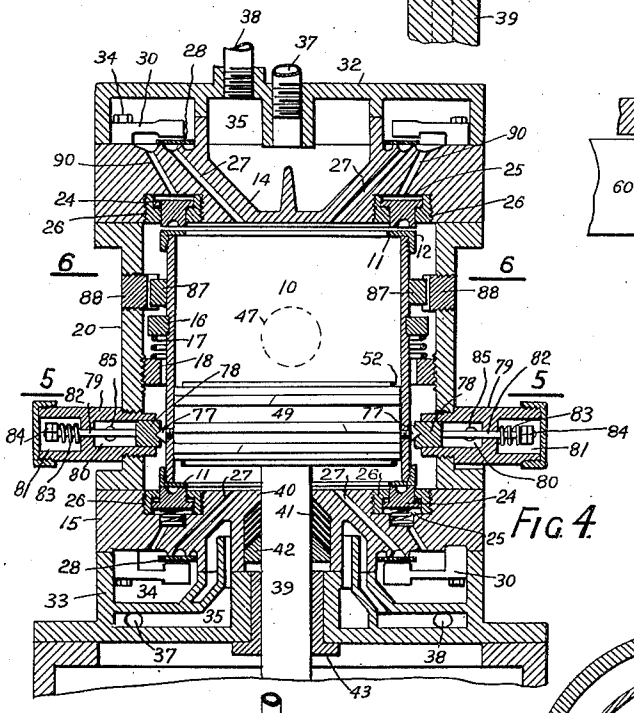


FIG. 4.

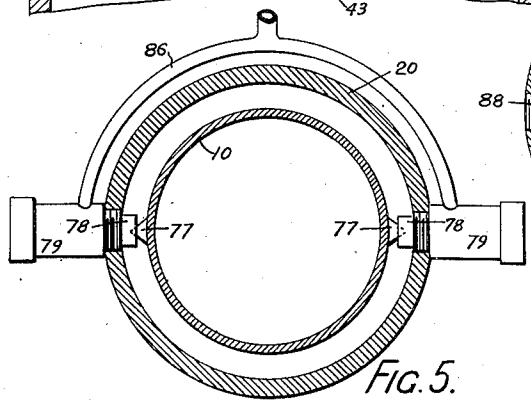


FIG. 5.

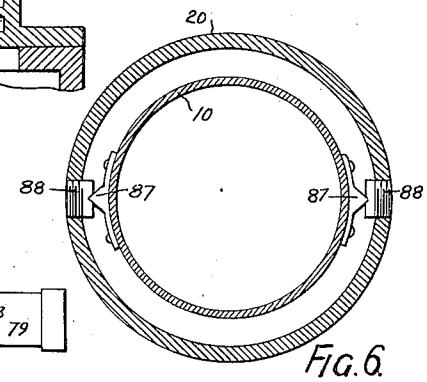


FIG. 6.

Inventors:-
John William Newton
Malcolm John Duff-Tyfe
by their Attorneys
Howson & Howson

Oct. 24, 1944. J. W. NEWTON ET AL 2,361,316

GAS COMPRESSOR

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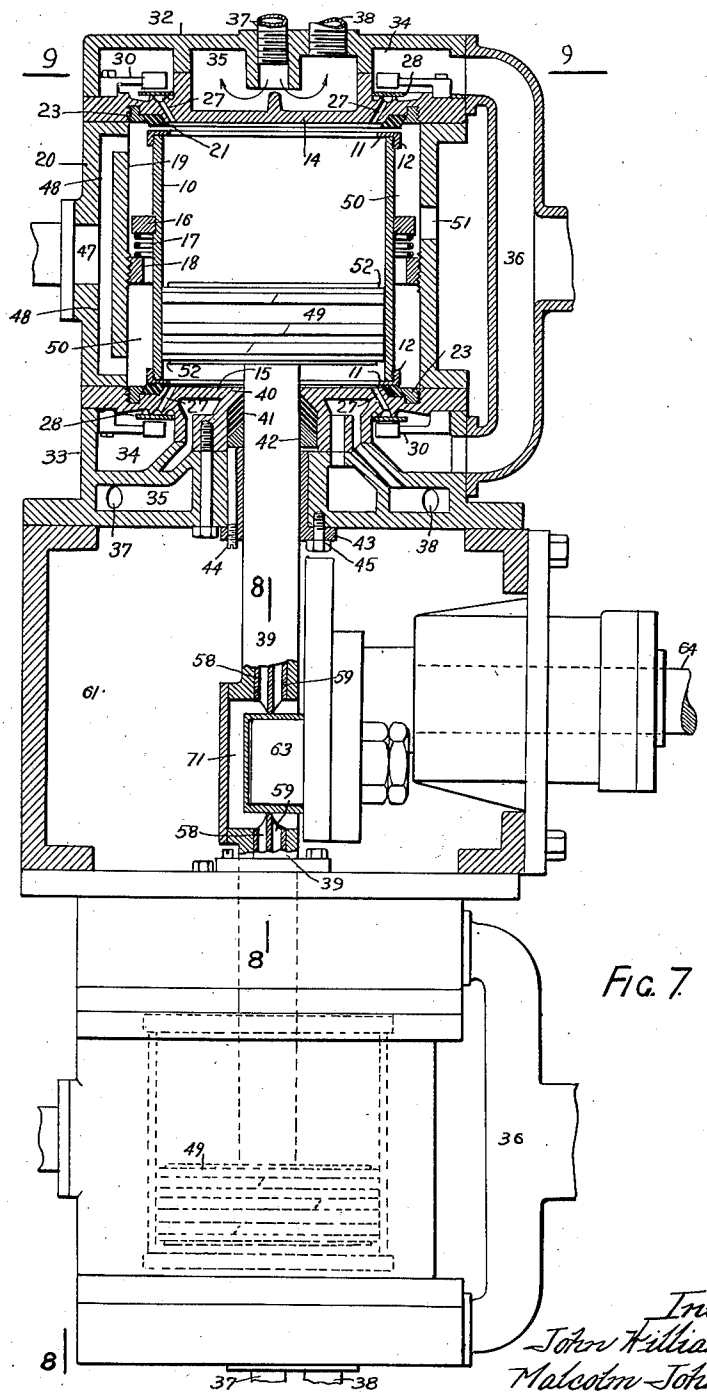


FIG. 7

Inventors:-
John William Newton
Malcolm John Duff-Fyfe
by their Attorneys
Howson & Howson

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GAS COMPRESSOR

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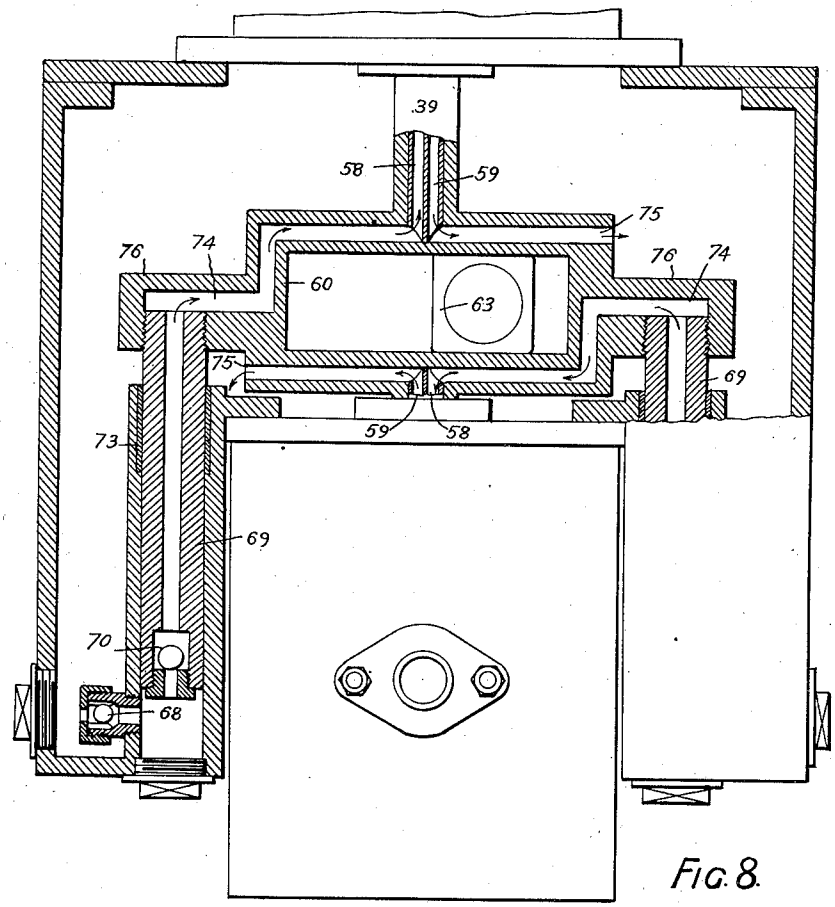


FIG. 8.

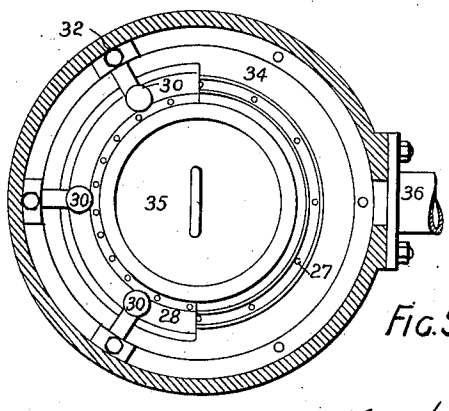


FIG. 9.

Inventors:-
John William Newton
Malcolm John Duff-Fyfe
by their Attorneys
Howson & Howson

Patented Oct. 24, 1944

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UNITED STATES PATENT OFFICE

2,361,316

GAS COMPRESSOR

John William Newton, Vaucluse, near Sydney, New South Wales, and Malcolm John Duff-Fyfe, Mosman, near Sydney, New South Wales, Australia, assignors to Commercial Steels and Forge Co. (Australia) Pty. Limited, Lidcombe, New South Wales, Australia, a company of New South Wales

Application August 18, 1942, Serial No. 455,228
In Australia September 16, 1941

13 Claims. (Cl. 230—179)

This invention relates to gas compressors and particularly to those moderate sized portable types used in industry; it has been devised to provide such a gas compressor of improved construction whereby the compressor unit and the gas under compression can be efficiently maintained at such low temperatures and the mechanical efficiency of the construction is such as will enable a single stage compressor to achieve a compression index substantially equivalent to that of the average two-stage compressor when operating at similar speeds and under similar conditions.

A further feature of the invention is the construction of a double-acting compressor which by reason of the facilities afforded by the construction to cool the working parts and the mechanical efficiency thereof can be operated at speeds higher than the speeds which existing compressors of similar dimensions can attain thereby increasing the output approximately proportionately to the speed increase.

A still further feature of the invention is the combination of parts whereby a compressor may be assembled having two opposed double-acting compressor cylinders having all the characteristics before mentioned.

Basically the invention is a floating self-aligning compressor cylinder which is free to reciprocate between end covers and is so moved by a piston reciprocating therein.

This self-aligning cylinder takes the place of the conventional intake valve or valves and provides the utmost freedom for air intake. The air intake is controlled by movement of the cylinder such movement being obtained from power that would otherwise be lost in friction that is, the tension of the piston rings against the cylinder wall. This feature in addition to providing a distinctly improved means of taking in air permits the cooling of substantially the entire compressor heads or covers as well as the compressor cylinder.

On each stroke of the piston the cylinder is moved by friction of the piston to seat against the end cover in the direction of movement of the piston. Compression of gas is effected between the piston and the said end cover. A port or ports in the cover lead to an outlet valve or valves which lift when the compression pressure exceeds that above the valves. On the return stroke the pressure in the said ports is gradually released and this permits of the valves seating gently. During this compression stroke gas is admitted to the other side of the piston through the clearance between the end cover and the cylinder and this gas is compressed on the next stroke of the piston.

Unloading means are provided to restrain the movement of the cylinder and to hold it centrally between the end covers when a predetermined compression pressure is reached so that during the period of restraint the reciprocation of the piston simply draws gas into the cylinder and discharges it again through the open ends.

Reciprocation of the piston is effected by a piston rod having the banjo frame of a harmonic link motion thereon. A crank pin in such frame is the actuating means. A circulating pump actuated by the banjo frame provides a cooling liquid for the piston which liquid is passed through ducts in the banjo frame and the piston rod to a cooling passage in the piston which traverses both faces thereof and the skirt.

The floating self-aligning cylinder permits the use of comparatively thin metal or metal alloy which could not be used in cylinders forming an integral part of a compressor casing as constructed hitherto. This thin metal provides for the effective transfer of heat which is taken away by gas circulating about the outer wall thereof. The end covers are cooled by water circulation.

The cooling of the cylinder and the end covers as aforesaid coupled with the cooling of the piston assists in the improvement of the compression index as previously stated and also makes possible the operation of a double acting compressor, both single and twin opposed cylinders, at high speeds not heretofore obtainable.

The use of the floating self-aligning cylinder of this invention is not of necessity confined to the reciprocating means described. Nevertheless it will be appreciated that the utilisation of the harmonic link motion as the means to reciprocate the piston makes a design of utmost simplicity capable of being erected with the least possible head room and with a very considerable reduction in moving parts.

The foregoing and other features of the invention will be described in greater detail with reference to the annexed drawings as applied to an air compressor wherein: Fig. 1 is a central sectional elevation of a double-acting compressor; Fig. 2 is a sectional elevation on line 2—2 of Fig. 1; Fig. 3 is a section plan on line 3—3 of Fig. 2; Fig. 4 is a sectional elevation illustrating an unloading device and a modified air cushioning means of seating the cylinder against the end covers; Figs. 5 and 6 are sectional plans on lines 5—5 and 6—6 respectively

of Fig. 4; Fig. 7 is an elevation (partly in section) of a compressor having two double-acting opposed cylinders; Fig. 8 is a sectional elevation approximately on line 8—8 of Fig. 7; Fig. 9 is a sectional plan on line 9—9 of Fig. 7.

Referring to Fig. 1, the cylinder 10 has at each end an internal flange or lip 11 which is conveniently made by screwing flanged rings 12 onto each end of the cylinder. The face 13 of these rings 12 constitutes a seating to seal the cylinder 10 against the end covers 14—15. On the outer wall of the cylinder 10 there is a collar 16 and there is a spring 17 between this collar 16 and a cylinder supporting ring 18 which is adjustable by screwing on the inner (cavity) wall 19 of cylinder casing 20, see Figs. 1 and 7. Where it is desired to construct a compressor with the wall 19 omitted the supporting ring 18 is mounted on the casing 20 (see Fig. 4). This variation in the construction relates to different methods of cooling the cylinder 10 and will be described later. The cylinder 10 may be of centrifugally spun cast iron or other metal of thin section which will provide for the effective transfer of heat through the wall to be carried away by cooling means.

It will be seen that the weight of the cylinder 10 is taken by the spring 17 and that the cylinder is free to reciprocate between the end covers 14—15. The amount of travel of the cylinder 10 is very little; it can be easily calculated to provide an unrestricted air inlet to the cylinder on the respective suction strokes.

Cylinder 10 is the compression chamber and by its movement is also an air inlet controller. The amount of projection of the internal lip 11 is calculated to enable the pressure of air under compression to be utilised to assist the frictional effort of the piston in sealing the cylinder against the end covers 14—15 on the respective compression strokes. This projection also provides a surface for that small portion of the compressed air remaining in the cylinder and outlet ports on completion of the compression stroke to act against and so prevent movement of the cylinder 10 until the piston has moved sufficiently to release such pressure; consequently there will be no harmful back-flow of air through the inlet, and the energy stored in the clearance volume of air is utilized in overcoming the inertia of the piston. This pressure of air also gives the discharge or outlet valve the necessary cushioning onto its seat thus preventing valve hammer.

End covers 14—15 are mounted on the casing 20; as the joint between the end covers is not required to resist pressure it can be a face joint. This factor enables the clearance between the piston and the end covers to be reduced to a practical minimum which provides for the appropriate expansion of the metals of the respective parts thereby increasing the volumetric efficiency of the compressor.

In the end covers 14—15 there is a seating ring 21 juxtaposed the face 13 of the rings 12. This seating ring 21 may be of any resilient material and it is secured into the end covers 14 and 15 by means of an annular screw-threaded ring 23. Fig. 4 illustrates a metal ring piston 24 which may be substituted for the seating ring 21; one such piston is slidably mounted in the annular chamber 25 located in each of the end covers 14 and 15. Each ring 24 is maintained in its annular chamber 25 by means of the annular screw threaded rings 26 and it is adapted to make contact with the flanged ring 12 by means of air pressure as will be explained later.

Outlet ports 27 in said end covers 14—15 are provided with annular disc valves 28 or other outlet valves of conventional construction. The valves illustrated are adapted to be controlled by the springs 29 located in the cup holders 30 which are secured to the end covers 14—15.

The covers 14—15 are provided with jackets 32 and 33 respectively and each of which is furnished with a pair of compartments 34 and 35, the former are in communication with the air outlet ports 27 and the common outlet 36. Through the latter a cooling medium such as water circulates, an inlet 37 and outlet 38 being provided. Additionally the cover 15 has a stuffing box for the compressor piston rod 39. This stuffing box consists of a neck ring 40, packing 41, gland ring 42 and a gland cap 43 furnished with screw threaded rods 44 to press the gland ring 42 against the packing 41; the gland cap 43 is held in place by studs 45.

Casing 20 has an air inlet 47 with ports 48 to each end of the cylinder 10. Air is drawn into the compressor by the action of the piston 49 therein and it may be assisted by a low pressure fan to act as a supercharger. Where a fan is used it is designed to deliver more air than the cylinder can absorb the surplus passing through the ports 50 to cool the cylinder 10 and then discharging to atmosphere through port 51.

In an alternative construction where a supercharger fan is not desired the inner wall 19 of the casing 20 is eliminated (see Fig. 4) thus providing a free passage of air from the air inlet 47 around the cylinder 10 and thence to the compression chamber. This construction may be preferred in some cases although there is a tendency for the intake air to become somewhat heated prior to entering the compression chamber due to contact with the cylinder 10. In this construction the cylinder supporting ring 18 is screwed onto the casing 20.

Piston 49 in the cylinder 10 is stepped as indicated at 52 to clear the lip 11 of the rings 12. In its piston ring fitting the piston is of conventional construction. The fitting of the piston is facilitated and the wear on the parts in frictional contact is minimised by the floating and self aligning mounting of the cylinder 10. The piston 49 has a cavity 53 therein and an internal boss 54 to take a piston rod 39. There are ports 56 communicating through the boss 54 to the cavity 53. These ports are in register with an inlet duct 58 in the piston rod permitting the flow of cooling liquid. An outlet duct 59 in the piston rod 39 permits the return of the cooling liquid after passing over the piston surfaces. The cooling liquid returns to an oil sump or to an oil cooler.

On the end of the piston rod 39 is a banjo frame 60 of a harmonic link motion which is housed in the compressor base frame 61. A crank pin 62 in link block 63 in said banjo frame is mounted on shaft 64 in bearings 65 in the base frame 61; said shaft 64 is rotated by an appropriate means.

In the single cylinder construction illustrated in Fig. 1 the bottom 66 of the base frame is an oil sump which may incorporate oil cooling means and in it is a pump barrel 67 having an inlet valve 68 while a hollow plunger 69 affixed to the banjo frame 60 in the same plane as the piston rod 39 has a delivery valve 70 therein.

The outlet from this pump is in communication with the inlet duct 58 through port 71. The outlet duct 59 in the piston rod 39 terminates in the outlet 72 which is directed onto the link block 63 and crank pin assembly. In this construction the plunger rod serves also as a guide for the harmonic link assembly and for this purpose the upper part of the pump barrel 67 has a substantial bearing 73.

Fig. 7 illustrates a compressor with opposed cylinders while Fig. 8 illustartes the piston cooling means. The compressor cylinder and parts in this construction are identical with that described with reference to Fig. 1, the second piston rod taking the place of the plunger 69. In this construction the banjo frame 60 has two inlet ports 74 in communication with the inlet ducts 58 in the respective piston rods 39 and two outlet ports 75 in communication with the outlet ducts 59. There is a piston cooling pump such as that described with reference to Fig. 1 for each compressor unit and the plunger rods 69 are mounted in cross-heads 76 on the banjo frame 60. The outlets from these pumps are in communication with the inlet ports 74.

In operation, the piston 49 moving in one direction will by means of the piston rings tension against the cylinder 10, move said cylinder until the ring 12 seats on the seating ring 21 of the end cover in the direction of movement of the piston. The piston thus causes the cylinder to make a totally enclosed area into which the piston compresses the air—drawn in on the previous stroke of the piston—until the pressure is sufficient to lift the outlet valves 28. The cylinder 10 is kept well seated by the air pressure acting on the internal lip 11 of the ring 12. The pressure on the lip 11 increases proportionally with the increase in air pressure so that such air pressure as well as the friction of the piston controls the effective sealing of the cylinder onto the end covers. When ring piston seatings 24 are employed as shown in Fig. 4 each of such seatings 24 when the piston 49 is on the compression stroke, is firmly pressed against the flanged rings 12 by the air pressure in compartment 34 passing into the ports 90 and leading into the annular chamber 25 and impinging upon the seatings 24. When the piston is on the suction stroke the seating ring 24 on the suction side of the piston contacts the projecting face 91 of the threaded ring 26 thus sealing the chamber 25 against leakage.

Figs. 4, 5 and 6 illustrate one form of unloading device which may be incorporated in the compressor. In this construction V nosed stops 77 are mounted on the cylinder 10 juxtaposed V notched plungers 78 in cylinder 79 mounted in the casing 20. These cylinders 79 are divided into plunger compartments 80 and spring compartments 81 and a plunger rod 82 passing through the plunger compartment 80 into the spring compartment 81 has a helical spring 83 thereon held in place by nuts 84. The plunger compartment has an air inlet 85 behind the plunger 78 and a pipe 86 therefrom is connected to the pressure side of the compressor through a conventional air governor. The springs 83 are loaded to hold the plungers 78 in the cylinders 79 until the air in the pipe and behind the plungers reaches a predetermined pressure when the plungers are forced outwardly against the tension of the springs until the V notches in the plungers 78 engage the V nosed stops 77 and so prevent movement of the cylinder 10. In this position the cylinder 10 is held centrally between the end covers 14—15 so that air is drawn in and ejected through the open ends of the cylinder without being compressed. The cylinder 10 is held in this position until the air pressure is so reduced that the springs 83 overcome the pressure acting on the plunger 78 and withdraw said plungers from engagement with the said stops 77. The stops 77 are kept in alignment with the plungers 78 by slippers 87 on the cylinder 10 which are mounted between guides 88 on the casing 20 or 19 as the case may be. Such an unloading mechanism as described above or other suitable unloading mechanism will be incorporated in the compressors as illustrated in Figs. 1 and 7; it has been omitted from the description of the mentioned figures in order to clarify the same.

Although the drawings show compressors with the cylinders on a vertical axis it is to be understood that the compressor may be constructed to operate with the axis of the cylinders horizontal.

We claim:

1. A gas compressor comprising a casing having a gas inlet therein, end covers fixed to said casing, said end covers each having outlet ports therein and compartments leading from said outlet ports to a common outlet duct, valves on said outlet ports, means providing a water jacket in said end covers for cooling same, a cylinder in said casing spring balanced between said end covers and reciprocable between said end covers to cause the admission of gas to said cylinder at each end alternately, means providing a seal between the cylinder and the end cover contacted thereby, a piston rod slidably mounted in one of said end covers and extending into said cylinder, a piston in said cylinder and connected to said piston rod, means for reciprocating said piston rod and piston, said piston having a cavity therein and communicating inlet and outlet ducts, means for supplying cooling liquid to said piston through said inlet duct, and means operable to unload the compressor when a predetermined pressure has been attained.

2. A gas compressor having a cylinder reciprocable between end covers operable to effect the admission of gas to said cylinder alternately at each end thereof, means to effect a seal between the cylinder and the end cover contacted by said cylinder, an outlet valve in each end cover, a piston in said cylinder, means for reciprocating said piston, and means for holding the cylinder stationary for the purpose of unloading the compressor when a predetermined compression pressure has been attained.

3. A gas compressor as claimed in claim 2 wherein the cylinder has a stop on its outer wall, a notched plunger adjacent said stop, a cylinder for said plunger comprising a plunger compartment and a spring compartment, a rod on said plunger extending into the spring compartment of the plunger cylinder, a helical spring on said rod, a gas inlet to the plunger compartment of said plunger cylinder, means connecting said gas inlet with the pressure outlet from the compressor, and guide means preventing rotation of the compressor cylinder.

4. A gas compressor comprising a casing having end covers, a cylinder balanced in said casing between said end covers, a piston reciprocable in said cylinder, said cylinder being mounted in self-aligning relation in respect to the piston and arranged for reciprocation between said end covers by the friction of the reciprocation of the

piston to effect the admission of gas to said cylinder alternately at opposite ends thereof, an inwardly projecting lip at each end of said cylinder, means to effect a seal between the lips and the end cover contacted by said cylinder, an outlet valve in each of said end covers, means for reciprocating said piston including means operable to maintain the same in axial alignment with said cylinder, and means for unloading the compressor when a predetermined compression pressure has been attained.

5. A gas compressor comprising a casing having end covers, a cylinder spring balanced in said casing between said end covers, a piston reciprocable in said cylinder, said cylinder being mounted in self-aligning relation in respect to the piston and arranged for reciprocation between said end covers by the friction of the reciprocation of the piston to effect the admission of gas to said cylinder alternately at opposite ends thereof, a flanged ring secured on each end of the cylinder with the flange thereof projecting inwardly and forming an internal lip, means to effect a seal between the lip and the end cover contacted by said cylinder, an outlet valve in each of said end covers, means for reciprocating said piston including means operable to maintain the same in axial alignment with said cylinder, and means for unloading the compressor when a predetermined compression pressure has been attained.

6. A gas compressor comprising a casing having end covers, a cylinder floating in said casing between said end covers, a piston reciprocable in said cylinder, said cylinder being mounted for reciprocation between said end covers by the friction of the reciprocation of the piston to effect the admission of gas to said cylinder alternately at opposite ends thereof, an inwardly projecting lip at each end of said cylinder, an external collar on said cylinder, an adjustable supporting ring internally of the casing, a spring interposed between said collar and supporting ring, means to effect a seal between the lip and the end cover contacted by said cylinder, an outlet valve in each of said end covers, means for reciprocating said piston including means operable to maintain the same in axial alignment with said cylinder, and means for unloading the compressor when a predetermined compression pressure has been attained.

7. A gas compressor comprising a casing having end covers, a laterally and longitudinally free floating cylinder in said casing between said end covers, a piston reciprocable in said cylinder, said cylinder being mounted for self-aligning concurrent and relative axial reciprocation with and with respect to said piston between said end covers by the friction of the reciprocation of the piston within the cylinder to effect the admission of gas to said cylinder alternately at opposite ends thereof, an inwardly projecting lip at each end of said cylinder, a resilient seat in each of said end covers adjacent the ends of said cylinder, a valve controlled outlet port in each end cover, means for reciprocating said piston including means operable to maintain the same in axial alignment with said cylinder, and means for unloading the compressor when a predetermined compression pressure has been attained.

8. A gas compressor comprising a casing having end covers, a laterally and longitudinally free floating cylinder in said casing between said end covers, a piston reciprocable in said cylinder, said cylinder being mounted for self-aligning concurrent and relative axial reciprocation with and with respect to said piston between said end covers by the friction of reciprocation of the piston within the cylinder to effect the admission of gas to said cylinder alternately at opposite ends thereof, an inwardly projecting lip at each end of said cylinder, a ring piston seat slidably mounted in an annular chamber in each end cover adjacent said cylinder, means for admitting air under pressure to the back of said piston seat, a valve controlled outlet port in each end cover, means for reciprocating said piston including means operable to maintain the same in axial alignment with said cylinder, and means for unloading the compressor when a predetermined compression pressure has been attained.

9. A gas compressor comprising a casing having a gas inlet therein, end covers fixed to said casing, said end covers each having outlet ports therein, valves on said outlet ports, means providing a jacket for cooling fluid in said end covers for cooling same, a laterally and longitudinally free floating cylinder in said casing spring balanced between said end covers and reciprocable therebetween to effect the admission of gas to said cylinder at each end alternately, means providing a seal between the cylinder and the end cover contacted by said cylinder, a piston rod slidably mounted in one of said end covers and extending into said cylinder, a piston in said cylinder and connected to said piston rod, a banjo frame of a harmonic link motion connected to said rod, a link block in said frame, crank means in said block, means for rotating said crank means, and means to unload the compressor when a predetermined compression has been attained.

10. A gas compressor as claimed in claim 9 wherein the piston has a cavity therein and an internal boss in which the piston rod is secured, said boss having an inlet and an outlet port to said cavity and said piston rod having inlet and outlet ducts therein in register with the inlet and outlet ports of said boss, and the banjo frame of the harmonic link motion of said piston rod having an inlet duct in register with said piston rod inlet duct and with a hollow pump plunger reciprocable in a pump casing, and means for delivering liquid through said hollow pump plunger and the inlet duct and port to the cavity in said piston upon reciprocation of said hollow pump plunger.

11. A gas compressor comprising a pair of axially aligned casings each having a gas inlet therein, end covers fixed to each of said casings, said end covers each having outlet ports therein and compartments leading from said outlet ports to a common outlet duct for the covers of each casing, valves on said outlet ports, means providing a water jacket in each of said end covers for cooling same, a laterally and longitudinally free floating cylinder in each casing spring balanced between the end covers thereof and reciprocable between said end covers to effect the admission of gas to each cylinder alternately at opposite ends thereof, means providing a seal between each cylinder and the casing end cover contacted thereby, a piston rod slidably mounted in each of the inner end covers and extending into each of said cylinders, a piston in each cylinder connected to said piston rod, means for reciprocating said piston rods and pistons conjointly, and means operable to unload the compressor when a predetermined pressure has been attained.

12. A gas compressor comprising a pair of axially aligned casings each having a gas inlet therein, end covers fixed to each of said casings, said end covers each having outlet ports therein and compartments leading from said outlet ports to a common outlet duct for the covers of each casing, valves on said outlet ports, means providing a water jacket in each of said end covers for cooling same, a laterally and longitudinally free floating cylinder in each casing spring balanced between the end covers thereof and reciprocable between said end covers to effect the admission of gas to each cylinder alternately at opposite ends thereof, means providing a seal between each cylinder and the casing end cover contacted thereby, a piston rod slidably mounted in each of the inner end covers and extending into each of said cylinders, a piston in each cylinder connected to said piston rod, a banjo frame of a harmonic link motion intermediate said piston rods and connected thereto, a link block in said frame, crank means in said block, means for rotating said crank means, and means to unload the compressor when a predetermined compression pressure has been attained.

13. A gas compressor as claimed in claim 12 wherein each piston has a cavity therein and an internal boss in which the piston rod is secured, said boss having therein registering outlet and inlet ports and ducts to said cavity, crossheads on opposite sides of the banjo frame, a hollow pump plunger affixed to each of said cross-heads, said frame having ducts therein in register with the ducts in said piston rods and the hollow pump plungers, pump casings for said plungers, and means for delivering liquid through said plungers, ducts and ports to the piston cavities upon reciprocation of said plungers.

JOHN NEWTON.
M. J. DUFF-FYFE.