May 6, 1952 W. R. BARRETT 2,596,004

CLEARANCE POCKET TYPE COMPRESSOR PISTON

Filed Jan. 24, 1947 4 Sheets-Sheet 1

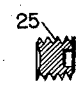

FIG. 7

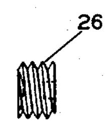

FIG. 5

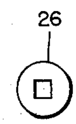

FIG. 6

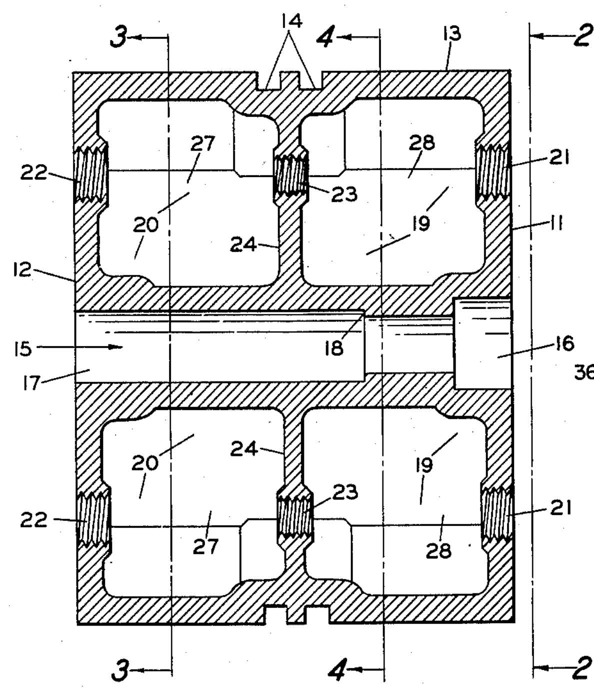

FIG. 1

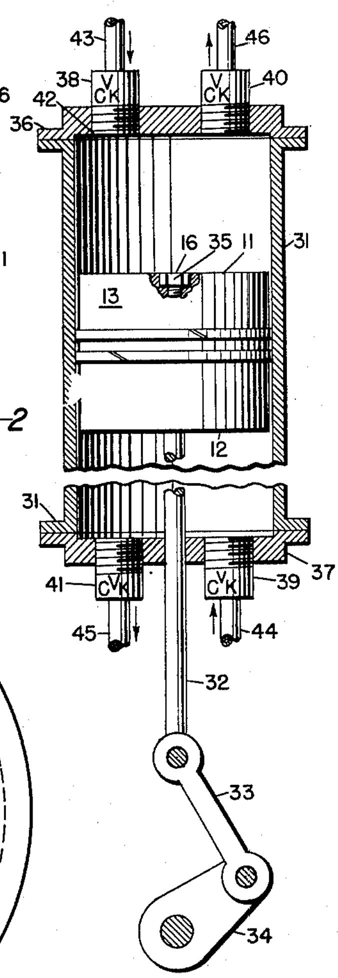

FIG. 8

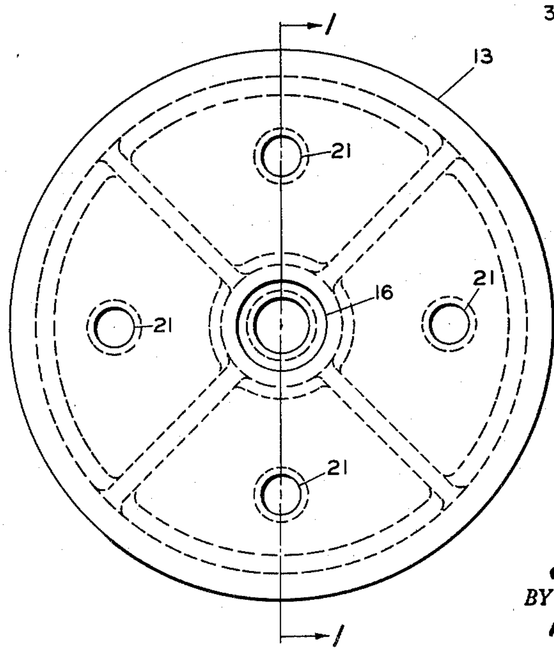

FIG. 2

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CLEARANCE POCKET TYPE COMPRESSOR PISTON

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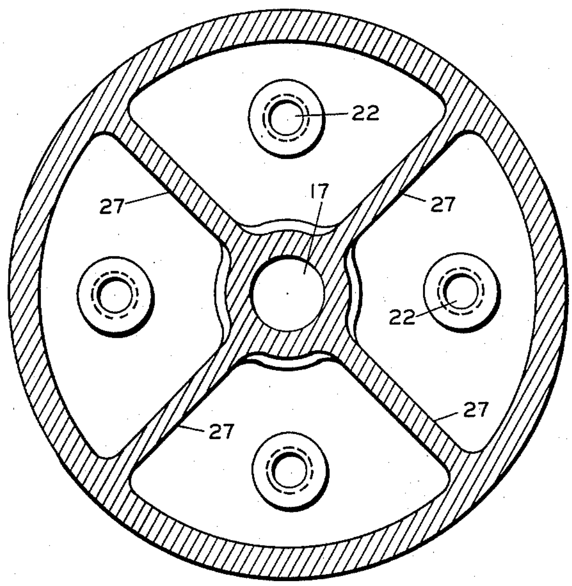

FIG. 3

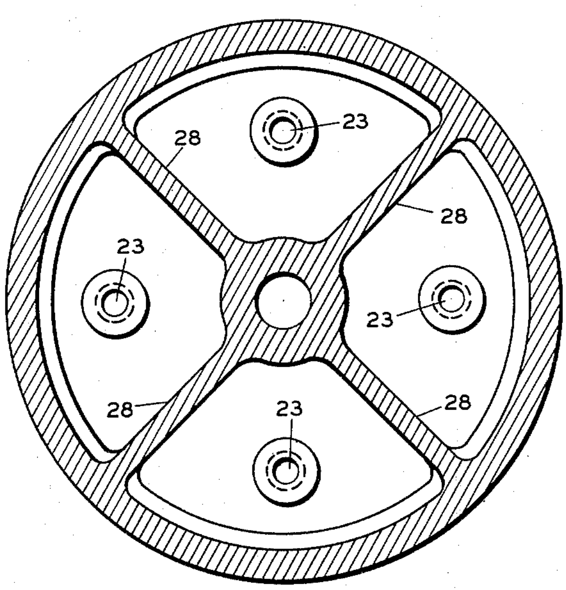

FIG. 4

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CLEARANCE POCKET TYPE COMPRESSOR PISTON

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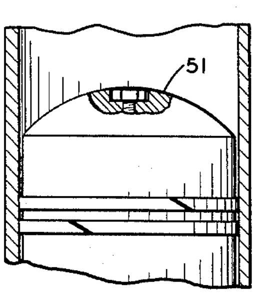

FIG. 9

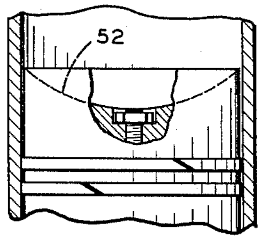

FIG. 10

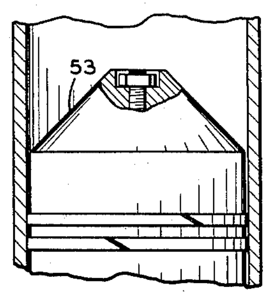

FIG. 11

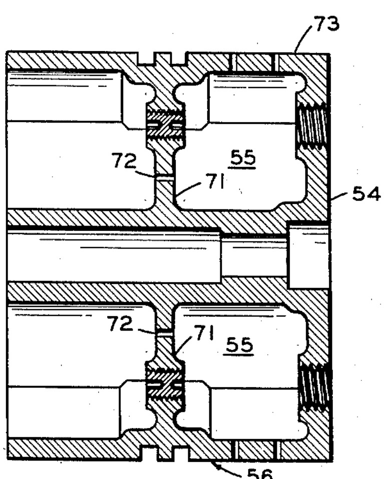

FIG. 12

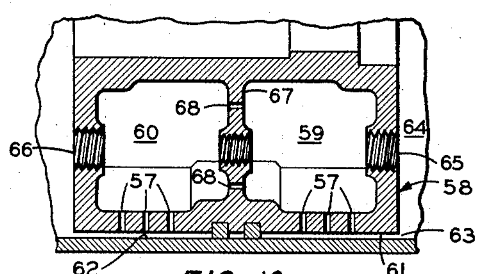

FIG. 13

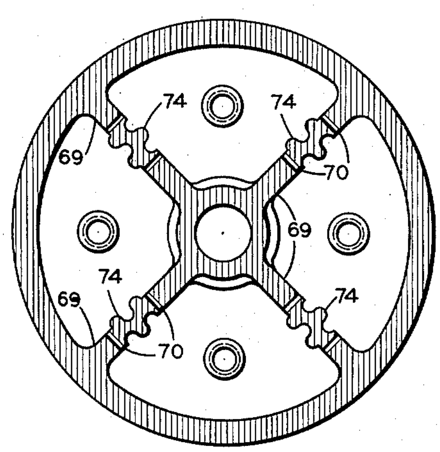

FIG. 14

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CLEARANCE POCKET TYPE COMPRESSOR PISTON

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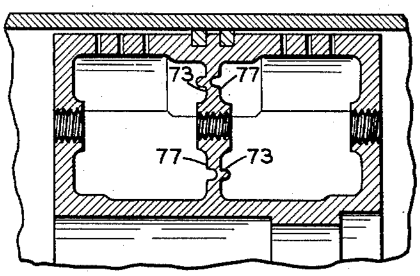

FIG. 15

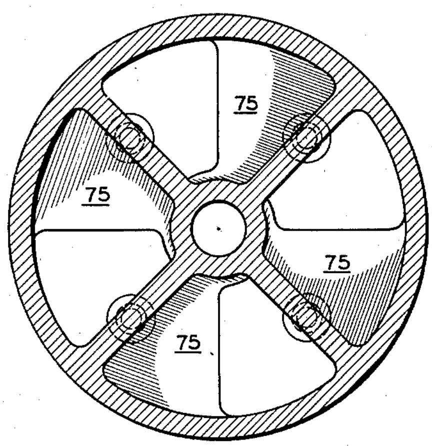

FIG. 16

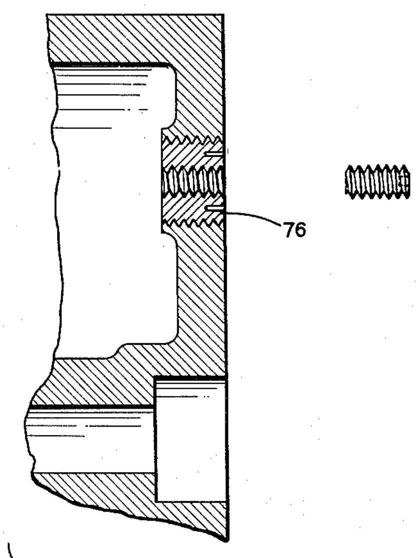

FIG. 17

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UNITED STATES PATENT OFFICE

2,596,004

CLEARANCE POCKET TYPE COMPRESSOR PISTON

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Application January 24, 1947, Serial No. 724,064

20 Claims. (Cl. 230—237)

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This invention relates to reciprocating compressors. In one of its more specific aspects it relates to clearance pocket type compressor pistons for use in reciprocating compressors.

The petroleum industry in general, and specifically the natural gas and gasoline industry use large numbers of reciprocating or piston type compressors. This latter industry uses these compressors for, among other things, compressing hydrocarbon gases prior to extraction of condensible or gasoline boiling range hydrocarbons.

Power units for operating the gas compressors are usually selected to operate at or very nearly capacity for maximum operating efficiency and for savings in capital investment. And further, these power units are selected to operate at capacity for compressing gas from an available intake pressure to a desired outlet pressure. For example, a compressor installation may be designed for compressing gas from a newly drilled field, from which a small amount of gas may be available for compression at a relatively low pressure. After the field is fully developed or the gas/oil ratio increases the pressure of the gas frequently starts to increase. This increase in field pressure often effects an increase in pressure in the suction manifold of a compressor system. Such a pressure rise means that the compressor cylinders will receive an increased quantity of gas on each suction or intake stroke. Since the compressor is discharging against a constant pressure, the compression of this increased quantity of gas will increase the horsepower demand on the power unit which was originally operating at its full rated power output. This increased horsepower demand will therefore overload the power unit.

Another compressor installation may be designed for compressing gas from a newly drilled field which is in a flush period of production. During this initial period the gas pressure available in the suction manifold of the compressor installation is relatively high. However, it is known that this gas pressure will decline and that the field will subsequently produce at lower pressures and over a long period of time.

In either type of production compressor cylinders are usually selected so that the power units will be fully loaded when the compressors are operating at the expected lower inlet pressure. The compressor cylinders so selected will overload the power units during the higher pressure production period because of the higher inlet pressure. Thus it is necessary to adjust

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the volumetric efficiency of the compressor cylinders so as to load fully but not overload the power unit during these higher pressure production periods.

Several methods have heretofore been available for solving such an engine overload problem; first, installation of larger power engine; second, replacement of the compressor unit with one having a smaller cylinder; third, replacement of the original compressor cylinder and piston with a smaller cylinder and piston which procedure may sometimes be followed since many compressors are adapted for such alterations; and fourth, installations of external clearance pockets, a clearance pocket being defined as an attached gas receiving space in direct connection with the compressor cylinder such that there is an increase in residual gas volume at the end of the compression stroke. The first two of these methods involves considerable investment, while the third involves less, yet appreciable expense. The last method requires the least expenditure, but its range of application is somewhat limited.

The installation of external clearance pockets on the side wall of a cylinder is possible only when connections or passageways were provided by the manufacturer in the original casting of the cylinder. Frequently a compressor cylinder head is fitted with suitable connections and if not they may be provided later in many instances, since no water jacket is involved. However, the installation of external clearance pockets on the head end only is an undesirable means of decreasing the volumetric efficiency of a double acting compressor cylinder. If it becomes necessary to reduce the volumetric efficiency of such a cylinder by the installation of external pockets on the head end, approximately twice as much clearance must be installed on the head end because no connection is available on the rod or crank end of the cylinder. This procedure will reduce the total power demand or requirement of the compressor cylinder but power requirement on each stroke will not be equal. It is well recognized that such an unbalanced condition is harmful to bearings as well as other parts of the machine.

The third method mentioned above for solving such an engine overload problem, that is changing to a smaller cylinder, may involve changing cylinders on compressors having 17 inch diameter cylinders and pistons to 16, 15 or even 14 inch cylinders and pistons. Thus, a supply of such cyliders and pistons would need be kept available. Stock of this type runs into expense.

I have found that clearance pockets may be made in pistons for such compressors and that by merely removing one or more plugs, one or more clearance pockets then becomes available, and the provisions of such clearance pockets involves litle extra expense.

One object of my invention is to provide an inexpensive method for decreasing the volumetric efficiency of gas compressors.

Another object of my invention is to provide an inexpensive method for reducing the volumetric efficiency of gas compressors to keep the compression load within the rated horsepower of the power cylinders driving such compressors.

Still another object of my invention is to provide an inexpensive method for decreasing the volumetric efficiency of gas compressors when compressor suction pressure has become increased, in order to maintain the compression load within the rated power output of the prime mover driving such compressors.

Yet another object of my invention is to provide a method for adding clearance volume for reducing the volumetric efficiency of a gas compressor, wherein installation or provision of added clearance volume in no way adversely affects structure of rigidity of the compressor cylinders.

Many other objects and advantages of my invention will be apparent to those skilled in the art from a careful study of the following disclosure and attached drawing which respectively describes and illustrates a preferred embodiment of my clearance pocket type compressor piston.

In the drawing:

Figure 1 is a longitudinal section of a compressor piston having clearance pockets taken on the line 1—1 of Figure 2.

Figure 2 is a plan view of the piston looking from the line 2—2 of Figure 1.

Figure 3 is a diametric section of the piston taken on the line 3—3 of Figure 1.

Figure 4 is also a diametric section of the piston, but taken on the line 4—4 of Figure 1.

Figure 5 is a side view of a clearance pocket plug.

Figure 6 is a top view of the clearance pocket plug of Figure 5.

Figure 7 is a cross sectional view of a plug inserted in an opening between adjacent pockets.

Figure 8 is a longitudinal view, partly in section, of a double acting gas compressor embodying the present invention.

Figures 9, 10 and 11 are longitudinal views partly in section of other embodiments of my invention showing pistons having respectively convex, concave and conoidal heads. Figures 12, 13 and 15 are longitudinal sectional views of other embodiments of my invention. Figures 14 and 16 are cross sectional views of still other embodiments of my invention. Figure 17 is a cross sectional view of still another embodiment of my invention showing parts removed.

Referring now to the drawing and specifically to the longitudinal section of the compressor piston shown in Figure 1, this piston is intended for use in a double acting compressor cylinder. On one end of the piston is a smoothly finished face or head 11, and on the other end a similar face or head 12. The side wall 13 is smoothly machined and contains one or more grooves 14 for compression rings shown in Figures 1 and 8. A centrally disposed opening 15 accommodates a piston rod 32, the end of which during assembling enters this opening at end 17 of the piston and the threaded end of the rod extends through the piston to the opening 16. This opening 16 is intended to accommodate a nut 35 or other fastening means, which in combination with a shoulder on the piston rod and a shoulder 18 in the opening 15, serve to hold the piston rigidly to the piston rod. In Figure 8 are illustrated the piston assembled in a compressor cylinder 31, the piston rod 32, a pitman rod 33 and a crank arm 34.

The cylinder 31 is provided with cylinder heads 36 and 37 which are preferably separable and removable from the cylinder. At each end of cylinder 31 are mounted the usual check valves, comprising intake valves 38 and 39 and exhaust valves 40 and 41, these valves being preferably separable and removable from the valve openings in the cylinder, or cylinder heads 36 and 37, being shown as screw threaded to the same. When one or more of these valves is removed access may be had to the plugs 26, and even 25, through the respective valve opening, such as 42, for removal of these plugs therethrough. Conduits, such as 43, are often connected to the cylinder 31 through, and controlled by, the respective valve 38, and like conduits, as 43 and 44, are often manifolded (not shown) and run to the source of gas, or conduits as 45 and 46, manifolded and run to a point to which the compressed gas is to be delivered (not shown). The cylinder 31, and heads 36 and 37 if used, may have portions provided with water jackets or other cooling means (not shown). The valves 38 to 41 are in the ends of the cylinder, but need not be in the cylinder heads, as it is also common practice (not shown) to have them inserted in the cylindrical wall portion near the ends of said cylinders.

This piston, as illustrated, is cast having four chambers or pockets 19 at one end and four pockets 20 adjacent the other end. Each pocket 19 communicates with the exterior through a threaded opening 21 while the pockets 20 have like outlets 22. Each pair of pockets 19—20 has a separating wall 24 in which is an opening 23. These walls 24 need not have the openings 23 as far as compressor operation is concerned; the openings, however, serve a definite purpose during the casting of the piston in permitting gases to escape. These openings may be threaded or otherwise prepared to receive a plug or permanent closure member. Walls or partitions 27 separate pockets 20 from one another while walls 28 separate the pockets 19 from one another.

Figure 7 illustrates a type of closure plug 25 for insertion into the openings 23. Such plugs or closure means should be adapted to make the openings fully gastight so that gas cannot leak from one pocket 19 to a pocket 20 or vice versa. The plugs should be so fixed in the openings that they will form substantially a permanent seal and will not loosen due to vibration during subsequent use of such a piston.

The diameter of the inner openings 23 should be smaller than the diameters of the openings 21 or 22 so that plugs therefor may be passed through the openings 21 or 22 for assembly.

The plugs 26 of Figures 5 and 6 are adapted to be inserted into the openings 21 and 22, or once inserted, they should be easily removable from these openings.

Figure 3 represents a cross section of the piston taken on the line 3—3 of Figure 1, and therefore illustrates the appearance of the inside of an end wall or head of the piston, showing the position of the piston rod opening 15 and the clearance pocket openings 22.

Figure 4 is a cross section of the piston taken on the line 4—4 of Figure 1 and shows the structure of the central partition 24 between the adjacent clearance pockets 19—20, and the openings 23 in the partition.

As mentioned hereinbefore the central partition plugs 25 should preferably be factory installed but this is not, of course, necessary.

It is further intended that the clearance pocket plugs 26 may be removed or replaced by working through a valve opening in the cylinder without removal of the cylinder head or the piston.

In the drawing four clearance pockets are shown at each end of the piston but it is not intended to be limited in this respect since any number of pockets, such as 1, 2, 3, 6 or even 8, or 4 as illustrated in the drawing may be used. The number of pockets in either end of a piston may be dependent among other factors, on the diameter of the piston, the clearance volume ahead of the piston when at dead center, and piston displacement.

The piston illustrated in the accompanying drawing may be representative of a 17 inch diameter piston, this diameter being one that is frequently used. When such a piston, of 17 inch diameter, has eight clearance pockets, each may have a volume of about 216 cubic inches. Thus in either end of a cylinder using such a piston, it is possible to increase the natural end clearance by 216, 432, 648, or 864 cubic inches depending upon the respective number of plugs 26 that have been removed.

In the drawing, the piston heads 11 and 12 are shown to be flat. However it will be readily apparent to those skilled in the art that the shape of the piston head is immaterial in the practice of my invention. Internal clearance pockets illustrated by items 19 and 20 may be provided in pistons with any shape of piston head such as concave, convex, conoidal, etc. In Figure 9 is illustrated a convex piston head 51, in Figure 10 a concave head 52 and in Figure 11 a conoidal head 53.

Example

A compressor equipped with standard 17 inch diameter pistons for service in compressing natural gas from 0 pounds per square inch gage pressure to 50 pound gage pressure was powered with a 250 horsepower engine. Sufficient gas was available for compression that the compressor operating at its optimum speed required substantially 250 horsepower engine output for operation.

When the gas inlet pressure increased the volume of gas taken into and discharged from the compressor cylinder by each respective suction and compression stroke of the piston was increased. The compression of this larger volume of gas increased the power demand on the prime mover, such as a gas engine. As the prime mover or power end of the compressor was already loaded or delivering its rated B. H. P. (brake horsepower), this additional power demand amounted to an overload. Some gas engines will operate for short periods of time with small overloads while others stall or stop. It is well known that the operation of gas engines above their rated capacities increases maintenance costs and materially shortens their useful life.

To reduce the volumetric efficiency of the compressor and thereby eliminate the overload on the power end, one or more clearance pocket plugs were removed from each end of the compressor piston. For the best operation it is usually desirable to open the same number of pockets on each end of the piston. This removal of plugs had the result of adjusting the compressor's gas handling capacity to approximate that of a 16 inch, or 15 inch or 14 inch diameter cylinder having the normal percent clearance and operating under identical intake and discharge pressures, depending on the number of pockets opened to effective operation. Such a reduction in effective cylinder capacity of course requires less horsepower for operation. Thus, as the compressor suction pressure increased, additional clearance pockets were opened and the compressor horsepower requirement was kept well within the capacity of the powering unit, while at the same time taking advantage of increased compression intake pressure to effect an increase in gas handling capacity.

One advantage in the use of such clearance pocket type compressor pistons is that an operator need purchase a compressor equipped with only one set of cylinders and pistons, the pistons having clearance pockets as herein disclosed. By opening one or more pockets to operation, an operator has the equivalent of a compressor having a smaller cylinder as regards compressor output for equal engine horsepower requirement when a decrease in volumetric efficiency is necessitated by an increase in gas pressure to the compressor, or by a change in service.

Another advantage of my invention is that by elimination of provision for external clearance pockets in compressor cylinder walls a marked decrease in the cost of manufacture of compressor cylinders is realized.

Single acting compressors having pistons with clearance pockets open at the head end only may be used as well as double acting compressors with pockets open at both ends of pistons as herein described. In Figure 12 are illustrated clearance pockets 55 adjacent the head end 54 of a single acting compressor piston 56.

Some perforations 57, Figure 13, may be made in the cylindrical walls of the piston 58 forming additional communication from pockets 59, 60 within the piston to space outside the piston. When such a piston is installed in a cylinder, communication then is between pocket 59 or 60, through the perforations 57 and by way of the very narrow annular space 63 between the circumference of the piston's outer wall 61 and the circumference of the inner wall 62 of the cylinder, and the main volume of a cylinder 64, in addition to communication through openings 65 or 66. In operation, such perforations may assist to a slight, yet appreciable extent, inflow and outflow of gas from a clearance pocket. Such a modification may, if desired, be used, but it is preferable that the clearance pocket or chambers be gastight with the exception of the openings 65 or 66 in the piston heads, illustrated in Figure 1.

Further, such a wall as wall 67, Figure 13, separating pocket 59 from pocket 60 may likewise contain perforations 68 thereby forming communication from a pocket 59 to a corresponding pocket 60. In this case the net effect is to permit flow of a small volume of gas undergoing compression from the compression end of a cylinder through the central wall 67 into the suction end of a cylinder. Such openings and their effect is to decrease further the volumetric efficiency of a gas compressor if and when desirable. Such a further decrease in volumetric efficiency occurs by reason of perforations 68 in wall 67 whether or not the pocket plug is in place or has been removed from the pocket opening in the partition 67 of a double acting piston.

Further walls 69, may likewise have perforations, 70, if desired as in Figure 14.

Such perforations may likewise be made in the corresponding walls of a single acting piston having clearance pockets adjacent its one head. In one case gas passing through perforations 72 in an end wall 71 of pocket 55, Figure 12, may be lost unless provision is made for saving it. While such perforations may be used for supplementing the clearance pocket effect, their use is not preferred.

Walls or partitions 77, Figure 15, and 69, Figure 14, may be formed with corrugations, 73 and 74, respectively, or the equivalent, or may be formed as planes inclined to the longitudinal axis of the piston or even spirally to permit expansion or contraction whenever desirable, as indicated by reference numeral 75 in Figure 16.

The openings 21, 22, as in Figure 1, may be variable openings, by provisions of bushings for reducing the size of opening, as bushing 76, Figure 17. In this manner the flow of gas through the openings may be retarded or cushioned or increased some as a means for making fine clearance pocket adjustments.

Such pistons as herein disclosed may be made of any materials as commonly used in casting or fabricating pistons of conventional or unconventional design.

The pistons may be altered in design and structure as regards size, number and size of pockets, and other features, such as number and size of compression rings, configuration of piston head, etc., and yet remain within the intended spirit and scope of my invention.

Having disclosed my invention, I claim:

1. A piston for use in reciprocating gas compressors comprising two piston heads rigidly connected to either end of a gas-tight cylindrical sidewall member, and means for attaching the piston to a piston rod; a plate means within the piston transverse to the axis thereof and forming a gastight connection with the cylindrical sidewall at a fixed distance from either end of the piston and forming a space between said transverse plate means and either end of the piston; and openings in the piston heads for communication with said spaces.

2. A piston for use in reciprocating gas compressors comprising two piston heads rigidly connected to either end of a gastight cylindrical sidewall member, and means for attaching the piston to a piston rod; a plate means rigidly fixed to the sidewall within the piston transverse to the axis thereof and at a fixed distance from either end of the piston, an axially disposed plate means within the piston and intermediate said transverse plate means and either end of the piston and the sidewalls thereof and forming adjacent either end of the piston a plurality of gastight spaces; and openings in the piston heads forming communication with said adjacent spaces.

3. A piston for a gas compressor cylinder comprising a body having a cylindrical surface for slideably fitting said cylinder and a piston head on one end of said body, said body having therein a clearance pocket comprising a gastight chamber, a conduit through said piston head providing for communication from the clearance pocket with the exterior of said body, and a removable closure positively closing said conduit to gas under pressure comprising a removable plug threaded into said conduit, said closure being adapted to be removed to vary the compression ratio of said piston in said cylinder.

4. A piston for a gas compressor cylinder comprising a body having a cylindrical surface for slideably fitting said cylinder and a piston head on one end of said body, said body having therein a clearance pocket comprising a gastight chamber, a conduit through said piston head providing for communication from the clearance pocket with the exterior of said body, and a removable closure positively closing said conduit to gas under pressure, said closure being adapted to be removed to vary the compression ratio of said piston in said cylinder.

5. A piston for a gas compressor cylinder comprising a body having a cylindrical surface for slideably fitting said cylinder and a piston head on one end of said body, said body having therein a plurality of clearance pockets each comprising a gastight chamber, a plurality of conduits through said piston head, one each of said plurality of conduits in said piston head being so disposed as to provide for communication respectively from one each of said plurality of clearance pockets with the exterior of said body, and a removable closure positively closing each said conduit to gas under pressure comprising a removable plug threaded into said conduit, said closures being adapted to be removed to vary the compression ratio of said piston in said cylinder.

6. A piston for a gas compressor cylinder comprising a body having a cylindrical surface for slideably fitting said cylinder and a piston head on one end of said body, said body having therein a plurality of clearance pockets each comprising a gastight chamber, a plurality of conduits through said piston head, one each of said plurality of conduits in said piston head being so disposed as to provide for communication respectively from one each of said plurality of clearance pockets with the exterior of said body, and a removable closure positively closing each said conduit to gas under pressure, said closures being adapted to be removed to vary the compression ratio of said piston in said cylinder.

7. A double-ended piston for a double-acting gas compressor cylinder comprising a body having a cylindrical surface for slideably fitting said cylinder and a piston head on each end of said body, said body having therein a plurality of clearance pockets each comprising a gastight chamber, each of said piston heads having at least one of said chambers adjacent thereto, a plurality of conduits in said piston heads, each of said piston heads having at least one of said conduits therethrough, said conduit in each of said piston heads being so disposed as to provide for communication from said adjacent chamber with the exterior thereof, and a closure for each of said conduits positively closing the same to gas under pressure comprising a screw plug threaded into said conduit, each of said closures being removable to vary the compression ratio of said piston in said cylinder.

8. A double-ended piston for a double-acting gas compressor cylinder comprising a body having a cylindrical surface for slideably fitting said

cylinder and a piston head on each end of said body, said body having therein a plurality of clearance pockets each comprising a gastight chamber, each of said piston heads having at least one of said chambers adjacent thereto, a plurality of conduits in said piston heads, each of said piston heads having at least one of said conduits therethrough, said conduit in each of said piston heads being so disposed as to provide for communication from said adjacent chamber with the exterior thereof, and a closure for each of said conduits positively closing the same to gas under pressure, each of said closures being removable to vary the compression ratio of said piston in said cylinder.

9. A gas compressor comprising in combination a cylinder having a closed end, a valve opening in said closed end, a valve removably mounted in said valve opening, a piston fitting said cylinder and having a piston head movable axially to a point adjacent said closed end to compress gas between said piston and said closed end, means to move said piston, and means to vary the effective clearance volume in said cylinder when said piston reaches said point comprising a clearance pocket in said piston, a conduit in said piston head providing for communication from said clearance pocket to the space between said piston and said closed end and a positive closure for said conduit secured to said piston head, said conduit and closure being disposed and positioned so that said closure is removable through said valve opening upon removal of said valve without further disassembly of said compressor, the removal of said closure increasing said clearance volume.

10. A gas compressor comprising in combination a cylinder having a closed end, a piston fitting said cylinder and having a piston head movable axially to a point adjacent said closed end to compress gas between said piston and said closed end, means to move said piston, and means to vary the effective clearance volume in said cylinder when said piston reaches said point comprising a clearance pocket in said piston, a conduit in said piston head providing for communication from said clearance pocket to the space between said piston and said closed end, and a positive closure for said conduit secured to said piston head, the removal of said closure increasing said clearance volume.

11. A gas compressor comprising in combination a cylinder having a closed end, an opening in said closed end, a first closure removably mounted in said opening, a piston fitting said cylinder and having a piston head movable axially to a point adjacent said closed end to compress gas between said piston and said closed end, and means to vary the effective clearance volume when said piston reaches said point comprising a clearance pocket in said piston, a conduit in said piston head providing for communication from said clearance pocket to the space between said piston and said closed end, and a second positive closure for said conduit in said piston head, said second closure being removable through said opening upon removal of said first closure without further disassembly of said compressor, the removal of said second closure increasing said effective clearance volume.

12. A piston for use in a reciprocating gas compressor cylinder comprising a piston head, a cylindrical sidewall fixed to said piston head, said piston being formed with a gastight chamber of constant volume therein, a threaded opening in said piston head communicating with said chamber, a removable threaded plug threaded into said threaded opening and sealing said opening gastight.

13. A piston for use in a reciprocating gas compressor cylinder comprising a piston head, a cylindrical sidewall fixed to said piston head, said piston being formed with a plurality of gastight chambers of constant volume therein, a threaded opening in the head of the piston to at least one chamber of said plurality of chambers, a removable threaded plug threaded into said opening and sealing said opening gastight.

14. A piston for use in a reciprocating gas compressor cylinder comprising a pair of piston heads, a cylindrical sidewall affixed to and connecting said piston heads, said piston being formed with a plurality of gastight clearance chambers therein and of constant volume, a threaded opening in one head of the piston to at least one chamber adjacent said one head, a threaded opening in the other head of the piston to at least one chamber adjacent said other head, a removable threaded plug threaded into said threaded openings sealing said openings gastight.

15. A piston for use in a reciprocating gas compressor cylinder comprising a pair of piston heads, a cylindrical sidewall affixed to and connecting said piston heads, said piston being formed with a plurality of gastight clearance chambers therein of constant volume, a portion of said plurality of chambers being adjacent one head of the piston and the remaining chambers of said plurality of chambers being adjacent the other head of said piston, a threaded opening in one head of the piston to each chamber adjacent said one head, a threaded opening in the other head of the piston to each chamber adjacent said other head, a removable threaded plug threaded into said opening into each chamber of said plurality of chambers sealing said openings gastight.

16. A reciprocating gas compressor having, in combination, a cylinder having one head end, a piston movable within said cylinder, a piston rod attached at one end to said piston and the other end extending out of the end of the cylinder opposite said head end to a source of motive power, valve openings in said cylinder adjacent said head end, removable valves in said valve openings for inlet and for outlet of gas, said piston being formed with a gastight clearance chamber of constant volume therein, a threaded passage in said piston head venting said clearance chamber to said cylinder and means for varying the effective clearance in said cylinder, said means comprising a removable threaded plug threaded into said passage in said piston head and sealing said passage gastight, said valve openings in said cylinder being of larger diameters than that of said threaded plug in said piston head to permit passage of said threaded plug therethrough without further disassembly of the compressor.

17. A reciprocating gas compressor having in combination, a cylinder, a cylinder head attached to one end thereof, a piston movable within said cylinder, a piston rod attached at one end to said piston and the other end extending out of the end of the cylinder opposite said cylinder head to a source of motive power, valves in said cylinder head for inlet and for outlet of gas to said cylinder, said piston being formed with a gastight clearance chamber of constant volume therein and a passage in said piston head venting said clearance chamber to said cylinder, means for varying the effective clearance in said cylinder,

said means comprising a removable plug disposed in said passage in said piston head and sealing said passage gastight; a passage in said cylinder head of larger diameter than that of said passage in said piston head and a removable closure closing said passage in said cylinder head.

18. A reciprocating gas compressor having in combination, a cylinder, a cylinder head attached to one end thereof, a piston movable within said cylinder, a piston rod attached at one end to said piston and the other end extending out of the end of the cylinder opposite said cylinder head to a source of motive power, valves in said cylinder head for inlet and for outlet of gas to said cylinder, said piston being formed with a plurality of gastight clearance chambers therein of constant volume and a threaded passage in said piston head venting each of said plurality of clearance chambers to said cylinder, and means for varying the effective clearance in said cylinder, said means comprising a removable threaded plug threaded into said threaded passage in said piston head of each of said plurality of clearance chambers and sealing said passages gastight; a plurality of passages in said cylinder of larger diameter than the diameters of said passages in said piston head, and a removable closure closing each passage of said plurality of passages in said cylinder head.

19. A reciprocating gas compressor having, in combination, a cylinder having both ends closed, a double headed piston movable within said cylinder, a piston rod attached at one end to said piston and the other end extending through one cylinder end to a source of motive power, valve openings in said cylinder adjacent said closed ends, removable valves in said openings for inlet and for outlet of gas, said piston having therein a plurality of gastight clearance chambers each of constant volume, a portion of said clearance chambers adjacent one head of said piston, the remaining chambers adjacent the other head of

said piston, a plurality of threaded passages in the heads of said piston one each of said plurality of threaded passages in the heads of said piston being so disposed as to vent respectively one each of said plurality of clearance chambers to said cylinder, means for varying the effective clearances in said cylinder, said means comprising a plurality of removable threaded plugs, one plug of said plurality of threaded plugs threaded respectively into one each of said plurality of threaded passages in the heads of said piston sealing said passages gastight, said valve openings in said cylinder being of larger diameter than the diameters of said threaded plugs in said piston heads to permit passage of said threaded plugs therethrough without further disassembly of the compressor.

20. A piston for the cylinder of a reciprocating gas compressor having means for varying the effective clearance in said cylinder without varying the stroke of said piston therein, said piston having a head and being formed with a plurality of gastight clearance chambers therein and a passage venting each of said chambers to the cylinder through the head of said piston, said piston being threaded around said passages, and said means for varying the effective clearance comprising a removable threaded plug threaded into one of said passages and sealing said passage gastight.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
500,720	Rebsamen	July 4, 1893
1,615,459	Jorgensen	Jan. 25, 1927
1,646,754	Leahy	Oct. 25, 1927