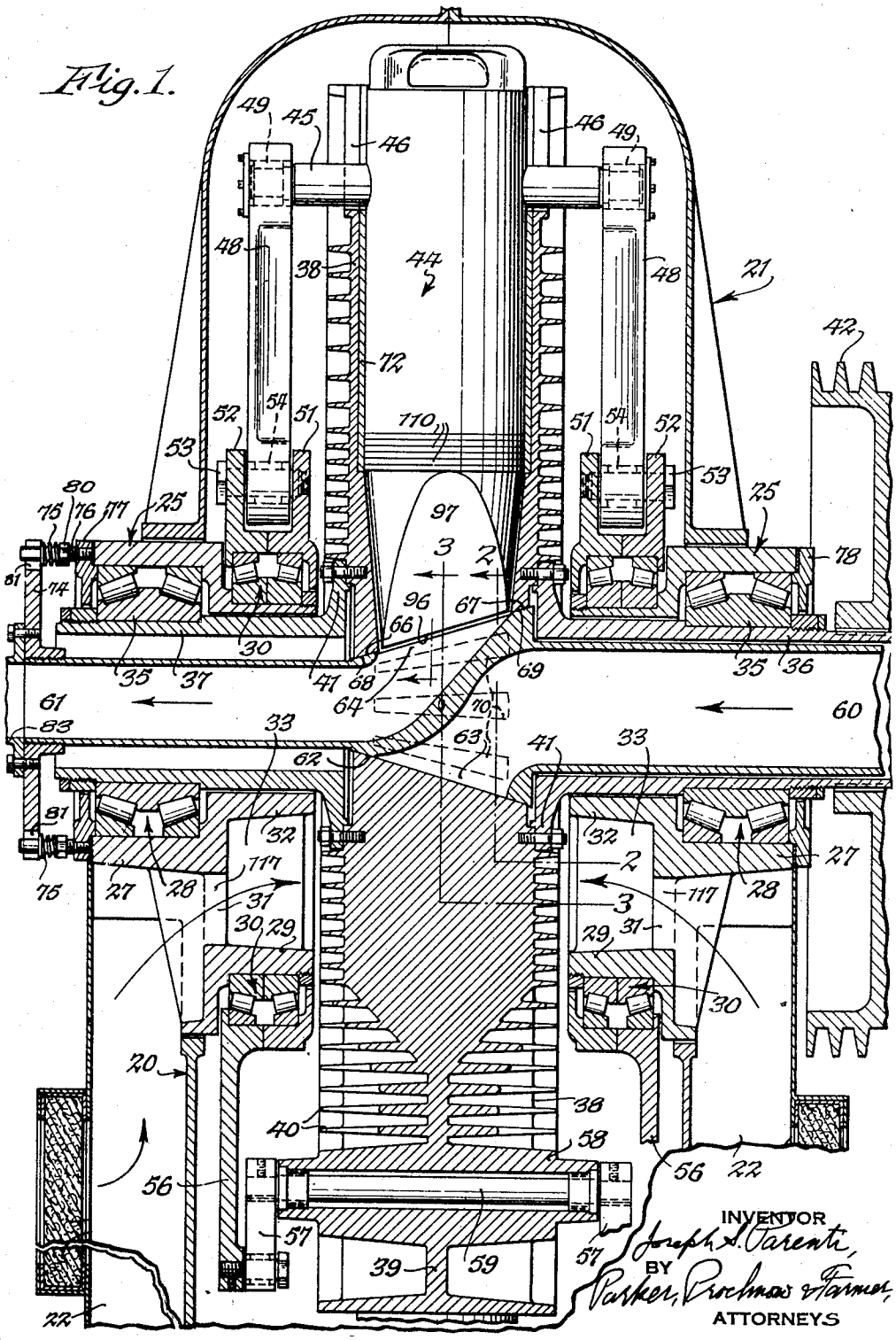
June 6, 1950 J. S. PARENTI 2,510,247

APPARATUS FOR COMPRESSING FLUIDS

Original Filed May 19, 1942 2 Sheets-Sheet 1

Fig. 1.



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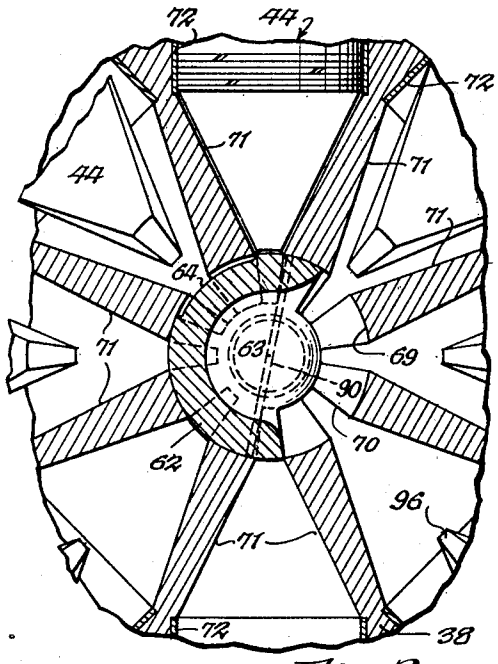


Fig. 2.

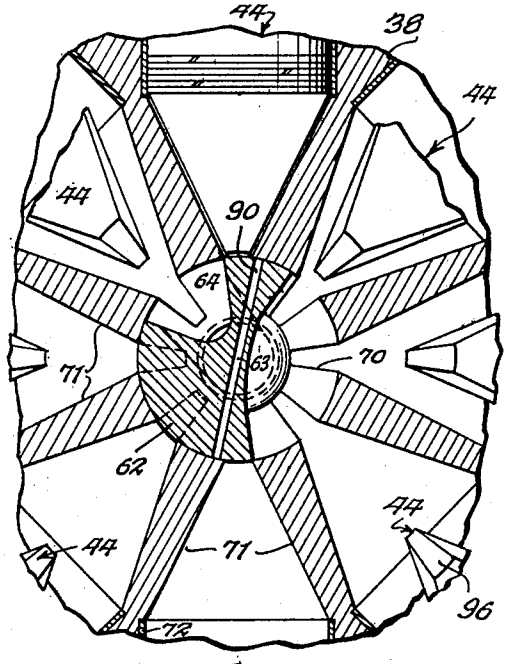


Fig. 3

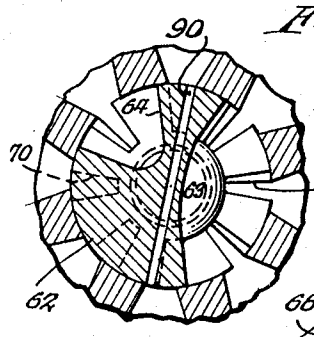


Fig. 4.

Fig. 5.

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2,510,247

APPARATUS FOR COMPRESSING FLUIDS

Joseph S. Parenti, Cleveland, Ohio

Original application May 19, 1942, Serial No. 443,666. Divided and this application September 29, 1945, Serial No. 619,391

3 Claims. (Cl. 230—177)

1

This invention relates to improvements in machines of the sliding piston or positive displacement type, which may be used, for example, as compressors or pumps to operate on air and other gases.

This is a division of my copending application Serial No. 443,666, filed May 19, 1942, now Patent No. 2,391,476 of December 25, 1945.

One of the objects of this invention is to provide an improved method of compressing gas in which residual compressed gas left in a compressing member after exhaust, is added to gas at a lower pressure which is about to be compressed.

It is also an object of this invention to provide compressors with means for injecting a supercharge of gas into a cylinder after completion of its intake stroke. A further object is to provide a compressor of this type with means whereby residual compressed gas remaining in a cylinder after the closing of the discharge valve is added to a charge of gas at a lower pressure, and which is about to be compressed. Another object of this invention is to provide a compressor of the revolving cylinder type, which is provided with a central valve member with which the cylinders cooperate and which has a passage for conducting residual compressed gas from one cylinder to a charge of gas to be compressed in another cylinder.

It is also an object of this invention to improve the construction of gas compressors of the rotary cylinder type in such a manner as to provide for improved and more efficient compressing of gas.

Other objects of this invention will appear from the following description and claims.

In the accompanying drawings:

Fig. 1 is a fragmentary sectional elevation of a compressor embodying this invention.

Fig. 2 is a fragmentary, transverse, sectional elevation thereof on line 2—2, Fig. 1.

Figs. 3 and 4 are fragmentary, transverse sectional elevations thereof on line 3—3, Fig. 1, the parts being shown in different positions in the two figures.

Fig. 5 is a fragmentary perspective view of the valve of the compressor.

While I have shown my improvements embodied in a rotary cylinder type of compressor, yet it will be obvious that it is not intended to limit all of the improvements herein described to the type of compressor shown in the drawings, since some of the improvements shown may be used in connection with machines for other purposes

2

than compressing gases and with machines in which the cylinders are stationary.

My improved machine may be mounted on any suitable or desired stationary supports and may be enclosed in a housing or casing of any desired construction. In the particular construction illustrated by way of example, I have provided a housing or enclosure, including a lower part 20 and an upper, removable part or cover 21, which may be suitably secured to the main or lower housing part 20. The lower housing part is also provided with integrally formed pedestals or supports for the revolving parts of the machine, these pedestals including two pairs of upright struts or flanges 22 which may be formed integral with the housing. A housing and supports of any other suitable or desired construction may be employed, if desired.

The machine shown in the drawing includes two revolving parts which rotate about different axes. In the particular construction shown, the cylinders rotate about an axis which is eccentric with reference to a rotary member which the piston rods are connected to, to produce relative movement between the pistons and their cylinders. I provide at each end of the machine a main stationary bearing support 25 on which the two revolving elements of the machine are journalled and which, in turn, is mounted upon the pedestals or supports 22. Consequently, each end of the machine is provided with one of these bearing supporting members 25 which are of tubular form and have oppositely extending lugs or projections arranged to be mounted on the pedestals 22. The bearing supporting members 25 are each provided with an annular cylindrical portion or flange 27 within which a suitable bearing, such as a roller bearing 28, is arranged. Each bearing support is also provided with a cylindrical portion 29 of larger diameter and eccentric with relation to the bearing flange 27. Another bearing 30 is arranged on the periphery of the cylindrical portion 29. These two flanges or cylindrical portions are connected by a vertical web 31. 32 represents an annular flange which is connected by means of radially extending ribs or supporting parts 33 with the cylindrical flange 29. The several parts of each bearing support are preferably formed integral, thus forming a strong and rigid bearing support which is amply capable of withstanding the reacting forces transmitted thereto by the bearings 28 and 30.

The bearings 28 of the two bearing supporting members 25 have their inner races 35 secured to rotatable hollow trunnions or shafts 36 and 37

which extend freely through the stationary bearing supporting members. The inner ends of these trunnions are suitably secured to a cylinder-carrying member or wheel with which the cylinders are preferably formed integral and which includes a plurality of cylinders 38 connected by radially extending webs 39 and also preferably by a series of radiating and reinforcing fins 40 which are substantially annular in form and concentric with the axis of rotation of the cylinder wheel. The trunnions 36 and 37 may be secured to the cylinder wheel in any suitable or desired manner, and in the construction shown, the inner ends of the trunnions are provided with outwardly extending flanges 41 which may be secured by bolts or other means to the cylinder wheel, see particularly Fig. 1. Consequently, the cylinder wheel is rotatably mounted on the bearings 28, and one of the hollow trunnions, for example the trunnion 36, may be provided at the outer end thereof with any suitable means for driving the cylinder wheel, a grooved pulley 42 being shown by way of example in Fig. 1.

The cylinders are provided with pistons 44 which will be hereinafter described more in detail. These pistons may be reciprocated in their cylinders in any desired manner, and in the construction illustrated by way of example, the pistons have pins 45 extending transversely through the same near the outer ends thereof. These pins 45 also extend outwardly beyond the sides of the cylinder wheel, this wheel being provided at the cylinder portions thereof with slots 46 into which the pins 45 may enter when the pistons are in their inner positions. On each end of each pin 45, one end of a piston rod or link 48 is journalled on suitable bearings 49, and the other ends of the piston rods or links 48 are pivoted on master rings which are journalled to rotate about the bearings 30, eccentrically with reference to the axis of rotation of the cylinder wheel. In the particular construction shown, these master rings are each constructed of two parts or halves 51 and 52, secured together by means of screws 53 which also serve as pivots for the other ends of the piston rods or links. Suitable bearings 54 are arranged between the pins 53 and the inner ends of the connecting links or rods. The master rings are arranged at the opposite sides of the cylinder wheel, and since the master rings rotate about the bearings, which are eccentric with reference to the bearings 28 of the cylinder wheel, it will be obvious that at each rotation of the cylinder and master rings, the pistons 44 will be moved by their piston rods 48 through an inwardly directed working stroke and an outwardly directed intake stroke.

In order to cause the master rings and cylinder wheel to rotate about their axes simultaneously and in correct relation to each other, a suitable connection between these parts is provided. In the construction illustrated by way of example, I have provided the outer portions 52 of the eccentric master rings with a plurality of outwardly extending arms 56, four such arms being preferably employed. To the outer end of each of these arms, one end of a link 57 is pivotally connected. The other ends of these links are pivotally connected with the cylinder wheel. This may be accomplished in any desired manner, and in the construction shown, the cylinder wheel is provided between some of the cylinders with enlargements or bosses 58 in which pins 59 are arranged, the pins being preferably journalled in these bosses. The ends of the pins are secured to the other ends of the links 57. It will be noted that during the rotation of the master rings and the cylinder wheel, the links 57 occupy various positions, and when these master ring links are in or near a plane passing through the two axes of rotation, no driving force can be transmitted through such links, but at such times the other master ring links are not located near this plane and will transmit the necessary force for driving the master ring from the cylinder wheel, which is positively driven from the pulley 42 or other driving means. The distance between pivotal centers of the master ring links 57 must be the same as the distance between the axes of the cylinder wheel and the master ring. By means of this arrangement, the relationship between all of the cylinders and their pistons will be the same as they pass any point in their path of movement about the center of rotation of the cylinder wheel, and also the connecting rods on both sides of the cylinder wheel are kept in alinement with each other so that the resultant of the force transmitted by a pair of rods to its piston is substantially coaxial with the piston, which, in turn, results in elimination of any cocking or wedging action on the pistons and of any tendency to turn or twist the pistons about their axes.

In order to supply gas to be compressed to the cylinders and to discharge the compressed gas from the cylinders, a tubular member is provided having both an inlet passage and a discharge passage therein, the member shown including an inlet duct 60 which extends through the hollow trunnion 36 and a discharge duct 61 which extends through the hollow trunnion 37. These inlet and exhaust ducts are preferably formed integral with a valve member 62 arranged for cooperation with the cylinder wheel at the inner ends of the cylinders 38. This tubular member including the valve 62, as well as the ducts 60 and 61, in the particular construction shown, is stationary with reference to the cylinder wheel, and the valve member is of frusto-conical shape. The valve member is provided with a relatively large inlet port 63 which forms substantially a continuation of the inlet duct or passage 60 and a smaller exhaust or discharge port 64 which forms a continuation of the discharge duct 61. Both of these ports are of elongated form in order to cooperate with elongated ports formed at the inner ends of each of the cylinders 38. The discharge duct 61 may, of course, be of smaller diameter than the inlet duct, and this enables the discharge duct to be spaced from the trunnions 37. This space between the duct and the trunnion resists the transmission of heat from the hot duct 61 to the trunnion bearing. If desired, suitable heat insulation may be provided in the space between this duct and the trunnion.

The middle portion of the cylinder wheel is provided with a frusto-conical bore formed for close fitting cooperation with the valve member 62, and the cylinder wheel is provided at the opposite ends of its frusto-conical bore with annular imperforate sealing surfaces 66 and 67 which fit against corresponding surfaces 68 and 69 formed on the valve member so that when the valve is in its operative position, discharge of gases past the cooperating sealing surfaces is prevented. The cylinder wheel is provided at its frusto-conical valve-engaging base with an elongated port 70 for each cylinder. The opposite longer bounding edges of these ports 70 are arranged at an inclination to each other because

of the frusto-conical form of the valve member, so that all portions of any longitudinal edge of any of the ports 70 will simultaneously come into and pass out of registration with the lognitudinal edges of the ports 63 and 64 of the valve member, thus reducing wire drawing to a minimum at the discharge ports.

In order to produce discharge ports of this narrow elongated type, the cylinders are provided at their inner end portions with converging side walls which are formed to converge uniformly from their outer portions of cylindrical cross section to the valve ports 70 thereof. Consequently, the side portions 71 of the cylinder ends which are nearest to adjacent cylinders are preferably substantially flat, see also Figs. 2 and 3. This makes it possible to provide a relatively large number of cylinders in the cylinder wheel, and at the same time keep the valve 62 of relatively small diameter. The cylinders in the construction shown are provided in their cylindrical portions with cylinder sleeves 72 rigidly secured thereto, which may be of a material differing from the material of which the cylinder wheel is made. For example, the cylinder sleeves 72 may be of cast iron and the cylinder wheel may, if desired, be made of a light weight metal or alloy.

By means of the construction of the valve and valve ports, the ports, because of their elongated shape, have the desired cross sectional area and, at the same time, the frusto-conical valve member is of comparatively small diameter, so that the lineal speed of the frusto-conical portion of the revolving cylinder wheel with reference to the stationary valve, is kept small enough to avoid excessive wear of these contacting surfaces.

The stationary valve may be maintained in tight seating relation to the frusto-conical inner portion of the cylinder wheel in any suitable or desired manner, and preferably, this is accomplished by yieldingly urging the valve member and its inlet and discharge passages in a lengthwise direction to seat the valve member in the base of the cylinder wheel. For example, in the construction illustrated, the discharge duct 61 of the valve member is provided with an outwardly extending flange 74 suitably secured to the discharge duct 61, for example, by means of a screw-threaded connection, as shown, and this flange 74 is yieldingly urged to the left in Fig. 1, by means of springs 75 extending about bolts or studs 76 which are screwed into a stationary disk or part 77 of the machine. This disk 77 also serves the purpose of holding the bearing 28 in place, as clearly shown in Fig. 1. A similar bearing retaining disk 78 is provided at the opposite end of the machine which is held in place by nuts or studs or other suitable means, and similar studs or screws (not shown) may be used for securing the disk 78 to the other stationary bearing shaft 25 on the discharge end of the machine. Consequently, the springs 75 urge the flange 74 to the left in Fig. 1 and urge the valve into seating engagement in the bore of the cylinder wheel. Nuts 80 are adjustably mounted on the studs 76 to permit varying the pressure with which the valve is urged into seating engagement with the bore of the cylinder wheel, so that the pressure of the springs can be varied, depending upon the pressure of the fluid discharged from the cylinders.

The valve construction described is desirable for the reason that the springs automatically compensate for wear of the valve or of the metal at the bore of the cylinder wheel.

The flange 74 and the studs 76 may also be used to hold the tubular member and the valve against turning with the cylinder wheel. For this purpose, the flange 74 may be provided with slots 81, Fig. 1, into which the ends of the studs 76 extend. Since during the rotation of the cylinder wheel, these studs will bear against one side only of the slots, the studs are preferably provided with flat sides which bear against those sides of the slots, with which they will engage during the rotation of the cylinder wheel, and the slots are also formed so that each side against which a stud bears lies substantially in a radial plane extending through the center of rotation of the cylinder wheel. Consequently, the studs 76 oppose force tending to turn the flange 74 without producing radial components of this force. The slots 81 are also made long enough and wide enough to permit any slight movement that may be imparted to the discharge duct 61 because of inaccuracies in machining.

83 represents a pipe or tube which conducts the compressed gas from the discharge duct 61, and which in the construction shown has a flange which is secured to the flange 74. This tube 83 is preferably flexible to allow for any slight movement of the duct 61.

In the operation of the compressor as thus far described, when power is applied to rotate the trunnion 35, the cylinder wheel rotates about its axis. Through the medium of the master ring links 57, rotary motion is imparted from the cylinder wheel to the eccentric master rings arranged at opposite sides of the cylinder wheel and mounted on the bearings 30, which are eccentric with relation to the axis of rotation of the cylinder wheel. Consequently, the pistons will be caused to reciprocate in their cylinders. In the machine illustrated in the drawings, the axis of rotation of the cylinder wheel is located vertically above the axis of rotation of the master ring, and consequently, when a cylinder reaches approximately the upper portion of the machine, its piston will be in its inner position. Assuming that rotation is in a clockwise direction in Figs. 2, 3 and 4, each piston, as it moves with the cylinder wheel from the upper position, will move outwardly, and will move into communication with the inlet port 63 of the valve member. When it reaches the lower portion of its movement, the piston will be in its outermost position, and from then on to its upper position, it will be moved inwardly in its cylinder to compress the gas taken in. During a part of the time that a cylinder passes through the upper, left quadrant in Figs. 2, 3 and 4, its port moves into registration with the discharge port 64 of the stationary valve, thus discharging the compressed gas into the discharge duct 61.

In compressors as now commonly constructed, the residual compressed gas which remains in a cylinder after the closing of the discharge valve, the volume of which depends upon the clearance between the head of the piston and the head of the cylinder, is re-expanding during the initial portion of the intake stroke of the piston, and consequently, this reduces the fresh charge of air which can be admitted to the cylinder during the intake stroke.

In accordance with my invention, I provide an improved method and means whereby this residual gas is discharged into a clyinder in which the piston has just completed its intake, and in which the intake valve is closed. This residual gas, consequently, supercharges the cylinder into

which it is discharged, so that this cylinder will compress not only the charge of gas taken in during the suction or intake stroke, but also such residual gas as is delivered to it.

Any suitable or desired means may be employed for carrying out my method. In the machine shown, this method can readily be carried out by providing a single relatively small passage through the valve 62, for example, such as the passage 90, shown in Figs. 2 to 5. It will be noted that this passage, which in the construction shown may be in the form of a hole drilled in the valve 62, is so arranged that any cylinder after its port passes out of registration with the discharge port 64 of the valve, will momentarily pass into registration with one end of the passage 90. The other end of this passage will be in registration with the port of another cylinder just after the port of such cylinder has moved out of registration with the inlet port 63. In Figs. 2 and 3, the upper cylinder is shown in the position in which it has just passed out of registration with the discharge port 64 of the valve and the lowest cylinder has just passed out of registration with the inlet port 63, and neither of these cylinders has as yet passed into communication with the connecting passage 90. Fig. 4 shows the positions of the cylinders after they have passed through a small arc beyond the positions shown in Figs. 2 and 3, and shows the upper cylinder in registration with the upper end of the passage 90 and the lowest cylinder also in registration with the lower end of this passage. Consequently, residual compressed gas in the upper cylinder will quickly flow through the passage 90 and will, consequently, be expanded during this passage, and the greater portion of this residual charge will be added to the charge of gas in the lowest cylinder, thus increasing the pressure and the quantity of gas in the lowest cylinder and also greatly reducing the amount of residual gas in the uppermost cylinder, so that when the port of this cylinder moves into communication with the inlet port 63 of the valve 62, it will take in a materially larger charge of gas than would be the case if it were first necessary to expand all of the residual compressed gas remaining in the cylinder after exhaust. Consequently, by use of the supercharge passage, the capacity of the compressor is increased, in the first place, because of the fact that with very little residual gas in the uppermost cylinder, this cylinder will take on a proportionately larger charge of fresh gas during its intake stroke. The capacity of the machine is further increased by the fact that the cylinder receiving the residual charge is supercharged and, consequently, compresses a proportionately greater amount of gas than would be the case if it had not been thus supercharged. Any other means for transferring residual compressed gas from a cylinder to supercharge a quantity of gas to be compressed may be provided.

Not only does my improved method greatly increase the capacity of any compressor to which it is applied, but also the efficiency of the compressor is greatly increased thereby. For example, the residual compressed gas which is added to the gas which is about to be compressed raises the pressure of this latter gas without requiring any additional work by the compressor. It is, consequently, also possible to make the intake port 63 larger, so that the intake port of each cylinder may be in communication therewith for a longer period of time, without having the residual compressed gas discharged into the intake

passage, which would cause objectionable turbulence of the incoming air. I preferably construct the valve so that the intake starts after the pressure in the cylinders is slightly below atmospheric, and since a number of cylinders are always in communication with the intake port, there will be a constant and steady flow of air in the inlet duct.

A further advantage of the removal of residual gas from a cylinder and employing it to supercharge an intake of gas, is that this enables compressors to compress gases to much higher pressures than has heretofore been possible in a single stage. Heretofore, the pressures which could be produced in a single stage were limited by the clearance between the cylinder heads and the pistons, or in other words, by the amount of residual compressed gas left in a cylinder. If the pressure in a cylinder reached a certain point at which the residual gas required the full stroke of the piston to become re-expanded, obviously no additional gas could be taken in and, consequently, no compressed gas would be delivered. Consequently, heretofore, the maximum pressure in any cylinder had a definite limitation because of the expansion of the residual compressed gas. By means of my method and construction, since most of the residual gas is discharged from the cylinder, it follows that only a very slight movement of the piston in the cylinder will expand the very small quantity of residual gas left in the cylinder after supercharging, and consequently, the maximum gas pressure that can be delivered by any cylinder is greatly increased.

I claim as my invention:

1. A multi cylinder compressor, comprising a pair of cylinders arranged in fixed relation to each other and having pistons therein, means connecting said pistons for reciprocating the same in said cylinders so that the pistons simultaneously occupy opposite positions of their strokes, a valve having inlet and discharge passages for communicating with said cylinders, said valve having a passage therein connecting said cylinders immediately after communication of said cylinders with said valve passages has been interrupted to discharge residual compressed gas from a cylinder whose discharge of compressed gas to said discharge passage has just been completed, into a cylinder whose intake of gas has just been completed.

2. A multi cylinder compressor having a member rotatable about an axis and having a plurality of cylinders formed integral therewith and arranged in pairs, the cylinders of each pair being located diametrically opposite each other on said member, means for imparting rotation to said member, said member having an axial bore and each of said cylinders having a port terminating in said bore for intake and discharge of gas, pistons in said cylinders, means for reciprocating said pistons in said cylinders during the rotation of said member and cylinders, said means being so constructed that the pistons in each of said pairs of cylinders will be simultaneously at opposite ends of their strokes, a central stationary valve arranged within the bore of said member and having inlet and discharge passages with which said ports of said cylinders communicate during their rotation, and an additional passage in said valve member arranged to connect a pair of oppositely disposed cylinders, said additional passage being so located in said valve member as to simultaneously communicate with the port of one cylinder of a pair immediately after its port

has passed out of communication with the discharge passage of said valve, and with the port of the opposite cylinder immediately after it has passed out of communication with the inlet passage of said valve, whereby compressed gas in said first mentioned cylinder supercharges the other cylinder of the pair.

3. In a rotary cylinder compressor having a plurality of cylinders arranged substantially radially with reference to the axis of rotation of said rotary cylinders and in fixed relation to each other, said cylinders being arranged in substantially diametrically oppositely located pairs, means for rotating said cylinders, pistons operating in said cylinders, means for reciprocating said piston in said cylinders so that the pistons in opposite pairs of cylinders are arranged at opposite positions in their strokes, a stationary valve member arranged substantially coaxial with the axis of rotation of said cylinders and having inlet and discharge passages, said cylinders each having a port arranged to cooperate with the passages of said valve member, and a third passage extending crosswise of said valve member and having one end thereof arranged to connect

with the port of a cylinder which has just passed out of communication with said discharge passage and having the other end arranged to simultaneously connect with the port of a cylinder which has just passed out of communication with said inlet passage, for supercharging one cylinder with residual compressed gas of the other cylinder.

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