March 17, 1936. H. WÄLTI 2,034,069

PISTON COMPRESSOR HAVING ROTARY VALVE GEAR

Filed Feb. 1, 1934 2 Sheets-Sheet 1

Fig.1.

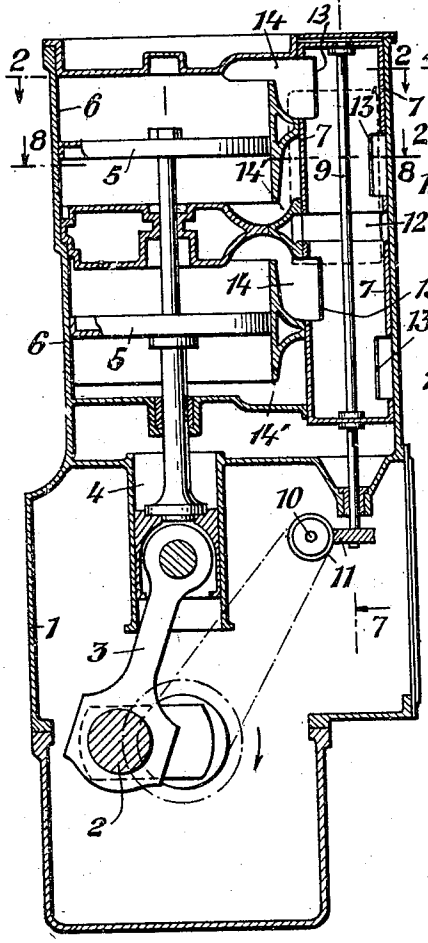


Fig.3.

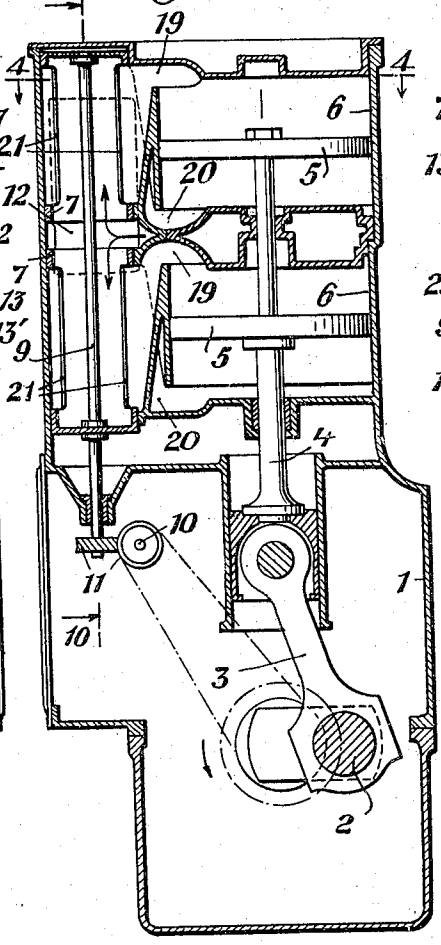


Fig.5.

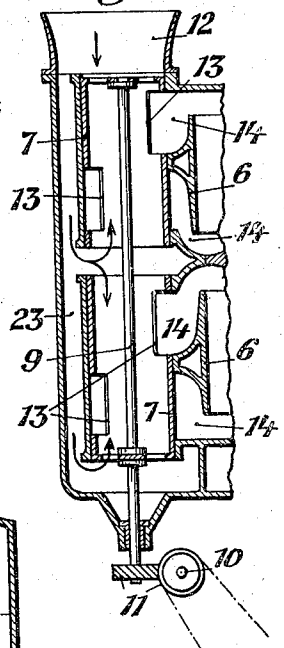


Fig.6.

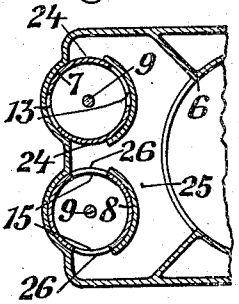


Fig.2.

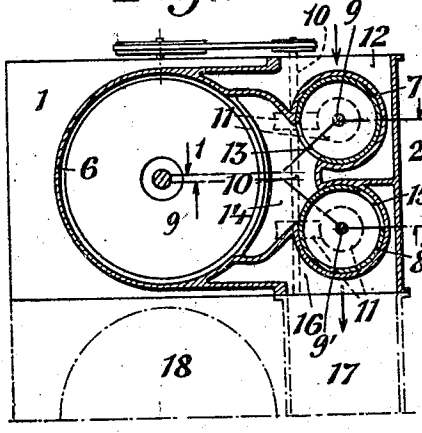
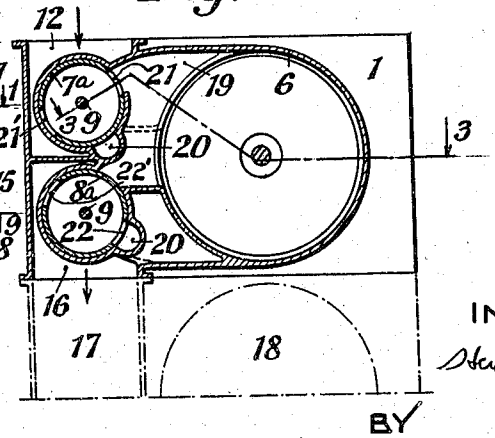


Fig.4.



INVENTOR:
Heinrich Wälti

BY
Pennie, Davis, Marvin & Edmonds
Attorneys

March 17, 1936. H. WÄLTI 2,034,069

PISTON COMPRESSOR HAVING ROTARY VALVE GEAR

Filed Feb. 1, 1934 2 Sheets-Sheet 2

Fig. 7

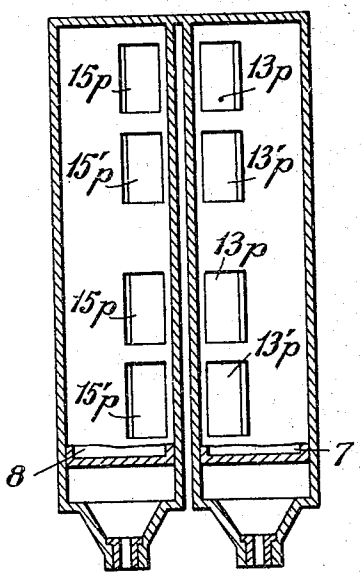


Fig. 8

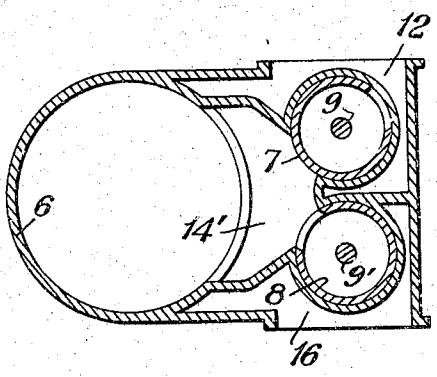


Fig. 10

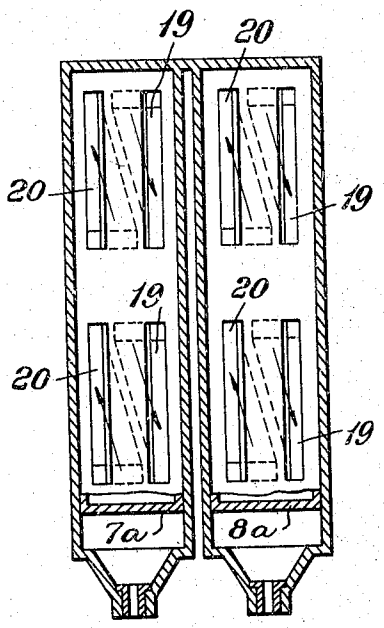
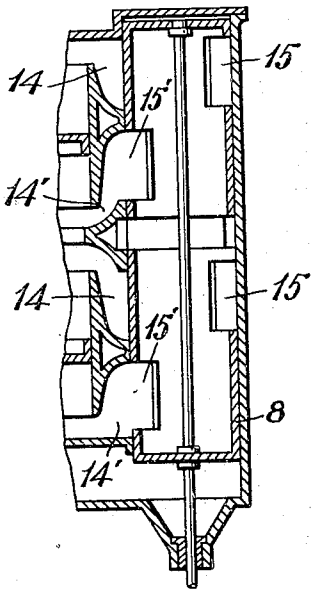


Fig. 9



Inventor:
HEINRICH WALTI

By Connie, Davis, Marin & Edmonds

Attorneys.

Patented Mar. 17, 1936 2,034,069

UNITED STATES PATENT OFFICE

2,034,069

PISTON COMPRESSOR HAVING ROTARY VALVE GEAR

Heinrich Wälti, Winterthur-Wulflingen, Switzerland, assignor to the firm of Sulzer Freres Societe Anonyme, Winterthur, Switzerland

Application February 1, 1934, Serial No. 709,324
In Switzerland February 9, 1933

6 Claims. (Cl. 230—225)

This invention relates to piston compressors having rotary valve gear and refers particularly, though not exclusively, to compressors for supplying scavenging air to internal combustion engines.

According to the present invention the admission of gas to and delivery of gas from the pump are controlled respectively by two rotary valves which rotate about separate axes extending in the direction of the longitudinal axis of the pump cylinder.

When the invention is applied to a pump having one or more cylinders of the double-acting type, each valve is arranged to control at least two ports in the valve housing leading respectively to the two working chambers of the associated cylinder.

The valves are conveniently of the tubular or sleeve type, the ports controlled by each valve being preferably so arranged that the gas pressures on the valve tend to balance each other, thereby reducing the resistance to rotation of the valves.

Two constructions of a double-acting piston compressor embodying the invention, together with some modified arrangements of the valve gear, are illustrated by way of example in the accompanying drawings, in which

Figure 1 represents a vertical section on broken line 1—1 of Fig. 2.

Figure 2 is a horizontal section on the line 2—2 of Figure 1,

Figure 3 is a longitudinal section of a modification,

Figure 4 is a horizontal section on the line 4—4 of Figure 3.

Figure 5 illustrates in section a modified arrangement of the valve gear,

Figure 6 shows in horizontal section a further modified arrangement of the valves.

Fig. 7 is a vertical section taken on line 7—7 of Fig. 1.

Fig. 8 is a horizontal section taken on line 8—8 of Fig. 1.

Fig. 9 is a vertical section taken on broken line 9—9 of Fig. 2, and

Fig. 10 is a vertical section taken on line 10—10 of Fig. 3.

In the construction illustrated in Figures 1 and 2, the compressor, generally indicated at 1, comprises a crank 2 from which the drive is transmitted through a connecting rod 3 to a piston rod 4 carrying two double-acting pistons 5 arranged in tandem within the cylinders 6 respectively. The admission and delivery of gas to and from the two working chambers of each of the cylinders 6 are controlled respectively by a rotary inlet valve 7 and a rotary delivery valve 8 (see Figures 1, 2, 8, and 9). These valves each extend along the total height of their associated cylinders. As the cylinders 6 are in tandem two inlet valves 7 are provided and are mounted on a common rotatable spindle 9. Also the two delivery valves 8 are similarly mounted on a second spindle 9', the two spindles extending in the direction of the longitudinal axis of the cylinders 6. It will be understood that the spindles 9 and 9' need not be parallel to the longitudinal axis of the cylinders 6 but may be slightly inclined to such axis. The inlet valve 7 and outlet valve 8 associated with each cylinder 6 are, as clearly shown in Figure 2, separate from each other. The spindles 9 and 9' are driven from a shaft 10 through worm gears 11 and 11' (see Fig. 2). The shaft 10 is driven from the crankshaft of the pump so that the valves 7 and 8 are rotated at the same speed as the crank 2, the timing of each inlet valve 7 relatively to the corresponding delivery valve 8 being determined in accordance with the compression desired.

Each of the valves 7 and 8 is of the sleeve or tubular type. A conduit 12 for supplying the medium to be compressed communicates with the interior of the admission valves 7 through their inner ends, as may be seen in Figs. 1 and 3. Each admission valve 7 has two openings 13 and 13', located, respectively, in the upper and lower portions of each valve, and displaced from one another about the axis of rotation of the valve by an angular distance of 180°. As may be seen in Fig. 7, the openings 13 of each inlet valve coact with ports 13_p in the valve housing, and the openings 13' coact with ports $13'_p$. Each of the ports 13_p communicates, respectively, by means of a passage 14 with the upper end of its corresponding cylinder. Likewise, each of ports $13'_p$ communicates, respectively, with the lower end of its corresponding cylinder by means of a passage 14'.

The outlet, or delivery, valves 8 are similarly constructed, and are shown in Fig. 9 in section corresponding to the section of the inlet valve 7 shown in Fig. 1. Each outlet valve 8 is provided with two valve openings 15 and 15' located, respectively at the upper and lower portions of the valve and displaced about the axis of rotation of the valve by an angular distance of 180°. Valve openings 15 coact with ports 15_p (see Fig. 7) and valve openings 15' coact with ports $15'_p$. Ports 15_p open into passages 14 by means of which they communicate with the upper end of their corresponding cylinders. Likewise, ports $15'_p$ open into passages 14' by which they communicate with the lower ends of their corresponding cylinders.

A delivery conduit 16, shown in Figs. 2, 4, and 9 communicates with the interior of the outlet valves 8 through their inner ends in the same way that supply conduit 12 communicates with inlet valve 7. Delivery conduit 16 is adapted to be connected to a supply manifold 17 of an internal combustion engine 18. During a downward stroke of the pump, i. e. with the valves 7 communicating

through valve openings 13 with ports 13_p and passages 14, air which is to be compressed flows in through the conduit 12 and the interior of the inlet valves 7 and thence into the cylinders on the upper side of each piston. At the same time air is being compressed on the other side of each piston and flows from the pump cylinders 6 through the passages 14' and the ports $15'_p$ and outlet valve openings 15' into the interior of the delivery valves 8. The compressed air flows through the interiors of the tubular valves 8 into a delivery conduit 16 and to supply manifold 17, of the internal combustion engine 18.

In the construction illustrated in Figures 3 and 4, the ports in the housing of the inlet and outlet valves 7_a and 8_a, instead of being in vertical alinement, as in the construction just described, are displaced angularly about the axis of the valve by an angle of 90°, as may be seen in Fig. 4. The valve gear controls the flow both for admission and delivery through conduits 19 and 20 communicating respectively with the upper and lower working chambers of the associated cylinder. The inlet valves 7_a are provided with two slot-like openings 21 arranged substantially diametrically opposite to each other and each extending for the full axial length of the corresponding cylinder 6. Similarly, the valves 8_a are furnished with two openings 22 for each cylinder arranged diametrically opposite to each other and each in the form of a slot which extends the full axial length of the corresponding cylinder 6.

The ports leading to the passages 19 and 20 for each cylinder are angularly spaced apart about the axis of rotation of the corresponding inlet or exhaust valve. Thus as clearly shown in Figure 4, the ports controlled by the inlet valves 7_a leading to the passages 19 and 20 are angularly spaced apart by 90° about the axis of rotation 9 of the valve 7_a, whilst the ports controlled by the delivery valves 8_a and leading to the same passages 19 and 20 are angularly spaced apart by 90° about the axis of rotation 9 of the delivery valve 8_a. In this construction since each valve 7_a or 8_a is furnished with two diametrically opposite ports for each cylinder the valves are driven at half the speed of the crankshaft of the compressor.

In this construction, while the piston moves downwardly, one of the inlet valve openings 21 which at the beginning of the downward stroke communicates with the passage 19, turns by the passage 19 and at the end of the stroke the inlet valve 7_a is closed; and at the same time the valve opening 22 of the outlet valve 8_a is in communication with the passage 20, thus delivering through the interior of the valve the medium compressed below the piston to the delivery conduit 16. When the piston reaches it lowermost position the opening 22 is removed from the passage 20, and instead the opening 21' of the inlet valve brought into communication with passage 20. During the upward stroke of the piston the medium supplied through conduit 12 flows through the passage 20 into the lower part of the cylinder, while the medium above the piston is compressed and delivered through valve opening 22' which now communicates with passage 19.

It will be seen that in the constructions above described the arrangement is such that the conduits 12 and 16 in the valve casing through which induction and delivery take place are so arranged that either of these conduits can be employed as the inlet conduit whilst the other is employed as the delivery conduit. Thus, for example, in the construction shown in Figure 4, the conduit 12 there employed as an inlet conduit corresponds to the conduit 16 employed in Figure 2 as a delivery conduit. The arrangement is therefore capable of being employed either with the valve gear on one or on the other side of the crankshaft of the pump.

By angular displacement, as above described, of the ports controlled by each valve, the passages available for the flow of air from and to each valve can extend along the whole axial length of the pump cylinder so that the increase or decrease of the cross-sectional area available per unit of time is increased.

In the modified arrangement illustrated in Figure 5, the air flows not only through an opening on the middle of the length of each tubular valve but each valve is open at both ends. Air enters through the suction conduit 12 and flows axially through the inlet valve 7 and also around this valve through a surrounding conduit 23. Thus air flows not only directly from the conduit 12 to the ports 13 of the valve 7, but also through the conduit 23 and into the open ends thereof. Similarly, in the case of the delivery valve 8, the air can flow through both open ends and through the middle of the valve to the delivery conduit (not shown). In this construction the valves are driven at the same speed as the crankshaft of the compressor.

In the arrangement illustrated in Figure 6, the conduit to or from each working chamber is so arranged that the gas pressures acting on the valve tend to balance each other. To this end the inlet valve 7 controls two ports 24 for each cylinder diametrically opposite to each other and both communicating with a chamber 25 leading, for example, to the upper working chamber of one of the pump cylinders 6. Similarly, the delivery valve 8 controls two ports 26 arranged diametrically opposite to each other and communicating with the chamber 25.

During the compression stroke within the working chamber connected with the chamber 25, the valve 7, being in its closed position, is subjected to the pressure within the chamber 25, this pressure acting on the surfaces of the valve 7 which cover the ports 24. Since the ports 24 are diametrically opposite to each other, the radial pressures on the valve 7 tend to balance each other, that is to say, the resultant air pressure from the chamber 25 on the valve 7 is substantially zero. The same applies to the delivery valve 8 during the suction stroke, since the excess pressure within the valve 8 acts on the two diametrically opposite surfaces covering the ports 26. In this construction the valves are driven at half the speed of the crankshaft of the compressor.

When large valves are employed, a one-sided or unbalanced loading of the valve transversely of its axis of rotation absorbs considerable power for driving the valve and this difficulty is overcome by arranging the ports so that the pressures tend to balance each other. It will, however, be understood that instead of providing two diametrically opposite ports, three or more symmetrically arranged ports may be employed, the cross-section of any one or more of such ports differing from that of the remaining port or ports. Thus, for example, the distribution and size of the ports controlled by each valve may be such as to tend to result in the pressure on the valve being reduced substantially to zero.

The invention is advantageous in that it pro-

vides simple valve gear and a simple drive, whilst the provision of one valve for the admission and another valve for delivery results in smaller valve diameters and therefore a reduction in the space occupied by the compressor. Furthermore the separation of the admission and delivery valves obviates the necessity for separate conduits or partitions in the valves so that manufacture of the valves themselves is simplified whilst better conditions of flow and smaller losses in air pressure both on the supply and on the discharge side are obtained. In constructions embodying the invention, where the valve gear can be driven at one-half the speed of the crankshaft of the pump or one-third the speed, not only is wear reduced, but less power is consumed for driving the rotary valve gear.

The provision of tubular valves through the interior of which air flow can take place is advantageous in that the cross-section available for the flow of gas through each valve need not exceed that necessary for the flow of gas to or from one working chamber or, in the case of two-cylinder tandem constructions, for one cylinder so that the valve diameter can be reduced. Further, with tubular valves the flow can be caused to take place through the open ends of each valve as well as through its walls. The provision in this manner of passages at both ends of each valve as also at the centre or in the length of such valve has the advantage in pumps employing the tandem arrangement that the shortest path from and to each working chamber is obtained and the diameter of the valve is reduced.

In the case of compressors employed for supplying air to internal combustion engines, the valve gear may be driven, for example, from the cam-shaft which drives the fuel pumps or valves of the engine. Further, in compressors having several cylinders constituting either one or several different stages and arranged on the same axis, a single inlet valve and a single delivery valve according to the invention may be employed for all the cylinders.

I claim:

1. A piston compressor comprising a cylinder, a piston therefor, means for driving said piston, a rotary inlet valve and a rotary outlet valve disposed adjacent one another on the same side of said cylinder, and a housing for said valves associated with said cylinder, said housing having passage means leading from each of said valves to one end of said cylinder, passage means leading from each of said valves to the opposite end of said cylinder, an inlet conduit terminating in a plane substantially tangent to one side of said cylinder and an outlet conduit terminating in a plane substantially tangent to the opposite side of said cylinder.

2. A piston compressor, comprising a cylinder, a piston therefor, means for driving said piston, a rotary inlet valve and a rotary outlet valve disposed adjacent one another on the same side of said cylinder, a housing therefor associated with said cylinder and having a common passage leading from each of said valves to one end of the cylinder, and a second common passage leading from each of said valves to the opposite end of the cylinder, and inlet and outlet conduits associated with said housing.

3. A piston compressor comprising a cylinder, a piston therefor, means for driving said piston, a tubular rotary inlet valve and a tubular rotary outlet valve for said cylinder, each of said valves having a slot-like opening substantially co-extensive in length with the length of the cylinder, a housing for said valves associated with said cylinder and having a port for each of said valves whose length is substantially co-extensive with the length of the cylinder communicating with one end of the cylinder, and a second port in said housing for each of said valves whose length is substantially co-extensive with the length of the cylinder communicating with the opposite end of the cylinder, an inlet conduit communicating with the interior of said tubular inlet valve, and a delivery conduit communicating with the interior of said tubular outlet valve.

4. A piston compressor comprising a cylinder, a piston therefor, means for driving said piston, a tubular rotary inlet valve and a tubular rotary outlet valve for said cylinder, each of said valves having two slot-like openings disposed 180° apart and substantially co-extensive in length with the length of the cylinder, a housing for said valves associated with said cylinder and having two ports coacting with each of said valves disposed 90° apart and whose length is substantially co-extensive with the length of the cylinder, one of said ports for each of said inlet and outlet valves communicating with one end of the cylinder, and one of said ports for each of said valves communicating with the opposite end of the cylinder, an inlet conduit communicating with the interior of said tubular inlet valve, and a delivery conduit communicating with the interior of said tubular outlet valve.

5. A piston compressor comprising a cylinder, a piston therefor, means for driving said piston, a tubular rotary inlet valve and a tubular rotary outlet valve for said cylinder, each of said valves being substantially coextensive in length with the length of the cylinder, and each having two ports disposed 180° apart near one end of the valve, and two ports disposed 180° apart at the opposite end of the valve, the two latter ports being disposed 90° with respect to the two former ports, a housing for said valves associated with said cylinder and having passages connecting the former ports with one end of said cylinder and passages connecting the latter ports with the opposite end of the cylinder, an inlet conduit communicating with the interior of said tubular inlet valve and a delivery conduit communicating with the interior of said tubular outlet valve.

6. A piston compressor comprising a cylinder, a piston therefor, means for driving said piston, a tubular rotary inlet valve and a tubular rotary outlet valve for said cylinder disposed adjacent one another on the same side of said cylinder and being substantially coextensive in length with the length of the cylinder, a housing for said valves associated with said cylinder, said housing having conduit means leading from each of said valves to one end of said cylinder and conduit means leading from each of said valves to the opposite end of said cylinder, an inlet conduit communicating with the interior of said tubular inlet valve, and a delivery conduit communicating with the interior of said tubular outlet valve.

HEINRICH WÄLTI.