

Oct. 28, 1952

M. R. A. CHABAY

2,615,618

COMPRESSOR

Filed July 31, 1947

3 Sheets-Sheet 1

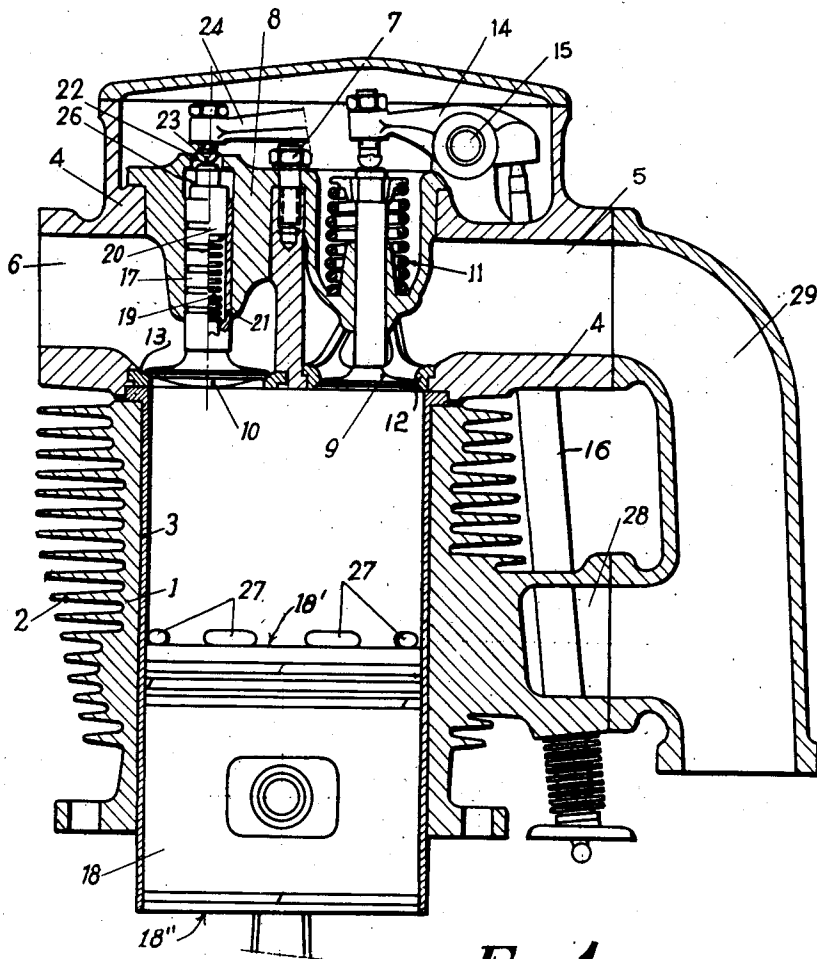


Fig:1

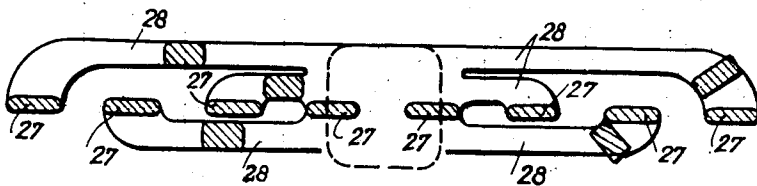


Fig:2

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3 Sheets-Sheet 2

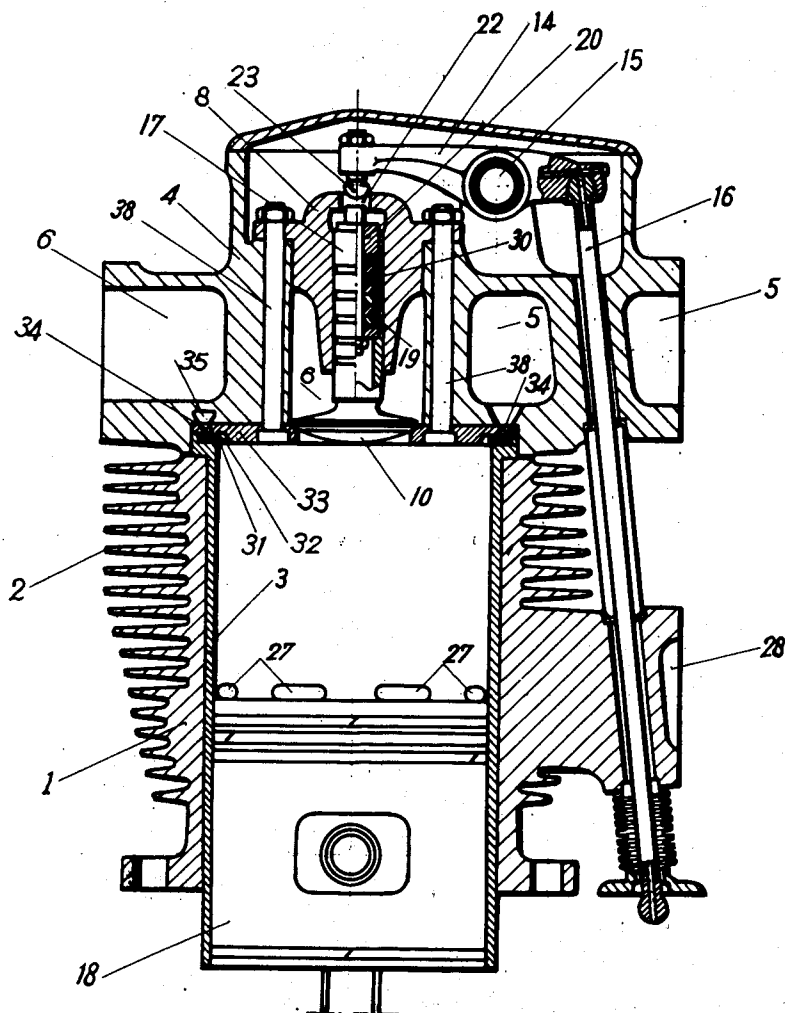


Fig. 4

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3 Sheets-Sheet 3

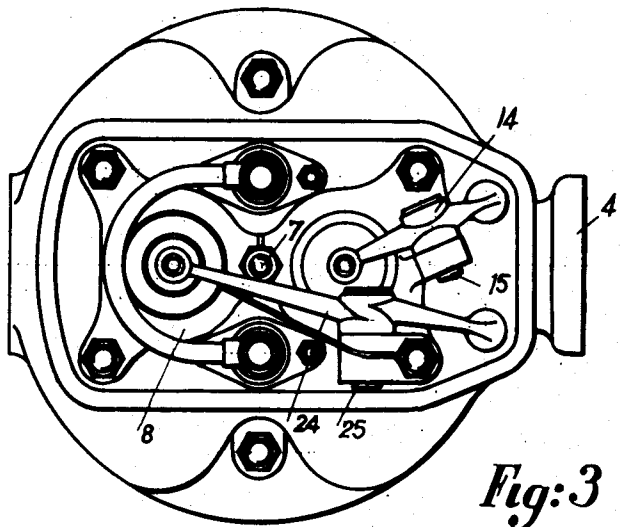


Fig: 3

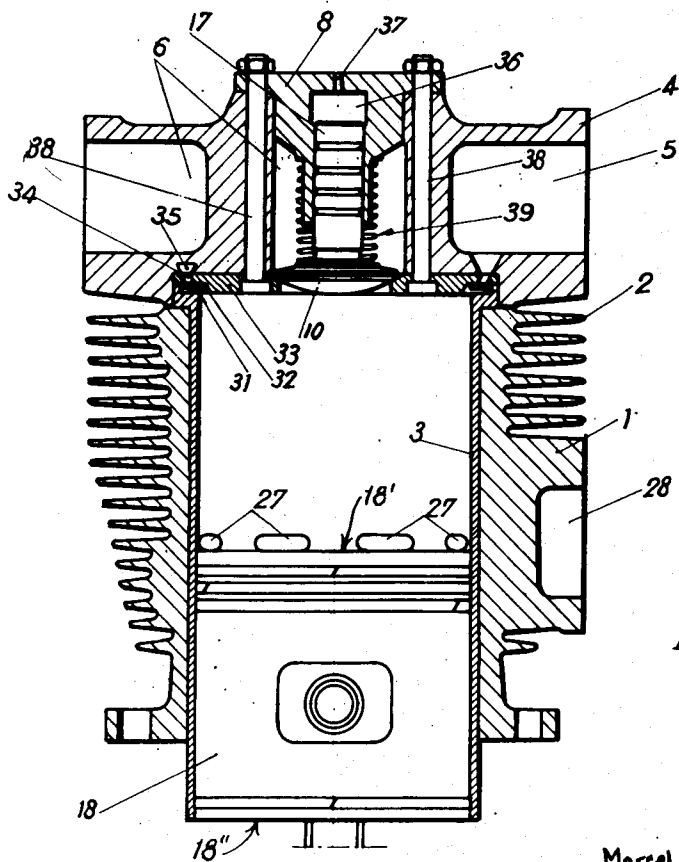


Fig: 5

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UNITED STATES PATENT OFFICE

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COMPRESSOR

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3 Claims. (Cl. 230-172)

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The present invention relates to improvements in compressors provided with pistons. In compressors of known types the rotation speed of the crank-shaft upon which are pivoted the connecting rods pertaining to the piston or pistons is limited; this fact involves immediately a corresponding limitation of the output of the compressor due to the fact that it becomes difficult to fill the cylinders and to evacuate the gaseous fluid contained in the cylinders.

In nearly all of the known compressors the inlet of the gaseous fluid into the respective cylinder is effected by means of a port situated in the cylinder or on the cylinder head and controlled by a valve. The same arrangement is also employed for the outlet. At high speeds the throttling of the gaseous fluid produced by these valves involves important losses of charge this being prejudicial for the obtainment of a good output. As regards the filling of the cylinders, experiments executed by applicant have shown that in the neighbourhood of the cylinder bottoms exists a depression space during the filling stroke which gives evidence of a bad filling of the cylinders.

In order to avoid this very serious drawback, the present invention provides ports in the walls of the cylinder, these ports communicating with the source of fluid and being uncovered when the piston arrives towards the end of its inlet stroke.

According to another feature of the invention, another port is provided together with a control valve in the closed end or in the head of the cylinder.

According to another feature of the invention, the outlet ports are provided in the cylinder heads or covers and are controlled by automatic balanced valves adapted for instantaneous opening and operating as soon as the pressure in the cylinder exceeds a certain value.

Other features will appear from the following specification with reference to the annexed drawings.

In these drawings:

Fig. 1 is an axial section of a cylinder of a compressor provided with pistons comprising the improvements according to the invention;

Fig. 2 is a development of the cylinder showing the arrangement of the inlet ports and of the conduits abutting thereto;

Fig. 3 is a plan view corresponding to Fig. 1 in which the cover has been removed;

Fig. 4 is a diagrammatic axial section of a piston-compressor according to a modification, in

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which the piston is at the end of its downward stroke;

Fig. 5 is a diagrammatic axial section of another modification.

According to the embodiment represented in Figs. 1 to 3, each cylinder of the compressor comprises a main body 1 provided with cooling wings 2 and with an inner sleeve 3 secured in a well known manner. A piston 18 slides in cylinder 1 and has its head portion 18' producing the compression, whereas its under portion 18'' is subjected to no compression at all. At its upper end cylinder 1 comprises a cover 4 provided with inlet conduits 5 and outlet conduits 6, said cover being secured by means of studs or the like. On this cover 4 is secured in a tight way and by means of studs 7 for instance a piece 8 serving as a guide for the inlet valves 9 and the outlet valves 10 of the cylinder.

Inlet valve 9 is held by spring 11 on its seat 12 which might be made in one with piece 8. Outlet valve 10 rests on its seat 13 pertaining to cover 4. In the embodiment represented in Figures 1 to 3, this inlet valve comprises means permitting of controlling its opening either by a cam or by an overturn device 14 (as represented) pivoted on a shaft 15 and controlled by a pushing rod 16 which latter is subjected on its other end to the action of a cam which has not been shown.

According to a feature of the invention, the outlet valve 10 is adapted for an instantaneous and automatic opening. As in Fig. 1, the tail portion 17 of this valve is guided in a suitable hole provided in piece 8.

According to a very important feature of the invention, this outlet valve is moreover locked in its closing position during the whole compressive stroke of piston 18 sliding in cylinder 1 or during a part of this stroke. In an embodiment which for the time being seems to be advantageous this locking is effected with the aid of resilient means. Tail portion 17 of outlet valve 10 comprises an axial closed bore 21 in which is located a small piston 20 subjected to the upward action of a spring 19 located in the bore 21. At its upper end piston 20 meets a hole 22 provided in piece 8 and may get in contact with a pusher 23 which is adjustable and provided at one end of a turnover device 24 pivoted on a shaft 25 mounted on a suitable protrusion of piece 8. The other end of turnover device 24 is controlled either directly by a cam or by a pusher which in turn is controlled by a cam. This cam is moved in synchronism with the crankshaft and has a suitable shape in order that

the resilient locking of valve 10 might take place during the whole stroke of compression or a part thereof.

The valve 10 is subjected on one of its faces to the pressure prevailing in cylinder 1. Its opposite face is subjected to the pressure prevailing in the outlet conduit 6, which is always less important than the pressure prevailing inside the cylinder 1, whereas the stem 17 is subjected to the pressure resulting from the action of spring 19 and arm 24. The dimensions of the valve faces and the diameter of the stem 17 are given such values that when the pressure inside cylinder 1 exceeds a certain predetermined value, the opposite pressures (in 6 and 8) become insufficient so that the opening of valve 10 is executed automatically.

Piston 20 also comprises a shoulder 25 which comes in contact with the edge of bore 22 of piece 8 when the valve 10 is opened. This contact pushes piston 20 downwards against the action of spring 19, thus ensuring a resilient braking of valve 10 at the end of its opening stroke.

According to the invention and as shown in Figs. 1 and 2, the inner lateral wall of cylinder 1 comprises ports 27 located on the periphery of this cylinder. In the represented embodiment, the number of holes or ports 27 is eight. These ports assume such a position, that they will be uncovered by piston 18 when this latter arrives at its lowermost position. These ports 27 are connected with conduits 28 provided in the wall of cylinder 1 with the inlet piping 29, or suction piping. According to the invention and in order to facilitate the arrangement of conduits 28 in the wall of cylinder 1, these latter conduits 28 have a section corresponding to the section of ports 27 and are preferably distributed on both sides of a middle horizontal plane passing through the axis of said ports as shown in Figure 2.

According to another important feature of the invention, the section of these ports is chosen in such way that the gaseous fluid might easily enter the cylinder. Moreover, the shape of these ports is such that their height is relatively small so as to avoid the backflow of the gas during the lifting motion of the piston. Numerous experiments executed by applicant have shown that due to this logical choice of the cross-section and of the shape of these ports, a real overfeeding of the cylinder is obtained, because of the transformation of the kinetic energy of the gas into pressure energy. This overfeeding is obtained for instance by rectangular ports the section of which is sufficient to avoid as far as possible losses of charge. The edges of these ports are rounded and their height which is relatively small with respect to their length depends upon the linear speed of the piston and upon the diameter thereof. It is also possible to use trapezoidal, triangular, semicircular or even circular ports disposed, as regards the three first shapes, in order that the width thereof should decrease along the compressive stroke.

Due to the use of ports having such a shape and arrangement it becomes possible to obtain a perfect filling of the cylinders whatever be the linear speeds of the piston. This result, as numerous experiments have shown it, cannot be obtained with the known compressors. Thus applicant could observe during these experiments that the filling coefficient of the cylinder increases together with the speed of the piston due to the transformation of the kinetic energy into

pressure energy, at the moment when the gases pass through the ports provided in the cylinder walls.

Preferably the ports are slightly convergent so as to form a kind of Venturi tubes at the spot where they open into the cylinder, this fact permitting on the one hand of improving the said transformation of the energy (from kinetic into pressure) inside the cylinder, and on the other hand of having a coefficient of contraction of the gaseous vein nearly equal to 1. The ports open in the cylinder through an orifice having a sharp edge. This fact combined with the above mentioned constructional features of the ports, permit of avoiding any backflow of the gas during the upward movement of the piston.

In order to obtain a most regular flow of fluid without any whirl when arriving into ports 27, pipings 28 provided in cylinder 1 have a constant shape, their area varying progressively from the pipe 29 up to ports 27 in order to correspond to the cross-section of these latter.

The operation of the compressor according to the invention is as follows. At the beginning of the suction stroke of the piston 18, the outlet valve 10 is closed and locked as shown hereabove. The inlet valve 9 opens under the action of turnover device 14 either at the beginning of the suction period, or with a certain delay, if desired. The gaseous fluid enters then into cylinder 1 by the upper end thereof. When the piston arrives to its lowermost position, it opens ports 27 and the gas then flows into the cylinder 1 through those ports ensuring thus a perfect filling of the cylinder. In fact, the upper space of this cylinder is filled by the gas arriving through valve 9 and the lower portion thereof is filled by the gas arriving by the ports 27.

At the beginning of the compressive stroke of piston 18, or even before this moment valve 9 is closed under the action of spring 11; piston 18 closes in turn ports 27 and the fluid contained in cylinder 1 is compressed up to the moment when outlet valve 10, which has been unlocked in due course, as indicated above, is opened and permits the compressed fluid of passing into pipe 6.

It is possible to provide on each cylinder of the compressor an automatic device of any known type permitting the operation without pressure. Such well known devices will not be described in the present specification.

In the modification represented in Figure 4 the inlet ports and the outlet valve with its automatic locking control are identical with those indicated hereabove and will of course not be described once again. The same numeral references indicate the same parts of the apparatus represented in Figs. 1 to 3. However, in this embodiment spring 21 has been replaced by resilient (rubber for instance) rings 30. Moreover, the outlet valve 10 has been shown here in axial arrangement with respect to cylinder 1.

According to the invention and as shown in Fig. 4, the inlet valve is of the type provided with means for an automatic opening and consists of a flap 31 having an annular shape guided in a hole 32 provided in a circular plate 33. This latter plate is secured on cover 4 by bolts 38 and is moreover maintained at its periphery between the upper part of sleeve 3 and cover 4. This circular plate 33 comprises at its periphery holes 34 abutting on the one hand, into boring 32 adjacent flap 31 and, on the other hand, into a convergent annular chamber 35 provided on

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cover 4 and communicating with the inlet piping 5, also provided on this cover, by means of a pipe having a progressively decreasing section, the progression depending upon the cross-section of borings 34.

The operation of this compressor is identical to that described with reference to the embodiment represented in Figures 1 to 3, except that the automatic closing and opening of the inlet valve are controlled by the depression and the pressure prevailing in cylinder 1.

In the embodiment shown in Figure 5 the inlet valve is analogous to the one described with reference to Fig. 4; however outlet valve 10 being adapted for automatic opening and closing (as in the preceding examples) does not comprise anymore any locking of the controlled type. In order to damp the shock which occurs when this valve 10 is suddenly and instantaneously opened, the tail portion 17 thereof slides in a hollow portion 36 provided in piece 8 secured on cover 4, this portion 36 being connected with the atmosphere by orifice 37 having a given cross-section in order that the whole arrangement should act as a dash-pot. A spring 39 is also provided to cooperate for the closing of the valve 10.

It is obvious that the invention is not limited to the embodiments herein represented and described, and that it covers all the cases where use is made of any one of the features above indicated. Thus for instance, the outlet valve or valves may be of the type wherein the opening and closing thereof is controlled by any suitable means in order that these valves should operate under a predetermined pressure. Moreover, the present invention also covers the use of the above mentioned ports 27 (whatever be their cross-section and arrangement) in compressors of any known or unknown types, for instance in single-flow compressors, in double-flow compressors and the like.

It is also possible, without departing from the scope of this invention to use only these ports without any other inlet means with a controlled valve, this being chiefly the case of compressors having a small stroke or a very high pressure.

The present invention also contemplates compressors of any known type incorporating one of the above indicated features.

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

1. A compressor comprising at least one cylinder, a piston reciprocating therein and adapted to compress a fluid during a single stroke, said piston comprising a head portion creating said compression and an under portion subjected to no compression at all, inlet and outlet valve means in said cylinder, means for the positive control of said inlet valve means, lateral aper-

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tures in said cylinder, said apertures being of an elongated shape, their height being substantially smaller than their length, said apertures being located in proximity of the lower dead center of the piston and being adapted to be uncovered thereby when said latter arrives at said dead center, tubular inlet means for said fluid provided with two equivalent branches adapted to connect directly said inlet means, first, said apertures, and secondly, with said inlet valve means, the said branches being adapted to provide upon the closure of the inlet valve means a continuous flow of the fluid into said cylinder through said apertures, thereby transforming the kinetic energy of said fluid into pressure energy, said outlet valve means comprising a stem and a main body, the two opposite faces of which are subjected, respectively, to the pressure prevailing in the cylinder and to the combined pressure exerted on the opposite face of said body by the outlet back pressure fluid and on the stem by the inlet pressure, said pressures on the area of said body and stem being adapted to create a balanced condition of said valve, further means provided for holding said outlet valve means in the closed position at least during the suction stroke of the piston, resilient means disposed in contact with said stem to yieldingly urge said outlet valve into closed position, a piston-like member supported over said resilient means and a control device acting on said piston.

2. A compressor according to claim 1, in which the inlet valve is annular and surrounds the outlet valve, and in which said stem comprises a sleeve with said resilient means within the sleeve.

3. A compressor according to claim 1, in which the resilient means is non-metallic.

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