May 4, 1926. 1,583,535

J. DUBROVIN

COMPRESSOR

Filed April 28, 1924

Fig. 1.

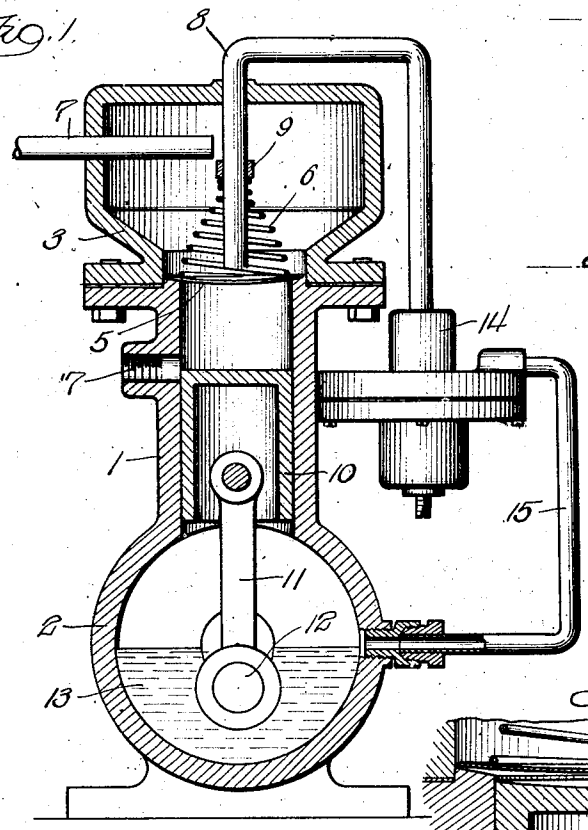


Fig. 5.

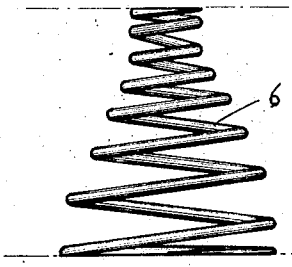


Fig. 4.

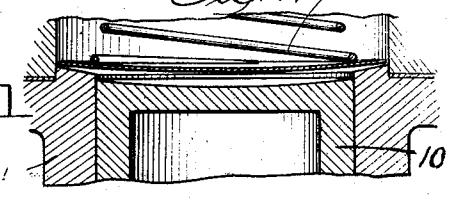


Fig. 2.

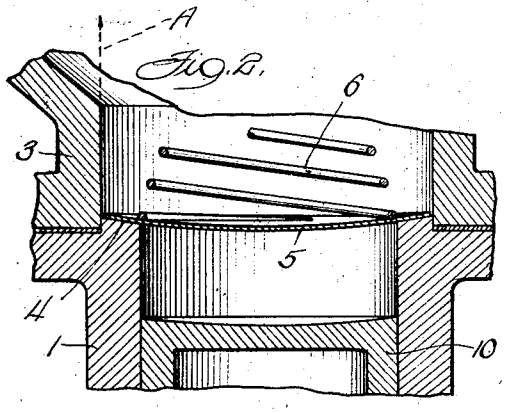
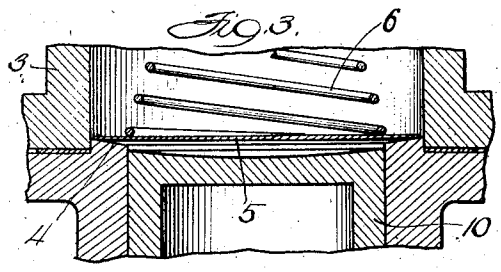


Fig. 3.



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UNITED STATES PATENT OFFICE.

JOHN DUBROVIN, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO UNIVERSE CORPORATION, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

COMPRESSOR.

Application filed April 28, 1924. Serial No. 709,472.

To all whom it may concern:

Be it known that I, JOHN DUBROVIN, citizen of Russia, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in a Compressor; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to air or gas compressors of the general type employing a reciprocating piston, and in some of its general aspects aims to provide simple and effective means for eliminating the noise commonly caused by the seating of the movable cylinder head, for effectively reducing the clearance between the piston and the cylinder head so as to increase the degree of compression and the efficiency of the compressor, and for separating the compresseed air or other gas from lubricating oil.

In U. S. Patent No. 1450122 of March 27, 1923, there is disclosed a compressor of this general class employing a lifting head for the cylinder and provided with an oil separating chamber in which the lubricating oil which has passed beyond the cylinder into the compressing chamber is separated from the compressed gas. While this arrangement has afforded a satisfactory separation of the oil from the gas and an automatic return of the separated oil to the crank chamber of the compressor it involves a bulky and relatively expensive construction, since it requires the providing of an additional oil separating chamber and of suitable baffle arrangements within the latter. My present invention provides a simple but effective substitute for this auxiliary oil separator by providing separate outlets from the discharge chamber for the compressed gas and the oil respectively, by arranging these outlets so that the compressed air flowing from this chamber will be practically free of oil instead of carrying oil with it, and by shaping the discharge chamber so that oil creeping up its inner wall will be forced away from this wall.

The said patent also disclosed the use of a light and bodily movable cylinder head normally held in its closure position by a spring, together with simple means for retaining a sufficient quantity of lubricating oil within the compression chamber above this head to aid both in affording a tight seal for the outlet end of the cylinder and in reducing the noise due to the seating of the head. While this feature also has given advantageous results, compressors constructed with the same have not been as free from noise as is desirable for certain purposes, as for example when such a compressor is employed as part of a mechanical refrigerating unit designed for household use. Furthermore, since the width of the flat seat portion required for such a cylinder head introduces a considerable friction or wire-drawing effect, this has retarded the securing of the desired high compression with a relatively slow rate of operation of the compressor.

My present invention aims to overcome the objections on the score of noise by providing a seat and head arrangement in which the head engages the end of the cylinder only along a single circular line at the moment of its seating or unseating, thereby affording so small a contact surface that the intervening slight film of oil can adequately cushion the same, and thereby also eliminating the noise-producing sudden expulsion of a considerable amount of air and oil from between the head and the seat. It also practically eliminates the wire-drawing or pressure reducing effect as heretofore encountered with a relatively small lifting of such a cylinder head by providing a divergence between the movable cylinder head and the adjacent end of the cylinder and by arranging the head so that its separation from the cylinder will be only along a single line instead of along an annular surface of considerable area.

Furthermore, my invention provides a movable cylinder head arranged so that it will be flexed into the adjacent end of the cylinder to some extent when in its closure position and provides a piston having a corre-

spondingly recessed rear end adapted to cooperate with the flexing of the cylinder head for permitting the operation of the compressor with an exceedingly small clearance between the piston and the head, thereby increasing the effective rate of compression and greatly expediting the attaining of a desired degree of compression.

My invention also provides such an interior shape for the chamber into which the compressed gas is discharged that oil which has entered this chamber will be projected away from the inner wall of this chamber, thereby preventing the movement of the gas from aiding capillary action in moving the oil further toward the discharge outlet of the chamber.

Still further and also more detailed objects will appear from the following specification and from the accompanying drawings, in which—

Fig. 1 is a central and vertical section through a compressor embodying my invention, showing the piston at the lowest point of its travel.

Fig. 2 is an enlargement of a portion of Fig. 1 with the piston in a more elevated position and the cylinder head in the effective closure position which it accompanies during the major part of the reciprocatory movement of the piston.

Fig. 3 is a section similar to Fig. 2 but showing the piston substantially at its highest point, and also showing the movable cylinder head in the position occupied by it just before it is raised off the adjacent end of the cylinder or when it has just returned to this seat-forming end by the spring.

Fig. 4 is a section similar to Fig. 3, but showing the use of a movable head which is normally convexed downwardly to a less extent than the slope of the annular seat.

Fig. 5 is a view of a desirable form of spring for use with my invention.

Referring to the embodiment of the drawings, Fig. 1 shows a compressor having a vertical cylinder 1 supported by a crank casing 2 and surmounted by a discharge chamber 3 having its lower end of larger interior diameter than the bore of the cylinder. Owing to this divergence in diameters, the cylinder presents an annular end portion 4 directed upwardly into the pressure chamber 3 and adapted to afford a seat for the movable head of the cylinder. Instead of forming this cylinder end or annular seat portion 4 in a plane transverse of the axis of the cylinder, I desirably slope it downwardly inward of the cylinder. Then I employ a relatively thin and normally flat cylinder head 5 of a resilient material such as a clock spring steel, this head being normally held in its closure position by a spring 6 of sufficient strength for flexing the cylinder head into a downwardly convexed form in which its radially outer portions engage the annular seat 4 from the outer edge of the head to the bore of the cylinder.

As an outlet for the compressed gas forced into the discharge chamber 3, I provide a duct 7 leading from this chamber at a considerable height above the cylinder head 5. This gas outlet duct 7 desirably extends through a side wall of the pressure chamber 3 for a considerable distance into the said chamber, as shown for example in Fig. 1. I also provide an oil outlet tube 8 which tube desirably extends vertically downward through the top of the chamber 3 to a point somewhat higher than the extreme height to which the head 5 will be lifted in practice against the resistance of the spring 6. This spring desirably tapers upward so that its upper end is sleeved upon the tube 8 for holding the spring axially central of the cylinder and its upper end desirably abuts against a suitable thrust member, such as a collar 9 secured to the oil outlet tube 8, while the lower end of the spring desirably has a substantially complete annular bearing surface of a diameter closely approximating the bore of the cylinder. Slidable within the cylinder 1 is a piston 10 connected by the usual pitman 11 to the pin 12 of the actuating crank of the compressor, the cylinder having a suitably disposed gas inlet 17.

In constructing a compressor after the manner above described, I desirably employ a spring 6 of sufficient strength for normally convexing the head 5 downwardly after the manner shown in Fig. 2, so that the radially outward portion of the head will correspond substantially in shape to the slope of the annular seat 4, thereby affording a wide seating engagement and a consequently highly effective seal. During the downward or intake movement of the piston, the resulting suction will cooperate with the pressure of the spring in holding the head in tight sealing engagement with the seat and this seating of a wide radially outer portion of the head on the annular seat 4 continues also during a portion of the upward or compressing stroke of the piston.

Then, as the pressure of the fluid entrapped in the cylinder between the piston and the movable head 5 increases, this pressure will gradually overcome the resistance of the spring 6 with the initial result of permitting the resiliency of the metal to return the head to its normal flat shape while the spring still resists a bodily lifting of the head and keeps the edge of the lower face of the head in engagement with the seat as shown in Fig. 3. In other words, the downward convexing of the head gradually decreases during the upward stroke of the piston so as to reduce the extent of the seating engagement until this engagement between the head and the seat is merely

along a single circular line. After this mere linear engagement of the head with the seat has been reached, the continually increasing pressure below the head reaches a point where it overcomes the resistance of the spring and lifts the head bodily off its seat in the usual manner so as to allow the compressed fluid to escape between the edge of the head and the bore of the chamber 3. In thus issuing from the cylinder, the compressed gas has a relatively wide opening provided for it at the mouth of the cylinder and this opening is at its narrowest only along the very edge of the movable head, so that the gas is not discharged through a relatively wide passage of quite restricted height as would be the case if the portion of the head opposite the seat was continuously of a cross-section corresponding to that of the seat. Consequently, I practically avoid the socalled "wire drawing" or pressure reducing effect encountered with the older constructions of compressors employing bodily movable cylinder heads, and hence can attain both a higher compression in the discharge chamber 3 and a more rapid discharge of the compressed fluid into the said chamber.

To increase the obtainable pressure still further, I desirably concave the upper end of the piston (or the end facing the movable head 5) as shown in Figs. 2 and 3, so as to correspond in central transverse section to that of the movable head when the latter is flexed into its downwardly convexed and firmly seating shape. By so doing, I can provide an unusually close approach of the piston to the end of the bore of the cylinder without the risk of having the piston come into contact at any time with the movable head.

To secure the needed continuous lubrication of the piston, crank and pitman, I desirably provide a sufficient quantity of lubricating oil in the crank casing 2 so that the crank will continuously splash some of this upward into the bore of the cylinder. Since some of this oil will also be carried up by the piston to the upper portion of the cylinder, oil will be carried into the chamber 3 with each charge of the compressed gas and will gradually form a layer of oil in the bottom of the said chamber. As soon as this layer extends above the bottom of the oil tube 8, the pressure of the gas which is gradually discharged from the chamber 3 through the relatively small bore of the outlet tube 7 forces the oil out through the oil duct 8. This duct is desirably connected through a differential valve 14 to an oil return tube 15 leading to the interior of the crank casing, the said valve being arranged after the manner of the said Patent No. 1,450,122 for permitting oil to pass from the duct 8 to the oil return tube 14 whenever the pressure within the crank casing falls to a predetermined point.

By arranging the gas outlet pipe 7 so that its inlet is disposed at a considerable height above the head 5, I prevent this from being reached by the fine spray in which the oil is carried into the chamber 3 with the compressed gas entering this chamber. However, this finely sprayed oil might be carried upward along the inner wall of the chamber 3 by capillary action and might be drawn into the tube 7 if the latter had its inlet flush with the said inner wall, hence my desirably extending the gas discharge tube 7 for a considerable distance beyond the wall of the chamber 3 into the latter, as shown for example in Fig. 1. I also desirably provide the discharge chamber only for a relatively short height above the said annular seat with a bore approaching the diameter of the movable cylinder head and then widen this chamber considerably as shown in Figs. 1 and 2, and preferably provide a sharp shoulder at the juncture between these two portions of the chamber. With the bore of the discharge chamber thus formed, the movement of the compressed gas can only assist capillary action in carrying the oil along the contracted bore portion up to this shoulder, after which the succeeding upward rushes of gas will project the oil substantially vertically or away from the widened lateral wall portion of the chamber as shown by the arrow A of Fig. 2. Almost all of the oil thus removed from the wall of the chamber is collected by gravity over the movable cylinder head and later is forced out through the oil tube 8, so that this shaping of the discharge chamber cooperates with the disposition of the gas outlet tube 7 in affording an effective separation of the oil from the gas. By so doing, I have found that I can effectively separate the lubricating oil from the compressed gas within this chamber without requiring an auxiliary separating chamber or oil separating baffles after the manner shown in U. S. Patent No. 1,450,122.

However, while I have heretofore illustrated and described my invention in a highly desirable embodiment, I do not wish to be limited to the various details of construction and arrangement disclosed in the same, it being obvious that many modifications might be made without departing either from the spirit of my invention or from the appended claims. For example, the resilient head might be initially formed so that it will normally be convexed slightly downward, provided that the slope of the annular seat corresponds to a convexing of smaller radius, as shown in Fig. 4. So also, the spring employed for resisting the bodily lifting of the head and for maintaining the edge of the head in engagement with the

seat until the head has returned to its normal shape might be of a diameter differing considerably from that of the cylinder bore. However, in each case I preferably form the spring so as to engage the head at a considerable number of points spaced radially inward from the edge of the head, for which I desirably employ a spring having a head engaging turn forming an almost complete circle and ground to afford a bearing in a plane at right angles to the axis of the spring. I also desirably make the bore of the chamber 3 only slightly larger in diameter than the head, so that this bore will afford a guide for limiting the lateral movement of the head in any directon.

With such a compressor of such a construction in operation, it will be obvious that after the head has been lifted off its seat, the return seating movement will initially cause the head to engage the seat only along the single line of its circular edge, so that I do not obtain the loud slapping noise which is produced whenever a pair of relatively wide surfaces are suddenly brought into contact with each other. Furthermore, since there initially is a gap of considerable height between the head and the extreme end of the cylinder at the bore of the latter, the initial seating movement does not expel gas from between the two engaging surfaces after the manner of flatwise seating contacts, and the subsequent gradual convexing of the head affords no noise whatever. Consequently, I have found that my exceedingly simple arrangement effectively overcomes the noise which has heretofore been considered unavoidable with compressors having bodily movable cylinder heads. Moreover, the film of oil upon the seat cooperates with the tightening of the seal, so that I can secure a highly effective closure even through the seat does not conform exactly in its slope to the curvature of the adjacent head portion. Owing to this effective sealing, together with the elimination of the usual wire drawing and the reduction in the clearance between the piston and the head, I am able to secure a decided increase in the compression obtained with a piston of given diameter and stroke in a given number of reciprocations, so that with a given size of compressor and a given rate of reciprocation I can attain a desired degree of compression much more quickly than I could without employing the above disclosed novel features.

Furthermore, I do not wish to be limited to the conjoint use of these various novel features, as they might obviously be employed separately.

I claim as my invention:—

1. In a compressor, a cylinder having at its discharge end an outwardly concaved annular seat; an imperforate circular and normally flat head of smaller diameter than the outer diameter of the seat and of a resilient and normally flat material adapted to be convexed toward the cylinder to a spherical curvature conforming substantially to the concaving of the seat; and a spring having an annular end portion of smaller diameter than the head and disposed with this end engaging the head on the side opposite the cylinder and cooperating with suction in the cylinder to flex the head to the said seat-fitting spherical curvature.

2. In a compressor, a cylinder having at its discharge end an outwardly concaved anuular seat, an imperforate head of smaller diameter than the outer diameter of the seat, the head being of a resilient and normally flat material adapted to be convexed toward the cylinder to a spherical curvature closely fitting the concaving of the seat while continuously maintaining the outer edge of the head in engagement with the seat, and a compression spring axially concentric with the cylinder and urging the head toward the cylinder, the spring having a head-engaging annular portion of a diameter not greater than the bore of the cylinder.

3. In a compressor, a cylinder having at its discharge end an annular seat flaring outwardly of the cylinder; an imperforate, circular and resilient head having a diameter greater than the bore of the seat and having its resiliency tending to maintain the head in a shape in which it engages the seat only along the edge of the face directed toward the seat, and spring means continuously urging the head toward the seat and adapted to flex the head into a shape in which it engages an annular seat portion of considerable width.

4. In a compressor, a cylinder having at its discharge end an annular seat, a normally flat head of thin resilient material having a diameter greater than the bore of the seat and engaged only along its edge by the seat when the head is flat, the head being adapted to be convexed toward the cylinder so as to have it bear against an annular seat portion of considerable width, and spring means continually urging the head toward the seat and engaging the head at a plurality of points spaced radially inward by a considerable distance from the edge of the head, whereby the spring will cooperate with the bearing of the edge of the head against the seat to convex the head into its said wider seat-engaging disposition.

5. The combination with the cylinder of a compressor, of a compressed gas chamber into which the discharge end of the cylinder opens, a movable head normally closing the connection between the cylinder and the said chamber, spring means continuously pressing the head towards the cylinder, an oil

discharge pipe extending into the chamber to a point near the head, and a compressed gas discharge pipe connected to the said chamber and having its inlet spaced by a considerable distance from the said head.

6. A compressor as per claim 5, in which the cylinder and the compressed gas chamber are in vertical alinement with the chamber above the cylinder, and in which the gas discharge pipe extends into the chamber and has its inlet spaced by a considerable distance from the inner walls of the chamber.

Signed at Chicago, Illinois, April 22nd, 1924.

JOHN DUBROVIN.