

May 8, 1928.

C. B. VAN HORN

1,668,664

COMPRESSOR

Filed May 14, 1926

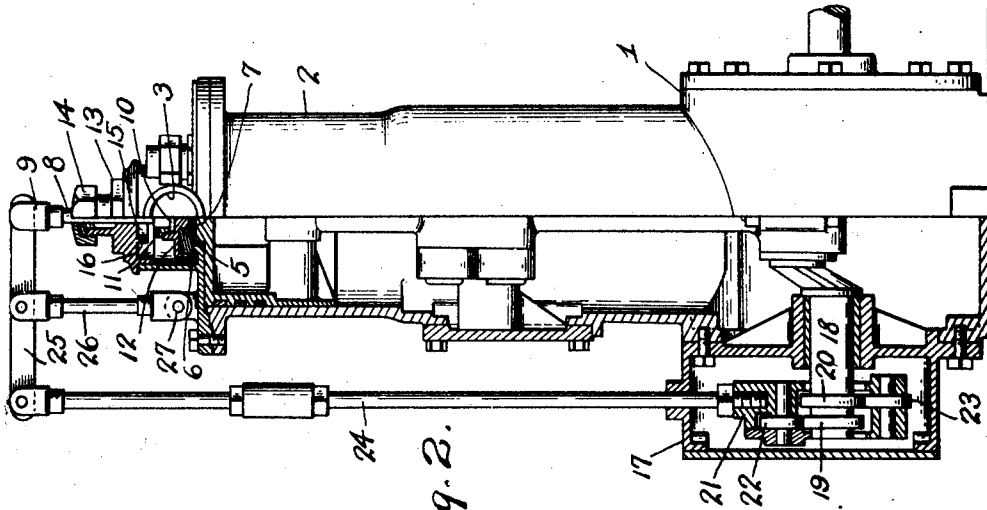


Fig. 2.

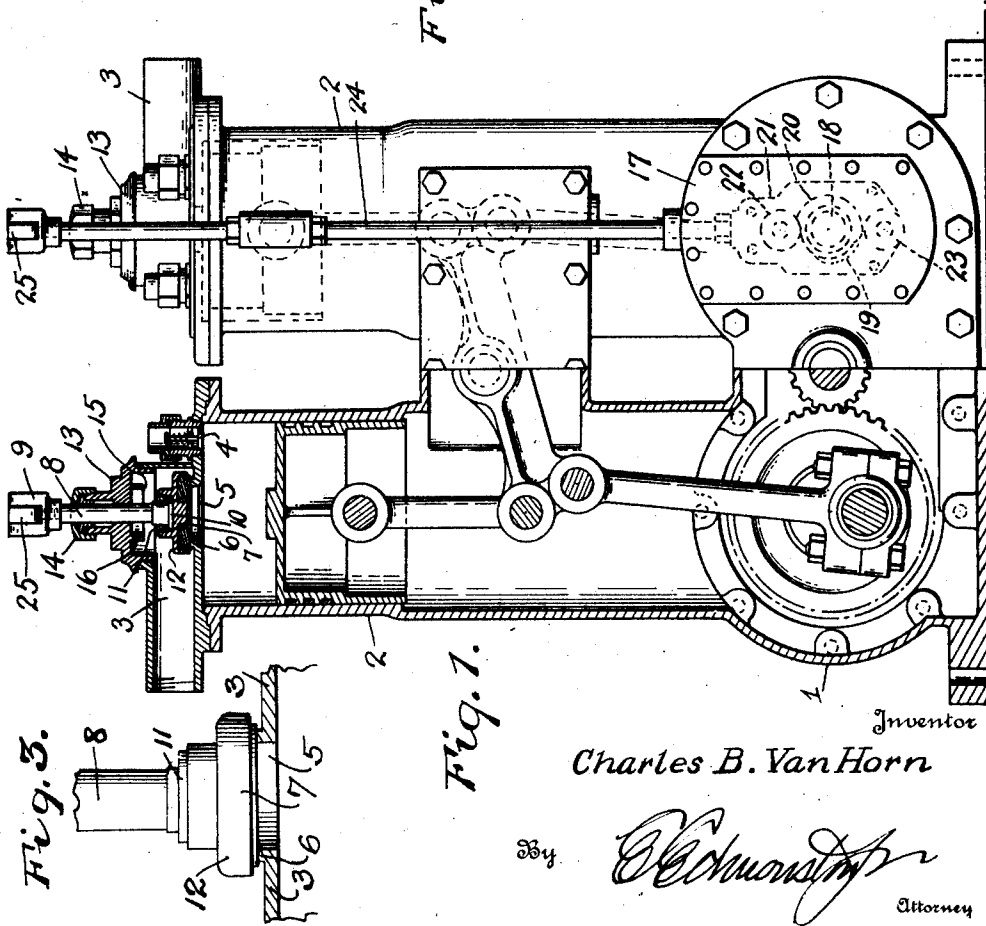
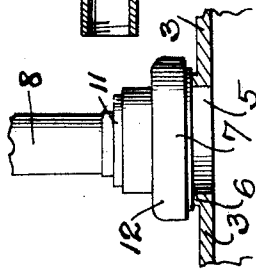


Fig. 1.

Fig. 3.



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UNITED STATES PATENT OFFICE.

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COMPRESSOR.

Application filed May 14, 1926. Serial No. 109,094.

This invention relates to compressors and to the method of operating that type of fluid compressor commonly utilized to continuously compress a quantity of air into a suitable reservoir, and the principle object of the invention is to provide for the elimination of heat and consequently the elimination of such heat absorbing elements as are usually employed in compressors of this type.

Heretofore it has been found expedient and absolutely necessary in certain instances to provide the cylinder either with water jackets or with suitable radiating fins so as to dissipate the heat generated in the operation of the compressors. The invention is designed as an improvement upon the constructions illustrated in my Patents Nos. 1,361,933 of December 14, 1920, and 1,415,852 of May 9th, 1922, to which further reference will be made.

The invention generally consists in constructing and proportioning the working areas of the discharge or exhaust valve in such a manner and in such relation to the discharge passage that the air passing from the compression chamber into the exhaust passage, instead of being forced out of the cylinder at a comparatively higher pressure than that existing in the reservoir, flows into the discharge passage at substantially the same pressure as that existing in the reservoir. In other words, when the discharge valve is fully open, as will be more clearly explained, the pressure in the discharge passage and the compression chamber are equalized and then further compressed by the advance of the piston, thus eliminating undue friction and consequent heat at and around the discharge valve parts.

In the majority of compressors of this type, air is compressed in the cylinder between the head thereof and the top of the piston to such an extent that the pressure per square inch is considerably in excess of the reservoir pressure before the compressed air is discharged from the cylinder. This causes a rush of air at extreme pressures into the discharge port, producing friction and consequent heat. Furthermore, these valves are usually opened by the pressure in the cylinder against the normal head or back pressure and a closing spring. To take care of the heat situation, it has been proposed, as before stated, to cool the cylinder with water jackets and radiating fins,

but I have found these cooling elements to be entirely superfluous and indeed detrimental to the production of the device when cost is considered and it is of course an object of this invention to eliminate the necessity of the use of such cooling elements. To accomplish this I construct the discharge valve in such manner that its interior face or that portion of its interior face which is exposed to the compressed air within the cylinder, of such area that it greatly exceeds the external area exposed to reservoir pressure and allows the valve to open freely under cylinder pressures when such cylinder pressures are below reservoir pressures, thereby permitting reservoir pressures to enter the cylinder thereby equalizing the pressure in the reservoir and cylinder and utilizing such reservoir pressure to act upon the greater area of the inner surface to assist in opening the valve. In doing this, I provide a full opening of the valve so as to produce a discharge port of equal area to the cross-sectional area of the discharge passage. Then upon the continued upward movement of the piston, air is compressed not only in the cylinder but in the discharge passage and in the reservoir equally, thus if friction is not absolutely eliminated, it is distributed over such a large area in the discharge passage and in the reservoir that it is ineffectual to produce any material amount of heat, certainly not sufficient to require any cooling elements.

Further objects of the invention will be clearly apparent when the following specific description is read in connection with the accompanying drawings which form a part of this application and in which:

Figure 1 is an elevation of the compressor with one-half thereof in section.

Figure 2 is an elevation taken at right angles to Figure 1 with one-half of the adjacent cylinder in section so as to show the valve operating cams, etc.

Figure 3 is a detail of the discharge valve on an enlarged scale with the stem somewhat exaggerated in size to clearly show the difference in the areas exposed to cylinder and reservoir pressures.

In the drawings, I have shown a compressor of the type illustrated in my Patent No. 1,415,852 of May 9, 1922, reference to which will constitute a sufficient disclosure of the structure embodying the operating mechanism for the pistons. I have gen-

erally indicated the crank case at 1, the cylinder at 2 and the discharge passage which is formed in the cylinder head at 3. As the operating mechanism for the pistons is clearly disclosed in Patent No. 1,415,852, I shall not attempt to enlarge upon that description, it being sufficient to say that by the mechanism disclosed in that patent, the pistons are reciprocated and each suck in air on their downward stroke through check valves 4.

While I have shown two cylinders in the present compressor, I wish it to be clearly understood that the invention involved herein may be practiced with one or more than two cylinders equally as well, if found desirable.

As the invention herein concerned relates essentially to the discharge valve mechanism and as the discharge valve on each cylinder is operated in a similar manner, a description of one discharge valve will be sufficient.

As shown in Figure 1, the head is provided with a discharge port 5 having surrounding the same an upstanding valve seat 6 upon which the valve 7 seats. This valve is provided with an operating stem 8 having a bifurcated or forked upper end 9, the purpose of which will be hereinafter described. As shown the valve stem 8 is provided with an enlarged lower end flanged at 10 so as to be clamped into position on the valve disk 7 by a clamping collar 11, which is threaded into an upstanding collar 12 on the valve disk. This arrangement provides for a convenient interchange of valve stems and valve disks whenever found to be desirable. The valve stem is guided in a cap piece 13 threaded into a suitable opening in the cylinder head and carrying a packing gland 14 of any preferred type.

The cap piece 13 is provided with an inwardly extending annular flange 15 serving as a cylinder or dash pot which is vented by lateral ports 16 formed in the side walls thereof adjacent the base of the cylinder. The clamping collar 11 and the sleeve 12 form a piston which enters the dash pot 15 and cushions the upward movement of the valve when forcibly opened by the pressure within the cylinder.

In the valve operating construction shown, I have illustrated one embodiment, but this, it must be considered is only illustrative of one convenient method of positively actuating the valve to closed position, and I might, without departing from the spirit of this invention, employ any other suitable mechanism for controlling the closing movement of the valve. In the form shown, I have shown the crank case supplied with what I shall call a valve cam case 17 into which an extended end of the crank shaft 18 projects, adjacent the terminal of this

crank shaft, I secure cams 19 and 20 operating within a common cam strap 21 which carries anti-friction rollers 22 and 23 bearing respectively against said cams 19 and 20. This cam strap has secured to it the valve operating rod 24 adjustable in its length in any manner and pivotally connected at its upper end to a rocker arm 25, whose opposite end freely engages within the bifurcated head 9 of the valve stem 8. This rocker arm is fulcrumed upon the upper end of a link 26 pivotally connected to the head at 27. This pivotal connection of the link connection 26 permits the rod 24 to operate in a fixed path and the free end of the rocker arm to actuate the valve stem also moving in a fixed path irrespective of the arc of movement of its other end. This is a convenient manner of accomplishing this result, but it is readily understood that other means might be provided, such for instance, as slotting the outer end of the rocker arm where it engages the pivotal connection with the cam rod 24.

In the operation of this device the crank shaft 18 is continuously rotated, as will be readily understood, and through the connecting rods and pitmans, the pistons are continuously reciprocated. As the piston in one cylinder descends on its suction stroke, air is sucked into the cylinder through the inlet check valve 4. The cam rod 24, at this time being lifted by the cam 19 and the valve disk 7 held tightly against its seat. Just prior to a complete downward movement of the piston, the cam rod 24 is depressed by the action of the cam 20 on the friction roller 23 and the free or inner end of the rocker arm raised out of engagement with the head 9 of the valve stem. The parts remain in this position during the entire up stroke or compression stroke of the piston and the valve 7 is not again forcibly closed until substantially all of the air in the compression chamber has been discharged therefrom, but is closed quickly and forcibly by the valve operating mechanism just prior to the start of the descending movement of the piston so that no air compressed into the discharge passage will be permitted to return.

The exposed or inner working surface of the valve being of a much greater area than the external surface or the surface exposed to the reservoir pressures (this difference being readily regulated by increasing or decreasing the diameter of the valve stem to suit operating conditions), the valve will open under cylinder pressures when such cylinder pressures are considerably below reservoir pressures. In other words, the inner exposed area of the piston is sufficiently larger than the outer area exposed to the reservoir pressures to cause the cylinder pressures to overcome the reservoir pressure

and permit the valve to open against such reservoir pressures. As for example, we will assume that we have a reservoir pressure of one hundred pounds and that when the piston has ascended to a point where the pressure in the cylinder is approximately ninety pounds per square inch, this pressure will then overcome higher reservoir pressure exerted upon the smaller outer area of the valve and the valve will be opened to a small degree, whereupon the higher reservoir pressure will enter the cylinder and raising the pressures therein until they are equal with the pressures in the reservoir and discharge passage, thereupon the valve is then exposed on its inner and outer faces to an equalized pressure, but the inner face having the greater working area which is increased the moment the valve is raised from its seat the high pressures act upon the inner face and will open the valve forcibly, but this action will be cushioned by the dash pot 15. Now, as the pressures are equalized within the compression chamber, the discharge passage, and the reservoir, the continued upward movement of the piston will compress the air further in all parts and the air compressed within the cylinder will flow evenly and smoothly into the discharge passage and reservoir without producing any appreciable friction and thereby eliminating heat and the necessity of employing heat dissipating elements.

This is clearly distinguished from all previous types of compressors which provide for the discharge of the fluid from the compression chamber at considerable higher pressures than are obtained in the reservoir.

It will be noted that I have referred to a slight opening movement caused by the lower compression chamber pressure action upon the larger area of the inner surface of the valves and a full opening movement due to the reservoir pressure equalizing with the cylinder pressure but the pause between the two movements of the valve is so infinitesimal as to be incapable of observation in the operation of the machine. In fact it is very doubtful whether there is any actual pause but the opening movement of the valve has its speed increased materially when the high pressures affect its action and it is thought it may be said with authority that the valve continuously moves, but with increasing speed over the initial starting movement.

From the foregoing it will be seen that by operating a compressor so that the discharge valve is opened by cylinder pressure of a lesser value than the reservoir pressure and then equalizing the pressures in the reservoir and the cylinder, I am enabled to discharge the compressed air from cylinder without friction and therefore without generating any appreciable amount of heat and at the same time I utilize reservoir pressures to open

the discharge valve. When I say that the reservoir pressures are utilized to open the discharge valve, this is to be taken literally because the cylinder pressures merely start the opening movement and the valve is not fully opened until the cylinder pressures are equalized by air from the reservoir flowing into the cylinder until the pressures are equalized and the then higher pressure acting upon the greater inner area of the valve, forces it to open position.

What I claim is:

1. In a compressor, the combination with a cylinder head having a discharge port, of a freely opening valve for controlling said port, said valve having the surface exposed to cylinder pressures of greater area than the surface exposed to reservoir pressure whereby the valve will be opened when the pressure in the cylinder is of lesser value than the value of the reservoir pressure, and means for positively closing said valve.

2. In a compressor, the combination with a cylinder and a reciprocating piston therein, of a cylinder head having a port therein, a freely opening valve for controlling said port, means for positively closing the valve, and a valve stem having a diameter adapted to regulate the external surface area which is exposed to reservoir pressures, the inner surface of said valve exposed to cylinder pressure being of greater area than the area exposed to reservoir pressures whereby the valve will open when the pressure in the cylinder is of lesser value than the reservoir pressure.

3. In a fluid compressor, the combination with a cylinder, a reciprocating piston therein, of a cylinder head having a discharge port leading into a reservoir, a valve for the discharge port, said valve being so constructed as to internal and external areas that it will be partially opened prior to the full compression stroke of the piston and when the cylinder pressure is less than the reservoir pressure thereby permitting the reservoir pressure to equalize with the cylinder pressure, said reservoir pressure then acting upon the valve to produce a full opening movement thereof upon the further upward movement of the piston, and means for positively closing the valve.

4. In a fluid compressor, the combination with a cylinder, a reciprocating piston therein, of a cylinder head having a discharge port leading to a reservoir, a valve for the discharge port, said valve being so constructed as to internal and external areas that it will be partially opened prior to the full compression stroke of the piston and when the cylinder pressure is less than the reservoir pressure thereby permitting the reservoir pressure to equalize with the cylinder pressure, said reservoir pressure then acting upon the valve to produce a full opening movement thereof upon the further upward movement of the piston, and means for positively closing the valve.

ing movement thereof upon the further upward movement of the piston, means for cushioning the opening movement of the valve and means for positively closing the
5 valve.

5. The method of operating a fluid compressor which consists in admitting reservoir fluid at reservoir pressure to the compression chamber of a compressor when the pressure
10 in said chamber is of a lesser value than the pressure in the reservoir, and then continuing compression of the fluid in the chamber of the compressor and reservoir.

6. The method of operating a fluid com-

pressor, which consists in admitting reservoir fluid at reservoir pressure to the compression chamber of a compressor when the pressure in said chamber is at a lesser value than the pressure in the reservoir thereby substantially equalizing the pressures in the
20 compression chamber and reservoir before the end of the piston stroke, and then continuing compression of the fluid in the chamber and reservoir simultaneously to the end
25 of the piston stroke.

In testimony whereof I affix my signature.

CHARLES B. VAN HORN.