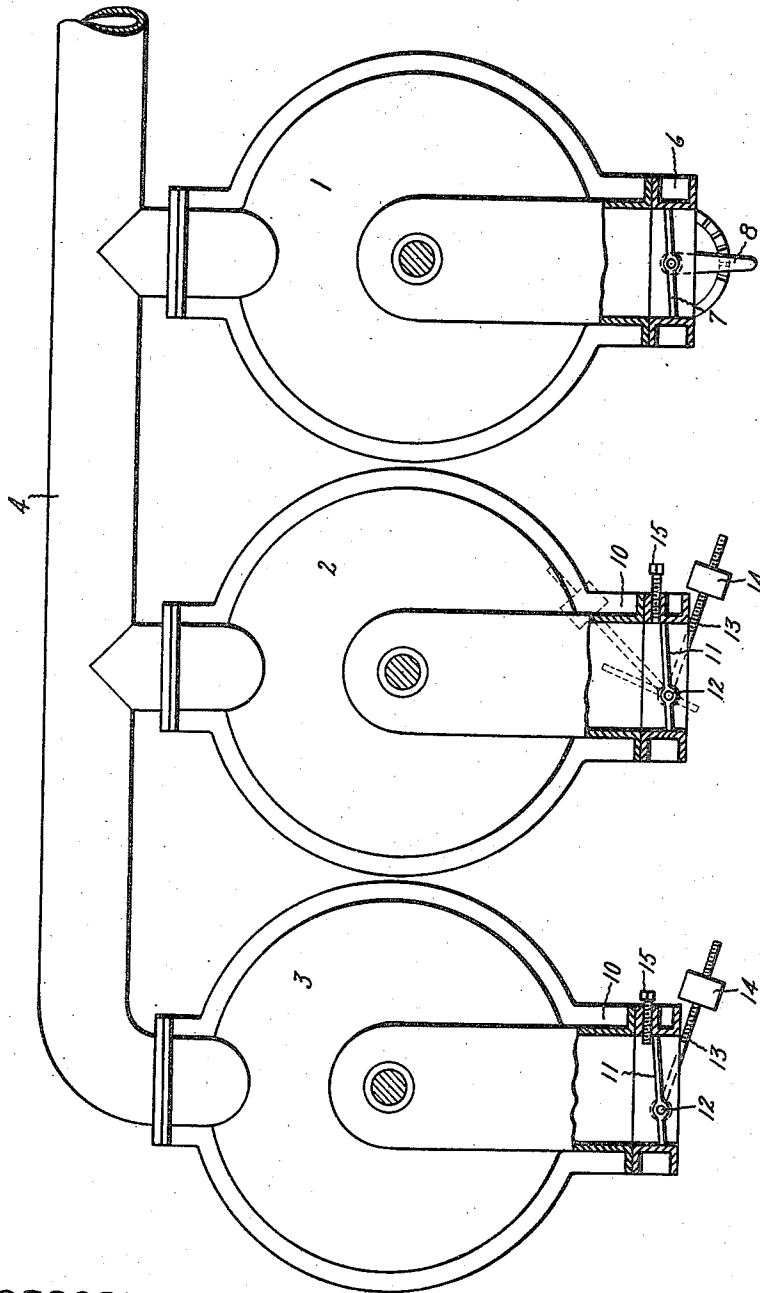


S. A. MOSS.
CENTRIFUGAL COMPRESSOR.
APPLICATION FILED MAR. 12, 1915.

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Patented Oct. 12, 1915.



Witnesses:

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UNITED STATES PATENT OFFICE.

SANFORD A. MOSS, OF LYNN, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

CENTRIFUGAL COMPRESSOR.

1,156,613.

Specification of Letters Patent.

Patented Oct. 12, 1915.

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To all whom it may concern:

Be it known that I, SANFORD A. MOSS, a citizen of the United States, residing at Lynn, in the county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Centrifugal Compressors, of which the following is a specification.

The present invention relates to centrifugal compressors, and particularly to the operation of two or more such machines in parallel.

The invention relates more particularly to centrifugal compressors for compressing air and will be described as applied to such use, but it will be understood that it is not necessarily limited thereto.

When two or more centrifugal compressors are connected to operate in parallel discharging into a common blast main the load will be fairly evenly distributed so long as the total load is such that that on each machine is of substantial value. This value varies with different installations depending upon the characteristics of the particular machines. When the total load falls below this value there is a tendency for one machine after another to drop its load to the remaining machines which will eventually take all the load and drive air back through the other or others. This has led to considerable difficulty in operating several machines in parallel.

The object of the present invention is to provide an improved arrangement which will permit of two or more centrifugal compressors being successfully operated in parallel at varying loads.

In carrying out my invention I provide an automatically closing valve or damper upon either the inlet side or the discharge side of each compressor, or all but one of them, and so arrange it that when air tends to pass through the machine in the reverse direction, it will automatically close. By this arrangement whenever a machine loses its load, the passage through it will be automatically closed and hence the other machine or machines cannot force air through it backward.

The accompanying drawing illustrates one form which my invention may take and is the form which I now believe to be preferable.

Referring to the drawings, 1, 2 and 3 are

three centrifugal compressors connected to discharge into the common blast main 4. These compressors may be of any suitable construction, and are of the type in which the delivery pressure varies with the load, the pressure increasing with the load up to a certain point and then decreasing again with further increases in load. Arranged in the inlet 6 of the compressor 1 is a gate valve or damper 7 having an operating handle 8 by means of which it can be moved and fastened in open, closed, or any intermediate position. In the inlet 10 of each of the other compressors is an automatic gate valve or damper 11 pivoted at 12. This pivot is located to one side of the center of the inlet and fixed to it is a threaded rod 13 upon which is the adjustable counterbalance weight 14. The weight is so adjusted that it at all times biases the valve slightly toward closed position. The pivot pin 12 is offset to such an extent that when the valve is open it will stand a few degrees off center toward the closed position. 15 is a pin for pinning the valve in closed position. The valve of compressor 2 is shown closed, but with the pin 15 screwed out so that it may open, and the valve of compressor 3 is shown pinned closed. The positions which the valve and counterweight assume when the valve is in open position is shown in dotted lines in connection with compressor 2.

The operation of my invention depends on the fact that as the load on a machine of this type, that is the number of cubic feet of air passing through it, varies, the pressure produced by it varies. For no load, the pressure is a certain amount. As the load increases the pressure increases somewhat up to a certain point and then decreases again. At full load the pressure may be about the same as at no load, and at over load the pressure will still further decrease.

In operation the machines are all started and brought up to speed with the valves closed, those of compressors 2 and 3 being pinned closed by the pins 15. The valve 7 of compressor 1 is then gradually opened by hand. If the load on the entire system is less than a certain predetermined minimum, for example, about one-third load for one machine, pulsations will occur if the valve 7 is opened wide, so it must be set at

some intermediate point so as to eliminate pulsations. Under these conditions there is, of course, no need for other machines and they can then be shut down. If, however, the valve 7 can be opened wide without pulsations occurring, it shows that the load is more than say the one-third value for one machine. The valve 7 is then locked in the wide open position and the stop pins 15 of compressors 2 and 3 are unscrewed so that the check valves are free to open. If the load on the entire system is less than the maximum load for one machine, the check valves will remain closed and compressor 1 will carry the load. This will be due to the fact that the discharge pressure of compressor 1 is greater than the no load pressure of the other machines and hence acts to keep the check valves of the other compressors closed. If the load on compressor 1 now increases when it reaches about full load, the pressure in the discharge pipe will be about the no load pressure of machines 2 and 3. If it still continues to increase, the pressure in the discharge pipe will become less than the no load pressure of the other machines. When this occurs the valve 11 of one of these machines will open. The weights 14 of these two machines will be so adjusted with regard to the characteristics of the machines that the valve 11 of one will open before the other. As soon as the valve 11 of the second machine opens, say compressor 2, the load will then be divided between compressors 1 and 2. This will mean that each of these machines is now carrying less than full load so that the discharge pressure increases and hence the valve 11 of machine 3 will remain closed. This state of affairs will continue until, as the load is increased, the pressure in the discharge pipe again drops to the no load pressure or slightly below. When this occurs, the valve 11 of machine 3 will automatically open and the load will then be divided among the three machines.

If now, with all three machines running with the load distributed among them, decrease in the load occurs, as soon as the load on each machine reaches a value where with further decrease a decrease in pressure occurs an unstable condition will be set up which causes oscillations of the valves 11, which as already stated, are nearly balanced. As soon as one of the check valves reaches a nearly closed position, in this case it would be that of compressor 3, the pressure becomes substantially the no load pressure, while the pressure of compressor 1 still maintains a value greater than the maximum load pressure and hence greater than the no load pressure. This will then cause the valve 11 to be closed. As soon as this occurs the load will then be automatically distributed between two of the machines.

Should still further decreases in load occur the same conditions will arise and the other automatic gate valve will close.

By the above structure it will be seen that I have provided an arrangement which will automatically take care of variations in the load above that which causes pulsations on one machine. Below this value, of course, the manually controlled inlet valve 7 has to be brought into operation and regulated.

I have illustrated my invention in connection with three machines connected in parallel but it will of course be understood that it may be carried out in connection with two machines or any number greater than two.

In accordance with the provisions of the patent statutes, I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrative, and that the invention can be carried out by other means.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. The combination with a plurality of centrifugal compressors having inlet conduits, and having discharge conduits which are connected in parallel to discharge into a common blast main, of valve means arranged in the conduits of some of said machines which automatically close in case there is a tendency to force fluid backward through said machine or machines.

2. The combination with a plurality of centrifugal compressors having inlet conduits, and having discharge conduits which are connected in parallel to discharge into a common blast main, of an automatic valve biased to closed position arranged in the inlet of one or more of said machines.

3. The combination with a plurality of centrifugal compressors having inlet conduits, and having discharge conduits which are connected in parallel to discharge into a common blast main, of a manually controlled valve in the inlet of one of said machines, and an automatic valve which opens inwardly and is biased toward closed position in the inlet of each of the remaining machines.

4. The combination with a plurality of centrifugal compressors having inlet conduits, and having discharge conduits which are connected in parallel to discharge into a common blast main, of a manually controlled valve in the inlet of one of said machines, an automatic valve which opens inwardly and is biased toward closed position in the inlet of each of the remaining machines, and means for fastening said last named valve or valves in closed position.

5. The combination with a plurality of

centrifugal compressors having inlet conduits, and having discharge conduits which are connected in parallel to discharge into a common blast main, of automatic valve means arranged in the inlet of one or more of said machines, and adjustable means for biasing each valve to closed position.

6. The combination with a plurality of centrifugal compressors having inlet conduits, and having discharge conduits which are connected in parallel to discharge into a common blast main, of a manually controlled valve in the inlet of one of said machines, and an inwardly opening valve in each of the others, said last named valve comprising a disk pivoted to one side of its center, adjustable means for biasing it to closed position, and means for fastening it closed.

7. The combination with a blast main, of a centrifugal compressor having a manually controlled valve in its inlet for regulating the flow of fluid therethrough and a discharge pipe connected to the blast main, one or more centrifugal compressors having inlet conduits, and having discharge conduits connected in parallel to said blast main, and automatic valves in the conduits of the last named compressors which close in case there is a tendency to force fluid backward there-through.

In witness whereof, I have hereunto set my hand this eighth day of March 1915.

SANFORD A. MOSS.

Witnesses:

WISTAR W. JOHNSON,
JOHN A. McMANUS, Jr.