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CENTRIFUGAL COMPRESSOR

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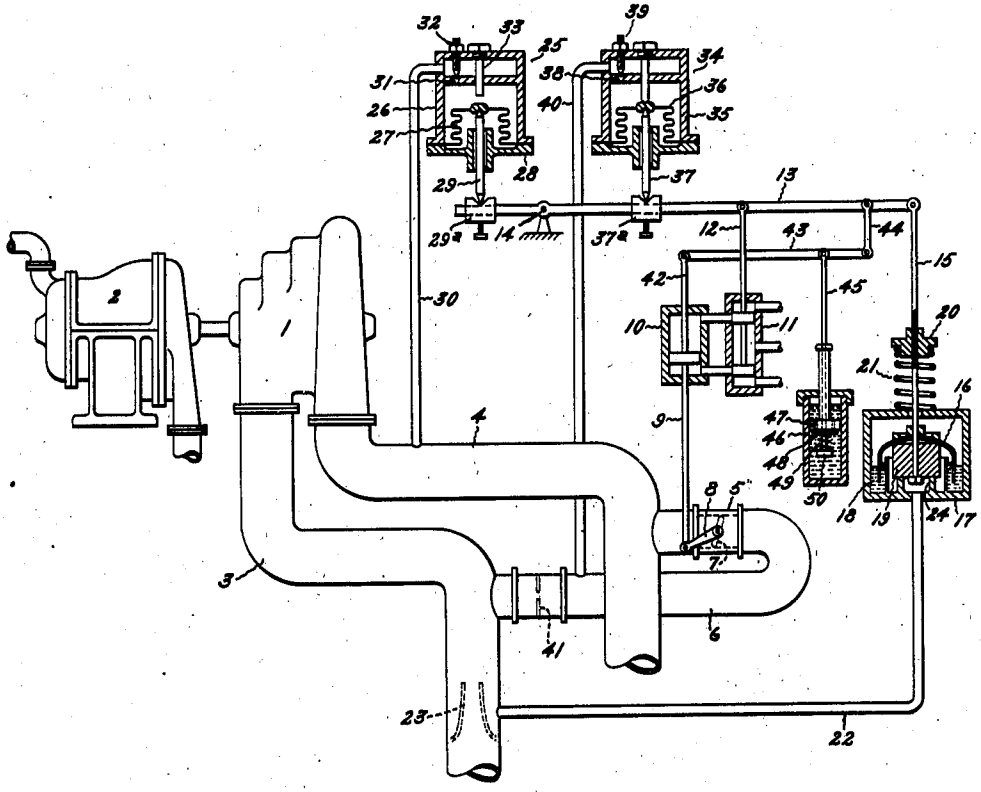

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CENTRIFUGAL COMPRESSOR

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6 Claims. (Cl. 230—115)

In connection with centrifugal compressors, it is known to provide a blow off valve or waste valve on the discharge side of the compressor which is opened at light load to waste air or other gas being pumped to atmosphere or back to the intake side of the compressor in order to prevent the occurrence of pulsations or "pumping". The load at which pulsation or "pumping" occurs depends on the volume and the pressure, which in turn bear a certain relation to the speed of the machine. For every volume, there is a critical pressure above which pulsations are likely to occur, and vice versa, for every pressure, there is a critical volume below which pulsations are likely to occur. The air or other gas which is discharged through the blow off valve represents a waste in power so that it is desirable to open the blow off valve only when necessary and only to the amount required under particular operating conditions to waste an amount of gas sufficient to prevent pulsation or "pumping."

The object of my invention is to provide an improved regulating means for a blow off valve, and for a consideration of what I believe to be novel and my invention, attention is directed to the following specification and the claims appended thereto.

My invention may be utilized in connection with a centrifugal compressor provided with a constant volume governing mechanism and it finds special utility in connection with a machine so equipped. However, it is not limited to such use necessarily.

In the drawing, the figure is a more or less diagrammatic view of a centrifugal compressor having a blow off valve provided with regulating means embodying my invention.

Referring to the drawing, 1 indicates a centrifugal compressor driven by elastic fluid turbine 2. The inlet to the compressor is indicated at 3; the discharge conduit is indicated at 4, and the blow off valve is indicated at 5. In the present instance, the blow off valve is shown as being located in a conduit 6, which leads from the discharge conduit 4 to inlet conduit 3 so that the fluid, which may be air or gas, discharged past the blow off valve is returned to the inlet conduit. This arrangement is preferable in the case where the compressor is provided with a constant volume governing mechanism. In the present instance, a constant volume governing mechanism is not shown in the drawing as it forms no part of the present invention. It is to be understood, however, that a constant volume governing mechanism may be utilized in connection with the turbine driven compressor if found desirable. For example, a regulating mechanism such as that shown in my Patent 1,729,692, dated October 1, 1929 may be utilized.

Valve 5 is of the butterfly type. It comprises movable valve member 7 having an operating arm 8 connected to its spindle. Arm 8 is connected by a rod 9 to the piston of a fluid actuated motor 10, the pilot valve of which is indicated at 11. Stem 12 of pilot valve 11 is pivotally connected to a lever 13 pivoted at 14. Pivotally connected to one end of lever 13 is a rod 15 which at its lower end is connected to an inverted bell 16 located in a casing 17, the bell being sealed in a liquid chamber 18 in casing 17. 19 is a weight connected to bell 16. On rod 15 is an adjustable nut 20 between which and the top of casing 17 is located a spring 21 which acts in a direction to move bell 16 upward. The under side of bell 16 is connected by a conduit 22 to the trailing side of a pressure difference creating device 23 located in conduit 3. The outer side of bell 16 is connected to atmosphere, for example, by clearance between rod 15 and the cam in casing 17 through which it passes. 24 indicates a stop which limits downward movement of bell 16, upward movement of the bell being limited by the top of casing 17. Pressure difference creating device 23, which is shown in the present instance as a flow nozzle, creates a pressure difference which bears a definite relation to the rate of flow of air through conduit 3 and bell 16 is subjected to this pressure difference so that it assumes a position in accordance with the rate of flow through conduit 3. In this connection, it will be noted that the leading pressure, that is the pressure in conduit 3 in advance of the device 23 is atmospheric pressure and remains substantially constant so that a leading pressure pipe connection from the leading side of device 23 to casing 17 is not required.

Mounted adjacent to the left hand end of lever 13 is a pressure responsive device 25, which is subjected to the pressure in discharge conduit 4. It comprises a casing 26 in which is located a corrugated bellows 27 the edges of which are held between the casing and its cover 28. Corrugated bellows 27 acts on lever 13 through the intermediary of a pivot pin 29 which engages an adjustable socket 29a at the end of the lever. The interior of casing 26 is connected to conduit 4 by a pipe 30. The connection between pipe 30 and the interior of casing 26 is through an orifice 31 in a partition plate in casing 26. The area of orifice 31 is adjusted by means of a needle valve 32. By adjusting the needle valve, the

sensitiveness of the corrugated bellows can be varied. At 33 is an adjustable stop for limiting upward movement of corrugated bellows 27.

Mounted adjacent to lever 13 is a second pressure responsive device 34 which is subjected to a pressure difference which bears a definite relation to the rate of flow through by-pass conduit 6. In other words, it is responsive to the rate at which air is discharged past blow-off valve 7. It comprises a casing 35 in which is located corrugated bellows 36 which acts on lever 13 through the intermediary of a pivot pin 37 which engages an adjustable socket 37a on the lever. The interior of casing 35 is connected through an orifice 38, the area of which may be adjusted by means of a needle valve 39, and a pipe 40 to by-pass conduit 6 on the leading side of a pressure difference creating device 41 located in conduit 6. In the present instance, pressure difference creating device 41 is shown as being in the form of an orifice. The inside of corrugated bellows 36 is subject to atmospheric pressure which corresponds substantially to the pressure on the trailing side of pressure difference creating device 41.

It will be noted that pressure responsive device 25 and flow responsive device 34 are located on opposite sides of pivot 14 so that they act in opposition to each other.

Valve rod 9 is provided with an extension 42 which is connected to one end of a floating lever 43, the other end of which is connected to lever 13 by means of a link 44. Connected to floating lever 43 is a stem 45 of a dash pot. The dash pot comprises a cylinder 46 in which is located a piston 47, which is connected to stem 45. Piston 47 is provided with a plurality of openings closed by a plate 48 which is held against the piston by means of a spring 49 located between the plate and a head 50 on an extension of stem 45. With this arrangement, when piston 47 moves down in cylinder 46 or when it moves up slowly in cylinder 46, plate 48 remains in the position shown in the drawing, thereby keeping the ports through piston 47 closed. Liquid 51 in the dash pot then functions to place a drag on the movement, the extent of the drag being determined by the leakage between the edge of the piston and the cylinder. Upon a quick upward movement of piston 47, disk 48 will be forced away from the piston, thereby uncovering the ports of the piston and permitting the upward movement to take place without appreciable resistance due to the dash pot.

The operation is as follows. Assume that the compressor is operating and delivering gas in volume and pressure such that pulsations or "pumping" are not likely to occur. Under these conditions, the drop in pressure through pressure difference creating device 23 is of a value such that bell 16 is held in its downward position as shown in the drawing against the action of spring 21 which tends to move it upward. Pressure device 25 acts on lever 13 in a direction opposite to that of bell 16. In substance, it modifies the action of bell 16 in accordance with the pressure on the delivery side of the compressor. At this time, valve 7 is closed so that there is no flow through blow-off conduit 6. Hence, corrugated bellows 36 is in neutral position against its stop and has no effect on lever 13.

If now the value of either the flow of the compressor or the pressure on the discharge side of the compressor or both, vary so that pulsations are likely to occur, then lever 13 will be moved in a counterclockwise direction on its pivot 14, thus raising pilot valve 11 to admit actuating fluid beneath the piston in cylinder 10 and permit it to escape from above the piston whereupon the piston is raised and valve 7 is opened to a greater or less extent. Flow of gas will occur now from conduit 4 past valve 7 and through conduit 6 to conduit 3 and there will be created by device 41 a pressure difference which bears a definite relation to the rate of flow through conduit 6. This pressure difference is applied through pipe 40 to bellows 36, creating a pressure downward on lever 13, thereby moving the right hand end of lever 13 downward and restoring the pilot valve 11 to normal position where it covers its ports, as is well understood in connection with the operation of a fluid actuated motor of this type. Thus it will be seen that the position of valve 7 is dependent not only on the flow through conduit 3 and the pressure in conduit 4 but also on the flow past the blow-off valve, this being in the present instance the flow through conduit 6. The several forces acting on lever 13 are so related and balanced against each other that valve 7 is opened enough to by-pass or waste just sufficient gas to prevent the occurrence of pusation.

When conditions of flow through conduit 3 and pressure in conduit 4 become such that pulsations are no longer likely to occur, lever 13 will be moved to effect closing of valve 7.

The dash pot serves to dampen or regulate the movement of both lever 13 and bell 16 and the valve 7, the dash pot permitting of a quick upward movement of bell 16 and a quick opening movement of valve 7 due to the arrangement of spring pressure plate 48, as already explained.

By adjusting sockets 29a and 37a along lever 13, the forces acting on the lever may be adjusted relatively to each other to give the characteristics desired for the control and to meet the conditions imposed by any particular compressor installation. In making adjustments it will be understood that the pressure responsive devices 25 and 34 will be moved to correct positions relatively to the sockets.

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

1. The combination with a centrifugal compressor having a pulsation preventing valve and means for opening and closing it in accordance with the resultant of the rate of flow through the compressor and the discharge pressure from the compressor, of means for further controlling the opening and closing of the valve in accordance with the rate of flow past it.

2. The combination with a centrifugal compressor having a pulsation preventing valve and means for opening and closing it in accordance with the rate of flow through the compressor, of means for further controlling the opening and closing of the valve in accordance with the rate of flow past it.

3. The combination with a centrifugal compressor having a pulsation preventing valve, of a fluid actuated motor connected to the valve, a pilot valve for the motor, a pivoted lever to which the pilot valve is connected, and means responsive to the flow to the compressor, the pressure on the discharge side of the compressor and the flow past the pulsation preventing valve for positioning said lever in accordance with a resultant value of said flows and pressure.

4. The combination with a centrifugal compressor having a pulsation preventing valve, of a fluid actuated motor connected to the valve, a pilot valve for the motor, a pivoted lever to which

the pilot valve is connected, means responsive to the flow to the compressor, the pressure on the discharge side of the compressor and the flow past the pulsation preventing valve for positioning said lever in accordance with a resultant value of said flows and pressure, and a dash pot for dampening movement of the lever and the pulsation preventing valve.

5. A centrifugal compressor having a blow-off valve, means responsive to a flow through the compressor to control the opening and closing of said valve, and means to adjust the opening and closing of said valve comprising means responsive to the flow past the blow-off valve, means responsive to the discharge pressure, and means connecting said two last named means to the valve whereby said valve is controlled in accordance with the resultant of the flow through the compressor, the flow past the blow-off valve, and the discharge pressure.

6. A centrifugal compressor having a blow-off valve, means responsive to the flow through the inlet of the compressor to control the opening and closing of said valve and means responsive to the flow past the blow-off valve to adjust the opening and closing of said valve, whereby said valve is controlled in accordance with the resultant of the flow through the inlet of the compressor and the flow past the blow-off valve.

REGINALD G. STANDERWICK.