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SURGE PREVENTING DEVICE FOR CENTRIFUGAL COMPRESSORS

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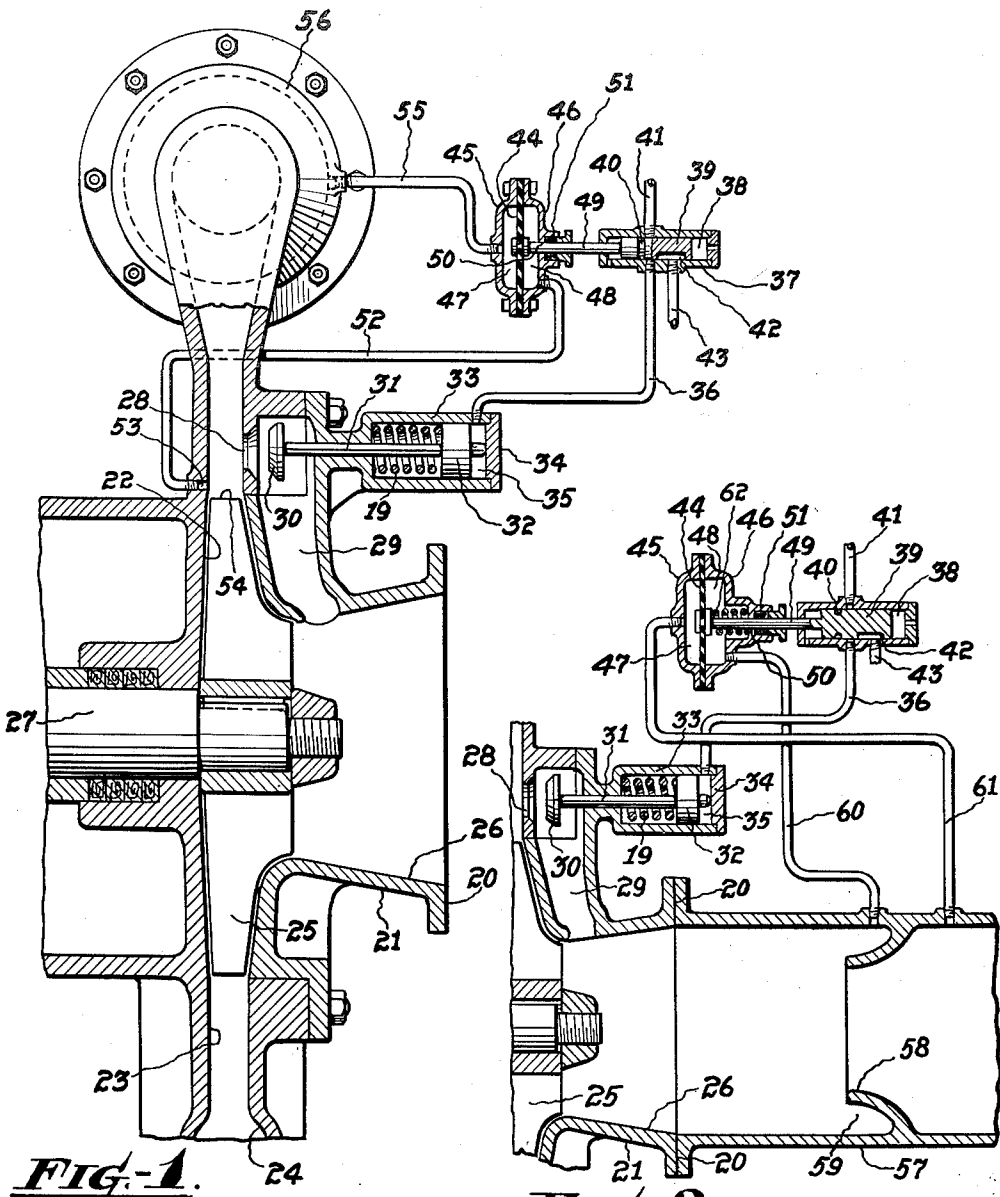


FIG.-1.

FIG.-2.

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SURGE PREVENTING DEVICE FOR CENTRIFUGAL COMPRESSORS

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5 Claims. (Cl. 230-115)

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This invention relates to compressors, but more particularly to compressors of the centrifugal type.

One object of the invention is to prevent the surging of compressed air back through the discharge line of the compressor into the impeller chamber.

Other objects will be in part obvious and in part pointed out hereinafter.

In the drawings accompanying this specification and in which similar reference numerals refer to similar parts,

Figure 1 is a longitudinal elevation, partly broken away, of a centrifugal compressor equipped with a surge preventing device constructed in accordance with the practice of the invention and showing the device connected for operation in response to pressure values existing at relatively spaced points in the discharge channel of the compressor, and

Figure 2 is a view similar to Figure 1 showing the surge preventing device connected for operation in response to pressure values existing at relatively spaced points in the inlet conduit of the compressor.

Referring more particularly to the drawings, 20 designates a centrifugal compressor the casing 21 of which is recessed to provide an impeller chamber 22, a diffusor chamber 23 encircling the impeller chamber and a volute discharge chamber 24 around the diffusor chamber 23. Within the impeller chamber 22 is an impeller 25 for pumping fluid medium from the inlet opening 26 of the compressor to the chambers 23 and 24, and said impeller is interlockingly secured to the end of a shaft 27 extending axially into the impeller chamber.

In accordance with the practice of the invention, the compressor is provided with means for preventing the compressed medium from breaking back through the discharge line into the impeller chamber whenever the normal pressure condition in the discharge line is disturbed, as when operating at light load or when a machine operated by the compressed fluid is suddenly shut-off and in consequence of which a pressure will build up in the discharge channels of the compressor that will overcome the current issuing from the impeller and cause a pulsation or pumping effect in the compressor.

The means serving to obviate this unfavorable occurrence includes a relief port 28 for the discharge channel and a passage 29 leading from the port 28 to the inlet opening 26. The port 28 opens into the diffusor chamber 23. It is preferably

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located immediately adjacent the impeller tip and is controlled by a valve 30 of the poppet type the stem 31 of which carries a piston 32 that is slidable in a cylinder 33 on the compressor casing 21.

The outer end of the cylinder is sealed by a cover 34 that also acts as an abutment for the end of the stem 31 which, in the example shown, projects from the piston 32 to abut the cover 34 and hold the piston in spaced relation therewith to define a pressure chamber 35 in the outer end of the cylinder 33 for fluid medium serving to hold the valve 30 in its port-closing position. The inner end of the cylinder 33 contains a compression spring 36 that seats against the end wall of the cylinder 33 and against the piston 32 and is biased to hold the valve 30 away from the port 28.

Any suitable pressure medium may be introduced into the chamber 35 for holding the valve 30 in position to seal the port 28, and such medium is conveyed to and from the chamber 35 by a conduit 36 leading from a valve casing 37 that may be affixed to the compressor and has a chamber 38 for the accommodation of a reciprocating valve 39. The valve 39 is of generally cylindrical shape and in its periphery is an annular groove 40 to afford communication between the conduit 36 and a pressure medium supply conduit 41 threadedly connected to the casing 37.

The valve 39 also controls the exhaust of fluid medium from the chamber 35 and to this end is provided, in the side thereof, with a recess 42 of suitable length to span the end of the conduit 36 and an end of a discharge conduit 43 threaded into the casing 37 and communicating with the chamber 38. The ends of the casing 37 are suitably vented to the atmosphere to assure the unrestricted movement of the valve 39 in the casing.

The valve 39 is shifted by an actuator that moves responsively to a differential existing between pressures acting on the opposed sides thereof and derived from up-stream and down-stream points in the discharge channel of the compressor. In the form illustrated the actuator consists of a flexible diaphragm 44 the marginal portion of which is clamped between two plates 45 and 46 that are recessed to provide pressure chambers 47 and 48, respectively.

The axial portion of the diaphragm 44 is secured to the end of a stem 49 carried by the valve 39, and the aperture 50 in the plate 46 through which the stem 49 extends is sealed by a suitable packing device 51. The diaphragm 44 is so positioned with respect to the valve 39 that when the

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diaphragm occupies the neutral or relaxed position both the annular groove 40 and the recess 42 will be out of communication with the supply conduit 41 and said conduit will be blanked off by a cylindrical portion of the valve 39 located between the annular groove 40 and the recess 42.

The pressure fluid serving to actuate the diaphragm is conveyed to the chamber 48 from the diffuser chamber 23 by a conduit 52 threadedly connected to the cover 46 at one end and at its other end to the casing 21 to communicate with a port 53 opening into the diffuser chamber 23 adjacent the tip 54 of the impeller 25. Similarly, a conduit 55 threadedly connected to the cover 46 and to the casing 21 conveys pressure fluid from the discharge end 56 of the volute chamber 24 to the chamber 47.

During the normal operation of the machine, the superior pressure in the chamber 47 acting against the diaphragm will shift the valve 39 toward the right hand end of the casing 37 and thereby place the annular groove 40 in communication with the supply conduit 41 and the conduit 36. Pressure medium will then flow through the conduits into the chamber 35 against the piston 32 and move the valve 30 into sealing relationship with the port 28. All the air thereafter discharged by the impeller will pass through the discharge channels of the compressor, for utilization, and the valves 39 and 30 will remain in the positions described as long as the pressure in the chamber 47 predominates over that in the chamber 48.

If, for any reason, the pressure in the discharge channel surges back toward the impeller, such impulse will be communicated through the conduit 52 against the side of the diaphragm in the chamber 48 and will shift the valve 39 leftward. In this position the valve 39 will blank off the supply conduit 41 and will establish communication between the conduits 36 and 43 to effect an outlet for the pressure medium in the chamber 35. The spring 19 will then shift the valve 30 away from the port 28 and permit the compressed fluid surging in the direction of the impeller to escape through the port 28 and the passage 29 into the inlet passage 26.

The valves 39 and 30 will occupy these positions only until pressure conditions in the discharge channel of the compressor again become normal, whereupon the normal pressure differential will again be established in the chambers 48 and 47 and the valve 39 will then again be shifted to effect closing of the valve 30.

In the modified form of the invention shown in Figure 2, the diaphragm 44 and the valve 39 move in response to a differential between pressures existing at relatively spaced points in the inlet conduit 57 of the compressor which has means for creating a sub-normal pressure therein. Such means is shown as being in the form of an orifice meter 58 and the space encircling it and that directly adjacent thereto constitute a zone 59 of sub-normal pressure. This zone 59 is in communication with the chamber 48 through a conduit 60, and a conduit 61 affords communication between the chamber 47 and the inlet conduit 57 at a point on the up-stream side of the orifice meter 58.

In this form of the invention, a spring 62 is interposed between the plate 46 and the diaphragm 44 to augment the pressure in the chamber 48 for shifting the valve 39 leftward to blank off the supply conduit 41 and to place the valve

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39 in position to establish communication between the conduits 36 and 43.

During the operation of the device, the pressure within the chamber 47, being normal inlet pressure, will overcome the pressure of the fluid in the chamber 48 and that of the spring 62 and move the valve 39 to the right hand limiting position in the chamber 38. In this position of the valve 39 pressure medium will flow into the chamber 35 against the piston 32 and move the valve 30 into sealing relationship with the port 28.

The valves will remain in the positions described as long as pressure conditions in the inlet and discharge channels remain normal. But if the pressure in the discharge channel closely approaches the value at which it may surge back toward the impeller this pressure condition is communicated through the impeller chamber and the zone 59 to the chamber 48 and will cause the pressure therein, together with the force exerted by the spring 62 to shift the valve 39 leftward.

During this movement, the valve will first cut-off the pressure chamber 35 from the source of fluid medium supply and next place said chamber into communication with the atmosphere through the recess 42 and the conduit 43. The spring 19 will then shift the valve 30 away from the port 28, and any compressed fluid surging back through the discharge channel in the direction of the impeller will escape through the port 28 and the passage 29 into the inlet conduit. These movements of the valves will take place in anticipation of a surge in the discharge line and the port 28 will, therefore, be uncovered before the surge reaches the impeller.

I claim:

1. In combination, a centrifugal compressor having an inlet channel and a discharge channel, an impeller to pump fluid from the inlet channel into the discharge channel, a relief port for the discharge channel adjacent the tip of the impeller, and means acting in response to an abnormal ratio of pressure values substantially at the impeller and at a point existing at a point relatively spaced from the first mentioned point to valve fluid from the discharge channel and thereby prevent the surging of compressed fluid from the discharge channel back through the impeller.

2. In combination, a centrifugal compressor having an inlet opening and a discharge channel and a diffuser chamber, an impeller to pump fluid from the inlet opening into said channel, a relief port for the diffuser chamber adjacent the tip of the impeller, and means acting in response to an abnormal ratio of fluid pressure values existing at a point substantially at the tip of the impeller and at a point relatively spaced from the first mentioned point to valve fluid from said discharge channel and thereby prevent the surging of compressed fluid from the channel back through the impeller.

3. In combination, a centrifugal compressor having an inlet opening and a discharge channel, an impeller to pump fluid from the inlet opening into the discharge channel, a relief port positioned adjacent the tip of the impeller for the discharge channel, a fluid actuated relief valve to govern fluid flow through the relief port, a spring acting constantly to position the relief valve for opening the port, a control valve for regulating flow of a pressure medium to position the relief valve for closing the port and to control the exhaust of such pressure medium from the relief valve, and a flexible diaphragm acting respon-

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sively to a pressure differential existing in the discharge channel for actuating the control valve.

4. In combination, a centrifugal compressor having an inlet opening and a discharge channel and a diffuser chamber, an impeller to pump fluid from the inlet opening into the discharge channel, a relief port for the diffuser chamber positioned adjacent the tip of the impeller, a fluid actuated relief valve for the relief port, a control valve to regulate the flow of a pressure fluid to the relief valve and to exhaust said fluid therefrom, means within the inlet channel for creating a subnormal pressure area therein, and a flexible diaphragm responsive to pressure variations in the subnormal pressure area for actuating the control valve.

5. In combination, a centrifugal compressor having inlet and discharge channels, an impeller to pump fluid from the inlet channel into the discharge channel, a relief port for the discharge channel positioned adjacent the tip of the impeller, a fluid actuated relief valve to regulate

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flow through the relief port, a spring acting constantly to position the relief valve for opening the port, a control valve for regulating flow of a pressure medium to position the relief valve for closing the port and for controlling the exhaust of such pressure medium from the relief valve, and a flexible diaphragm for actuating the control valve acting responsively to a pressure differential existing in one of said channels.

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