Aug. 18, 1964 R. N. BROWN 3,144,766

FLOW INDICATING MEANS FOR IMPOSITIVE DISPLACEMENT MACHINES

Filed June 22, 1961

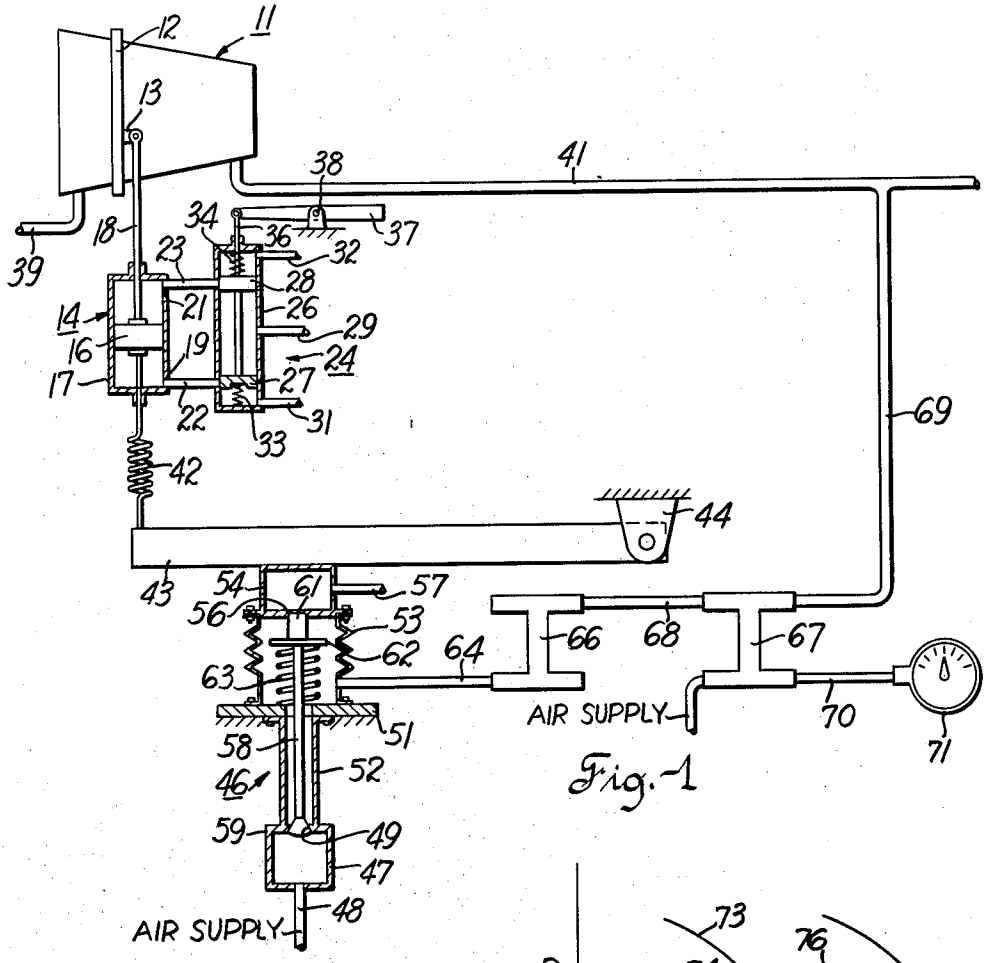


Fig. 1

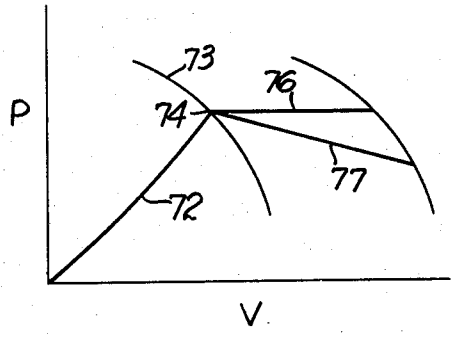


Fig. 2

Inventor
Royce N. Brown
By John P. Hines
Attorney

United States Patent Office 3,144,766 Patented Aug. 18, 1964

3,144,766

FLOW INDICATING MEANS FOR IMPOSITIVE DISPLACEMENT MACHINES

Royce N. Brown, New Berlin, Wis., assignor to Allis-Chalmers Manufacturing Company, Milwaukee, Wis., a corporation of Wisconsin

Filed June 22, 1961, Ser. No. 118,834
4 Claims. (Cl. 73—168)

This invention pertains to an arrangement for measuring the volumetric flow of fluid of impositive displacement machines such as pumps and compressors and more particularly to such an arrangement wherein the machine includes adjustable vanes.

Quite frequently it is necessary to determine the volumetric flow of an impositive displacement machine such as the volume of air delivered by a compressor. In the past, many means have been provided for measuring such volumetric flow. However, most of these prior known arrangements for measuring volumetric flow were quite expensive or detracted considerably from the efficiency of the machine. It is the intended purpose of the subject invention to provide a system of elements arranged in a novel manner so that the volumetric flow of a machine can be obtained in an inexpensive manner and in a manner which does not materially detract from the efficiency of the machine.

Although the invention should not be so limited, it will be described in relation to an axial compressor for the sake of clarity. An axial compressor is quite frequently supplied with adjustable stator vanes which are pivoted about their radially extending axes by an annular ring disposed about the compressor housing and operatively connected to each stator vane. By revolving the annular ring, the vanes are adjusted to change the amount of air which is admitted to the inlet of the compressor. For a given size machine having adjustable vanes, it is possible to determine the particular volumetric intake of the compressor for a given pressure of the discharge air at a particular setting of the stator vanes. This would be accomplished by positioning the vanes to a particular setting, physically adjusting the amount of air admitted to the compressor and reading the discharge air pressure. These steps would be repeated until a pressure volume curve is developed for the different vane settings.

It is a general object of the subject invention to utilize this known relationship between vane position, pressure and volume to provide a system which transposes the vane position and the pressure of the discharge air into a volumetric reading on a gauge.

A more specific object of the subject invention is to provide a system which superimposes a signal proportional to the position of the vanes onto a signal received from the pressure of the exhaust fluid and correlate this resultant signal to the known pressure volume characteristic of the machine to arrive at a volumetric reading.

These and other objects and advantages of the invention will become more fully apparent as the following description is read in light of the attached drawings wherein:

FIG. 1 is a schematic view of the invention; and

FIG. 2 is a pressure volume curve for a specific axial compressor having adjustable stator vanes.

Referring to FIG. 1, a compressor generally designated 11 is shown including a ring 12 for adjusting compressor stator vanes. The vanes may be attached to the ring in any conventional manner such as that disclosed in U.S. Patent 2,371,706 to A. P. E. Planiol, issued March 20, 1945. The guide vane ring may be actuated by a conventional servomotor generally designated 14 having a piston 16 slidably contained within a cylinder 17. The piston 16 has a rod 18 connected thereto which extends through the cylinder and is pivotally atached to a boss 13

on the guide vane adjusting ring 12. The servomotor cylinder 17 has two ports 19 and 21 which are connected by means of conduits 22 and 23 to a conventional pilot valve generally designated 24.

The pilot valve 24 is herein shown for purposes of illustration as comprising a cylindrical casing 26 having two axially spaced and connected pistons 27 and 28 slidably retained therein. A conduit 29 is connected in fluid communication to the central portion of the pilot valve casing and supplies pressurized fluid thereto from a source (not shown). Each end of the pilot valve casing is provided with an exhaust conduit 31 and 32 which is in fluid communication with the interior of the pilot valve casing and with a sump (not shown). Springs 33 and 34 bias the pistons 27 and 28 to the position shown in the drawings wherein the conduits 22 and 23 connecting the pilot valve to the servomotor 14 are closed off.

A rod 36 connected to piston 28 extends through the pilot valve casing 26 and is pivotally connected to a lever 37. This lever 37 may be fulcrumed on a pivot point 38 and is movable to position the pistons 27 and 28 to permit pressurized fluid to flow through either of the conduits 22 or 23 to the servomotor to move the piston 16 in the desired direction. The lever 37 may be operated to control the pilot valve pistons by any desired signal or the lever may be manually moved to position the pilot valve.

The air inlet for the compressor 11 is shown as conduit 39 and the pressurized exhaust from the compressor is delivered to its required destination (not shown) by the exhaust conduit 41.

A resilient member or spring 42 may be connected to the opposite side of piston 16 from the rod 18. The spring 42 is also connected to one end of a beam 43; the other end of which is pivotally connected to a support 44. As the servomotor piston 16 moves, the beam 43 follows the movement of the piston as it is pivoted about its support 44.

Although it would be possible to transpose the movement of the piston 16 into an electrical or hydraulic signal and feed this signal into a conventional electrical or hydraulic amplifier to combine it with an electrical or hydraulic signal proportional to the pressure of the air discharged from the compressor, the invention is herein shown, for purposes of illustration only, as employing pneumatic signals. In order to transpose the movement of the compressor vanes into a pneumatic signal, a valve generally designated 46 is employed. It should be understood that the valve itself forms no part of this invention and is merely shown as one particular type of valve which may be used. This valve or signal converting means includes a housing 47 provided with a supply of pressurized air from a source (not shown) through a conduit 48. The housing 47 is provided with a valve seat 48 and the housing is also shown as being connected to a support 51 by means of an elongated cylindrical housing 52. As shown in the drawings, a resilient means or bellows 53 is connected to the upper side of the support 51 and this in turn is connected to an additional housing 54 which is in turn connected to the beam 43. The housing 54 is provided with a valve seat 56 and is also provided with a discharge conduit 57 which connects the interior of the housing 54 with the atmosphere. An elongated valve stem 58 having valves 59 and 61 at either end thereof is disposed within the elongated cylindrical housing 52 and the bellows 53. The valves 59 and 61 are positioned for operative coaction with the valve seats 49 and 56, respectively. A shoulder 62 provided on the valve stem 58 acts as a reaction member for a biasing means or spring 63 disposed between the shoulder 62 and the support 51.

An outlet conduit 64 is in fluid communication with the interior of the bellows 53 and also in fluid communication

with a commercially available pneumatic relay 66. The pneumatic relay 66 is in fluid communication with an additional pneumatic relay 67 by means of a conduit 68. It is not believed necessary to provide a more complete description of the pneumatic relays 66 and 67 as any type of relay which is capable of adding or subtracting signals may be employed. However, for a more complete description of a relay which may be used in the subject arrangement, reference may be had to Bulletin MSP–120 of Hagan Chemicals and Controls, Inc., Pittsburgh 30, Pennsylvania. The relay 67 is also connected in fluid communication with the discharge conduit 41 by means of a conduit 69. Also connected to the output of the relay 67 is a pressure gauge 71 which may be calibrated in any desired manner such as actual volumetric flow or percentage of volumetric flow.

To assist in explaining the manner in which the above described arrangement operates, reference is now made to FIG. 2 wherein a conventional pressure volume curve for a particular type of axial compressor having adjustable stator vanes is shown. As the compressor is started up, the pressure and volume increases substantially along the load line curve designated 72. For a minimum vane setting when the machine is running at rated speed, the load line 72 will intercept the pressure volume curve 73 approximately at point 74. For an ideal theoretical machine, as the vanes are opened the pressure will remain constant and the volume would increase along the line designated 76. However, it is known that as the stator vanes are opened, the volume will increase while the pressure will decrease. For the particular machine shown the pressure will decrease substantially along the line 77 as the stator vanes are opened. It is possible to calculate and plot this curve 77 by actually taking process load parameters into account. Pressure and volume readings for the particular machine are plotted for each stator vane setting. With this knowledge once attained, it is possible to transmit a signal instigated by the position of the stator vanes to the pneumatic relay 67. The relay 67 combines this signal with a signal instigated from the pressure of the air discharged from the machine in the conduit 41 in a manner to give a resultant signal which is proportional to the volumetric flow for that particular stator vane setting and discharge pressure as previously calculated.

In describing a cycle of operation of the subject invention, it will be assumed that the compressor is operating at rated pressure and volume with a minimum stator vane setting as shown at point 74 on the pressure volume graph of FIG. 2. As the piston 16 is moved downward, the stator vanes will open permitting a greater volume of air to enter the compressor. This is accomplished by rocking the lever 37 in a clockwise direction about its fulcrum 38. This causes the pistons 27 and 28 to move upward permitting pressurized fluid from the conduit 29 to flow through the conduit 23 to the upper side of the piston 16 of the servomotor 14. As the servomotor piston moves downward, fluid on the lower side of the piston 16 is forced out through the conduit 22 and through the exhaust conduit 31 back to sump (not shown). As the piston 16 moves downward, the spring 42 forces the beam 43 downward about its support 44. This causes the bellows 53 and spring 63 to compress causing the valve 59 to be removed from its seat 49. As the valve 59 is removed from its seat, pressurized air in the housing 47 flows through the elongated cylindrical housing 52 into the bellows 53 placing the spring 42 and bellows in pressure balance. The air that enters bellows 53 passes out through the conduit 64 into the first pneumatic relay 66. This relay is merely used to proportion the signal which is to be imposed on the combining relay 67 and would not be required if the magnitude of the air pressure in housing 47 were properly selected. At the same time, as the signal is imposed on the relay 67 from the movement of the vanes, an additional signal is imposed on this relay due to the pressure of the air in the exhaust conduit 41.

Since it has been previously determined what the volumetric flow of the particular machine would be for a particular pressure of air exhausting from the machine at a particular stator vane setting, the pressure of the signal delivered through the conduit 69 is combined with the pressure of the signal admitted through the conduit 68 and the gauge 71 is calibrated so that the pressure of the air passing through a conduit 70 causes a substantially accurate reading of volume on the gauge 71.

It should be understood that if the lever 37 is actuated by some automatic mechanism, any type of conventional feed back connection could be provided between the beam 43 and lever 37 so that pilot valve 24 would be repositioned in the neutral position when the stator vanes had been moved the required amount. If the lever 37 is manually operated, the operator will close the conduits 22 and 23 when the vanes have been moved to the proper position. When the pressure in the bellows 53 equals the pressure in the relay 66, the bellows will begin to expand pushing the beam 43 upward and compressing the spring 42. This will cause the valve stem 58 to follow the upward movement of the bellows because of the biasing effect of the spring 63 until the valve 59 closes off the housing 47 from the elongated cylindrical housing 52. At this point, both valves 59 and 61 are seated and the pressure in bellows 62, which is proportional to the adjusted position of the stator, is maintained on the relay 66 so that a continuing reading is shown on the gauge 71.

If it is desired to decrease the opening of the vanes, the servomotor piston 16 will move upward causing the beam 43 to move upward about its support 44. This will cause the valve seat 56 to move away from the valve 61 opening the bellows and the pneumatic relay 66 to atmosphere through the housing 54 and conduit 57. In this manner the value of the signal imposed on the relay 67 will be decreased and the resultant volumetric reading on the gauge 71 will be proportionally decreased.

While there has been shown and described a particular embodiment of the present invention, it will be apparent to those skilled in the art that various changes and modifications may be made without departing from the spirit of the invention, and it is therefore intended in the appended claims to cover all such changes and modifications as fall fairly within the spirit and scope of this invention.

Having now particularly described and ascertained the nature of my said invention and the manner in which it is to be performed, I declare that what I claim is:

1. A combination for measuring the volumetric flow of a fluid handling machine having inlet means in fluid communication with a fluid source and means for varying the volumetric flow of said machine comprising: means for moving said volume varying means to a number of positions between open and closed positions to vary the volumetric flow of said machine; signal combining means; signal converting means connecting said signal combining means to said volume varying means, said converting means imposing a signal of predetermined magnitude on said signal combining means for a predetermined position of said volume varying means; means connecting the discharge of said machine to said signal combining means, said connecting means transmitting a signal to said combining means proportional to the discharge pressure of said machine; and gauge means connected to said signal combining means, said gauge means being calibrated to cause a particular indication of volumetric flow for a particular signal from said signal combining means and said signal combining means being calibrated to give said particular signal to said gauge means as a result of receiving predetermined signals from said connecting means and said signal converting means.

2. A combination for measuring the volumetric flow of a fluid handling machine having adjustable inlet means in fluid communication with a fluid source comprising: means for moving said inlet means to a number of positions between open and closed positions to vary the

volumetric intake of said machine; signal combining means; signal converting means connecting said signal combining means to said inlet means, said converting means imposing a signal of predetermined magnitude on said signal combining means for a predetermined position of said inlet means; means connecting the discharge of said machine to said signal combining means, said means imposing a signal on said signal combining means proportional to the discharge pressure of said machine; and gauge means connected to said signal combining means, said gauge means being calibrated to cause a particular indication of volumetric flow for a particular signal from said signal combining means and said signal combining means being calibrated to give said particular signal to said gauge means as a result of receiving predetermined signals from said connecting means and said signal converting means.

3. A combination for measuring the volumetric flow of an impositive displacement pump having adjustable inlet means in fluid communication with a fluid source comprising: means for moving said inlet means to a number of positions between open and closed positions to vary the intake of said pump; signal combining means; signal modifying means connecting said signal combining means to said inlet means, said modifying means imposing a signal of predetermined magnitude on said signal combining means for a predetermined position of said inlet means; means connecting the discharge of said pump to said signal combining means; and gauge means connected to said signal combining means, said gauge means being calibrated to cause a particular indication of volumetric discharge for a particular signal from said signal combining means and said signal combining means being calibrated to give said particular signal to said gauge means as a result of receiving predetermined signals from said connecting means and said signal modifying means.

4. A combination for measuring the volumetric flow

of a compressor having inlet means in fluid communication with a fluid source and adjustable stator vanes comprising: adjusting means for moving said stator vanes to a number of positions between open and closed positions to vary the intake of said compressor; signal combining means; signal proportioning means connected to said signal combining means; an air valve connecting said signal proportioning means to said adjusting means, said valve being provided with a source of pressurized air to impose an air pressure signal on said proportioning means when said valve is opened as a result of movement of said adjusting means, said proportioning means imposing a signal of predetermined magnitude on said signal combining means for a predetermined air pressure signal from said valve; means connecting the discharge of said compressor to said signal combining means; and gauge means connected to said signal combining means, said gauge means being calibrated to cause a particular indication of volumetric flow for a particular signal from said signal combining means and said signal combining means being calibrated to give said particular signal to said gauge means as a result of receiving predetermined signals from said connecting means and said signal proportioning means.

References Cited in the file of this patent

UNITED STATES PATENTS

2,339,150	Codrington	Jan. 11, 1944
2,371,706	Planiol	Mar. 20, 1945
2,949,735	Stefucza	Aug. 23, 1960
3,002,380	Grove	Oct. 3, 1961
3,007,628	Nichols	Nov. 7, 1961
3,054,288	Bowman et al.	Sept. 18, 1962

OTHER REFERENCES

Publication: Article by Pountney et al., "Automatic Fan Testing" Instrumentation, vol. 12, July-August 1959, pages 12–15.