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CONTROL SYSTEM FOR FLUID COMPRESSORS

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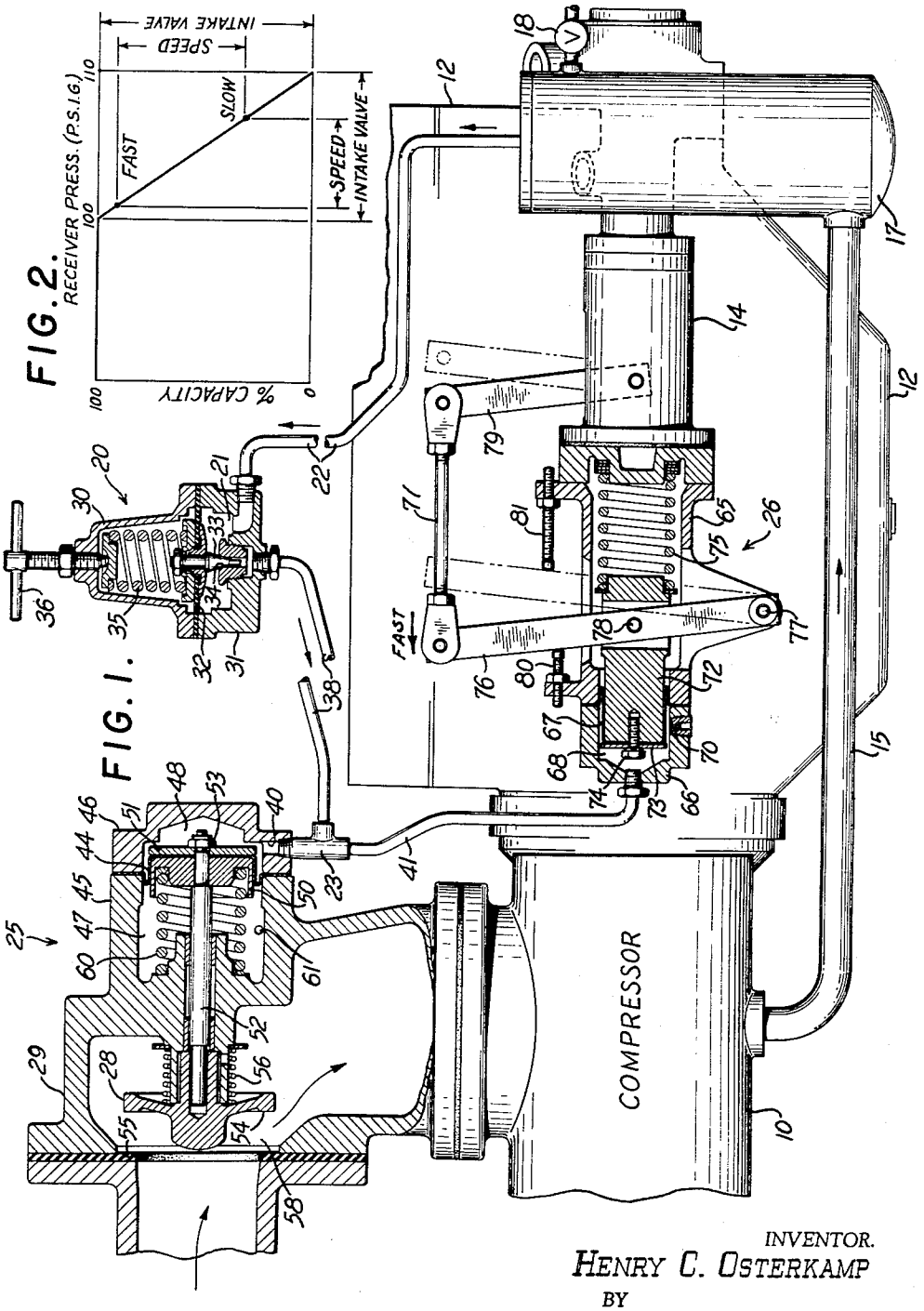

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CONTROL SYSTEM FOR FLUID COMPRESSORS

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This invention relates to control mechanisms for fluid compressors of the motor driven type. More particularly the invention relates to dual control mechanisms for simultaneously controlling both the compressor speed and air intake, at least over part of the compressor load range, in accordance with the discharge pressure of the compressor.

Control devices of this nature are in use which control the output of the compressor by varying its speed over a portion of its load range. Over another portion of the compressor load range, the compressor output is controlled by simultaneously varying the compressor speed and controlling its rate of air intake. These prior art devices utilize complicated control mechanisms which are inflexible as to where and how they can be installed on the compressor-motor unit; present service and maintenance problems, and furthermore make it difficult to diagnose and locate the part needing repair or replacement. It can be appreciated that any malfunctioning of the unit should be quickly located and corrected without unnecessary disassembly of associated parts.

Accordingly, the present invention provides a comparatively simple and compact control mechanism for a fluid compressor unit, which mechanism is easy to install, the various parts of which are easy to service and any part of which that needs adjustment or repair can be quickly isolated and corrected without affecting the adjustment of associated parts. More specifically, the control valve, speed control valve and intake control valve are independently mounted which facilitates diagnosing of trouble and permits flexibility of application.

The present invention provides a control system for controlling the output of a fluid compressor in accordance with its discharge pressure by simultaneously regulating both the compressor motor speed and the intake of the compressor. This aspect of the invention further contemplates that the limits of the discharge pressure range over which the compressor motor speed is adjustable, can be varied within the range of discharge pressure over which the compressor intake valve is variable. Thus the speed control is effective intermediate the intake control range and can be varied for the most suitable engine speeds.

A control system of the above type is provided by this invention which provides automatic drainage of condensate from the controls, is economical to produce, reliable in operation and efficient in performing its intended functions.

These and other objects and advantages of the present invention will appear hereinafter as this disclosure progresses, reference being had to the accompanying drawings in which:

Figure 1 is a schematic diagram of a compressor-motor unit embodying a control system made in accordance with the present invention, certain of the parts being shown in section, broken away or removed for clarity in the drawings, and

Figure 2 is a controls response curve which is characteristic of the present system and in which curve the compressor capacity is plotted against the discharge pressure.

Referring in greater detail to the drawings, the compressor 10 is shown as being of the rotary type but may be any other type which serves to compress air or other fluids, and is driven by a power source shown here as an internal combustion engine 12. The engine has a conventional governor 14 which controls the speed of the engine through suitable and conventional linkages, not shown.

The compressor discharges fluid under pressure through conduit 15 and into the receiver 17 from which it may be drawn as needed via service valve 18 to actuate pneumatic tools or other machinery (not shown).

The system includes a control valve 20 having a chamber 21 that receives discharge pressure from the receiver via conduit 22. The control valve 20 is preferably located in the highest point of the system so that any condensate forming therein will drain to other parts by gravity. Valve 20 is actuated in response to variations in compressor discharge pressure to control both the air inlet and the speed of the compressor, as follows.

Cooperating with the control valve 20 and connected therewith at a common point 23 is an inlet valve actuating mechanism 25 for controlling the rate of air flow into the compressor, and an engine speed control mechanism 26. Mechanism 26 is connected directly to the governor 14 and has a link connection therewith to control the speed of the engine.

Mechanism 25 is actuated in response to variations in compressor discharge pressure for shifting the inlet valve 28 positioned in the compressor intake chamber 29.

The control valve 20 and the air inlet control 25 both act throughout the entire load change range of the compressor. This valve starts to open at a predetermined minimum pressure, for example 100 p.s.i., and permits air to flow from conduit 22 to conduit 38 up to a maximum of say 110 p.s.i., or the differential attainable by controls 25 and 26. After achieving maximum opening, the valve 20 gradually closes again until the pressure is 100 p.s.i. The speed control 26, however, is adjustable as to that portion of the compressor load change range in which it will function. In other words, the air inlet control 25 is effective over the entire load change range to change the output of the compressor, while the speed control 26 can be made to effect speed changes of the engine, and thus vary the compressor output, over any selected portion of the compressor load change range.

In this manner the advantages of dual control speed and intake can be utilized in the lower portion of the load change range. At the upper portion of the load change range when higher discharge pressure develops, the air inlet may be varied, and the engine speed may be maintained at a predetermined minimum to prevent its stalling.

If desired for other operating conditions, the speed and intake may both be varied simultaneously over the entire load range of the compressor.

The control valve 20 comprises an upper body 30 secured to a lower body 31 and between which is secured a diaphragm 32. A valve needle 33 is carried by the diaphragm and is engageable with a valve seat 34 carried by the lower body 31. The needle 33 is held in the seated position by spring 35, the force of the latter being variable by the manually operated handle 36. The force of the spring is adjusted by handle 36 so the valve remains closed until the pressure in chamber 21 reaches a predetermined amount. For example, assume that it is desired to maintain a discharge pressure of 100 p.s.i. in the up-

stream or high side of the system. The control valve **20** would be set so that when pressure above this predetermined maximum of 100 p.s.i. was reached in the chamber **21**, the diaphragm would raise against the force of spring **35** to lift the needle off its seat, thereby admitting pressure fluid to conduit **38**.

Thus the operation of the control valve **20** is such that a variable pressure of from 0 to 100 p.s.i. will exist in chamber **21** during operation of the system, the valve **33** remaining closed. When the compressor discharge pressure exceeds the predetermined valve of 100 p.s.i., the valve **33** will be lifted and the excess pressure will pass through line **38** to the control mechanisms now to be described in detail.

It will be noted that the pressure fluid from the control valve **20** is distributed from the common point **23** to the air inlet control mechanism via passage **40** and to speed control mechanism **26** via line **41**, and both controls **25** and **26** may be operated simultaneously when excess pressure is discharged from the regulator or control valve **20**.

Air inlet valve actuator **25** comprises a rolling bellows type diaphragm **44** which is secured between the tubular casing portion **45** of the housing **29** and the end housing **46**, thus forming two chambers **47** and **48**. The particular type of diaphragm shown is more reliable for applications of this nature because it is more resistant to the wearing action imposed by the continual flexing than is a tight type diaphragm. A piston **50** is secured to the "bellofram" **44** by means of the plate **51** which engages the opposite side of the bellofram and is held captive on the piston rod **52** by the nut **53** threaded on the end of the rod. The rod is slidably mounted in the housing **29** and a valve disc **54** is slidably mounted on the other end of the rod. Disc **54** is engageable with the gasket seat **55** when in the sealing position. The light spring **56** constantly urges the valve **54** to the closed position and serves to close the valve when the compressor is shut down. Thus the valve is free to close, independently of its regulating mechanism, when the compressor stops, and is urged to the closed position by spring **56** or reverse fluid flow at the compressor intake. The spring **56** is only of such strength so the impact of fluid flowing at a relatively low rate through opening **58** is sufficient to hold the valve **54** in the open position.

Thus when pressure fluid is admitted to chamber **48** to overcome the force of spring **60**, the piston **50** and its associated valve **28** are urged to the left (Fig. 1) toward the sealing position to throttle or cut off the flow of air through the compressor. A breather **61** is provided in chamber **47** for permitting condensate to escape therefrom. This breather also prevents reverse roll-up of the bellofram when the compressor is stopped and the valve inlet chamber pressurized and in communication with chamber **47** due to the free fit of rod **52**.

The engine speed control unit **26** comprises a tubular body **65** which is secured at one end to the governor **14**. A cup-shaped end cap **66** is secured to the other end of the body and a rolling bellows diaphragm **67** is secured between body **65** and cap **66** to define a chamber **68**. Conduit **41** communicates with chamber **66** and unit **26** is thereby responsive to pressure variations at the outlet of control valve **20**.

An orifice **70** is located at the lower side of the chamber **68** and places the latter in communication with the atmosphere. The orifice is preferably located at the lowest side of the system and acts to automatically draw any condensate from the system. This orifice controls the pressure on the downstream or lower side of the system and for this purpose could be located elsewhere in the downstream side, that is, on the outlet side of the valve **20**. The orifice continuously bleeds off air after the control valve **20** opens and effects a response in the system. The size of the orifice **70** is determined by the effective area upon which the pressure may act to move mechanism **25** and also on the responsiveness and size of valve **33** and its ability to regulate the flow of air therethrough. These dimensions may all be variable, of course, but it is desirable to have the downstream pressure as close as possible to the upstream pressure, and still get good response (not close the controls) in order to have the maximum amount of force available to actuate the mechanisms **25** and **26**.

Mechanism **26** also includes a piston **72** connected to the bellofram **67** by the plate **73** and bolt **74**. A spring **75** acts against the piston and tends to urge it to the fast engine speed position. Lever **76** is pivoted at **77** to the housing **65** and has a loose pivotal connection at **78** with the piston **72**. Lever **76** is connected by the adjustable link **71** with the regulating lever **79** of the governor.

A high speed stop is provided for the mechanism **26** in the form of an adjustable set screw **80** and a similar but oppositely disposed low speed stop **81** is also provided. The stops **80**, **81** determine the speed range over which the engine **12**, and therefor the compressor **10**, can operate.

Résumé

By referring to Figure 2 it will be seen that the range of engine speed may be adjustable anywhere within the range of operation of the intake valve. In the setting shown by Figure 2, when the compressor is operating and the discharge pressure rises above 100 p.s.i., the intake valve starts to close before the engine speed decreases. By adjusting the screw **80**, the point at which the engine speed changes may be varied; for example, the point at which the engine speed starts to drop under these conditions may be made to coincide with the point at which the air intake valve starts to close. The same regulation may be made at the lower end of the compressor load range, but it has been found desirable to locate the lower limit of the speed range at a point considerably before the intake valve closes completely.

The present invention provides a control system in which the speed modulation is intermediate or simultaneous to the air intake modulation. There is no need to maintain a constant force on the inlet valve in a direction opposite to that imposed by the outlet pressure of the control valve, and thus the necessity of considerable equipment, such as reducing valves, plumbing and the like, is not required.

In the present arrangement, the speed control **26** can be located adjacent the governor and only a conduit **41** is required between the control valve **20** and control **26**, no complicated linkage or adjustments being necessary to actuate the governor. In other words, the fluid operated mechanism **26** is separately mounted adjacent the governor and independently of the control valve **20**. As a result, flexible mounting of the system is possible and, furthermore, if any element of any of the control mechanisms fail, such as a diaphragm, the faulty element can be easily located and repaired or replaced without disassembling the other mechanisms or affecting their adjustment.

Various modes of carrying out the invention are contemplated as being within the scope of the following claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention.

I claim:

1. In combination, a fluid compressor, a motor drivingly connected to said compressor, a control valve in fluid communication with said compressor and responsive to variations in compressor discharge pressure, said control valve having an outlet conduit through which pressure fluid over a predetermined value is discharged, a governor mounted on said motor for regulating the speed thereof, a fluid pressure operated speed control mechanism and having an operating link connected with the governor for shifting said governor between slow and fast positions, a conduit placing said speed control mechanism in pressure fluid communication with said outlet conduit to urge said

link toward said slow position when pressure fluid is discharged from said control valve, resilient means in said control mechanism for urging said link to said fast position, an inlet valve in said compressor for controlling the flow of fluid through the compressor, pressure fluid actuating inlet valve mechanism in said compressor and connected to said inlet valve and also being in fluid communication with said outlet conduit, whereby said inlet valve is urged toward a closed position by discharge pressure from said control valve, a spring in said valve mechanism for urging it away from valve closing position, and resilient means acting on said inlet valve for urging the same toward closed position independently of said valve mechanism.

2. A device as recited in claim 1 further characterized in that said speed control mechanism has adjustable limit stops for maintaining the pressure range which is effective to operate said speed control mechanism within the pressure range which is effective to actuate said inlet valve mechanism.

3. A device as recited in claim 1 further characterized in that the connection between said pressure fluid actuating inlet valve mechanism and said inlet valve includes an actuating rod having a free sliding fit with said valve.

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