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UNLOADING SYSTEM FOR COMPRESSORS

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Fig. 1.

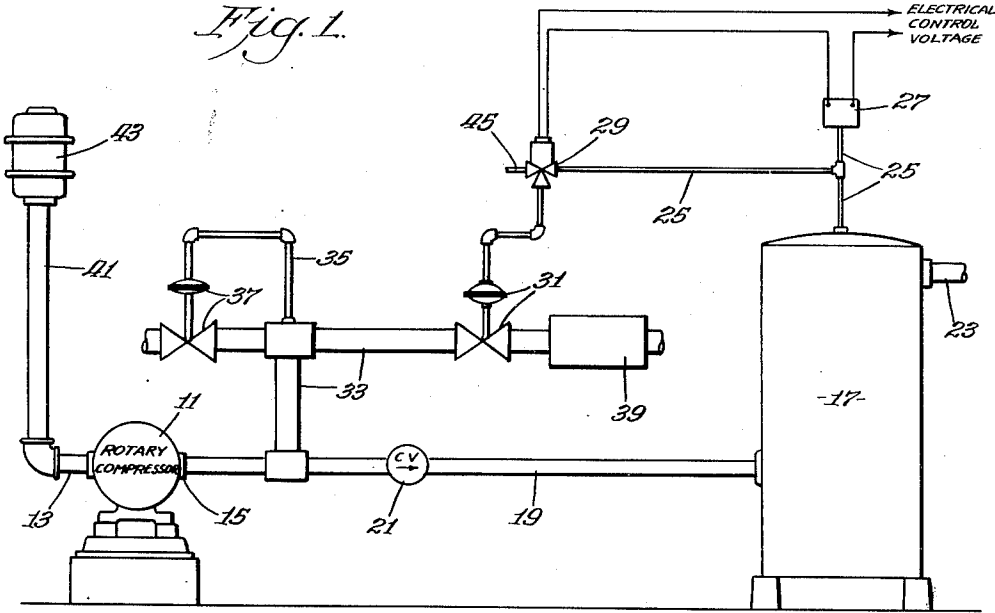
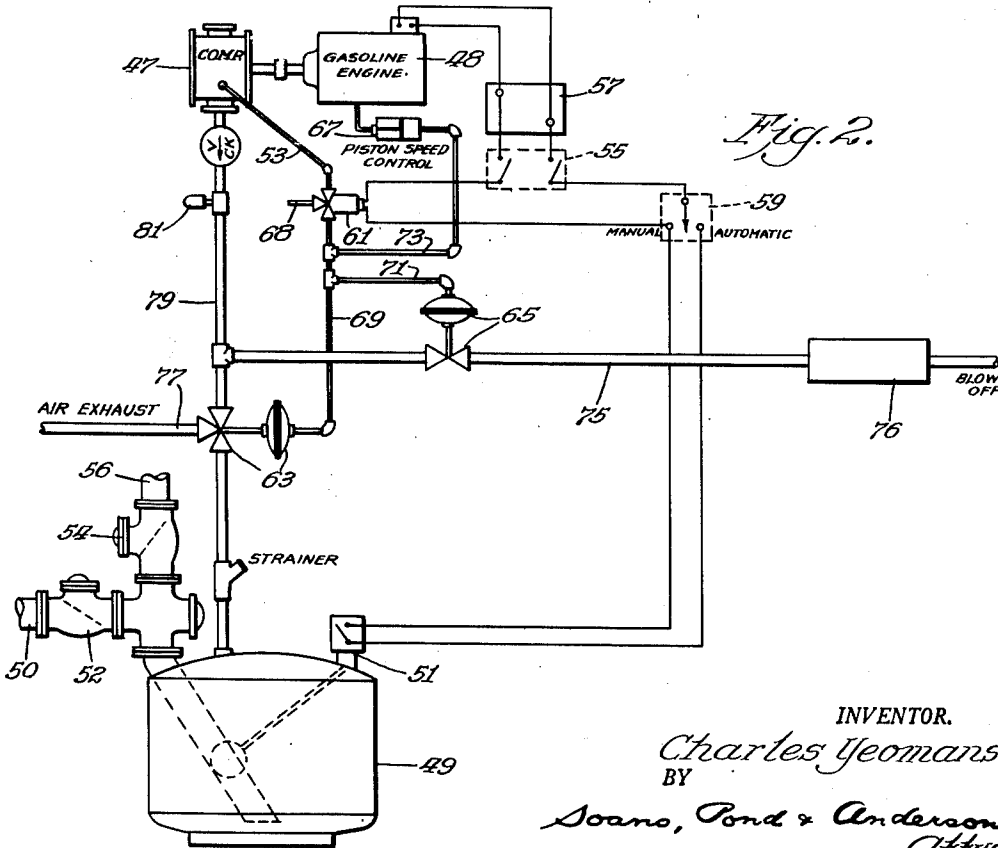


Fig. 2.



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UNLOADING SYSTEM FOR COMPRESSORS

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1 Claim. (Cl. 230-22)

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The present invention relates to unloading systems for gas compressors and, in particular, to unloading systems for continuously operating rotary air compressors.

An unloading system is desirably incorporated into a compressor installation to effect power savings when the compressor is used with air powered apparatus requiring an intermittent load. During operation, the unloading system reduces the back pressure on the compressor outlet so that the energy put into the compressor is reduced to a minimum during periods of low air flow demand. The simplest type unloading system is the conventional pop-off safety valve. This arrangement does not result in the efficient unloading of a compressor, because the air bled off through the pop-off type valve is at substantially the same pressure as the air in the system. Thus, the air exhausted to the atmosphere will have been compressed to substantially the same pressure as the air in the pressure system and a large amount of power will be wasted during the periods of low air demand.

Reasonably efficient unloading systems have been developed for piston type compression, but attempts to provide unloading systems for rotary air compressors have resulted in complicated arrangements which are expensive to install and difficult to maintain in operating condition. Due to this, in instances of intermittent pressure air demand, piston type compressors have been used despite the known advantages of rotary compressors for this type service. The availability of a satisfactory unloading system overcame the inherent high cost of a reciprocating type air compressor.

The principal object of the present invention is to provide an improved unloading system for rotary air compressors which will decrease the load on the compressor driving motor to a minimum value, in response to a predetermined variation in the pressure air demand. Another object is to provide a system of the class described which will be economical to install and which may be easily maintained in operable condition. Further objects and advantages of the invention will be apparent by reference to the following description and the accompanying drawing:

In the drawing.

Fig. 1 is a diagrammatic view of an unloading system embodying the general features of the present invention; and

Fig. 2 is a diagrammatic view of a more specific application of the principles of the invention.

An air compressing system in accordance with

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the invention includes a compressor, which may be connected to an air receiver, suitable air mains and valves for conducting the compressed air to the various associated air powered apparatus, and unloading means responsive to predetermined pressure in the receiver. The unloading means comprises a source of electrical power, pressure responsive electrical controls, and a system of pilot pipelines and valves co-operating with the control means to reduce the back pressure in the compressor outlet.

In the particular system shown in Fig. 1, there is provided a rotary compressor 11 having an air inlet 13 and outlet 15 which is connected to an air receiver 17 through a suitable main 19. The main 19 includes a check valve 21 which allows flow only in the direction shown by the arrow. The air receiver 17 has an outlet 23 through which air is drawn for the various associated air powered apparatus. A pilot pipe line 25 is provided which transmits pressure to an electrical pressure responsive switch 27 and the pressure air control system. The electrical pressure responsive switch 27, in turn, operates a three-way solenoid valve 29 which controls the air pressure in the control chamber of a diaphragm valve 31 located in the unloading main 33.

The unloading main 33 is adapted to connect the outlet side of the compressor with the atmosphere through a silencer 39, as illustrated in Fig. 1. The pilot pipe line 35 is connected to a diaphragm-controlled safety valve 37 in the unloading main 33.

In operation, air is drawn into the compressor inlet 13 through a suitable main 41 and an air filter 43. The air is then compressed and forced past the check valve 21 into the air receiver where it is stored for use. When the pressure reaches a predetermined value the pressure responsive switch 27 closes the electrical circuit, thereby energizing the solenoid valve 29 and effecting the admission of pressure air into the control chamber of the diaphragm valve 31. The valve 31 opens and allows the compressor to exhaust through unloading main 33 and the silencer 39 at atmospheric pressure; thus, the pressure on the intake side of the compressor and the pressure on the outlet of the compressor are substantially equal.

When the pressure in the receiver 17 is lowered to a predetermined point the electrical control switch 27 opens, breaking the electrical circuit and causing the solenoid-operated valve 29 to close the line 25 and to vent the control chamber of the diaphragm valve 31 to the atmosphere

through the pipe line 45. The reduced pressure in the control chamber of the diaphragm valve allows the valve 31 to close, and forces the air from the compressor through the delivery main 19 and into the air receiver 17.

The diaphragm-operated safety valve 37 is provided in case of power failure in the control circuit. Its pressure limit is set slightly higher than the pressure at which the electrical pressure responsive switch 27 operates. If the electrical system fails, the compressor 15 will maintain the pressure at which the safety valve 37 is calibrated, throughout the system, and the excess air will be exhausted through unloading main 33 and the safety valve 37. When the compressor is exhausting through the safety valve, the operation is relatively inefficient, because the compressor must compress all of the air to the pressure at which the safety valve is set.

Diaphragm valves are used in the unloading system because the air mains are large, and solenoid-operated valves are not economically or mechanically practical for large-sized installations. The present invention utilizes the power in the compressed air to operate the large valves and this power is, in turn, controlled by small solenoid valves. On small installations, solenoid valves may be used throughout the system without a large increase in the cost of installation and maintenance. The diaphragm-controlled safety valve 37 operates in the same general manner as a spring balanced pop-off type valve, but is inherently a more accurate control device. Pop-off type valves tend to reduce the pressure unduly once the valve has opened.

Fig. 2 shows a continuously operating compressor system having an intermittent load but no receiver for retaining a supply of compressed air. This system is entirely self-powered and while shown as embodying a sewage ejector adapted for use in remote locations, the arrangement can be easily modified by substituting an air storage receiver for the ejector to provide a portable source of pressure air. In the system illustrated, a continuously operating, gasoline engine driven, rotary air compressor 47 is used to provide compressed air for a standard type pneumatic sewage ejector 49. The ejector 49 is filled with liquid by gravity flow through an inlet pipe line 50. When the liquid level rises to a predetermined point the float-controlled electrical switch 51 effects the admission of compressed air to the ejector 49. The compressed air, in conjunction with the check valves 52 and 54, and the discharge line 56, pumps the material to a higher level. When the liquid level in the ejector drops to a minimum, the float switch 51 closes off the air supply and vents the pressure air in the ejector to the atmosphere through the pipe line provided for the purpose. In the interest of economy of operation and reduced wear on the equipment, it is desirable that the compressor be unloaded and slowed down when compressed air is not needed on the ejector. To accomplish this end, the elements of the present invention are used to unload the compressor, and also through the addition of a special valve and pipe line to operate a speed control on the driving motor when peak power is not needed.

As there is no source of compressed air at constant pressure in the external system, the pressure air is obtained by inserting a bleeder pipe line 53 through the casing of the compressor 47 in a position from which the line may be supplied with compressed air from one of the cells

of the compressor. A suitable rotary compressor having an air cell and bleeder line of this general type is described in my prior patent, 2,385,905.

In operation, the gasoline engine 48 or other prime mover is started, and the electrical control line switch 55 from the battery 57 is closed to energize the control circuit. The operation selector switch 59 is placed in the automatic pumping position, in order to effect continuous operation. When the ejector 49 is filling, the float switch 51 opens the solenoid valve 61, which vents the control chambers of the diaphragm valves 63 and 65 and the engine speed control piston 67 through the pipe line 68. Simultaneously, the pilot pipe line 53, which leads to the compressor cell, is blocked, thereby maintaining a source of pressure air. The reduced pressure in the pilot pipe lines opens diaphragm operated valve 65; the compressor then unloads through pipe line 75 and the silencer 76; the diaphragm operated three-way valve 63 is positioned to vent the ejector 49 through the exhaust pipe line 77 and to seal off the compressor pipe line 79, preventing interference with the normal venting of the ejector. Thus, while the ejector 49 is filling, the compressor 47 is vented to the atmosphere through the pipe line 75 and the silencer 76. At the same time, the ejector 49 is vented through the ejector exhaust pipe line 77. The compressor is then operating at a low speed and at a small portion of the original load.

When the ejector is full, the float switch 51 closes, energizing the solenoid valve 61, which closes the vent pipe line 68 and, at the same time, admits pressure air to the pilot pipe lines. Simultaneous with the closing of the vent and the admission of pressure air to the pilot pipe lines 69, 71, and 73, the speed of the gasoline engine 48 and the compressor 47 are increased through the action of the piston control 67; the pipe line 79 from the compressor 47 to the ejector 49 is opened; the air exhaust line 77 is closed; and the compressor unloading line 75 is closed. The compressed air then flows from the compressor 47 to the ejector 49, until the ejector contents are discharged and the float switch 51 again opens the control circuit.

The safety valve 81 is provided in case of breakdown in the control system and may be of the ordinary spring loaded type, as it will not be needed unless there is a serious failure in the system. Manual operation of the ejector is also provided for on the selector switch 59, whereby the system will allow pumping even though there has been a failure in the float valve control 51.

The unloading system of the present invention allows unloading of a rotary compressor by simple and economical means, whereby the power required by the compressor at periods of low air demand may be reduced to less than 25 per cent of the usual running value, depending upon the operating discharge pressure. The higher the operating pressure, the greater the reduction in the power required by the compressor. When air is compressed, the compressor operates under full load at normal efficiency, but when the need for pressure air ceases, the load on the compressor and the driving means is greatly reduced, allowing for economical operation. In an installation such as is illustrated in Fig. 2, which is particularly adapted for portable or semi-portable equipments, speed control of the driving motor is also employed, and the fuel or power consumption costs of the compressor may be even more greatly reduced. The motor speed control feature is not

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recommended except when the compressor is running at low capacity for comparatively long periods of time.

The features of my invention which are believed to be new, are expressly set forth in the appended claim.

I claim:

In a system of the class described for supplying a variable demand of compressed air, the combination of an air compressor which operates continuously regardless of whether or not compressed air is demanded, said compressor having an outlet connection and an inlet connection which is in communication with the atmosphere, an air receiver for maintaining the pressure of the air which is supplied by said compressor, an air main connecting said compressor outlet with said receiver, a uniflow valve in said air main intermediate said compressor outlet and said air receiver, an unloading main connected to said air main intermediate said compressor outlet and said uniflow valve, said unloading main being of sufficient size to carry the entire output of said compressor without building up any substantial back pressure at the compressor outlet, an air-operated valve in said unloading main which is adapted to connect said unloading main to the atmosphere without substantial throttling of the air flow through said main, a pilot pipe line connecting

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said air receiver with said air-operated valve, an electrically actuated valve in said pilot line for controlling the air supplied to said air-operated valve, and an electric switch for opening and closing the circuit to said electrically actuated valve which is responsive to variations in the pressure in said air receiver whereby the entire output of said air compressor is vented to the atmosphere whenever the pressure in said air receiver is above a predetermined value and the entire output of said air compressor is directed to the air receiver whenever the pressure in said air receiver is below a predetermined value.

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