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COMPRESSOR UNLOADING SYSTEMS

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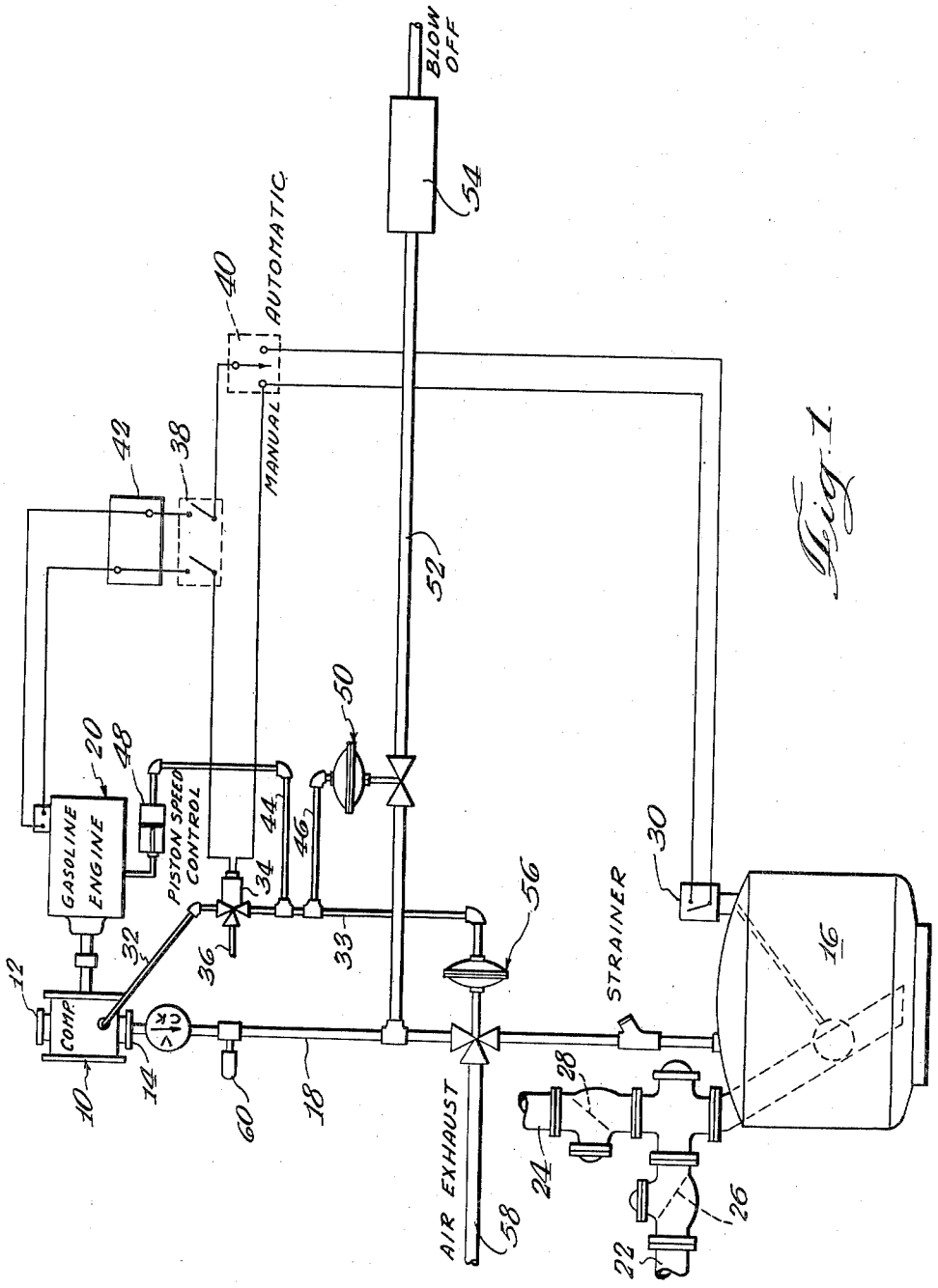


Fig. 1.

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COMPRESSOR UNLOADING SYSTEMS

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Original application October 30, 1946, Serial No. 706,593, now Patent No. 2,637,485, dated May 5, 1953. Divided and this application October 13, 1952, Serial No. 314,559

7 Claims. (Cl. 103—248)

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 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 demand. The simplest type unloading system is the pop-off type of safety valve which involves bleeding off the air through the safety valve at substantially the same pressure as the air in the pressure system. Thus, 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, and especially engine driven compressors, have resulted in complicated arrangements which are expensive to install and difficult to maintain in operating condition. Consequently 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 primary 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 aforementioned type wherein the air compressor is engine driven and supplies pressure air directly to the air operated mechanism upon demand, and wherein the control means includes apparatus for regulating the speed of the engine according to the requirements of the compressor. Additional objects and advantages will be apparent by reference to the following description and to the accompanying drawing, wherein:

Figure 1 is a diagrammatic view of apparatus embodying the principles of the invention.

The illustrated embodiment, which is disclosed in my copending application, Serial No. 706,593, filed October 30, 1946, now Patent No. 2,637,485, May 5, 1953, and of which this application is a division, includes a continuously operating compressor system intermittently supplying compressed air to sewage ejector, in response to variation in the volume of material in the ejector. An unloading means, comprising a source of electrical power, electrical controls, and a system of pilot pipelines and valves, is responsive to predetermined level in the ejector to reduce the back pressure in the compressor outlet. The compressor supplies pressure air directly to the ejector through the valve controlled pipelines and, consequently, the system is adapted for use in connection with remotely located ejectors or other air operated apparatus.

More particularly, the illustrated system includes a rotary air compressor **10** having an air inlet **12**, and an

outlet **14** which is connected to a pneumatic sewage ejector **16** through a suitable pipe line **18**. The compressor **10** is continuously driven by a gasoline engine **20**, or the like.

The ejector **16** is filled with the generally liquid sewage material by gravity flow through an inlet pipe line **22**, and the material is then ejected through an outlet or discharge pipe **24**. The inlet line **22** and the outlet line **24** include check valves **26** and **28**, respectively, which prevent a back flow in these pipes. When the liquid level in the ejector tank reaches a predetermined level, a float controlled electrical switch **30** effects the admission of compressed air to the ejector **16** to discharge the material therein past the check valve **28** into the outlet line **24**. When the liquid level in the ejector drops to a predetermined minimum, the float switch **30** closes off the air supply to the ejector and vents the latter to the air, permitting the ejector **16** to refill.

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 required in the ejector. To achieve this result, 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.

The structural elements involved in the unloading system include a bleeder pipe line **32** which extends through the casing of the compressor **10** in a position to receive 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 U. S. Patent No. 2,385,905, issued October 2, 1945. The bleeder line **32** is controlled by a three-way solenoid valve **34** which also controls communication to the atmosphere through a pipe line **36**. The solenoid valve **34** is electrically connected with the float switch **30** through a circuit including a control switch **38** and an operation selector switch **40**. The control switch **38** is connected with a battery **42**, which also serves the electrical system of the gasoline engine **20**, to energize the control circuit. The selector switch **40** is normally positioned in the "automatic" position to effect continuous operation in accordance with the opening and closing of the float switch **30**. Manual operation of the ejector can be achieved by moving the switch **40** to "manual."

The downstream portion of the bleeder line **32** with respect to the three-way valve **34**, that is, the pilot pipe line **33**, includes two branch pilot pipe lines **44** and **46**. Pipeline **44** communicates with an engine speed control piston **48**, and the pipe line **46** communicates with the control chamber of a diaphragm valve **50** which controls the flow of air through a branch line **52** from the main pipe **18** to the atmosphere. Preferably, a silencer **54** is placed near the end of this outlet branch **52**. The bleeder line **32** terminates in the control chamber of a three-way diaphragm valve **56** controlling communication between the air compressor **10** and the ejector **16**, and communication between the ejector and the atmosphere via a branch pipe line **58**.

As indicated in the drawings, it is preferred that the compressor outlet line **18** include a check valve and a safety valve **60** as precautionary measures against possible failure of the control system.

In operation, the gasoline engine **20** is started and the electrical control line switch **38** is closed to energize the control circuit through the battery **42**. The operation selector switch **40** is placed in the automatic pumping position in order to effect continuous operation. When the ejector **16** is filling, the float controlled switch **30** is open and, as a result the solenoid valve **34** is de-energized

and assumes its closed position. This vents the control chambers of the diaphragm valves 50 and 56, and, also, the engine speed control piston 48 through the pipe line 36. Simultaneously, the bleeder line 32 leading from the compressor cell is blocked by the solenoid valve 34, thereby maintaining a source of pressure air in the control system.

The reduced pressure in the pilot pipe lines opens diaphragm operated valve 50; the compressor then unloads through the pipe line 52 and the silencer 54; the diaphragm operated three-way valve 56 is positioned to vent the ejector 16 through the exhaust pipe line 58 and to seal off the compressor pipe line 18, preventing interference with the normal venting of the ejector. Consequently, while the ejector is vented to the atmosphere for filling, the compressor is operating at a low speed and at a small portion of the original load.

When the ejector 16 is full, the float switch 30 closes and thereby completes the circuit to energize the solenoid valve 34 to move to a position admitting pressure air to the pilot pipe lines and closing the vent pipe line 36. The pressure air in the pilot line 44, 46 and 33, respectively, moves the piston 48 to increase the engine speed, closes the compressor or unloading line 52, opens the pipe line 18 from the compressor 10 to the ejector 16, and closes the air exhaust line 58. The compressed air then flows from the compressor 10 to the ejector 16, until the ejector contents are discharged and the float switch 30 again opens the control circuit as described above.

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 peak operating requirement, 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. Further, it will be apparent that the illustrated system is particularly adapted for portable or semi-portable equipment.

I claim:

1. In a system of the class described, a continuously operating air compressor having an outlet connection and an inlet connection which is in continuous communication with the atmosphere during the operation of the system, an engine drivingly connected with said air compressor, air powered apparatus having an intermittent demand for pressure air, an air main connecting said compressor outlet with said air powered apparatus, unloading means comprising an unloading main connected with said air main and including a diaphragm controlled valve for connecting the compressor outlet to the atmosphere, pressure responsive speed control means for said compressor engine, a pilot line connecting said compressor with said diaphragm controlled unloading valve and with said speed control means, a control valve in said pilot line affording communication with the atmosphere and operable to control the flow of pressure air in said pilot line to said speed control means and said diaphragm unloading valve, said control valve being also operable to connect said speed control means and said unloading valve with the atmosphere, and means connecting said control valve with said air apparatus which is operable in response to a removal of the demand for pressure air by said apparatus to position said control valve so as to vent said diaphragm valve and speed control means, to thereby open said diaphragm controlled unloading valve to vent said compressor to the atmosphere through said unloading main and also to thereby reduce the speed of said engine, said means being also operable in response to a demand for pressure air by said apparatus to direct pressure air from said compressor to said diaphragm valve and speed control means to thereby close said diaphragm controlled unloading valve and to increase the speed of said engine.

2. In a system of the class described, a continuously operating air compressor having an outlet connection and an inlet connection which is in continuous communication with the atmosphere during the operation of the system, an engine drivingly connected with said air compressor, a receiver including means providing for the inflow and outflow of liquid material with respect thereto, an air main connecting said compressor outlet with said receiver, an exhaust main connected with said air main, a diaphragm controlled exhaust valve for controlling communication between said receiver and said exhaust main and between said compressor outlet and said receiver, unloading main connected with said air main at a position between said compressor outlet and said exhaust main and including a diaphragm controlled unloading valve for connecting the compressor outlet to the atmosphere, pressure responsive speed control means for said compressor engine, a pilot line connecting said compressor with said diaphragm controlled exhaust and unloading valves and with said speed control means, a control valve in said pilot line affording communication with the atmosphere and operable to control the flow of pressure air in said pilot line to said speed control means and said diaphragm controlled unloading and exhaust valves, said control valve being also operable to connect said speed control means, said unloading valve and said exhaust valve with the atmosphere, and means connecting said control valve with said receiver for operation of said control valve in response to a change in the level of the liquid material in said receiver, whereby attainment of a predetermined maximum level in said receiver will effect a positioning of said control valve to direct pressure air from said compressor to said diaphragm valves and thereby close said exhaust and unloading mains and direct compressed air to said receiver, and to direct pressure air from said compressor to said speed control means to thereby increase the speed of said engine, and whereby attainment of a predetermined minimum level in said receiver will move said control valve to a position venting said diaphragm valves and said speed control means to the atmosphere and thereby open said exhaust and unloading mains and reduce the speed of said engine.

3. In combination in a system of the class described a continuously operating, engine driven air compressor having an outlet connection and an inlet connection which is in continuous communication with the atmosphere during the operation of the system, air powered apparatus having an intermittent demand for pressure air, an air main connecting said compressor outlet and said air powered apparatus, unloading means comprising an unloading main including a diaphragm controlled valve for connecting the compressor outlet to the atmosphere, a source of electrical power, an electrically operated control valve, pressure responsive speed control means for said compressor engine, and pilot pipe lines connecting said compressor with said control valve, said diaphragm operated valve, and said speed control means, said electrically operated control valve being operable in response to the removal of a demand for pressure air by said air powered apparatus to so control the pressure of the air in said pilot pipe lines to said unloading diaphragm controlled valve and said speed control means that said compressor will be vented to the atmosphere through said unloading main and the speed of the compressor driving engine will be reduced.

4. In combination in a system of the class described, a continuously operating air compressor having an outlet connection and an inlet connection which is in continuous communication with the atmosphere during the operation of the system, air powered apparatus having an intermittent demand for pressure air, an air main connecting said compressor outlet and said air powered apparatus,

unloading means comprising an unloading main connected with said compressor outlet and a diaphragm controlled valve in said unloading main for connecting the compressor outlet to the atmosphere, a pilot pipe line connecting the pressure side of said compressor with said diaphragm operated valve, a source of electrical power, an electrically operated control valve connected with said electrical power source and disposed to control the flow of pressure air from said compressor through said pilot pipe line, said control valve being operable in response to the demand of said air powered apparatus for pressure air to admit pressure air from said compressor through said pilot pipe line to said diaphagm control valve, to thereby close said diaphragm control valve and prevent said compressor outlet from being vented to the atmosphere through said unloading main.

5. In combination in a system of the class described a continuously operating, engine driven, rotary air compressor having an outlet connection and an inlet connection which is in continuous communication with the atmosphere during the operation of the system, air powered apparatus having an intermittent demand for pressure air, a uni-flow valve, an air main connecting said compressor outlet, said uni-flow valve and said air powered apparatus, said uni-flow valve being located intermediate the main outlet of said compressor and said air powered apparatus, unloading means comprising an unloading main and a diaphragm controlled valve for connecting the compressor outlet to the atmosphere, a source of electrical power, an electrically operated control valve, an engine speed control piston, and pilot pipe lines connecting said compressor with said electrical control valve, said diaphragm operated valve, and said engine speed control, said electrical control valve being operable in response to removal of the demand of said air powered apparatus for pressure air to so control the pressure of the air in said pilot pipe lines to said diaphragm controlled valve and said engine speed control that said compressor will be vented to the atmosphere through said unloading mean and the speed of the compressor driving engine will be reduced.

6. In a system of the class described, a continuously operating, engine driven air compressor having an outlet connection and an inlet connection which is in continuous communication with the atmosphere during the operation of the system, air powered apparatus having an intermittent demand for pressure air, an air main connecting said compressor outlet with said air powered apparatus, unloading means comprising an unloading main connected with said compressor outlet and including a fluid pressure responsive unloading valve for connecting the compressor outlet to the atmosphere, pressure responsive speed control means for said compressor engine, a pilot line connecting said compressor with said unloading valve and with said speed control means, a control valve in said pilot line affording communication with the atmosphere and operable in response to the removal of a demand for pressure air by said air powered apparatus to so control the pressure of the air in said pilot pipe line to said fluid pressure responsive unloading valve and said speed control means that said compressor will be vented to the atmosphere through said unloading main and the speed of the compressor driving engine will be reduced.

7. In combination in a system of the class described, a continuously operating engine driven, rotary air compressor having an outlet connection and an inlet connection which is in continuous communication with the atmosphere during the operation of the system, a receiver including means providing for the inflow and outflow of liquid material with respect thereto, an air main connecting said compressor outlet with said air powered apparatus, a uni-flow valve located in said air main intermediate the outlet of said compressor and said air powered apparatus, an exhaust main connected with said air main, a diaphragm controlled exhaust valve for controlling communication between said receiver and said exhaust main and between said compressor outlet and said receiver, an unloading main connected with said air main at a position between said compressor outlet and said exhaust main and including a diaphragm controlled unloading valve for connecting the compressor outlet to the atmosphere, a pressure responsive speed control means for the compressor engine, a pilot line connecting said compressor with said diaphragm controlled exhaust and unloading valves and with said speed control means, a source of electrical power, an electrically operated control valve in said pilot line affording communication with the atmosphere and operable to control the flow of pressure air in said pilot line to said speed control means and said diaphragm controlled unloading and exhaust valves, said control valve being also operable to connect said speed control means, said unloading valve and said exhaust valve with the atmosphere, means connecting said control valve with said receiver for operation of said control valve in response to a change in the level of the liquid material in said receiver, whereby attainment of a predetermined maximum level in said receiver will effect a positioning of said control valve to direct pressure air from said compressor to said diaphragm valves and thereby close said exhaust and unloading mains and direct compressed air to said receiver, and to direct pressure air from said compressor to said speed control means to thereby increase the speed of said engine, said control valve being further operable in response to attainment of a predetermined minimum level in said receiver to vent said diaphragm valves and said speed control means to the atmosphere to thereby open said exhaust and unloading mains and reduce the speed of said engine.

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