Nov. 14, 1939. H. BENTLEY 2,180,274

PNEUMATIC EJECTOR PLANT

Filed June 23, 1938 2 Sheets-Sheet 1

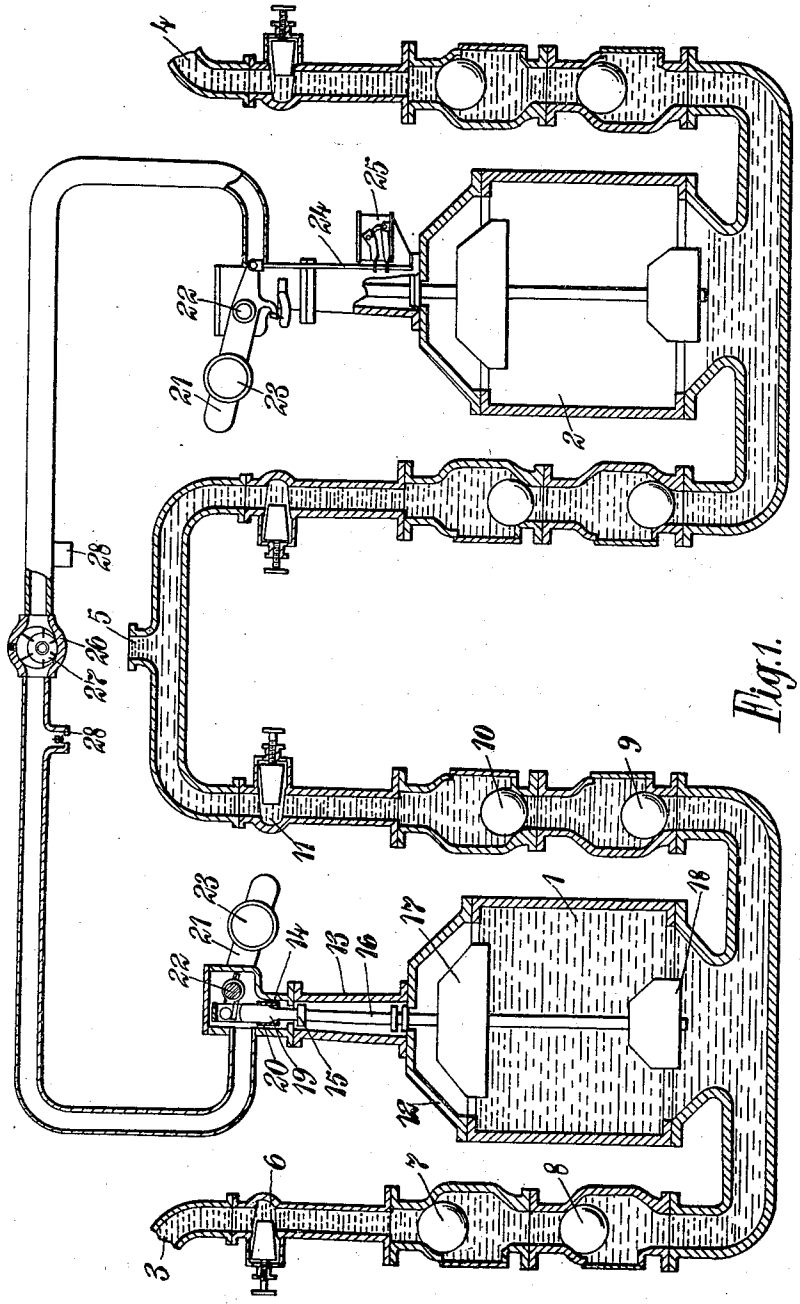

Fig. 1.

Harry Bentley
Inventor

By: Glascock Downing & Seebold
Attys.

Nov. 14, 1939. H. BENTLEY 2,180,274

PNEUMATIC EJECTOR PLANT

Filed June 23, 1938 2 Sheets-Sheet 2

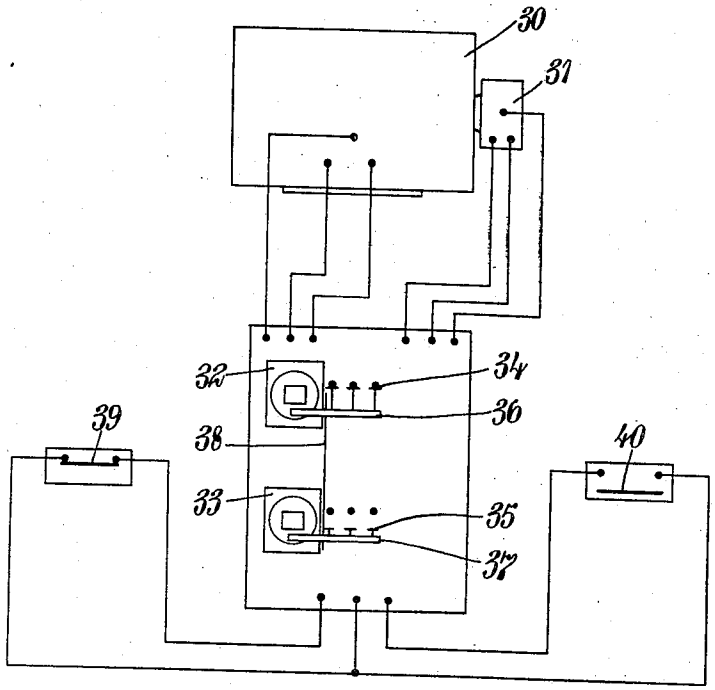

Fig. 2.

Harry Bentley
Inventor

By: Glascock Downing & Seibold
Attys.

Patented Nov. 14, 1939

2,180,274

UNITED STATES PATENT OFFICE

2,180,274

PNEUMATIC EJECTOR PLANT

Harry Bentley, Huddersfield, England, assignor of one-half to W. C. Holmes & Company Limited, Huddersfield, England

Application June 23, 1938, Serial No. 215,489
In Great Britain June 30, 1937

9 Claims. (Cl. 103—238)

This invention relates to pneumatic ejector plant employed for raising liquids such as sewage for example, of the kind comprising a pair of vessels in which the liquid is received and alternately discharged by means of compressed air.

It has hitherto been customary to control the admission and release of compressed air from the ejector vessels by automatically operated valves and it has also been proposed to return compressed air from the ejector vessels, after the liquid has been discharged therefrom, to the intake of the air compressor or pump.

One of the objects of the present invention is to provide an improved and simplified control arrangement for ejector plant of the general kind described in which the necessity for change-over valves and their attendant complications is eliminated.

According to the invention a reversible compressor or pump is arranged to withdraw air from one ejector vessel of a pair while delivering compressed air to discharge liquid from the other vessel, and means is provided for reversing the operation of the compressor or pump in accordance with conditions within the ejector.

According to a feature of the invention a compressor of the rotary positive displacement type or other type which is conveniently reversible is employed, the connections being arranged so that air may be pumped through the compressor casing in either direction according to the direction of rotation of the rotary member, the said connections which serve alternately as inlets and outlets being respectively conected to the ejector vessels.

According to a further feature of the invention, a sliding vane type of compressor is employed and the suction and delivery connections thereof are disposed symmetrically with respect to the eccentrically mounted rotor.

The compressor or pump is driven by a reversible electric or other motor which is controlled by float means in the ejector vessels. Obviously other control means dependent upon the presence or absence of liquid in the ejector vessels could be employed in the place of floats. The floats or their equivalents are arranged to actuate control means for the motor so that the latter is reversed when one ejector is empty and the other is full. Electrical control circuits may be provided for this purpose, the circuits being interlocked both mechanically and electrically so that when for example one ejector has been emptied the motor is not reversed until the second ejector is completely filled.

The invention will best be understood from a consideration of the following descriptive example of an ejector installation for raising sewage as illustrated in the accompanying drawings, in which:

Figure 1 is a general view showing the lay-out of the installation mainly in section and more or less diagrammatic;

Figure 2 is a diagram showing the electrical connections for the control of the motor driving the compressor.

In carrying the invention into effect according to one convenient mode as applied by way of example to the raising of sewage, the plant comprises a pair of closed ejector vessels 1 and 2. The sewage enters ejector 1 by gravity through a pipe 3 and ejector 2 similarly through a pipe 4. In each inlet connection there is provided a sluice valve 6 and a pair of reflux or non-return valves 7 and 8. At the lower end of each ejector there is a connection to a common delivery pipe 5 through reflux or non-return valves 9 and 10 and a sluice valve 11. The sluice valves enable either of the ejectors to be isolated if necessary.

The upper end of each ejector vessel is closed by a cover 12 which has an upward tubular extension 13 supporting a valve casing 14. A rod 16 carrying a sealing valve 15 extends within the ejector and has attached thereto an upper bell float 17 and a lower float 18. The valve 15 cooperates with a seat on the casing 14 to close the exit from the tubular extension 13 when the rod 16 is in its uppermost position. A stop limits the downward movement of the rod to the position in which the sealing valve 15 is open. The rod 16 is extended upwardly to form a piston 19 slidable in fixed guides 20 and the piston is provided with a further upward extension which has a loose pivotal connection with a crank arm carried by a shaft 22 extending through the valve casing 14. The shaft 22 extends outside the said casing and mounted thereon is a double-armed lever 21. A counterweight 23 is mounted on one arm of the lever and the other arm is connected to a vertically movable rod 24 arranged to actuate a switch mechanism 25. It will be understood that each of the ejectors is similarly equipped.

The switch actuating rod 24 has a pair of spaced collars or stops thereon which actuate the switch lever and the arrangement is such that when the ejector is full and the floats in their uppermost position (as shown for ejector 1), the counterweight 24 of that ejector actuates the

switch to close the contents thereof. Conversely when the ejector is empty the weight of the float gear raises the arm 21 and opens the switch contacts.

The respective sealing valve casings 14 are closed and are connected by pipes to the opposite sides of the casing 26 of a rotary air compressor of the sliding vane type having a rotor 27. The compressor is in general of conventional construction and the rotor is disposed in the casing to form a crescent shaped chamber which is symmetrically disposed with respect to the air connections to the pipes leading to the respective ejectors. With this arrangement the compressor will deliver compressed air in either direction with equal facility according to the direction in which the rotor is driven. Thus as viewed in Figure 1, if the rotor 27 is driven anticlockwise the compressor will draw air from ejector 2 and deliver the compressed air to ejector 1. In each of the air pipe connections to the ejectors there is provided a weight loaded or spring loaded air inlet valve 28.

The compressor is driven by an electric motor of any suitable reversible type and the reversing circuits are controlled from the ejectors. Figure 2 shows in schematic form the arrangement of the control circuits. The electric motor comprises the stator 30 and the rotor 31 (indicated diagrammatically) and the respective circuits are controlled by a pair of contactors 32 and 33 having main switch contacts 34 and 35 mounted on clapper bars 36 and 37 actuated by the usual magnet coils. When the appropriate magnet coil is energised the clapper bar is drawn in and closes the contacts as indicated at 37, thereby causing the motor to start up and run in a predetermined direction. The clapper bars 36 and 37 are interconnected by an interlocking bar indicated at 38 which is operated when the clapper bar is operated and thereby assumes a position in which it prevents operation of the clapper bar to close the switch of the other contactor. Thus only one of the two contactors can be closed at any one time.

The actuating magnets of the contactors are controlled by the float switch contacts indicated at 39 and 40, these being the contacts of the switch mechanisms 25 shown in Figure 1. Closing of the contacts energises the corresponding magnet and closes the contactor switch to start up the motor.

The operation of the installation will now be understood on reference to the drawings. Assuming as shown in Figure 1 that ejector 2 is empty whereas ejector 1 has just filled, the float contacts 40 which are controlled by the float of ejector 2 will be open whereas the float contacts 39 of ejector 1 will be closed. The closing of contacts 39 operates the contactor 32 which starts up the motor to rotate the rotor 27 in an anticlockwise direction. Compressed air is delivered thereby into the valve casing 14 of ejector 1 and air will be simultaneously withdrawn from ejector 2. The compressed air in the valve casing acting upon the exposed surfaces of the piston 19 and sealing valve 15 will depress the latter against the buoyancy of the floats 17 and 18 and the air will enter the ejector and discharge the sewage through the reflux valves 9 and 10 and the delivery outlet 5. Meanwhile if further sewage is available this will enter ejector 2 as the air is withdrawn therefrom.

As soon as ejector 1 is fully discharged the floats 17 and 18 will fall and their weight will raise the lever 21 to actuate the switch and open the contacts thereof, thus de-energising the contactor 32 and interrupting the motor circuit with the result that the compressor is stopped. At the same time the de-energising of contactor 32 returns the locking bar 38 to a position which permits the closing of contactor 33.

As previously explained, during the discharge of sewage from ejector 1 the simultaneous withdrawal of air from ejector 2 allows sewage to enter the latter. When this ejector is full the floats 17 and 18 will be raised to their uppermost position to close the sealing valve 15, thus positively preventing the possibility of any sewage being forced into the air line or compressor. At the same time the raising of the floats allows the lever 21 to fall under the influence of its counterweight and to actuate the switch and close the contacts 40. These contacts control the contactor 33 which is closed and thereby starts up the motor in the opposite direction. The compressor thereupon draws air from the empty ejector 1 and delivers compressed air to the full ejector 2 which will then be discharged in the manner previously described.

It will be seen that the system is a closed one, the air used to discharge one ejector being used again to discharge the other ejector. In order to make up for any losses the inlet valves 28 are provided. These are loaded by weights or springs and are adjusted so that when the pressure in the air line falls to a predetermined value under the suction of the compressor the valve opens and admits atmospheric air in the required amount.

As long as there is a supply of sewage or other liquid the ejectors will continue to discharge alternately. Should the supply fail, however, both float switches will be open and the motor will be brought to rest. The plant will start up again immediately and automatically upon a resumption of the supply.

By reason of the interlocking of the contactors controlling the motor reversals it is impossible for both contactors to be closed at one and the same time and thus alternate and regular sequential operation of the ejectors is ensured.

It will also be understood that the arrangement of the compressor connections as described results in the transfer of compressed air from the discharged ejector to the discharging ejector with but little increase in pressure, i. e. the compressor is arranged so that it does not substantially compress the air it receives and in this way maximum economy in operation is achieved.

Many modifications of the arrangement described above may be made without departing from the invention. For example the control may be effected by mechanical or fluid pressure means instead of by the use of electrical contacts and control circuits. The reversal of the compressor may be obtained by means of gearing or other mechanical devices instead of by employing a reversing motor. The compressor or pump may be other than of the sliding vane type, for example, the rotary abutment type may be employed.

I claim:

1. Pneumatic ejector plant for raising liquids comprising a pair of ejector vessels each having an inlet and an outlet, an air compressor of reversible type connected to said vessels to withdraw air from or deliver air to either vessel ac-

cording to the direction of operation of the moving parts of the compressor, the air withdrawn from one vessel being delivered to the other vessel, and means responsive to liquid level conditions within the vessels for reversing the compressor.

2. Pneumatic ejector plant for raising liquids comprising a pair of ejector vessels each having an inlet and an outlet, an air compressor of reversible type having a pair of connections acting alternatively as suction and delivery according to the direction of operation of the compressor, one of said connections communicating with one of the said vessels and the other of said connections communicating with the other of said vessels, and means responsive to liquid level conditions within the vessels for reversing the compressor.

3. Pneumatic ejector plant for raising liquids comprising a pair of ejector vessels, an air compressor of the rotary positive displacement type having a reversible rotary element, one of said vessels being connected to one side of the compressor and the other vessel being connected to the other side of the compressor, and means responsive to liquid level conditions within the vessels for reversing the compressor.

4. Pneumatic ejector plant for raising liquids comprising a pair of ejector vessels, an air compressor of the reversible rotary sliding vane type, one side of the compressor being connected to one of the said vessels and the other side of the compressor being connected to the other of said vessels, and means responsive to liquid level conditions within the vessels for reversing the compressor.

5. Pneumatic ejector plant for raising liquids comprising a pair of ejector vessels, a rotary air compressor of reversible type, one side of said compressor being connected to one of said vessels and the other side of the compressor being connected to the other of said vessels, a reversible electric motor for driving the compressor, control means for reversing the motor, and means responsive to liquid level conditions within the vessels for actuating the said control means to reverse the motor.

6. Pneumatic ejector plant for raising liquids comprising a pair of ejector vessels, a rotary air compressor of reversible type one side of which is connected to one of the said vessels and the other side of which is connected to the other of said vessels, means responsive to liquid level conditions within the vessels for reversing the direction of operation of the compressor annd means for preventing delivery of air for discharging either vessel until the other vessel has been emptied.

7. Pneumatic ejector plant for raising liquids comprising a pair of ejector vessels, a rotary air compressor of reversible type one side of which is connected to one of the said vessels and the other side of which is connected to the other of said vessels, motor means for driving the compressor in either direction, float means in the vessels, a control device associated with said float means for causing the compressor to be driven in one or the other direction according to the liquid level conditions within the vessels, and means for preventing discharge of either vessel until the other vessel has been discharged.

8. Pneumatic ejector plant for raising liquids comprising a pair of ejector vessels, a rotary air compressor of reversible type one side of which is connected to one of the said vessels and the other side of which is connected to the other of said vessels, motor means for driving the compressor in either direction, switch means controlling the direction of operation of the motor, means responsive to liquid level conditions within the vessels for actuating said switch means and interlocking means for preventing operation of said switch means until the vessel to be discharged has been completely filled.

9. Pneumatic ejector plant for raising liquids comprising a pair of ejector vessels, a rotary air compressor of reversible type one side of which is connected to one of the said vessels and the other side of which is connected to the other of said vessels, motor means for driving the compressor in either direction, switch means operable to effect rotation of the motor in one direction, a second switch means operable to effect rotation of the motor in the other direction, float means in the vessels controlling the operation of said switches in accordance with the level of liquid in the vessels, and means for preventing operation of one of said switch means until the other switch means is in inoperative position.

HARRY BENTLEY.