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G. L. WALLACE ET AL

3,508,570

CONTROL SYSTEM FOR PNEUMATIC EJECTOR

Filed Aug. 6, 1968

2 Sheets-Sheet 1

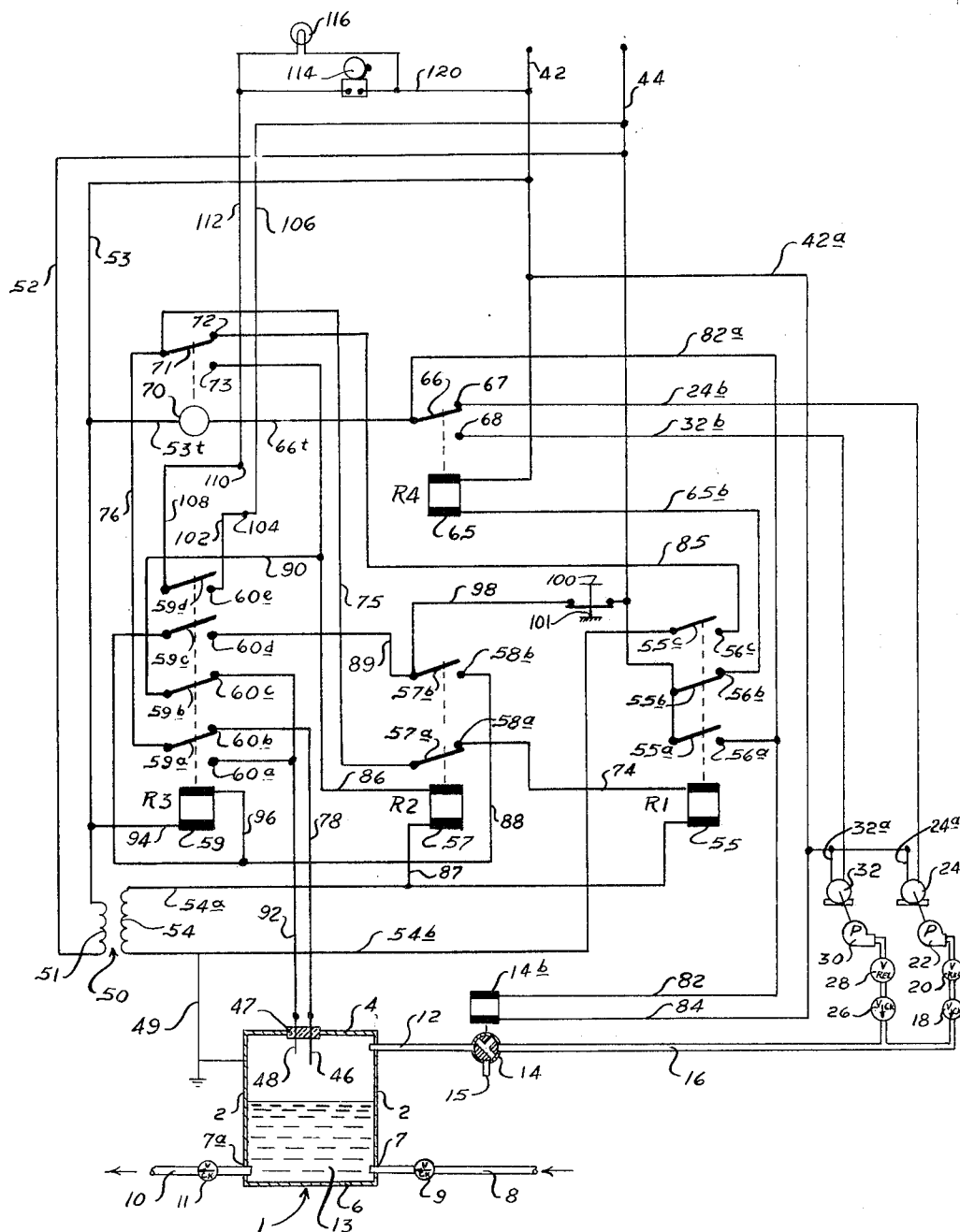


Fig. 1

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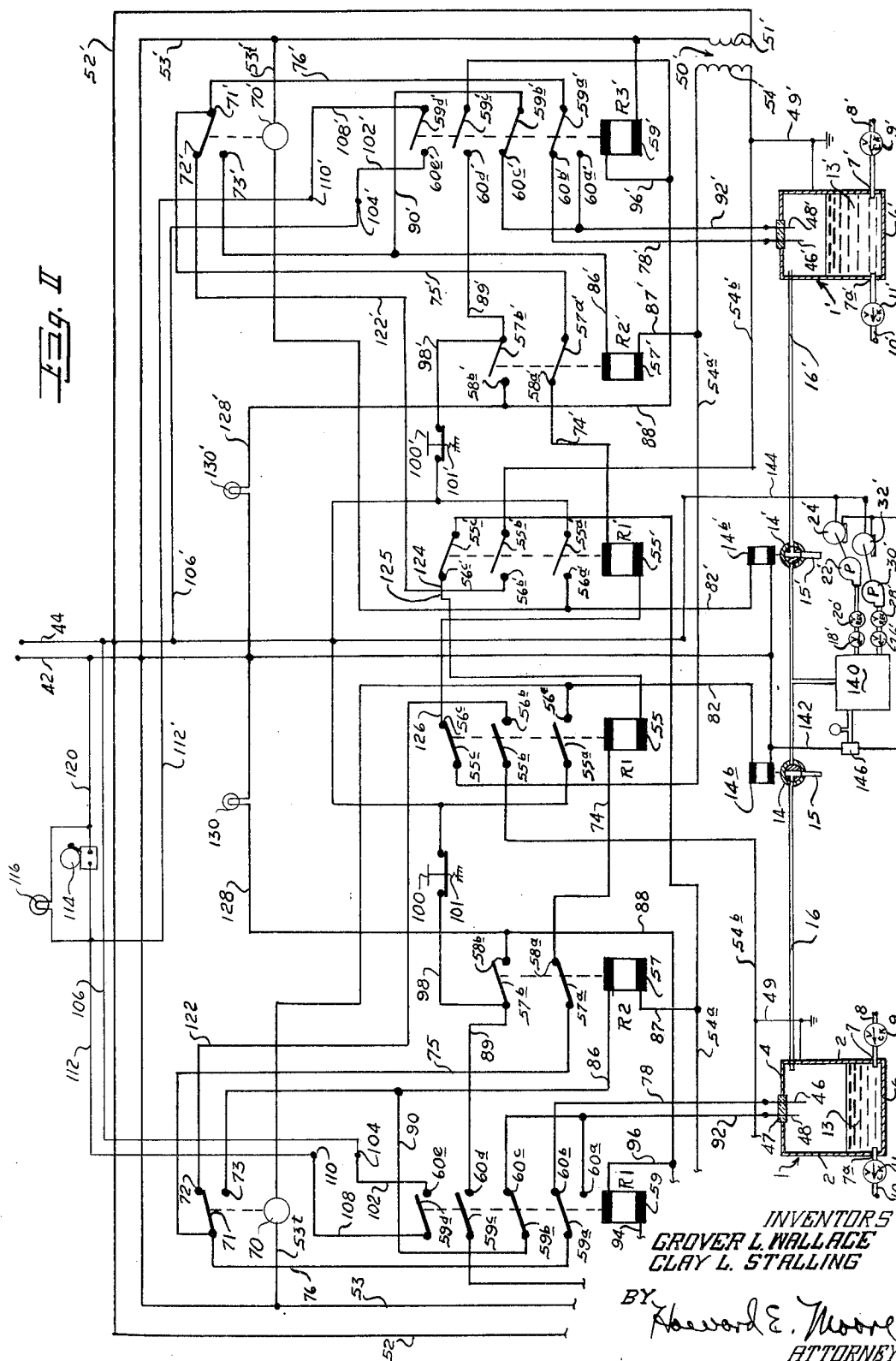
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CONTROL SYSTEM FOR PNEUMATIC EJECTOR
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U.S. Cl. 137—209

11 Claims

ABSTRACT OF THE DISCLOSURE

A control system for pneumatic ejectors wherein each receiver has a long electrode which normally generates a signal to connect the receiver to a source of compressed air to eject the contents thereof and a short electrode mounted therein to guard against compressor breakdown, a shorted electrode or insulated electrode.

BACKGROUND OF THE INVENTION

Sewage is a liquid composed of fluid suspended waste from such sources as domestic dwellings, commercial buildings and factories, together with any ground or surface water which may enter the sewerage system. The average composition of sewage is about 99% water, the solid parts being composed of grease, fats, animal and vegetable matter, both dissolved and undissolved and some inorganic matter. Since sewage is a foul liquid, it must be carried in watertight, underground conduit systems known as sewers.

If a sewerage line is very long, pumping stations are often necessary to keep the flow line near the surface of the ground to reduce construction costs so that the line will not have to be built at excessive depths.

Sewerage pumping stations generally consist of a receiver having an electrode mounted therein at the normal water line. When water from a lower line in the receiver reaches the electrode, compressed air is forced into the receiver forcing the water therefrom to a second sewerage pipe positioned above the elevation of a first sewerage pipe which is the inlet of the receiver.

Since sewage is waste water and polluted liquid filth, it is essential that pumping stations be of durable construction and extremely dependable.

The most common failure of pneumatic pumping stations results when a string or rag wraps around the electrode thereby shorting the electrode against the side of the receiver causing compressed air to be wasted because most systems continue to blow until the shorted electrode is corrected.

A second cause for failure of pneumatic pumping stations results when the air compressor becomes defective and fails to deliver compressed air to empty the receiver.

A third cause for failure of pneumatic pumping stations results when the electrode becomes insulated when foreign matter adheres to and builds up thereon.

SUMMARY OF THE INVENTION

We have developed an improved control system for sewerage pump stations utilizing a long electrode positioned in the receiver at the normal water line and a short electrode positioned above the normal water line. Under normal operating conditions only the long electrode will come in contact with water in the receiver.

The wiring arrangement of the control circuit is such that the air compressors will be energized by a signal through the short electrode if the long electrode becomes insulated or shorted. When the long electrode remains shorted it is automatically disconnected from the control circuit and an alarm is energized.

Two air compressors are provided one of which serves as a backup if the other malfunctions.

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It is, therefore, a primary object of the present invention to provide a control system for pneumatic ejectors which will prevent continuous operation of compressors in the event that the sensing electrode becomes shorted to ground.

Another object of the invention is to provide a control system for pneumatic ejectors which will automatically switch to a standby compressor if a first compressor fails to operate properly.

Another object of the invention is to provide a control system for pneumatic ejectors having two electrodes wherein the receiver will be ejected even though one of the electrodes is insulated or shorted.

A further object of the invention is to provide a control system with two electrodes wherein the receiver will be ejected even though one electrode remains shorted at the end of the ejection cycle.

Another object of the invention is to provide a control system utilizing dual compressors which are energized alternately under normal operating conditions to equalize wear.

A further object of the invention is to provide a control system for pneumatic ejectors adaptable for use with a plurality of receivers wherein the ejection controls for each receiver are interlocked electrically to prevent simultaneous ejection which would result in an exponential increase in a total dynamic head and extreme demands upon the air supply equipment.

A still further object of the invention is to provide a control system for pneumatic ejectors having an alarm to warn of a partial malfunction of the control circuit and in the case of dual receivers to point out which receiver has a partial malfunction.

A still further object of the invention is to provide a control system for pneumatic ejectors which is inexpensive to manufacture and install while presenting simplified efficient operations.

A still further object of the invention is to provide a control system for pneumatic ejectors adaptable for use with existing pump station equipment to increase the efficiency and durability thereof.

Other and further objects of the invention will become apparent upon reading the detailed specification herein-after following and by referring to the drawings annexed thereto.

DESCRIPTION OF THE DRAWINGS

The accompanying drawings of two preferred embodiments of the present invention are provided so that the invention may be better and more fully understood, in which:

FIGURE I is a wiring diagram of the control system shown in relation to a single receiver, and

FIGURE II is a wiring diagram of a second embodiment of the control circuit adapted for use with dual receivers.

Numerical references are employed to indicate the various parts as shown in the drawings and like numerals indicate like parts throughout the various figures of the drawings.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring to FIGURE I of the drawing numeral 1 generally designates a closed material receiving vessel or receiver pot which may be of any suitable configuration. However, in the particular embodiment shown in the drawing receiver 1 is a cylindrical vessel having side walls 2 closed at the upper end by top 4 and at the lower end by bottom 6. While receiver 1 may be constructed of any suitable material, an electrically welded steel receiver, hermetically sealed to prevent odor problems caused by

septicity; provides smooth interior walls free of obstructions that might interfere with the passage of solids.

An inlet line 8 having a check valve 9 therein extends through material receiving opening 7 in side wall 2 of receiver 1 providing a means for delivering sewage or other liquids to the receiver 1. Discharge line 10, having a check valve 11 therein, extends through material discharge opening 7a in a wall 2 of receiver 1 providing an outlet for removing sewage or other liquid from receiver 1.

It should be noted that inlet check valve 9 is arranged to allow liquid to pass through line 8 toward receiver 1 while discharge check valve 11 allows fluid to pass there-through away from receiver 1.

Fluid inlet 12 is positioned in an upper portion of receiver 1 communicating with the inside thereof. While any suitable means may be employed for delivering compressed air or other fluids to inlet 12 for forcing liquid 13 out of receiver 1 through discharge line 10, the particular embodiment illustrated in the drawing shows a two-way solenoid operated valve 14 allowing the inside of receiver 1 to be alternately connected to line 15 venting the inside of receiver 1 to atmosphere eliminating residual pressures during the filling cycle, or to line 16 which is in communication with a source of pressurized fluid to control air flow to the receiver during the ejection cycle.

Air line 16 is connected through check valve 18 and pressure relief valve 20 to an air compressor 22 driven by an electric motor 24. Line 16 is also in communication with a check valve 26, pressure relief valve 28 and air compressor 30 driven by motor 32. Check valves 18 and 26 are provided to assure that air which has been in contact with liquid in receiver 1 cannot reach air compressors 22 and 30.

Air compressors 22 and 30 may be of any suitable design and any number of stages may be provided allowing delivery of air through line 16 at any desired pressure. Pressure required in line 16 will vary from installation to installation, depending upon the head required to eject liquid 13 from receiver 1.

It is desirable to position inlet 12 adjacent electrode 46 and 48 (hereinafter described) to cause air to blow there-across during the ejection cycle to clear the electrodes.

Preferably air compressors 22 and 30 will be utilized alternately to eject liquid 13 from receiver 1 to equalize wear on said compressors while one compressor serves as a backup for the other if one of said compressors fails to function properly as will be hereinafter more fully explained.

Other accessories such as air storage tanks may be provided in line 16, if it is deemed desirable to do so, to adapt the means for providing pressurized fluid to specific installation requirements.

Motors 24 and 32, driving compressors 22 and 30 respectively, and solenoid valve 14 are energized through a timed switch or control circuit when liquid 13 in receiver 1 reaches the normal water line 40 therein to eject liquid 13 through discharge line 10.

The control circuit is connected through lines 42 and 44 to opposite terminals of any suitable source of electrical power.

The control circuit is connected to receiver 1 through a long electrode 46 and a short electrode 48, mounted in insulated electrode holder 47, and through grounded connector 49 as will be hereinafter more fully explained. If receiver 1 is constructed of material which is a conductor of electricity, grounded conductor 49 may be connected onto the wall of the receiver. However, if non-conductor material is utilized, conductor 49 may extend through the wall of receiver 1 to contact liquid 13 therein.

The control circuit consists of a transformer 50 and current responsive switching devices such as three-pole single throw relay R1, double-pole double throw relay R2, four-pole double throw relay R3, alternating single-

pole double throw relay R4, time delay relay 70, reset switch 100 and wiring associated therewith.

Transformer 50 has primary turns 51 having opposite ends thereof connected through lines 52 and 53 to lines 42 and 44 respectively which in turn are connected to a source of electrical power. Transformer 50 has secondary turns 54 having lines 54a and 54b connected to opposite ends thereof.

Although reference is made hereinafter to positive and negative terminals of the source of power, such reference is made merely for purposes of explanation and is not intended to restrict the use of the present invention to the use of direct current.

Grounded conductor 49 is connected to line 54b and to a wall 2 of receiver 1.

Relay R1 consists of a coil 55 magnetically coupled to switches 55a, 55b and 55c having movable poles and fixed contacts 56a, 56b and 56c. When coil 55 of relay R1 has no current flowing therethrough switch 55b is normally closed and engaging fixed contact 56b. When current passes through coil 55, thereby energizing same, switches 55a and 55c close, engaging fixed contacts 56a and 56c respectively while switch 55b is disengaged from fixed contact 56b.

Relay R2 consists of a coil 57 magnetically coupled to switches 57a and 57b having moveable poles and fixed contacts 58a and 58b. When coil 57 is not energized switch 57a and contact 58a are normally closed while switch 57b is normally open. When coil 57 or relay R2 is energized switch 57a is disengaged from contact 58a while switch 57b engages fixed contact 58b.

Relay R3 has a coil 59 magnetically coupled with switches 59a, 59b, 59c and 59d having moveable poles and fixed contacts 60a, 60b, 60c, 60d and 60e. When coil 59 of relay R3 is not energized switches 59a and 59b engage contacts 60b and 60c respectively while switches 59c and 59d are disengaged from contacts 60d and 60e. When coil 59 is energized poles 59a and 59b are moved away from contacts 60b and 60c respectively while poles 59a, 59c and 59d are moved to engage contacts 60a, 60d and 60e respectively.

Alternating relay R4 has a coil 65 magnetically coupled to switch 66 which is moved between fixed contacts 67 and 68. Each time coil 65 of the alternating relay R4 is energized, switch 66 switches from contact 67 to contact 68 or from contact 68 to contact 67.

Time delay relay 70 is operably connected to switch 71 for moving said switch between fixed contacts 72 and 73. When current is provided to time delay relay 70 the timer is set whereby switch 71 will be moved from a normally closed position in engagement with contact 72 at the end of the ejection cycle to momentarily engage contact 73 and then return to the normally closed position at contact 72.

Line 54a connected to secondary turns 54 of transformer 50 is connected to one end of coil 55 of relay R1. The other end of coil 55 is connected to the long electrode 46 positioned in receiver 1 through line 74, contact 58a, switch 57a, line 75, line 76, switch 59a of relay R3, contact 60b and line 78.

It should be readily apparent that when liquid 13 rises to normal water line 40, thereby engaging the long electrode 46 a circuit will be completed from the long electrode 46 through coil 55 of relay R1 thereby energizing said relay closing normally open switches 55a and 55c and opening the normally closed switch 55b.

Switches 55a and 55b of relay R1 are connected through line 44 to one terminal (for example the positive terminal) of a source of electrical power. Fixed contact 56a is connected by line 82 to coil 14b of solenoid operated valve 14. The other end of coil 14b is connected through line 84 to branch lines 24a and 32a connected to the windings of motors 24 and 32 respectively and through lines 42a and 42 to the source of electricity. The opposite side of the windings of motors 24 and 32 are connected

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through lines 24b and 32b respectively to fixed contacts 67 and 68 respectively of alternating relay R4. Switch 66 of alternating relay R4 is connected through line 66t to timer 70.

The conventional activating mechanism of timer 70 is connected through line 53t to line 53 and consequently through line 42 to the negative terminal of the source of power. The opposite side of the timer setting mechanism is connected through lines 66t and 82a to normally open contact 56a of relay R1.

The coil 65 of alternator relay R4 is connected through line 65b to contact 56b of relay R1.

Referring to FIGURE I of the drawing, it should be readily apparent that when liquid 13 contacts long electrode 46, coil 55 of relay R1 will be energized, thereby closing switches 55a and 55c and opening switch 55b as hereinbefore explained.

When switch 55a of relay R1 is closed a circuit is completed from the negative terminal of the source of power through line 42, line 53, line 53t, through the actuating mechanism of timer 70, through line 66t, line 82a, contact 56a, switch 55a, through line 44 to the positive terminal of the source of power. Closing the circuit sets timer 70, causing current to pass through a holding circuit to maintain relay R1 in the energized condition for a previously determined interval. The holding circuit is a loop from switch 55c of relay R1 through line 85, contact 72 and switch 71 of timer 70, line 75, switch 57a of relay R2, line 74, coil 55 of relay R1, line 54a, secondary turns 54 of transformer 50, line 54b to switch 55c. The holding circuit is broken, de-energizing relay R1, when switch 71 of timer 70 moves to the normally open position.

When relay R1 is activated closing switch 55a, a circuit is made from the negative terminal of the source of power to line 42, line 42a, line 84 through coil 14b, through line 82, switch 55a, line 44 to the positive terminal of the source of power. Current through coil 14b causes valve 14 to be switched from the vent position, thereby connecting inlet 12 with air line 16.

A circuit is also completed through either compressor motor 24 or compressor motor 32, depending upon the position of switch 66 in alternating relay R4. When switch 66 engages contact 67, a circuit is completed from the negative terminal of the source of power through line 42, line 42a, line 24a, through the winding of motor 24, line 24b, contact 67, switch 66, line 82a, switch 55a of relay R1, to line 44 connected with the positive terminal of the source of power.

Current through motors 24 or 32 and through coil 14b of solenoid valve 14 causes compressed air to flow through line 16, through valve 14, to inlet 12, thereby forcing the contents of receiver 1 through discharge 10. The duration of the ejection cycle is determined by timer 70, for example, 30 seconds. When the period for the ejection cycle elapses, switch 71 opens contact 72 and the holding circuit through coil 55 of relay R1 and consequently circuits through motor 24 or 32 and coil 14b are broken when switch 55a of relay R1 opens thereby causing solenoid operated valve 14 to revert to the vent position.

When coil 55 of relay R1 is energized, during the ejection cycle, switch 55b is open. When coil 55 is deenergized pole 55b reverts to its normally closed position, engaging contact 56b and sending current through line 65b to the coil 65 of alternating relay R4 causing switch 66 to move to contact 68 thereby routing current for the next ejection cycle through motor 32.

Normally open contact 73 of timer 70 is connected to a failure sensing back-up circuit including line 86 connected to one side of coil 57 of relay R2. The other side of coil 57 is connected through line 88, line 54a and line 49 to ground.

At the end of each ejection cycle timer 70 causes switch 71 to shift momentarily to contact 73, thereby connecting long electrode 46 with the failure sensing circuit

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to see if liquid 13 has been ejected from receiver 1. If long electrode 46 is shorted to ground through liquid 13 or any conductible foreign matter, current through switch 71, contact 73, line 86, coil 57 of relay R2 will energize said coil, causing switch 57a to open and 57b to close momentarily.

Opening switch 57a of relay R2 breaks the circuit holding relay R1 in the energized condition.

Contact 58b is connected through line 88 to switch 59c of relay R3 and through line 96 to coil 59 of relay R3. Contact 60d of relay R3 is connected through line 89 to switch 57b of relay R3. Contacts 60a and 60c are connected through lines 92 to short electrode 48.

One end of coil 59 of relay R3 is connected through line 94, line 53, line 42, to the negative terminal of the source of power. The other end of coil 59 of relay R3 is connected through line 96 to line 88, connecting contact 58b of relay R2 and switch 59c of relay R3. Line 44, connected to the positive terminal of the source of power, is connected through line 98 to switch 57b of relay R2. A pushbutton reset switch 100 positioned in line 98 is maintained in the normally closed position by a spring 101 or any other suitable means.

Closing switch 57b of relay R2 energizes the coil 59 of relay R3 through lines 88 and 96 thereby closing switch 59c to energize a holding circuit from line 44, reset switch 100, line 98, line 89, switch 59c, line 88, line 96, coil 59 of relay R3, line 94, line 53 to line 42. Relay R3 is held in the energized condition until the holding circuit is broken by opening reset switch 100 at which time the long electrode 46 is reconnected to the control circuit as switch 59a of relay R3 closes.

Contact 60e of relay R3 is connected through line 102 to terminal 104 which is in turn connected through line 106 to line 44 connected to the positive terminal of the source of power. Switch 59d is connected through line 108 to terminal 110 which is in turn connected through line 112 to any suitable alarm device such as a bell 114, incandescent light 116 or remote equipment (not shown) over land lines or radio. The alarm device is connected through line 120 to line 42 which is connected to the negative terminal of source of power. It should be readily apparent that when switch 59d is closed a circuit is completed from the negative terminal of source of power through the alarm device to the positive terminal of the source of power, causing the alarm device to be actuated.

From the foregoing it should be readily apparent that when liquid 13 rises to the normal water line 40 a circuit will be completed from a long electrode 46 through contact 60b of relay R3, through contact 58a of relay R2, through coil 55 of relay R1, through line 54a and 49 to ground. When coil 55 of relay R1 is energized a circuit is completed from the negative terminal of the source of power through timer 70, switch 55a of relay R1 to line 44 to the positive terminal of source of power, thereby causing timer 70 to be set.

Setting timer 70 allows current to flow from the negative terminal of the source of power through line 42, line 42a, line 24a, through the winding of motor 24, through line 24b, contact 67, switch 66 of relay R4, through line 82a, switch 55a of relay R1 and line 44, to the positive terminal of the source of power. Simultaneously, a circuit is completed from the negative terminal through line 42, line 42a, line 84, through coil 14b of solenoid operated valve 14, through lines 82, switch 55a, line 44 to the positive terminal of the source of power. Current will flow through the winding of motor 24 and coil 14b of solenoid valve 14 for the duration of the timed ejection cycle, causing compressed air to flow from air compressor 24 through line 16 through solenoid valve 14 to eject contents of receiver 1.

When the ejection cycle has elapsed switch 71 of timer 70 will switch momentarily to contact 73, thereby completing a circuit from long electrode 46 through contact 60b, contact 73, line 86, coil 57 of relay R2, line 87,

line 54a, line 49 to ground. If long electrode 46 is grounded through liquid 13 when pole 71 engages contact 73, coil 57 of relay R2 will be energized opening switch 57a and closing switch 57b. When switch 57a is opened the circuit is broken from long electrode 46 to coil 55 of relay R1, thereby de-energizing coil 55 causing switches 55a, 55b and 55c to revert to the relaxed position.

As switch 57b of relay R2 is closed a circuit is completed energizing and holding relay R3 as hereinbefore explained.

Closing switch 59d with contact 60e completes the circuit through alarm device 114 or 116 as hereinbefore explained. The alarm remains energized until reset switch 100 is opened thereby breaking the holding circuit.

When switch 59a of relay R3 is switched from contact 60b to contact 60a, long electrode 46 is disconnected from the circuit and short electrode 48 is connected through line 92, switch 59a to line 76. When long electrode 46 is disconnected and short electrode 48 is connected to the circuit, liquid 13 is ejected from receiver 1 in exactly the same manner as hereinbefore described except that the signal is delivered from short electrode 48 to energize coil 55 of relay R1 for setting timer 70 and energizing motors 24 and 32 alternately to deliver compressed air through solenoid valve 14 to receiver 1.

From the foregoing it should be readily apparent that we have developed a control system for pneumatic ejectors having two air compressors which are normally energized by a signal from long electrode 46, causing the contents of receiver 1 to be ejected. If long electrode 46 is fouled and remains grounded at the end of a measured ejection cycle, the long electrode 46 is disconnected from the circuit and motors 24 and 32 are energized alternately by signals through short electrode 48.

Therefore, it should be readily apparent that the control system which we have developed insures against malfunction of receiver 1 due to compressor failure. The ejector will also continue to operate even though long electrode 46 is shorted.

It should also be noted that the control system will continue to operate even though long electrode 46 is insulated or broken. If long electrode becomes insulated by accumulation and hardening of foreign matter thereon, continued rising of liquid 13 in receiver 1 will ground short electrode 48, thereby delivering a signal through line 92, contact 60b of relay R3, line 90, line 86, coil 57 of relay R2, line 87, line 54a, line 49 to ground. Actuation of relay R2 actuates relay R3, thereby sounding alarm 114 while routing a signal from short electrode 48 to motor 24 and solenoid valve 14 as hereinbefore explained.

DESCRIPTION OF A SECOND EMBODIMENT

To increase the capacity of an ejector station, duplex receivers are often utilized. The second embodiment, illustrated in FIGURE II of the drawing, utilizes two separate sewage receivers 1 and 1' which operate alternately and independently, permitting twice the flow of the simplex unit heretofore described. The ejection controls are interlocked electrically to prevent simultaneous ejection which would result in an exponential increase in the total dynamic head and extreme demands upon the air supply equipment.

Each receiver 1 and 1' has two electrodes 46, 46' and 48, 48' positioned therein.

The electrical control system for operating each ejector consists of two circuits of the type hereinbefore described with respect to the first embodiment with minor changes in the wiring thereof.

Alternating relay R4 together with switch 66 and fixed contacts 67 and 68 have been removed from the circuit. Lines 66i, 82a, 32a, 32b, 24a, 24b, have also been removed from the circuit together with line 65b.

Elimination of alternator relay R4 frees switch 55b and fixed contact 56b, allowing line 54b to be connected

between switch 55b and the secondary winding 54 of transformer 50. Line 122 connects fixed contact 72 of timer 70 and contact 56b of relay R1. When switch 55b is closed coil 55 of relay R1 is held in the energized condition as will be hereinafter explained.

Line 54a is connected between the secondary turns 54 of transformer 50 through switch 55c' of relay R1' to coil 55 of relay R1 through line 125.

Line 54a' extends between secondary turns 54' of transformer 50' through switch 55c of relay R1, line 126 to coil 55' of relay R1'.

Shorting long electrode 46' in receiver 1' sends a signal through 78', switch 59a', of relay R3', line 76' line 75' switch 57a' of relay R2', line 74', coil 55' of relay R1', line 126, switch 55c of relay R1, line 54a', secondary turns 54' and line 49' to ground, thereby completing a circuit actuating relay R1'.

When switch 55b' is closed, relay R1' is held in the energized position through a holding circuit comprising line 122', switch 71', line 75', switch 57a', line 74', coil 55' of relay R1', line 126, switch 55c of relay R1, line 54a', secondary windings 54', line 54b', switch 55b', thereby holding relay R1' in the energized position until the holding circuit is broken when timer 70' momentarily moves switch 71' to the normally open position, contact 73'.

It should be readily apparent that relay R1 cannot be energized while relay R1' is in the energized condition because switch 55c' is open when relay R1' is energized. Therefore, a circuit cannot be completed to energize relay R1 until relay R1' is de-energized.

Since the interlocking circuitry prevents a given receiver from ejecting during the operation cycle of the other, a false signal on one electrode would render both units inoperable and allow air to exhaust continuously except that switches 59a and 59a' disconnect the shorted electrode at the end of the timer cycle, thereby switching a receiver which has the shorted electrode to short electrode 48 or 48' causing the control circuit to operate from a secondary signal.

Terminal 104' is connected through line 106' to line 44 connected to the positive terminal of the source of power. Terminal 110' of the alarm circuit is connected through line 112' to line 112 to sound the alarm 114 or 116 when switch 59d' of relay R3' is closed.

Line 28 is connected between fixed contact 58b of relay R3 through a pilot light 130 to line 42 connected to the negative terminal of the source of power. Line 128' is connected through pilot light 130' to connect contact 58b' of relay R2' to line 42. Pilot light 130 is burning when relay R3 is energized. Pilot light 130' is burning when relay R3' is energized.

When duplex receivers 1 and 1' are utilized, it is desirable to use an air storage tank 140 in line 16 connecting air compressors 30 and 32 through valves 14 and 14' to the inside of receivers 1 and 1'.

Air compressor motors 24' and 32' are not connected to the control circuit in the particular embodiment illustrated in FIGURE II. Line 142 is connected to line 42 which is connected to the negative terminal of the source of power while line 144 is connected through pressure switch 146, which is closed when pressure in storage tank 140 drops below a desired level, to the positive terminal of the source of power.

Air storage tank 140 is used to supply a reservoir of air and to equalize the pulsations in the air coming from the compressor.

Operation of the duplex control system is as follows:

Liquid 13 rises in receiver 1 to long electrode 46, completing a circuit to ground and energizing relay R1. Relay R1 actuates solenoid valve 14 and air under pressure, from a separate air supply system, is introduced to receiver 1, ejecting the contents for a preset time interval controlled by timer 70. Upon termination of the timer cycle, relay R1 is de-energized, returning solenoid oper-

ated valve 14 to the vent position, allowing receiver 1 to fill.

When the interlock contacts 55c of relay R1 are closed, the second receiver 1' can eject.

If electrode 46 is shorted to ground and remains in this state beyond the normal time cycle, timer contacts 71 are momentarily placed in the normally open position, causing current to flow momentarily through relay R2, energizing relay R3 which holds in this condition and places the system in the alarm mode.

When the system is in the alarm mode, alarm contact 59d of relay R3 is closed to activate external warning 114 and 116 which will remain "on" until reset button 100 is manually disconnected. Simultaneously a panel mounted warning indication, pilot light 130, is activated to identify the offending unit.

Relay R3 also switches to short electrode 48, causing the system to operate off of the secondary signal through the short electrode 48 until long electrode 46 has been cleared and the system reset for normal operation.

At the end of the time cycle the momentary change from normally closed to normally open position of switch 71 of timer 70 interrupts the interlock contact 55c of relay R1, permitting receiver 1' to eject if there is a signal on electrode 46' or 48'.

If long electrode 46 is insulated, rising liquid causes no signal to pass through line 78. The liquid level will continue to rise until short electrode 48 is shorted to ground, thereby routing current through line 92, switch 59b, line 90, line 86, to energize coil 57 of relay R2. As heretofore explained, activation of relay R2 activates relay R3.

When relay R3 is energized, operation is the same as heretofore described and short electrode 48 acts as the primary signal source until reset switch 100 is manually reset.

The cycle of operation of receiver 1' is the same as that for receiver 1.

From the foregoing it should be readily apparent that we have developed an improved control system for pneumatic ejectors which includes backup circuitry for overcoming the most common malfunctions of pneumatic ejectors operated by a signal from an electrode. The improved ejector system will continue to operate even though the long electrode is fouled by shorting or by becoming insulated. The improved control system will also continue to function even though one compressor becomes defective.

An alarm device is provided to warn of a partial malfunction of the system whereby the defect may be discovered and corrected when periodic inspections are conducted.

The improved control system is adaptable for use with a single receiver or with duplex receivers and may be installed quickly and simply in existing pneumatic ejector systems to increase efficiency and reliability. It should be readily apparent that the control system is a completely self-contained, compact, plug-in unit requiring only seconds to replace.

The improved control system is very simple and inexpensive to construct and install and requires minimum maintenance.

While the description has been directed to pneumatic ejector pump stations for use in sewage systems, it should be readily apparent that the control system is adaptable for use in numerous systems for triggering a desired operation in response to a change in liquid level. The control system is a timed switch with an overtime alarm and level sensor for use as a fluid material control in storage tanks, supply lines, cisterns, wells, sewage systems, refineries, or food processing plants.

Having described our invention, we claim:

1. A fluid material control comprising a closed receiver; a material receiving opening in said receiver; conduit means connected to a source of material adapted to

deliver material through the opening to the inside of said receiver; a discharge opening in said receiver; a pressure fluid inlet to said receiver; a source of pressurized fluid; a vent communicating with the atmosphere and the receiver; valve means adapted to alternately connect the pressure fluid inlet with the vent and the source of pressurized fluid, the said valve means being adapted to connect the inside of the receiver to the vent during the fill cycle and being adapted to close the vent and connect the inside of the receiver to the source of pressurized fluid during the ejection cycle; first material sensing means disposed inside the receiver; second material sensing means disposed inside the receiver; a first timing circuit connected to the first material sensing means, said circuit being adapted to actuate the valve means to connect the inside of the receiver with the source of pressurized fluid and close the vent when material in the receiver contacts the material sensing means; timer actuated switching means in the timing circuit adapted to open said circuit after a predetermined time ejection cycle; a failure sensing circuit associated with said timer actuated switching means; current responsive switching means in said failure sensing circuit, said current responsive switching means being adapted to disconnect the first material sensing means from the first timing circuit and being further adapted to connect the second material sensing means to the first timing circuit, if electrical current is flowing through said first timing circuit at the end of the timed cycle, thereby causing the second material sensing means to actuate the valve means to connect the inside of the receiver with source of pressure fluid and close the vent when material in the receiver engages said second material sensing means.

2. The combination called for in claim 1 with the addition of an alarm energized by the failure sensing circuit, said alarm being energized when the second material sensing means is connected to the first timing circuit.

3. The combination called for in claim 1 with the addition of a second source of pressurized fluid, and means in the first timing circuit adapted to alternately connect the first and second source of pressurized fluid with the inside of the receiver in successive ejection cycles.

4. The combination called for in claim 1 wherein the second sensing means is positioned at a higher elevation in the receiver than the first sensing means and the first and second sensing means are connected to the first timing circuit, whereby the second material sensing means will actuate the valve and actuate the alarm when material in the receiver engages the second material sensing means.

5. The combination called for in claim 1 wherein the valve means is a solenoid operated valve; and with the addition of a current responsive relay in the first timer circuit; a normally open switch in a line between the solenoid operated valve and a source of power; a coil in the first timing circuit magnetically coupled with said switch adapted to close the switch when electrical current is routed through said coil, said solenoid operated valve being adapted to connect the inside of the receiver to vent when the coil of the current responsive relay is de-energized and to connect the inside of the receiver to the source of pressurized fluid when the current responsive relay is energized.

6. The combination called for in claim 5 with the addition of means connectable to the coil of the relay for holding the current responsive relay in energized condition for a predetermined period of time.

7. The combination called for in claim 6 with the addition of a second current responsive relay; a normally open switch and a normally closed switch in said second relay; the first timing circuit being connected through the normally closed switch and the failure sensing circuit being routed through the normally open switch; a coil in the second relay magnetically coupled with the said switches adapted to be momentarily connected to the first timing circuit after the expiration of the predetermined time of the ejection cycle.

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8. The combination called for in claim 7 wherein the coil of the second relay is connected to the second material sensing means to route current through the failure sensing circuit when material in the receiver engages the second material sensing means.

9. The combination called for in claim 8 with the addition of a third current responsive relay in the failure sensing circuit; normally open switches and normally closed switches in the third relay; a coil magnetically coupled with said switches, said coil being connected to the normally open contacts of the second relay; a holding circuit connected to a first normally open switch of the third relay and the coil of the third relay, said holding circuit being adapted to maintain the coil of the third relay in an energized condition when the coil of the second relay is de-energized; a reset switch in the holding circuit adapted to break the holding circuit when an external force is applied to said reset switch; a second normally open switch of the third relay being connected between the alarm and a source of electricity; a third normally open switch being connected between the second material sensing means and the first timing circuit; a first normally closed switch being connected between the first material sensing means and the first timing circuit; and a second normally closed switch being connected between the second material sensing means and the coil of the second relay; whereby the coil of the third relay is energized, the first material sensing means is disconnected from the first timing circuit, and the alarm remains energized if the first material sensing means is shorted at the end of the ejection cycle or if material in the receiver engages the second material sensing means.

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10. The combination called for in claim 1 with the addition of a second closed receiver; a material receiving opening and a discharge opening in the second receiver; a fluid inlet in said second receiver; second valve means for connecting the source of pressurized fluid to the inside of the second receiver; third and fourth material sensing means disposed inside the second receiver; a second timing circuit connectable between the third and fourth material sensing means and the second valve means for connecting the source of pressurized fluid to the inside of the second receiver; a second failure sensing circuit connectable to the third and fourth material sensing means and to the alarm; wherein the first and second timing circuits are electrically interlocked to prevent simultaneous actuation of the first and second valve means for connecting the inside of the first and second receivers to the source of pressurized fluid.

11. The combination called for in claim 10 with the addition of a pilot light in each failure sensing circuit to designate which receiver has a partial malfunction when the alarm is energized.

References Cited

UNITED STATES PATENTS

3,155,049 11/1964 Mandelbaum ----- 137—392 X

ALAN COHAN, Primary Examiner

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137—392