May 26, 1959 G. F. LYTLE 2,887,849

VACUUM CONTROL LIFTING APPARATUS

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FIG. 1.

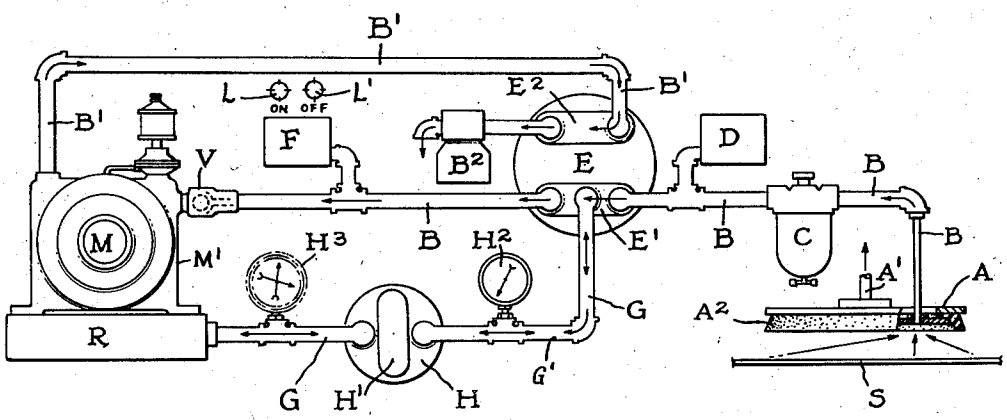


FIG. 2.

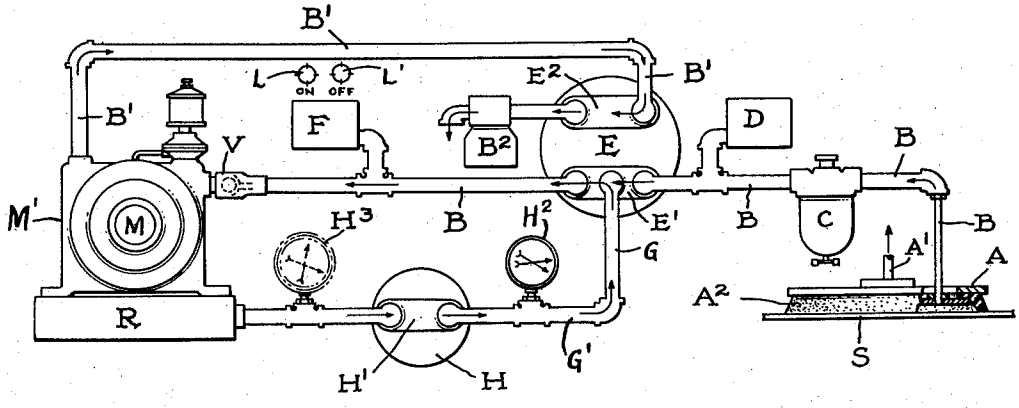
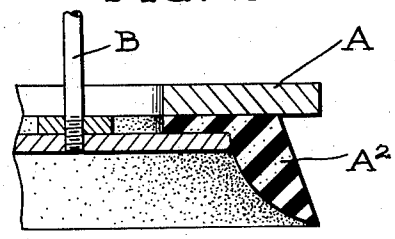


FIG. 2a.



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FIG. 3.

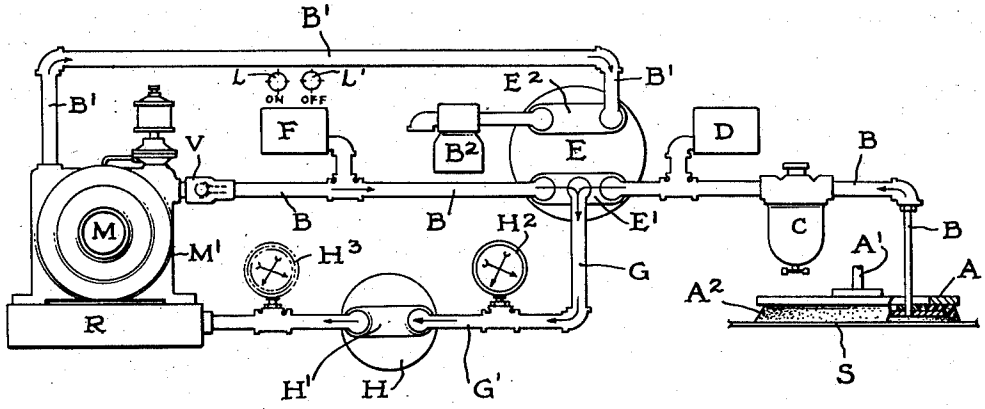
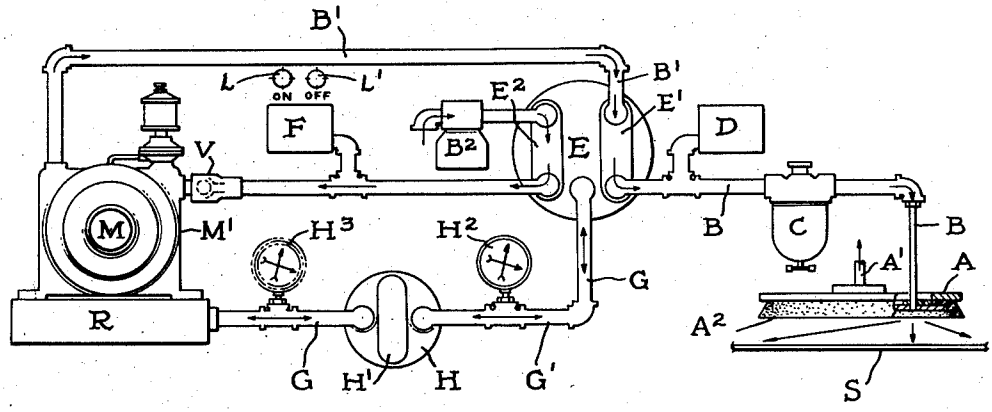


FIG. 4.



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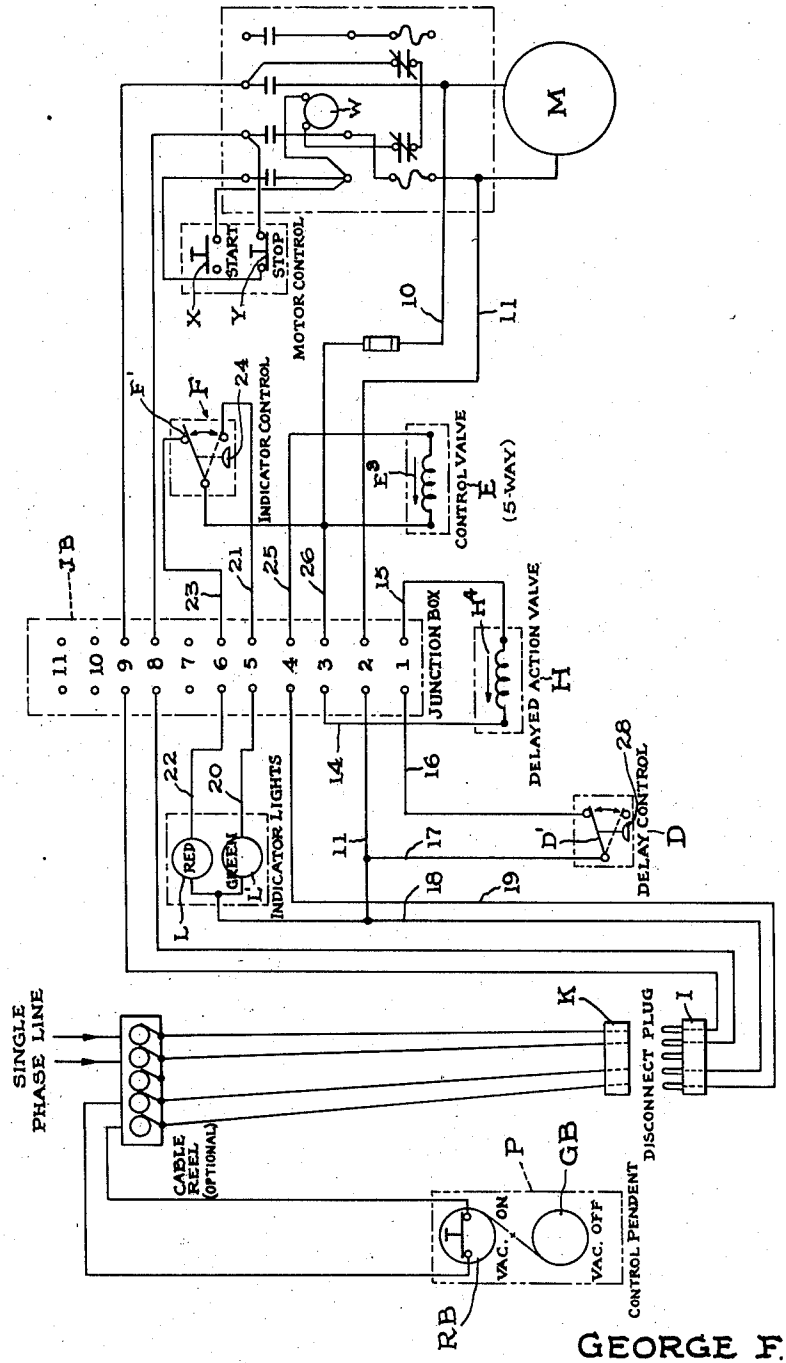


FIG. 5.

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VACUUM CONTROL LIFTING APPARATUS

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Application March 22, 1957, Serial No. 647,794

6 Claims. (Cl. 60—60)

This invention relates to stationary or mobile vacuum controlled lifting apparatus having the capacity to lift, transport, and selectively deposit metal sheets, or any non-porous material either in flat or irregular shapes.

In operations of this type it is essential that little or no time be lost in picking up the object to be transported. To provide maximum efficiency, the vacuum or suction pad or pads should adhere to or grip the object to be lifted at the instant of contact. To insure such efficiency a source of reserve vacuum supply should be maintained to safeguard operations against either lack of operators skill or power failure.

For example, if the operator is inexperienced or careless in handling the push button controls and activates them too soon before the lifting pads make contact, the time of attachment is prolonged until the necessary degree of vacuum builds up to effect the desired grip. This delay, due to inefficient handling may reach the point where speed of operation is materially reduced and the pick-up and transfer is unacceptably slowed down because the reserve tank is filled with air which must be evacuated along with the rest of system before lift can be consummated. Also, in the event of a power failure, safety considerations require that the suction on the object being lifted or transported be continued over a period of time which will enable the object to be held or gripped until safely deposited.

Accordingly, a primary object of the present invention is to remedy the foregoing conditions by providing means which assure the proper functioning of the apparatus through the use of an automatically controlled vacuum reserve supply. That is to say, the present invention provides a system which, in addition to a primary push button controlled five-way solenoid actuated valve also has a two-way automatic pressure responsive solenoid actuated valve in the suction line between the system proper and a vacuum reserve supply tank. In use, the reserve tank is blocked off during all operations and at all times when the suction pads are not in contact with the object or material to be handled. A predetermined setting permits the reserve tank valve to open immediately after a sufficient degree of vacuum has been attained thereby opening the reserve tank to the system. This condition exists until the push button control is operated to release the material at which time the reserve valve immediately closes to hold or maintain the vacuum constant in the reserve tank. The safety factor of the delayed action reserve portion of the system is in no way impaired because during "on vacuum" the tank is open to the system. Likewise, if power failure should exist, the valve would immediately open or remain open as the case may be, thereby permitting the reserve vacuum in the tank to be instantly available to maintain lift.

With the above and other objects in view which will more readily appear as the nature of the invention is better understood, the same consists, in the novel construction, combination, and arrangement of parts hereinafter more fully described and claimed.

A preferred and practical embodiment of the invention is shown in the accompanying drawings, in which:

Fig. 1 is a diagrammatic view illustrating the system when the vacuum is on but a seal has not yet been established with the object or material to be lifted, the electrically operated solenoid valve being shown in its normal or first position as it also appears in Figs. 2 and 3.

Fig. 2 is a diagrammatic view similar to Fig. 1 showing the so-called "vacuum-on" condition where a seal has been established between the lifting pad and the material or object.

Fig. 2[a] is a fragmentary detail view of one of the suction pads used in the system.

Fig. 3 is a diagrammatic view illustrating conditions in the system where the suction pad is in sealing contact with the material or article, and also where there has been a power failure, in which event the reserve tank is in communication with the suction line to hold the material or object to be lifted, the check valve adjacent the motor-pump being closed.

Fig. 4 is a diagrammatic view showing the condition of the system where the solenoid controlled five-way valve has moved to its second position where it has opened the primary suction line to the atmosphere to release the article, and the secondary line to the reserve tank is blocked off both at the five-way valve and the two-way valve.

Fig. 5 is a diagrammatic view of the electrical control circuit.

Similar reference numerals designate corresponding parts throughout the several figures of the drawing.

Referring to Fig. 1, it will be seen that the lifting pad designated generally as A may be connected as at A′ to a dirigible boom or the like in the conventional manner of a hoist and communicates with the primary suction line B.

The pad A is preferably of the type shown in Fig. 2[a] wherein the body is provided with a sealing ring A^2 of soft rubber having a feathered contact edge to engage the article with a quick seal. This pad is intended to cooperate with an article to be lifted or transported, such for example, as the impervious sheet S or any irregular shaped object such as pipe, drums, etc.

The primary suction line B is connected through a check valve V with vacuum motor driven pump M of conventional type contained within the housing M′. The housing M′ also preferably contains a reserve tank R. The valve V is normally open to the pump but closes in the event of power failure, as in Fig. 3, so that there is no chance of the reserve vacuum supply being connected with the exhaust line B′.

The primary suction line B between the pad A and the motor M is in communication with an air filter C, a delayed action control valve D, a five-way manually controlled solenoid actuated valve E and an indicator control device F through its passage E′. The indicators are lamps L and L′, respectively, red for "off vacuum" and green for "on vacuum." These lights L (red) and L′ (green) are responsive only to the indicator pressure switch or control F and not the manual switch buttons RB and GB and the green light L′ is turned on when 20 inches of vacuum exists in the circuit, the red light L being turned on by reduction of the vacuum in the system below fifteen inches of vacuum. This relates only to the circuit proper or primary circuit and has no connection with the reserve section which maintains a constant 25 to 28 inches of vacuum. The structural details of these devices are conventional and will, therefore, not be described in detail, since only their functions are important here.

The exhaust line B′ of the motor driven pump M communicates with a muffler B^2 through the passage E^2 of the main five-way valve E. The valve E is controlled by push-button GB and RB on the pendant P. It will of

course be understood that the outlet end of the exhaust line B' is in communication with the atmosphere.

The five-way valve E has its passage E' communicating with a reserve pipe line G which leads to the reserve tank R through a main automatic pressure responsive reserve solenoid shut-off valve H having a single passage H'. At either side of the said valve suitable vacuum gauges H^2 and H^3 are provided. The gauge H^2 will show the degree of vacuum in line G when the vacuum is "on" during normal operations, but, when the main automatic valve H has its passageway H' in closed position (as in Fig. 1) the gauge H^3 will show the degree of vacuum in the reserve tank R since the valve blocks off the reserve tank under the conditions of Figs. 1 and 4.

The operational phases of the apparatus are as follows:

Referring more particularly to Fig. 1 illustrating a condition where the vacuum or suction is "on" and the seal has not yet been established with the article S for various reasons, the following conditions exist in the system: the primary suction line B is in direct communication with the motor driven vacuum pump M through valve V and the automatic solenoid valve H blocks the reserve line G. Suction is established from pad A through line B, passage E' to the pump M and air is exhausted through line B' to the atmosphere through the passage E^2 of valve E.

As soon as the seal is established between pad A and article S (Fig. 2) the automatic reserve solenoid actuated valve H is automatically turned in a manner described later so that its passage H' establishes communication between the reserve tank R through line G to the passage E' of the five-way valve E. In other words, the motor driven pump M is then inducing vacuum conditions throughout all of the system including line B and line G. In this way the article or material S is held together and air is being exhausted from the reserve tank to create the desired degree of vacuum in said tank and which will show up on gauges H^2 and H^3 in Fig. 2. The gauge H^2 gives a reading of the degree of vacuum in line G at all times while gauge H^3 may do the same under certain conditions. However, when passage H' of valve H is closed as in Figs. 1 and 4, the gauge H^3 only shows the degree of vacuum in the reserve tank.

In Figs. 1, 2 and 3, it will be observed that the primary control valve E occupies a position wherein the passage E' establishes communication between the primary suction line B and the pad.

However, in Fig. 4, where the system is in a condition that the vacuum to the pad is off, to release the load the control valve E is turned through an angle of 90° as compared with Figs. 1–3 so that, compressed air from the back of pump M is being forced through line B', passage E' and part of line B to effect positive release of the article S. Actually there is as much as forty pounds of compressed air to effect positive article release. Thus, the pad A is more than put in direct communication with the atmosphere through the pipe B', the check valve V and that portion of the primary suction line B leading to passage E'. In this phase of operation it will also be understood that the reserve valve H is cut off from the primary suction line not only because that portion of reserve line G including gauge H^3 is closed, but, also because passage E' of the automatic valve E is out of registry with the inlet portion of line G so that the vacuum will be retained in the reserve tank.

In other words, in Fig. 4, which shows the main valve E in its second position, as when the vacuum is cut off to release the load or article S, the reserve line G is blocked or closed to preserve the desired degree of reserve vacuum in tank R. This condition exists because reserve valve H turns 90° so that passage H' does not connect the portion G' with the rest of the line G.

In Fig. 2 when the pad is in contact with the article, vacuum is being restored continuously to tank R. Its degree is sufficient to last up to three hours or more of operation when there is a power failure and the article is being held to the pad A as indicated in Fig. 3.

Referring more particularly to Fig. 3 to further explain a situation where there is a power failure, and current is cut off to the motor M, it will be seen that the check valve V automatically closes the line B adjacent the vacuum pump M while the passage E' of the five-way valve E continues to establish communication with the reserve tank R through the line G and passage H' of automatic solenoid controlled valve H. The vacuum in the reserve tank will therefore continue to exert its influence on the article S through the line G, a portion of passage E' of valve E and that part of the primary suction line including the delayed action control device D, filter C and the pad A.

It will be understood that the motor-pump M operates continuously while the system is in use and the lifting and release of the article S is controlled by an operator who ordinarily holds in one hand the pendant P, which includes a red push button RB and a green push button GB. These buttons are in circuit with a conventional cord having an electrical receptacle K intended to detachably connect with the plug element I and selectively control the position of the solenoid valve E to "vacuum-off" and "vacuum-on" positions and their respective signal lamps L and L'.

The valve E is solenoid actuated and is controlled solely by the push-buttons GB and RB. The pressure controls F and D are motivated by line condition responsive elements **24** and **28**, respectively, whereby, solenoid H^4 is maintained and energized and valve H closed even though vacuum seal is released between the lifting pad A, as long as the vacuum line pump is energized. However, the moment that pressure in the vacuum lines is sealed by the lift head coming into sealed contact with a work sheet S to be lifted, the indicator control F moves to the dotted line position, thereby turning on green light L', the delay control arm D' of control D shifts to de-energize the solenoid H^4 of the valve H and permits the opening thereof to build up the vacuum in the reserve tank R.

Referring more specifically to Fig. 5, the motor control circuit shown is a single phase line and includes a starter W in circuit with start and stop switches X and Y, said starter W being connected to the motor as is well known in the motor art. When the starter switch is closed the motor runs continuously and independently of the "vacuum-on" and "vacuum-off" solenoid valve control circuits.

A circuit is tapped off by leads **10** and **11** to the junction box JB, which connects by lead **14** to the solenoid H^4 of a delayed action valve H in the reserve tank line G, and by lead **15** to point **1** of the box JB to delay control D by lead **16** and thence by lead **17** to the power line **11** and to the red and green indicator lights L and L', respectively, by line **18**, which with line **19** lead into box JB from plug I.

The indicator lights L and L' are connected by leads **20** and **21** through points **5** to one side of an indicator pressure responsive switch control F for the green light or vacuum on circuit and by leads **22** and **23** from the other side of the control F through points **6** of the box JB to the red light L in the vacuum off circuit. These lights are responsive only to the resulting position of the switch arm F' of the switch F. For example, the pressure element **24** of the control F moves to the dotted position when twenty inches of vacuum exists in the fluid circuit, and the green light is turned on. This closes a circuit through the green light L' and the solenoid E^3 of the multiple valve E to disconnect the line B—B from the lift pad A, see Fig. 4 and the dotted line position of the switch arm F'. Also, this in turn through leads **25** and **26** to points **3** and **4** of the box JB control the respective solenoids E^3 and H^4 through the pressure responsive

delay controls F and D and the closed "vacuum on" position of the valve E and the normally open position of the delayed action valve H, thereby causing the valve H to be closed, until a vacuum seal is established, see Fig. 2. However, when vacuum on seal is established in the lift A this serves to produce a change in pressure in delay control switch D and element 28 moves the switch arm D' to thereby open the switch and deenergize the solenoid H^4 of the two-way valve H to again open the same and produce increased vacuum in the reserve tank R and the lift head A. When the red light circuit is energized, and the vacuum is cut-off, the two-way valve H is again closed by the solenoid H^4 to hold the vacuum in tank R. However, when power failure occurs the solenoids E^3 and H^4 of the valves become deenergized and the valve H, held closed only when power is on, will open and will continue to provide suction for lifting by means of the vacuum reserve tank R and connections by conduits G—G'. Such lifting suction is not broken, until the lift has been completed by placing the lift head A in a position to deposit the article S at the desired location and restoring the valves E and H to the position shown in Figure 3, as previously described.

I claim:

1. A vacuum control article lifting system, comprising a pump, an exhaust line communicating with the pump, a reserve vacuum tank, a primary suction line connected with the pump and including a terminal portion having operative and inoperative positions, said primary suction line having a check valve therein, a reserve pipe line for the tank, a pressure responsive automatic reserve valve in said reserve line for closing same when said terminal portion is in inoperative position, and an electrically operated main valve in said primary suction line for establishing communication between said terminal portion, the pump, the exhaust line, and the reserve tank.

2. Lifting apparatus according to claim 1, wherein, the reserve valve in the reserve line is an automatic two-way valve responsive to a vacuum pressure control device in the primary suction line to open the tank to the pump as soon as a lifting degree of vacuum has been obtained.

3. Lifting apparatus according to claim 1, wherein, the electrically operated valve in the primary suction line has a pair of passages which in a first position establishes simultaneous communication from the terminal portion to the pump, to the exhaust line, and the reserve tank while the terminal portion is in operative position; said valve being solenoid actuated to move through an arc of 90° from the first position to a second position to

connect the primary suction line from the terminal portion to the pump and to the exhaust line while blocking passage from the suction line to the reserve line, and push button controlled circuits to said solenoid actuated valve to enable an operator selectively to move the valve from the first position to the second position.

4. Lifting apparatus according to claim 1, wherein the reserve valve is solenoid operated to turn 90° to close the reserve line, and vice-versa, and its solenoid is operated by a pressure responsive switch device which is subject to vacuum in the main suction line, whereby, when the vacuum diminishes as when the said terminal portion moves to inoperative position the reserve valve closes the reserve line and when the vacuum increases it will open the reserve line.

5. In a vacuum controlled lifting system, including an electric motor connected to continuously drive a vacuum pump, an electric circuit for said motor, a primary suction line connected to said pump, a reserve tank, a reserve suction line in said system communicating with said tank, and manually operated "vacuum-on" and "vacuum-off" buttons connected in a second circuit independently of said motor circuit, a multiple solenoid actuated valve connected to control said primary suction line by a solenoid in said second circuit when said buttons are operated, a delayed action pressure switch and a solenoid valve in an electric circuit therewith responsive to said reserve suction line vacuum condition, to thereby hold said delayed action switch closed and hold said last named valve in the reserve line closed until a predetermined vacuum is induced in the primary suction line, to open the said delay switch, said last-named valve and the reserve tank of the system.

6. The vacuum control system of claim 5, wherein the said delayed action pressure switch closes when the vacuum in the primary suction line drops below ten inches or less and wherein the same opens as soon as the vacuum in the line is induced to a preselected amount, such for example as twenty inches.

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