# United States Patent

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[54] **PUSH BUTTON VACUUM CONTROL VALVE AND VACUUM SYSTEM USING SAME**
**7 Claims, 2 Drawing Figs.**


[52] **U.S. Cl.** ..... **137/565,** 137/627.5
[51] **Int. Cl.** ..... **F16k 11/02**
[50] **Field of Search** ..... 137/565, 627.5, 596; 251/285, 288



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**ABSTRACT:** A pushbutton vacuum control valve and vacuum system using same is disclosed. The pushbutton vacuum control valve includes an output port, a vacuum port, and an atmospheric vent port. A pushbutton type plunger is slidable within the body of the valve and includes an extension extending outwardly of the valve structure to form a pushbutton for manual operation. The plunger includes a gas passageway therethrough providing gas communication between the output port of the valve and the vent port as formed at the pushbutton extremity of the plunger. As the plunger is manually depressed the finger which actuates the pushbutton covers over and seals the vent port. When the pushbutton plunger is depressed, it opens a gas passageway communicating between the vacuum port and the output port of the valve for applying the vacuum to the output port. The vent passageway in the pushbutton plunger also includes an adjustable stop which is accessible to a tool which is inserted through the vent passageway in the pushbutton plunger. Adjustment of the position of the stop determines the gas conductance between the opened vacuum port and the output port of the valve for adjusting the rate at which the vacuum is applied to the output device being controlled by the valve. The valve body is adapted to be inserted through an evacuated chamber and is sealed at its ends to the chamber such that the evacuated chamber forms a vacuum manifold for the valve structure and such that the plurality of such pushbutton valves may be installed in a single evacuated chamber thereby providing a common vacuum manifold for the plural valves. The pushbutton control valves are especially useful in vacuum systems employing vacuum power assisted actuators since the output of the vacuum for powering the vacuum actuators can be selectively controlled by the pushbutton control valves.

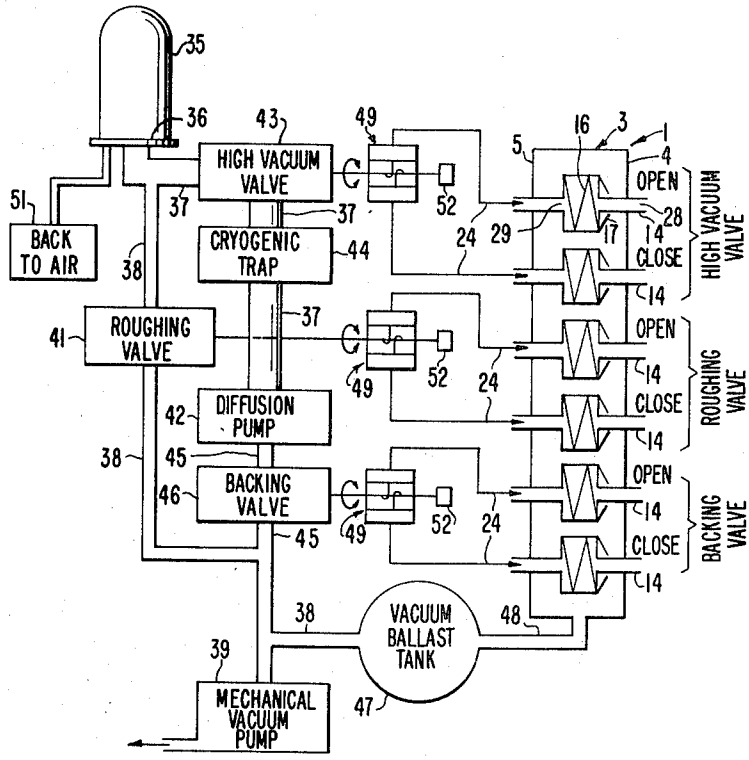



FIG. 1

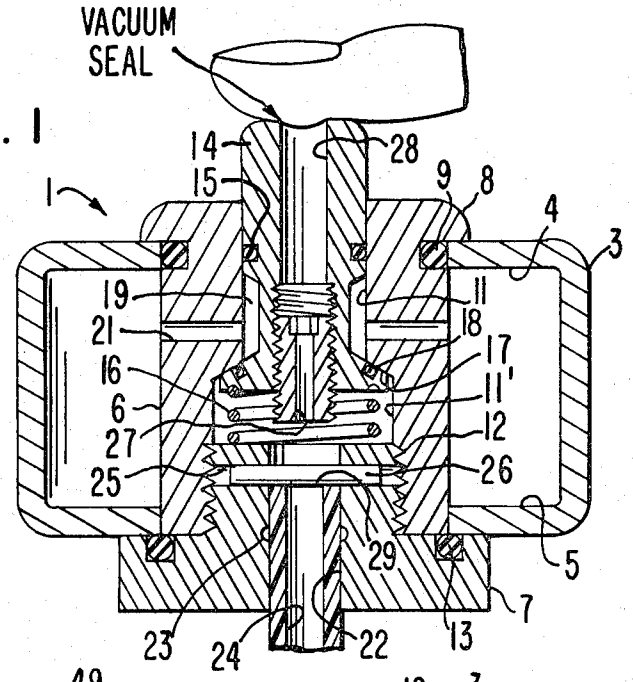
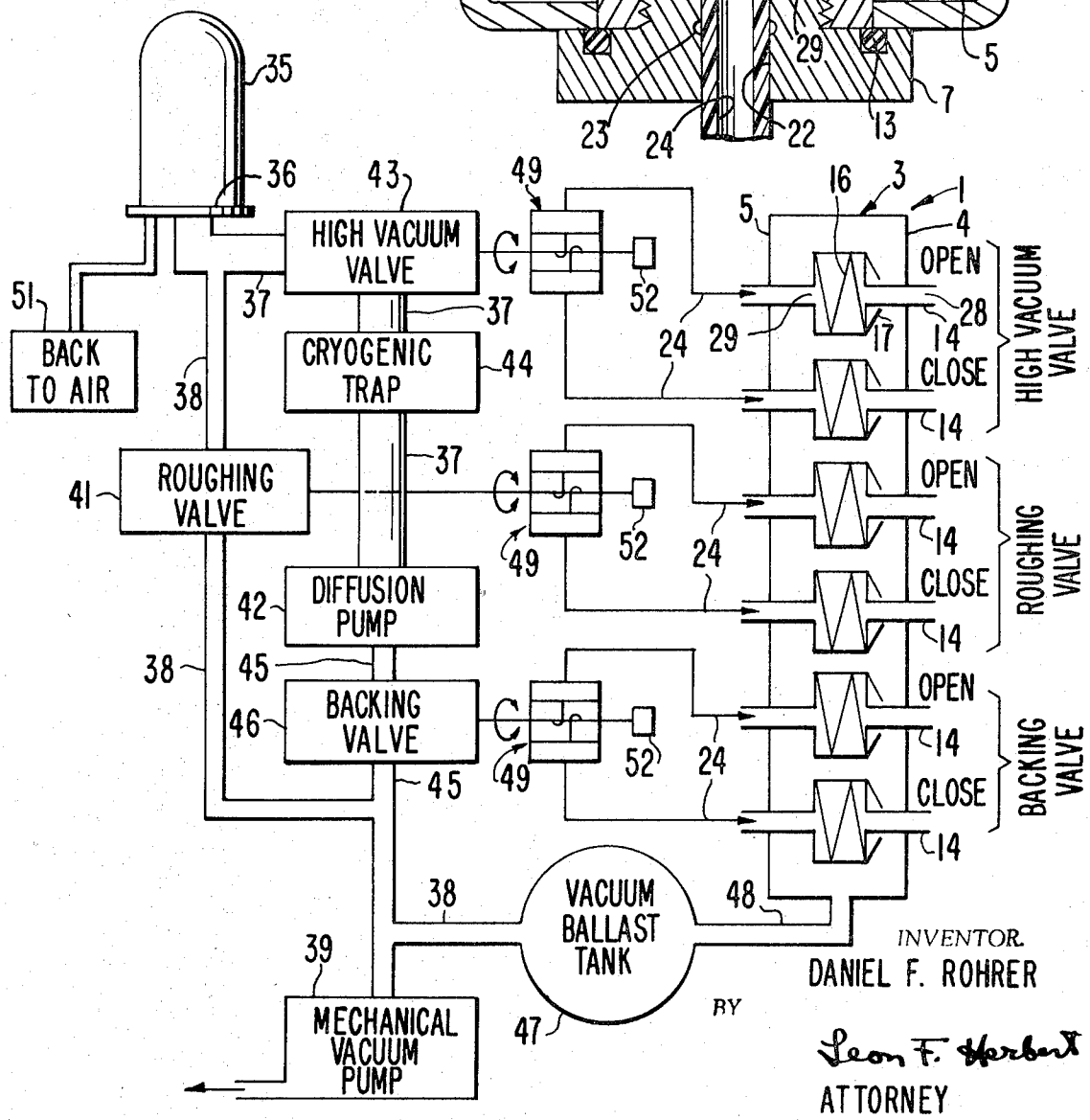



FIG.2

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# PUSH BUTTON VACUUM CONTROL VALVE AND VACUUM SYSTEM USING SAME

## DESCRIPTION OF THE PRIOR ART

Heretofore pushbutton type vacuum control valves and systems using same have been built. Such prior vacuum control valves have included a vacuum port, an output port, and an atmospheric vent port. A slidable pushbutton type plunger has been employed for covering and uncovering the ports and determining the gas communication between the ports for switching the output of the valve from vacuum to atmosphere and vice versa. Typically, the prior pushbutton control valve utilized a pushbutton type plunger having a plurality of sealed chambers defined therealong for determining the gas communication passageways between the three ports in the valve body. Such a valve construction is relatively complicated due to the rather intricate machining required for the plunger and the ports in the valve body. In addition, the pushbutton control valve included no simple means for adjusting the gas conductance between the output port of the valve and the vacuum port for controlling the rate at which the vacuum was applied to the output device through the valve structure. Moreover the valves were relatively complicated in that each valve included separate fittings for applying vacuum to the vacuum ports of the valves from a vacuum manifold structure.

In addition, prior high vacuum systems of the type wherein a bell jar or the like is evacuated by means of a vacuum pump through a conduit have employed butterfly control valves or the like for valving off the chamber. However, such butterfly valves have been operated either mechanically or by electric motors operating mechanical drive mechanisms.

## SUMMARY OF THE PRESENT INVENTION

The principal object of the present invention is the provision of an improved pushbutton vacuum control valve and vacuum systems using same.

One feature of the present invention is the provision, in a pushbutton vacuum control valve, of a movable plunger for valving the flow of vacuum between the output port of the valve and the vacuum port of the valve. The plunger is elongated and extends out of the valve structure to form a pushbutton. The elongated plunger includes a gas passageway communicating between the output port of the valve and the outer surface of the pushbutton. The open end of the gas passageway, at the outer surface of the pushbutton, forms the vent port such that when the operator places his finger over the vent port, in the button to depress the button, he thereby seals the vent port within the valve, thereby simplifying the construction of the valve structure.

Another feature of the present invention is the same as the preceding feature wherein the valve structure includes a valve body portion containing the movable plunger, the valve body structure extending across an evacuated enclosure and being sealed at its ends to the walls of the enclosure to define a vacuum manifold within the enclosure in a region thereof surrounding the valve body, whereby a plurality of such valves may be similarly inserted within the vacuum enclosure to form a common manifold for the plural valves.

Another feature of the present invention is the same as any one or more of the preceding features wherein the air passageway through the movable plunger includes an axially adjustable sleeve forming an adjustable limit spout for limiting maximum inward movement of the plunger to adjust the maximum gas conductance of the gas passageway between the output port and the vacuum port of the valve for controlling the rate at which the vacuum is applied to the output device being controlled by the pushbutton valve.

Another feature of the present invention is the same as any one or more of the preceding features including, in combination, an evacuable chamber to be evacuated by means of a vacuum pump connected in gas communication with the chamber via a gas conduit, such conduit containing a valve structure for valving the chamber from the pump. A vacuum powered actuator is provided for operating the valve and the actuator is controlled by the output of the pushbutton control valve. The control valve derives its vacuum from the vacuum pump.



Other features and advantages of the present invention will become apparent upon a perusal of the following specification taken in connection with the accompanying drawings wherein:

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal sectional view of a pushbutton vacuum control valve incorporating features of the present invention, and

FIG. 2 is a schematic line diagram, partly in block diagram form, depicting a high vacuum system employing the pushbutton control valves of the present invention.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1, there is shown the pushbutton vacuum control valve 1 of the present invention. The valve structure 1 includes a cylindrical valve body 2 as of aluminum. The cylindrical valve body 2 passes through an evacuated rectangular chamber 3, as of aluminum, from a first broad wall 4 to an opposed broad wall 5 of the chamber 3. Valve body 2 is made in two sections, an upper section 6 and a lower section 7. The upper section 6 includes an upper flange portion 8 which abuts the outside surface of the upper wall 4 of the chamber 3 and includes a peripheral resilient sealing ring 9, as of rubber, for sealing the marginal edge of the aperture in the top wall 4 of the chamber 3 to the upper section 6 of the valve body 2. The upper section of the valve body 6 includes an axial bore 11 passing therethrough from the top to the bottom with the bottom section of the bore 11 being counterbored at 11′ and threaded at 12 to threadably receive an end capping plug 7 which forms the lower section 7 of the valve body 2. The lower plug 7 includes an annular sealing ring 13 having a diameter equal to the diameter of the aperture in the lower wall 5 of the chamber 3.

A sliding plunger 14 is axially slidable within the bore 11 and is sealed to the upper extremity of the bore 11 by means of an annular sealing O-ring 15 carried within a peripheral groove in the plunger 14. The lower extremity of the sliding plunger 14 is outwardly flared and is disposed within the enlarged counterbore 11′ of the valve body 2. A compression spring 16 is disposed between the end capping plug 7 and the sliding plunger 14 for urging the outwardly flared portion of the plunger 14 into sealing engagement with an inner shoulder 17 formed at the intersection of the counterbore 11′ and the bore 11. A resilient sealing ring 18 is contained within a peripheral groove in the outwardly flared portion of the plunger 14 for producing a gastight seal between the plunger 14 and the shoulder 17.

The sliding plunger 14 is necked down for a section intermediate its length to define an annular chamber 19 in a space between the plunger 14 and the inside wall of the bore 11. Two bores 21, as of one-sixteenth inch diameter, pass radially through the wall of the upper section 6 of the valve body 2 and serve to interconnect the vacuum chamber 3 with the inner chamber 19.

The end capping plug 7 includes a central bore 22. The bore 22 includes a peripheral recess 23 which serves to capture a resilient tubing 24, as of Tygon, which is inserted into the end capping plug 7 and which extends away to a vacuum device, not shown, to be controlled by the pushbutton vacuum control valve 1.

The inner end of the end capping plug 7 includes a transverse bore 25 containing a pin 26 which extends diametrically across the open end of the tubing 24. The pin 26 serves as a stop for limiting the extent of travel of plunger 14 by engaging the inner end of a hollow set screw 27 threadably inserted within a hollow bore 28 passing axially through the plunger 14.

The inner end 29 of the tubing 24 defines the output port of the valve 1. The annular shoulder 17 which is sealed by the plunger 14 defines the vacuum inlet port for the valve 1. The outer end of the plunger 14 defines a pushbutton and the entrance to the axial bore 28, at the surface of the pushbutton, defines the vent port of the valve 1.

In operation, the envelope 3 is evacuated to subatmospheric pressure by means of a mechanical pump as more fully disclosed in FIG. 2 and described below. The tubing 24 is connected to a vacuum powered device such as an actuator more fully disclosed and described below with regard to FIG. 2. Before the pushbutton plunger 14 is manually depressed, the gas passageway 28 vents the output line 24 to atmosphere such that atmospheric pressure is applied to the actuator device. When it is desired to apply vacuum to the actuator device, the finger of the operator is placed on the pushbutton, thereby sealing the vent port at the surface of the pushbutton. As the pushbutton 14 is depressed against the spring bias force the vacuum port is uncovered, thereby opening a gas communication passageway between the output port 29 and the vacuum in the vacuum manifold 3. In this manner, vacuum is applied to the actuator device by air being drawn from the actuator through the tubing 24, output port 29, vacuum port 17 and through the vacuum manifold 3 to the vacuum pump. The vacuum power is applied to the actuator so long as the pushbutton plunger 14 is depressed and so long as the finger is held over the end of the vent port thereby sealing same. The rate at which the vacuum is applied to the actuator is determined by the extent to which the pushbutton plunger 14 is depressed. The maximum rate at which the vacuum will be drawn on the actuator is determined by the maximum amount of depression of the plunger 14. The maximum depression is controlled by the setting of the adjustable set screw stop 27. The stop 27 is readily adjusted by means of a set screw tool which is inserted through the gas passageway 28 for turning the set screw 27.

In many actuator applications, it is desirable that the device, to be controlled by the actuator, such as a butterfly valve in a vacuum system, be operated relatively slowly in which case the set screw 27 is screwed down toward the pin stop 26 such that only a slight amount of axial travel for the pushbutton 14 is obtainable. In this manner, the gas conductance through the vacuum port 17 to the output port 29 is substantially constricted for slowly applying the vacuum to the actuator to obtain relatively slow movement of the device being controlled.

When the device being controlled has reached the desired position, the operator lifts his finger from the vent port and pushbutton 14, thereby allowing the spring 16 to return the plunger 14 and to close the vacuum port 17, and allowing the output line 24 and actuator to be vented to atmospheric pressure to remove the vacuum power from the actuator device.

Referring now to FIG. 2, there is shown a high vacuum system incorporating the pushbutton vacuum control valves 1 of the present invention. The system includes a bell jar 35 defining, with a base plate 36, a chamber to be evacuated to a relatively low pressure as of $10^{-9}$ Torr. A gas conduit 37 is connected through the base plate 36 for evacuation of the bell jar 35. A roughing line conduit 38 is connected into the first conduit 37 and interconnects conduit 37 with a mechanical vacuum pump 39 via a roughing butterfly valve 41 for valving the flow of gas through the conduit 38. An oil diffusion pump 42 is connected to the bell jar 35 via the relatively large conduit 37. A high vacuum butterfly valve 43 is connected in the conduit 37 for controlling the flow of gas from the bell jar 35 to the diffusion pump 42 and for valving off the bell jar 35 from the diffusion pump 42. A cryotrap 44 is disposed in the conduit 37 between the diffusion pump 42 and the high vacuum valve 43 for eliminating back streaming of oil from the diffusion pump into the evacuated bell jar 35. A conduit 45 interconnects the diffusion pump with the mechanical pump for evacuating the diffusion pump. A backing control butterfly valve 46 is disposed in the conduit 45 between the diffusion pump 42 and the mechanical pump 39.

The mechanical vacuum pump 39 includes a vacuum ballast tank 47 connected to the vacuum lines of the mechanical vacuum pump to provide vacuum ballast. A conduit 48 interconnects the vacuum ballast tank 47 with the vacuum manifold chamber 3 of the pushbutton vacuum control valves 1.

Three vacuum powered actuators 49, more fully disclosed and claimed in copending U.S. application Ser. No. 706,553 filed Feb. 19, 1968 and assigned to the same assignee as the present invention, are coupled to the output shafts of the butterfly valves 43, 41 and 46, respectively, for actuating same. A back to air leak 51 is connected to the base plate 36 in the bell jar 35 for leaking the bell jar up to atmospheric pressure when it is desired to open the bell jar.

In operation, assuming the vacuum system of FIG. 2 has been in operation and the bell jar 35 is at atmospheric pressure, the high vacuum valve 43 will be closed, the backing valve 46 will be open, the roughing valve 41 will be closed, and the vacuum ballast tank 47 will be at about $10^{-3}$ Torr. To evacuate the bell jar 35 to $10^{-9}$ Torr, the back to air leak valve 51 is closed, the roughing valve 41 is opened, and the backing valve 46 is closed. In order to open the roughing valve 41 and to close the vacuum valve 46 the respective pushbuttons 14 on the pushbutton control valves 1 are manually depressed. This causes the vacuum within the manifold 3 and ballast tank 47 to be applied via the respective output lines 24 to the proper side of the vacuum actuators 49 to cause the valves to be operated as determined by the pushbuttons 14. The buttons are depressed sufficiently long to complete opening and closing operations of the valves 41 and 46, respectively. Upon release of the pushbuttons 14, the vacuum power actuators 49 are vented through the lines 24 and pushbutton plungers 14 to atmospheric pressure. The valves 41 and 46 may then be manually operated via manual control knobs 52 affixed to the valve stems of the valves, as desired.

When the pressure within the bell jar 35 is reduced to about 100 microns, as sensed by a vacuum gauge, not shown, the roughing valve 41 is closed by manual depression of its "CLOSE" pushbutton 14. The backing valve 46 and the high vacuum valve 43 are opened by depressing their "OPEN" pushbutton plungers 14. Then the diffusion pump 42 pumps the bell jar 35 down to the desired pressure, as of $10^{-9}$ Torr.

The advantage of a vacuum pushbutton control valves 1, in the vacuum system of FIG. 2, is that the vacuum for powering the vacuum actuators 49 is already available in the ballast tank 47 of the mechanical vacuum pump 49. Application of the available vacuum power is easily controlled via the pushbutton vacuum control valves 1, thereby avoiding the complexity of electrical drive motors and control switches together with their appropriate power supplies.

I claim:

1. In a manually operated pushbutton control valve, a valve structure having first, second and third ports therein, said first port forming an output port for connection to a device which it is desired to control with said valve, said second port forming an input port for selective communication of a source to said output port, said third port forming a vent port for venting said output port to ambient atmospheric pressure, means forming a source of vacuum connected to said input port; a plunger tranlationally movable within said valve structure between a normal position preventing flow communication between said input port and said output port and interconnecting said output port with said vent port for venting said output port to atmospheric pressure and an inward actuated position communicating said input port simultaneously with both said output port and said vent port for the application of vacuum thereto, said plunger extending to the exterior of the valve structure for manual operation, means spring biasing said plunger to said normal position, said vent port passing through said plunger and terminating at a position on the exterior end thereof at which said port will be covered by an operator's finger during manual movement by said operator of said plunger from said normal position to said actuated posi-

tion with said finger to thereby close said vent port with said finger simultaneously with the actuation of said valve.

2. The valve of claim 1 wherein stop means are provided on said plunger for limiting the maximum inward movement of said plunger.

3. The apparatus of claim 1 wherein said valve structure includes a valve body structure containing an axial bore therein, said movable plunger being sealed in a gas tight manner to the interior wall of said bore and being axially slidable within said bore, and means forming an evacuated chamber, said valve body structure passing through said evacuated chamber, means forming gastight seals between the walls of said chamber and said valve body structure to define a vacuum manifold within said evacuated chamber in the region thereof surrounding said valve body structure, and means forming a vacuum passageway formed in said valve body structure and interconnecting said vacuum port and said vacuum manifold.

4. The apparatus of claim 3 wherein a plurality of said valve body structures are similarly sealed into said evacuated chamber to form a common vacuum manifold for said plural valve body structures.

5. The apparatus of claim 1 wherein said vent port through said movable plunger includes means forming an axially movable sleeve portion forming an adjustable limit stop limiting the maximum inward movement of said plunger and thereby adjusting the maximum gas conductance between said output port and said source port.

6. The apparatus of claim 5 wherein said movable sleeve means is a hollow screw, said screw having its head portion facing said vent port to facilitate adjustment of said screw by insertion of a tool through said vent port and air passage in said movable plunger.

7. The apparatus of claim 1 including in combination, means forming an evacuable chamber to be evacuated, means forming a vacuum pump connected in gas communication with said chamber via a gas conduit for evacuating same, means forming a second valve structure, said second valve structure being disposed in said gas conduit between said chamber and said pump for valving off said chamber from said pump, means forming a vacuum powered actuator for operating said second valve structure, said vacuum powered actuator connected to said output port of said first pushbutton vacuum valve apparatus, and said means forming a source for applying vacuum connected to said input port being said vacuum pump.