United States Patent

[11] 3,583,779

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[21] Appl. No. **766,110**
[22] Filed **Oct. 9, 1968**
[45] Patented **June 8, 1971**

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[54] **APPARATUS FOR ESTABLISHING AND MAINTAINING A CONSTANT-PRESSURE ENVIRONMENT**
1 Claim, 3 Drawing Figs.

[52] **U.S. Cl.** **312/1,** 137/103, 137/251
[51] **Int. Cl.** **A61g 11/00**
[50] **Field of Search** 137/102, 103, 116.3, 116.5; 312/1; 128/1.02

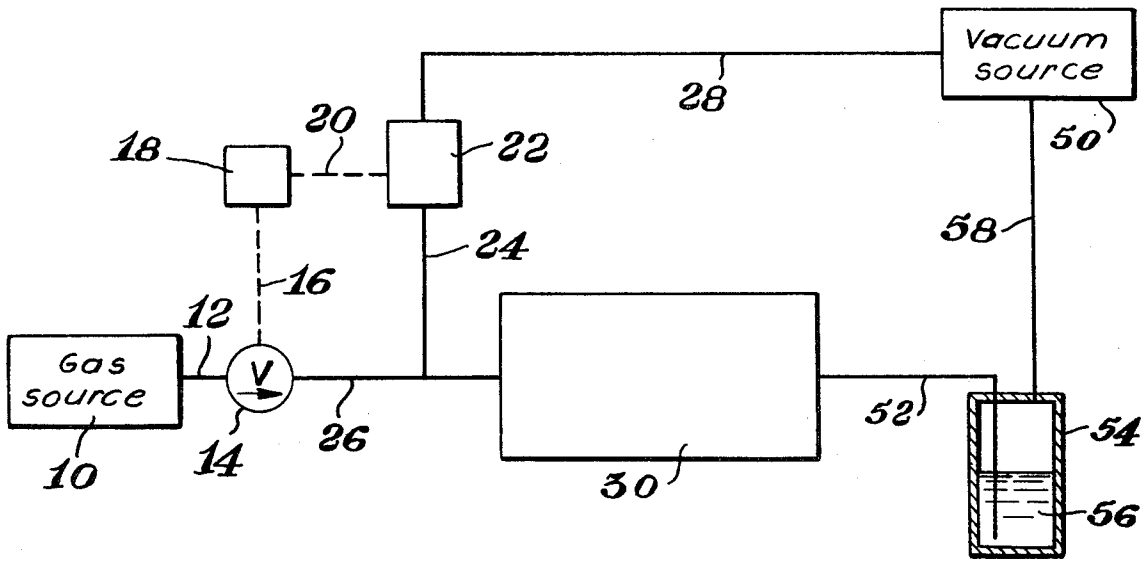
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ABSTRACT: The invention comprises an apparatus for establishing and maintaining a constant-pressure environment and which permits the overall pressure with an enclosure to be changed by a single manipulation, said device comprising an enclosure, means for regulating the flow of a gas into the enclosure, means for regulating the flow of gas out of the enclosure, a gas source, a vacuum source, and means which (a) sense the pressure differential between the interior of the enclosure and the vacuum source, and (b) which activate the inlet and outlet means when this differential falls below or above a preselected value.



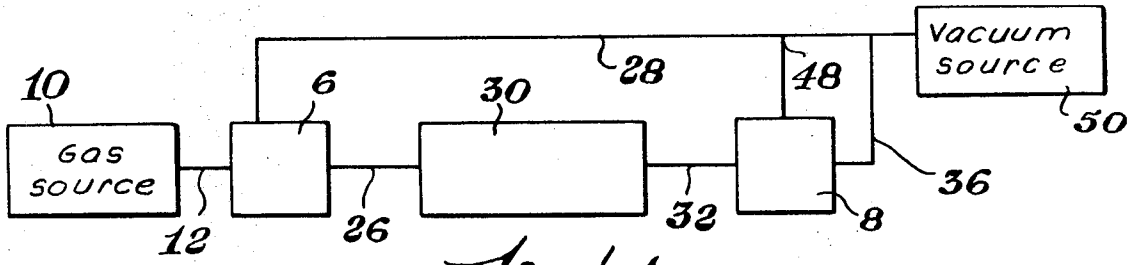


Fig. 1

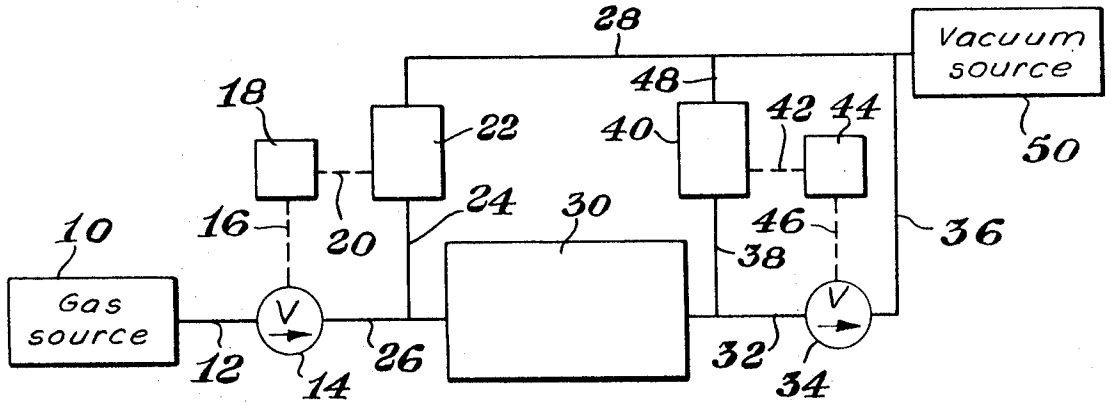


Fig. 2

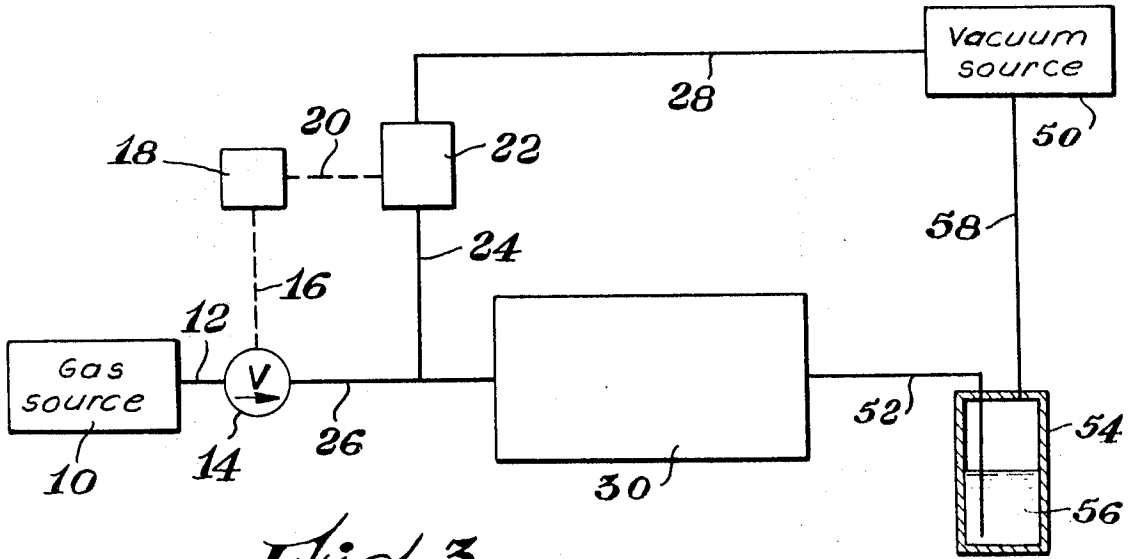


Fig. 3

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APPARATUS FOR ESTABLISHING AND MAINTAINING A CONSTANT-PRESSURE ENVIRONMENT

BACKGROUND OF THE INVENTION

It is often desirable to regulate the operating pressure within an enclosure. One such enclosure is typically called a "glove box" because it has one or more pairs of gloves connected to it in such a way that a worker can place his hands therein and work inside the enclosure without exposing his skin to the enclosure's interior environment. Another advantage of such regulation is the ability to choose the components of the environment, e.g., oxygen can be excluded if desired.

It is desirable that the pressure within a "glove box" be kept reasonably close to atmospheric pressure in order that the operator does not become fatigued. To accomplish this requires that gas be discharged from the enclosure when its interior volume is decreased by inward movement of the hands in the gloves, and that gas be added to the enclosure when the volume is increased by outward movement of the gloves.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1, briefly, is a schematic drawing of the invention in its broadest scope.

FIG. 2 shows one possible arrangement of the major components of such a device, and their individual parts.

FIG. 3 shows a preferred embodiment of the invention.

DESCRIPTION OF THE INVENTION

More precisely, FIG. 1 embodies the invention in its broadest scope, i.e., an apparatus for establishing and maintaining a constant-pressure environment, which comprises:

A. An enclosure **30**;

B. Means **6** for (a) sensing the pressure differential between the interior of the enclosure **30** and a vacuum source **50**, and (b) regulating the flow of gas from a source **10** into the enclosure when said differential falls below a predetermined value;

C. Means **8** for (a) sensing the pressure differential between the interior of the enclosure **30** and the vacuum source **50**, and (b) regulating the flow of gas out of the enclosure when said differential rises above a predetermined value;

D. Conduits **26** and **32** connecting means **6** and **8** respectively to the enclosure **30**;

E. Conduits **12** and **36** connecting means **6** and **8** to the gas source **10** and the vacuum source **50** respectively;

F. Conduits **28** and **48** connecting means **6** and **8** respectively to the vacuum source **50**.

Any enclosure in which it is desirable to maintain a constant, or near constant, pressure forms a suitable part of the apparatus of this invention. The preferred enclosure is of the type designated as a "glove box," as described above.

The gas source can suitably be any source of gas under a pressure greater than the pressure to be maintained in the enclosure. A cylinder of compressed gas is, for example, suitable.

The vacuum source suitable is any device capable of producing a steady pressure somewhat less than the pressure desired in the box. This device serves two functions: (a) to produce a reference pressure for the inlet **6** and outlet **8** pressure differential sensing means, and (b) to provide a low-pressure "sink" for gases exhausted by the outlet means **8**.

Any "vacuum pump" is suitable for the above, but a centrifugal blower is preferred because of its constant-pressure characteristic when gas flow is varied, and the ease of varying the speed of said blower, thus varying the vacuum produced.

An array of devices are suitable for performing the dual functions of means **6** and **8**, i.e., to sense the pressure differential, and to regulate gas flow accordingly. These devices will be discussed in the description of FIGS. **2** and **3** below.

Generally the device functions as follows. For convenience sake, the practice of the invention will be typified by a "glove box" as the enclosure. Pressure will be absolute, assuming atmospheric pressure= 760 mm. Hg.

Typically a glove box should be operated within approximately 8 mm. Hg of atmospheric pressure (P_a) in order to assure the comfort of the operator and ease of glove manipulation. Therefore, the box's pressure should fall within the range of 752 mm.—768 mm. Hg.

Generally a variance of 1 mm. Hg within the box will not disrupt operations. Such a variance will allow the box to be operated without a constant flow of gas, which would be the case if no variance was established. Therefore, small box volume changes will not generally require pressure regulation.

The pressure within the box (P_b) is selected, preferably within the above-described range (for example, 765 mm. Hg), and can be allowed to vary within 1 mm. Hg, i.e., 764.5 to 765.5 mm. Hg.

The vacuum source is then adjusted to produce a pressure, P_{vs}, below P_b, and preferably only slightly below P_b, but in any case below atmospheric pressure. Suitably, the differential between P_b and P_{vs} should be of the order of 5—50 mm.

Since the regulators **6** and **8** on the inlet and exit lines of the box use P_{vs} as their reference pressure, they are now set to open at pressures slightly (e.g., 0.5 mm.) below and above P_b, respectively. The box is then ready for use.

Having once set the regulators **6** and **8** to operate at a fixed differential above P_{vs}, their operation is then independent of the chosen value of P_b, the latter depending only on the chosen value of P_{vs}. Hence, the operating pressure P_b can be changed at will by merely adjusting the vacuum source to produce the appropriate value of P_{vs}. The value of P_b will be a linear function of P_{vs}. Accordingly, any desired new value of P_b is attained by merely adjusting the vacuum source to establish the appropriate value P_{vs} without making any adjustment of the inlet and outlet mechanisms and controls **6** and **7**.

If the chosen P_b is 765 mm., the vacuum source, such as a pump, might be set to produce a pressure, P_{vs}, between, for example, 700 and 755 mm. Having arbitrarily chosen, say, 750 mm., means **6** is then adjusted to open the inlet valve when P_b is less than 14.5 mm. above P_{vs}, i.e., less than 764.5 mm. Likewise, means **8** is adjusted to open the exit valve when P_b is more than 15.5 mm. above P_{vs}, i.e., more than 765.5 mm. Each valve, of course, is adjusted to close when it has effected a pressure correction of the order of 0.5 mm. The box is now ready for use at a pressure of 765±0.5 mm. Should it now be desired to change P_b to a new value, say 756 mm., a decrease of 9 mm., it can be done by merely adjusting P_{vs} to a value 9 mm. lower, i.e., to 741 mm.

The precise manner of setting means **6** and **8** depends upon the type of equipment used, and will be illustrated in the discussion of FIGS. **2** and **3**.

FIG. **2** illustrates one possible arrangement of components to accomplish pressure regulation in an enclosure. It comprises:

A. An enclosure **30**;

B. Sensing means **22** and **40** for sensing the pressure differential between (a) the interior of the enclosure **30**, connected thereto by conduits **24** and **38**, and (b) a vacuum source **50**, connected thereto by conduits **28** and **48**, said means adapted to developing a signal of at least a certain magnitude when the pressure differential is below or above, respectively, a preselected value;

C. Valve actuator **18** and valve **14** for regulating the flow of gas into the enclosure **30**, connected to a source of gas **10** by a conduit **12** and to the enclosure by a conduit **26**, and adapted to admit gas to the enclosure in response to a signal from the sensing means **22** in excess of the "set point" of actuator **18**, i.e., when the pressure differential falls below a preselected value;

D. Valve actuator **44** and valve **34** for regulating the flow of gas out of the enclosure **30**, connected to the vacuum source **50** by a conduit **36** and to the enclosure by a conduit **32**, and adapted to permit escape of gas from the enclosure in response to a signal from the sensing means **40** in excess of the "set point" of actuator **44**, i.e., when the pressure differential rises above a preselected value;

E. Signal-transmitting means (**16**, **20**, **42** and **46**) connecting valve actuator means **18** and **44** to sensing means **22** and **40** and valves **14** and **34**.

Essentially, the device represented by FIG. **2** is identical to that of FIG. **1**, except that means **6** and **8** are detailed.

Means **22** and **40** receive pressures from the enclosure and the vacuum source. The differential therein is then transmitted to valve actuators **26** and **44**, said actuators operating the inlet valve **14** or outlet valve **34** when the conditions noted above arise. It is thus apparent that one pressure-sensing means could suffice; two are shown merely for clarity of illustration.

Various devices can be utilized for the sensing means and actuating means. For instance, a diaphragm pressure sensor is suitable. An electrical device responsive to the signal from the sensor, such as a solenoid in the plate circuit of a gas-fired triode biased by the signal, makes a suitable valve actuator. It is also possible to combine the sensor and actuator into one device as, for instance, a mercury U-tube with electrical contacts. Other suitable devices are well known in the process control instrument art.

The manner of setting the inlet and outlet means to admit or exhaust gas depends upon the equipment used, as noted above.

If a diaphragm pressure sensor is used which develops an electrical signal directly proportional to the magnitude of the measured differential, the signal can be transmitted to a valve actuator, comprising, for instance, an electrical circuit comprising a variable resistor. A resistance, then, corresponding to a certain pressure "set point" can be selected.

In the case of a mercury U-tube, by changing the amount of mercury and the distance between contacts, the valve can be set to open or close at any desired pressure differential.

FIG. **3** shows a preferred embodiment of the apparatus of this invention. It differs from the device of FIG. **2** only in the outlet means, which, in this embodiment, comprises a sealable container **54** connected to:

A. The enclosure **30** by a conduit **52**, said conduit terminated near the bottom of the container **54**, and sealed within the container;

B. The vacuum source **50** by a conduit **58**, said conduit sealed to the container at its point of exit therefrom, said container containing a suitable fluid **56**.

The device of FIG. **3** differs from that of FIG. **2** in that a bubbler pressure-relief valve is the outlet valve, actuator and sensing means. The use of a bubbler has the advantages over other types of controls of simplicity and ease of adjustment.

The operation of the total system is unchanged except that the pressure differential at which gas will exhaust from the bubbler is determined by the depth of immersion of conduit **52** in the liquid **56** contained in the container **54**.

Water is a suitable fluid for use therein. Also inert hydrocarbons with low vapor pressure-densities are also suitable, e.g., mineral oil and silicone oils.

We claim:

1. An apparatus comprising:

A. A generally gastight glove box enclosure including one or more gloves;

B. A source of gas of the same type as that to be utilized in said enclosure, said source being at a pressure above the operating pressure of said enclosure;

C. Means for admitting gas from said source to said enclosure when the pressure differential between the interior of said enclosure and a centrifugal blower vacuum source falls below a predetermined level;

D. Means for sensing said pressure differential between the interior of said enclosure and the blower; and

E. A centrifugal blower vacuum source, said blower producing a pressure essentially constant when gas flow through the blower is varied, said blower being in communication with the enclosure through a bubbler pressure-relief valve, said bubbler acting as both a means for sensing the pressure differential between the interior of the enclosure and the blower, and as a means for exhausting gas from said enclosure to said blower when the pressure differential rises above a predetermined value; whereby, as said pressure differential tends to change, the gas-admitting means or bubbler, respectively, admits or exhausts gas so as to maintain an operating pressure within said enclosure within a predetermined range.