July 15, 1969 R. V. GLICK ET AL 3,455,314

OXYGEN THERAPY FLOW TIME MEASURING SYSTEM

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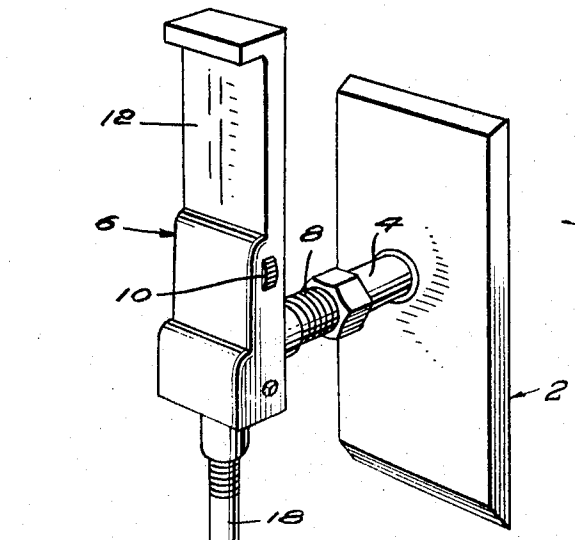


Fig. 1.

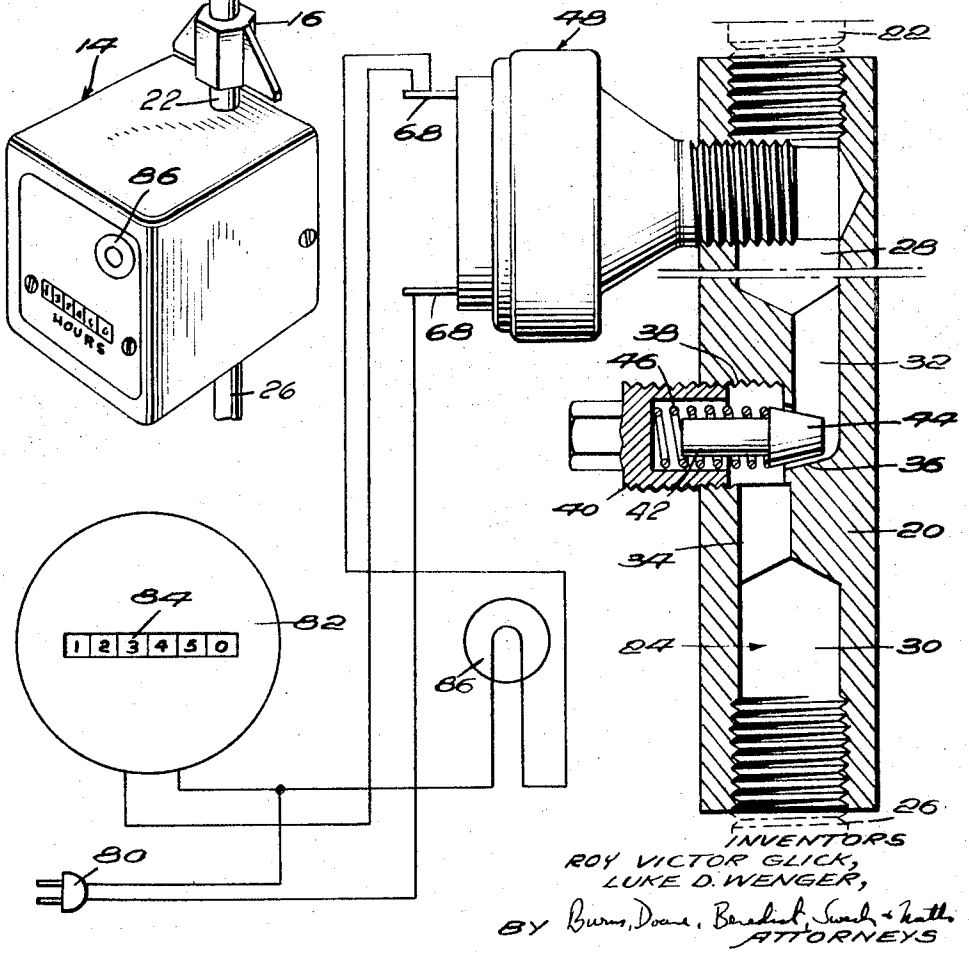


Fig. 2.

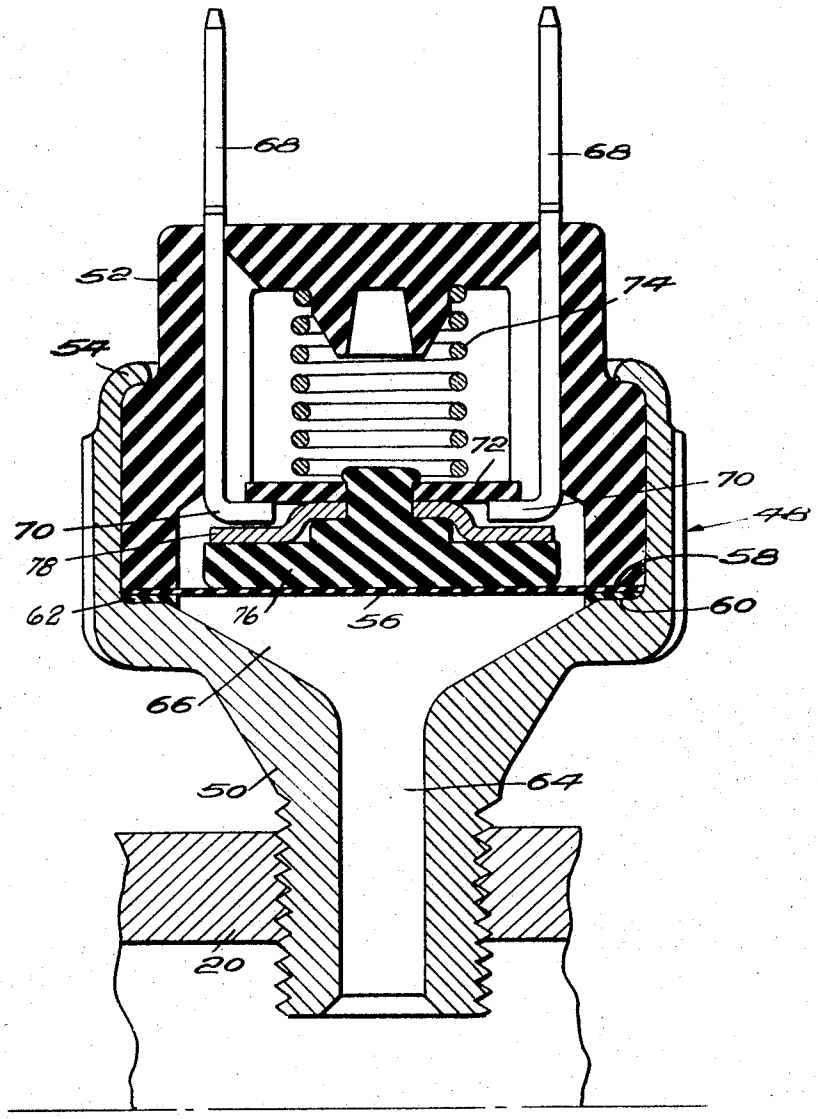
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Fig. 3.



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OXYGEN THERAPY FLOW TIME MEASURING SYSTEM

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ABSTRACT OF THE DISCLOSURE

A system for measuring the duration of oxygen flow during oxygen therapy whereby a patient is supplied with oxygen while enclosed in a tent, or by other means, such as a mask. This system may also measure any non-explosive medical gas. The oxygen flows through a valve conduit in the system. The valve conduit has a flow restriction in the form of a valve which is spring biased towards a seat, but is displaced away from the seat by pressure upstream from the valve. A pressure responsive switch is positioned in the flow passage upstream from the valve. The switch is normally open and the pressure of the fluid in the passage closes the switch when the pressure in the passage exceeds a predetermined pressure. The switch is connected with an electric motor which drives a timing device. Thus, the timer indicates the total elapsed time during which at least a predetermined minimum rate of oxygen is flowing through the system.

BACKGROUND OF THE INVENTION

This invention relates to medical therapy apparatus, and more particularly to systems for recording the length of time that oxygen is used by a patient.

In hospitals the customary practice is to charge a patient for oxygen therapy on the basis of the duration of time that oxygen is being used. Usually, a nurse records the time when the oxygen starts flowing through the system to the patient. When the period of therapy is completed, the supply valve for the oxygen is closed and the nurse again records the time. The duration of the therapy then is used to calculate the charge to the patient for the oxygen therapy. Usually, the volume of oxygen used is not taken into consideration in determining the amount of the charge.

This typical system is not entirely satisfactory because the nurse may forget to record either the time that the therapy begins or when it ends. Furthermore, the flow of oxygen to the patient may be interrupted during the course of the therapy and this time interval may be overlooked. For example, oxygen may be shut off for brief intervals while the patient is being examined by a physician or while the patient is receiving medication. Unless the length of these time intervals is recorded, the nurse, in making up the charge for oxygen, either ignores the fact that the oxygen was shut off or estimates the time that is to be deducted from the total time for the oxygen therapy. In either event, the patient's charge for oxygen is not based on the actual time that oxygen is being used.

Various devices have been used for measuring the total volume of oxygen used by a patient. These devices contain intricate parts which require careful calibration and assembling, and since they measure volume, regardless of flow, the nurse cannot determine whether any portion of the volume indicated on the meter represents flow below a minimum required rate. Therefore, if oxygen is leaking through the system at a low rate when the supply valve is shut off, the patient will be charged for the volume of oxygen that leaks, because this volume is recorded by the meter irrespective of the flow rate. Another disadvantage of these devices is that they are expensive and require periodic servicing to maintain their accuracy.

Accordingly, it is an object of this invention to provide an oxygen flow timing apparatus.

It is another object of this invention to provide oxygen flow measuring apparatus which readily indicates the duration of oxygen flow above a predetermined minimum rate.

A further object of this invention is to provide an oxygen flow meter which may be easily installed in an oxygen supply system.

SUMMARY OF THE INVENTION

These objects are accomplished in accordance with the preferred embodiment of the invention by an oxygen flow system having a conduit through which the oxygen flows from a source to the patient. A valve seat in the conduit is positioned transversely of the length of the conduit and a valve element is mounted in the conduit for movement toward and away from the valve seat. The valve element is biased toward the seat by a spring. The valve element resists the flow of fluid past the valve seat. The resistance of the valve element causes the fluid pressure upstream from the valve to increase approximately in proportion to the rate of flow at intermediate flow rates. There is practically no increase in fluid pressure due to the presence of the valve when the fluid is flowing at a low rate, which is, for example, a rate less than one liter per minute. This is to allow a small flow of gas through the system without counting the hours of this unintended flow. A pressure responsive electrical switch is positioned upstream from the valve and a chamber in the switch communicates with the conduit through which the oxygen is flowing. The chamber in the switch has a movable wall. An electrical contact element is attached to the movable wall and spring biased away from electrically conductive terminals in the switch. The terminals are connected in series circuit with an electric motor which drives a register at a constant rate.

The movable wall of the pressure switch is designed to displace the contact element into engagement with the terminals when the pressure in the chamber exceeds a selected minimum value. When this occurs, the circuit is closed and the electric motor starts. The motor continues to drive the register as long as the contact element remains in engagement with the terminals in the pressure responsive switch. When the oxygen flow stops or when the pressure drops below the selected minimum value, the electric motor stops. The pressure value is selected to correspond to the minimum oxygen flow rate that is to be used in the therapy. The register is calibrated to read hours directly, so that the operator merely notes or records the meter reading at the beginning of the therapy and again when the therapy stops. If during the course of the therapy, the oxygen flow should fall below the pressure value, the meter stops and the duration of flow at low rate is automatically subtracted from the total time of the therapy.

DESCRIPTION OF THE DRAWINGS

This preferred embodiment is illustrated in the accompanying drawings in which:

FIG. 1 is a perspective view of the oxygen measuring system of this invention;

FIG. 2 is a schematic view of the system of this invention; and

FIG. 3 is a cross sectional view of the pressure responsive switch.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Hospitals usually have wall outlets for supplying oxygen for use in oxygen therapy. Referring to FIG. 1, a

typical wall outlet 2, having a pipe fitting 4, is shown. A conventional flow rate valve 6 is shown schematically in FIG. 1. The valve 6 is connected to the outlet fitting 4 by a threaded coupling 8. The valve 6 includes a movable screw 10 for adjusting the rate of flow of oxygen from the wall outlet 2. The valve 6 also includes a flow indicator 12 which indicates the rate of flow of oxygen through the valve 6.

The meter 14 of this invention includes a coupling 16 which includes a standard wing nut, connected with the valve 6 by a length of tubing 18, or the tubing 18 may be omitted and the coupling 16 connected directly with the valve 6. The meter 14 is shown schematically in FIG. 2, and includes a conduit 20. The upper end of the conduit 20, as viewed in FIG. 2, is connected with the coupling 16 (FIG. 1) by a pipe fitting 22. The conduit 20 has a central passage 24 extending from the inlet end to the outlet end, where an outlet pipe 26 is threadedly secured in the conduit 20. The passage 24 includes an inlet section 28 and an outlet section 30. A pair of axially extending, laterally offset bores 32 and 34 are connected by a transverse opening forming a frusto-conical valve seat 36. A radial bore 38 is aligned with the valve seat 36 and threaded to receive a valve cap 40. A valve stem 42 is mounted in the cap 40 and a valve element 44 which is substantially frusto-conical is provided on the end of the stem 42. A coil spring 46 extends coaxially over the valve stem 42 and is compressed between a shoulder in the cap and a radial shoulder formed at the junction of the stem 42 and the valve element 44. The valve spring 46 urges the valve element 44 toward the valve seat 36. The compression force of the spring 46 may be adjusted by turning the valve cap 40, thereby changing the position of the cap relative to the valve seat 36. The outer end of the cap 40 is in the form of a hexagonal head to facilitate turning the cap 40 relative to the conduit 20.

Upstream from the valve seat 36, a pressure responsive switch 48 is threadedly secured on the conduit 20. Referring to FIG. 3, the pressure responsive switch 48 includes a threaded fitting 50 which is threadedly secured in the wall of the conduit 20. The fitting 50 is assembled with a housing 52 by means of a flange 54 which is crimped over a corresponding shoulder on the housing 52. Preferably, the fitting 50 is formed of a metallic material, while the housing 52 is formed of an insulating material, such as hard rubber or plastic. A flexible wall diaphragm 56 is clamped between opposed shoulders 58 and 60 on the housing 52 and the fitting 50, respectively. A gasket 62 is preferably inserted between the diaphragm and the shoulder 60 to assure adequate support of the diaphragm 56 and to prevent the leakage of gas from the interior of the fitting 50.

The fitting 50 has a central passage 64 which communicates between the inlet section 28 and a chamber 66 defined by the interior of the fitting 50 and by the lower surface of the diaphragm 56, as shown in FIG. 3.

A pair of electrically conductive terminals 68 are mounted in the housing 52. These terminals may be in the form of narrow strips of metal. The end of each terminal 68 that is inserted in the housing 52 has a tab 70 which projects toward the center of the housing. A circular washer 72 having a diameter greater than the distance between the tabs 70 is urged downwardly against the tabs by a compression spring 74. The interior of the housing 52 is preferably sealed, so that the pressure on the upper side of the diaphragm 56 remains substantially constant, thereby assuring greater accuracy of the switch 48. A spacer 76 is secured to the washer 72 on one side and has a flat surface on the other side which bears against the diaphragm 56. A circular contact element 78 is mounted on the spacer 76 adjacent the washer 72. The peripheral portion of the contact 78 is positioned on the opposite side of the tab 70 from the washer 72. The washer and the spacer 76 are formed of insulating material, while the contact 78 is electrically conductive. Displacement of the diaphragm 56 upwardly, as viewed in FIG. 3, causes the contact 78 to move into engagement with the tabs 70, thereby completing an electric circuit from one terminal 68 to the other.

Referring to FIG. 2, one of the terminals 68 is connected with a source of electric current by a conventional plug 80. The other terminal 68 is connected with a motor driven register 82. The register 82 is of conventional construction and includes an electric synchronous motor of the type used in electric clocks. The electric motor drives a register which records the number of revolutions of the motor. The register includes appropriate gearing to a drive a dial 84 at the rate of one unit per hour. The dial 84 may also indicate tenths of an hour. Thus, the dial 84 indicates the elapsed time in hours during which the motor has been operating. An indicator light 86 is connected in parallel circuit with the motor of the register 82. The light 86 indicates that the circuit has been closed by the pressure responsive switch 48.

In operation, the system is assembled as in FIG. 1, with the pipe 26 being connected with the equipment that is to use the oxygen, such as for example, an oxygen tent. The screw 10 of the valve 6 is adjusted to provide approximately the desired rate of flow of oxygen through the pipe 26. The spring bias on the valve element 44 is adjusted by turning the valve cap 40. As the gas flows through the inlet section 28, and the bore 32, gas pressure is sufficient to displace the valve element 44 to the left as viewed in FIG. 2. The spring 46, however, resists displacement of the valve element away from the valve seat 36. The flow area around the valve element, therefore, is substantially less than the area of the bore 32, so that the pressure upstream from the valve increases in proportion to the rate of flow through the valve. When the rate of flow exceeds a predetermined minimum rate, the pressure acting on the diaphragm 56 displaces the spacer 76 and the contact 78 into engagement with the tabs 70 on the terminal 68.

When the contact 78 engages the tabs 70 the electrical circuit between the terminals 68 is completed and the electric motor in the register 82 is started. The motor continues to operate as long as the pressure in the inlet section 28 is sufficiently high to maintain the contact 78 in engagement with the tabs 70. If the rate of flow should decrease below the rate for which the switch 48 is set, the spring 74 displaces the spacer 76 away from the tabs 70 to open the circuit between the terminals 68. The motor in the register 82 then stops. Since the indicator light 86 is in parallel circuit with the register 82, the light is turned on and off by the closing and opening, respectively, of the switch 48.

The position of the valve in the conduit 20 permits relatively high rates of flow without inducing vibration or fluttering of the valve element 44. The dynamic forces of the gas stream on the valve element 44 are generally transverse to the axis of the stem 42 when the valve is fully open, and these forces are resisted by the valve seat 36 and the stem 42. Thus, the valve element does not tend to flutter at high rates of flow. Since the switch 48 closes when the pressure upstream from the valve builds up to a pressure above a certain predetermined minimum pressure, it is not necessary to impose a flow restriction at high flow rates. Gas flowing at high flow rates displaces the valve element 44 a substantial distance from the seat 36 and therefore minimum resistance to flow is achieved at high flow rates.

An important feature of this system is the use of a valve downstream from the pressure responsive switch. The valve causes an increase in fluid pressure in the gas stream that is sufficient to operate the switch at low flow rates. Furthermore, by adjusting the spring bias on the valve, the extent of pressure build-up can be varied, as desired.

We claim:

1. Apparatus for measuring the duration of fluid flow comprising conduit means, means in said conduit means

for restricting fluid flow through said conduit means, switch means, means for registering elapsed time, electric motor means for driving said registering means, and said switch means being operable to open and close a circuit connecting said motor means with a source of electricity, and means for operating said switch means in response to fluid pressure in said conduit means, said operating means closing said circuit when fluid pressure in said conduit means upstream from said restricting means exceeds a predetermined value and opening said circuit when fluid pressure in said conduit means is below said predetermined value.

2. The apparatus according to claim **1** wherein said flow restricting means includes a movable valve element, abutment means in said conduit means, means for adjusting the position of said valve element relative to said abutment means, whereby the flow area between said element and said abutment means may be adjusted.

3. The apparatus according to claim **2** wherein said flow restricting means includes spring means biasing said valve element toward said abutment means.

4. The apparatus according to claim **2**, wherein said conduit means includes an elongated body having a fluid passage extending generally longitudinally therethrough, said passage having a transversely extending portion, said abutment means being located at said transversely extending portion.

5. The apparatus according to claim **4** wherein said valve element is aligned with the axis of said passage portion, said abutment means including a shoulder in said passage portion in position to be engaged by said valve element upon axial movement toward said shoulder, and spring means biasing said valve element toward said shoulder.

6. The apparatus according to claim **1** wherein said operating means includes means forming a fluid chamber, a movable wall dividing said chamber into first and second fluid zones, means for conducting fluid from said conduit means to said first zone, said second zone being maintained at a substantially constant pressure, whereby movement of said wall in response to fluid pressure in said conduit means operates said switch means.

7. The apparatus according to claim **6** wherein said switch means includes a contact in position to be engaged by said wall when said conduit means fluid pressure exceeds ambient pressure by a predetermined increment.

8. The apparatus according to claim **7** wherein said wall is spring biased away from said contact.

9. A method for measuring the duration of fluid flow comprising conducting the fluid through a passage, restricting the effective cross sectional flow area of said passage at a fixed region in said passage in response to flow greater than a predetermined rate to increase the fluid pressure above a predetermined value, operating a switch in response to pressure in said passage upstream from said region, placing said switch in series circuit with an electrically driven time indicating device, starting said device by closing said switch when said upstream pressure exceeds said predetermined value, and stopping said device by opening said switch when said upstream pressure is below said predetermined value.

10. The method according to claim **9** including recording the length of time that said switch is closed during a predetermined time interval.

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