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Olsson

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[54] **DEVICE FOR PRODUCING GAS FLOWS**

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[52] **U.S. Cl.** **92/40,** 137/505.47, 137/606, 138/31

[51] **Int. Cl.** **F16j 3/00**

[58] **Field of Search** 137/88, 505.36, 505.42, 137/505.46, 505.47, 606; 138/30, 31; 92/40

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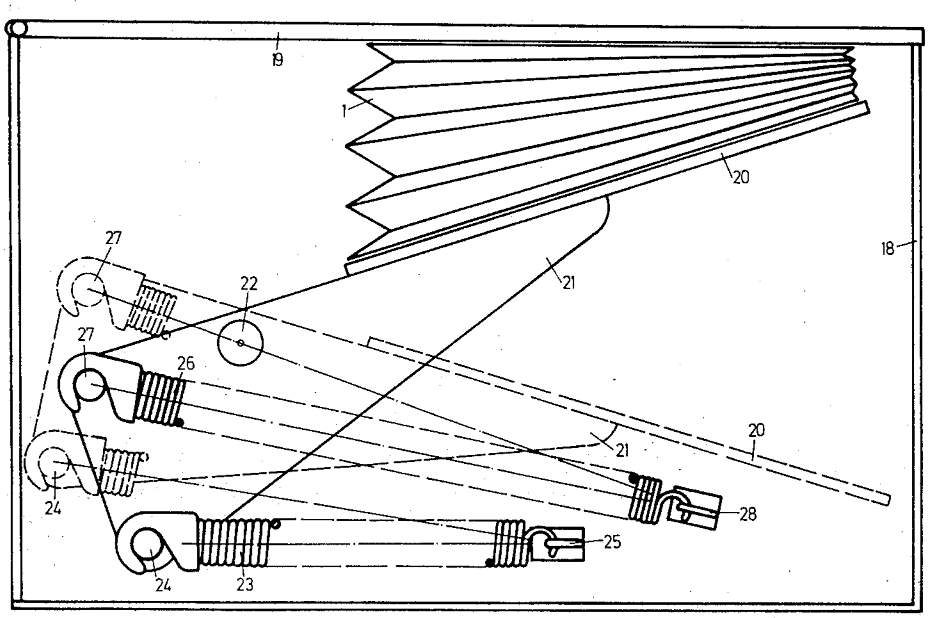
[57] **ABSTRACT**

A device for producing gas flows, particularly for the operation of a respirator, is characterized by a container for the gas the volume of which is variable within predetermined limits and which is connected with an inflow line and an outflow line. The device includes means producing a constant gas pressure in the container which is independent from its volume.

1 Claim, 2 Drawing Figures



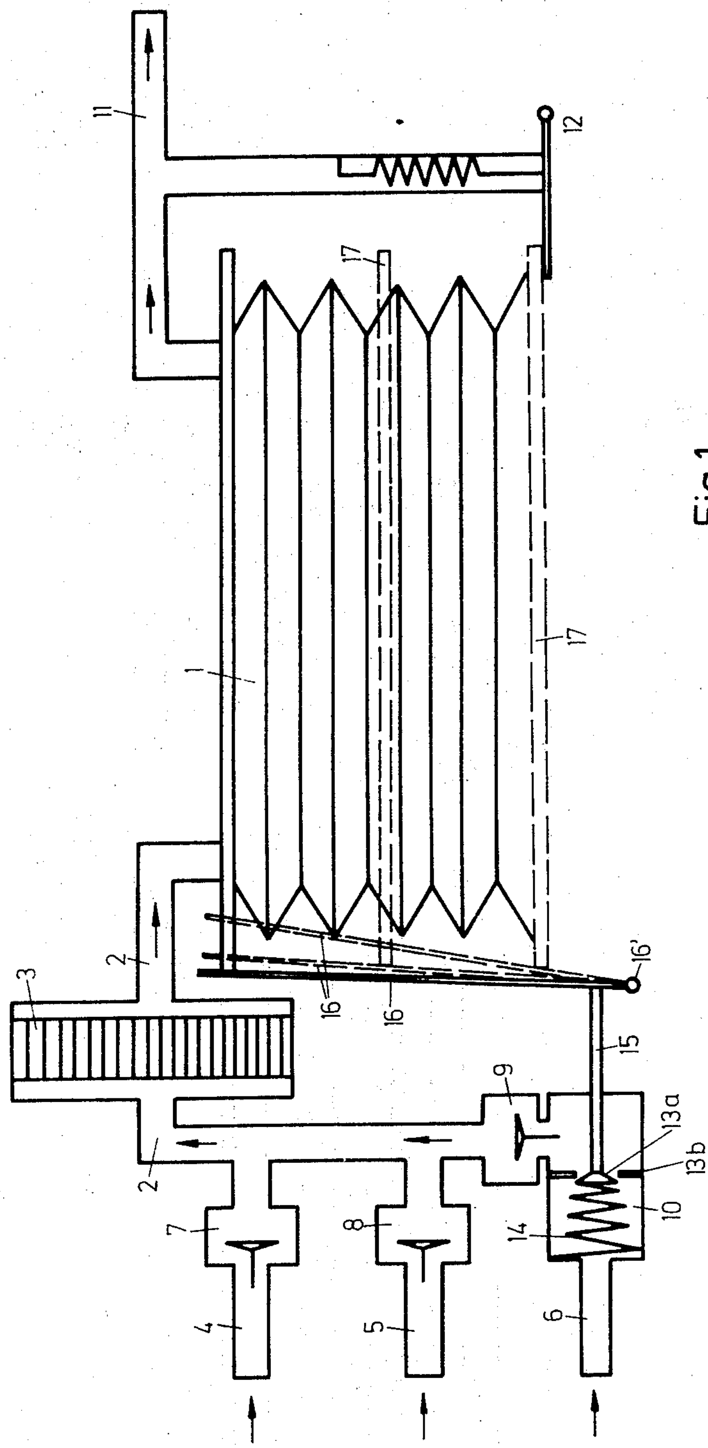


Fig.1

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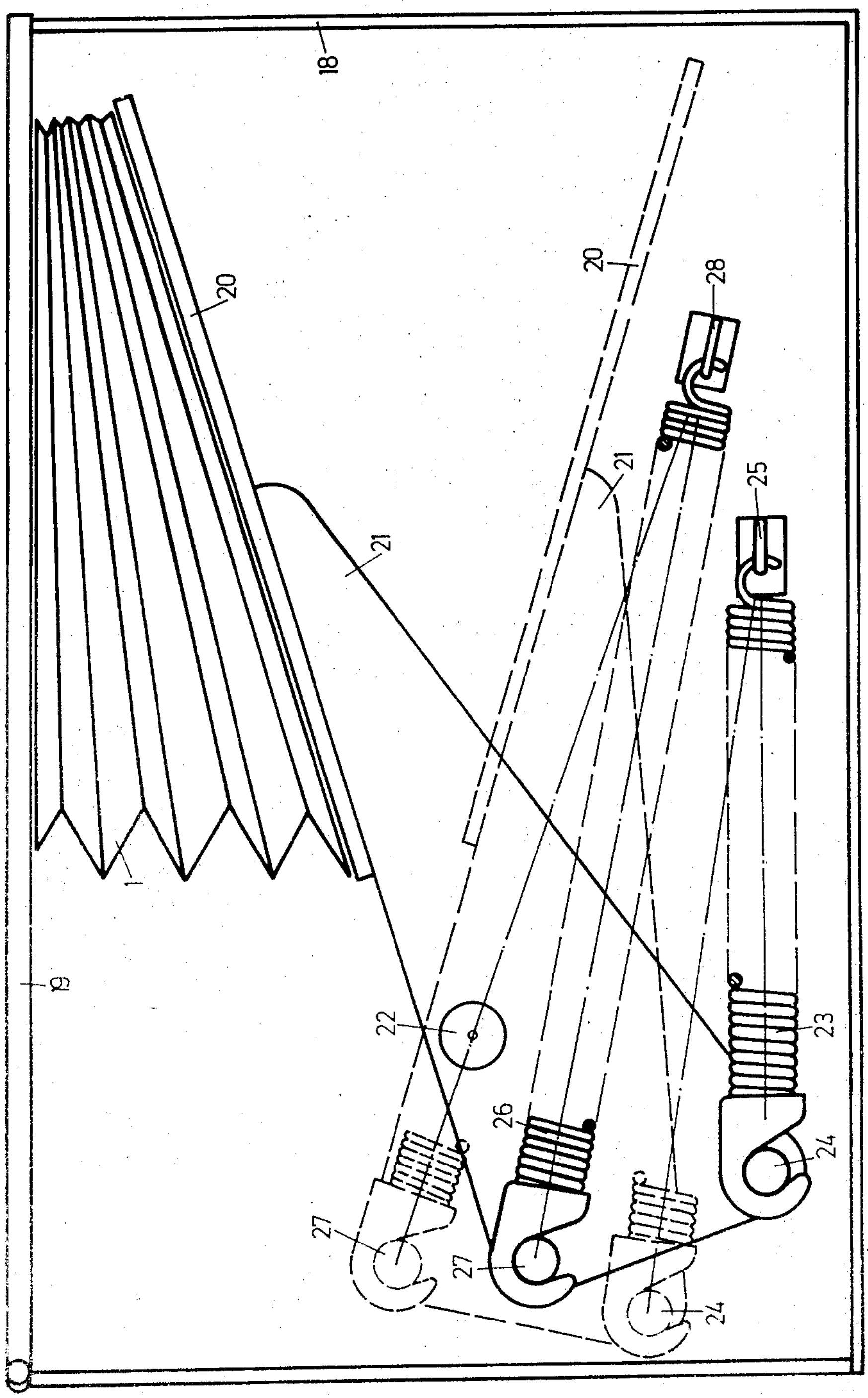

Fig. 2

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DEVICE FOR PRODUCING GAS FLOWS

This invention relates to a device for producing gas flows, particularly for operating a respirator.

Modern hospitals as a rule receive breathing gas and other gases necessary for the operation of respirators from central high pressure systems. Since gas pressure for the operation of respirators particularly with servo-operation, amounts to between 30 and 100 cm. water column, it is necessary to carry out a substantial reduction of pressure of gases coming from the high pressure system. This diminution of pressure must be also provided when using gas bottles for gas distribution.

Furthermore, the operation of respirators has various requirements concerning the operational pressure of the breathing gas. On the one hand, the operational pressure must be sufficiently high to produce the desired breathing-in flow; (the operational pressure must overcome the pressure drop resulting from resistance in inflow circuits and in breathing passages of the patient, as well as an increase in pressure in the lungs of the patient which is dependant from the volume). On the other hand for safety reasons the operational pressure should not exceed a predetermined value.

The normal volume per minute of the breathing gas supplied to the respirator amounts to between 1 to 30 l/min., while the flow supplied to the patient in the breathing-in phase can reach 150 l/min. If there is no central high pressure system, a compressor is required for the operation of the respirator. A compressor of this type is always calculated for the highest flow so that it is rather unwieldy, has a high noise range and is quite expensive in purchase price and operation.

An object of the present invention is the provision of a device of the described type wherein, on the one hand, the desired operational pressure value can be obtained in a simple manner and on the other hand, the technical expenditure for producing the desired flows is small, particularly for the high flows in respirators in the breathing-in phase.

Other objects of the present invention will become apparent in the course of the following specification.

In the accomplishment of the objectives of the present invention it was found desirable to provide a container for the gas the volume of which is variable within predetermined limits and which is provided with an inflow conduit and an outflow conduit, as well as with means producing a constant gas pressure in the container which is independent from its volume.

The present invention provides by simple means that an operational pressure value which has been once set will always remain constant independently from outside influences. The danger that, for example, the operational pressure will drop during a respirator treatment below the value required for satisfactory treatment or will rise in a manner endangering the patient, is not present any more. In case of respirators with servo-operation there is also the additional advantage that the stability of flow operation of the breathing gas is greatly improved by the constant operational pressure. Since operational pressure is actually produced in the container, the device can be connected selectively to a high pressure system or a low pressure system or to a combination of the two systems.

Furthermore, by introducing a gas container having a correspondingly variable volume between the actual gas suppliers (high or low pressure systems) and the respirator, it is provided that during the operational phase of the respirator when substantially no gas is supplied to the patient (breathing-out phase), breathing gas is accumulated in the gas container and then in the breathing-in phase enough gas is available for producing the desired high breathing-in flow. Then compressors, for example, can be also used for the operation of the respirator, the dimensions of which can be calculated for the average flow instead of the highest flow. Such compressors are less unwieldy, produce less noise and are cheaper.

During respirator treatment it often happens that special gases, for example, oxygen or narcose gas, are added to the breathing gas. The weighing of the introduced gases takes place in the simplest manner by flow meters and throttle valves, whereby the flow meter operates with a swinging float. Heretofore it was not possible to use these simple flow meters since, due to the fact that the floats cannot operate intermittently, it was not possible to provide the required accumulation of the gas flowing back during the breathing-out phase. The device of the present invention provides this accumulation in a simple manner by the gas gathering container, thus making possible the use of the above-mentioned flow meters.

According to a preferred embodiment of the present invention the constant pressure is produced by a constant force acting upon the container and independent from the volume of the container.

Furthermore, according to the present invention it is advantageous to provide means for operating the gas supply to the container in such manner that when the volume of the container becomes smaller, the supply of gas is correspondingly increased. This makes certain that the container will always have enough gas even if large amounts of gas are to be removed. For safety reasons it is also necessary to provide means which interrupt the flow of gas to the container when the upper volume limit has been reached.

In a device of the present invention wherein several gases are supplied to the container and the removal of the gas mixture is regulated depending upon the desired outflow value, it is advantageous to provide regulating means for all gases, besides the one gas, to set the desired constant inflow values to the container for these gases and operate the supply of only the remaining gas depending upon the then existing container volume. Then it is possible to supply to the patient additional gases, for example oxygen or narcose gas, in precisely regulated amounts without affecting the total flow.

The invention will appear more clearly from the following detailed description when taken in connection with the accompanying drawings showing by way of example only, a preferred embodiment of the inventive idea.

IN THE DRAWINGS:

FIG. 1 is a diagrammatic side view partly in section of a device of the present invention.

FIG. 2 is a diagrammatic side view illustrating a spring system used in the present invention.

FIG. 1 shows a foldable bellows 1 which is the container receiving gas, such as breathing gas from a pipe 2 containing a filter 3. The volume of the bellows 1 can be changed within predetermined limits. The bellows 1 is subjected to a constant pressing force independent from the volume of the bellows, as will be described in detail hereinafter. This constant pressure exerting force causes the gas pressure in the bellows 1 to remain always constant independently of the volume of the bellows 1.

The pipe 2 is connected with a total of three supply pipes 4, 5 and 6 having check valves 7, 8 and 9 for the supply of different gases to the pipe 2. For example, the pipes 4 and 5 can be used for the supply of oxygen, narcose gas or air from low pressure systems while the pipe 6 can be used to supply air from a high pressure system. The pipe 6 then has a valve 10 operating depending upon the volume of the bellows.

The bellows 1 has an outflow pipe 11 extending to a respirator (not shown) and provided with a safety valve 12 which connects the pipe 11 with outside air when the upper volume limit of the bellows 1 is exceeded.

The valve 10 in the inflow pipe 6 has a valve plate 13*a* which in its position of rest is pressed by a spring 14 against the valve seat 13*b*. The valve plate 13*a* is connected with a rod 15 which engages a lever arm 16 swingable about a fixed axis 16'.

The lower portion 17 of the bellows 1 operates upon the arm 16 in such manner that when the volume of the bellows 1 is diminished the arm will be swung counter clockwise about the axis 16'. The rotation of the arm 16 causes the raising of the valve plate 13*a* from the valve seat 13*b* against the action of the spring 14, so that air will be introduced into the bellows 1 through the pipe 6.

The arm 16 is so arranged with respect to the rod 15, that it will not exert any force upon the rod 15 when the bellows 1 is filled with gas to a greater extent than one-half of its maximum volume. Thus the valve 10 is always closed when the bellows 1 has such volume values.

The device shown in FIG. 1 operates as follows:

If a gas mixture consisting, for example, of oxygen, narcose gas and air is to be supplied to the respirator, this can be accomplished, for example, by connecting the sources of oxygen and narcose gases to the pipes 4 and 5 and connecting the gas source for air to the pipe 6. The desired flow valves for oxygen and narcose gas can be set and held constant by flow measurer and suitable set valves (not shown) located in the conduits 4 and 5. A flow regulator (not shown) is provided in the pipe 11 extending from the bellows 1 to the respirator for regulating the desired flow of breathing gas from the bellows to the respirator.

When a larger amount of gas per time is removed from the bellows 1 through the conduit 11 than is supplied to the bellows through the conduits 4 and 5 (for example, during the breathing-in phase), the volume of the bellows 1 is quickly diminished. Then the lever arm 16 actuates the rod 15 so that the valve 10 will open and air will flow through the pipe 6 into the bellows. This supply of air causes the bellows 1 to blow up again and thus the withdrawn air is compensated. The flow in the pipe 6 always constitutes the difference between the flow in the pipe 11 and the sum of the flows in the pipes 4 and 5. This has the advantage that no special device is required for regulating the individual gas flows relatively to each other, since the percentage-wise current composition of breathing gases supplied through the pipe 2 always takes place automatically.

If the supply of gas through the pipe 2 to the bellows 1 should be greater than the amount of gas removed from the bellows 1 through the conduit 11 (for example, breathing-out phase), then the part 17 of the bellows 1 will cause the opening of the valve 12 when the highest volume value is reached. This prevents a pressure increase in the bellows 1 which would be higher than the preset constant pressure value.

The embodiment of FIG. 1 permits the mixing of a total of three gases. Obviously the number of gases to be mixed can be increased at will by providing a correspondingly greater number of supply pipes connected to the pipe 2.

The bellows 1 consists preferably of a plurality of slack bags placed next to each other and pheumatically interconnected. Its volume should be preferably variable between 0.5 l. to 1.5 l. limits.

FIG. 2 illustrates a spring system for producing a constant pressure force exerted upon the bellows 1. The bellows 1 and the spring system are located in a casing 18. A part of the bellows 1 is fixed to the cover 19 of the casing 18 while its other end has a plate 20 firmly connected with a lever arm 21. The lever arm 21 is swingably mounted upon an axial pivot 22.

A first pull spring 23 has a hooked end connected firmly with the casing 18 by a member 25, while its other end engages a part 24 of the lever arm 21 and exerts a pulling force thereon. The pull of the spring 23 causes the arm 21 to swing counter clockwise about its pivot 22 so that pressure is exerted upon the bellows 1.

A second pull spring 26 is provided between another connecting part 28 of the casing 18 and a part 27 of the lever arm 21 to make certain that the lever arm 21 will always exert a constant force upon the bellows 1 within the operating range irrespective of its swinging position. The location of the part 27 engaged by the spring 26 upon the lever arm 21 is so selected relatively to the axis of rotation 22 of the lever arm 21, that in the end position of the lever arm 21 (shown by broken lines in FIG. 2) in which the bellows 1 will have reached its maximum volume, the line connecting the fixed part 28 with the spring engaging part 27 will extend through the center of the axis 22 of the lever arm 21. In this end position of the lever arm 21 the spring 26 will not exert any turning moment upon the lever arm. Then the entire pressure force upon the bellows 1 will be exerted only by the spring 23.

If thereupon the volume of the bellows 1 is reduced, the spring 23 will be increasingly relaxed. The diminution of the pulling force 23 produces a decrease in its turning moment and thus also a decrease of the force with which the lever arm 21 presses upon the bellows 1. Due to the special location of the part 27 engaged by the spring 26 and located upon the lever arm 21 relatively to the axis of rotation 22 and the part 24 engaged by the spring 23, the spring 26 will provide an additional turning moment with the increased rotation of the lever arm 21 which will always precisely compensate for the decreasing turning moment of the spring 23.

Thus the interaction of the two springs 23 and 24 results in that the turning moment produced at the lever arm 21 is always constant in each position of the lever arm. Then the pressure force exerted by the lever arm 21 upon the bellows 1 will be also always constant.

The spring 26 can be so dimensioned that the elasticity of the bellows 1 or similar force influencing factors can be compensated at the same time. A corresponding dimensioning of the spring system can also provide a so-called cover-compensation, for example, in such manner that the spring system will exert an increasing force upon the bellows **1** while the volume of the bellows is diminishing.

The present invention is not limited to the described embodiment. For example, the illustrated and described valve devices can be replaced by other similarly operating devices. Also, a spring system producing a constant pressure force upon the container can be used which is different from that illustrated. The constant force can be also produced by systems which have no springs, for example by weights pressing by their gravitational force upon the container.

I claim:

1. A device for producing gas flows, particularly for a respirator, comprising a gas container having a volume which is variable within predetermined limits, a

gas inflow line connected with said container, a gas outflow line connected with said container and constant pressure force means engaging said container and exerting a constant pressure force upon said container for producing in the container a constant gas pressure independent from the volume of the container, wherein said force means comprise a lever swingable about a fixed axis and two springs engaging one end of said lever with a turning moment to press the other end of said lever against said container, said two springs having adjacent ends engaging parts of said one end of the lever, the location of said parts relatively to the axis of the lever being such that when the turning moment produced by one spring is changed, the other spring compensates for this change to maintain the turning moment constant.

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