(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 087 034**
A1

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: **83101096.2**

(22) Date of filing: **05.02.83**

(51) Int. Cl.³: **A 62 B 7/04**
A 62 B 9/02

(30) Priority: **16.02.82 US 348871**

(43) Date of publication of application:
31.08.83 Bulletin 83/35

(84) Designated Contracting States:
DE FR GB IT SE

(71) Applicant: **CANOCEAN RESOURCES LTD.**
610 Derwent Way
New Westminster, B.C. V3M 5P8(CA)

(72) Inventor: **Suchy, Les**
3029 Connaught Avenue
North Vancouver, B.C. V7K 1Y1(CA)

(74) Representative: **Patentanwälte Kohler - Schwindling - Späth**
Hohentwielstrasse 41
D-7000 Stuttgart 1(DE)

(54) **Breathing protective apparatus.**

(57) An improved breathing protective apparatus has an inhalation regulator (23) and a primary source of breathing air supplied to the user through a pressure line (18). An exhalation regulator (29) with a return line (19) is connected to a vacuum source to remove exhaust gases from the work area. The apparatus has a positive pressure and free flowing regulator which provides an extra measure of safety in a toxic environment and to provide low breathing resistance under high work load conditions. The arrangement is such that if the exhalation regulator is bypassed for exhaust without vacuum conditions, positive pressure and the free flowing regulator is automatically eliminated to save emergency air for escape of the user from a contaminated environment.

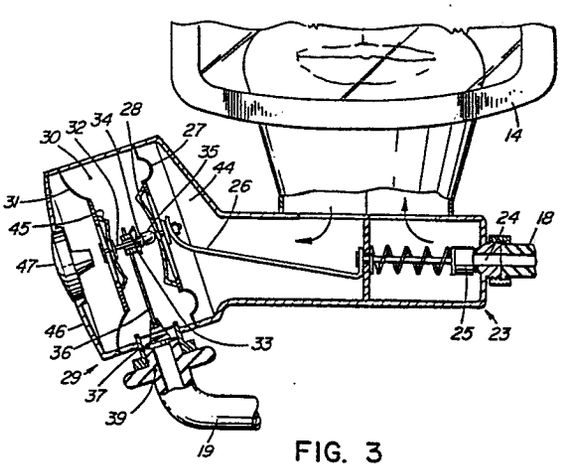

FIG. 3

EP 0 087 034 A1

COMPLETE DOCUMENT

Croydon Printing Company Ltd.

Field of the Invention

This invention relates to a breathing protective apparatus used for working in a contaminated or oxygen deficient environment, and in particular to breathing apparatus wherein breathable gas is supplied from a remote place, and exhaust gases are not discharged to the surrounding atmosphere.

Background of the Invention

A conventional type of breathing protective apparatus is one wherein breathing gas, usually compressed air, is supplied through a hose to a demand valve connected with the mask of the user. During inhalation, the user receives the required amount of air and then exhaled gas is discharged to the surrounding atmosphere. The breathing mask may be maintained at slightly higher than ambient pressure, preventing inward leakage of toxic contaminants. However, in a confined environment where a high level of hydrocarbon gases or vapours are present, exhaled gas containing unused oxygen may create a potential explosion hazard.

Problems with the above described type of breathing apparatus is also evident if it must be used in an oxygen free inerted atmosphere as discharge of oxygen into an inerted environment will require an additional costly inerting operation.

In order to increase efficiency in some closed-circuit underwater breathing apparatus, the diver's exhaust gas is pumped back to a bell or submersible unit for CO_2 removal, reconstitution and recirculation. Due to the complexity of such a system, weight and high costs, that type of apparatus cannot be utilized as a breathing protective means for working in a contaminated atmosphere.

In more complex decompression chambers, a special oxygen breathing mask is employed to eliminate a need for a high ventilation rate for oxygen removal during oxygen breathing. This type of mask has a common demand valve controlling the oxygen flow during an inhalation, and an exhalation valve connected through a hose and dumping means with an outside decompression chamber. The small exhaust capacity of the exhalation valve when used with a vacuum source, and lack of positive pressure in the mask to prevent leaks of toxic contaminants, eliminates the possibility of using it for moderate work in atmospheres containing toxic gases or vapours.

The present invention overcomes the above mentioned problems by providing an improved breathing protective apparatus with an inhalation regulator and primary source of breathing air supplied to the user through a pressure line, and an exhalation regulator with a return line connected to a vacuum source to remove exhaust gases from the work area, the apparatus has a positive pressure and free flowing regulator to provide an extra measure of safety in a toxic environment, and to provide low breathing resistance under high work load conditions.

Another feature of the invention is to provide a breathing apparatus of the type described, wherein a failure of the supply-return lines will allow a user to switch to an emergency air supply and bypass the exhaust regulator.

Yet another feature is to provide a breathing apparatus, wherein bypassing the exhalation regulator for exhaust without vacuum conditions will automatically eliminate positive pressure and free flowing regulator to save emergency air for escape from a contaminated environment.

According to an object of the present invention a breathing protective apparatus is provided including a facemask having a regulator housing incorporating an inlet valve, an inhalation diaphragm controlling said inlet valve, an exhalation diaphragm controlling said inlet valve, an exhalation diaphragm and an outlet valve controlled thereby, a supply line connecting said inlet valve with a source of

breathable air pumped under pressure to said valve; a return line connecting said outlet valve with a source of vacuum; said outlet valve and diaphragm therefore being so arranged that movement towards a closed position exerts a force on inlet valve lever means to create a positive pressure and small free flow in the facemask and regulator housing.

The invention is described with referenece to the accompanying drawings, in which:

Figure 1 illustrates the use of the present invention in an environment with a high level of hydrocarbon gases;

Figure 2 shows a general arrangement of the present invention;

Figure 3 is an elevation in cross-section of an embodiment of the present invention;

Figure 4 is a detailed perspective view of the exhaust valve;

Figure 5 is a sectional view showing the position of the exhaust regulator components without a vacuum; and

Figure 6 is a sectional view illustrating the position of the exhaust regulator components when a vacuum is applied to the outlet.

Referring to Figure 1, there is shown a typical environment in which the present invention may be used.

Oil production equipment 10 which is encapsulated in a one-atmosphere pressure subsea chamber 11 and installed on the ocean flor may require an intervention for maintenance or troubleshooting. The access to the chamber 11 is possible through a one-atmosphere service capsule 12 supplied with compressible breathable air and vacuum from a surface support vessel, not shown. The atmosphere in the chamber 11 may be inerted to eliminate fire hazard due to a possibilty of hydrocarbon gas leaks. The subsea operator 13 may enter and exit from the chamber through flexible hatches separating atmospheres in the chamber compartments.

Figure 2 shows the breathing apparatus of the present invention, worn by an operator 13 and consisting of a face mask 14 with an integrated inhalation/exhalation regulator 15. Breathable air is fed under pressure through an umbilical supply line 16, manifold 17 equipped with a check valve and

supply hose 18 into the regulator 15 and facemask 14. The exhaled gas travels back from the mask 14 and regulator 15, return hose 19 through the manifold 17, umbilical return line 20 and up to the topside vacuum source. Compressed air cylinders 21 with a pressure reducing means and suitable valves are provided for an emergency return to the service capsule 12 should a failure occur in the umbilical lines 16,20.

In Figure 3 a typical inhalation regulator 23 is shown with the inlet port 24 closed by a spring loaded poppet valve 25, connected to lever 26 and controlled by an inhalation diaphragm 27 equipped with a check valve 28.

The exhalation regulator 29 has a cylindrical housing 30 with an exhalation diaphragm 31, actuator rod 32, disc 33, spring 34, and an adjustment nut 35 as illustrated in Figure 4. A stem 36 of the exhaust tilt valve 37 is engaged with an actuator rod 32 and the disc 33 with a U-shaped fork 38.

The exhaust valve 37 is held in the closed position of Figures 3, 4 and 6 by a vacuum in the return hose 19 attached to the exhaust regulator 29 with a connector 39, Figure 3.

The details of the exhaust valve 37 are shown in Figure 4. A cylidnrical cavity 40 holding the exhaust valve 37 is closed from at its bottom by the return hose bayonet connector 39. By disconnecting the connector 39, an annular passage is formed between the walls of the cavity 40 and the valve body 37. Radial movements of the valve 37, ensuring overlapping of the conduit opening 41 in the connector 39, is restricted by pins 42 extending from the valve body 37 and the walls of the cavity 40.

Once the connector 39 is removed from the cavity 40, the axial movement of the valve 37 is restricted by a pin 43 attached to the walls of the cavity 40 and passing through an elongated aperture in the valve body 37. Referring to Figure 5 it will be seen that the inward and outward movement of the exhalation diaphragm 31 in housing 30 produces a tilting movement of the exhaust valve 37 in the cavity 40.

Figure 5 further illustrates the position of the components of the exhalation regulator 29 when vacuum is not present in the conduit 41 of the return hose. The exhalation diaphragm 31 is positioned so that the exhaust valve 37 is held in a tilted open position.

In Figure 6 the exhaust regulator 29 is shown with the vacuum applied to the conduit 41. The suction developed between the valve body 37 and the opening of the conduit 41 overcomes the stiffness of the diaphragm 31 and deflects it inward housing 30. Movement of the diaphragm 31 and the actuator 32 activates the inhalation diaphragm 27, lever 26 and opens the inlet port 24 of the inhalation regulator 23. With applied supply pressure and worn facemask 14 this in turn creates a flow of air and pressure build-up in the facemask 14 and regulator housing 44. The pressure differential opens a check valve 28 and pressure increases also in the exhaust housing 30 moving the exhalation diaphragm 31 and the actuator rod 32 outward, terminating activation of the inhalation diaphragm 27 and related inflow. The outward movement of the actuator rod 32 compresses the spring 34 so that the movement does not affect the exhaust valve 37 still kept in the closed position.

Upon exhalation, exhaled gas flows from the facemask through the regulator housing 44, check valve 28, into the exhaust housing 30 applying exhaust pressure on the diaphragm 31.

The outward movement of the diaphragm 31 tilts open the exhaust valve 37 and the exhaled gas is carried away by the vacuum in the return hose 19. Once the exhaust flow and the corresponding exhaust pressure on the diaphgram 31 ceases, the suction closes valve 37 again causing the positive pressure build-up in the facemask 14.

The level of positive pressure eliminating the risk of contamination leak into the facemask could be set with adjustment nut 35 and position of the lever 26 in relation to the diaphragm 27.

The positive pressure inside housing 30 and the related force applied on the exhalation diaphragm 31, as well as the force from the elastic deflection of the diaphragm 31, helps to overcome the relatively high initial resistance to the open exhaust valve 37. This arrangement of the regulator 29 permits effortless high volume exhalation. Furthermore, a small continuous flow of air through the facemask 14 and exhalation regulator 29 can be adjusted with nut 35 so that the visor of the mask is continuously flushed with fresh air, eliminating mask fogging during work and, even more important, the work of inhalation is greatly reduced.

To prevent a possible face squeeze, if exhaust valve 37 fails to close, a safety relief valve 45 is built into the exhaust diaphragm 31. A perforated cover 46 has an installed purge button 47, Figure 3, allowing manual actuation of the regulator 15.

If the umbilical supply and return flow through the umbilical lines 16,20 are interrupted, the operator will open the emergency air supply 21 and disengage the return hose bayonet connector 39 from the exhaust regulator 29. Lack of actuation force from diaphragm 31 allows use of the emergency air supply on the normal demand mode. Exhaled gas passes through the check valve 28, annulus formed in cavity 40 and is discharged into the surrounding atmosphere.

If necessary, the operator can free himself from the umbilical lines by disconnecting the quick disconnects 48,49.

CLAIMS

1. A breathing protective apparatus including a facemask having a regulator housing incorporating an inlet valve, an inhalation diaphragm controlling said inlet valve, an exhalation diaphragm and an outlet valve controlled thereby, a supply line connecting said inlet valve with a source of breathable air pumped under pressure to said valve; a return line connecting said outlet valve with a source of vacuum; said outlet valve and diaphragm therefore being so arranged that movement towards a closed position exerts a force on inlet valve lever means to create a positive pressure and small free flow in the facemask and regulator housing.

2. A protective apparatus according to claim 1 wherein the exhalation regulator includes a cylindrical housing with a diaphragm therein in juxtaposition to the inhalation diaphragm; an actuator rod concentrically mounted on the interior of the exhalation diaphragm and directed toward the inhalation diaphragm; a tiltable exhaust valve having a base covering an exhaust port and an upwardly extending stem engaging said actuator rod, said exhaust valve being held in a port closing position by vacuum in said return line; and return line connector means attaching the return line to said exhaust port and regulator.

3. A protective apparatus according to claim 2 including a cylindrical cavity retaining the base of said exhaust valve; means on the valve body restricting radial movement thereof; a pin extending diametrically across the cylindrical cavity and passing through the valve body to restrict axial movement thereof.

4. A protective apparatus according to claim 2 wherein said exhaust port is formed by a body of the return line connector.

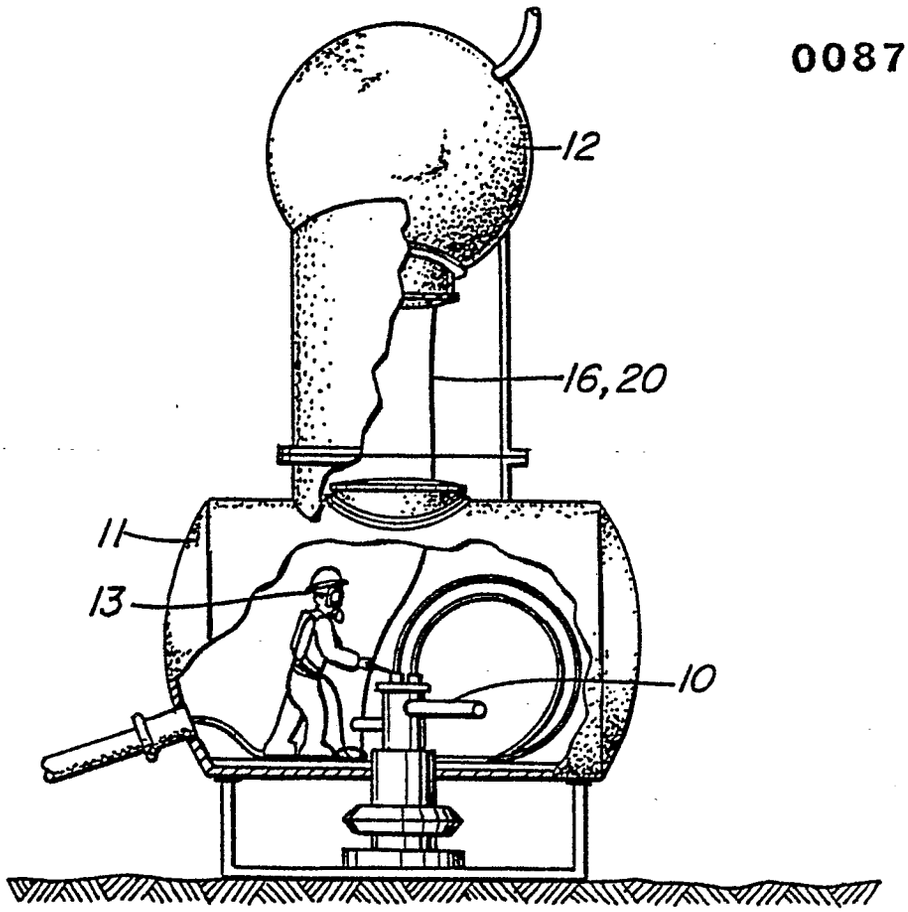

FIG. 1

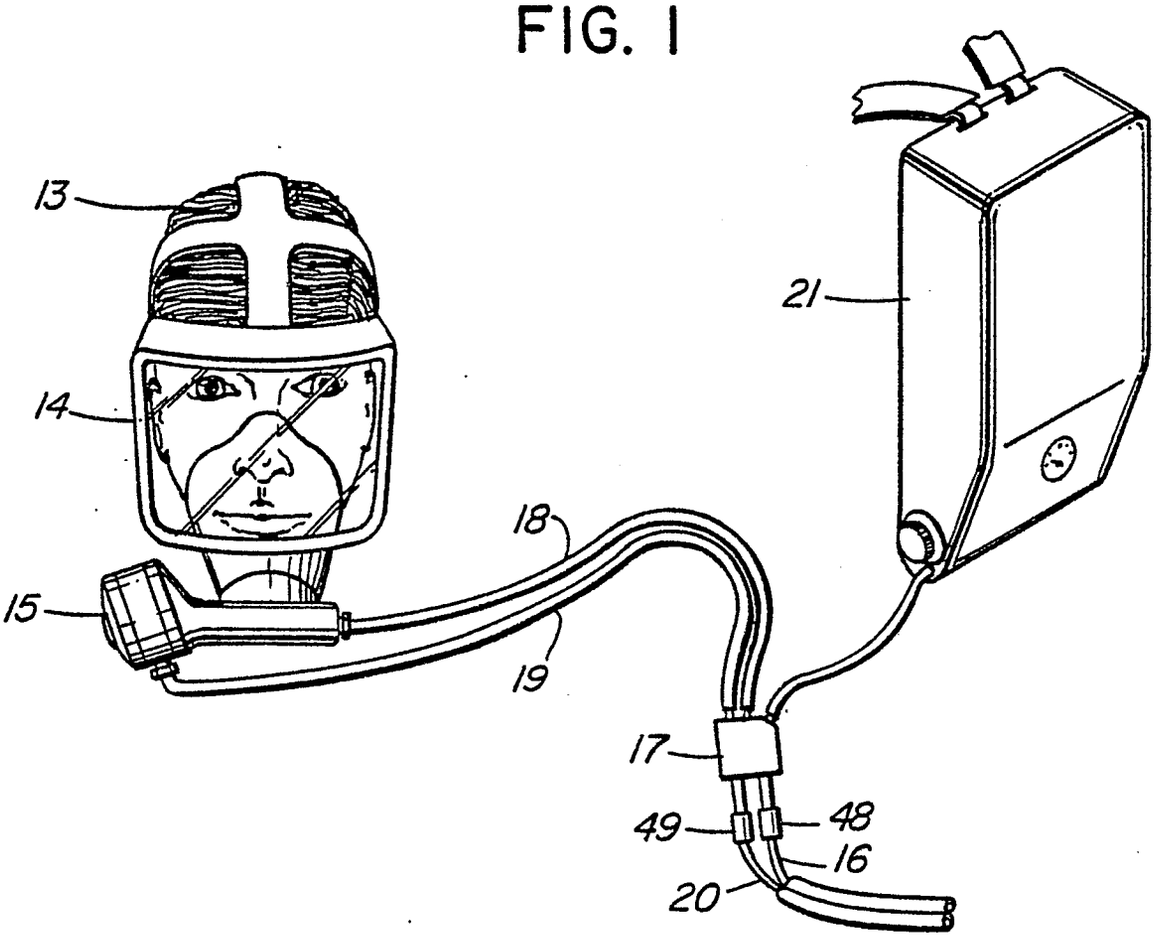

FIG. 2

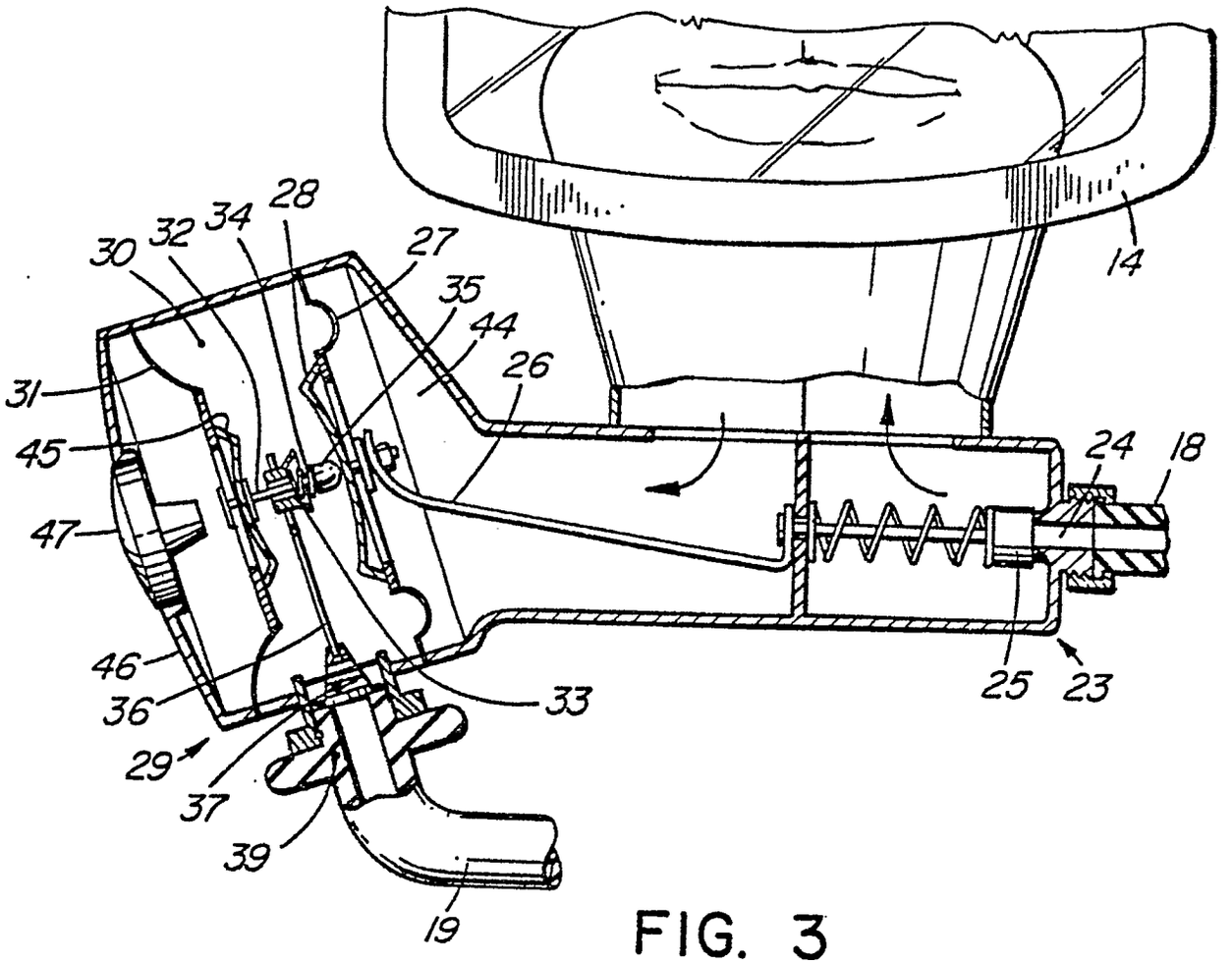
14
28
34
32
30
27
35
44
26
31
45
47
24
18
46
36
33
29
37
39
25
23
19

FIG. 3

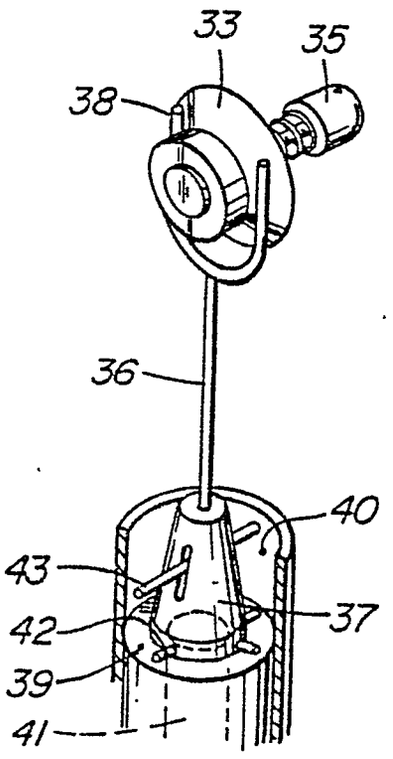
33
35
38
36
40
43
42
37
39
41

FIG. 4

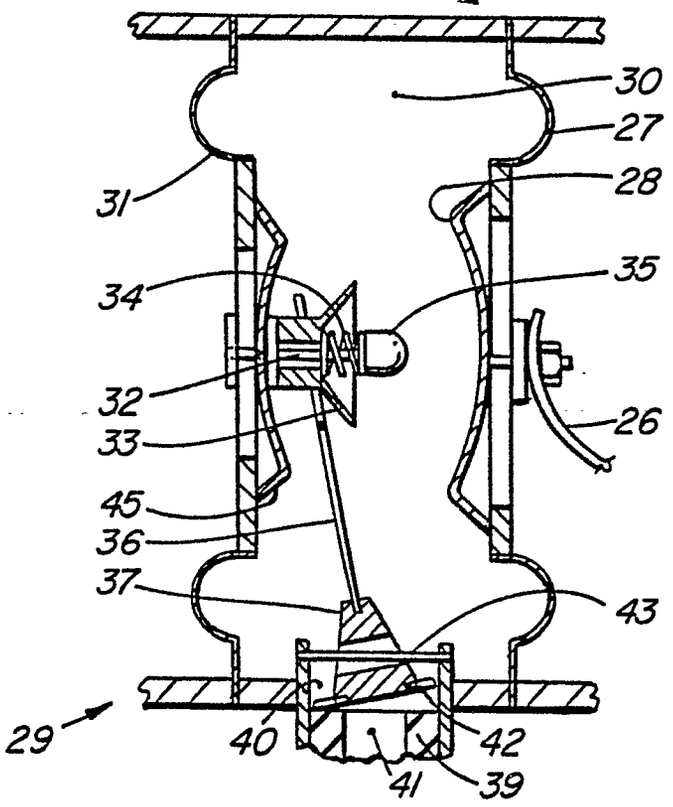
30
27
31
28
34
35
32
26
33
45
36
37
43
29
40
42
41
39

FIG. 5

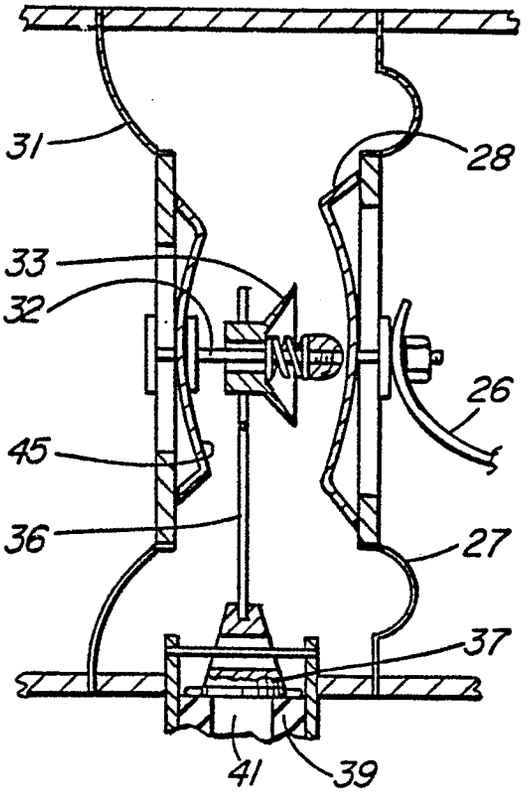
31
28
33
32
26
45
36
27
37
41
39

FIG. 6

European Patent Office

EUROPEAN SEARCH REPORT

0087034
Application number

EP 83 10 1096

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
Y	US-A-3 468 307 (CUMMINS) * Claim 1 *	1	A 62 B 7/04 A 62 B 9/02
Y	US-A-2 418 034 (KIZAUR) * Figures 1, 5 *	1	
A	FR-A-1 438 515 (LA SPIROTECHNIQUE)		
A	DE-C-1 120 279 (DRÄGERWERK)		
A	US-A-2 085 249 (BULLARD)		

TECHNICAL FIELDS SEARCHED (Int. Cl. ³)

A 62 B 7/00
A 62 B 9/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	11-05-1983	KANAL P K

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO Form 1503. 03.82