May 9, 1967 S. V. NICASTRO 3,318,307

BREATHING PACK FOR CONVERTING LIQUID AIR OR OXYGEN INTO BREATHABLE GAS

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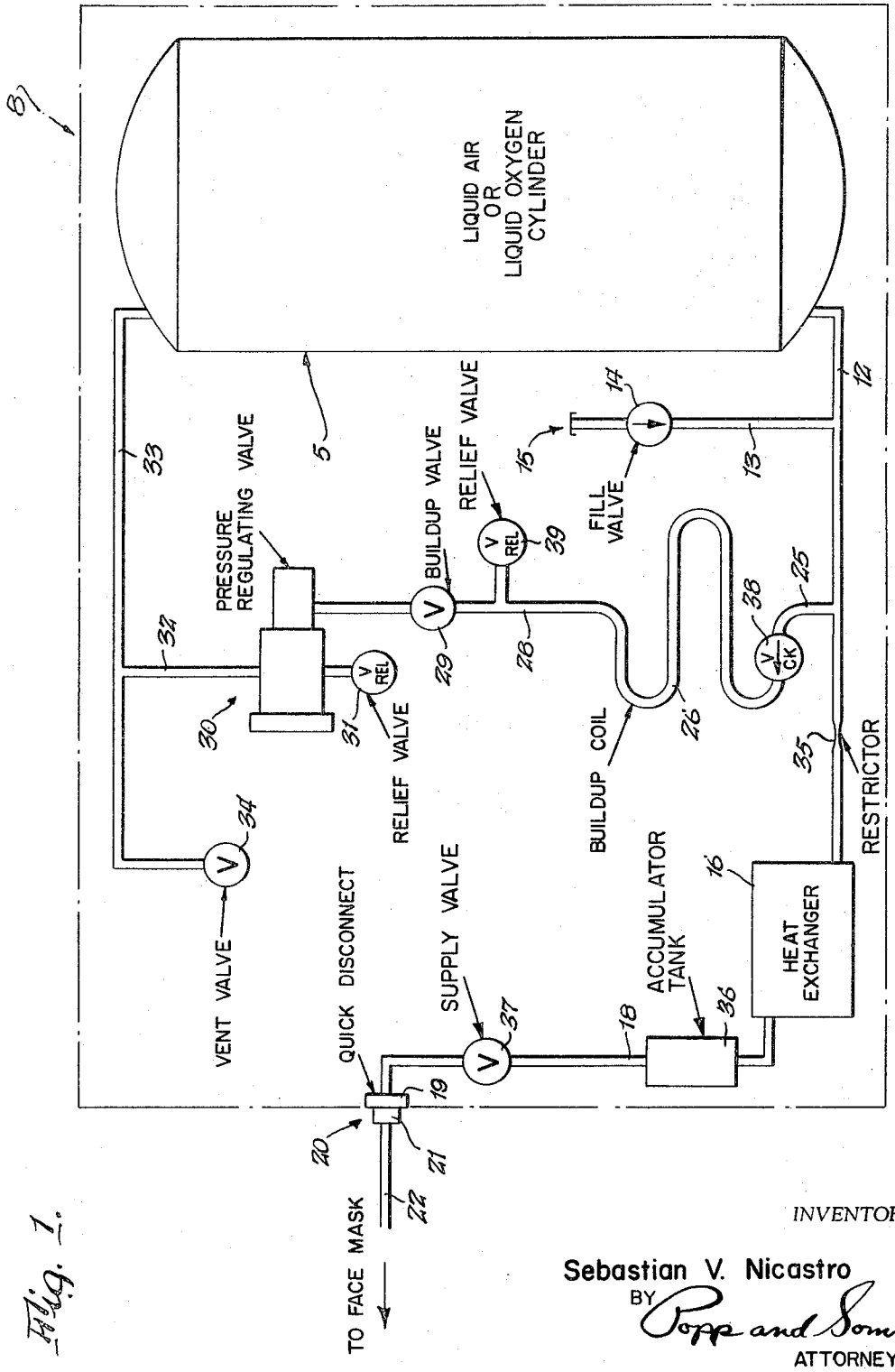


Fig. 1.

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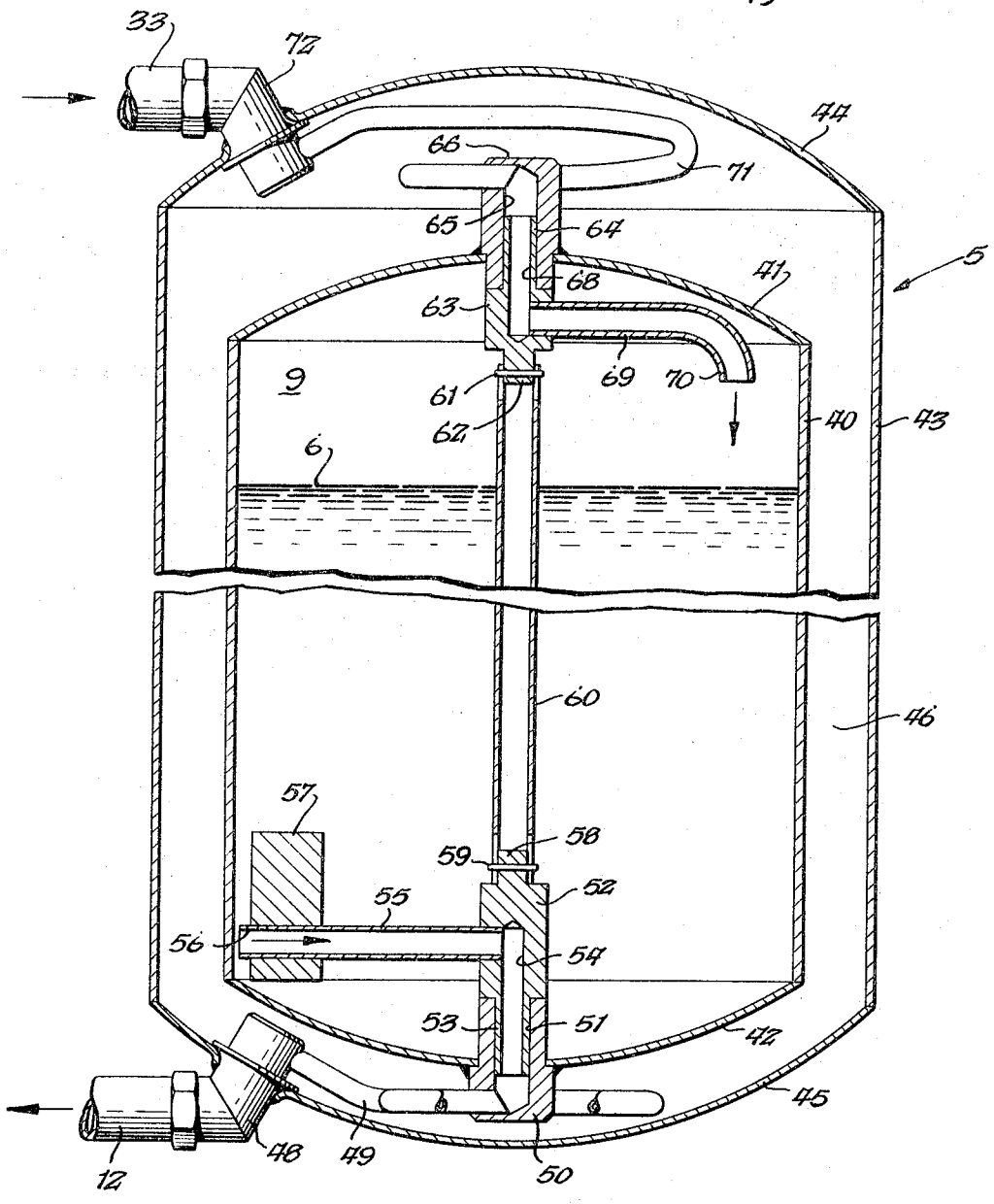
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Fig. 2.



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BREATHING PACK FOR CONVERTING LIQUID AIR OR OXYGEN INTO BREATHABLE GAS

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5 Claims. (Cl. 128—142.2)

This invention relates to a portable pack for converting liquid air or oxygen into gaseous form for breathing use and more particularly for use in work, such as emergency or rescue work or in mines, where in use the pack is shifted and held in various positions with reference to its normal vertical position, such as when carried on the back of a miner crawling up a slope in the mine.

One of the principal objects of the present invention is to pressurize the liquid air or oxygen in the supply container by gas developed from the contained liquid. To achieve this object a part of the liquid is withdrawn, heated and returned as a gas to the gas head above the liquid. By this means advantage is taken of the high ratio of expansion of the liquid to gas which in the case of liquid air is 630 to 1.

Another important object is to prevent such returned gas from being recondensed into the liquid thereby to destroy its pressurizing effect and impair the expulsion of the liquid for breathing purposes. This object is effected by moving the open outlet end of a pressurized gas return tube by gravity to the highest part of the container in angular positions of the latter with reference to its normal upright position so that the returned gas is discharged into the gas head in such angular positions and not into the body of liquid to condense therein.

Another object is to expel a large total amount of the liquid regardless of such angular positions of the container so as to render available for breathing purposes the largest practicable amount of the liquid. This object is effected by moving the open inlet end of a liquid outlet tube by gravity to the lowest part of the container in angular positions of the latter with reference to its normal upright position.

Another object is to combine such gravity positioning of the outlet end of the pressurized gas tube and inlet end of the liquid outlet tube by a simple interconnection between the two. This object is effected by mounting these tubes to project radially from swivels journalled on the upper and lower ends heads of the liquid container, connecting the swivels by a concentric rod or tube fixed thereto, and weighting the outboard end of the liquid discharge tube.

Another object is to provide such a pack which is simple and extremely reliable in operation and not subject to breakdown or malfunction.

Other objects and advantages of the invention will be apparent from the following description and drawings in which:

FIG. 1 is a schematic representation of a breathing pack embodying the present invention.

FIG. 2 is an enlarged central longitudinal section through a container for the liquid air or oxygen included in the breathing pack.

The invention is essentially concerned with the mechanism contained within a double walled container or bottle indicated generally at **5** and containing a body **6** of liquid air or oxygen for breathing purposes. This container is included in a portable pack designated generally by the dot-dash line **8** and which can be strapped to the back of the miner or other user. A gas head **9**, derived from the liquid **6** as hereinafter described, is used to pressurized the bottle **5**.

The liquid air or oxygen **6** is withdrawn from the container or bottle **5** through a liquid outlet conduit **12** which has a branch **13** containing a fill valve **14** and having a filling connection indicated generally at **15**. The liquid air or oxygen from the liquid outlet conduit **12** is converted into gas for breathing purposes by passage through a heat exchanger or heater **16** and the outlet line **18** which connects with a fitting **19** forming part of a quick disconnect indicated generally at **20**. The other part **21** of this quick disconnect has a flexible line **22** leading to the face mask (not shown) of the miner or other user.

In the practice of the present invention a part of the liquid air or oxygen from the liquid outlet conduit **12** is converted into gas and this gas is used to pressurize the double walled container or bottle **5** by being admitted into the gas head **9** above the body **6** of liquid in the double walled container or bottle **5**. To this end a branch line or pipe **25** from the liquid outlet conduit **12** connects with the inlet of a buildup heating coil **26**, the outlet line **28** of which contains a valve **29** and connects with the inlet of a pressure regulating valve indicated at **30**. This pressure regulating valve has a relief valve **31** discharging into the atmosphere and its outlet line **32** connects with a gas pressurizing conduit **33** having a vent valve **34** and leading to the gas head **9** in the top of the double walled container or bottle **5**. Desirably the breathing pack also includes a restrictor **35** in the liquid conduit **12** between the branch line **25** and the heat exchanger **16**; an accumulator tank **36** followed by a supply valve **37** in the line **18**; a check valve **38** in the branch line **25** in advance of the buildup coil **26** and a relief valve **39** in the line **28** following this buildup coil **26**.

This double walled container or bottle **5** is preferably of cylindrical form with its axis normally arranged upright and includes an inner cylindrical shell **40** having an upper end head **41** and a lower end head **42** and a concentric outer cylindrical shell **43** having an upper end head **44** and a lower end head **45**. The space **46** between these shells can contain insulation (not shown). This insulation is preferably a pure vacuum or in the form of super-insulation, that is, alternative layers or porous paper and reflective foil.

To withdraw the liquid air or oxygen from the bottom of the double walled container or bottle **5**, the liquid outlet conduit **12** connects with a fitting **48** extending through and secured, as by welding, to the lower end head **45** of the outer shell **43** and connected by a pipe **49** in the space **46** with a fitting **50** extending concentrically through the lower end head **42** of the inner shell **40**. This fitting **50** has a bore **51** extending downward from the top of the fitting concentric with the axis of the inner container **40** and communicating at its lower end with the outlet pipe **49** leading to the liquid outlet conduit **12**. An important feature of the invention resides in the bore **51** of the fitting **50** serving as bearing for a swivel **52**. This swivel has a depending stem **53** journalled in the bearing bore **51** and has a vertical bore **54** extending upwardly from its bottom. The upper end of this bore **54** communicates with a liquid outlet tube **55** secured to and extending laterally outwardly from the swivel **52** and having its outer open end **56** arranged close to the juncture of the side wall of the shell **40** and its bottom end head **42**. The outboard end **56** of this tube **55** also carries a weight **57** for a purpose which will presently appear.

The swivel **52** has an upstanding concentric neck **58** secured, as by a pin **59**, to a thin walled tube **60**. This tube is arranged concentrically of the inner shell **40** and its upper end is secured, as by a pin **61**, to the depending neck **62** of a swivel **63**. This swivel **63** has an upstanding neck **64** which is journalled in the open lower end of a bore **65** of a fitting **66** extending concentrically through

and secured, as by welding, to the upper end head **41** of the inner shell **40**. The swivel **63** has a bore **68** which is open at its upper end and at its lower end communicates with a gas pressurizing tube **69** fixed to and extending laterally outwardly from the swivel **63**. The open outboard end **70** of the gas pressurizing tube **69** is arranged to swing close to the line of juncture of the side wall of the inner shell **40** and its upper end head **41** and an important feature of the invention resides in the open ended gas pressurizing tube **69** projecting in the opposite direction with relation to the open ended liquid outlet tube **55**, that is, these two tubes being 180° out of phase with reference to each other.

The upper end of the bore **65** is connected by a pipe **71** contained within the space **46** to a fitting **72** extending through and secured to the upper end head **44** of the outer shell **43**. This fitting **72** connects with the gas pressurizing conduit **33**.

In use, in response to the inhalation demand of the user as applied at the quick disconnect **20**, liquid air or oxygen is supplied to him, this liquid air or oxygen being supplied from the body **6** contained within the inner shell **40** of the double walled container **5** and flowing out the inlet end **56** of the weighted liquid outlet tube **55** into the bore **54** of the swivel **52**. From this bore the required liquid air or oxygen flows into the bore **51** of the fitting **50** and thence through the pipe **49** and fitting **48** into the liquid outlet conduit **12** of the breathing pack. In the heat exchanger or heater **16** this liquid air or oxygen is converted into gaseous form before being supplied to the quick disconnect and to the breathing mask (not shown) of the user.

A part of this liquid air or oxygen from the liquid outlet conduit **12** enters the buildup heating control and is converted into gas, the pressure of this gas being under control of the pressure regulating valve **30** and its relief valve **31**. From the outlet **32** of this pressure regulating valve **30** this gas enters the gas pressurizing conduit **33** and through the fitting **72**, pipe **71** and fitting **66** enter the bore **65** of this last fitting and enter the bore **68** of the swivel **63** journalled in this bore **65**. From the swivel **63**, the gas enters the gas pressurizing tube **69** and its pressure is impressed against the gas head **9** in the inner shell **40** above the body **6** of liquid air or oxygen contained therein.

Since the swivels **63** and **52** are connected together by the concentric tube **60**, as the outboard weighted end **56** of the liquid outlet tube **55** seeks the lowest position, through the tube **60**, it swings the outboard end **70** of the gas pressurizing tube **69** to the highest position within the inner shell **40**. As a result, the incoming gas from the gas pressurizing tube **69** employed to pressurize the gas head **9** is admitted directly into this gas head because the outboard end **70** of this gas pressurizing tube seeks the highest elevation which is also sought, of course, by the gas head **9**. This is an important feature of the invention since if the incoming gas were introduced into the body **6** of liquid air or oxygen, it could recondense into liquid form and fail to provide the necessary pressure within the inner shell **40**. There is a 630 to 1 expansion of liquid air into gas form, this being the basis for pressurizing the liquid body **6** to provide a uniform and steady pressure to expel the liquid air or oxygen.

As a further advantageous feature of the invention, the seeking of the lowest level within the inner shell **40** of the outboard weighted end **56** of the liquid outlet tube **55** also insures the discharge of a large amount of liquid air or oxygen regardless of the position of the tank.

It will be seen that the invention is particularly applicable for air packs to be used by miners or other workers who are required to work in other than upright body positions, as when a miner is required to crawl along a slope in the mine. Thus, when this occurs, the axis of the double walled container **5** is brought to an angular position with reference to the vertical. When this occurs, the weight **57** at the outboard end **56** of the liquid outlet tube **55** swings this outboard end to the lowest position within the inner shell **40** so that even if only a small amount of liquid air or oxygen **6** is left within this inner shell, it will be supplied to the miner in response to his demands. More important, if the inner shell **40** at this time contains the maximum amount of liquid air or oxygen **6** with a minimum gas head **9** thereabove, this swinging of the weighted liquid outlet tube **55**, through the tube **60** connecting the two swivels **52** and **63**, swings the outboard end **70** of the gas pressurizing tube **69** to the highest position within the inner container **40** so that it discharges directly into the gas head **9** and not into the body **6** of liquid air or oxygen to recondense therein and fail in its function of pressurizing this body **6** of liquid air or oxygen for use by the miner.

I claim:

1. In a portable pack for converting liquid air or oxygen into gaseous form for breathing use in work where the pack is subject to being held in various positions, the combination comprising a container for a body of said liquid and for a head of gas evolved from said liquid and having a side wall shell enclosed by upper and lower end heads, an open-ended liquid outlet tube movably mounted in the bottom of said container, an open-ended gas pressurizing tube movably mounted in the top of said container, a liquid outlet conduit communicating with said liquid outlet tube, means converting the liquid in said liquid outlet conduit into gas for breathing purposes, a gas pressurizing conduit communicating with said gas pressurizing tube, means converting a part of the liquid in said liquid outlet conduit into gas and conducting such gas to said gas pressurizing conduit, and means actuated by gravity to move the open end of said liquid outlet tube to its lowest position and the open end of said gas pressurizing tube to its highest position within said container, whereby in angular positions of said container with reference to the vertical, the gas pressurizing tube will discharge gas into said gas head and thereby avoid recondensing said gas into said body of liquid and whereby in all such angular positions of said container said liquid outlet tube will expel a large total quantity of said liquid.

2. The combination set forth in claim **1** wherein said liquid outlet tube projects radially from a swivel journalled on said lower end head to permit movement of its open end along the line of juncture of said side wall shell and lower end head, wherein said gas pressurizing tube projects radially from a swivel journalled on said upper end head to permit movement of its open end along the line of juncture of said side wall shell and upper end head, and wherein means connect said swivels and compel them to rotate in unison.

3. The combination set forth in claim **2** wherein said gravity actuated means includes a weight fixed to said open end of said liquid outlet tube to cause it to seek the lowest level in all such angular positions of said container.

4. The combination set forth in claim **3** wherein said swivels are concentric and a rod is fixed at its opposite ends to said swivels to compel them to rotate in unison.

5. The combination set forth in claim **4** wherein opposing necks are provided on said swivels concentric with their axis of rotation and wherein said rod is in the form of a thin-walled hollow tube with its opposite ends embracing and fixed to said necks.

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