HARNESS FOR A BREATHING MASK AND MASK FOR USE WITH SUCH A HARNESS

The invention relates to head harnesses for quick-attachment or quick-donning of a respiratory mask and it finds a particularly important application in the pressurized cabin of high altitude aircraft.

As the cruising altitude of airliners and business airplanes increases, it becomes more and more difficult to protect the occupants against the effects of a sudden pressurization. However, it is necessary to prevent any loss of consciousness of the pilot (or at least of one of the pilots) in the event of a depressurization, so that he may bring back the aircraft to a lower altitude.

There are already known (patent FR 1,506,342 or US 3,599,636, and patent US 4,437,462) head harnesses for a respiratory mask, used in numerous passenger aircrafts, which have at least one expandable strap whose ends are connected to the mask and including an element which can be inflated with a pressurized gas for extending the strap up to a determined size, sufficient for the user to place the strap around his head, and provided with manual controlled means making it possible to deliver pressurized gas into said element in order to expand and vent this element for enabling the strap to apply against the head and maintain the mask in position.

In an advantageous embodiment, the inflating gas consists of respiratory gas which is delivered as required to the demand regulator carried by the mask.

Such a head harness enables the user to take hold of the mask stored in a box located in the vicinity of his seat and to don it in a few seconds. However, in case of a very sudden depressurization at high altitude, the lack of oxygen due to exposure to thin air during these few seconds may suffice for causing a delayed loss of consciousness after which it will be too late for the pilot to resume the

control of the aircraft.

Such a risk is avoided if the pilot, or one of the pilots, permanently dons his respiratory mask as long as the aircraft is flying at high altitude, for instance above 10,000 meters. However, permanently donning the mask applied against the face causes respiratory fatigue and discomfort. Furthermore, if the mask is continuously fed with oxygen, the capacity of the oxygen storage bottles or cylinders should be higher than the one currently required.

The invention aims at providing a quick-attachment or quick-donning head harness for a respiratory mask better meeting the requirements encountered in the practice than those of the prior art, especially in that they practically eliminate the post-incident time-delay after which the user has respiratory oxygen at his disposal, while limiting the prolonged wearing of the mask.

For this purpose, the invention provides a head harness of the above type as defined in claim 1.

The switch may comprise a calibrated valve provided with a control handle with at least two positions, whereby the calibration of the valve may be adjusted once for all or remain adjustable. In the latter case, a user of the mask may adapt the intermediate pressure to his or her specific morphology, which is particularly advantageous if the mask remains permanently stored in the cockpit for use by individuals of quite variable sizes.

The calibrated valve advantageously comprises a shutter sliding over a rod and the control handle comprises an eccentric cam for the travel of the rod towards a shutter seat, whereby resilient means are mounted between the rod and the valve in order to force the latter back towards the seat up to a predetermined position relatively to the rod.

In an advantageous embodiment, the manually controlled means for the inflation cooperate with the switch in such a way that when the latter is in a state in

which it maintains the gas pressure at the residual value, a gradual inflating process may be generated upon the actuation of the manually controlled means, which in particular makes it possible for the user to restore the residual pressure by temporarily actuating the manually controlled means if the application force of the mask increases as a result of a leakage in the inflatable element.

The invention will be better understood from the following description of particular embodiments given as non-limiting examples. The description refers to the accompanying drawings, in which:

- Figure 1 is a perspective view showing the exterior aspect of a mask provided with a head harness according to the invention;
- Figures 2A and 2B are principle diagrams showing a simple switch structure, respectively in the "comfort" and "emergency" positions;
- Figures 3 and 4, similar to Figure 2A, illustrate two modified embodiments;
- Figure 4A, similar to a part of Figure 4, shows the addition of an altitude responsive valve; and
- Figure 5 shows a possible structure for a switch according to the diagram of Figure 3.

Figure 1 shows an emergency respiratory apparatus in its position of use when over the head of the user. This apparatus may be considered as having an oro-nasal face cover 10 (which may be provided with a transparent eye shade for protection against smoke) integral with a rigid connecting block 14, straps 20 for maintaining the face cover 10 applied against the face and attached to the connecting block 14 and a housing 16. The housing contains a demand regulator and possibly a microphone.

The assembly consisting of the straps 20, the connecting block 14 and the elements contained in the block may be considered as a harness 12 carrying the demand

regulator and the face cover 10.

The connecting block 14 is provided with a nozzle piece or inlet for connection with an inflatable hose 17 for the delivery of pressurized respiratory gas. The connecting block connects the regulator with the hose and has manually controlled means for inflating the head harness, comprising a control valve for actuation by squeezing two ears 18 carried by the connecting block 14 between the thumb and index finger of the user.

When the control valve is at rest, it connects an internal volume of the connecting block to the atmosphere for permitting retraction of the head harness. When the valve is manually actuated, it receives pressurized gas from the supply hose 17 in the volume.

In a particular embodiment shown in Figure 1, the head harness comprises two straps 20 each having an inner tube of resilient material contained in a non-stretchable sheath which limits the extension of the tubes. The length of the inner tubes at rest is such that the latter tend to apply the face cover 10 onto the face with a pressure sufficient to provide the required airtightness. However, the invention would equally be applicable, although with somewhat less interest in this case, to a harness having one or a plurality of non-stretchable bands, or even a ring, formed to contact the rear of the head and one or more than one pneumatic jacks for moving the band or ring away from the mask by a sufficient amount for the head to go through easily.

The head harness according to the invention comprises a switch which makes it possible, according to its selected position, to connect the straps with the internal volume of the connecting block or to retain in the straps a determined overpressure relatively to the volume, when the pressure in the latter decreases below the pressure prevailing in the straps.

In the simple embodiment of the invention shown in

Figures 2A and 2B, the valve comprises a body 21 defining a chamber 22 which permanently communicates with the internal volume 26 of the switch 28 through a passage 24. The chamber 22 opens into a space which receives pressurized gas from the hose 17 through a first valve seat and opens into the atmosphere through a second seat. These two seats respectively cooperate with an inlet valve member 27 for admission of pressurized gas and a valve member 29 for venting to the atmosphere, carried by the same rod actuated by the tiltable ear 18. Gas pressure (and possibly the force of a return spring, not shown) biases the movable unit consisting of valve members 27 and 29 and the rod 33 to the position shown in Figure 2A in which the chamber 22 is connected to the atmosphere. When the user presses down the tiltable ear 18, the latter displaces a movable unit, separates chamber 22 from the atmosphere and connects it with the pressurized gas supply hose 17.

As in the case illustrated in Figure 2A, the switch 28 is formed with a passage 30 connecting an internal volume 26 with the straps, surrounded with a seat accomodating a shutter valve member 32. This valve member 32 slides over a rod 34 coaxial with the seat, which a control handle 36 makes it possible to shift between a position close to the seat (shown in Figure 2A) and a position spaced away from the seat (shown in Figure 2B). In the illustrated embodiment, this control handle consists of a tiltable or rotatable lever around an axis 37 and provided with an eccentric cam 38 abutting against the rod 34. A spring exerting a very slight force 39 permanently maintains the rod 34 in abutment against the eccentric cam. Between the rod 34 and the valve member 32 is interposed a spring 40 which brings the shutter valve member against a stop 41 of the rod when the rod is in the remote or withdrawn position illustrated in Figure 2B, and sets the residual pressure maintained in the straps when the rod is in the forward or closest position shown in Figure 2A.

The amount of travel of rod 34 given by the eccentric cam 38 is selected in such a way that, when the control handle is in the "emergency" position shown in Figure 2B, which corresponds to the actual use of the mask in case of incident, the valve member 32 is quite clear of the seat and leaves a free communication between the straps 20 and the volume 26. In return, when the control handle is placed in the "comfort" position shown in Figure 2A as long as the user does not release his action on the ear 18, the pressure in the straps will only return to a value set by the calibration spring 40 and selected so as to enable a long duration use to take place.

The modified embodiment schematically shown in Figure 3 comprises, interposed between the eccentric cam 38 and the rod 34, an adjustment cam 42 which sets the spacing between the rod and the cam and therefore the compression force of the spring 40 when the control handle is in the "comfort" position as shown in Figure 3.

The embodiment schematically shown in Figure 4 further comprises a non-return check valve 44 having a closure spring of low compression force, intended for allowing a gas flow from volume 26 towards the straps if the pressure in volume 26 exceeds the residual pressure in the straps. This valve 44 may be provided in conjunction with the cam 42 or independently. In particular, if a leak in the straps gradually increases the tension of the latter, it makes it possible to slacken the straps by re-inflating same up to the selected pressure. To achieve this, the user will squeeze the ears 18. The non-return check valve 44 is advantageously provided with a low cross-sectional flow area for re-inflation to occur slowly. As a result, the straps remain in contact with the head during re-inflation and there is no risk of mislocating the mask. A valve 44 having a cross-sectional flow area of about 0.05 to 0.1 mm^2 for a supply pressure of 5 bars generally gives satisfactory results.

To avoid the need for manual actuation in the event of depressurization, the device of Figure 4 may additionally include a valve 52 associated with an altitude sensible bellow for automatically communicating the internal volume 26 with the harness such as an arrangement is shown in Figure 4A.

In practice, the relative arrangement of the various components may be as shown in Figures 1 and 5. The manually controlled handle 36 is carried by a support bracket 48 for rotation between a lower position (illustrated in full lines in Figure 1) and an upper position (in dash-dot lines). The rod of the handle 36, radially shifted relatively to the axis 37 constituting the eccentric cam 38 carries the adjustment cam 42 which has flats for abutting against rod 34, preventing it from rotating untimely from the position into which it was manually moved. For easier orientation of the cam by the user, the cam carries a knurled wheel 50. The cam is freely rotatable on the eccentric so as to keep the same angular position relatively to the rod 34 when the eccentric 38 is rotating.

When the mask is not worn, it must be stored with the handle 36 in the "emergency" position. In fact, should it not be so, it would prove impossible to inflate the head harness with the arrangement shown in Figures 2A, 2B and 3 and the inflating process would be slow in the case shown in Figure 4. To this end, it is sufficient that the box housing the emergency respiratory mask be arranged in such a way that the mask cannot enter it when the control handle 36 is in the "emergency" position. A simpler solution consists in coating the handle face with a sharp color to be visible in the "comfort" position, the handle becoming thus visible when it is in the stored position.

The method for using the mask is as follows.

When the mask is stored for use only in an emergency condition, the handle 36 is in the "emergency" position. The operation is identical to that of the head

harnesses disclosed in the aforesaid patents.

When the mask should be worn for a long time period, in a stand-by condition, the user removes it from the box. The user presses down the ears 18 in order to inflate the head harness, and he then rotates the handle 36 to "comfort" position. If the switch is of the type shown in Figure 5, the user moves the knurled wheel 50 to the position of maximum residual pressure. He positions the mask on his face and releases the ears. The head harness deflates down to a maximum residual pressure known. Then the user adjusts the residual pressure by acting on the knurled wheel 50.

In the event of a leakage, the tension of the head harness will gradually increase. If it becomes excessive, the user slightly re-inflates the harness by squeezing the ears until he obtains the appropriate adjustment again.

In case of an incident, resulting for instance into a depressurization or an emission of smoke in the cockpit, while the user is donning the mask in the "comfort" position, the user will just have to swing the handle 36 into the "emergency" position for causing the complete venting of the head harness and airtight application of the face cover on his face. However, even before such application is achieved, respiratory oxygen is available to the user.

Finally, when the user wishes to remove the mask, he first moves the handle to "emergency" position. Then, he inflates the head harness by squeezing the ears.

It is important to note that existing masks having a quick-donning harness (for instance as described in the French Patent 1,506,342 already mentioned by way of example), may easily be retrofitted, simply by adding means as illustrated in Figures 2 to 5, so as to constitute masks according to the invention as well as masks for lower altitude starting from the components which are common for the most part; existing masks can also be retrofitted in order to be adapted to higher altitude flights.

* C L M S *

CLAIMS

1. Harness for respiratory mask, having at least one expandable strap (20) whose ends are connected to the mask and which has an element inflatable by pressurized gas for lengthening the strap to a predetermined size, sufficient for enabling a user to position it over his head and having manually controlled means (18) enabling to admit pressurized gas into said element for lengthening it and to vent the element for enabling the strap to contact the head and to maintain the mask, characterized in that said manually controlled means comprise a switch (32, 39) enablig, at will, to vent the inflatable element or to maintain a predetermined residual gas pressure, lower than the complete inflation pressure, therein.

2. Harness according to claim 1, characterized in that the switch is constituted of an preloaded valve (32, 34) provided with a control handle (36) having at least two positions and which, in one position, lifts the closure member of the valve from its seat, the preload of the valve being either fixed once for all or adjustable.

3. Harness according to claim 2, characterized in that the preloaded valve comprises a closure member (32) slidably received on a rod (34) and in that the control handle (36) has an excentric cam (38) for moving the rod toward a closure member seat, resilient means (40) being provided between the rod and the valve for biasing the latter toward the seat up to a predetermined position with respect to the rod.

4. Harness according to claim 2 or 3, characterized in that it comprises a rotable adjustment cam (42) located between the handle and the valve.

5. Harness according to claim 4, characterized in that said cam has a plurality of flat sizes for abutment against the rod and a knurled wheel (50) for manual angular adjustment.

6. Harness according to any one of the preceding claims, characterized in that the manual control means are arranged in parallel relation with a non-return check valve (44).

7. Harness according to any one of the preceding claims, characterized in that it comprises an altitude responsive valve for venting said element upon depressurization.

8. Fast doning respiratory mask, comprising a harness according to any one of the preceding claims, connected to a connecting block fast with a face cover and carrying a demand regulator.