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(71) Applicant : **Beard, Michael**
7 Cattell Road
The Cape, Warwick CV34 4JP (GB)

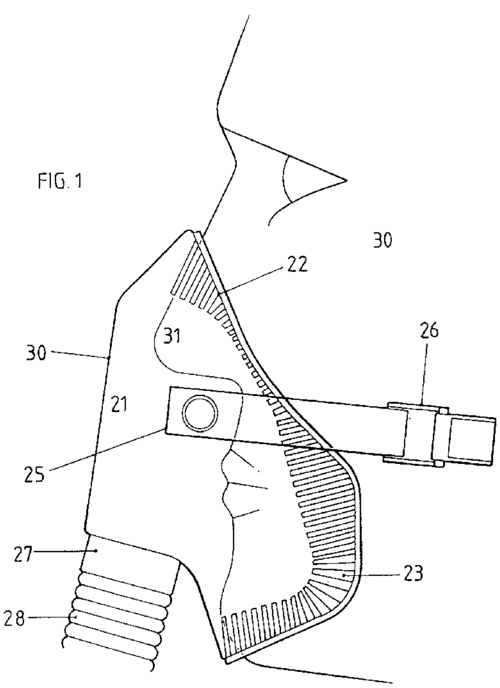
(72) Inventor : **Beard, Michael**
7 Cattell Road
The Cape, Warwick CV34 4JP (GB)

(74) Representative : **Tillbrook, Christopher John**
Chris J Tillbrook & Co
5 Old Rectory Close
Churchover
Rugby, Warwickshire CV23 0EN (GB)

(54) Seal for respiratory mask.

(57) A respiratory aviation mask (20) utilises a light-weight pyramid shell (21), surmounted by a triangular peripheral resilient rubber seal (22) for contact with a wearer's face contours, and with an embedded seal stiffener (23) comprising a series of inward sprung fingers (24) disposed for pre-loading the seal when mounting the mask and preserving seal contact under extremes of differential pressure and 'g' loading.

FIG. 1



EP 0 613 699 A1

This invention relates to seals and is, particularly but not exclusively, concerned with seals for respiratory masks, in particular those for close sealing conformity with the face or visage contours of the human form.

As such, the masks provide a controlled respiratory or breathing environment adjacent the oral and nasal respiratory tracts and organs - and one admitting respiratory gases at a required composition, pressure and flow rate.

Accordingly, seal performance is crucial to overall mask performance.

In respiratory mask technology, aviation masks are subject to particularly rigorous operational conditions and yet the required performance standards are also onerous and tightly specified - not least since the life of an aviator, in particular a pilot, and consequently the safety and fate of an aircraft and crew may ultimately depend on their being met.

Military aviation imposes especially stringent demands, since - in providing and maintaining a controlled breathing environment - the mask must inhibit - indeed ultimately prohibit altogether - the ingress of hazardous or contaminated ambient gases, such as those associated with the deployment into the atmosphere of chemical and biological (CB) weaponry.

Operationally, respiratory masks for aviation use are subject to a differential pressure, which may in certain (extreme) circumstances undermine the mechanical seal action and thus the overall dynamic sealing effectiveness.

Thus, at great altitude, the ambient pressure is low and this is reflected in a prevailing cockpit pressure in a non-pressurised aircraft. In such conditions the atmosphere is also characteristically 'thin' - ie of low density - and thus a supplementary respiratory supply must be provided to maintain normal pilot breathing.

A supplementary supply is typically regulated by a control valve and available on-demand through an alternate inspiratory/expiratory-exhalation valve arrangement.

An additional problem arises with the mechanical forces applied to the mask in severe or sudden high-speed aircraft manoeuvres. Specifically, accelerative or so-called 'g-loads' may increase the effective weight of the mask by several times (say 2/3 to 8/9 g).

Typically, the mask is of not insignificant mass and bulk and thus inertia and so tends to reflect such 'g' loads in a perceptible manner, both in terms of seal contact performance and user comfort.

For example, under extreme negative 'g' loads, the mask and attendant peripheral face seal may tend to move away from the wearer's face contours. This undermines the seal contact load and overall seal efficacy.

In contrast, under extreme positive 'g' loads, the mask may press uncomfortably tight against the face contours. Indeed, the seal profile itself (particularly with a turned over or rolled edge seal) may distort and no longer provide the resilient deformability for intimate face contour contact.

For general mounting support - and to deal with such diverse 'g' loadings and ambient pressure variations, typically the mask is entrained by fairly simple opposed tension straps tethered at each side of the wearer's head, for example to a helmet.

It is common to incorporate adjustable tensioner buckles, toggles or the like, whereby the wearer can pre-set the mask tension to some degree - in anticipation of high g-loads.

However, such mechanical adjustment cannot compensate for every condition, nor is repeated adjustment practical for varying conditions. In consequence the particular strap tension setting adopted may represent an unsatisfactory compromise.

Pre-tensioning may also be deployed in anticipation of high altitude, high pressure differential conditions.

Indeed, there have also been various proposals for automatically tensioning mask mounting straps under high altitude and attendant high mask pressure differential conditions.

Typically, these rely upon some form of pressurised cuff around the mask periphery and/or a mask mounting and support harness, fed by a pressure bleed from the (artificial) supplementary respiratory supply.

Attention has also been given to the performance degradation of respiratory flow control valves under the variable 'g' load and differential pressure conditions identified.

There now follows a description of some particular embodiments of the invention, by way of example only, with reference to the accompanying diagrammatic and schematic drawings, in which:

Figure 1 shows a side perspective view of a general respiratory aviation face mask; and

Figure 2 shows a plan view of a face mask seal for incorporation in a mask such as that depicted in Figure 1.

Referring to the drawings, a respiratory (aviation) face mask 20 comprises a lightweight, rigid or semi-rigid shell 21 covering or embracing both the nose region 31 and mouth region 32 of a wearer's face 30 - as the inlet and outlet orifices of the external respiratory organs.

Around the circumference of the mask shell 21 is disposed a resiliently deformable seal 22 (shown in more detail in Figure 2), typically of rubber or synthetic rubber composite.

The seal 22 is configured to achieve intimate sealing contact with the wearer's individual (and variable/movable) face contours around the external respiratory organs of the nose 31 and mouth 32 - from the (relatively hard, bony) nose bridge, around the (relatively soft/compliant fleshy tissue) cheeks to the (relatively hard, bony) chin.

The mask shell 21 thus defines a shallow respiratory breathing chamber 29, closely or tightly defined around the nose 31 and mouth 32 - and to which there may be admitted a prescribed breathing atmosphere, thereby creating a controlled breathing environment.

The mask 20 is mounted upon opposed restraining straps 25 at each side of the wearer's head, typically secured to an aviation helmet (not shown) or alternatively in a closed loop around the wearer's head.

The straps 25 incorporate length and thus pretensioning adjustment buckles 26.

At the underside of the mask shell 21 is fitted a breathing tube 27, connected to a flexible supply tube 28, typically of corrugated profile to inhibit collapse whilst allowing extension, contraction and bending, and in turn in communication with a pressurised supplementary supply of respiratory gas, such as neat oxygen, for controlled admixture to the mask under regulatory intake and exhalation valves, not shown.

As more readily appreciated from Figure 2, the seal 22 is of generally triangular profile in plan and incorporates a sprung stiffening element 23 to improve seal (contour contact) performance.

The seal 22 need only extend at and around the periphery of the mask shell 21, leaving a free chamber 29.

The stiffening element 23 has an intricate serrated or multiple toothed (internal) edge profile 24 and is fabricated - for example by stamping from strip or sheet material or even chemical etching from a thin metal foil - with modest inherent spring characteristics.

Both individually and (co-operatively) collectively, the stiffener teeth 24 impart a selective localised reinforcement or bracing to the seal (contour contact) action of the resiliently-deformable rubber seal body or substrate 22.

Thus, the marginal 'interstitial' strips 38 of seal substrate located in between the individual fingers 24 can flow over (intricate or complex-curved) local surface contact contours - ie they can flex in a somewhat less constrained manner to preserve seal contact than those areas directly underlying fingers.

However, the 'fingered' areas impart a spring-biassed or pre-loaded contact base closely adjacent the inter-finger regions 38, thus constraining their freedom of movement somewhat and inhibiting them from flexing entirely out of sealing (contour) contact.

The individual tooth profiles may vary around the periphery of the seal stiffener 23, for example shorter/more slender fingers 36 around the less compliant/variable nose (upper bridge) contours and longer/broader fingers 35 towards the cheeks and at the lower chin periphery.

The individual finger size and profile and the relative disposition of fingers 36 may vary to meet individual mask requirements. Thus, for example, in some variants a lesser number of fingers may be deployed than that illustrated.

The fingers 24 are effectively mounted upon - and so constrained by - a common outer peripheral base edge 34, which in this case is of the same/integrated material, but could be a differential mass of other material, such as local thickening of the rubber substrate.

When the mask 20 is applied to the face 30, the initial contact between the circumferential rubber seal 22 is promoted and reinforced or braced, locally and collectively, by the spring action of the fingers 24 and their bending about the base rim 34.

The seal stiffener 23 may be embedded within or applied to one or both sides of the seal 22.

Indeed, a series of different seal stiffeners 23 may be incorporated in different areas to meet the particular conditions locally - for example at the semi-rigid nose bridge and chin on the one hand and the relatively soft cheek areas on the other hand.

The co-operative deployment of seal materials with disparate individual characteristics, enables a more controllable and adaptable, pre-determined and sophisticated seal performance capability under diverse conditions - in particular against extremes of positive and negative differential pressures.

Such performance enhancement is available in not only static - ie constant pressure or 'g' loading - but also under dynamic - ie (continuously) variable pressure and 'g' loadings.

Similarly, the seal performance in critical conditions such as under a CB (chemical/biological) atmospheric threat can be relied upon.

The improved seal performance sophistication, without increasing the mask and mounting complexity, enables a relatively light-weight, yet stiff and resilient structure, for example a glass or carbon fibre reinforced plastics, to be employed for the mask shell 21.

Indeed appropriate moulded synthetic plastics may be employed for the stiffener 23 itself.

Claims

1. A seal element for a respiratory mask (20) comprising
   a resiliently deformable substrate (22) - for example a rubber mass -
   pre-configured to follow generally a desired surface contact profile - such as the visage or face (30) of a wearer -
   a stiffening element (23) embedded within, or bonded to one or more sides of the substrate
   the stiffening element incorporating a plurality of flexible or sprung finger elements (24) mounted upon one or more base elements (34)

the fingers extending transversely across the seal boundary or periphery
and disposed - when the mask is initially mounted - to bias the underlying resilient substrate into intimate sealing contact - ie with the wearer's face contours -
and similarly to allow intervening elements of resilient substrate to move independently into sealing contact
whereby to maintain/preserve seal performance under varying g-loads and pressure differentials across the mask, without the necessity for varying independently the mask mounting tension.

2. A respiratory mask seal, as claimed in Claim 1, configured as a closed loop with a succession of inwardly directed spring tensioner fingers integrated at their corresponding outer ends in a continuous peripheral ring at the seal periphery.

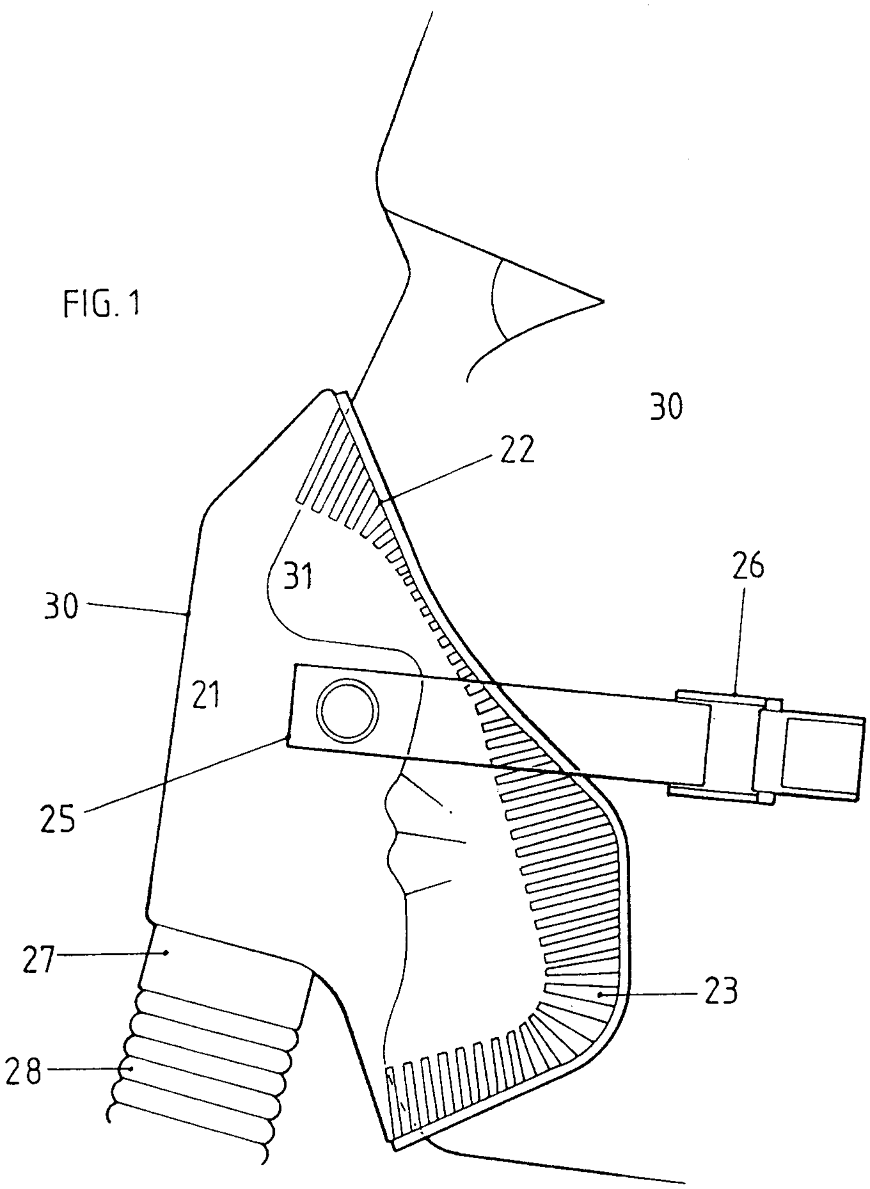
3. A respiratory mask seal, as claimed in Claim 2, incorporating a plurality of differently profiled stiffening fingers - eg varying from short and slender on the one hand to long and broad on the other hand - to provide localised adaptation of seal conformity.

4. A respiratory mask seal, as claimed in any of the preceding claims, and of generally triangular profile in contact area plan, with rounded comers, to embrace at one apex a wearer's nose region and at the opposite side a wearer's mouth region.

5. A respiratory mask incorporating a mask seal as claimed in any of the preceding claims.

6. A respiratory mask, as claimed in Claim 5, incorporating a lightweight, rigid or semi-rigid shell - for example of glass or carbon-reinforced synthetic plastics material - forming a breathing chamber, for disposition externally around a wearer's nose and mouth regions, of generally pyramid shaped profile, upon a triangular base periphery defining the seal contact region.

FIG. 1



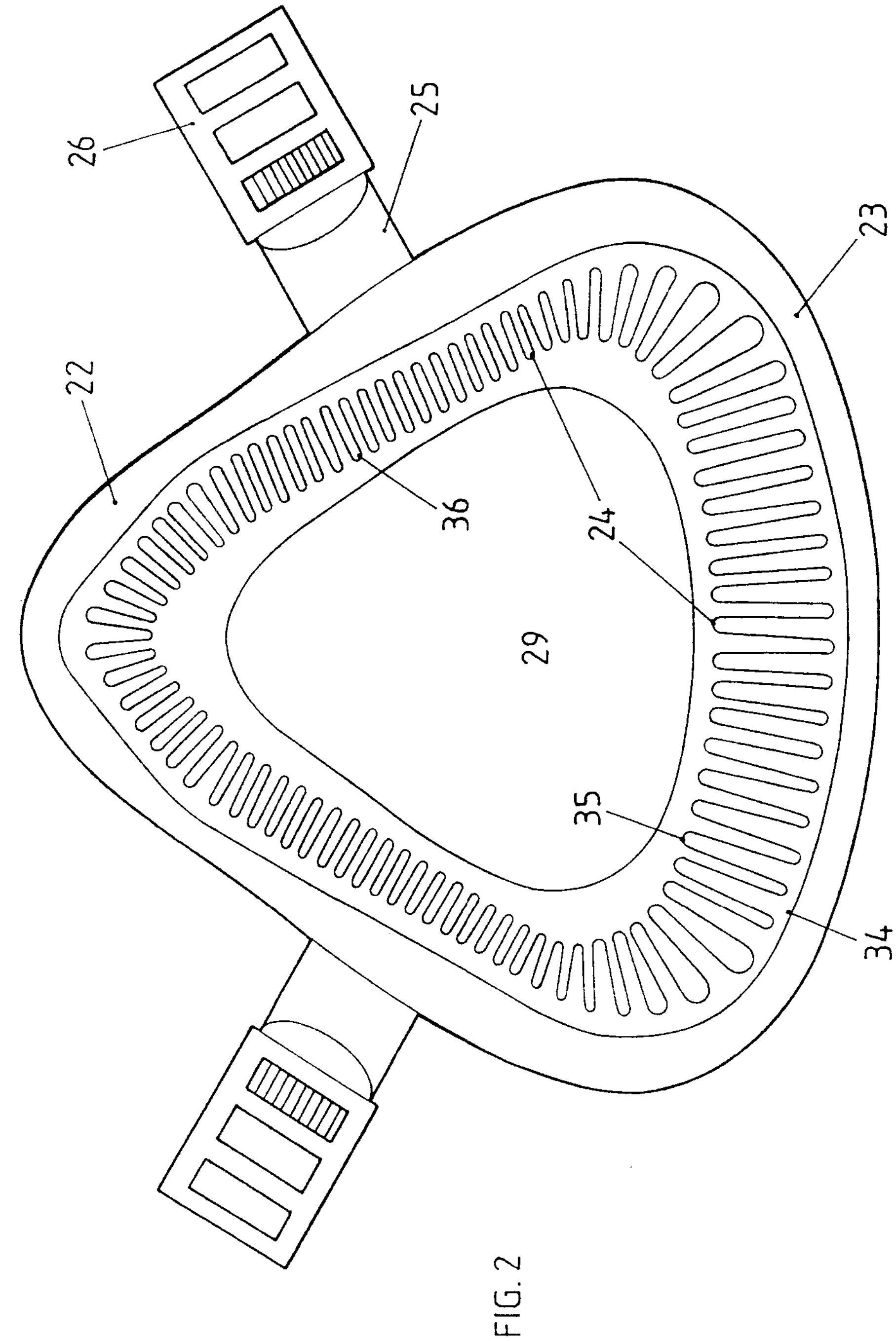


FIG. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 94 30 1473

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.5)
X,P	GB-A-2 260 084 (INTERTECHNIQUE) * the whole document * ---	1,4-6	A62B18/08
X,P	GB-A-2 267 647 (MEL (AVIATION OXYGEN) LIMITED) * the whole document * ---	1,5	
A	FR-A-776 057 (A.SENFT) ---	1	
A	US-A-4 907 584 (G.E.MCGINNIS) -----	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.5)
			A62B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	27 May 1994	Triantaphillou, P

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
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
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