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(54) **MODULAR HELMET-MASK ASSEMBLY**

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(58) **Field of Classification Search** 128/201.19, 128/201.22, 201.23, 201.24, 201.25; 2/5, 2/6.1–6.7, 8.2–8.8, 417, 421, 422, 10, 426–435, 2/441, 9
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,433,222	A *	3/1969	Pinto	128/201.24
3,910,269	A *	10/1975	Ansite et al.	128/201.24
3,943,572	A *	3/1976	Aileo	2/209
4,288,268	A *	9/1981	Hartung	156/245
4,549,541	A *	10/1985	Sundahl	128/201.19
4,667,348	A *	5/1987	Sundahl	2/410
4,676,236	A *	6/1987	Piorkowski et al.	128/201.23
4,886,056	A *	12/1989	Simpson	128/201.25
4,986,282	A *	1/1991	Stackhouse et al.	128/857
5,038,776	A *	8/1991	Harrison et al.	128/207.11
5,078,130	A *	1/1992	Van Oosten et al.	128/201.24
5,191,882	A *	3/1993	Vogliano	128/207.11
5,291,880	A *	3/1994	Almovist et al.	128/201.22
5,349,949	A *	9/1994	Schegerin	128/201.24
5,509,436	A *	4/1996	Japuntich et al.	137/15.18
5,555,569	A *	9/1996	Lane	2/424
5,572,990	A *	11/1996	Berlin	128/201.19
5,649,532	A *	7/1997	Griffiths	128/206.24
5,758,639	A *	6/1998	Ikonen	128/201.14
5,924,420	A *	7/1999	Reischel et al.	128/206.21
6,006,366	A *	12/1999	Vondrak	2/10
6,121,881	A *	9/2000	Bieback et al.	128/201.19
6,279,172	B1 *	8/2001	Epperson et al.	2/410
6,481,019	B2 *	11/2002	Diaz et al.	2/171.3
6,513,168	B2 *	2/2003	Paris et al.	2/171.3

* cited by examiner

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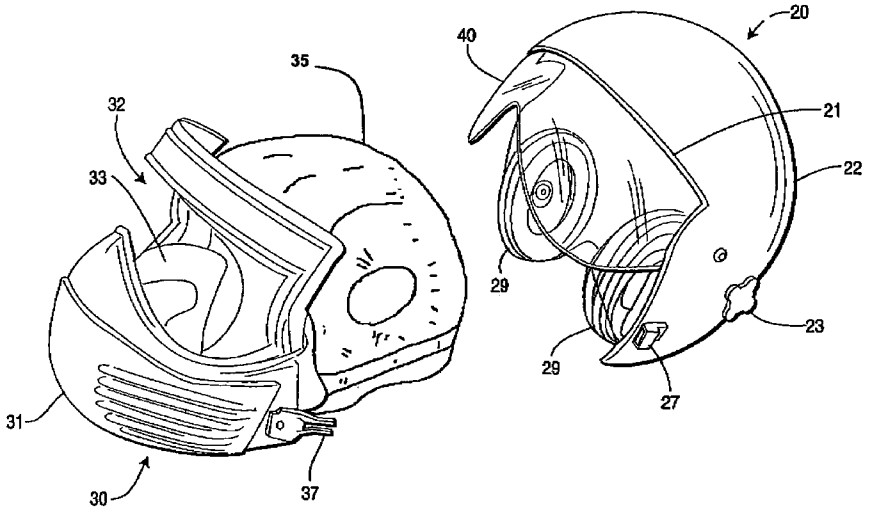
(57) **ABSTRACT**

A modular helmet-mask assembly for protecting a user's head and face from hazards such as from chemical and biological warfare agents. The invention includes an impact resistant helmet; a face protection assembly, which can be attached and detached from the helmet; and a transparent, impact resistant lens. The face protection assembly includes an impact resistant face protection shell with a vision port, through which the transparent lens can be positioned; a flexible nosecup assembly positioned to engage the mouth and nose of the user, which also includes a breathe-through airflow assembly and filter unit; and a flexible face seal which surrounds the nosecup assembly and lens and engages the face of the user. An adjustable head harness is attached to the shell or face seal, for adjustably securing the face seal and nosecup to the user's face to maximize comfort and protection while preventing fogging of the lens.

14 Claims, 4 Drawing Sheets



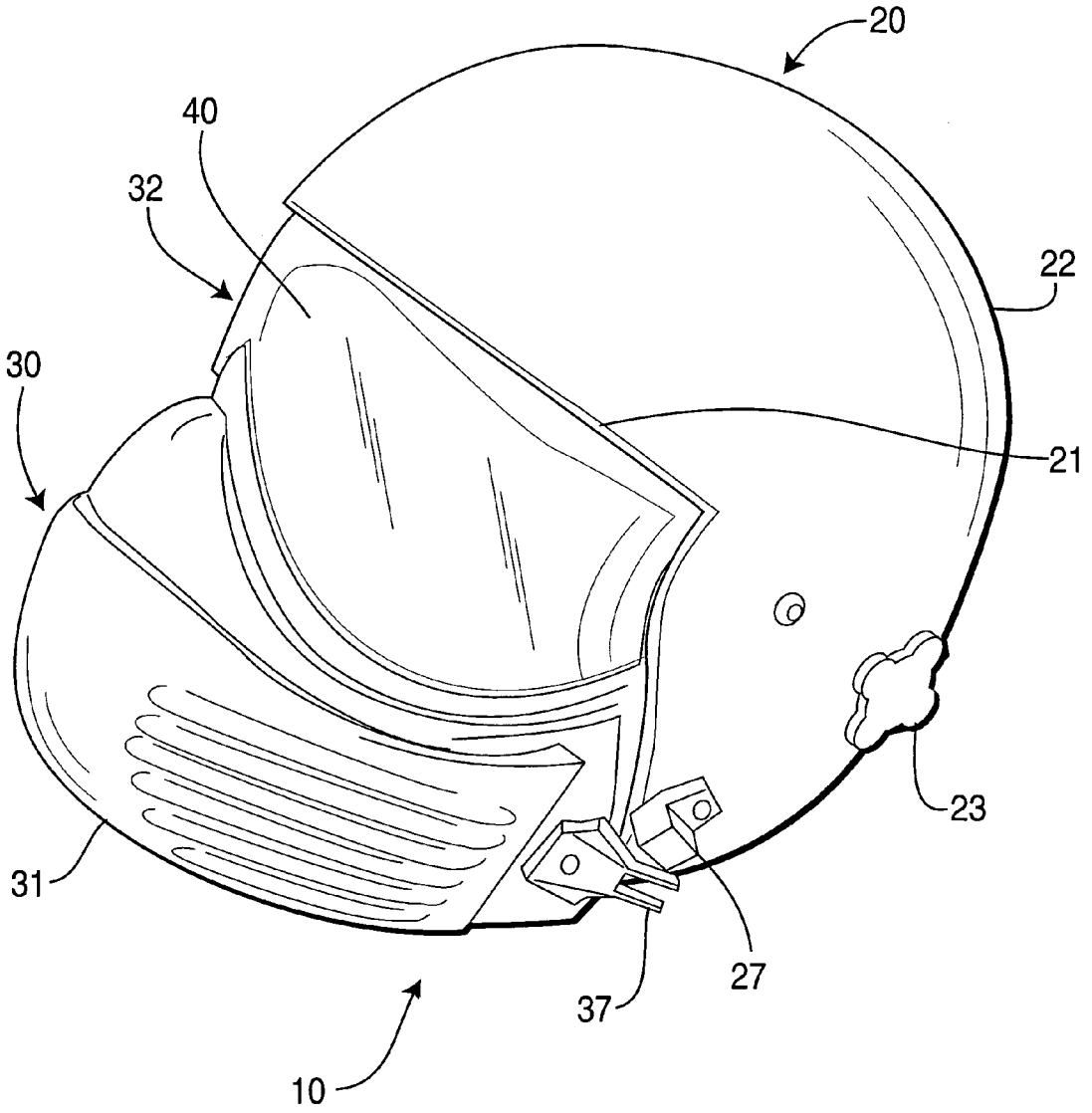


FIG. 1

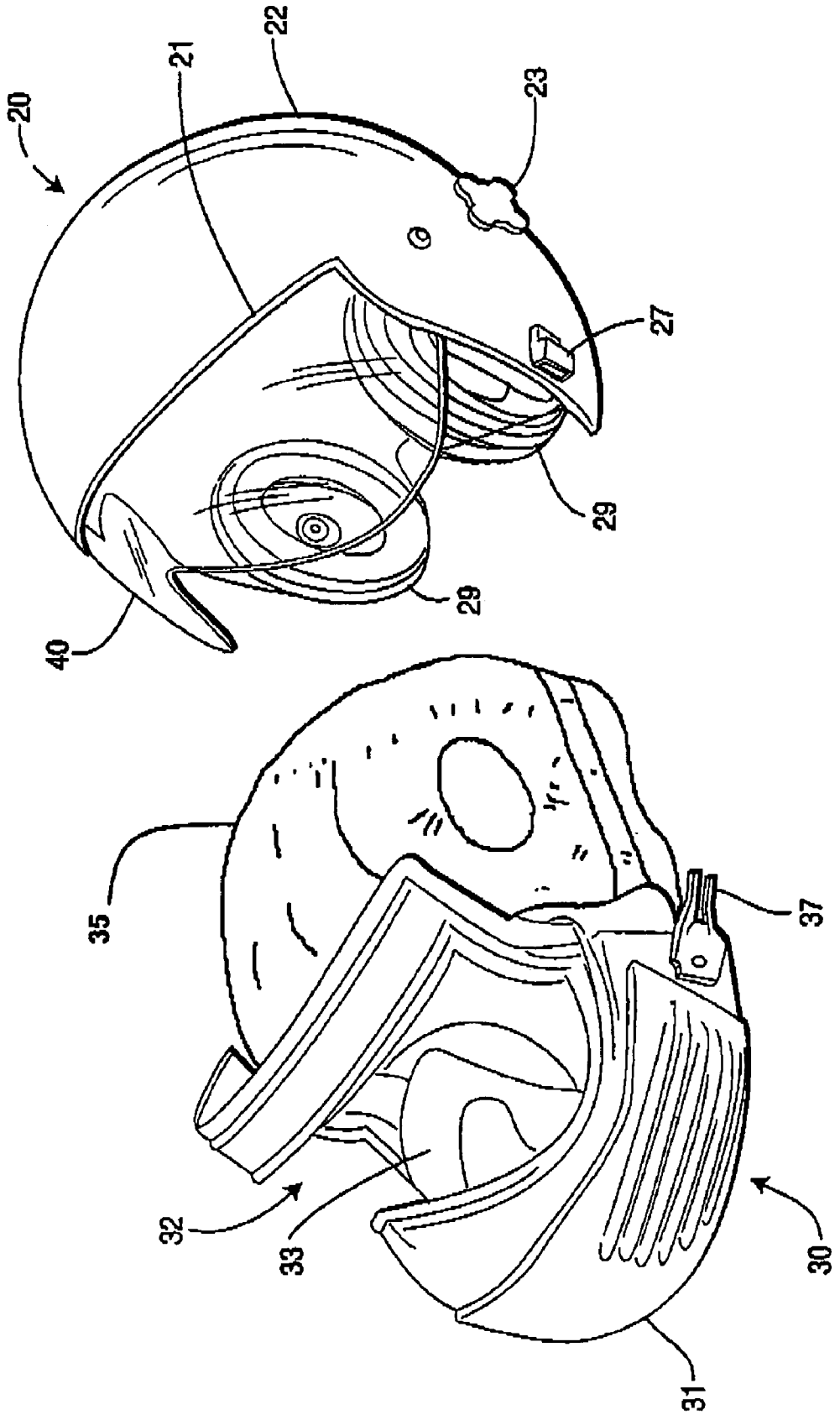


FIG. 2

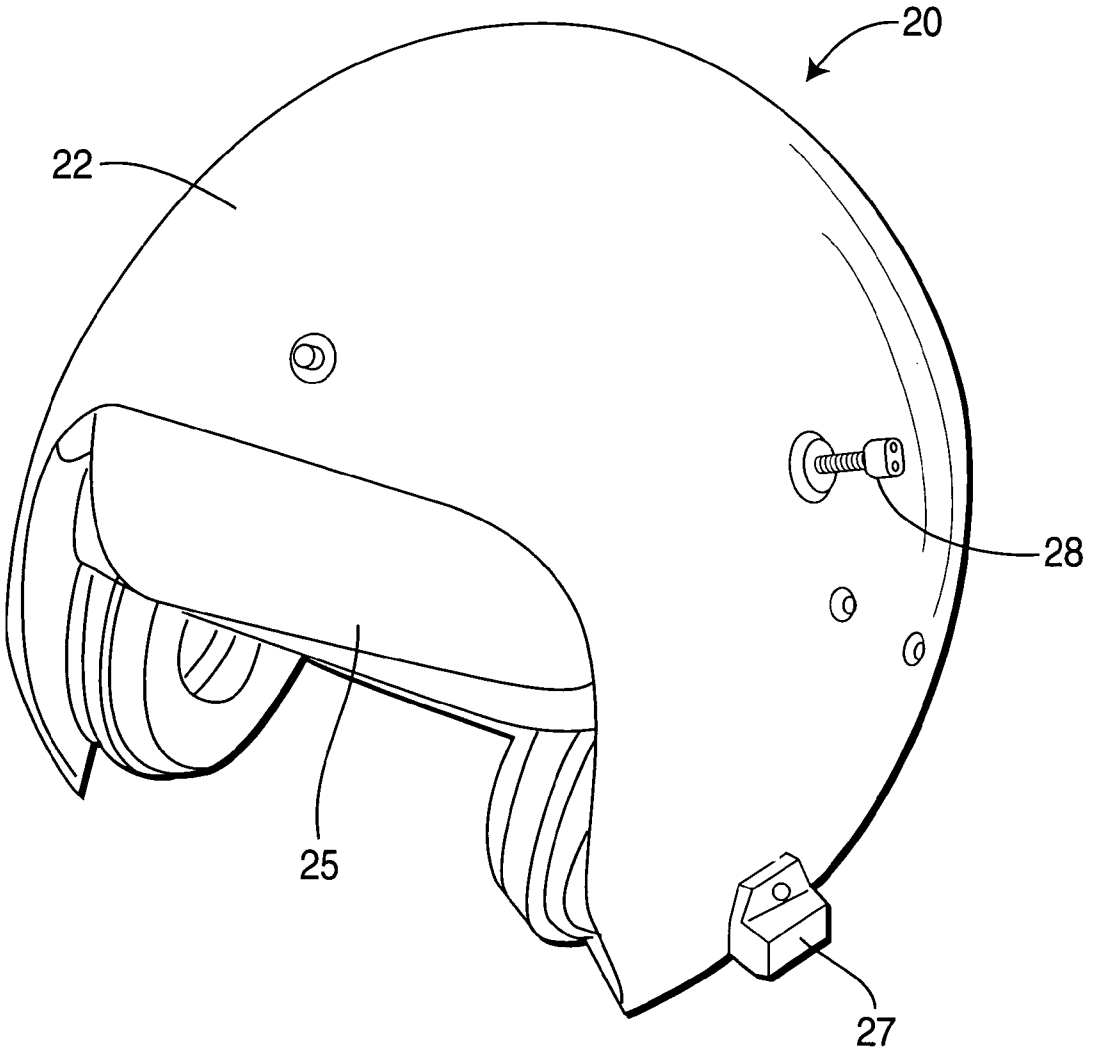


FIG. 3

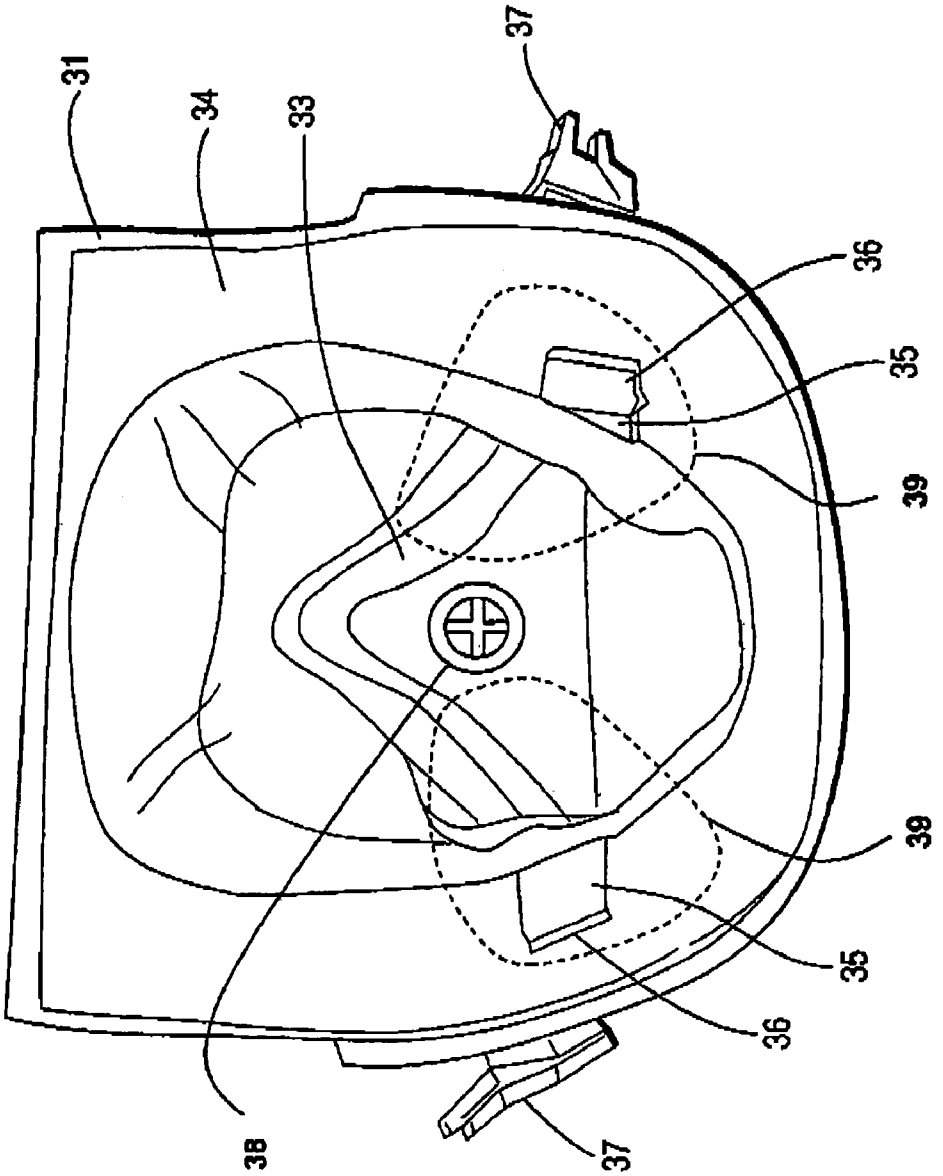


FIG. 4

MODULAR HELMET-MASK ASSEMBLY

GOVERNMENT INTEREST

The invention described herein may be manufactured, licensed, and used by or for the U.S. Government.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to respiratory masks, or more particularly to modular respiratory masks that offer protection from hazardous chemical and/or biological warfare agents and the like.

2. Description of the Related Art

Protective masks are currently used by the military for protection against chemical and biological contaminants. However, such masks often impose a substantial physiological burden on the wearer. These masks are typically difficult to wear for prolonged periods because they are relatively bulky and heavy, have high breathing resistance, impair vision and communications, cause thermal stress, physical discomfort, and degrade job performance. Furthermore, the demands placed on such protective masks for use by the crews of military vehicles, such as land and sea vehicles and aircraft, are even greater due to the limitations on the size or bulk of such masks in crowded crew cabins, the need to avoid fogging of the lenses, and crew person exhaustion from heat buildup, physical discomfort, and respiratory effort.

Thus, mask systems used by military crews, and particularly vehicle crews, must be optimized for minimal bulk and weight, in order to readily fit within the limited crew space provided. In addition, such masks must be optimized to provide a sufficient flow of purified air for enhancing respiration and comfort, while minimizing lens fogging, heat stress, respiratory effort, and excessive pressure caused by the mask seals on contacted parts of the user's face and head.

Previous efforts to provide crew masks include the U.S. Army M45 (Aircrew) and M42 (Combat Vehicle) masks. These masks use a standard six-point suspension system and an intern periphery design, where the contact point/seal between the mask and the skin of the user is provided by an inwardly turned mask edge. However, the M45 has no powered blower system due to weight and logistic concerns. While the M45 provides adequate unblown protection and defogging properties, this crew mask is known to be somewhat uncomfortable when used in combination with helmet systems, such as aircrew helmets, due to the harness buckles and the presence of the intern seal in the forehead area, where a crew helmet can press the seal into the forehead. In addition, the lack of a powered blower system results in high breathing resistance, adding to crew fatigue.

In an alternative approach, the U.S. Air Force AERP mask system eliminates the face seal, in favor of a neck seal design. In addition, both the U.S. Army M48/M49 and the U.S. Air Force AERP use a dual canister blower system for providing the overpressure needed for protection against inward diffusion of toxic agents, and to provide additional airflow for keeping the lenses free of moisture or fog. Existing blowers are built to provide for air flow rates of approximately 4 cubic feet per minute (CFM) and attendant overpressure. Given the need for an air flow of approximately 4 CFM, the presently employed blowers for all current crew mask systems are sub-optimal in size and bulk.

Thus, there remains a need in the art for a crew mask for protection against chemical or biological toxic agents that provides a comfortable face seal and helmet interface and an optimized size and bulk of the equipment, while still providing adequate protection and defogging.

The present invention provides a solution to this problem. The invention includes a modular helmet-mask assembly which includes a helmet, a face protection assembly, and a transparent, impact resistant lens. The helmet is made of an impact resistant material for protecting the user's head. The face protection assembly, which can be attached and detached from the helmet, includes a face protection shell which is also made of an impact resistant material, for protecting the head and face of the user. The shell includes a vision port through the shell at the level of the eyes of a user, through which a transparent lens can be positioned for protection of the user's eyes. The face protection assembly includes a flexible nosecup assembly within the shell and flexible face seal on an inner surface of the shell. The flexible nosecup assembly is positioned to engage the mouth and nose of the user, and it includes a breathe-through airflow assembly and filter unit. The flexible face seal is disposed on an inner surface of the shell around the nosecup assembly and the lens, such that the face seal engages the face of the user. A strap or harness is attached to the shell or face seal, for adjustably securing the face seal and nosecup to the user's face to maximize comfort and protection while preventing fogging of the lens.

SUMMARY OF THE INVENTION

The invention provides a modular helmet-mask assembly which comprises:

(a) a helmet capable of enclosing the head of a user, said helmet comprising an impact resistant material; and

(b) a face protection assembly, alternately attachable to and detachable from a front part of said helmet, which face protection assembly comprises

- (i) a face protection shell comprising an impact resistant material;
- (ii) a vision port through the shell at the level of the eyes of a user;
- (iii) a flexible nosecup assembly within the shell, which nosecup assembly is positioned to engage the mouth and nose of a user, said nosecup comprising a breathe-through airflow assembly and a filter unit;
- (iv) a flexible face seal, disposed on an inner surface of the shell around the nosecup assembly and the vision port, which face seal is capable of engaging the face of a user; and
- (v) an adjustable head harness attached at an surface of the shell or the face seal which is capable of engaging the back of a user's head to thereby adjustably secure the face seal and nosecup assembly to a user's face, and

(c) either (i) or (ii):

- (i) a transparent, impact resistant lens fixed to the vision port at the level of the eyes of a user;
- (ii) a transparent, impact resistant lens rotatably attached at the front part of the helmet and positioned to alternately engage and disengage with the vision port of the shell at the level of the eyes of a user.

The invention also provides a method for protecting a user's face from chemicals which comprises:

(I) providing a modular helmet-mask assembly which comprises

- (a) a helmet capable of enclosing the head of a user, said helmet comprising an impact resistant material; and
- (b) a face protection assembly, alternately attachable to and detachable from a front part of said helmet, which face protection assembly comprises

(i) a face protection shell comprising an impact resistant material;

(ii) a vision port through the shell at the level of the eyes of a user;

(iii) a flexible nosecup assembly within the shell, which nosecup assembly is positioned to engage the mouth and nose of a user, said nosecup comprising a breathe-through airflow assembly and a filter unit;

(iv) a flexible face seal, disposed on an inner surface of the shell around the nosecup assembly and the vision port, which face seal is capable of engaging the face of a user; and

(v) an adjustable head harness attached at an surface of the shell or the face seal which is capable of engaging the back of a user's head to thereby adjustably secure the face seal and nosecup assembly to a user's face, and

(c) either (i) or (ii):

(i) a transparent, impact resistant lens fixed to the vision port at the level of the eyes of a user;

(ii) a transparent, impact resistant lens rotatably attached at the front part of the helmet and positioned to alternately engage and disengage with the vision port of the shell at the level of the eyes of a user;

(II) placing the face protection assembly onto a user's head such that the flexible face seal engages the user's face, and such that the nosecup assembly engages the user's mouth and nose;

(III) adjusting the an adjustable head harness such that the face seal and nosecup are secured to the user's face;

(IV) placing the helmet onto the user's head such that the helmet encloses the user's head and attaching the helmet to the face protection assembly; and

(V) adjusting the helmet to secure the helmet, face seal, and nosecup assembly to the user's head.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a perspective view of a helmet-mask assembly of the invention showing the helmet portion attached to the face protection assembly portion.

FIG. **2** shows a view of a helmet and mask of the helmet-mask assembly showing the helmet portion separated from the face protection assembly portion.

FIG. **3** shows a rear side perspective view of a helmet of the invention.

FIG. **4** shows an inside view of a face protection assembly of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The invention provides a helmet-mask assembly for protecting the face and head of a user. FIGS. **1** and **2** respectively show a helmet-mask assembly **10** according to the invention in assembled and disassembled condition. As shown in FIG. **1**, the helmet-mask assembly **10** comprises a helmet portion **20** and a mask portion, or face protection assembly, **30**.

The helmet portion **20** is capable of enclosing the head of a user, and comprises an outer protective surface comprising an impact resistant material suitable for protecting the user's head. Suitable materials for the outer protective surface nonexclusively include graphite, fiberglass, Kevlar® (available commercially from E. I. du Pont de Nemours and Company, Wilmington, Del., USA), Spectra® (available commercially from Honeywell International Inc. of Morristown, N.J., USA), and the like, and combinations thereof.

The helmet has a front part **21** and a rear part **22**. As shown in FIGS. **1** and **2**, the front part **21** is attachable to and detachable from the face protection assembly **30**. The helmet **10** preferably comprises attachment fasteners **27** for attaching and detaching the front part **21** of the helmet to the face protection assembly **30** as shown in FIG. **1**. Suitable attachment fasteners nonexclusively include clips, snaps, straps, hooks, and the like.

As shown in FIG. **2**, the helmet **20** may comprise ear cups **29** for protection of the user's ears, or for radio communications purposes. The helmet may also contain an optional communications assembly comprising a microphone, a speaker, a transmitter and a receiver integrated with said helmet. FIG. **3** shows a communications port **28** which may be used to access such a communications assembly, if present.

FIG. **3** also shows a rear view of the helmet portion which has a position adjustable adjustment pad **25** which is preferably attached to a rear part **22** of the helmet **20**. The adjustment pad **25** is capable of engaging the back of the user's head. The adjustment pad **25** comprises an impact resistant material, which is preferably the same material as the helmet portion and is capable of being adjusted to push the user's head forward towards a front part **21** of the helmet **20**, and adjustably securing the face protection assembly to a user's face, as described below. The adjustment pad **25** may be adjusted using a tightening adjustment knob **23** or a tightening adjustment lever, or the like. FIGS. **1** and **2** show such a tightening adjustment knob **23** on the helmet **20**. A suitable narrow band may be attached at one end to an inside of the helmet wall as well as to the adjustment pad **25** and then the tightening adjustment knob **23**. The tightening adjustment knob **23** can the be turned, causing the adjustment pad **25** to move forward from the rear part **22** of the helmet towards the front part **21** of the helmet. Such action may be taken to move a user's head forward in the helmet, towards the mask portion of the helmet-mask assembly **10**. The helmet may further comprise other additional features such as interior padding and the like.

The mask portion, or face protection assembly, **30**, comprises a face protection shell **31**, a vision port **32**, a flexible nosecup assembly **33**, a flexible face seal **34**, and an adjustable head harness **35** attached to harness clips **36**. The face protection shell **31** comprises an impact resistant material suitable for protecting a user's face. Suitable materials for the face protection shell nonexclusively include those listed above for the outer helmet surface including graphite, fiberglass, Kevlar® (available commercially from E. I. du Pont de Nemours and Company, Wilmington, Del., USA), Spectra® (available commercially from Honeywell International Inc. of Morristown, N.J., USA), and the like, and combinations thereof.

The vision port **32** comprises an opening extending through the face protection shell **31** at the level of the eyes of a user. The vision port **32** is sufficiently sized to allow the user to see through the shell **31** when it engages the user's head. The vision port **32** may optionally be fitted with a transparent, impact resistant lens, as described below.

The flexible nosecup assembly **33** is positioned on an inside surface of the face protection shell **31** such that the nosecup assembly **33** is capable of engaging the mouth and nose of the user. The nosecup assembly **33** comprises a flexible material, preferably an elastic material such as silicone rubber, and the like, and combinations thereof. The nosecup assembly **33** also comprises a breathe-through airflow assembly **38** and a filter unit **39** which may either be fitted inside of the nosecup assembly **33**, or may be externally attached to it. Such breathe-through airflow assemblies may be a simple

filter arrangement or may be attached to an oxygen supply as are well known in the art. The nosecup assembly **33** may optionally further comprise a port for connecting a source of breathing oxygen to the nosecup. The filter unit preferably comprises a filter element comprising a material capable of filtering chemical vapors and biological aerosols. Suitable filter materials nonexclusively include carbon filters such as bonded or packed-bed carbon filters. The nosecup assembly may also further comprise a negative pressure filter assembly, a positive pressure filter blower device, or a circulating filter blower device as are well known in the art.

The flexible face seal **34** is disposed on an inner surface and edge of the face protection shell **31**, around the nosecup assembly **33** and the vision port **32**. The face seal **34** is capable of engaging with the face of a user. This serves to protect the user's face from the entry of harmful chemical and biological hazards and the like. Suitable materials for the flexible face seal nonexclusively include an elastic material such as silicone rubber, and the like. The flexible face seal may comprise a material which is the same or different from the material of the flexible nosecup.

The adjustable head harness **35** is attached at a surface of the face protection shell **31** or the face seal **34**. The head harness **35** is preferably capable of engaging the back of a user's head to thereby adjustably secure the face seal **34** and nosecup assembly **33** to the user's face. The head harness **35** may comprise a strap, band, belt, skullcap, or the like, and may comprise any suitable material such as cloth, elastic, plastic, leather, and combinations thereof. In a preferred embodiment, shown in FIG. **4**, the head harness **35** comprises a strap which is attached to the face seal **34** by threading the strap through harness clips **36** attached to the face seal **34**.

The face protection assembly **30** is alternately attachable to and detachable from the front part **21** of the helmet **20**. The face protection assembly **30** preferably comprises attachment fasteners **37** for attaching and detaching the front part **21** of the helmet to the face protection assembly **30** as shown in FIGS. **1** and **2**. Suitable attachment fasteners nonexclusively include clips, snaps, straps, hooks, and the like. FIG. **2** shows an embodiment wherein the face protection assembly **30** comprises a clip **37** capable of engaging a clip **27** on the helmet **20**, for attaching the face protection assembly **30** to the helmet **20**. The face protection assembly **30** may optionally comprise other additional attached or integrated features such as a communications assembly, as described above, an electronic display, and the like.

The invention further comprises a transparent, impact resistant lens **40** which serves to protect the user's eyes. According to the invention, the lens **40** may be fixed to the vision port **32** at the level of the eyes of a user. Alternatively it may be attached at a front part **21** of the helmet **20** and positioned to alternately engage and disengage with the vision port **32** of the face protection shell **31** at the level of the eyes of a user by rotating up into the inside of the helmet **20**.

In an embodiment where the lens **40** is fixed to the vision port **32**, it may be fixed using any suitable means such as bonding, gluing, screwing, and the like. In an embodiment where the lens **40** is attached at the front part **21** of the helmet **20**, it may be attached using any suitable means, such as via a rotatable hinge or the like, which would allow a user to alternately engage and disengage the lens **40** with the vision port **32** of the face protection shell **31** at the level of the eyes of a user. Suitable materials for the lens **40** nonexclusively include polycarbonate, polyurethane, and the like, and combinations thereof.

In a preferred embodiment, the face protection assembly **30** is placed onto a user's head such that the flexible face seal **34** engages the user's face, and such that the nosecup assembly **33** engages the user's mouth and nose. The adjustable head harness is adjusted such that the face seal **34** and nosecup **33** are secured to the user's face. The helmet **20** is then placed onto the user's head such that the helmet **20** encloses the user's head, and the helmet **20** is attached to the face protection assembly **30**. A position adjustable adjustment pad **25** of the helmet **20** engages the back of the user's head. The adjustment pad **25** is adjusted by turning a tightening adjustment knob **32** such that it pushes the user's head forward towards a front part **21** of the helmet **20**, thereby adjustably securing the face seal **34** and nosecup assembly **33** to the user's face.

While the present invention has been particularly shown and described with reference to preferred embodiments, it will be readily appreciated by those of ordinary skill in the art that various changes and modifications may be made without departing from the spirit and scope of the invention. It is intended that the claims be interpreted to cover the disclosed embodiment, those alternatives which have been discussed above and all equivalents thereto.

What is claimed is:

1. A modular helmet-mask assembly which comprises:

(a) a helmet capable of enclosing the head of a user, said helmet comprising an impact resistant material; and

(b) a face protection assembly, alternately attachable to and detachable from a front part of said helmet, which face protection assembly comprises

(i) a face protection shell comprising an impact resistant material;

(ii) a vision port through the shell at the level of the eyes of a user;

(iii) a flexible nosecup assembly within the shell, which nosecup assembly is positioned to engage the mouth and nose of a user, said nosecup comprising a breathe-through airflow assembly and a filter unit;

(iv) a flexible face seal, disposed on an inner surface of the shell around the nosecup assembly and the vision port, which face seal is capable of engaging the face of a user; and

(v) an adjustable head harness attached at a surface of the shell or the face seal which is capable of engaging the back of a user's head to thereby adjustably secure the face seal and nosecup assembly to a user's face, and

(c) either (i) or (ii):

(i) a transparent, impact resistant lens fixed to the vision port at the level of the eyes of a user;

(ii) a transparent, impact resistant lens rotatably attached at the front part of the helmet and positioned to alternately engage and disengage with the vision port of the shell at the level of the eyes of a user.

2. The modular helmet-mask assembly of claim **1** further comprising a position adjustable adjustment pad attached at a rear part of said helmet which engages the back of a user's head to thereby adjustably secure the face seal and nosecup assembly to a user's face.

3. The modular helmet-mask assembly of claim **2** wherein said adjustable adjustment pad comprises a tightening adjustment knob or a tightening adjustment lever.

4. The modular helmet-mask assembly of claim **1** comprising a transparent, impact resistant lens fixed to the vision port at the level of the eyes of a user.

5. The modular helmet-mask assembly of claim **1** comprising a transparent, impact resistant lens rotatably attached at the front part of the helmet and positioned to alternately engage and disengage with the vision port of the shell at the level of the eyes of a user.

6. The modular helmet-mask assembly of claim 1 wherein the impact resistant shell material comprises graphite, fiberglass, or combinations thereof.

7. The modular helmet-mask assembly of claim 1 wherein the impact resistant lens comprises polycarbonate, polyurethane, or combinations thereof.

8. The modular helmet-mask assembly of claim 1 wherein the face seal and nosecup comprise an elastic material.

9. The modular helmet-mask assembly of claim 1 wherein the filter unit comprises a filter element comprising a material capable of filtering chemical vapors and biological aerosols.

10. The modular helmet-mask assembly of claim 9 wherein the filter element comprises a carbon filter.

11. A method for protecting a user's face from chemicals which comprises:

(I) providing a modular helmet-mask assembly which comprises

(a) a helmet capable of enclosing the head of a user, said helmet comprising an impact resistant material; and

(b) a face protection assembly, alternately attachable to and detachable from a front part of said helmet, which face protection assembly comprises

(i) a face protection shell comprising an impact resistant material;

(ii) a vision port through the shell at the level of the eyes of a user;

(iii) a flexible nosecup assembly within the shell, which nosecup assembly is positioned to engage the mouth and nose of a user, said nosecup comprising a breathe-through airflow assembly and a filter unit;

(iv) a flexible face seal, disposed on an inner surface of the shell around the nosecup assembly and the vision port, which face seal is capable of engaging the face of a user; and

(v) an adjustable head harness attached at a surface of the shell or the face seal which is capable of engaging the back of a user's head to thereby adjustably secure the face seal and nosecup assembly to a user's face, and

(c) either (i) or (ii):

(i) a transparent, impact resistant lens fixed to the vision port at the level of the eyes of a user;

(ii) a transparent, impact resistant lens rotatably attached at the front part of the helmet and positioned to alternately engage and disengage with the vision port of the shell at the level of the eyes of a user;

(II) placing the face protection assembly onto a user's head such that the flexible face seal engages the user's face, and such that the nosecup assembly engages the user's mouth and nose;

(III) adjusting the adjustable head harness such that the face seal and nosecup are secured to the user's face;

(IV) placing the helmet onto the user's head such that the helmet encloses the user's head and attaching the helmet to the face protection assembly; and

(V) adjusting the helmet to secure the helmet, face seal, and nosecup assembly to the user's head.

12. The method of claim 11 wherein the modular helmet-mask assembly further comprises a position adjustable adjustment pad attached at a rear part of said helmet which engages the back of a user's head to thereby adjustably secure the face seal and nosecup assembly to a user's face, the method further comprising adjusting the adjustment pad such that the face seal and nosecup are secured to the user's face.

13. The method of claim 11 wherein the modular helmet-mask assembly comprises a transparent, impact resistant lens fixed to the vision port at the level of the eyes of a user.

14. The method of claim 11 wherein the modular helmet-mask assembly comprises a transparent, impact resistant lens rotatably attached at the front part of the helmet and positioned to alternately engage and disengage with the vision port of the shell at the level of the eyes of a user.

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