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(54) **Low burden integrated chemical protective hood for use with helmets**

(57) A chemical protective hood (20) designed to be worn over a respirator (16) in a manner such that it is located between a helmet and the respirator (16). The hood (20) has a skirt portion (22) of filter barrier material containing an opening with edges configured to surround and fit against the respirator's facepiece. A top

portion of the hood (20) is formed of a thin single layer (24) that fits under the helmet and is configured to match the curved inner surface of the helmet. The thin single layer (24) allows the helmet to be comfortably donned without requiring any modification to be made to the helmet.

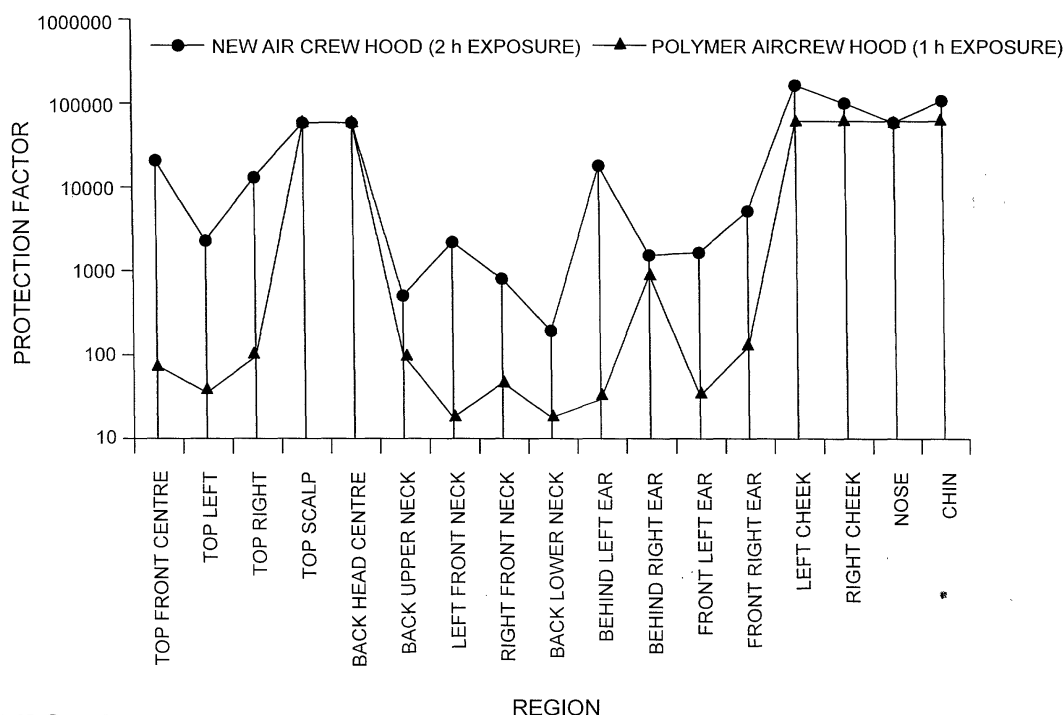


FIG. 8

Description

FIELD OF THE INVENTION

[0001] The present invention relates to a protective hood to be worn over a respirator when used in hazardous environments such as those where nuclear, chemical and biological agents may exist and, in particular, to a hood that is positionable over respirators when used with aircrew flight helmets.

BACKGROUND OF THE INVENTION

[0002] In hazardous environments where toxic chemicals might exist or where nuclear, biological and chemical (NBC) agents may be present (or expected) personnel must wear protective clothing and respirators, in addition to their regular equipment, to protect themselves from those type of agents. For personnel who require helmets or headgear, such as aircrew, the protective clothing must not impair the intended function of the headgear. The helmet that is worn by aircrew has several functions that must be maintained, even during NBC operations. These functions include, for instance, protection of the head in the event of a crash, protection of ears against excessive noise and the provision of means for electronic communications. If a protective hood is to be worn under the headgear, then it must not cause discomfort to the wearer, or at least minimize any discomfort, and it must maintain the functions of the headgear to an acceptable level.

[0003] An incompatibility problem involving the present in-service aircrew chemical protective hood and aircrew flight helmets exists. This problem is forcing the aircrew to either forgo wearing the existing chemical protective hood or remove structural components inside the helmet to achieve a comfortable fit. Either scenario represents a serious risk to flight safety in any training or operational environment.

[0004] Chemical protective (CP) hoods that are presently available are made from multiple layers of materials or from polymers. Multiple layer CP hoods are described in Canadian Patent Application 2,027,850 that was filed on October 17, 1990. These multi-layered hoods are thick and cannot be worn underneath aircrew helmets, such as a SPH5-CF helmet, without requiring some modification to the helmet. Layers in the Thermal Plastic Liner (TPL) in the SPH5-CF helmet or in some cases the entire impact protective layers need to be removed to enable the donning of this helmet over a multi-layered chemical protective hood. One alternative would be to don a thinner rubber hood. The rubber hoods would, however, impose an undue thermal stress on users in hot climates or in heated aircrafts.

[0005] Thin air impermeable polymer hoods and multi-layered filter barrier hoods are two types which are currently available. The polymer hoods are thin but impose an undue thermal burden on users. The seams of

these polymer hoods are rigid and may cause hot spots or stress points underneath the hood and, furthermore, they offer a poor seal with respirators such as the Canadian Forces (CF) AC4. The multi-layered filter barrier hoods such as the CF in-service hoods are made from a thick barrier layer and separate outer layer sewn separately. This causes extra bulk in seam areas and can only be worn if TPL layers are removed from the SPH5 helmet which would compromise the impact safety and the head protection provided by this helmet.

SUMMARY OF THE INVENTION

[0006] It is an object of the present invention to provide a chemical protective hood that can be worn under an aircrew flight helmet without imposing an undue thermal burden on users or requiring modification to be made to that helmet.

[0007] A chemical protective hood to be worn over a respirator in a manner such that it is located between a helmet and the respirator, according to the invention, comprises a skirt portion of filter barrier material containing an opening with edges configured to surround and fit against a respirator's facepiece, a top portion of the hood being formed of a thin single layer that fits under a helmet, the thin single layer being configured to match the curved inner surface of the helmet.

DESCRIPTION OF THE DRAWINGS

[0008] Embodiments of the present invention will now be described in more detail with reference to the accompanying drawings, in which:

Fig. 1 is a drawing of a known helmet, the SPH5-CF helmet,

Fig. 2 are drawings that illustrate the thermoplastic liner and the energy absorbing liner for the SPH5-CF helmet,

Fig. 3 is a drawing that illustrates the head harness of an AC4 respirator,

Fig. 4 is a drawing that illustrates a known multi-layer hood located over an AC4 respirator,

Fig. 5 shows the SPH5-CF helmet with a multi-layer hood and AC4 respirator assembled,

Fig. 6 shows a known polymer hood assembled over an AC4 respirator,

Fig. 7(A), (B) and (C) show, respectively, a front view, a side view and a back view of a hood according to the present invention assembled over an AC4 respirator, and

Fig. 8 contains a graph illustrating the Protection Factors (PF's) measured on a head form for the low burden integrated protective hood according to the present invention and a graph that shows the measured PF's for a M45 polymer hood when used with AC4 respirators and the SPH5-CF helmet.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0009] The helmet that is worn by aircrews has several functions that must be maintained even during nuclear, biological and chemical (NBC) manoeuvres where NBC protective clothing must be worn. These functions include protection of the head in the event of a crash, protection of ears against excessive noise and the provision of means for electronic communication. An NBC chemical protective hood when worn under the headgear along with a respirator should not cause discomfort to the wearer, or at least should minimize any discomfort, and it must allow the functions of the helmet to be maintained at an acceptable level.

[0010] An incompatibility problem involving the present in-service aircrew chemical protective hoods and aircrew flight helmets exists. This problem is forcing the aircrew to either forgo wearing an existing chemical protective hood under the helmet or to remove structural components inside of the helmet in order to achieve a comfortable fit. Either scenario represents a serious risk to flight safety in any NBC training or operational environments. The present SPH5-CF helmet shell illustrated in Fig. 1 and identified by the number 10 is a nylon, graphite and fibreglass cloth composition with black rubber edge beading. Components located inside of the helmet shell 10 include an energy absorbing liner 12 (see Fig. 2) to absorb and reduce impact forces and a pre-formed thermoplastic liner (TPL) 14 that sits inside the energy absorbing liner 12. The energy absorbing liner 12 is formed from rigid foamed white polystyrene plastic and is moulded to conform to the contour of the shell's inner surface. Hook fastener tabs on the outside surface of the liner mate with pile fastener on the inside of the shell 10 to secure the liner in place. Hook fastener tabs on the inside surface of the liner secure the TPL 14 to the energy absorbing liner 12. The pre-formed TPL 14 provides a comfortable inner helmet which can be custom fit to an individual head size. It consists of a plastic layer assembly and a removable, washable cloth cover. The TPL cloth cover is an air permeable black fabric featuring sides made of pile material to allow attachment to the hook fastener tabs on the energy absorbing liner 12. The TPL is pre-formed in three sizes and can be custom fitted by removing any of the eight separate layers of plastic from the TPL.

[0011] It was found in one study that while one size of helmet should provide an acceptable fit, this was not the case when worn with or without a chemical protective (CP) hood for use in a NBC threat environment and all operational scenarios. The existing multi-layered hoods 18 shown in Fig. 4 when worn over the head harness 16' of the AC4 respirator 16 shown in Fig. 3 led to an unacceptable fit due to the excess bulk. The multi-layered hood 18 shown in Fig. 4 is a dual-layer air-permeable hood composed of a thick inner charcoal-impregnated fabric layer for vapour protection and an outer liq-

uid-repellent and flame-retardant Kermel (trade-mark) fabric layer. The hood has a front opening with edges that surround and fit against the facepiece of the respirator. The assembly of the respirator 16, hood 18 and helmet 10 is illustrated in Fig. 5. In one study, out of 15 aircrew, 80% would need a larger size helmet to operate with chemical defence headgear while 20% would require modification to the TPL 14 of the SPH5 helmet. In another study, 75% of the subjects using a SPH5 helmet could not don their helmets over the respirator and hood. Modifying the TPL or issuing two sizes of helmets is possible but an expensive alternative and would not be feasible for those requiring larger size helmets. An alternative would be to use a polymer hood 19 as illustrated in Fig. 6 rather than a multi-layered hood. The polymer hoods are thin but, however, impose an undue thermal burden and offer a poor seal with respirators such as the AC4.

[0012] An integrated hood according to the present invention provides a solution to the above-mentioned problems in that it is thin enough above the respirator not to compromise the fit underneath the helmet and it also provides chemical protection to the pilots without compromising the protection and functions of the helmets. The low burden integrated chemical protective hood 20 according to the present invention is illustrated in Fig. 7 where 7(A) is a front view of hood 20 assembled over a respirator 16, 7(B) being a side view and 7(C) a back view of the assembly. The hood 20 is composed of two portions, a multi-layer lower skirt portion 22 similar to the bottom of hood 18 in Fig. 4 and a thin layer top portion 24 which is configured to match the curved surface area of the thermoplastic liner (TPL) inside the aircrew helmet. In the integrated hood 20, the main body skirt portion 22 of the hood 20 is constructed of a single or multi-layered filter barrier material while the area underneath the helmet, i.e. under the TPL in a SPH5 helmet, is formed of a thin single layer 24. In one embodiment of the invention, the portion of the hood that fits under the TPL is formed as a mesh, e.g. a polyester mesh 24, as shown in Fig. 7A, B and C to minimize the bulk wherever there is contact with helmet and to minimize any heat stress. In this embodiment, the area that is married to the helmet needs to be suitably sized in order to prevent toxic vapours from reaching the skin of the users. In a second embodiment of the invention, the thin single layer 24 is formed of thin single layer of activated carbon impregnated filter material such as carbon impregnated lycra which would maintain some vapour protection in that area of the hood. When a mesh layer 24 is used, the mesh portion should be perfectly matched with the outer edges of the TPL so that the filter material provides optimum protection in areas where the helmet may not be fitted tightly to the head. The thin single layer may be made of woven, knit or non-woven material. The integrated hood 20 provides a proper and comfortable fit for the user, does not compromise the impact protection of the helmet or impose an undue heat

load in the head area.

[0013] Three modifications of the low burden integrated chemical protective hood was trialled for user acceptability in a study conducted in November 2000. All three were satisfactory for comfort and fit when worn over the CF AC4 and under the SPH5-CF helmet. The new hoods designed according to the present invention were found to provide an improved fit over the current in-service aircrew chemical protective hoods.

[0014] The Protective Factors (PF) of a CP lightweight hood and CP polymer hood, measured on a head form at various regions in a controlled environmental chamber using a chemical agent stimulant vapour are shown in Fig. 8. The PFs for a new light-weight chemical protective hood with a polyester mesh portion under the TPL typically ranged between 1000 and 10000+ over the majority of the regions of the head. A PF of 50000 was obtained at the top scalp which essentially reflects a complete absence of chemical vapour in this region and is the result of the extremely tight fit achieved between the thermoplastic liner and the thin mesh layer of the hood at this location. Therefore, this hood provides very good protection without the use of carbon absorbent at locations where equipment interfaces tightly with the body. The thin mesh layer, at the same time, permits the helmet to be used without removing any structural components from the liner to achieve a safe comfortable fit.

[0015] The measured PFs determined for a chemical protective polymer hood were, in sharp contrast to the integrated hood, generally less than 100 over all regions of the head with the exception of the top scalp, right ear and under the respirator. The measured PFs for the polymer hood are shown in Fig. 8 where they can be compared with the PFs obtained for the integrated hood. The polymer hood, based on the results of the measured PFs, offers between 10 and 100 times less chemical vapour protection than the new light-weight chemical protective hood over most regions of the head. It should be noted that the dosage used in the vapour test on the polymer hood was one half that of the dosage used for the tests on the other hood. It is strongly suspected that the protection afforded by hoods that contain no carbon absorbent may be concentration-time dependent, i.e. the longer that it is worn or the higher the vapour concentration during an exposure, the lower the protection to the user.

[0016] The measured PFs shown in Fig. 8 clearly show that the chemical protective hood according to one embodiment of the present invention provides superior vapour protection compared to a typical polymer hood. In addition, this new light-weight chemical protective hood concept offers improved fit and comfort with the potential for a significant reduced thermal burden when compared to a 100% polymer hood.

[0017] Various modifications may be made to the preferred embodiments without departing from the scope of the invention as defined in the appended claims. The

top portion and a layer of the skirt portion, for instance, may be formed of a single layer, permeable, highly absorbent chemical protective carbon barrier material. An ultra-thin insert at the top of hood that is configured to match the curved surface area of the thermoplastic liner inside the aircrew helmet may be used in other versions.

Claims

1. A chemical protective hood (20) to be worn over a respirator (16) in a manner such that it is located between a helmet and the respirator (16), the hood (20) comprising a skirt portion (22) of filter barrier material containing an opening with edges configured to surround and fit against a facepiece of the respirator (16);

CHARACTERIZED IN THAT a top portion of the hood (20) is formed of a thin single layer (24) that fits under a helmet, the thin single layer (24) being configured to match the curved inner surface of the helmet.

2. A chemical protective hood (20) as defined in Claim 1, wherein the skirt portion (22) is multi-layered.
3. A chemical protective hood (20) as defined in Claim 2 wherein the multi-layered skirt portion (22) comprises an inner charcoal-impregnated fabric layer and an outer liquid-repellent and flame-retardant fabric layer.
4. A chemical protective hood (20) as defined in any of Claims 1 to 3, wherein the thin single layer (24) is formed of an activated carbon impregnated material.
5. A chemical protective hood (20) as defined in any of Claims 1 to 4, wherein the thin single layer (24) is formed of a woven material.
6. A chemical protective hood (20) as defined in any of Claims 1 to 4, wherein the thin single layer (24) is formed of a knitted material.
7. A chemical protective hood (20) as defined in Claim 4, wherein the thin single layer (24) is formed of a carbon impregnated lycra.
8. A chemical protective hood (20) as defined in any preceding claim wherein the thin single layer (24) and one layer in the skirt portion (22) are formed of the same material.
9. A chemical protective hood (20) as defined in any of Claims 1 to 3, wherein the thin single layer (24) is a mesh layer.

10. A chemical protective hood (20) as defined in Claim 9, wherein the thin single layer (24) is a polyester mesh layer.

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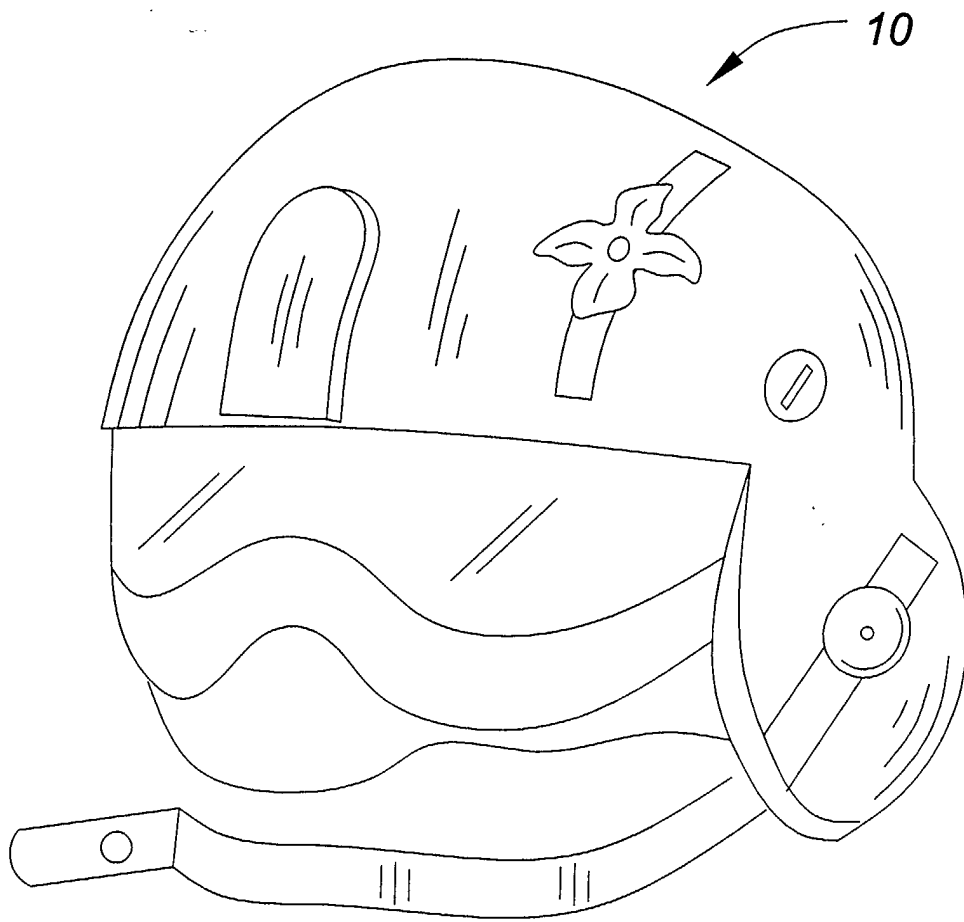
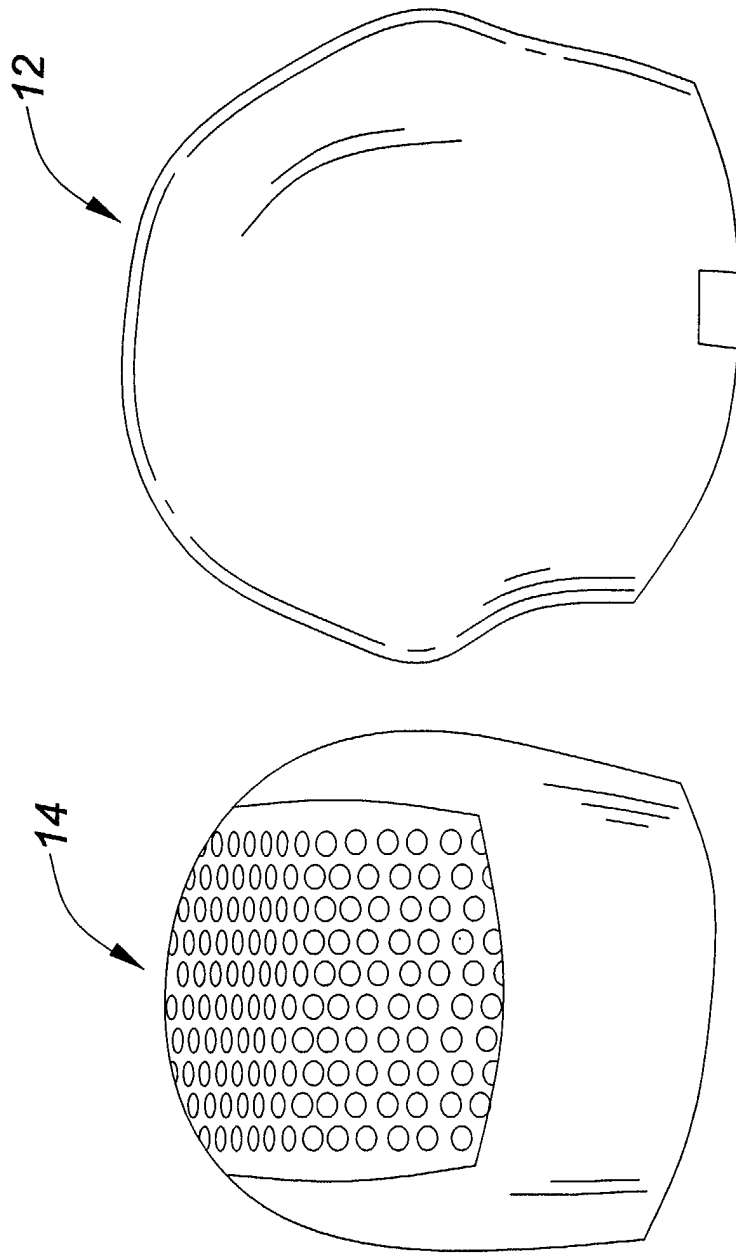
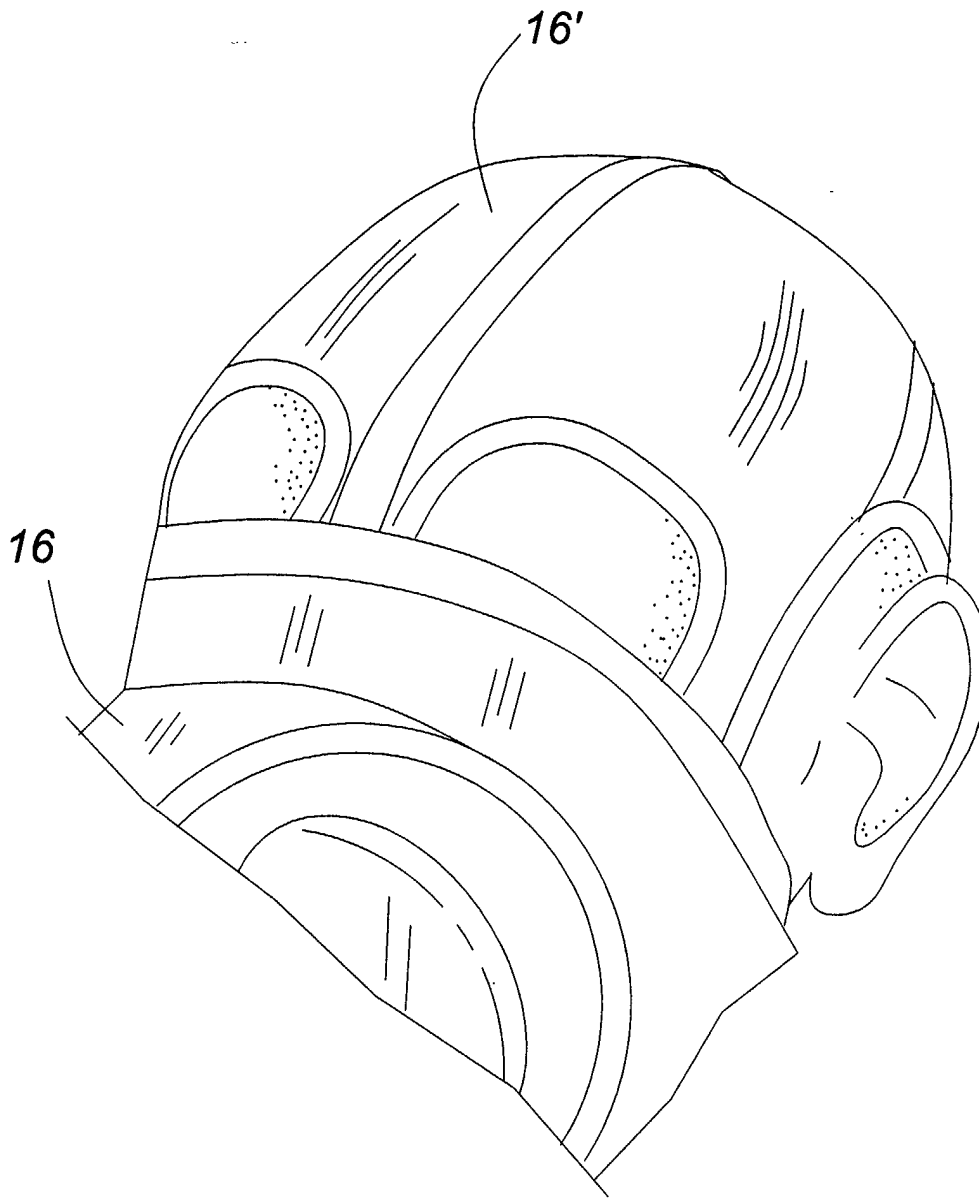


FIG. 1

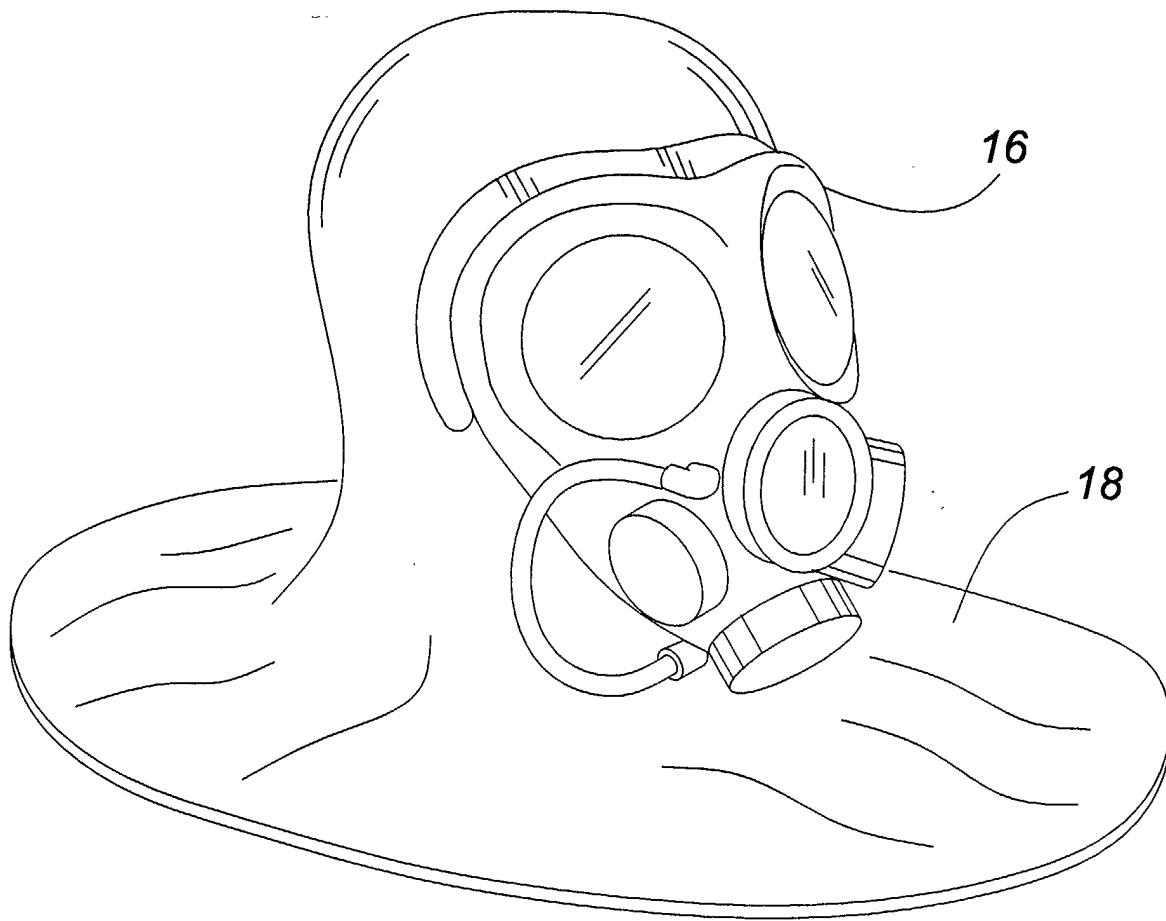


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FIG. 2

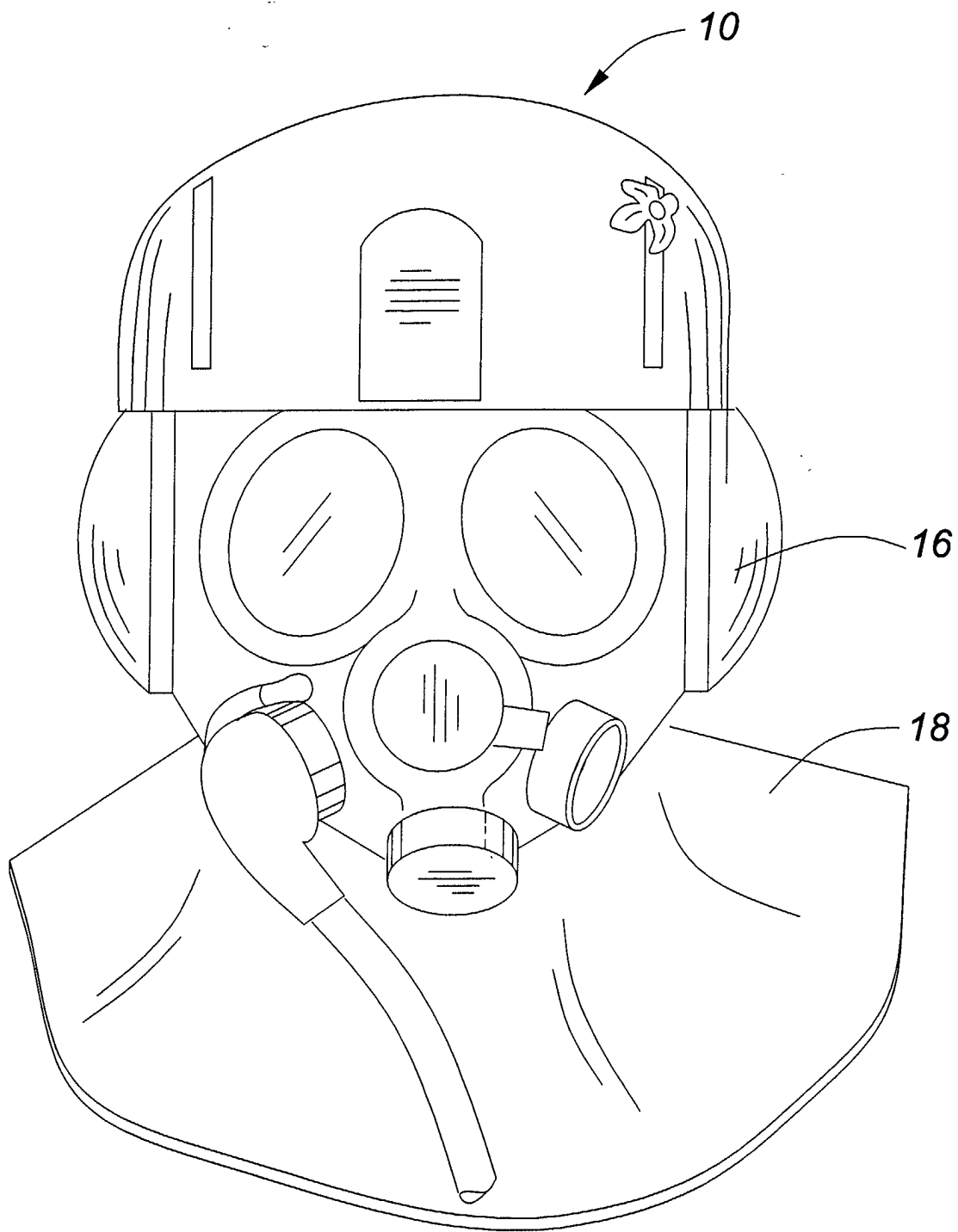


PRIOR ART

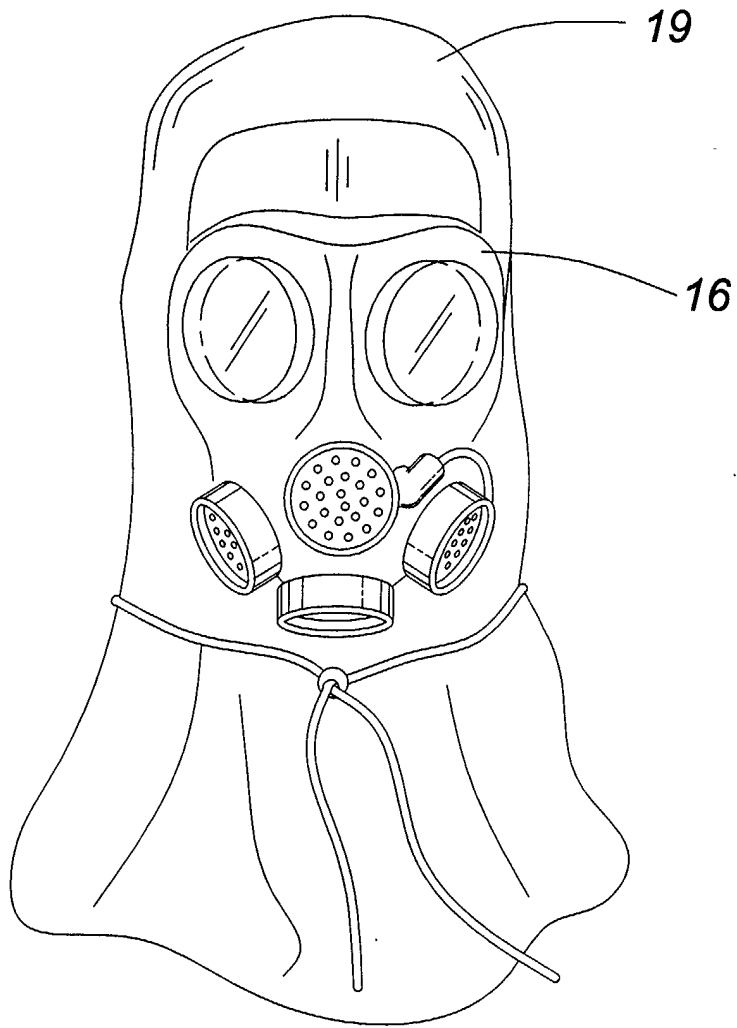
FIG. 3



PRIOR ART
FIG. 4



PRIOR ART
FIG. 5



PRIOR ART

FIG. 6

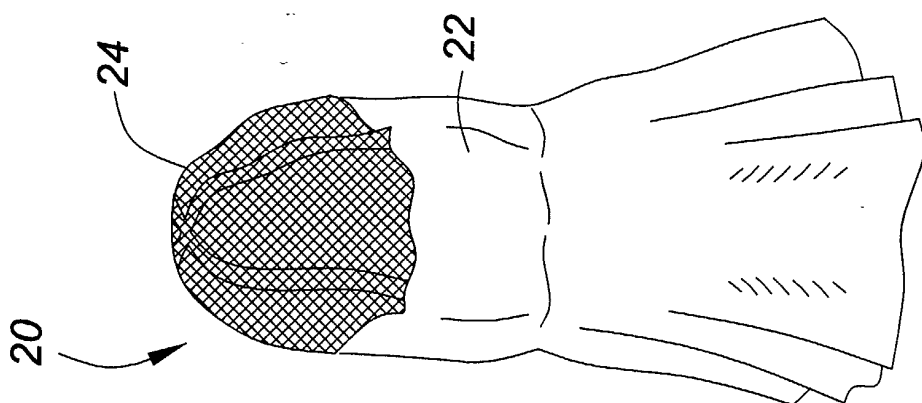


FIG. 7C

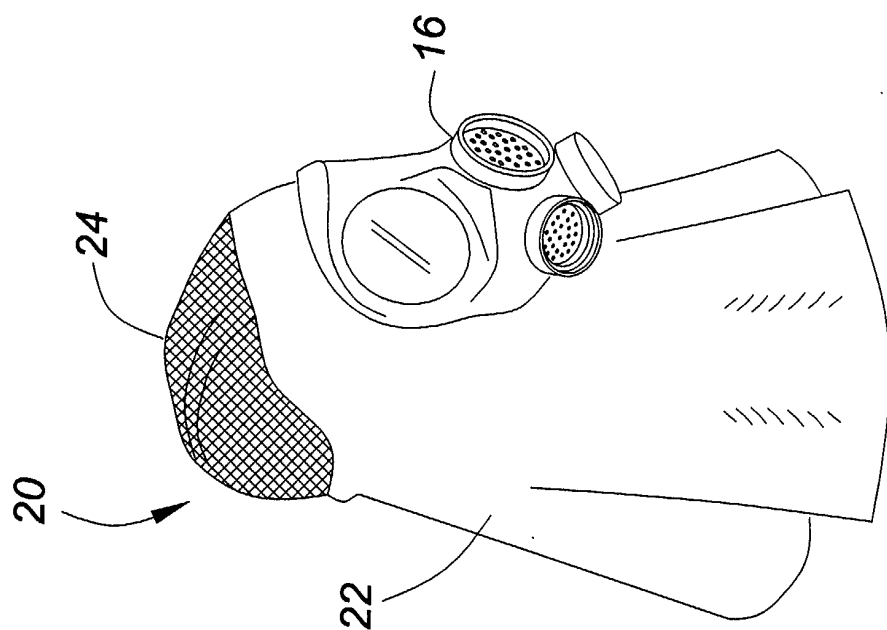


FIG. 7B

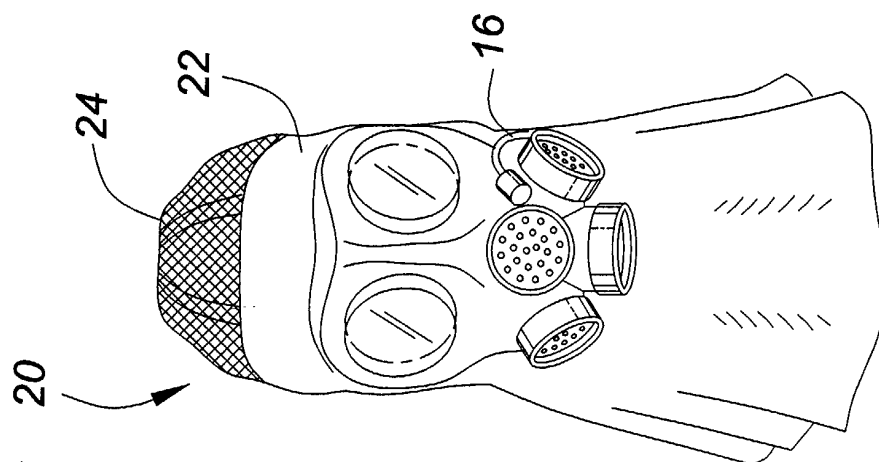


FIG. 7A

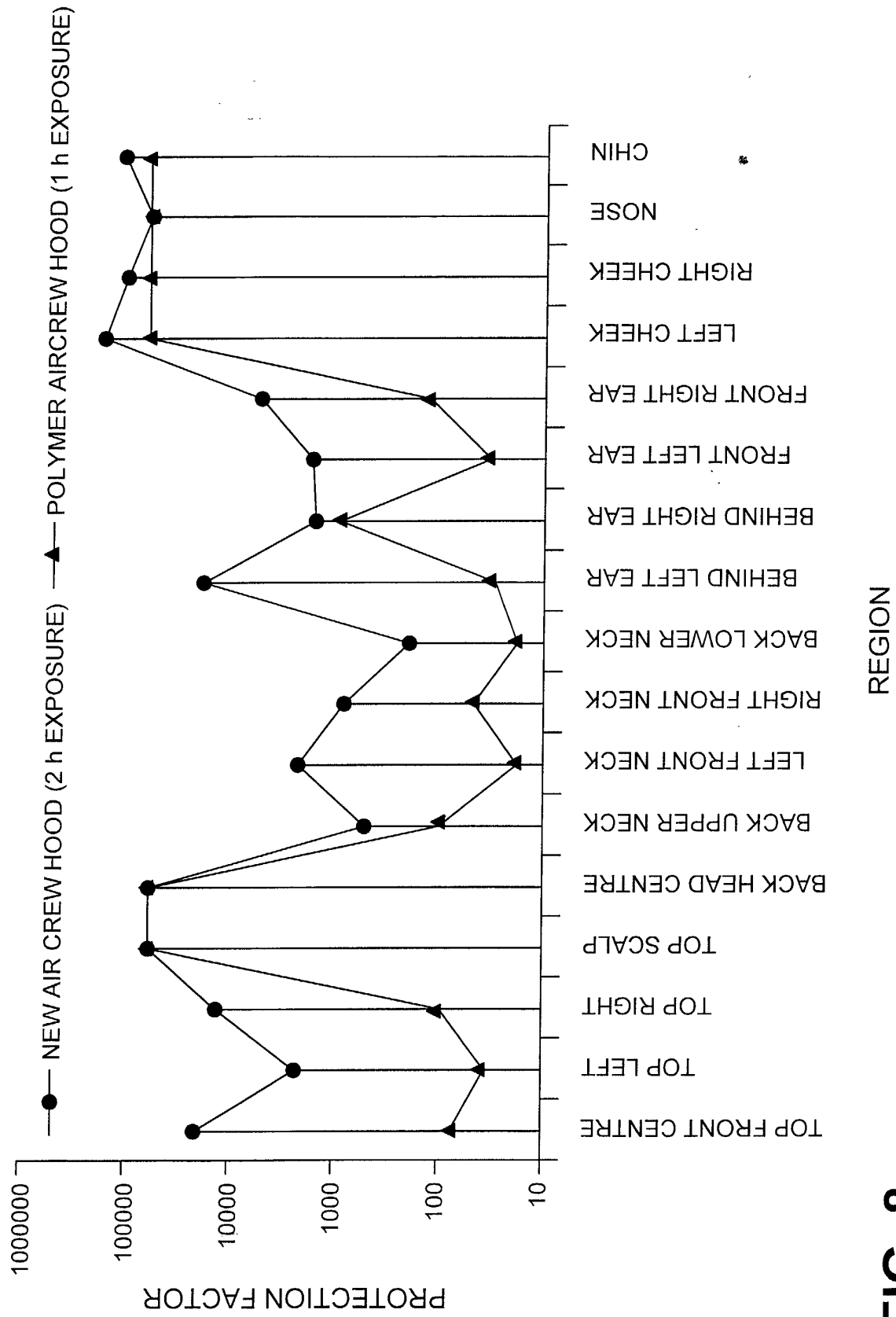


FIG. 8



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EUROPEAN SEARCH REPORT

Application Number
EP 02 07 7024

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The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 1 October 2002	Examiner van Bilderbeek, H.
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			

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EUROPEAN SEARCH REPORT

Application Number
EP 02 07 7024

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The present search report has been drawn up for all claims			
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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