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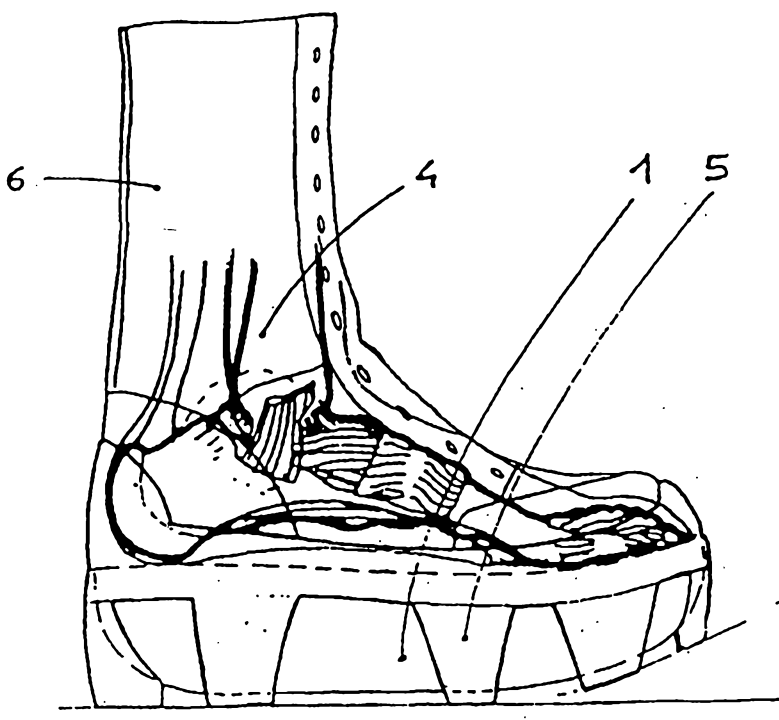
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(54) Title: PROTECTIVE DEVICE AGAINST THE EFFECTS OF EXPLOSIVES

(54) Titre: DISPOSITIF DE PROTECTION DES EFFETS D'ENGINS EXPLOSIFS

(57) Abstract

The invention concerns a device for protecting the bottom part of human lower limbs, and in particular the foot, against the propagation of the blast wave and the heat generated by the detonation of an explosive device such as a landmine. The invention concerns an ankle boot, whereof the walking sole consists of a dihedral dispersing assembly, a fireproof barrier and supporting studs. The assembly provides both an optimal dispersing effect and satisfactory use for walking and running on all types of terrain. It is also heat-resistant and does not generate piercing projectiles as it consists of a homogeneous assembly.



(57) Abrégé

Dispositif pour protéger l'extrémité inférieure des membres inférieurs humains, et notamment du pied, de la propagation de l'onde de souffle et de la chaleur générée par l'explosion d'un engin explosif de type mine. L'invention concerne une chaussure de type brodequin, dont la semelle de marche est constituée par un ensemble dièdre de dispersion, barrière anti-feu et picots de soutien. L'ensemble autorise à la fois un effet dispersant optimum et une utilisation satisfaisante pour la marche et la course sur tout type de terrain. Il est aussi résistant à l'explosion, à la chaleur et non créateur de projectiles perforants parce qu'il constitue un ensemble homogène.

AN APPLIANCE FOR PROTECTING AGAINST THE EFFECTS OF  
EXPLOSIVE DEVICES

The invention relates to a boot serving  
simultaneously to protect the lower limbs of humans  
5 against the deflagration of explosive devices of the  
antipersonnel mine type, and to allow a person to walk or  
run on any type of terrain.

10 The present state of the art presents two types of  
protection for the lower limbs against the deflagration  
of explosive devices:

- Rigid armoring (armored soles mounted on a walking  
boot) which make walking possible while providing  
15 protection against shrapnel but which are ineffective  
against the energy conveyed by the blast wave and the  
shock wave, which waves give rise to the major portion of  
the destructive effects leading to irreparable lesions in  
man and often leading to amputation.

- 20 • Appliances for dispersing the blast waves.

Dispersion is performed by the geometrical shape of the  
sole, referred to below as a "boat-shape", which is  
generally in the form of a triangular or wedge-shaped  
prism with a downwardly-directed ridge or "keel" formed  
25 by two faces of the dispersion boat-shape meeting. These  
boat-shapes are fixed to the bottom portion of a boot and  
have the following disadvantages:

- either they are incorporated in a rigid mass  
to make walking possible, but the dispersion effect is  
30 then considerably reduced. The plane surface created in  
this way transmits practically all of the effects of the  
blast wave.

In addition, the mass covering the boat-shape  
will be broken into pieces that (depending on the  
35 material concerned) can constitute puncturing projectiles  
that give rise to lesions. (This applies to patent

GB 2 191 384 to Dalzell, Goldsmith, and Hudson, and to patent US 3 143 898 to Lewis and Holland);

· or the boat-shape is exposed and fitted with a "skate" type support beneath the ridge of the prism. The skate is unsuitable for balanced walking or for use on all types of terrain. (This applies to  
5 patent US 3 516 181 to Jordan);

· the above-mentioned boat-shapes suffer from another drawback: like an orthosis, they are fixed beneath a walking boot by straps or belts attached by  
10 buckles (Lewis, Dalzell, and Jordan patents). The assembly comprising the boot and the protective appliance thus does not constitute an assembly that is homogeneous and integral. Thus, in the event of an explosion, the  
15 protection appliance is torn away and becomes a projectile causing additional injuries;

· finally, none of those appliances provides protection against the flame of the explosion. For example, the temperature can reach 4000°C during the  
20 initial stage of an explosion.

One aspect of the present invention provides an appliance for protecting a bottom end of a human lower limb from a propagation of a blast wave and from heat generated by exploding an explosive device of a mine type, the  
25 appliance comprising:

a boot including:

an upper;

a boat-shape type sole, with a keel formed by two faces converging downwardly towards a lower ridge and  
30 exposed so as to disperse a major fraction of the blast wave and the heat of the explosion; and

support studs incorporated in the sole around the keel, enabling the sole to be stable on the ground and also making natural walking and running possible on all types of  
35 terrain, said studs each having a free end,

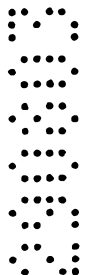
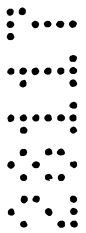
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said boot constituting a homogeneous assembly usable without fitting detachable elements, and integrating in its structure the upper of the boot, the keel, and the support studs for walking, wherein the lower ridge is  
5 located above the free end of the support studs.

Another aspect of the present invention provides a method of manufacturing the appliance according to the first aspect, the method comprising the following steps:

- 10 sticking a subassembly comprising the upper to a subassembly comprising the boat-shape type sole;
- placing the resulting assembly in a mold for injecting polyurethane resin;
- closing the mold;
- injecting molten polyurethane resin to produce the  
15 support studs and to weld all the subassemblies together;
- and
- unmolding the appliance after it has cooled.

An object of a preferred embodiment of the invention is to mitigate the incompatibility between the shape of the  
20 dispersive appliance and the need to make a boot can be used under any type of circumstance and on any type of terrain.



The appliance of a preferred embodiment of the invention is an ammunition type boot, whose sole is constituted by a boat-shaped assembly with supporting studs and an antifire barrier. The assembly provides simultaneously an optimum dispersing effect, effective protection against heat, and satisfactory use in walking and running on any type of terrain. It also withstands the explosion and does not create puncturing projectiles because it is constituted by a homogeneous assembly.

The appliance of the present invention preferably has the following characteristics:

· The purpose of the first characteristic is to stabilize the boot relative to the ground. This is done by adding supports to the boat-shape. These supporting "studs", "props", or "spikes" are assembled to both faces of the boat-shape so that its bottom keel is perpendicular to the ground. The studs extend perpendicularly to the longitudinal axis of the keel.

· The purpose of the second characteristic is to provide proper support for a walker. This is done by a particular disposition of the supporting studs. These are disposed to correspond with the anatomical supporting surfaces of the foot, at the toe and heel ends of the boot. The toe end studs are situated beneath the big toe and the ball of the foot; the heel end studs are situated beneath the talus.

· The purpose of the third characteristic is to allow the keel to act fully in deflecting the blast wave. This is ensured by the supporting studs being thin. In the invention, the total area of the studs preferably represents 15% to 35% of the area of the sole. The keel thus remains exposed over at least three-quarters of its bottom surface area.

The purpose of the fourth characteristic is to enable the keel to act fully in deflecting the blast wave. This is achieved by the tapering shape of the support studs as shown in Figure 3. The studs are perpendicular to the keel of the boat-shape and they are distributed along it (characteristics 1 and 2). Consequently, during an explosion, the first obstacle encountered by the deflected blast wave will be the support studs. These brake the blast wave. To limit this effect, the studs are preferably of a shape that provides as small an obstacle as possible to the blast wave. This is done by means of a streamlined shape as shown in Figure 3.

The purpose of the fifth characteristic is to reinforce the deflection effect of the boat-shape and the studs acting together. This is provided by selecting composite materials of different stiffnesses for making them. The boat-shape must be rigid in order to withstand the blast of the explosion and thus deflect it. The studs are preferably destroyed immediately.

The purpose of a sixth characteristic is to avoid creating puncturing projectiles when the studs are destroyed by the blast of the explosion. This is provided by using non-rigid material for making them. Such material preferably has a hardness on the Shore scale lying in the range of about 40 to 80. It can be made up of polyurethane resin or any other material presenting such characteristics.

The purpose of a seventh characteristic is to provide protection from the flame of the explosion. This is done by combining the dispersing effect of the boat-shape (characteristics 3 to 5) with an antifire barrier included in the boat-shape and in the upper of the boot. The preferred location for the antifire barrier is inside the boat-shape (preferably under the arch of the foot) and in the material constituting the upper of the boot. By way of illustration, antifire barriers tested on

conventional soles were destroyed. Similarly, boat-shapes without an antifire barrier behave in much less satisfactory manner than those so equipped. It is therefore this combination which provides the best protection.

The purpose of an eighth characteristic is to obtain a protective boot that is homogeneous. This is achieved by integrating the top portion of the boot, the insole, the keel, and the studs in an overall assembly by a preferred implementation. The result is a homogeneous structure which presents excellent resistance to blast of the explosion while allowing the keel to perform its function because it is exposed and rigid (characteristics 3 to 5) and because it remains secured to the boot during an explosion.

A preferred implementation has the features set out below.

The upper subassembly (i.e. the top portion of the boot) is stuck to the boat-shape type sole subassembly.

The resulting assembly is then placed in a mold for injecting polyurethane resin.

The mold is closed.

Molten polyurethane resin is injected. Injection makes it possible to produce the support studs and to weld all the subassemblies together.

After cooling, the boot is unmolded.

Two secondary implementations have been identified.

#### Secondary implementation No. 1

As in the preferred implementation, the upper and the boat-shape type sole subassemblies are stuck together.

Then the stud subassembly is made separately by injection molding polyurethane resin.

The boot is then assembled by adhesive.

Secondary implementation No. 2

· As in the preferred implementation, the upper and the boat-shape subassemblies are stuck together.

· The studs are made individually by being cut out  
5 from elastomer plates.

· The studs are subsequently assembled to the upper/boat-shape assembly by adhesive.

Preferred embodiments of the present invention will now be described, by way of example only, with reference to the  
10 accompanying drawings, as set out below.

Figure 1 is a section through a preferred embodiment of the invention and shows the component parts of the boot:

· a dispersion boat-shape type sole having a keel (1);  
· support studs (5) for stabilizing the assembly  
15 relative to the ground;

· an antifire barrier (7) situated in the boat-shape type sole under the arch of the foot and also in the upper of the boot; and

· the upper of the boot (6).

20 Figure 2 shows the preferred embodiment of the invention in profile and illustrates its ergonomic aspects:

· the foot (4) is held in the upper of the boot (6) and is situated above the dispersion boat-shape type sole and its keel (1) assembled to the support studs (5);

· to make walking easier, the studs (5) are  
25 distributed along the boat-shape type sole around keel (1) and include toe end and heel end supports; and

· the heel end studs are situated beneath the talus and the toe end studs beneath the toes and the ball of  
30 the foot. This disposition provides the user with good support.

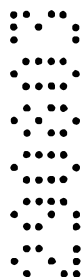
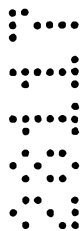
Figure 3 shows the preferred embodiment of the invention seen from beneath and illustrates its blast wave dispersing characteristics:

· the blast wave is deflected (2 and 3) along the  
35 bottom faces of the keel (1);

- the tapering shape of the studs offer as little resistance as possible to the blast of the explosion; and
- for this purpose, the leading edges of the tapering volumes of these studs are positioned perpendicularly to the longitudinal axis (8) of the keel (1).

Throughout this specification and the claims which follow, unless the context requires otherwise, the word "comprise", and variations such as "comprises" and "comprising", will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

The reference to any prior art in this specification is not, and should not be taken as, an acknowledgment or any form of suggestion that that prior art forms part of the common general knowledge in Australia.



THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. An appliance for protecting a bottom end of a human lower limb from a propagation of a blast wave and from heat generated by exploding an explosive device of a mine type, the appliance comprising:

5 a boot including:  
an upper;  
a boat-shape type sole, with a keel formed by two faces converging downwardly towards a lower ridge and exposed so as to disperse a major fraction of the  
10 blast wave and the heat of the explosion; and  
support studs incorporated in the sole around the keel, enabling the sole to be stable on the ground and also making natural walking and running possible on all types of terrain, said studs each having a free end,  
said boot constituting a homogeneous assembly usable without fitting  
15 detachable elements, and integrating in its structure the upper of the boot, the keel, and the support studs for walking, wherein the lower ridge is located above the free end of the support studs.

2. An appliance according to claim 1, wherein the support studs comprise vertically  
20 extending tapering volumes with leading edges situated perpendicularly to the longitudinal axis of the keel.

3. An appliance according to claim 1 or 2, wherein the support studs are disposed so as to correspond with the anatomical supports of the foot; said support studs including toe  
25 end studs situated beneath the ball of the foot and the big toe and heel end studs situated beneath the talus.

4. An appliance according to any one of the preceding claims, wherein the support studs are thin, having a total area representing 15% to 35% of the area of the sole, to allow  
30 the keel to be exposed over at least three-fourths of its surface area.

5. An appliance according to any one of the preceding claims, wherein the support studs are of tapering shape so as to offer reduced resistance to the blast wave and so as to disperse it better along the keel.

5 6. An appliance according to any one of the preceding claims, wherein the keel is made of rigid composite material so as to provide good resistance to the explosion, and thus better dispersion.

7. An appliance according to any one of the preceding claims, wherein the support  
10 studs are made of non-rigid composite materials having hardness on the Shore scale lying in the range of about 40 to 80, in order to avoid creating puncturing projectiles when the support studs are destroyed by the explosion.

8. An appliance according to any one of the preceding claims, wherein the appliance  
15 protects the foot of a human.

9. An appliance according to any one of the preceding claims, wherein the boat-shape type sole extends substantially over the entire length of the appliance.

20 10. An appliance according to any one of the preceding claims, the boat-shape type sole being in the form of at least one of a triangular shape and wedge-shaped prism.

11. An appliance according to any one of the preceding claims, the lower ridge being formed by an intersection of the two faces.

25

12. A method of manufacturing an appliance according to claim 1, the method comprising the following steps:

sticking a subassembly comprising the upper to a subassembly comprising the boat-shape type sole;

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placing the resulting assembly in a mold for injecting polyurethane resin;  
closing the mold;

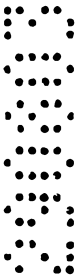
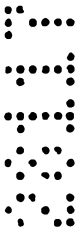
injecting molten polyurethane resin to produce the support studs and to weld all the subassemblies together; and  
unmolding the appliance after it has cooled.

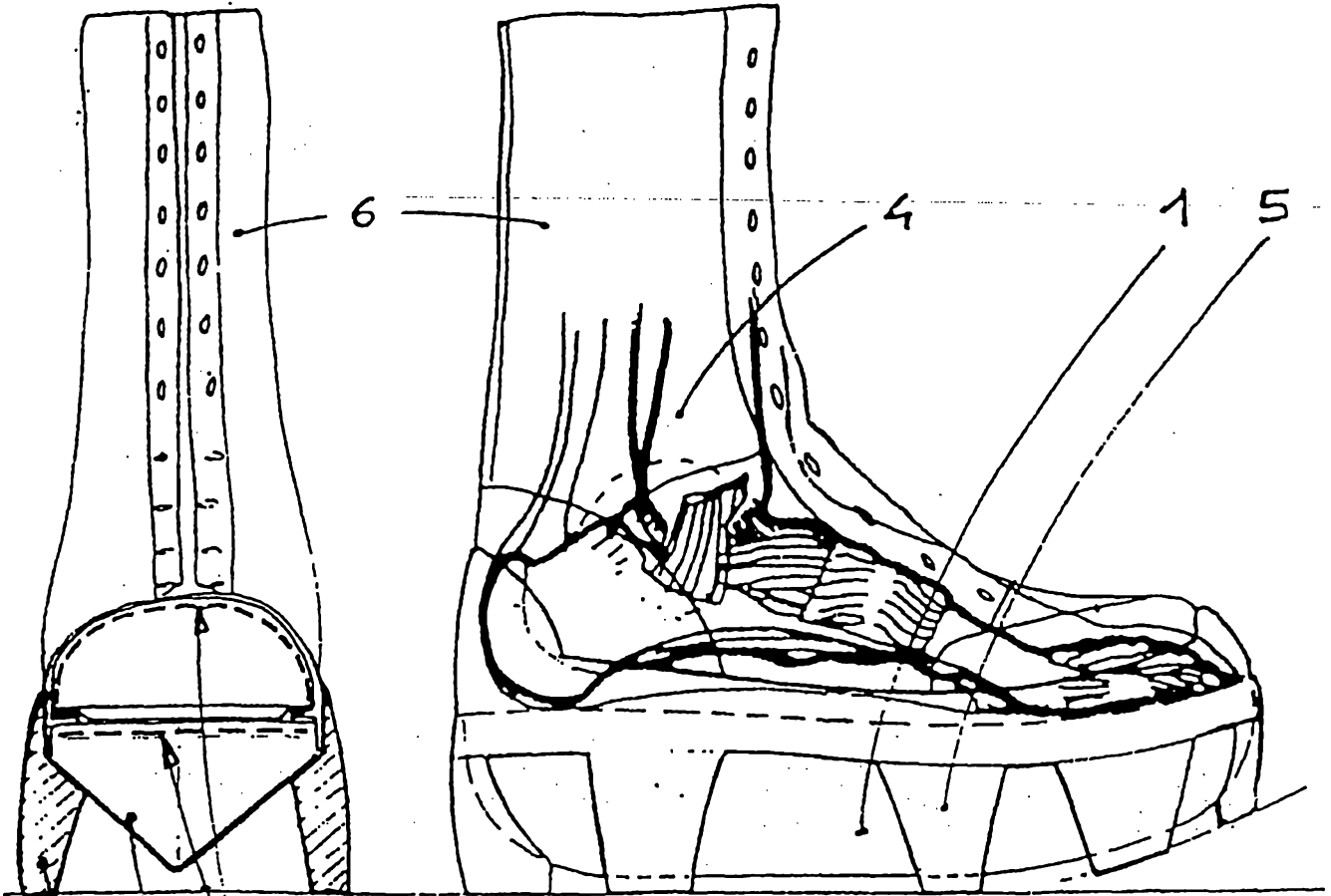
- 5 13. The method of manufacturing an appliance according to claim 12, further comprising using the appliance to make an ammunition boot.
14. An appliance, substantially as described with reference to the drawings.
- 10 15. A method, substantially as described with reference to the drawings.

DATED this 29th day of August, 2003

**Anonymate**

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FIG. 1

FIG. 2

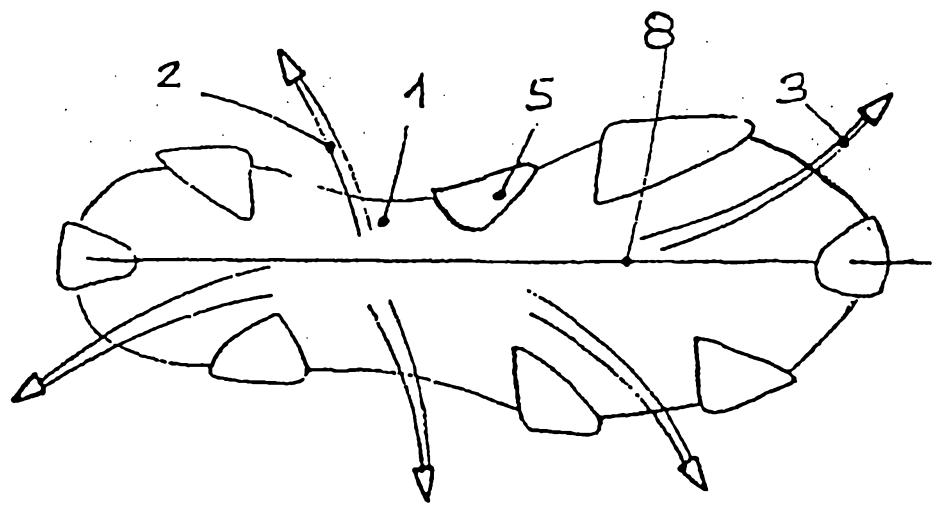


FIG. 3