

IMPROVED BLAST AND FRAGMENT RESISTANT SAFETY BOOT FOOTWEAR

Inventor : Guy Andrew Vaz, 7 Jalan Insaf, SINGAPORE 2057

Application Number:

Filed:

Field of Search

DERWENT WPI 1981-1995/UD=9502;UA=9441;UM=9438

Int. Cl.A43b-013/00, A43b-013/12, A43b-013/16

U.S. Cl.36/32; 36/43; 36/43; 36/73

References Cited:

U.S PATENT DOCUMENTS 5,237,758 7/1993 Zachman

5,285,583 2/1994 Aleven et al.

International

DE 4214802 11/1993 ZEPF H

ABSTRACT

An improved blast and fragment resistant vulcanised rubber boot sole for protection against large anti-personnel mines is described, comprising embedded protective material composed of at least one of woven polyaramid (Kevlar) layer and its critical supporting structure and an additional safety graphite or engineering polymer (Delrin 100) toe-cap..

This Sheet Has Been Replaced



BACKGROUND OF THE INVENTION

Field of the invention

The field of the invention relates to the construction of a boot sole, and its critical supporting structure, and more particularly pertains to a new and improved safety boot sole construction to prevent puncturing of the sole by high energy and high velocity projectiles from an anti-personnel mine containing up to 60 grams of compressed compound-B high explosive thus affording greater protection to an individual's foot without over-restricting movement.

Description of the Prior Art

U.S. Pat. No. 5,237,758 to Zachman : this uses semi-elliptical sections intersecting at loops with adjacent webbs of adjacent loops intersecting with flexible rods directed through the intersecting loops to minimize lateral displacement of adjacent webs.

U.S. Pat. No. 5,285,583 to Aleven: this uses a protective layer composed of plastic and including and including a flexible forepart portion having an insole board bonded to its bottom surface and a fabric liner bonded to its top surface during the process of moulding the protective plastic layer. The plastic used by Aleven is molten plastic injected in the final bonding process.

International Patent DE 4214802, by ZEPF H, to SPORTARTIKELFABRIK UHL GMBH KARL : A multi-layer boot sole having a walking surface, a damping intermediate sole, and an upper insole. The base is a thermo-plastic moulding, or is made of metal, ceramic or graphite, in which multi-filament organic or inorganic reinforcing fibers are embedded in the form of a mat, or woven or knitted structure. The elastic profiled portions are formed on the underside of the base by injection moulding or pressing. The base can contain only a single layer of woven fibres, its total thickness being approximately 0.5 mm.

Aleven achieved strength and impact resistance from a plastic plate in the sole and the use of a fabric mesh was to reinforce the plastic and not to provide impact resistance. ZEPF H, could only achieve a single layer of not more than 0.5mm thickness of woven fibers through injection moulding or pressing. Aleven made no discussion of metal, ceramic or graphite materials. So far, techniques to use aramid, ceramic, or graphite fibers in the construction of a boot sole in thicknesses to prevent puncturing of the sole by high energy and high velocity projectiles has not been mentioned or made feasible due to problems in rigidity and bonding.

An earlier application by VAZ 1995 Blast and Fragment Resistant Sole for safety footwear was designed for the much smaller "scattered mines" of Soviet design. However this design could not afford much protection when a large anti-personnel mine was detonated under the toes or by the side of the boot.

This Sheet Has Been Replaced



SUMMARY OF THE INVENTION

The boot soles described in the prior art are insufficient protection against the larger anti-personnel mines containing up to 60 grams of high explosive when it is desired to conserve toe-to-heel flexion. Especially if the anti-personnel mine is detonated in the toe area or by the side of the boot. To attain this, the present invention provides anti-personnel mine resistant rubber boot sole comprising embedded protective material in which the material is embedded throughout the entire sole is composed of at least 10 woven polyaramid (Kevlar) layers, the density of each layer which is less than or equal to 4 oz per square yard. This invention suggests that more thin layers affords better protection than few thick layers of the same overall thickness and density. Increasing density and additional layers of woven polyaramid fibers increases the blast and fragment resistance. The present invention also includes the critical supporting structure comprising sandwiched protective polyaramid (Kevlar) material is embedded throughout the boot-upper. The protective material is composed of at least 1 woven polyaramid (Kevlar) layers, the density of each layer which is less than or equal to 4 oz per square yard. Increasing density and additional layers of woven polyaramid fibers increases the protection.

It is also an object of the present invention to provide a boot sole with good adhesion between the various polyaramid (Kevlar) layers and/or graphite fiber bundles, and leather, inspite of the poor intrinsic adhesion between the polyaramid fibres, graphite fibres, leather and the rubber. Solvant based rubber adhesive is applied onto pretreated polyaramid (Kevlar) and/or graphite fiber bundles before vulcanisation. The boot upper with the embedded supporting kevlar and protective mid-sole are sewn together along the edge around the entire sole before vulcanising.

According to the invention, at least one layer of woven carbon graphite fibres can be sandwiched between the polyaramid (Kevlar) layers to further strengthen and to stiffen the sole before stitching.

According to the invention, a composite or advanced polymer shank replaces the steel. The composite shank is made of carbon graphite fibres and/or polyaramid (Kevlar) roving saturated in epoxy placed in a mould, or moulded engineering polymer (Zytel or Delrin).

According to the invention, a composite or advanced polymer toe-cap replaces steel. The toe-cap is made of epoxied carbon graphite fibres and/or epoxied polyaramid (Kevlar) roving, or engineering polymer (Delrin 100).

Also according to the invention, a woven layer of mineral fibres, notably ceramic fibres or S-glass fibres, can be included into the boot just before the insole to act as a fire wall for protection against hot gasses with temperatures of between 1500-3000 deg F.



BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be better understood and objects other than those set forth above will become apparent when consideration is given to the following detailed description thereof. Such description makes reference to the annexes drawings wherein:

(Please note: Drawings are not scaled technical drawings but are meant to convey the principal of the invention.)

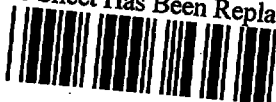
Figure 1 : Drawing illustrating embodiment 1. Shows the cross section side view of the whole boot including the outer (lower), middle, and insole. The protective sandwich of polyaramid (Kevlar) is illustrated as the middle sole. The supporting structure of polyaramid (Kevlar) sandwiched between the leather upper and the inside vamp.

Figure 2 : Is the cross section of the front mid-boot showing an expanded view of the sole construction showing the outer (lower) sole and middle sole, and the relative place of the embedded polyaramid (kevlar) layer. The sewing of the upper and protective mid-sole is also illustrated.

Figure 3 : Drawing illustrating embodiment 2. Shows the cross section side view of the whole boot including the outer (lower), middle, and insole with the carbon graphite layer inserted inbetween the kevlay layers.

Figure 4 : Drawing illustrating embodiment 3. Shows the cross section side view of the whole boot including the outer (lower), middle, and insole with the composite or advanced polymer toe-cap is illustrated.

This Sheet Has Been Replaced



DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the first embodiment (FIG-1) of this invention, the safety boot sole is made in a traditional single-stage vulcanising mould which is commonly used in the vulcanised rubber shoe soling industry.

The leather upper containing the supporting structure comprising sandwiched supportive material of 4 layers of polyaramid (Kevlar) each layer which is less than equal to 4 oz per sq yard. The supportive material is sandwiched between the leather-upper and the inner VAMP leather layer throughout the entire upper. In the toe and heel sections of the leather upper the crowfoot or lino weave (bi-directional) makes it easier to form the polyaramid during lasting.

The main protective sandwich mid-sole consists of 30 layers of polyaramid (Kevlar) the density of each layer which is less than or equal to 4 oz per square yard. The protective sandwich is then sewn unto the upper including the supporting structure of Kevlar and insole, along the whole sole about 5mm from its edge while in the lasting last. The sole is then coated with industry standard latex adhesive and left to dry on racks.

After drying the last is inserted into the boot is then ready to be inserted into the vulcanising machine. About 350 grams of rubber (for size 277) is placed into a vulcanising sole mould cavity to form the outer (lower) sole.

According to the invention, to allow good adhesion and/or penetration to/by the rubber, the lowest polyaramid (Kevlar) layer can be precoated with industry standard rubber solvent adhesives.

The thickness of each layer of the polyaramid (Kevlar) is typically 0.010 inches, using Kevlar 49 plain weave with tensile strength of 43,000 PSI and modulus 19 million PSI.

A boot with sole made according to the above method with the preferred 30 layers of 4 oz per sq yard polyaramid woven Kevlar is effective in providing blast and fragment resistance from a large anti-personnel mine with 50 grams of compressed Compound B high explosive. It was found that large numbers of thinner layers of polyaramid was more effective than fewer number of thicker layers. It was also found that the supportive structure in the upper is not critical for protection but critical in keeping the protective mid-sole in place so as to be effective against large mines. Without the supporting structure the mid sole will loose its integrity and break up, allowing blast penetration of the foot cavity. The protective attributes of the preferred 6 layers of polyaramid embedded upper are effective against a 100 grain projectile with a velocity of 1000 fps (about a small caliber pistol), increasing the layers will improve on the bullet proofing qualities. It also conserves good toe-to-heel flexion in order to enable running, jumping and to clear obstacles such as rope ladders, rope climbing, small steps etc, while avoiding the peeling apart of the sole in subsequent use.

In the second embodiment (FIG-2) of this invention, the outer and middle sole and leather upper are made in the same manner as embodiment 1. In addition, one to 4 layers of woven graphite is inserted into the mid-sole before sewing. Each layer of graphite is less than equal to 8 oz per sq yard and a thickness of .013 inches with tensile strength of 550,000 psi and 36 million Modulus.



In the third embodiment (FIG-3) of this invention, the outer and middle sole and leather upper are made in the same manner as embodiment 1. In addition, a composite or engineering polymer toe-cap is inserted prior to the lasting of the leather upper. The composite toe cap is constructed of epoxied graphite and kevlar or engineering polymer (Delrin 100) engineering plastic. The steel toe-cap has a higher likelihood of causing injury to the wearer than the composite or advanced polymer which is also stronger yet more resilient.

In the forth embodiment (No Figure) ceramic fiber layers are inserted into the mid-sole before sewing just as in the second embodiment in Figure 2.

What is claimed is:

1. An improved blast and fragment resistant rubber boot sole comprising embedded protective material characterised in that the material is embedded through the entire sole and is composed of at least 10 woven polyaramid (Kevlar) layers where the density of each layer which is less than or equal to 4 oz per sq yard and its supporting structure comprising embedded protective material characterised in that the material is embedded throughout the upper and is composed of at least 2 woven polyaramid (Kevlar) layers.
2. The sole according to claim 1, characterised in that in the embedded material consists of multiple thin layers of polyaramid (Kevlar) woven layer, the thickness of which is less than or equal to 0.01 inches.
3. The sole according to claim 1 characterised in that the embedded material includes at least 10 polyaramid (Kevlar) woven layers, the thickness of each layer being less than 0.01 inches, is sewn together to the upper along the entire edge of the sole.
4. The sole according to any given one of the above claims characterised in that a composite or advanced polymer toe-cap is inserted prior to the lasting of the leather upper and is constructed of epoxied graphite and kevlar or engineering polymer (Delrin 100).
5. The sole according to any given one of the above claims characterised in that carbon graphite layers are sandwiched between the polyaramid (Kevlar) layers.
6. The sole according to any given one of the above claims characterised in that a composite or engineering polymer shank replaces the steel shank in that carbon graphite or polyaramid rovings with epoxy are made in the form of the steel shank, whereas the engineering polymer is moulded Delrin 100.





In the third embodiment (FIG-3) of this invention, the outer and middle sole and leather upper are made in the same manner as embodiment 1. In addition, a composite or engineering polymer toe-cap is inserted prior to the lasting of the leather upper. The composite toe cap is constructed of epoxied graphite and kevlar or engineering polymer (Delrin 100) engineering plastic. The steel toe-cap has a higher likelihood of causing injury to the wearer than the composite or advanced polymer which is also stronger yet more resilient.

In the forth embodiment (No Figure) ceramic fiber layers are inserted into the mid-sole before sewing just as in the second embodiment in Figure 2.

What is claimed is:

1. An improved blast and fragment resistant rubber boot sole comprising embedded protective material characterised in that the material is embedded through the entire sole and is composed of at least 10 woven polyaramid (Kevlar) layers where the density of each layer which is less than or equal to 4 oz per sq yard and its supporting structure comprising embedded protective material characterised in that the material is embedded throughout the upper and is composed of at least 2 woven polyaramid (Kevlar) layers.
2. The sole according to claim 1, characterised in that in the embedded material consists of multiple thin layers of polyaramid (Kevlar) woven layer, the thickness of which is less than or equal to 0.01 inches.
3. The sole according to claim 1 characterised in that the embedded material includes at least 10 polyaramid (Kevlar) woven layers, the thickness of each layer being less than 0.01 inches, is sewn together to the upper along the entire edge of the sole.
4. The sole according to any given one of the above claims characterised in that a composite or advanced polymer toe-cap is inserted prior to the lasting of the leather upper and is constructed of epoxied graphite and kevlar or engineering polymer (Delrin 100).
5. The sole according to any given one of the above claims characterised in that carbon graphite layers are sandwiched between the polyaramid (Kevlar) layers.
6. The sole according to any given one of the above claims characterised in that a composite or engineering polymer shank replaces the steel shank in that carbon graphite or polyaramid rovings with epoxy are made in the form of the steel shank, whereas the engineering polymer is moulded Delrin 100.

