

BALLISTIC GRILLE FOR SPECIAL PURPOSE VEHICLE

The invention concerns a ballistic grille for use in special vehicles like armoured vehicles and especially a ballistic grille of reduced weight to protect the vehicle effectively from damage caused by bullets and splinters.

Special vehicles usually have encapsulated engine and cooling system compartments to prevent the vehicle from malfunctioning due to damage caused by penetration of bullets or splinters. Normally, the combustion and cooling air is supplied and discharged through inlet and outlet openings. The ballistic grilles are installed to cover the inlet and outlet openings to prevent penetration of bullets into the engine and cooling system compartments.

The requirement of the ballistic grille is to effectively prevent penetration of bullets or splinters and to maximize air channel size to permit the necessary airflow with minimized weight for the entire system.

Reference is made to German patent 37 03 716 which discloses a prior art ballistic grille. In this patent, the ballistic grille includes several profiles manufactured with structural steel. Additional whole or partial profile parts are attached at the end of each profile toward the vehicle with an angle to prevent passage of bullets or splinters.

In this kind of ballistic grille, as the profiles and profile parts are made mostly of steel there is a high risk of splinter formation when hit by a bullet, which splinters can penetrate through the grille. Sometimes, the bullet can penetrate a profile to reach the engine compartment.

Reference is also made to German patent 40 15 304 A1 entitled "Device for reliably covering air holes in special purpose vehicles". In this patent the profiles are made of a minimum of two individual profiles forming a

hollow space therebetween. This hollow space can be filled with sandwich elements. An outer profile section is made of metal or metal alloy with lower hardness and high elongation and an inner profile section is made of metal or metal alloy with high hardness and lower elongation. Therefore, this can absorb the kinetic energy of a bullet and a bullet having penetrated the outer profile can be caught in the hollow space. This type of grille improves the protection level by minimizing fragments.

10 But even though the outer profile section is made of a material with lower hardness and high elongation, it is basically made of metal and has limited capability in shock absorbing and protection. Furthermore, there is a difficulty in reducing the weight of the entire system as
15 both individual profiles are made of metal.

The invention has been conceived to solve the problems encountered with the prior art ballistic grilles. The object of the invention is to provide a ballistic grille for special purpose vehicles to effectively prevent
20 penetration of bullets or splinters.

Another object of the invention is to contribute in reducing the weight of the vehicle by providing a ballistic grill with minimized weight.

The grille according to the invention protects the
25 special purpose vehicle from Rader and Infra-Red detection.

This protection beams are made of a kinetic energy absorbing core entirely surrounded by shock-absorbing outer shell. The core is made of steel or other alloys of iron, other metal, metal alloys, cermets, ceramics, fabrics or combinations thereof that are either treated or untreated.
30 The outer shell is made of glass fiber, carbon, aramid, polyamid, polyester, polyethelene or hybrids of these materials.



According to the characteristics of this invention, the core is entirely surrounded by an outer shell having shock-absorbing properties. So, a bullet penetrating the outer shell will hit the core and create splinters which will make the outer shell bulge. So, all splinters will be trapped between the core and the outer shell. In case of penetration of the core, the outer shell of the other side will bulge to absorb the remaining kinetic energy of the bullet. Thus, the penetration of bullets and splinters to the inside of the vehicle can be effectively prevented. Furthermore, this system can contribute to reducing the weight of the ballistic grille as the outer shell is made of light material.

The surface of the core can have specific shapes to strengthen the connection between the core and the outer shell.

To improve the camouflage against Rader and Infra-Red detection additional material can be applied to the surface of outer shell.

The connection of the core with the outer shell can be releasable or non-releasable.

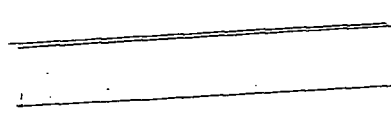
The outer shell may consist of several sheets.

There can be a slight hollow space between the core and the outer shell.

The invention will now be described in greater detail with reference to the drawings. The same numbers have been used for same parts throughout the drawings, wherein:

Figure 1 shows a special purpose vehicle with a ballistic grille of the invention.

Figure 2 shows a ballistic grille of the invention for a special purpose vehicle.



Figures 3a, 3b, 3c show various examples of cross-sections of the ballistic beams of the invention.

Figure 4 shows the absorbing of the kinetic energy of a bullet.

5 Figure 5 shows another example of the connection between the core and the outer shell.

Figure 1 shows special vehicle (12) with a ballistic grille (10). The engine compartment of the special vehicle (12) has an inlet opening and an outlet
10 opening to supply air for combustion and cooling and to discharge used air.

The ballistic grilles covering the inlet and outlet openings provide air inlet channels and protect the vehicle from malfunctioning by penetration of bullets or splinters.

15 As shown in Figure 2, the ballistic grille (10) of this invention includes several protection beams (22) and a support (24). Each beam (22) is fixed on the support (24) with a spacing between the beams selected and angled to prevent penetration of bullets or splinters through the
20 grille. Protection beam (22) consists of the kinetic energy absorbing core (14) and outer shell (16). Outer shell (16) surrounds the core (14) entirely with a non-releasable connection therebetween. The core (14) is made of a
25 material which has high strength and hardness, for example, steel, alloys of iron, metal, metal alloy, cermet, ceramic, fabric that are either treated or untreated. The outer
shell (16) is made of the material which has shock-absorbing property, for example, glass fiber, carbon, aramid, polyamid, polyester, polyethylene or hybrids of
30 these material.

Figure 3 shows various shapes of the protection beams. Figure 3a shows L-type protection beams. Figure 3b shows S-type protection beams. Figure 3c shows T-type protection beams. There can be a serrated area (18) on the



surface of core (14) to increase the connection with the outer shell (16), note Figure 3a. This can minimize shifting of the outer shell when the beam is hit by a bullet.

5 Figure 4 shows the absorption of the kinetic energy of a bullet by the ballistic grille of the invention. As the core (14) is entirely made of hard material and surrounded with the outer shell (16) made of shock absorbing material, the bullet will penetrate the outer
10 shell without creating any splinters and strike the core (14) which will absorb most of the kinetic energy. The bullet or splinters formed after collision with the core will be reflected away from the core (14) which will make the outer shell (16) bulge and absorb the remaining kinetic
15 energy of the bullet or splinters. So, the bullet or splinters will stay in between the core (14) and the outer shell (16). In case of penetration through the core (14) due to high kinetic energy, the outer shell on the other side will bulge and absorb the remaining kinetic energy. In
20 case of penetration through the bulge due to very high kinetic energy, the bullet will hit the outer shell (16) of the next ballistic beam (22) because this bulge will not crack before it will touch the surface of the next outer shell due to the size of the width of the air-gaps and
25 between the beams the "defence procedure" starts again.

 This behaviour opens the possibility that due to the design, several ballistic beams can be used as kinetic energy absorbers against one bullet without creating any splinters which can migrate into an air channel. That means
30 that with this invention one can attain ballistic protection levels which are not to be achieved by all known grille systems including those described in the prior patents referred to.

 Figure 5 shows another connection between the core
35 (14) and the outer shell (16). The outer shell has several

sheets (26) detachably connected with the core (14) by bolts (20).

Therefore, as explained, bullets and splinters are stopped effectively from penetration into the engine compartment. Also, the required protection is achieved with minimum weight of the ballistic grille.



CLAIMS:

1. Ballistic grille for special purpose vehicles, having parallel ballistic beams of various cross-sectional shapes, characterized in that the ballistic beams are made of a kinetic energy absorbing core entirely surrounded with an outer shell which offers high kinetic deforming behaviour.
2. Ballistic grille as in claim 1, characterized in that the kinetic energy absorbing core is steel and other alloys of iron, other metals and metal alloys, cermets, hard metals, ceramics, fabrics or combinations thereof that are either treated or untreated.
3. Ballistic grille as in claims 1 and 2, characterized in that the outer shell which surrounds the core entirely is made of fibers of glass, carbon aramid, polyamid, polyester, polyethylene or hybrids of these materials.
4. Ballistic grille as in claim 1 or 2, characterized in that the surface of the core is serrated.
5. Ballistic grille as in claim 1, characterized in that the outer shell is provided with additional materials on the surface thereof to improve the camouflage against Rader and Infra-Red detection.
6. Ballistic grille as in claim 1, characterized in that the connection of the core with the surrounding outer shell is releasable or non-releasable.
7. Ballistic grille as in claim 1, characterized in that the outer shell consists of several sheets which are detachable.
8. Ballistic grille as in claim 1, characterized in that there is a slight hollow space between the core and the outer shell.

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