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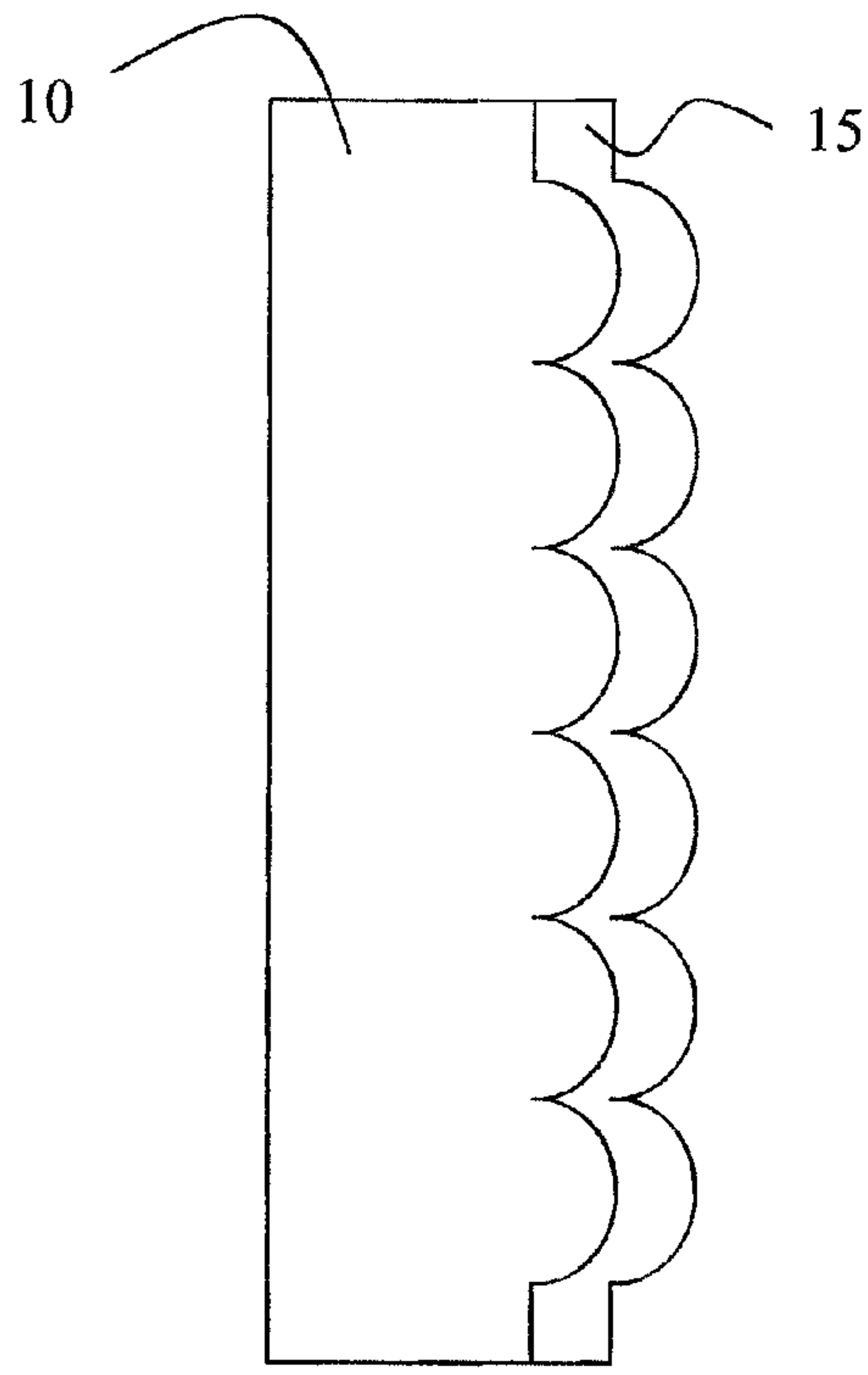
(54) Titre : SYSTEME DE BLINDAGE EN CERAMIQUE AVEC REVETEMENT DE DIAMANT
(54) Title: CERAMIC ARMOR SYSTEM WITH DIAMOND COATING



(57) Abrégé/Abstract:
An improved ceramic armor system comprising a ceramic component and a diamond powder based slurry bonded to a strike surface of the ceramic component, the diamond powder based slurry including a diamond powder and a base selected from the group consisting of a silicate and a phosphate base.

ABSTRACT

An improved ceramic armor system comprising a ceramic component and a diamond powder based slurry bonded to a strike surface of the ceramic component, the diamond powder based slurry including a diamond powder and a base selected from the group consisting of a silicate and a phosphate base.

CERAMIC ARMOR SYSTEM WITH DIAMOND COATING

FIELD OF THE INVENTION

The present invention relates to ceramic and ceramic matrix composite armor systems and specifically relates to the increase of hardness of the strike face using a diamond coating on the ceramic component.

Ceramic armor systems require two properties to be effective in their protection against projectiles. A first aspect of ceramic armor is the hardness of the ceramic. Ceramic armor systems are effective protection against armor piercing projectiles as the hardness of the ceramic exceeds that of the metal or steel of the projectiles.

A second consideration is the fracture toughness of the ceramic plate. Fracture toughness is an important characteristic for the ballistic performance of ceramic armor.

Ideally, a ceramic armor system would have a high hardness and a high fracture toughness.

In current applications, the ceramics of principal interest for protection against armor piercing projectiles are boron carbide, silicon carbide and aluminum oxide (alumina). Among these ceramics, boron carbide has the highest hardness, but quite a low fracture toughness.

Alumina is an alternative material that is used. Alumina has a lower hardness than boron carbide but when alloyed with a second phase, creating a ceramic-ceramic phase composite, it can exhibit reasonably high fracture toughness. However, this composite is still less hard than boron carbide.

SUMMARY OF THE INVENTION

The present invention seeks to overcome the deficiencies of the prior art by providing a diamond coating on a ceramic component. Specifically, synthetic diamond dispersed into a silicate or a phosphate based slurry can be used for coating a monolithic armor plate for either personal protection or for tiles for a vehicle protection. This coating can then be heat treated to create a bond with the ceramic component. The diamond-coated ceramic exhibits better performance against armor piercing steel core projectiles than the ceramic component on its own.

The present invention therefore provides an armour plate comprising a ceramic base layer having an inner surface and an outer surface, the outer surface having bonded thereto at least one layer of a composite comprising diamond powder dispersed in a substrate bonded to said outer layer of said ceramic base layer.

The present invention also provides a method of increasing the hardness of a ceramic component comprising the steps of fabricating a diamond powder slurry by mixing a diamond powder with a base, applying the diamond powder slurry onto a strike face of said ceramic component, and hardening diamond powder slurry to form a bond between the diamond powder slurry and the ceramic component.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be better understood with reference to the drawings in which:

Figure 1 shows a side cross-sectional view of a ceramic plate coated with the diamond coating of the present invention.

DETAILED DESCRIPTION OF THE DRAWINGS

Passive armor has the function of defeating and/or deflecting an impacting projectile. The present invention seeks to provide increased protection against armor piercing projectiles with a steel or other hard core for both vehicle and personal body armor. The present invention may be used for other purposes, as would be appreciated by those skilled in the art, including protection shields and building protection.

In a preferred embodiment of the invention, as illustrated in Figure 1, a ceramic component 10 is used to defeat an armor piercing projectile. In a preferred embodiment, the ceramic component is composed of aluminum oxide (Alumina), silicon carbide, or a composite made therefrom. These ceramic components have a lower hardness than boron carbide but have an increased fracture toughness.

In order to improve the hardness of these ceramic components, a diamond coating 15 is added over the ceramic component 10. By coating a ceramic component 10 with a diamond coating 15, a higher hardness than boron carbide ceramics is accomplished.

Synthetic diamond, preferably in the 8-15 μm particle size can be used for coating monolithic armor plates for personal protection or tiles for vehicle protection. A diamond powder is dispersed into a hardenable slurry such as a silicate or a phosphate based slurry and in a preferred embodiment is sprayed onto the strike face of a ceramic component. The preferred silicate is calcium silicate, although other silicates such as sodium silicate may be used. As will be appreciated by one skilled in the art, other materials could also be used as long as a chemical adhesive or mechanical bond is achieved between these materials and the ceramic component 10.

Once the ceramic component 10 has been sprayed with the diamond powder and silicate or phosphate slurry mixture, it is then hardened. In the case of most silicate or phosphate compounds, heat-treating at between 300° and 400° F to form a chemical bond (silicate or phosphate bonding in the preferred embodiment) with the surface of ceramic component 10 is sufficient. However, it will be appreciated that other compounds may be hardened at different temperatures or by other means such as UV curing or chemical catalysis, as will be apparent to one skilled in the art of laminating materials.

In one embodiment of the present invention, diamond is mixed with a liquid base such as calcium silicate in any proportion suitable for creating a protective diamond layer on ceramic component 10. In a preferred embodiment it has been found that 5g of diamond powder mixed with 10g of silicate produces the desired results. However, this is not meant to be limiting.

The above therefore provides a diamond coated ceramic system which exhibits higher ballistic performance against armor piercing steel core projectiles. Through diamond coating, ballistic performance of boron carbide can be achieved in terms of the hardness of the ceramic component while still having the fracture toughness of alumina or silicon carbide based ceramics. Specifically, the inventors have found that a diamond coated ceramic component such as an alumina composite can be harder than a boron carbide plate while having a fracture toughness 6 (six) times greater than boron carbide.

It will be appreciated that multiple layers of coating may be applied, and that additional coatings or layers of other materials such antispall coatings, or UV protective coatings, may be applied over the diamond layer.

The above described embodiments are meant to be illustrative of preferred embodiments and are not intended to limit the scope of the present application. Also, various modifications, which would be readily apparent to one skilled in the art, are intended to be within the scope of the present application. The only limitations to the scope of the present application are set forth in the following claims.

CLAIMS

We claim:

1. An armour plate comprising:

a ceramic base layer having an inner surface and an outer surface, the outer surface having bonded thereto at least one layer of a composite comprising diamond powder dispersed in a substrate bonded to said outer layer of said ceramic base layer.

2. The improved ceramic armor system of claim 1, wherein the diamond powder comprises synthetic diamonds with a particle size in the range of 8-15 μm.

3. The ceramic armor system of claims 1 or 2, wherein the diamond powder slurry is bonded to the ceramic component using heat treatment.

4. The ceramic armor system of claim 3, wherein the heat treatment is performed between 300° and 400° F.

5. The ceramic armor system of any of claims 1-5, wherein the ceramic component is selected from the group consisting of silicon carbide and aluminum oxide.

6. A method of increasing the hardness of a ceramic component comprising the steps of:

fabricating a diamond powder slurry by mixing a diamond powder with a base;

applying the diamond powder slurry onto a strike face of the ceramic component; and

hardening diamond powder slurry to form a bond between the diamond powder slurry and the ceramic component.

7. The method of claim 6, wherein the base is selected from the group consisting of a silicate and a phosphate base.

8. The method of claim 6 or 7, wherein slurry is hardened by heat treating, performed between 300° and 400° F.

9. The method of any of claims 6 to 8, wherein the diamond powder comprises synthetic diamonds with a particle size in the range of 8-15 μm.

10. The method of any of claims 6 to 9, wherein the ceramic component is selected from the group consisting of silicon carbide and aluminum oxide.

11. The method of any one of claims 6 to 10, wherein said slurry is applied to said strike face by spraying.

Application number/numéro de demande: 2483231

Figures:

Pages: 2 pages Drawings

Unscannable items
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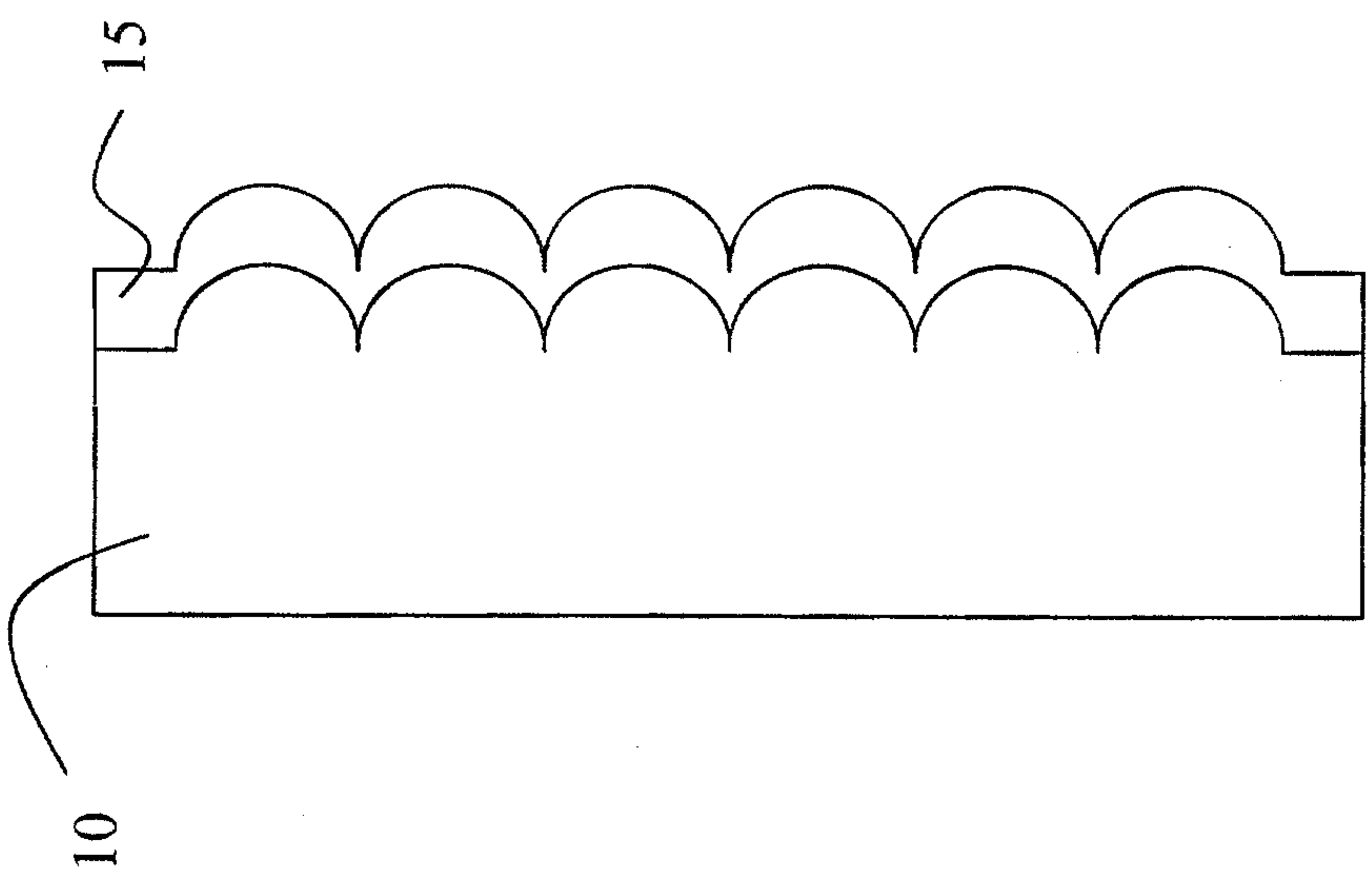
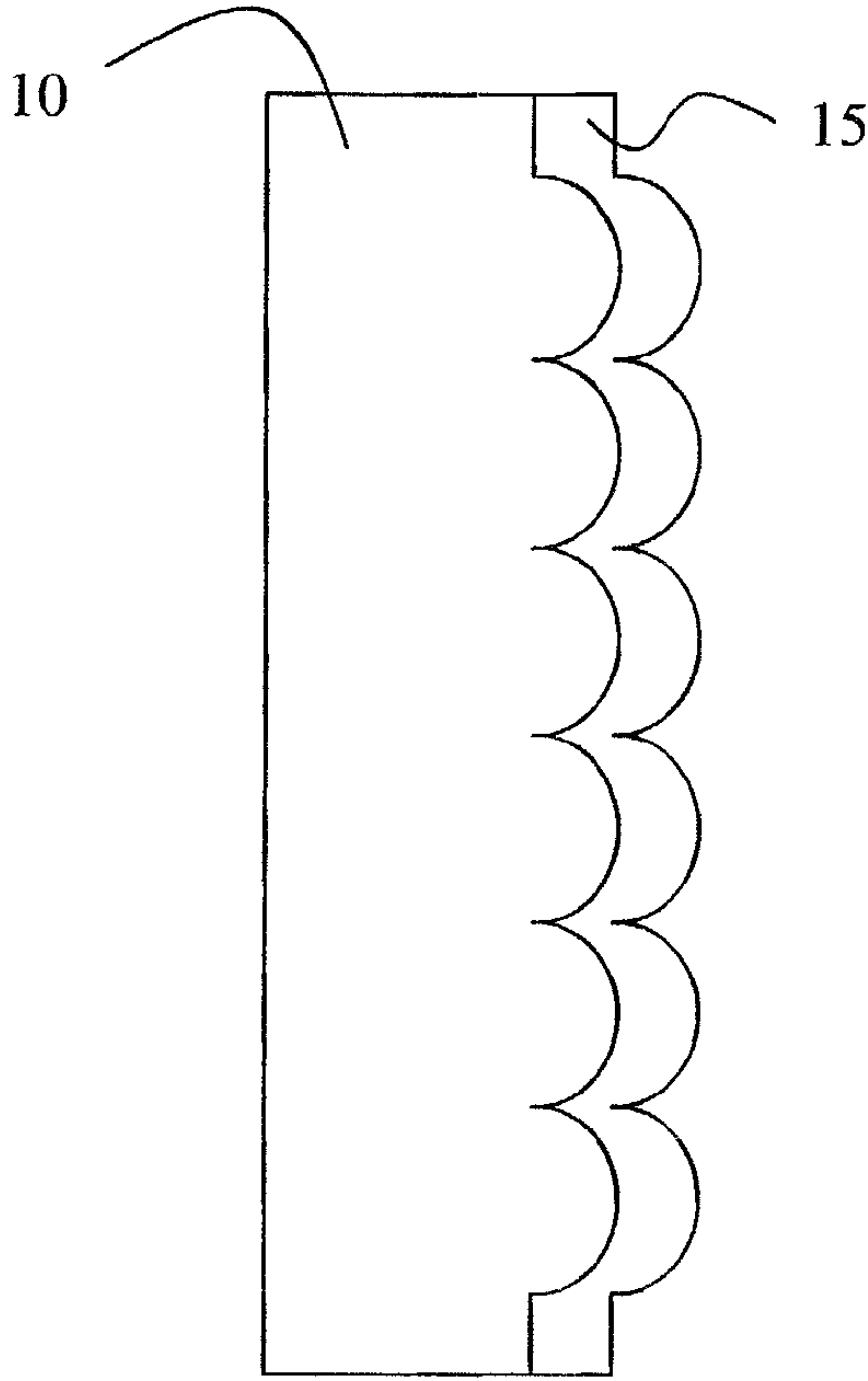


Fig. 1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