Sept. 11, 1945. H. C. BIERMAN 2,384,594

PROTECTIVE ARMOR

Filed Oct. 18, 1941

Fig. 1

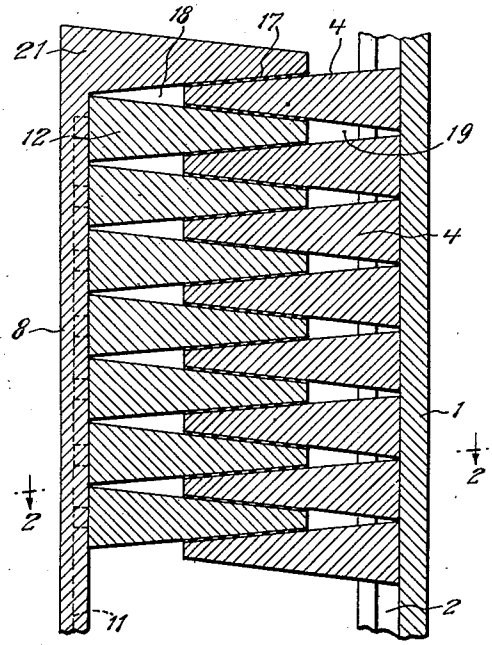


Fig. 2

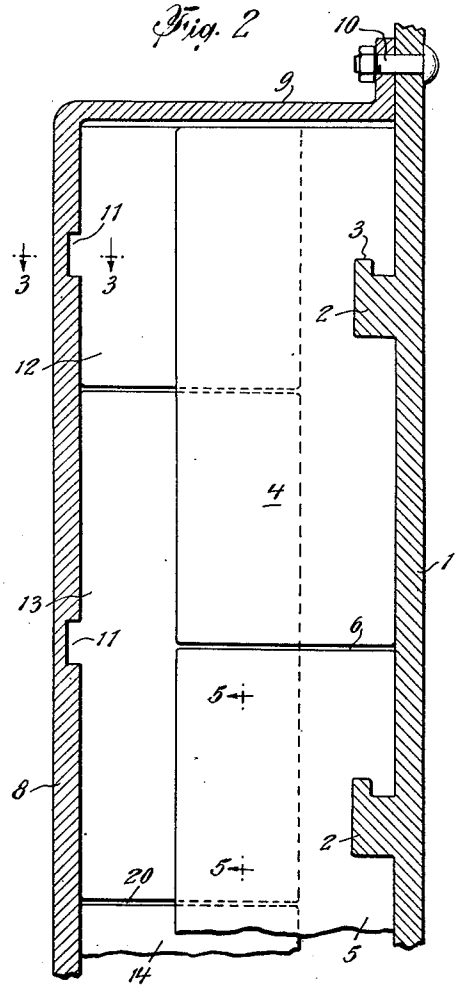
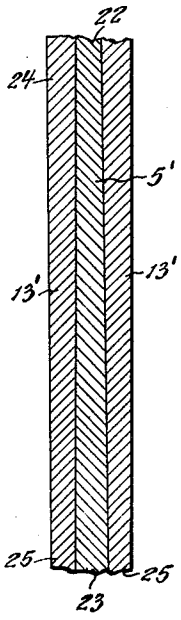


Fig. 5



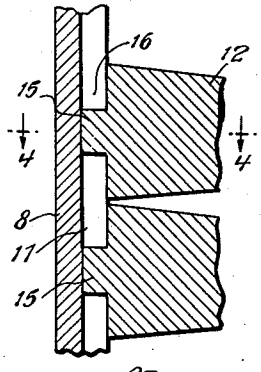


Fig. 3

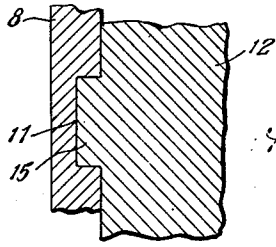


Fig. 4

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UNITED STATES PATENT OFFICE

2,384,594

PROTECTIVE ARMOR

Harry C. Bierman, New Rochelle, N. Y.

Application October 18, 1941, Serial No. 415,515

13 Claims. (Cl. 109—81)

This invention relates to protective surfaces for vessels of war, such as naval vessels, tanks, airplanes, and the like. It is particularly adapted to provide a structure in which the impact of a projectile is distributed over a relatively wide area.

In armor plate as made heretofore, the construction included principally a solid plate of metal, usually steel or alloys thereof, which plate might be of considerable thickness, depending on the amount and character of the protection desired. Large plates of this character were mounted on the vessel to be protected from the impact of projectiles. It has heretofore been impossible to make the armor plate of such thickness as to with certainty withstand the blows of the projectile, because to do so would be to so greatly increase the weight of the vessel that its value would be decreased due to the lack of speed and maneuverability. Therefore, a compromise was reached wherein the thickness of the armor plate was sufficient to withstand most of the projectiles and thus afford a reasonable degree of protection.

The present invention is intended to provide a structure of armor for vessels of the type described above wherein for the same weight of steel, greater protection is obtained, or, conversely, for the same protection, a lesser amount of steel may be used.

In the armor plate as used heretofore, the force of the impact of a projectile was concentrated at the point of impact. In other words, all of the energy of the projectile was dissipated within the very limited area of contact between the projectile and the vessel. Therefore, very often the heat generated by the concentrated dissipation of the energy fused the steel and rendered further penetration of the projectile relatively easy. In this manner, projectiles could reach the interior of the vessel and therefore cause great damage.

The present invention is based upon the concept that if the energy in the projectile could be distributed over a relatively large area, fusion of the steel could be prevented to at least some extent and the force of the impact could be dissipated before penetration through the armor took place. To accomplish this, there is provided a series of cooperating wedge-shaped members in two sets. One set thereof extends outwardly from the vessel or other object to be protected and the other set of wedge-shaped members extends inwardly and interlaces with the first set of members, but not secured thereto. Preferably, all of the wedge-shaped members are independently movable, but in close relationship to each other, so that unless there is an impact, the said members are relatively stationary. Upon the impact of a projectile upon, say, one of the outer wedges, it causes movement thereof and frictional engagement with the two inner wedges contacting therewith, and the friction between the said three wedges will absorb part of the energy of the impact. There will be slight motion of all of the wedges and this motion is in turn imparted to adjacent wedges so that finally the energy of impact is absorbed by a considerable number of wedges. The areas of contact of the two sets of wedges may be made relatively large compared to the thickness of the armor. Therefore, instead of as in prior armor plate the energy of the impact being absorbed on an area of a few square inches, in the present construction the energy of impact is distributed over a number of square feet.

In the accompanying drawing, constituting a part hereof, and in which like reference characters indicate like parts,

Fig. 1 is a horizontal sectional view looking down upon armor of the present invention as applied to the side of a vessel;

Fig. 2 is a longitudinal, cross-sectional view taken along the line 2—2 of Fig. 1;

Fig. 3 is a fragmentary, enlarged, cross-sectional, top view showing the junction of the outer wedge-shaped members with the outer shell;

Fig. 4 is a vertical, cross-sectional view taken along the line 4—4 of Fig. 3 and

Fig. 5 is a longitudinal, cross-sectional view taken along the line 5—5 of Fig. 2.

Numeral 1 represents the outer shell of the vessel to be protected, or it may be a special shell of suitable material, and constitutes the inside shell of the new armor. Formed on shell 1 is a horizontal bar 2 having a projection 3 along the upper edge thereof. Usually, several such bars 2 are formed, depending upon the size and character of the vessel to be protected. A series of wedge-shaped members 4 and 5 having recesses in the bases thereof, similar to projections 2, are hung on said projections and are held in place thereby. As shown particularly in Fig. 2, a series of such wedges 4—5 may extend the entire length of the surface to be protected, being separated by very narrow spaces 6, which may be filled with sponge rubber or the like in order to prevent relative movement thereof under ordinary conditions. The wedges 4 normally cannot move in a vertical direction, but by reason of their mounting are capable of limited movement in a horizontal direction.

An outer shell 8 is provided for the armor plate. This may be of a special alloy suitable for resisting great stresses, and by reason of the fact that it is relatively thin, it is not an expensive matter to make the outer shell of the toughest material available. The upper end of shell 8 is bent inwardly, as shown at 9, in close proximity to the top of the wedges and is secured to the inner shell 1 by means of bolts 10. Similarly, the lower end of outer shell 8 may be secured to inner shell 1 or other suitable support. On the inner surface of outer shell 8 is formed one or more recesses 11. A series of wedges 12 extend inwardly from the outer shell 8 and interlace with wedges 4, being in close contact therewith, but sufficiently spaced therefrom so as to allow of slight relative movement. There are a series of wedges 12, 13 and 14, longitudinally spaced and substantially in contact with each other and forming in effect, as shown in Fig. 2, a continuous wedge. Each of said wedges has a projection 15 extending from the base thereof and entering into recess 11. The width of extensions 15 is less than that of recess 11, providing a space 16 as shown in Fig. 3 to allow lateral movement of the wedges.

If desired, the meeting surfaces 17 of the sets of outwardly and inwardly extending wedges may be provided with a thin layer of sponge rubber to normally prevent relative movement of the wedges and to assist in retaining the same in proper relative positions. This also prevents undue noise due to movements of the vessel. Spaces 18 and 19 remain between the free ends of each of the wedges and the opposite shell to allow for movement of the wedges upon the impact of a projectile. If desired, the spaces 18 and 19 may also be provided with sponge rubber inserts, since they will not interfere with the functioning of the device. Similarly, sponge rubber may be placed at areas 20 between the wedges 12, 13 and 14.

It is not necessary that all of the wedges be movable but in some instances it may be convenient to form a few of the wedges integrally with a shell. For instance, as shown in Fig. 1, the wedge 21 at one of the sides of outer shell 8 may be made integral therewith or fixed thereto. Such wedges will assist in maintaining the proper alignment of the various elements. The bases of the wedges may be provided with lubricating means in order to avoid the freezing of the wedges to the shells and allow the free action thereof upon impact. Such lubrication may be by means of graphite worked into the shells or wedges or by any other suitable means.

The outer shells 8 may be made in relatively narrow strips and anchored at but a few points. Thereby, upon injury to any portion of the armor, the removal of a few bolts 10 will allow access to all of the wedges within the section for replacement and repair. Because of the fact that the wedges are relatively small and light in weight, it is possible to handle the same without the use of cranes and therefore repairs may be made without bringing the vessel into a shipyard and it is even possible to make repairs under water without placing the vessel in dry dock. Metals other than steels may be used for the wedges.

All of the wedges may be made of exactly the same construction if desired, and they may be forged or rolled or even cast to a desired pattern. By reason of the ease of formation of the desired shapes, materials which otherwise could not have been worked for large, massive armor plate, may be used in the present invention. Because of the character of the device, the individual wedges may be readily hung in place and the assembly is rapid and simple. It also does away with precision work and renders the same cheaper to install and repair.

Not only may the present invention be used for the principal protection of a vessel, but it may be used for auxiliary protection. For instance, it may be placed within the vessel at certain vital points, such as a magazine, which requires special protection. It may also be used as a buffer for protection against torpedo attack. It may be used for the decks of vessels where the device would be placed in a horizontal instead of in a vertical position, and if desired springs may be placed in spaces 18 and 19 to normally hold the wedges in proper position for movement upon impact. It may also be used for turret protection on battleships wherein a radial arrangement of the wedges both for the top and sides of the turret may be provided.

Because of the movability of the wedges, advantage may be taken of the friction between relatively large adjacent surfaces which dissipate energy very quickly, and thus to some extent prevent the concentration of the energy and cause a spread of the force of impact. This greatly lessens the chance of penetration, particularly since the area over which the force would be spread is a great many times the area contacted by the projectile.

In Fig. 5 there is shown a slight modification of the structure. In many cases a shell does not hit the armor normally, but at an angle to the horizontal, which angle may be great or small. In such case, it exerts a force in a vertical direction, which may be substantial. According to the modification of Fig. 5, the wedges are made tapering both longitudinally and transversely. The wedges 5' are made narrower at the top 22, tapering outwardly as shown at 23, at the lower portion thereof. Wedges 13' are made relatively wide at the top 24 and they become narrower towards the bottom 25. Thereby, upon a shell striking the outer wedges, the force of the vertical component is transmitted laterally by reason of the tapering construction.

Since the inner wedges do not carry any great proportion of the force, they may be made of light metals such as aluminum or magnesium and preferably of the well-known tough alloys thereof. The inner wedges may, if desired, be made hollow in order to reduce the weight thereof. The outer wedges may be provided with hardened and toughened faces. They may also be provided with surfaces of special alloys or of carborundum or the like, in order to offer increased resistance to penetration.

The faces of the wedges which are exposed to contact with the projectile may have a head rectangular in cross-section, so that adjacent wedges are in contact for a substantial depth to present a solid surface. The grain of the metal should be parallel to the face to present the sides of the crystals to the impact. The grain is such that the friction between adjacent wedges is a maximum. By the use of different metals for the inner wedges and the outer wedges a combination may be obtained which provides the maximum friction effects therebetween.

By the term "outwardly extending" used in the claims is meant a direction from the apex to the base of the wedges and to the outside of the structure, the impact thereon coming from the

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outside. The term "inwardly extending" indicates a direction from the apex to the base of the wedges and to the inside of the structure.

What I claim is:

1. Armor plate comprising wedge-shaped members extending outwardly and complementary wedge-shaped members extending inwardly, the latter members being alternatingly arranged relative to the first said members, the faces of said several members being in frictional contact, said members being mounted for relative movement, the apexes of said members terminating short of the bases of the respective opposed wedges, whereby an impact on one of said members causes transmission of the force over a relatively large area of the faces of adjacent members.

2. Armor plate comprising wedge-shaped members extending and tapering outwardly and complementary wedge-shaped members extending and tapering inwardly, the latter members being alternatingly arranged relative to the first said members, the faces of said several members being in frictional contact, said members being mounted for relative movement, the apexes of said members terminating short of the bases of the respective opposed wedges, whereby an impact on one of said members causes transmission of the force over a relatively large area of the faces of adjacent members.

3. Armor plate comprising an inner shell having wedge-shaped members extending outwardly and complementary wedge-shaped members extending inwardly, the latter members being alternatingly arranged relative to the first said members, the faces of said several members being in frictional contact, said members being mounted for relative movement, the apexes of said members terminating short of the bases of the respective opposed wedges, whereby an impact on one of said members causes transmission of the force over a relatively large area of the faces of adjacent members.

4. Armor plate comprising an inner shell having wedge-shaped members extending outwardly, an outer shell having complementary wedge-shaped members extending inwardly, the latter members being alternatingly arranged relative to the first said members, the faces of said several members being in frictional contact, said members being mounted for relative movement, the apexes of said members terminating short of the bases of the respective opposed wedges, whereby an impact on one of said members causes transmission of the force over a relatively large area of the faces of adjacent members.

5. Armor plate comprising an inner shell having wedge-shaped members extending outwardly and complementary wedge-shaped members extending inwardly, the latter members being alternatingly arranged relative to the first said members, the faces of said several members being in frictional contact, said latter members being mounted independently of said inner shell for movement relative to said first members whereby an impact on one of said members causes transmission of the force over a relatively large area of the faces of adjacent members, and means for securing said first members to said inner shell to allow lateral movement of said first members upon impact.

6. Armor plate comprising an inner shell having wedge-shaped members extending outwardly, an outer shell, complementary wedge-shaped members extending inwardly, the latter members being alternatingly arranged relative to the first said members, the faces of said several members being in frictional contact, said latter members being mounted on said outer shell for movement relatively to said first members, whereby an impact on one of said members causes transmission of the force over a relatively large area of the faces of adjacent members, and means for movably securing said members to their respective shells, said outer shell being secured to said inner shell at intervals to maintain said members in their relative positions.

7. Armor plate comprising wedge-shaped members extending outwardly and complementary wedge-shaped members extending inwardly, the latter members being alternatingly arranged relative to the first said members, the faces of said several members being in frictional contact, said members being mounted for relative movement, the apexes of said members terminating short of the bases of the respective opposed wedges, whereby an impact on one of said members causes transmission of the force over a relatively large area of the faces of adjacent members, there being a plurality of said members in longitudinal alignment.

8. Armor plate comprising wedge-shaped members extending outwardly and complementary wedge-shaped members extending inwardly, the latter members being alternatingly arranged relative to the first said members, the faces of said several members being in frictional contact, said members being mounted for relative movement, the apexes of said members terminating short of the bases of the respective opposed wedges, whereby an impact on one of said members causes transmission of the force over a relatively large area of the faces of adjacent members, there being a plurality of each of said members in longitudinal alignment and in substantial contact, the joints between the adjacent complementary members being staggered.

9. Armor plate comprising wedge-shaped members extending outwardly and complementary wedge-shaped members extending inwardly, the latter members being alternatingly arranged relative to the first said members, the faces of said several members being in frictional contact, said members being mounted for relative movement, the apexes of said members terminating short of the bases of the respective opposed wedges, whereby an impact on one of said members causes transmission of the force over a relatively large area of the faces of adjacent members, and an elastic material interposed between adjacent wedge members to assist in maintaining the same in their relative positions.

10. Armor plate comprising an inner shell having wedge-shaped members extending outwardly, an outer shell having complementary wedge-shaped members extending inwardly, the latter members being alternatingly arranged relative to the first said members, the faces of said several members being in frictional contact, said members being mounted for relative movement, the apexes of said members terminating short of the bases of the respective opposed wedges, whereby an impact on one of said members causes transmission of the force over a relatively large area of the faces of adjacent members, at least one of said wedge members being fixed on one of said shells.

11. Armor plate comprising a surface to be protected, a set of relatively long, narrow plates, one of the edges of said plates constituting bases, said plates tapering towards the opposite edges,

said bases being substantially contiguous to present a surface on which projectiles may impinge, a second set of similarly formed plates interlaced with said first plates and tapering in the opposite direction, the bases of said second set being substantially contiguous and contacting with the surface to be protected, said sets being relatively movable under impact, the apexes of said members terminating short of the bases of the respective opposed wedges.

12. Armor plate comprising a surface to be protected, a set of relatively long, narrow plates, one of the edges of said plates constituting bases, said plates tapering towards the opposite edges, said bases being substantially contiguous to present a surface on which projectiles may impinge, a second set of similarly formed plates interlaced with said first plates and tapering in the opposite direction, the bases of said second set being substantially contiguous and contacting with the surface to be protected, the plates of each set extending towards but being short of the bases of the other set, said sets being relatively movable under impact, the apexes of said members terminating short of the bases of the respective opposed wedges.

13. Armor plate comprising a surface to be protected, a set of relatively long, narrow plates, one of the edges of said plates constituting bases, said plates tapering towards the opposite edges, said bases being substantially contiguous to present a surface on which projectiles may impinge, a second set of similarly formed plates interlaced with said first plates and tapering in the opposite direction, the bases of said second set being substantially contiguous and contacting with the surface to be protected, said sets being relatively movable under impact, said second set being of metal which is soft and deformable relative to said first set, the apexes of said members terminating short of the bases of the respective opposed wedges.

HARRY C. BIERMAN.