Nov. 7, 1967 R. W. FORSYTH ET AL 3,351,374

ARMOR CONSTRUCTION

Filed July 1, 1963 5 Sheets-Sheet 1

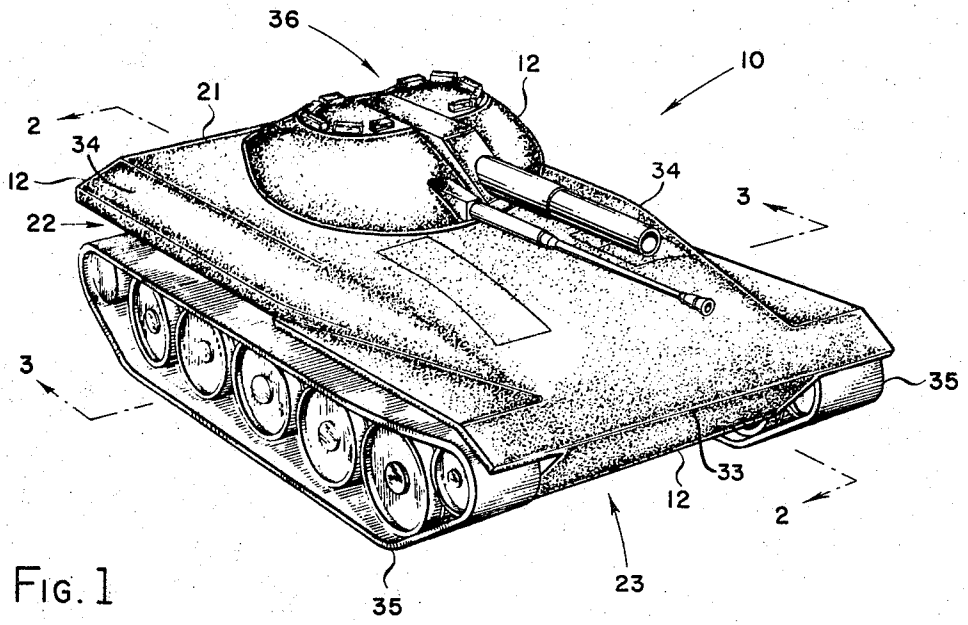


FIG. 1

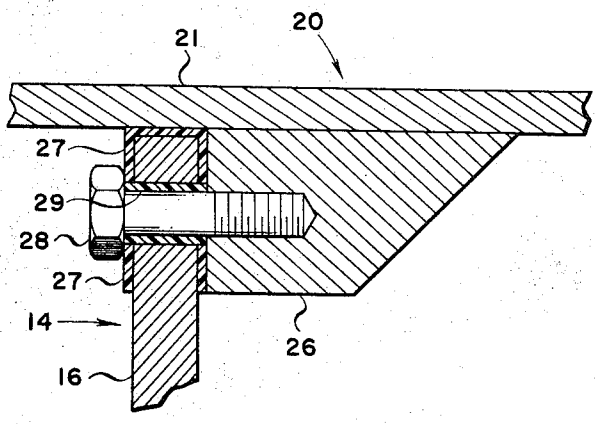


FIG. 5

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ARMOR CONSTRUCTION

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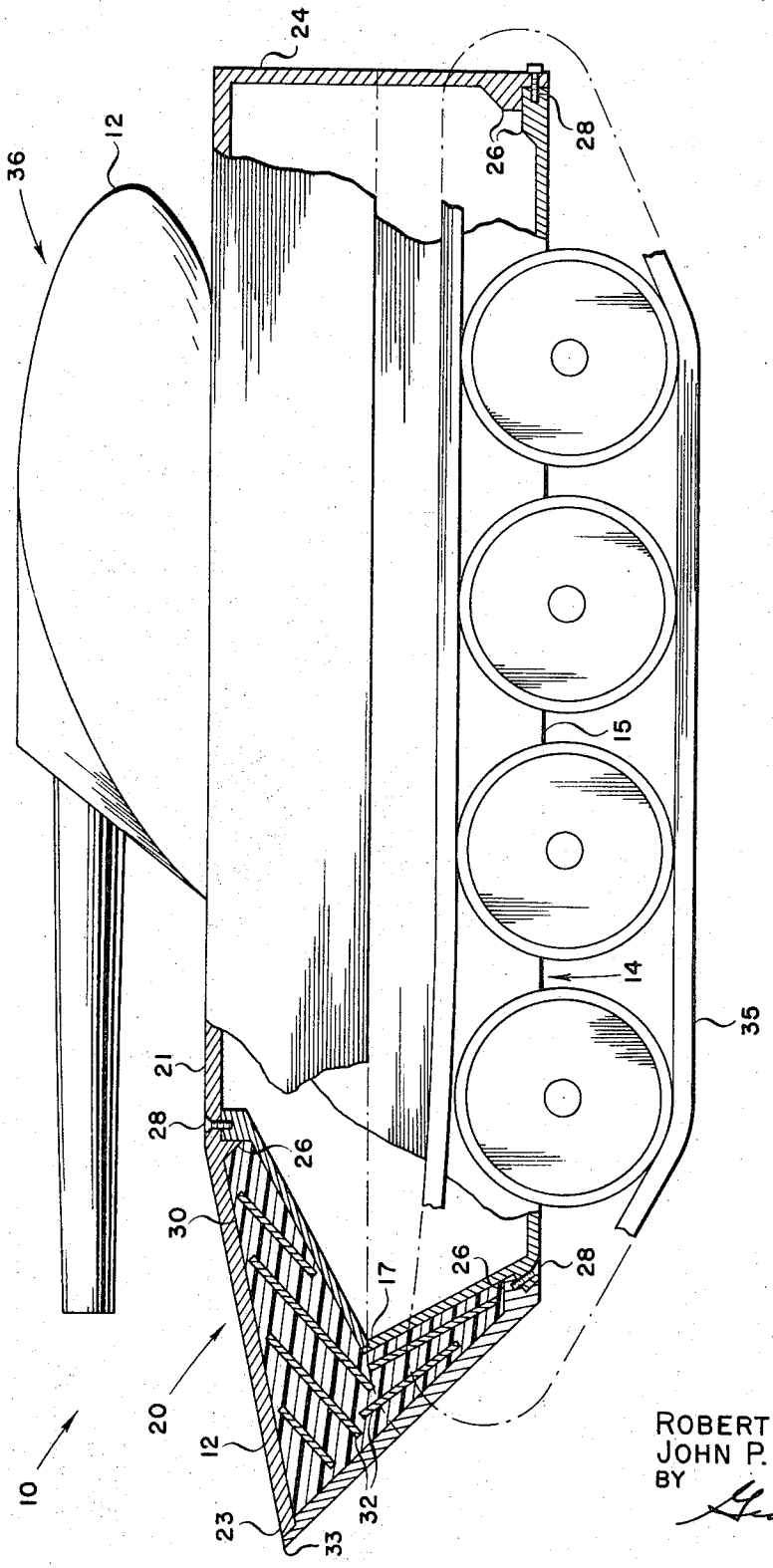


FIG. 2

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ARMOR CONSTRUCTION

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FIG. 3

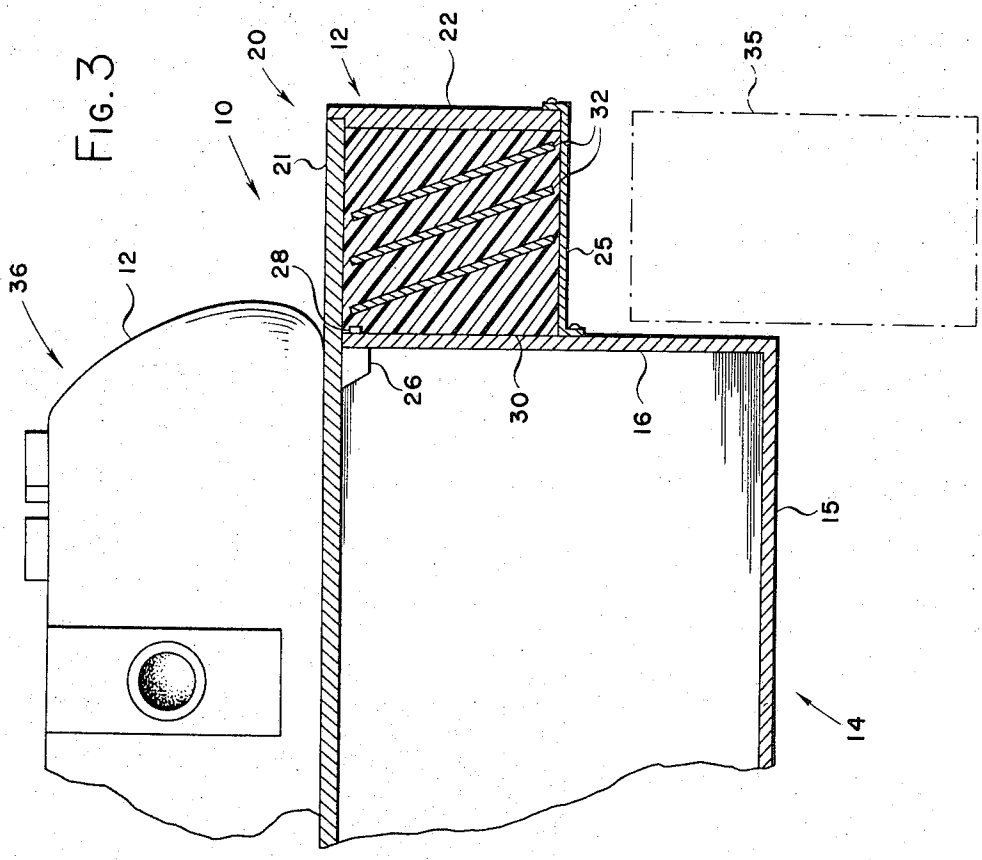
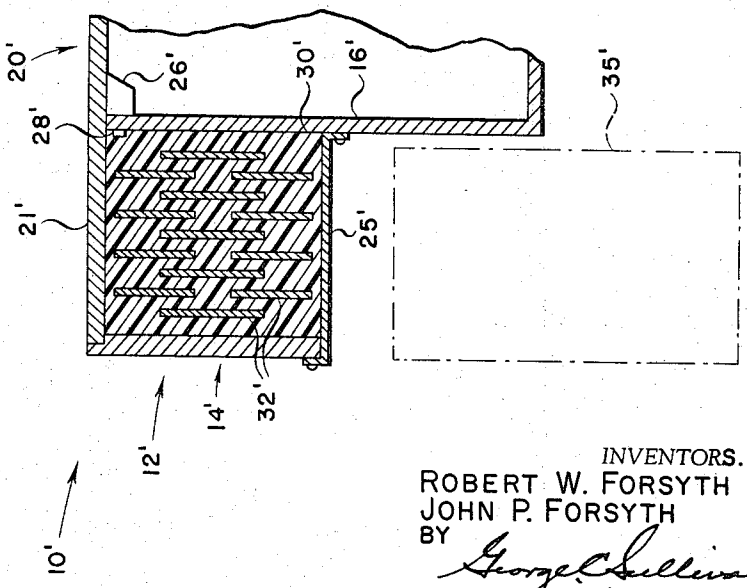


FIG. 6



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ARMOR CONSTRUCTION

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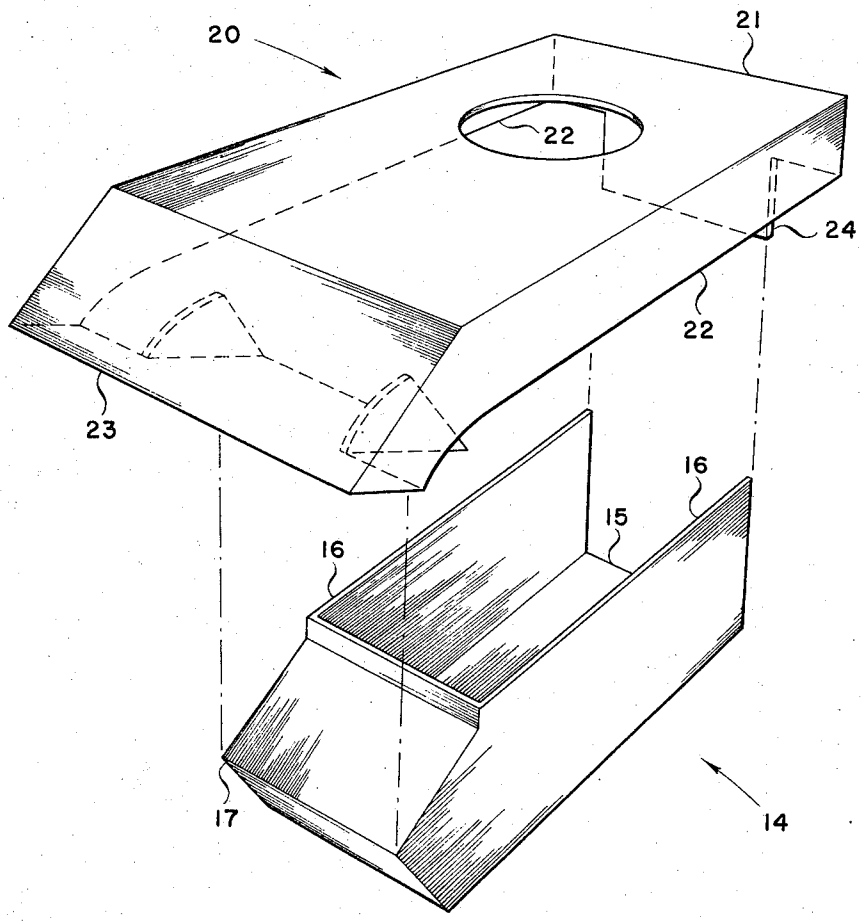


FIG. 4

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ARMOR CONSTRUCTION

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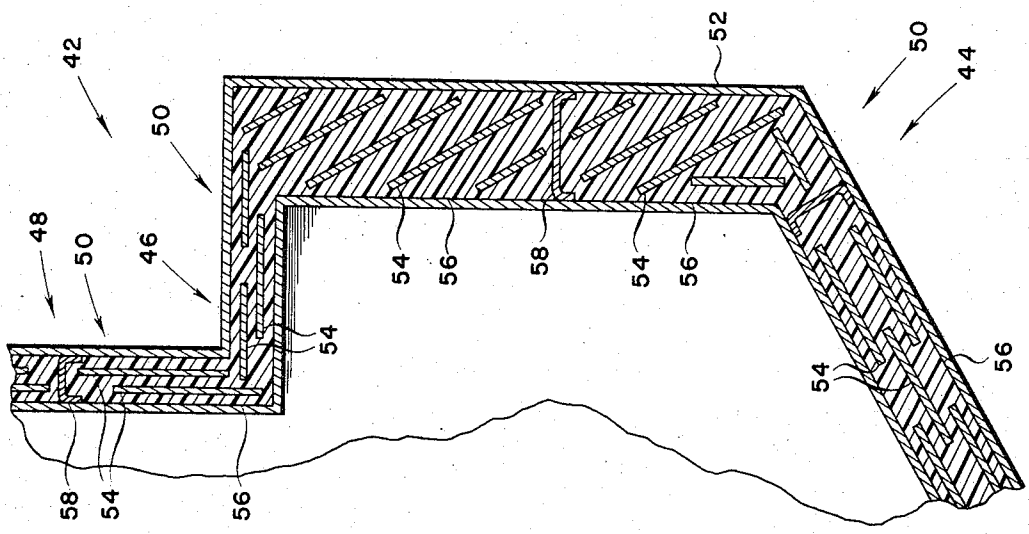


FIG. 7

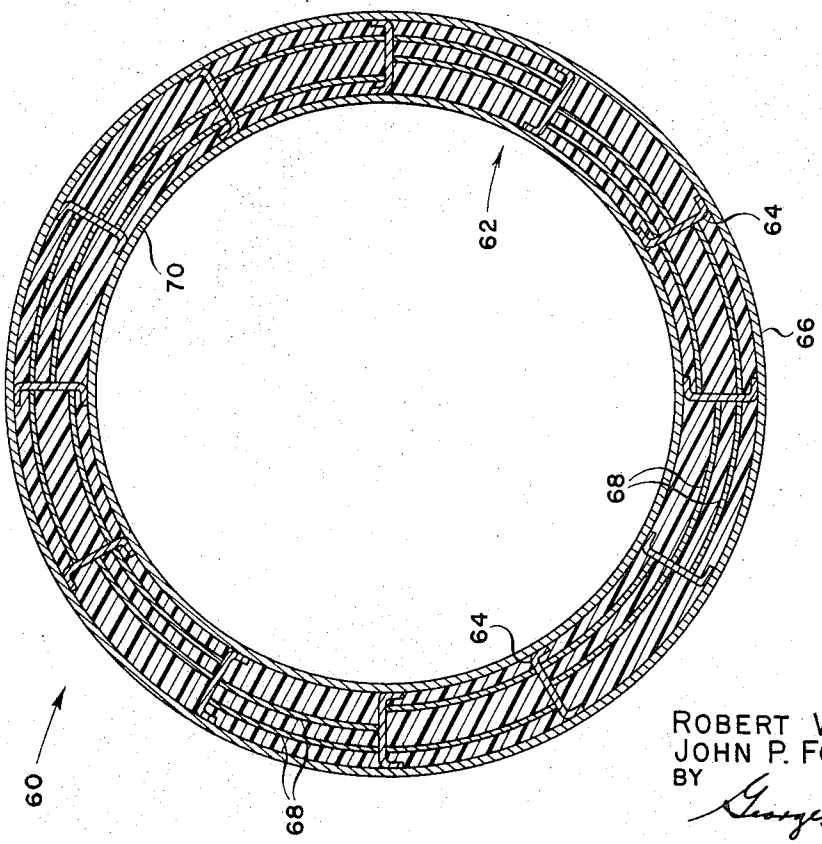


FIG. 8

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3,351,374
ARMOR CONSTRUCTION

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Filed July 1, 1963, Ser. No. 291,768
1 Claim. (Cl. 296—31)

This invention pertains to the field of armor construction. More specifically it pertains to new and improved armor which is specifically adapted for use on military vehicles such as tanks, but which is capable of being used with other types of vehicles.

For many years face hardened homogeneous steel plate has been used in order to provide protection against various difference types of projectiles. As the projectile art has developed so as to provide projectiles having greater armor piercing characteristics than prior projectiles, it has been conventional to increase the thickness of such conventional armor plate in order to provide protection against these newer projectiles.

Unfortunately, there are a number of disadvantages to merely increasing the thickness of steel armor plate in order to provide protection against presently known projectiles. Although cost in the military field is a matter of secondary or less importance, it is a factor which is considered to make it disadvantageous to use comparatively thick steel armor plate. A much more important factor against the use of such thick or comparatively thick armor steel plate is the weight of such armor plate. This is particularly important in armoring vehicles such as tanks, weapons carriers and the like.

To be acceptable for military purposes, a tank must be of a size enabling it to be transported from one area of operations to another. Further, the motor means used in such a tank must be capable of moving it over various different types of terrain at comparatively reasonable speeds. If thick enough conventional armor plate to provide protection against various different presently known types of projectiles is used on a tank, the size and weight of such a tank become so large that the tank cannot be readily transported and such a tank requires a comparatively large motor.

An object of the present invention is to provide new and improved armor construction which is capable of being used in place of comparatively thick, face hardened steel plate as has been employed as armor for years. Another object of this invention is to provide new and improved armor which is comparatively light in weight, which is reasonably limited as to size, and which is capable of being constructed so as to provide effective protection against various different types of presently known projectiles. Other related objects of the present invention are to provide armor constructions having "spaced" or "stand-off" armor characteristics, which may be easily and conveniently manufactured, which require little if any maintenance, and which are relatively inexpensive in terms of their performance characteristics.

These and various other objects of this invention as well as many specific advantages of it will be apparent from a detailed consideration of the remainder of this specification, the appended claim and the accompanying drawings in which:

FIGURE 1 is a perspective view of a military tank using armor construction of this invention;

FIGURE 2 is a partial cross-sectional view taken at line 2—2 of FIGURE 1;

FIGURE 3 is a partial cross-sectional view taken at line 3—3 of FIGURE 1;

FIGURE 4 is an exploded view illustrating part of this construction of the tank shown in FIGURE 1;

FIGURE 5 is an enlarged detail view showing the manner of connecting the parts shown in FIGURE 4;

FIGURE 6 is a partial cross-sectional view corresponding to FIGURE 3 showing a modified armor of this invention;

FIGURE 7 is a diagrammatic partial cross-sectional view of a boat using armor construction of this invention; and

FIGURE 8 is a diagrammatic cross-sectional view showing armor construction of this invention utilized on a submarine hull.

The accompanying drawings are primarily intended so as to clearly illustrate for explanatory purposes several presently preferred uses of armor constructions of this invention. From a careful consideration of these drawings those skilled in the field of military armor will realize that armor constructions as herein described may be adapted to a wide variety of land and water vehicles, and that such construction may be modified so as to have different appearances and configurations without departing from the features or principles of this invention set forth in the appended claim.

As an aid to understanding this invention it can be stated in essentially summary form that is concerns armor constructions which include first and second sheets of rigid armor material spaced from one another, a plurality of armor panels capable of deflecting and causing fragmentation of certain types of projectiles located between these sheets, and a filler material located so as to fill the space between the sheets and so as to hold the panels with respect to one another and the sheets. Preferably this filler material is of a cellular or foam variety in order to conserve or lower the weight of a complete armor construction as herein described. It may include various materials serving to enhance the value of the armor construction against military weapons other than projectiles of a conventional type.

The actual details of the present invention are best more fully explained by referring to the accompanying drawings. In FIGURE 1 there is shown a military tank **10** which is constructed so that certain of its surfaces are covered with an armor or armor construction **12** of this invention. This tank is preferably constructed so as to utilize an inner hull assembly **14** formed of armor plate such as conventional face hardened homogeneous steel armor plate as indicated in FIGURE 4 so as to have a bottom **15**, parallel sides **16** and a pointed front end **17**. The various parts of the assembly **14** are secured to one another and are sufficiently rigid so as to serve as a structural frame for the complete tank **10**. Various conventional parts of the tank **10** supported by the assembly **14** are not set forth herein since such parts are not necessary to an understanding of this invention.

The assembly **14** is utilized with an outer hull assembly or shell **20** (note FIGURE 4) which is also formed of a rigid armor plate. Preferably, this shell **20** is formed of a different material than is utilized in the assembly **14** so as to have physical properties which are different from the projectile resistant properties of the assembly **14**. Preferably, this shell **20** is formed out of a projectile resistant light weight aluminum armor plate type of alloy such as the known aluminum alloy commonly referred to by the number 5083.

As constructed, this shell **20** includes a top **21** which is adapted to extend across the top of the assembly **14** and beyond the sides **16**. It also includes parallel sides **22** which are spaced from the sides **16** when it is secured to the assembly **14**, a pointed front end **23** which is also adapted to overlie and be spaced from the front end **17** of the assembly **14** and a rear wall **24** which is adapted to fit within and close off the space between the sides **18** of the assembly **14** at the back of the tank **10**. The

spaces between the sides 22 and the sides 16 are closed with comparatively thin plates 25.

Preferably a plurality of interlocking brackets 26 serving a holding or positioning function are located on both the assembly 14 and the shell 20 at various points where parallel sides 22 and the assembly 14 contact one another. In order to lessen or effectively decrease corrosion problems such as would be caused by galvanic action, conventional inert plastic sealant strips 27 (note FIGURE 5) such as polysulfide sealant strips are used between the contacting part of the assembly 14 and the shell 20. Within at least part of the interlocking brackets 26 bolts 28 are utilized in order to secure the shell 20 to the assembly 14. Preferably the bolts 28 utilized are plated with a corrosion resistant film or layer such as a cadmium layer, and are protected by plastic inserts 29 (note FIGURE 5) such as inserts of a polysulfide synthetic rubber.

The armor construction 12 includes between the body assembly 14 and the shell 20 a filler material 30 and a plurality of spaced, parallel separate armor panels 32. These panels 32 are preferably of a type capable of deflecting or upsetting any projectiles which might pierce the shell 20 and of causing fragmentation of such of those projectiles as are capable of being fragmented. As shown in FIGURES 2 and 3 they are located at an angle to adjacent parts of the shell 20 and the assembly 14.

These panels 32 may be constructed in a variety of different ways. They may consist of a plurality of thin sheets of glass fiber or metal fabric laminated to one another and impregnated with a relatively "tough" plastic or resinous type of composition capable of imparting strength to such a laminated structure. Such a composition may be a known epoxy-urethane copolymer blend such as various known blends of this type having approximately the characteristics of tough rhinoceros hide. Various other known apoxy, polyurethane and other known plastics may be used in such a laminated structure as a panel 28.

The filler material 30 used in the armor construction 12 serves to effectively space the shell 20 from the body assembly 14 and to hold the various panels 32 between this shell and this assembly so that these panels are located in various different positions. Preferably this filler material 30 holds the panels 32 so that they are disposed at an angle to adjacent portions of the body assembly 14 and the shell 20 in order to accomplish effective deflection of projectiles. As the panels 32 are supported by this filler material, the filler material serves to "take up" and distribute forces applied to the panels 32 as when these panels 32 are contacted by a projectile. Because the filler material 30 serves this function it can be considered as acting as a cushioning or energy absorbing material, even when it is of a rigid type.

A number of different types of filler material 30 may be used in the armor construction of this invention. It is presently preferred to utilize a cellular or foam plastic composition which occupies a comparatively large amount of space per unit of weight in order to decrease the weight of the entire armor construction 12 to as great an extent as is reasonably possible. Because of their physical properties as well as the ease with which they may be located in various locations within the armor construction 12, it is preferred to utilize as a filler material 30 a known type of rigid or semi-rigid polyurethane resin.

It is considered that such a resin when used should contain various secondary materials providing protection against radiation. Thus, the filler material 30 used may be a conventional rigid polyurethane foam containing cyclohexylstearate or dimer acid serving to thermalize neutrons, a lead compound such as a lead oxide providing protection against gamma radiation or a cadmium or boron compound such as cadmium oxide or boric oxide serving as a neutron attenuator. The use of such fillers in foamed polyurethane resins is known at the present time. Various foam materials are also considered desirable for use as a filler material 30 because of the fact that they tend to attenuate heat effects and can be used to provide buoyancy to the armor construction 12.

From a consideration of the initial three figures of the drawings, it will be realized that the armor construction 12 employed in the tank 10 is located at the front end 33 of this tank and at the sides 34 of the tank 10 above propulsion tracks 35 used in order to move it. Thus, the armor 12 is used in the tank 10 along the portions of this tank where there is a greater possibility of the tank being hit by a projectile. Obviously the specific manner in which the armor construction 12 is formed or constructed may be varied at various different locations around the tank 10 in order to provide protection against different types of missiles.

If desired, all surfaces of the tank can be covered by or include this armor construction 12. As an example of the fact that this armor construction 12 can be used on various specific parts of the tank there is shown in the drawings a conventionally constructed gun turret 36 which is mounted on the top 21 of the shell 20 in a conventional manner. This turret 36 is covered with an armor construction 12 of the same type as the armor construction previously described.

In FIGURE 6 of the drawings there is shown a modified armor construction 12′ which is capable of being employed in a modified tank 10′ constructed in the same manner as the tank 10 previously described. For convenience of designation and in the interest of brevity, various parts of the tank 10′ which are substantially identical to various parts of the tank 10 previously described are not designated herein and are indicated both in the accompanying drawings and the remainder to this specification by the primes of the numerals previously used to designate such parts. In the tank 10′ the armor construction 12′ differs from the armor 12 solely in the manner in which the armor panels 32′ are used. These armor panels 32′ in the tank 10′ are located parallel to one another so as to overlap and are disposed so as to be spaced from the parallel to adjacent parts of the assembly 14′ and the shell 20′.

In FIGURE 7 of the drawings there is shown in a schematic manner a part of a boat 42 having a hull 44 and an attached deck 46 and an attached superstructure 48. Preferably the entire hull 44, the deck 46 and at least part of the superstructure 48 constitute an assembly which is formed of a rigid armor plate material such as is used in the assembly 14 so as to serve as an integral part of armor construction 50 corresponding to the construction 12 previously described. The armor construction 50 used in the boat 42 includes a shell 52 corresponding to the shell 20 previously described, panels 54 corresponding to the panels 32 previously described and a filler material 56 corresponding to the filler material 30 previously described. The armor construction 50 differs from the armor construction 12 in that the shells 52 illustrated are supported on brackets 58 which extend from the hull 44, the deck 46 and those portions of the superstructure 48 covered with the armor construction 50.

In FIGURE 8 of the drawings there is shown in a diagrammatic manner a part of a submarine 60 having a hull assembly 62 formed out of the material corresponding to the material used in the body assembly 14. This assembly 62 carries brackets 64 which serve to support and space from this assembly a shell 66 corresponding to the shell 20 previously described. The space between the shell 66 and the assembly 62 contain panels 68 corresponding to the panels 32 previously described and a filler material 70 corresponding to the filler material 30 set forth in the preceding.

In the tank 10, the boat 42 and the submarine 60 the armor constructions utilized can differ at various points or at various spaces along these composite structures so as to obtain different types of protection against different types of projectiles or the like. Such variation may

be achieved by varying the thickness of different parts of the body assemblies **14**, the corresponding parts of the hull **44**, the deck **46** and the superstructure **48** or of the assembly **60**, or by varying the thickness or spacing of the shells **20**, **52** or **66**, or by varying the number, type or spacing of the panels **32**, **54** or **68**, and by varying the physical properties of the filler materials **30**, **56** and **70**. With the present invention the same or different metals can be used in parts corresponding to the body assembly **14** and the shell **20** of the tank **10** depending upon specific needs in protecting against various different types of projectiles.

From a careful consideration of this specification those skilled in the art of military armament will realize that the armor construction herein shown and described is capable of being used in place of more conventional comparatively thick metallic armor plate, and that this armor construction effectively achieves the various objects of the present invention indicated in the initial portions of this specification. Because of the nature and scope of this invention it is to be considered as being limited solely by the appended claim forming a part of this disclosure.

We claim:

A light weight armor construction for use as protection against projectiles comprising:

means for securing said armor construction to a structure, said armor construction comprising;

first and second sheets of rigid projectile resisting armor material spaced from one another;

a plurality of discrete, freely positioned projectile resisting armor panel means disposed between said sheets and locating at an angle with respect thereto;

said panel means being spaced from one another and from said sheets and positioned successively so as to successively absorb the kinetic energy of projectiles;

a compressible, relatively easily deformable, plastic, filler material located so as to fill the space between said sheets and substantially surround said plurality of panel means with respect to one another and with respect to said sheets; and

said filler material being of the type which occupies a comparatively large amount of space per unit of weight and having a rigidity which in a normal state maintains said panel means in fixed position relative to said sheets;

said securing means including:

a plurality of interlocking projections formed on said structure and said armor construction;

inert sealant means located between said structure and said armor construction; and a plurality of bolt means connecting said structure and said armor construction.

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A. HARRY LEVY, *Primary Examiner.*