March 7, 1944. R. G. THOMPSON 2,343,344

PROJECTILE

Filed Dec. 26, 1941

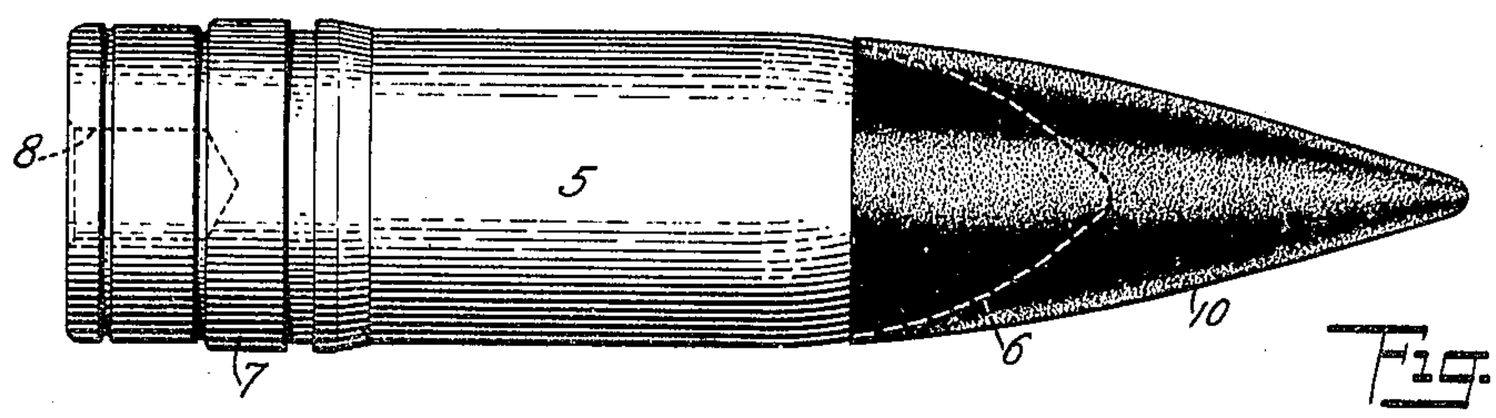

Fig. 1

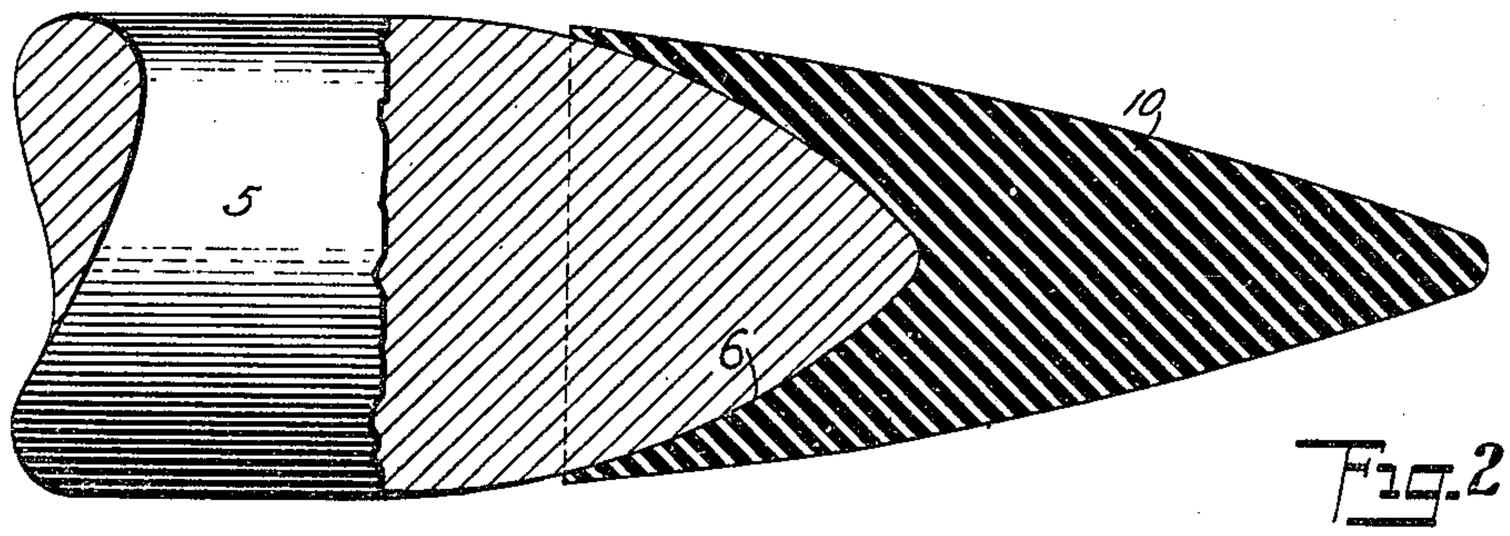

Fig. 2

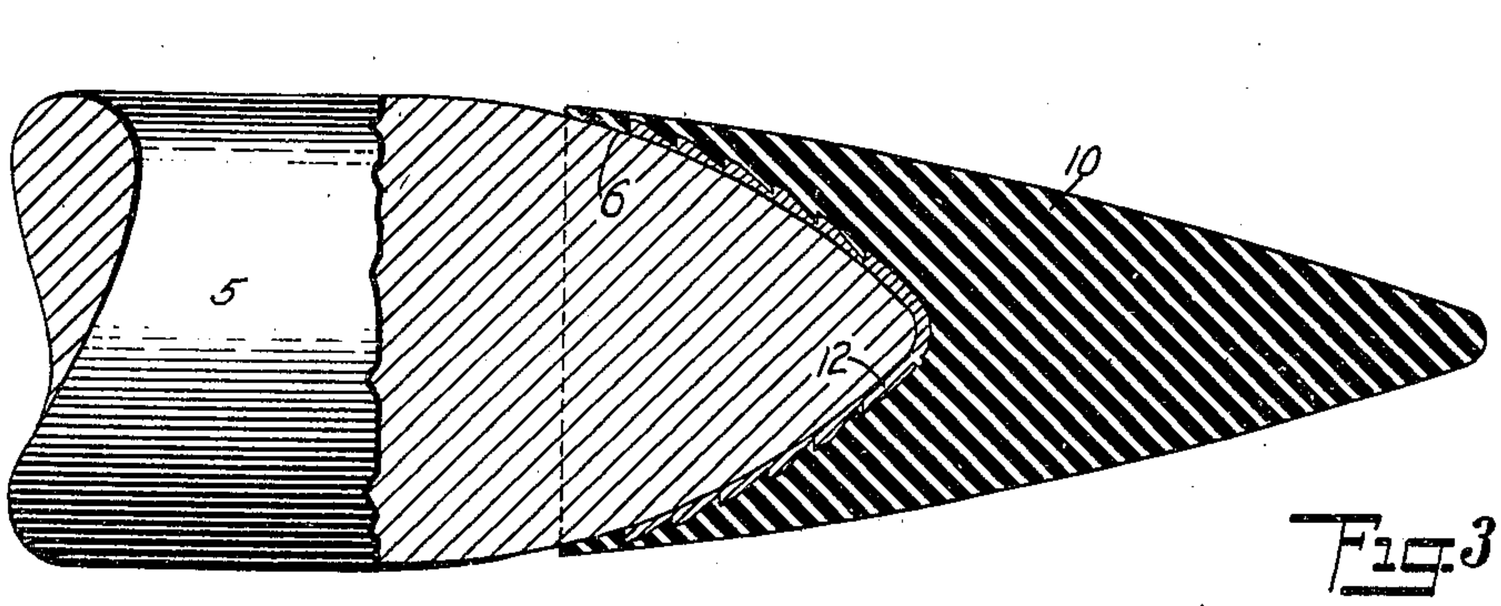

Fig. 3

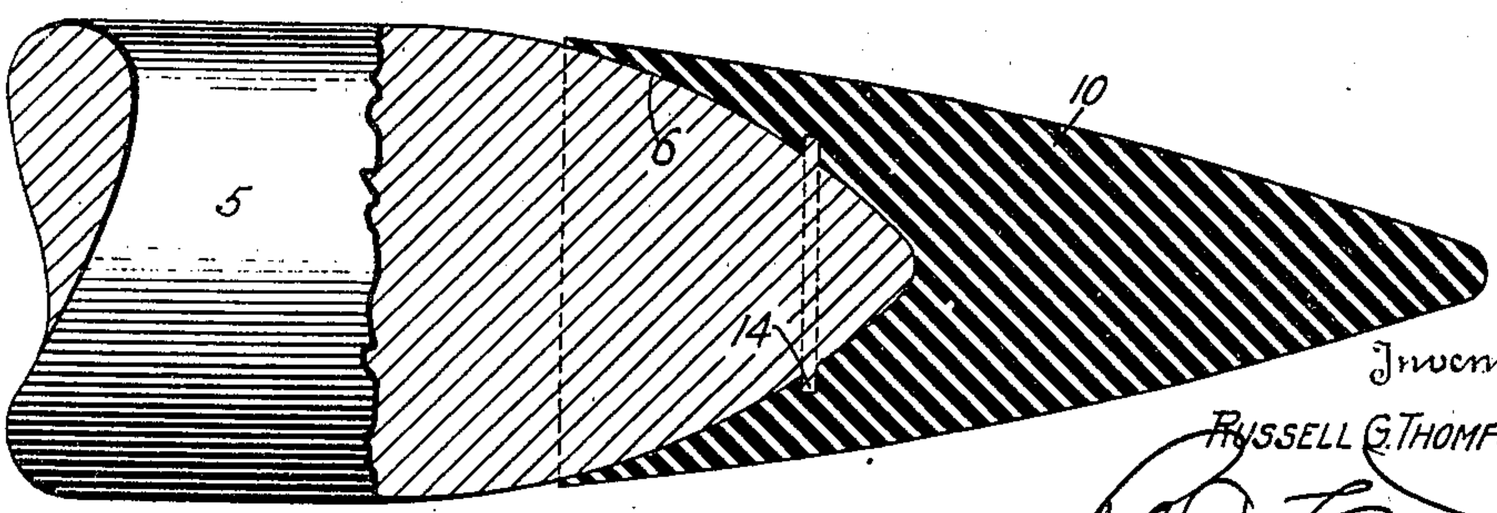

Fig. 4

Inventor
Russell G. Thompson

By Roland T. Booth
Edwin O. Blodgett
Attorneys

Patented Mar. 7, 1944 2,343,344

UNITED STATES PATENT OFFICE

2,343,344

PROJECTILE

Russell G. Thompson, Elmira, N. Y.

Application December 26, 1941, Serial No. 424,405

14 Claims. (Cl. 102—52)

This invention relates to projectiles, and more particularly to projectiles of the armor-piercing type provided with auxiliary windshields.

Projectiles of the armor-piercing type are usually of steel hardened at least at the front end portion, and this end portion should be rather bluntly pointed to form an ogive having the required strength to pierce the armor. This bluntly pointed end however results in considerable air resistance, and it has been found that an auxiliary windshield placed around the end portion can be shaped to greatly reduce this air resistance and allow the projectile to reach its objective at a considerable higher velocity.

Such an auxiliary windshield should add as little as possible to the weight of the projectile and should possess much less strength than the body of the projectile so that upon impact with the objective the windshield will break away or disintegrate permitting the strong, bluntly pointed end of the projectile body to pierce the armor. It is necessary to securely attach such windshield to the pointed end portion of the projectile body to withstand rough handling, temperature changes, and to remain in place until it reaches its objective against the great forces set up in firing and the temperature drop encountered in its travel through the air. However it is not desirable to secure the windshield to the projectile body by any arrangement which materially alters the ogival shape of the bluntly pointed hardened end of the projectile, as this shape is important to attain the required piercing ability of the projectile and any material change therein usually weakens the end portion so that it may break upon impact to prevent effective piercing of armor.

In view of the above and other considerations, it is proposed in accordance with the present invention to provide a projectile having an auxiliary windshield which adds only a small amount of weight to the projectile with means for securely attaching the windshield thereto without affecting the piercing ability of the hardened end portion or ogive of the projectile. More specifically, it is proposed in accordance with the present invention to provide a projectile having a windshield of plastic material molded in place around the end portion of the metal projectile body with means for securely attaching the molded windshield thereto to prevent its removal until impact with its objective.

Other objects, purposes and characteristic features of the present invention will appear as the description thereof progresses, during which references will be made to the accompanying drawing, in which:

Fig. 1 is a side elevational view of a projectile constructed in accordance with the present invention.

Figs. 2, 3 and 4 are enlarged, fragmentary sectional views showing different methods of securing the plastic windshield to the projectile body.

The projectile or shot illustrated in the accompanying drawing is the 37 millimeter armor-piercing type, but it is to be understood that the present invention is not restricted to this particular size or type of projectile. In other words, the present invention may be applied to substantially any size and style of projectile wherever the front end portion of the projectile body should be bluntly pointed to provide maximum strength rather than minimum air resistance.

The illustrated projectile may be generally described as including a cylindrical, steel body portion 5 having a bluntly pointed end portion or ogive 6. The invention in the present instance is not particularly concerned with the construction of the rear end portion of the projectile, and various different arrangements and specific details of construction may be used in this portion according to the particular requirements. In the form shown in Fig. 1, the rear portion of the projectile body 5 is provided with a rotating band 7 of the usual construction which comprises a band of softer metal than the body portion 5, such as copper, securely retained in a seat or annular groove in the steel body portion 5 of the projectile. The outside diameter of the rotating ring 7 is slightly larger than the outside diameter of the body portion 5 to cooperate with the rifling of the gun barrel and cause rotation of the shot when it is projected. The extreme rear end portion of the projectile body 5 may otherwise be suitably shaped according to requirements, the particular form shown including a concentric tracer cavity 8.

The projectile body 5 is a suitable carbon steel which is processed to provide the maximum possible strength for piercing armor. This steel is preferably forged to the general shape shown in the drawing and hardened by suitable heat treatment. The body portion 5 is also machined to be symmetrical and accurately balanced and a smooth cylindrical outer surface is provided by suitable grinding operation.

The shape of the front end portion or ogive 6 of the projectile body 5 is important and has

been carefully established to provide the maximum strength and armor piercing qualities. This shape may be generally described as forming a blunt point or ogival shaped nose wherein the tapering portion is only slightly longer than the diameter of the projectile body.

The ogive 6 thus shaped to provide maximum strength and armor-piercing qualities is obviously too blunt to offer minimum air resistance, and as previously pointed out it has been found that the projectile will reach its objective with considerably greater velocity if an auxiliary pointed end member or windshield is provided on the ogive of the projectile body. An auxiliary pointed member or windshield 10 is formed in accordance with the present invention of plastic composition molded in place on the bluntly pointed end or ogive 6 of the projectile body 5. As shown in the drawing, the windshield 10 forms a considerably more gradually tapering point than ogive 6 and this shape affords much less air resistance thereby allowing the projectile to pass through the air with less loss of speed and arrive at its objective with greater effective force.

Various different molding compounds or specific plastic compositions may theoretically be used in molding the windshield 10. However, it is considered preferable to employ a shock-resistant plastic of the thermosetting variety which becomes permanently rigid after molding in order that the windshield will not be deformed or become loosened from the projectile body when subjected to moderately high temperatures or to low temperatures. It is of course necessary that the plastic material used for the windshield should be stable as to dimensions and shape after molding. It is also considered necessary to employ a plastic material having relatively high impact strength in order to withstand rough handling and the great forces set up when the projectile is fired in a high power gun. A suitable plastic composition of this type may be formed from wood pulp filler with phenolic resin binder. Various different proportions of wood pulp and resin may be used, and it has been found that up to 70% wood pulp filler provides a suitable materiel having relatively high impact strength.

In forming the plastic windshield 10, a suitable mold may be used having a cavity shaped to provide the desired shape of the windshield as shown in the drawing, and this mold may also be suitably adapted to hold the projectile body 5 in accurately positioned relation to the cavity of the mold so that the plastic windshield 10 is formed or molded directly upon the ogive 6 of the projectile. In this manner, it is assured that the axis of windshield 10 will accurately align with the axis of the projectile body 5. The required degrees of heat and pressure are employed in molding windshield 10 in accordance with well-known molding processes.

Various means may be used for reliably holding the plastic windshield 10 on the ogive of the projectile body 5, and in Fig. 2 the plastic material is shown as mounted directly on the metal surface of ogive 6 which should be previously treated to insure proper bonding of the molded plastic thereto. Thus, for example, the surface of ogive 6 may be previously coated with a suitable bonding material such as liquid plastic or phenolic resin in suitable liquid form. It is also possible to provide a suitable bonding coating by using a cement which sticks or bonds to both the metal surface of ogive 6 as well as to the molding material used in windshield 10. It may also be found desirable in certain instances to provide an intermediate layer of material which may be secured to the metal surface of ogive 6 by a suitable cement or bonding agent and this intermediate layer may be attached to the plastic material of windshield 10 by the same or a different cement or bonding material.

In order that the bonding coating and the plastic composition of the windshield may adhere more strongly to the steel surface, the surface of ogive 6 should be materially roughened but no grooves or rings of any material depth should be provided which will tend to weaken this portion of the projectile body. The surface of ogive 6 may thus be suitably roughened to provide small inequalities therein during the contour machining or rough grinding operation. It is also possible to suitably roughen the surface of ogive 6 by using a suitable acid to slightly etch or pit the steel surface.

In order to still more securely hold the plastic windshield 10 on the propectile body, a bonding element in the form of relatively soft metal may be secured to the surface of the hard steel ogive 6 and irregularities may be formed in the outer surface of this softer metal to mechanically interlock with the plastic material of windshield 10. Thus in Fig. 3, a comparatively heavy bonding coating 12 of relatively soft material such as copper is deposited on the surface of ogive 6. This metal coating 12 may be deposited by electroplating, by blasting heated metal thereon, or by other known means of applying heavy metal coatings, and the outer surface of coating 12 may be formed irregularly to interlock with the plastic material. As shown in Fig. 4, ribs may be formed in coating 12 by cutting annular notches or V-shaped rings therein. In some cases, it may be found that it is not necessary to cut these rings in the copper coating 12 as the copper may be electrically deposited in a manner to form a rough or pebbly outer surface to afford a secure gripping bond with the plastic material.

The copper coating 12 shown in Fig. 3 thus securely locks the plastic windshield 10 on the projectile body 5, and upon impact with armor, windshield 10 is broken away and the relatively soft metal of coating 12 serves as a lubricant which assists the piercing of the armor by the projectile. It will also be clear that the soft metal coating 12 in no way decreases the strength of the ogive 6 of the projectile body and serves the dual purpose of providing a medium for securely holding the plastic windshield on the projectile and in addition serves as a lubricant for the piercing action of the projectile.

It has been previously pointed out that it is not desirable to materially alter the rather critical shape of ogive 6 as the strength and piercing quality of the projectile would thereby be affected. In other words, it is not desirable to cut grooves or other cavities in the surface of the hardened steel ogive as the projectile would tend to fracture at these points upon impact with armor. However, certain types of irregularities may be provided on the ogive 6 without causing material reduction in its piercing qualities, and as an example, a ring or flange 14 is shown in Fig. 4 at the intermediate portion of ogive 6. This flange 14 may be formed integrally with the ogive 6 or may be a ring of separate material secured to the ogive by brazing, soldering or the like. The flange is thus effective to mechanically interlock the windshield with the projectile body when imbedded in the plastic ma-

terial as shown, and if the flange is integral with the ogive, it is sufficiently thin so that it may be broken away during the piercing of the armor by ogive 6 and accordingly does not materially obstruct the piercing operation nor materially weaken the ogive. Likewise if flange 14 is a separate part secured to the ogive, it may be displaced therefrom during the piercing operation.

Various other shapes of irregularities or comparatively frail projections may be used on the ogive 6 to securely hold the plastic windshield 10 thereon without materially altering the strength or forming an effective obstruction to the piercing action of the ogive. For example, a head or button-shaped end might be formed integrally with the point of ogive 6 and connected thereto only by a comparatively frail stem portion to effectively interlock the plastic windshield with the projectile body, yet allow this end portion to be broken away with the windshield upon impact with its objective.

It will be apparent that the windshield may be molded separately if desired and then secured to the projectile body by cements either with or without an intermediate layer as previously described. However, it is preferable to mold the entire windshield assembly onto the projectile body in one operation and to secure the plastic directly to the machined surface of the ogive. In this case, it is preferred to employ a bonding coating of resin of the same nature used in the plastic molding compound, and this coating is preferably applied by dipping the ogive in the liquid resin after the ogive has been cleaned to insure that its surface is free from oil, grit and other foreign material. The resin coating is allowed to dry before molding the windshield thereon to insure that the coating remains uniformly in place during the molding operation.

The projectile body is preferably preheated to a temperature slightly below the molding temperature before it is placed in the mold with the plastic molding compound. This allows the resin in the plastic in the windshield and the resin in the bonding coating on the ogive of the projectile to be cured uniformly throughout at substantially the same time when subjected to proper heat and pressure in the mold. It has been found that a pressure substantially greater than ordinarily used in molding operations is preferable in order to increase the strength of the plastic material of the windshield and to facilitate the bonding of the plastic to the projectile body.

As a modification of the composition previously described for molding the windshield 10, a suitable lubricant may be included to facilitate piercing of the armor by ogive 6 upon impact therewith. Thus, graphite or the like may be included with the plastic composition forming windshield 10, or powdered soft metal such as copper or an alloy having lubricating qualities may be used. It is also contemplated that windshield 10 may be either uniform throughout or the core of this windshield may be of a different material or having different physical characteristics than the outer surface. For example, the outer shell of the windshield as well as a layer surrounding ogive 6 might be of the material containing wood pulp previously described to possess high impact strength, and the central or core portion of the windshield could then be of a more fragile or brittle plastic material. This outer shell may be further strengthened by a reinforcing metal shield or metal wire screen molded therein.

A projectile or shot has thus been provided having an improved windshield which adds only a small amount to the weight of the projectile and which may be rapidly and accurately manufactured at low cost and without the use of materials essential for other purposes. Several means have been disclosed for securely attaching the plastic windshield to the projectile body, and it will be clear that in each instance the molding of the plastic material on the projectile body results in greater accuracy of alignment between the projectile body and windshield than would be obtained by more complicated methods of fabrication and assembly.

It is to be understood that various modifications, adaptations and alterations may be made in the specific details of the projectile shown and described in order to meet the requirements of practice, without departing from the spirit or scope of the present invention, as defined by the accompanying claims.

The invention claimed is:

1. A projectile comprising a cylindrical hardened metal body having a bluntly pointed end portion, a coating of relatively soft material having a pebbly surface applied to said bluntly pointed end portion, and a windshield of rigid plastic material molded in place on said coating.

2. A projectile comprising a cylindrical body having a bluntly pointed end, a molded on windshield of rigidly thermosetting plastic material, and means bonding said windshield to the end of said body.

3. A projectile comprising a cylindrical body having a bluntly pointed end, and a windshield molded on said bluntly pointed end of the projectile, said windshield comprising a rigidly thermosetting molded plastic composition containing wood pulp and phenolic resin.

4. A projectile comprising a cylindrical body having a bluntly pointed end portion, a bonding coating of phenolic resin applied to said end portion, and a rigidly thermosetting plastic windshield of filler and phenolic resin molded in place on said bonding coating to polymerize both the resin in said coating and the resin in said windshield.

5. An armor-piercing projectile comprising a cylindrical body of hardened steel having a bluntly pointed end portion, a windshield of molded rigidly thermosetting plastic material, and means for securing said windshield to said end portion including a coating of relatively soft metal electroplated on said end portion to provide a pebbly surface embodied in the material of the windshield.

6. An armor-piercing projectile comprising a cylindrical body of hardened steel having a smooth bluntly pointed end, a coating of copper electroplated on said end and provided with an irregular surface, and a windshield of thermosetting plastic material molded on said coating to interlock with the irregularities of its surface.

7. A projectile comprising a cylindrical steel body having a bluntly pointed hardened end portion shaped to pierce armor plate, a thin coating of relatively soft metal deposited on the surface of said pointed end portion and having an irregular outer surface, and a windshield of rigidly thermosetting plastic material molded on said coating.

8. A projectile comprising a cylindrical body having a bluntly pointed end portion with a com-

paratively frail projection thereon, and a windshield of plastic material molded on said end portion to interlock with said projection.

9. A projectile comprising a cylindrical body having a bluntly pointed end portion, a plastic windshield molded on said end portion, and means for holding said windshield on said end portion including an annular ring on said end portion embedded in and interlocking with the plastic of said windshield.

10. A projectile comprising a cylindrical body having an integral bluntly pointed end, a molded on windshield of rigid thermosetting plastic, and means for mechanically retaining said windshield on said end of the cylindrical body.

11. A projectile comprising a body portion having an integral bluntly pointed end portion, the surface of said end portion being roughened to provide small inequalities therein, and a rigid windshield of high impact strength plastic material molded around said end portion in a manner to cause the plastic material to strongly bond to said roughened surface.

12. A projectile comprising a body portion having an integral bluntly pointed end portion, a rough surface on said end portion provided by acid etching, a coating of thermosetting resin applied thereto, and a windshield of rigidly thermosetting plastic molded on said coating to securely bond to said end portion.

13. A projectile comprising a body portion and an integral bluntly pointed end portion, a superficially rough surface on said end portion provided by acid etching, and a windshield of rigidly thermosetting plastic molded around said end portion to securely bond to said rough surface thereof.

14. A projectile comprising a body portion and an integral bluntly pointed end portion, means presenting a superficial roughness on said end portion only, a coating of thermosetting resin applied thereto, and a windshield of rigidly thermosetting plastic including a filler and thermosetting resin molded on said end portion to polymerize both the resin in said coating and the resin in said plastic windshield.

RUSSELL G. THOMPSON.