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54 **Frangible projectile body.**

57 A frangible projectile body (which fragments upon impact with a target) is a die-casting formed of a brittle zinc-based alloy, preferably having a dynamic yield strength of more than 35 ksi. Neither a polymeric binder nor an encapsulating polymer is needed for the projectile, which may be used, for example, as a target practice round.

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TITLE MODIFIED

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"Ammunition Projectiles"

The present invention is concerned with ammunition projectiles having frangible bodies (that is, bodies which fragment upon impact with a target).

5 It is known that ricochet of ammunition projectiles, such as target practice rounds, can give rise to undesirable hazards, particularly when the projectile is fired from an aircraft at a low angle relative to the target. This phenomenon of ricochet is illustrated, by way of example, in
10 Figure 1 of the accompanying drawings, in which the dimensions shown are illustrative of those encountered using 20 mm. ammunition.

Projectiles having frangible bodies (instead of bodies of conventional materials such as steel) have been proposed, for example, in
15 U.S. Patents 2,995,090, 3,570,406, 3,902,683 and 3,951,035. Such projectiles generally have a body which is encapsulated in a polymeric material and/or formed from metal particles bonded with a polymeric
20 binder. Such bodies require special processing.

We have now developed a frangible ammunition projectile which requires neither a polymeric binder nor an encapsulating polymer.

25 According to the invention, there is provided a frangible ammunition projectile, at

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least the body of which is a die-casting formed of a brittle zinc-based alloy.

5 The projectiles according to the invention may be, for example, target practice rounds or rounds for short-range use.

10 The zinc-based alloy which constitutes the body of the projectile according to the invention should be one which consists of a zinc matrix and one or more embrittling alloying elements (that is, elements which provide easy paths of fracture, for example, along grain boundaries of intermetallic compounds formed by the zinc matrix and the alloying element(s)). The alloy preferably contains at least 80% by weight, more preferably, at least 15 85% by weight of zinc. Such a zinc-based alloy preferably contains aluminium in an amount of up to 12% by weight (more preferably 8 to 12% by weight) and, optionally, a minor amount of other metals such as copper or copper and magnesium, the 20 latter being preferably present in an amount of up to 0.1% by weight. Other zinc-based alloys which may be employed include alloys containing manganese, cadmium, antimony, tin, magnesium, copper, nickel, cobalt, or iron.

25 The exact choice of ingredients for the brittle alloy depends on a number of criteria, such as the size and design of the projectile body, the nature of the expected impact with the target and the launch stresses to be encountered. In particular, 30 the alloy preferably has a dynamic yield strength of more than 35 ksi; this enables the body to survive typical launch stresses consistently, so that ballistically consistent results can be obtained.

35 Examples of suitable zinc-based alloys for use according to the invention are given in the

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following Table, together with their dynamic yield strengths and, in some cases, their ability to survive a typical launch stress.

TABLE

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PROPERTIES OF ZINC-BASED ALLOY DIE
CASTINGS IN AS-CAST CONDITION

	Alloy Composition (%by weight)	Dynamic Yield Strength ksi	Structural Integrity at 3350 feet per Second (at 72° F)
	1 99.9% Zn	-	
10	2 95% Zn-4% Al-1% Cu	37.6	yes
	3* 93% Zn-6% Al-1% Cu	47.3	
	4* 91% Zn-8% Al-1% Cu	47.3	
	5* 89% Zn-10% Al-1% Cu	51.1	yes
	6* 94% Zn-6% Al	46.3	
15	7* 92% Zn-8% Al	42.5	
	8* 90% Zn-10% Al	46.3	yes
	9 95% Zn-5% Cd	27.0	
	10 97.5% Zn-2.5% Sb	13.5	no
	11 95% Zn-5% Sn	21.2	
20	12 95.5% Zn-4.5% Mg	25.1	no
	13 95% Zn-5% Cu	30.9	
	14 93% Zn-7% Mn	42.5	
	15 96% Zn-4% Ni	25.1	
	16 98% Zn-2% Co	23.2	
25	17 98% Zn-2% Fe	15.4	
	18 97% Zn-3% Mg	-	no

* Also contains 0.03-0.04% by weight magnesium

The physical properties of such alloys may be modified, for example, by heat treating, or quenching cycles. Such modifying treatments are desirably effected when they increase the dynamic yield strength and thereby promote resistance to launch stress. For example, we have found that heat treatment of certain alloys (such as alloys

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5 and 8 identified in the above Table) at 360°C for 1 to 4 hours results in improved physical properties for use according to the invention.

As mentioned above, the body of the
5 projectile is a die casting. This may constitute the whole of the projectile or there may be a separate nose-tip of the same material or of a different material, or a core of a different material. When a core or separate nose-tip is
10 employed, it may be of aluminium, graphite-epoxy (or other plastics material) or graphite, for example.

A rotating band (for example, of zinc, copper or plastics) may be applied to the projectile,
15 as is conventional.

An embodiment of the present invention will now be described with reference to Figure 2 of the accompanying drawings, which is an exploded view of a projectile having a hollow die-cast
20 frangible body and a frangible body cap adapted to fit in the hollow body.

The frangible body shown is trimmed, sized and machined as necessary to the desired dimensions after die casting and then a rotating
25 band is applied as described above.

The body cap may be fabricated from a variety of materials, including aluminium alloys (such as 6061) or the same zinc-based alloy as the body. The cap may be a die casting, but it may
30 also be made by screw machining. After fabrication, the cap is press-fitted into the body.

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CLAIMS:

1. A frangible ammunition projectile, characterised in that at least the body of the projectile is a die-casting formed of a brittle zinc-based alloy.
2. A projectile according to claim 1, in which the alloy contains up to 12% by weight of aluminium.
3. A projectile according to claim 2, in which the alloy contains a minor amount of copper.
4. A projectile according to claim 2 or 3, in which the alloy contains up to 0.1% by weight of magnesium.
5. A projectile according to any of claims 1 to 4, in which the alloy has a dynamic yield strength of more than 35 ksi.

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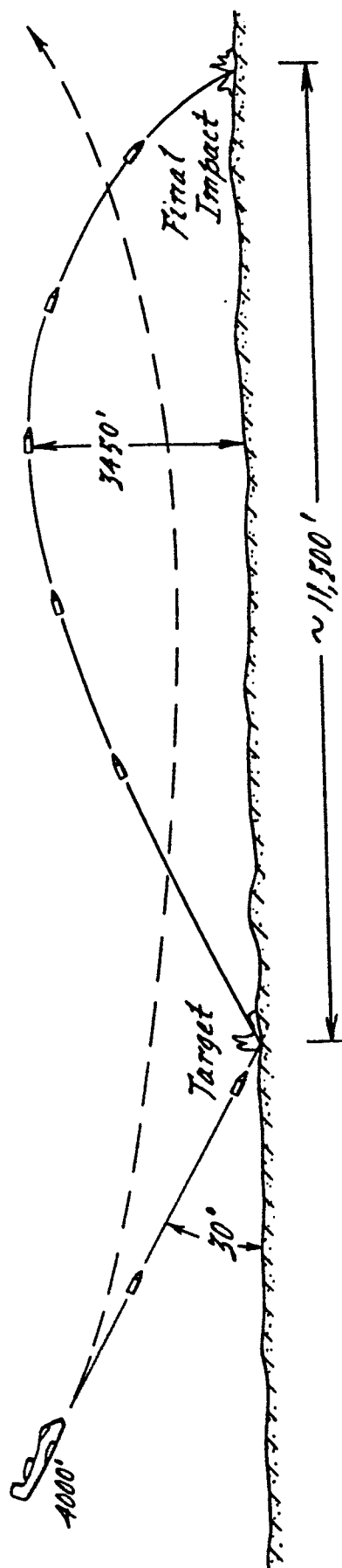


FIG. 1.

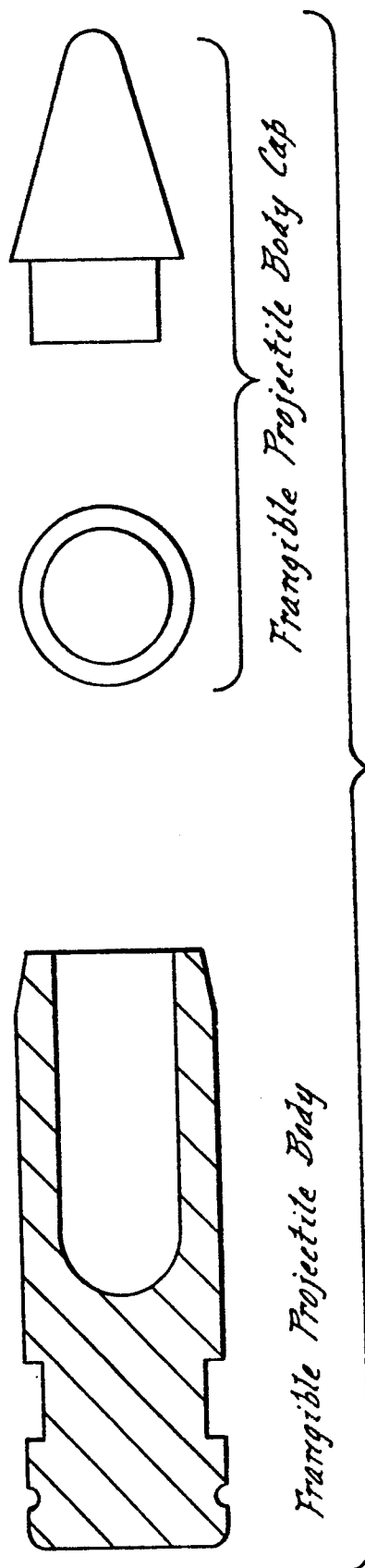


FIG. 2.

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EUROPEAN SEARCH REPORT

Application number

EP 79 30 1093

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
	<u>US - A - 3 440 963</u> (DE LUCA) * Column 2, line 71,72; figure 1 * -- <u>BE - A- 452 009</u> (DEUTSCHE PYROTECHNISCHE FABRIKEN) * Page 4, lines 3-11; page 5, lines 30 and 31 * -- <u>DE - C - 715 511</u> (METALLGESELL- SCHAFT) * The whole patent * -- A <u>US - A - 2 991 718</u> (FERGUSON) A <u>CH - A - 218 110</u> (KRUPP) A <u>FR - A - 2 229 036</u> (HAUT-RHIN) A <u>US - A - 2 102 869</u> (WINTER) A <u>US - A - 1 852 442</u> (ANDERSEN) ----	1 1 1-4	F 42 B 13/02 F 42 B 13/20 C 22 C 18/04 TECHNICAL FIELDS SEARCHED (Int.Cl.) F 42 B C 22 C CATEGORY OF CITED DOCUMENTS X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons &: member of the same patent family, corresponding document
☒ The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 04-09-1979	Examiner VAN DER PLAS