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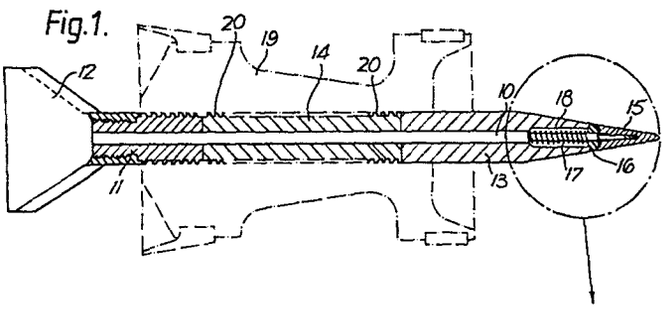
(54) **Improvements in or relating to sub-projectiles for discarding sabot practice shot.**

(57) The invention relates to a sub-projectile for a discarding sabot practice shot, and provides a close ballistic match to a service sub-projectile whilst having a limited range for use on small firing ranges. The invention comprises a central longitudinal rod (10) attached to a finned tail member (11), and two annular cylindrical body portions (13 and 14) slidably assembled on the rod (10) and secured by a nose member (15) attached to the rod (10) remotely from the tail member (11). Thermally deformable separating means are provided which are resiliently biased and actuatable after a given time of flight by aerodynamic heating to initiate break-up of the sub-projectile and limit its range. The separating means may be a joint between the rod and nose member which fails at a certain temperature, supplemented if necessary by a structurally weak annular portion (22) of the nose member (15) having a thermal failure threshold.

Fig.1.



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IMPROVEMENTS IN OR RELATING TO SUB-PROJECTILES FOR A DISCARDING SABOT PRACTICE SHOT

This invention relates to sub-projectiles for discarding sabot practice shot, and in particular to practice sub-projectiles which both closely match service devices in ballistic characteristics and have a limited range for safety of use on small firing ranges.

Discarding sabot practice shot utilise a comparatively large calibre sabot to position a smaller calibre sub-projectile within the gun barrel. The large calibre provides a greater pressure area for propelling the shot than would be available with the sub-projectile alone. Once projected from the gun barrel the sabot is rapidly discarded to leave the sub-projectile free to continue its ballistic trajectory.

One of the problems associated with discarding sabot practice shot is the relatively long range associated with their trajectory and ricochet characteristics. These limit the use of practice shot to firing ranges of large area, or may limit the use of a particular firing range to shots aimed in a particular direction.

Various proposals have been made for a practice shot designed to break-up or become unstable at a given distance within the limits of a typical firing range.

Prior art practice shot designed for break-up commonly incorporate a thermally deformable member which fails under aerodynamic heating during flight. Failure of the member initiates break-up. It is also known to employ aerodynamic or gas pressure to actuate break-up. In particular, US Pat, No 4,140,061 describes a practice shot comprising three 120° part-cylindrical body sections assembled around a central rod. The sections are retained on the rod by a heat-sensitive metal nose-cap. The nose-cap disintegrates during flight

under aerodynamic heating to allow the sections to diverge radially producing break-up. US Pat No 3,747,533 relates to a practice shot having a missile head consisting partially of thermally deformable material. The material melts under in-flight aerodynamic heating, and this allows access of air pressure to the missile head interior. The missile head bursts under this pressure, terminating aerodynamic flight. United Kingdom Pat Application No 2,010,452A describes a missile having three symmetrical 120° cylindrical body sections retained together either by a circumferential band or by a nose-cap. The band and cap melt under aerodynamic heating to allow the body segments to diverge radially and the missile to break-up. United Kingdom Pat No 1,581,108 also employs a practice shot or projectile having three 120° body sections, but uses the propellant gases generated at firing to initiate break-up via a delay mechanism.

The prior art discarding sabot practice sub-projectiles exhibit a degree of complexity which leads to expense in manufacture. Moreover, the prior art devices generally have only passive break-up characteristics, ie break up is produced aerodynamically after failure of a component. It is an object of the present invention to provide a simplified form of practice shot which has a ballistic geometry close to that of a service sub-projectile and has controlled and active fail-safe range characteristics.

The present invention provides a sub-projectile for a discarding sabot practice shot, the sub-projectile including at least one annular cylindrical body portion slidably assembled on a longitudinally disposed central rod attached at one end to a tail member, and a nose member connected to the rod by a connection associated with resiliently biased thermally deformable separating means operative in response to in-flight aerodynamic heating. In operation, the thermally deformable separating means weakens under aerodynamic heating to permit separation of the rod from the nose member thereby initiating break-up. The provision of resilient biasing ensures that separation is positive and rapid. The invention simplifies the problems of engineering discarding sabot sub-projectiles by avoiding the use of multiple part-cylindrical sections for the body portion or complex pressure-actuated means for producing break-up, as in the prior art, and does not rely wholly on passive aerodynamic initiation of break-up. The combination of annular

cylindrical construction with resilient biasing allows inexpensive engineering yet retains reliable break-up characteristics.

The sub-projectile may include two or more discrete annular cylindrical body portions retained in longitudinal contiguity by the nose member. Conveniently resilient biasing of the separating means may be provided by a compression spring housed within the sub-projectile in the region of the nose member/body portion interface.

The thermally deformable separating means may in one embodiment, comprise a layer of jointing material securing the nose member to the rod, the jointing material being designed to fail under aerodynamic heating. Suitable jointing materials include solder, Woods metal and thermoplastic adhesive.

A washer-shaped plug of material of relatively low thermal conductivity may be provided between the nose member and the body portion to concentrate kinetic heating effects in the nose member of the sub-projectile.

The body member and, if appropriate, part of the tail member may be provided with external thread-like projections to engage with corresponding recesses in the bore of the sabot.

Two embodiments of the invention will now be described by way of example only with reference to the accompanying drawings in which:-

Figure 1 shows in sectional elevation the sub-projectile of a discarding sabot practice shot of the invention

Figure 2 shows in sectional elevation the forward body portion of Figure 1 on a larger scale, and

Figure 3 shows also in sectional elevation the forward portion embodying an alternative thermal trigger separating means.

Referring initially to Figures 1 and 2 the sub-projectile comprises a central rod 10, a tail member 11 having fins 12, a main body assembly having annular cylindrical portions 13 and 14 and a nose member 15.

The rod 10 is securely attached to the tail member 11 by a screw thread, brazing or any other suitable means. The main body assembly of the sub-projectile comprises the cylindrical body portions 13 and 14 which are arranged to be a sliding fit on the rod 10. The body portions 13 and 14 are maintained in place by the nose member 15, which is soldered with a jointing material to an end length of the

rod member 10 having reduced diameter. The jointing material is designed to soften under aerodynamic heating to provide separating means.

A washer-like plug 16 of thermo-setting plastic or other low thermal conductivity material is located between the nose member 15 and the forward cylindrical portion 13.

Resilient biasing means 17 in the form of an axially compressed coil spring is located in a tubular recess 18 in the forward end region of the cylindrical body portion 13.

The diameter of the rod 10 is stepped over a first length in the region of the recess 18 and over a second and final length where it is attached to the nose member 15, the stepping being compatible with the reducing cross-section of the sub-projectile. The reduced diameters also facilitate nose member separation and subsequent break-up as the body portions slide forwardly along the rod 10 as will be described later.

The assembled sub-projectile is located within a conventional sabot 19 by means of external thread-like or annular projections 20 on, as shown, the cylindrical portion 14 and part of the tail member 11.

In operation the sub-projectile is located within the sabot 19 and fired, the sabot 19 discarding in the conventional manner once free of the gun barrel. The sub-projectile then assumes a ballistic trajectory. As the sub-projectile moves through the atmosphere, it is subjected to aerodynamic heating particularly in the forward region of the nose member 15. The provision of the low conductivity plug 16 inhibits thermal conduction to the body portions 13 and 14. This concentrates the effects of aerodynamic heating in the nose member 15.

Aerodynamic heating melts the jointing material or separating means by which the nose member 15 is retained on the rod 10, and these separate under resilient biasing from the coil spring 17 initiating break-up.

The cylindrical body portions 13 and 14 of the sub-projectile are considerably heavier than the combined rod 10 and tail member 11, and their consequently greater forward momentum persists longer after break-up is initiated. Accordingly the portions 13 and 14 slide forwardly off the rod 10. Aerodynamic drag on the fins 12 of the tail member 11 also contributes to separation. The stepping of the rod 10

as previously described assists clean separation of the individual component parts, since less sliding resistance is presented by the reduced diameter lengths of the rod 10. Aerodynamic integrity of the sub-projectile is lost after break-up is initiated, and its component parts tumble to the ground.

For any particular size of sub-projectile, it is necessary to determine the point at which the thermally deformable separating means operates to initiate break-up. This is a function of aerodynamic heating, thermal conduction rates through the nose member 15 and the softening or melting point of the jointing material. To achieve reproducibility of break-up in terms of time of flight and/or range, experimentation is required. Current technology provides materials which are capable of giving reproducible performance for the purposes of the invention.

An alternative form of nose member 15 incorporating a thermal trigger as part of the separating means is shown in Figure 3, like reference numerals being used for identical or similar integers.

The nose member 15 is hollow and thin-walled, and is attached to a thermally insulating nylon sleeve 21 mounted on the rod member 10. The sleeve 21 is secured to the nose member 15 and rod 10 by thread or adhesive means. The nose member 15 includes an annular relieved section 22. A recess 18 in the cylindrical portion 13 of the body member houses a stack of belleville washers (disc springs) 17, these being retained in a substantially fully compressed condition to prevent further compression during acceleration.

In operation of the Figure 3 embodiment, aerodynamic heating is concentrated in the forward tip region of the nose member 15 and is particularly effective in the relieved section 22, and this section radiply overheats.

The low conductivity nylon insulating sleeve 21 also increases in temperature to some extent, but inhibits heat loss to the rod 10. The nose member 15 is manufactured from aluminium alloy which loses strength quite dramatically above a threshold temperature. The nose member 15 consequently fails in the region of the relieved section 22 and separates from the body portion 13 under resilient bias from the belleville washers 17. The insulating sleeve 21 is also designed to fail at the appropriate time, and in an optimum design

would fail simultaneously with failure of the relieved section 22. At failure the cylindrical portions 13 and 14 of the body member sequentially separate longitudinally as in operation of the embodiment of Figures 1 and 2.

The sub-projectile described with reference to Figures 1 to 3 has two annular cylindrical body portions 13 and 14, although in some arrangements it might be preferred to have one or more than two. The particular construction of the invention allows a very close ballistic match and similar handling and appearance characteristics as compared with the in-service sub-projectile. The cylindrical construction is very advantageous, since the body portions may be produced from bar stock. In order to ensure reliable break-up characteristics, prior art sub-projectiles have employed complex and expensive nested arrangements of symmetrical part-cylindrical sections. The invention avoids the need for such complex geometry by resiliently biasing apart components of the sub-projectile giving active break-up initiation.

CLAIMS

1. A sub-projectile for a discarding sabot practice shot, the sub-projectile including at least one body portion (13 or 14) slidably assembled on a longitudinally disposed central rod (10) attached at one end to a tail member (11), and a nose member (15) in connection with the rod (10), characterised in that the body portion (13 or 14) is annular and cylindrical and in that the rod/nose member connection is associated with a resiliently biased thermally deformable separating means operative in response to in-flight aerodynamic heating.

2. A sub-projectile according to claim 1 characterised in that the sub-projectile comprises two or more annular cylindrical body portions (13 and 14).

3. A sub-projectile according to claim 1 or 2 characterised in that the resilient bias is provided by a compression spring (17) housed within the sub-projectile and disposed to urge apart the nose and body portions (15, 13 or 14).

4. A sub-projectile according to claim 1, 2 or 3 characterised in that the thermally deformable separating means comprises a jointing material connecting the rod (10) and nose member (15), the jointing material being softenable under in-flight aerodynamic heating.

5. A sub-projectile according to claim 4 characterised in that the jointing material is solder, Woods metal or a thermo-plastic material.

6. A sub-projectile according to claim 4 or 5 characterised in that the separating means includes a structurally weak region (22) of the nose member (15), which region (22) is arranged to fail under in-flight aerodynamic heating.

7. A sub-projectile according to claim 6 characterised in that the weak region (22) is generally annular and coaxial with the central rod (10).

8. A sub-projectile according to any preceding claim characterised in that the diameter of the rod (10) is reduced towards the nose member (15).

9. A sub-projectile according to any preceding claim characterised in that the sub-projectile includes means for inhibiting thermal conduction between the nose and body portions (15, 13 or 14).

10. A sub-projectile according to claim 9 and characterised in that the sub-projectile includes a washer-shaped plug of low thermal conductivity material arranged to inhibit thermal conduction between the nose and body portions (15, 13 or 14).

11. A sub-projectile according to any preceding claim characterised in that a body portion (14) has external formations (20) for engaging complementary formations of a sabot.

12. A sub-projectile according to any preceding claim characterised in that the tail member (11) has external formations for engaging complementary formations of a sabot.

CLAIMS

1. A sub-projectile for a discarding sabot practice shot comprising a longitudinally disposed central rod (10) fixed at its rear end to a tail member (11), a body member (13 or 14) slidably assembled on the rod and retained in position by a nose member (15) located at the forward end of the rod, characterised in that a thermally degradable retaining means (22) retains the nose member on the rod and a spring (17) housed within the sub-projectile is disposed to urge separation of the nose member from the rod whereby after a pre=determined flight time the retaining means fails by aerodynamic heating and the spring urges the nose member fowards and away from the rod to initiate break-up of the sub-projectile.

2. A sub-projectile according to Claim 1 characterised in that the body member comprises two or more annular cylindrical portions (13 and 14) retained in longitudinal contiguity by the nose member.

3. A sub-projectile according to either preceding claim characterised in that the retaining means comprises a joint securing the nose member (15) to the rod (10), said joint being made of a thermally softenable material.

4. A sub-projectile according to Claim 3 characterised in that the joint material is solder, woods metal or a thermoplastic adhesive.

5. A sub-projectile according to any preceding claim characterised by including a region of structural weakness, stressed by the spring (17) and located adjacent and to the rear of the nose member (15) and which is designed for structural failure after aerodynamic heating during the given time of flight.

6. A sub-projectile according to Claim 5 characterised in that the region of structural weakness (22) is generally annular and coaxial with the longitudinal axis of the sub-projectile.

7. A sub-projectile according to any preceding claim characterised in that the diameter of the rod (10) is reduced towards its forward end.

8. A sub-projectile according to any preceding claim characterised by including means for inhibiting thermal conduction between the nose and body members.

9. A sub-projectile according to Claim 8 characterised in that the means for inhibiting thermal conduction includes a washer-shaped plug (16) of relatively low thermal conductivity material disposed between the nose and body members.

10. A sub-projectile according to any preceding claim characterised in that a body portion (14) has external formations (20) for engaging complementary formations of a sabot.

11. A sub-projectile according to any preceding claim characterised in that the tail member (11) has external formations for engaging complementary formations of a sabot.

Fig.1.

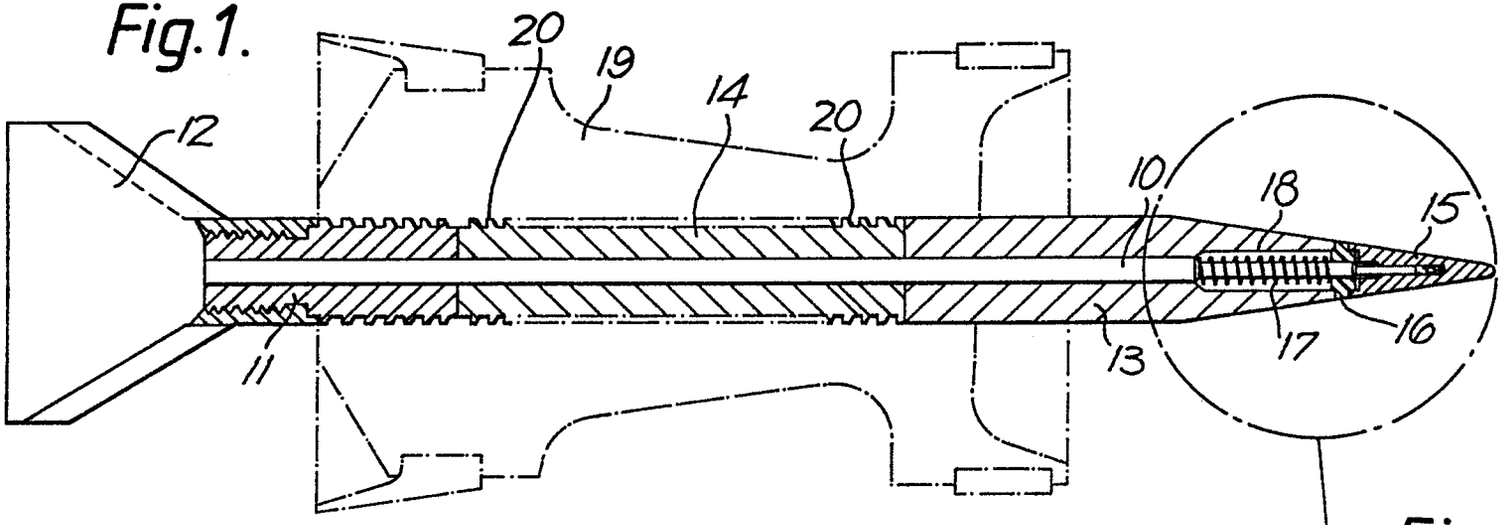


Fig.2.

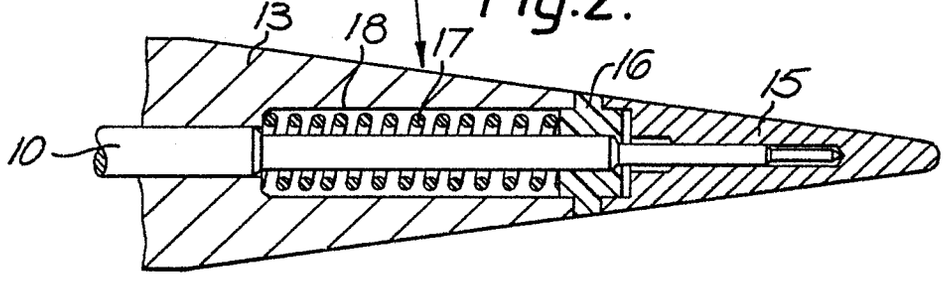
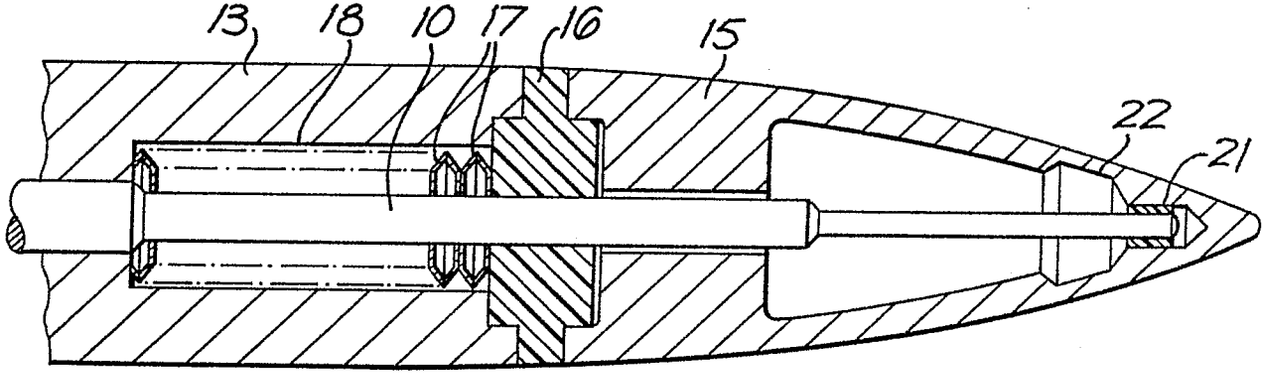


Fig.3.



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EUROPEAN SEARCH REPORT

0090888
Application number

EP 82 30 1142

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
D,Y	GB-A-2 010 452 (RHEINMETALL) *Page 1, lines 102-106; page 2, lines 28-101; figures 1-6*	1,2,3, 4,5,8	F 42 B 13/20
Y	DE-C- 734 429 (PANTOFLICEK) *Page 3, lines 65-97; figure 7*	1,2,3, 4,5,8	
E,X	GB-A-2 084 703 (SECRETARY OF STATE OF DEFENCE) *The whole document*	1,3,4, 6,7	
E,X	US-A-4 334 478 (GOES) *Column 3, lines 4-50; column 4, lines 11-16; figures 1,2*	1,3	
A	DE-A-2 846 998 (WERNER) *Page 3, paragraph 4; page 4, paragraphs 1-3; page 7, paragraphs 3-5; page 8, paragraph 1; figure 3*	1,2,3	TECHNICAL FIELDS SEARCHED (Int. Cl. ³) F 42 B
D,A	US-A-4 140 061 (CAMPOLI) *Column 2, lines 2-8,24-33,53-59; figures 1-5*	1,4,5, 6,7,11 ,12	
D,A	US-A-3 747 533 (ROSSMANN)		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	23-11-1982	VAN DER PLAS J.M.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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