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Title: Sabot

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Description

The invention relates to a sabot for a subcaliber
25 projectile, in particular for a kinetic energy projectile,
comprising a plurality of sabot segments, which adjoin each
other in a circumferential direction and which each have a
front part with respect to a firing direction, as a push
part, and a rear part with respect to the firing direction,
30 as a pull part, between which a pressure flange is located,
wherein the sabot and the sabot segments have a front
terminal region with respect to the firing direction and a
rear terminal region with respect to the firing direction,
wherein the front part and also the rear part of the sabot
35 segments have recesses which are open radially outward,

said recesses being arranged consecutively in the circumferential direction and being delimited by struts extending in the firing direction, wherein the struts extend between the front terminal region with respect to the firing direction and the pressure flange and between the rear terminal region with respect to the firing direction and the pressure flange.

A sabot for a subcaliber projectile should perform a plurality of functions in a satisfactory manner. It must initially seal the annular gap remaining between the projectile, which in the case of kinetic energy projectiles is often referred to as the penetrator, and the barrel wall, so that the propellant gases can be used effectively to propel the projectile in the weapon barrel. Furthermore, the sabot guides the projectile in the weapon barrel, so that it precisely follows the bore axis of the weapon barrel without lateral deflection or deviation. In the case of highly subcalibered projectiles, the sabot must also support and stabilize the projectile during acceleration in the weapon barrel, wherein the force introduced into the projectile via the sabot should, if possible, be distributed over a larger section of the projectile's longitudinal extension. If the force applied to the projectile is too concentrated - as is often the case with sabot projectiles with a rear or front propellant base - the projectile threatens to collapse and tear under the effect of inertial forces. After sabot projectiles pass through the muzzle, the sabot and projectile separate from each other. The terminal ballistic effect of the projectile

is therefore achieved solely by the projectile itself hitting the target structure. The kinetic energy stored in the sabot is thus lost with regard to a terminal ballistic effect.

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This results in a first conflict of objectives in the design of modern sabots or sabot projectiles. On the one hand, the sabot should be stable and expansive in order to be able to absorb the propellant charge pressure caused by the explosion of the propellant charge and to be able to transfer this pressure to the projectile in a largely uniform manner and over a significant longitudinal section of the projectile for accelerating the projectile in the weapon barrel.

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On the other hand, the sabot should be designed with the lowest possible mass for minimizing the kinetic energy that is not available for terminal ballistics.

20 DE 10 2020 115 703 A1 discloses a sabot of the type mentioned above, which is designed to be weight-optimized by providing recesses in the sabot segments. According to the teaching of this publication, the wall thickness in the rear terminal region of the sabot segments should be thin, so that a low bending stiffness is achieved there in order to allow the sabot segments to fold away after passing through the muzzle without sudden transverse forces being introduced into the projectile. However, the recesses formed in the sabot segments and the resulting increasingly filigree design of the sabot result in a deterioration in

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the guiding and supporting function of the sabot for the projectile.

DE 10 2008 029 395 A1 shows a sabot projectile, however not
5 of the push-pull type with a central pressure flange, but with a double-shell hollow cylindrical guide cage, which is designed as an extruded profile with cavities.

US 5,196,650 shows a sabot projectile which is also not of
10 the same type and has a sabot with a terminally arranged propellant base, i.e. arranged at the rear. The sabot and its sabot segments are solidly formed in a rotationally symmetrical manner, with the exception of slot-shaped recesses formed in the interior, wherein the recesses serve
15 to accommodate temperature-sensitive memory metal plates between each two sabot segments, which are intended to support the separation of the sabot segments from each other at the intended time.

20 DE 39 04 626 A1 shows a non-generic sabot projectile which has a sabot with a front propellant base and a cylindrical guide segment in the rear part.

DE 10 2004 017 675 A1 shows a push-pull type sabot
25 projectile with solidly formed propellant segments, at the front ends of which webs made of carbon fiber reinforced plastic are attached, which carry an annular support and guide body provided with predetermined breaking points. A similar sabot projectile is shown in DE 10 2004 017 674 A1,
30 with which a front annular support and guide body with

radial struts and an inner sleeve body, which also has predetermined breaking points, is inserted axially into the assembled sabot segments from the front by means of the inner sleeve body.

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The present invention is based on the object of specifying a sabot with which, on the one hand, a high muzzle velocity of the sabot projectile is achieved and the kinetic energy not available for terminal ballistics is minimized and, on
10 the other hand, the guiding and supporting function of the sabot is not significantly impaired and no shock-like transverse forces are introduced onto the projectile.

This object is achieved by a sabot having the features of
15 claim 1.

Proceeding from a sabot of the type mentioned at the outset, it is therefore proposed according to the invention that a front terminal strut region of each of the struts in
20 the front part of the sabot segments runs radially outward and integrally transitions into an externally cylindrical ring element segment and holds and supports said ring element segment, and the ring element segments adjoin each other in the circumferential direction and form a ring
25 element, and the ring element has through-openings, which extend in the axial direction and are located between the struts with respect to the circumferential direction.

The struts in the front part of the sabot segments absorb
30 and transfer substantially all of the pressure forces from

the pressure flange forward and toward the projectile. This results in a locally concentrated introduction of force onto the projectile, specifically in the region of a particular strut. As a result of the fact that the front

5 terminal strut region of each of the struts in the front part of the sabot segments runs radially outward and integrally transitions into an externally cylindrical ring element segment, the struts are supported radially from the outside by the inside of the weapon barrel and guided

10 through the weapon barrel. This can prevent or at least reduce the occurrence of uncontrolled vibrations in the region of the front struts and thus a shock-like application of force and force transmission from the front struts to the projectile. According to the invention, it

15 was recognized that this makes it possible to design the sabot with an optimized weight, without the sabot segments being subjected to jerky fluttering movements, which have an undesirable and detrimental effect on the projectile during acceleration in the weapon barrel but also on the

20 subsequent flight stability of the projectile. As a result of the fact that the ring element has through-openings which extend further in the axial direction and are located between the struts with respect to the circumferential direction or open there, forces on the ring element

25 segments caused by air resistance can also be reduced, which in turn has a stabilizing effect on the struts supporting the ring element segments. Furthermore, the struts in the front terminal strut region running radially outward are also stabilized in position by the high air

30 pressure flanking them in the region of the through-

openings. The recesses also have the advantage that the pressure flange can be designed with pocket-shaped recesses on its front side and that air can flow effectively through the through-openings after the sabot projectile has passed
5 through the muzzle to these pocket-shaped recesses, so that the sabot segments can detach from the projectile.

In a further embodiment of the invention, it proves to be advantageous if the respective front terminal strut region
10 running radially outward has a greater wall thickness in the circumferential direction concentric to the longitudinal direction than in an adjoining and rear region of the same strut. This makes the strut in question even more stable in the particularly stressed front terminal
15 region.

Overall, it proves to be advantageous if the front or rear struts and preferably the front and rear struts are designed in such a way that their wall thickness increases
20 in the circumferential direction concentric to the longitudinal direction in the direction of the pressure flange, i.e. increases from the front and from the rear in the direction of the pressure flange. This can also improve the torsional stability of the sabot.

25 It is also advantageous if the sabot is designed in such a way that in the front part of the sabot segments, exactly one strut extending in the firing direction is provided for each sabot segment, so that the ring element segment of
30 each sabot segment is held and supported by exactly one

strut. In this way, a particularly weight-optimized design of the sabot segments in the region in front of the pressure flange, i.e. at the front with respect to the firing direction, can be realized.

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Furthermore, it proves to be advantageous if a through-opening is formed and delimited by ring element segments of two adjacent sabot segments. This design supports the detachment of the sabot segments from the projectile after
10 passing through the muzzle.

As already mentioned, it proves to be advantageous if in the front part of the sabot segments in the region of the pressure flange, curved pocket-shaped recesses are formed
15 opposite to the firing direction, which are delimited in the circumferential direction by the struts in the front part of the sabot segments. This measure can support the weight optimization and the detachment behavior of the sabot segments from the projectile after passing through
20 the muzzle. It also proves to be advantageous if the through-openings, if viewed in the firing direction, are aligned with the pocket-shaped recesses in the region of the pressure flange. This allows an effective flow of air into the pocket-shaped recesses to be achieved.

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With regard to a stable design of the sabot, it proves to be advantageous if the struts of the sabot segments, when viewed in a longitudinal center plane enclosing the firing direction, are inclined from the pressure flange to the
30 firing direction and slope inward to the rear and to the

front along their extension, or in other words, the struts rise radially outward from the front and rear in the direction of the pressure flange. The radially outer boundary line of the struts is therefore inclined to the firing direction or bore axis of the barrel. This also has a positive effect on the torsional rigidity and stability of the sabot. In addition, the forces exerted by the propellant charge pressure on the rear part of the three body segments and in particular on the pressure flange can be transferred radially inward to the projectile via a larger strut cross section of the rear struts as tensile forces and the front struts as compressive forces.

It also proves to be advantageous if the struts in the rear part of the sabot segments have a rear terminal strut region with a constant radial wall thickness. In a further development of this idea, it is proposed that the sabot segments are surrounded in their rear terminal region by an annular holding element with predetermined breaking points, which only detaches from the projectile at an advanced stage of the folding of the sabot segments and by means of which the rear terminal of the sabot segments can initially be held in contact and supported in a positive-locking manner in the firing direction against the projectile, so that the sabot segments can fold away from the projectile at the front after passing through the muzzle, but initially remain held together at their rear terminal and are supported against the projectile, wherein the annular holding element is finally broken open to allow the sabot segments to be detached.

It proves to be advantageous if the holding element is designed in a sleeve-shaped, cylindrical manner. It can be pushed from behind onto the terminal region of the sabot, particularly after the sabot segments have been mounted on the projectile, or it can be molded directly onto the sabot.

In a further embodiment, the holding element can have weakening lines extending substantially in the longitudinal direction, which form the predetermined breaking points.

10 In a further embodiment of the sabot according to the invention, it proves to be advantageous if an annular closed guide band is applied radially to the outside of the pressure flange, which is first manufactured separately from the sabot and is then pushed from behind onto the sabot already accommodating the projectile until it reaches an intended mounting position radially on the outside of the pressure flange under radial expansion and springback. By selecting a suitable material for the guide band, in particular a material that is softer than the material of the sabot, improved sealing and thus more effective use of the propellant charge pressure to accelerate the sabot projectile can be achieved.

It proves to be advantageous if the intended mounting position of the guide band is formed in a positive-locking manner radially on the outside of the pressure flange. This prevents unintentional displacement of the guide band during the acceleration process of the sabot projectile in the weapon barrel.

It also proves to be advantageous if the pressure flange has sawtooth-like or wedge-shaped surface sections on the outer circumference which are aligned with each other and are complementary to corresponding surface sections formed
5 radially on the inside of the guide band.

The invention also relates to a sabot projectile with a projectile and a sabot which is connected in a positive-locking and detachable manner to the projectile with respect to a firing direction according to the present
10 invention. Furthermore, the invention relates to ammunition with such a sabot projectile and with a propellant charge.

Further features, details and advantages of the invention result from the appended claims and from the drawings and subsequent description of a preferred embodiment of the
15 sabot according to the invention. In the drawings:

Figure 1 is a perspective view of the sabot according to the invention;

Figure 2 is a view of the sabot according to Figure 1 with a projectile in the form of an arrow-type
20 projectile accommodated therein;

Figure 3 is a perspective detailed view of a guide band for mounting on the pressure flange of the sabot according to the invention;

Figure 4 is a view corresponding to Figure 2 with a holding
25 element with predetermined breaking points in a rear terminal region of the sabot.

Figures 1 and 2 show a sabot 2 according to the invention for a subcaliber projectile 4, which is indicated in Figure 2. The projectile 4 may be a so-called kinetic energy projectile, in particular an arrow-type projectile, as is typically used for armor-piercing ammunition. It is also often referred to as a penetrator. The sabot 2 comprises, by way of example and preferably, three sabot segments 8 which adjoin each other in a circumferential direction 6 and each comprise a segment of 120° . The sabot 2 or the three sabot segments 8 comprise a front part 12 with respect to a firing direction 10 or longitudinal direction, which is referred to as a push part for reasons to be explained below, and a rear part 14 with respect to the firing direction 10 or longitudinal direction, which is referred to as a pull part. Between the front part 12 and the rear part 14, a pressure flange 16 is located, by means of which the sabot 2 is in direct or indirect sealing contact with the inner wall of the weapon barrel, so that the propellant charge pressure generated when the propellant charge of the ammunition burns can accelerate the sabot 2 and with it the projectile 4 in the weapon barrel in a manner known per se.

The sabot 2 or its sabot segments 8 delimit a continuous barrel section radially on the inside, which is formed by means of a groove structure 18 or thread structure or by means of other positively-locking means in order to form a positive-locking connection to the inner projectile 4 with respect to the firing direction 10 in a known manner.

The sabot 2 or the sabot segments 8 further comprise a rear terminal region 20 with respect to the firing direction 10 and a front terminal region 22 with respect to the firing direction 10.

- 5 The sabot segments 8 are not solidly formed in a rotationally symmetrical manner to the firing direction 10 or longitudinal direction, but the front part 12 and also the rear part 14 have recesses 24 which are open radially outward, said recesses being arranged consecutively in the
10 circumferential direction 6 and being formed elongated in the firing direction 10 or longitudinal direction or axial direction. They are each laterally delimited by struts 26 in the front part 12 extending in the firing direction 10 and struts 28 in the rear part 14. This makes it possible
15 to achieve a reduction in the mass of the sabot 2, which, however, is at least fundamentally accompanied by a weakening of the sabot 2, but, as will be shown below, this is acceptable and can be compensated for by further development.
- 20 The struts 26 extend in the front part 12 between the aforementioned front terminal region 22 and the pressure flange 16, and the struts 28 extend in the rear part 14 between the rear terminal region 20 and the pressure flange 16. In the exemplary and preferred case shown, the radial
25 height of the struts 26 and 28 increases in the direction of the pressure flange 16. This allows a stable introduction and dissipation of tensile forces and compressive forces from the pressure flange 16 to the

struts 26, 28 and the remaining sabot material. If the rear part 14 of the sabot 2 is subjected to the entire propellant charge pressure, this rear part 14 is subjected to tensile stress radially inward due to the positive-
5 locking coupling with the projectile, which is why it is referred to as the pull part. Starting from the pressure flange 16, however, pressure or thrust forces are exerted and introduced into the front part 12, which is why this front part 12 is referred to as the "push part". In the
10 material-reduced design of the sabot 2 in question here, the introduction and transmission of the tensile forces into the rear part 14 and the compressive forces into the front part 12 takes place predominantly via the elongated struts 28 or 26, and from there further radially inward via
15 the positive-locking support of the sabot segments 8 against the projectile 4. According to the invention, the struts 26 in the front part 12 of the sabot segments 8 run radially outward with a respective front terminal strut region 30, preferably rounded, and thereby integrally
20 transition into an externally cylindrical ring element segment 32, wherein the struts 26 with their radially outward running strut region 30 hold and support the ring element segments 32. The ring element segments 32 adjoin each other in the circumferential direction 6 and thus form
25 a closed ring element 34. This ring element 34 is designed radially on the outside in such a way that it can be placed against the inside of the weapon barrel in a sealing and supporting manner. In this way, the ring element 34 and its ring element segments 32 exert a radially inward supporting
30 and stabilizing function on the elongated struts 26. This

prevents the sabot segments 8 from fluttering up and the high thrust load in the front struts 26 is evenly distributed over the circumference into the projectile 4.

The aforementioned front terminal strut region 30 is
5 preferably also formed with a greater wall thickness d in the circumferential direction 6 than an adjacent region of the respective strut 26, which is clearly visible from Figure 1. This wall thickness d increases radially outward in the transition to the respective ring element segment
10 32, in order to allow stable support of the ring element 34.

The ring element 34 further comprises through-openings 36 which extend in the firing direction 10 and are located between the struts 26 with respect to the circumferential
15 direction 6. On the one hand, these through-openings 36 reduce the air resistance of the ring element 34, and on the other hand, they are aligned with pocket-shaped recesses 38 which are curved against the firing direction 10 and which are formed into the pressure flange 16
20 starting from a front side of the pressure flange 16. This in turn reduces mass. On the other hand, the formation of the pocket-shaped recesses 38 after the muzzle passage of the sabot projectile exerts a tilting force directed radially outward on the three sabot segments 8, as a result
25 of which the sabot segments 8 fold away from the projectile and detach.

As already indicated, the struts 26, 28 of the sabot segments 8 are inclined to the firing direction when viewed

transversely to the firing direction 10 and in a longitudinal center plane enclosing the firing direction. Starting from the pressure flange 16, they slope radially inward to the rear and to the front, or in other words, 5 their radially outer boundary line rises from the rear and front in the direction of the pressure flange 16. Their wall thickness in the circumferential direction also increases in the direction of the pressure flange 16. This also supports the dissipation of tensile forces and 10 compressive forces, which are mainly generated from the pressure flange 16, and increases the torsional rigidity of the sabot 2 as a whole.

Figure 2 shows the sabot 2 mounted on a projectile 4.

It can further be provided that the struts in the rear part 15 14 of the sabot segments 8 have a rear terminal strut region with a constant radial wall thickness. It would also be conceivable that the rear terminal region 20 of the sabot segments, in particular over a length of a few centimeters, approximately up to 8 cm in length, is formed 20 as an external cylinder, so that no struts are formed there.

Independently of this, an annular holding element 44 with predetermined breaking points 46 running in the longitudinal direction could be applied in the rear 25 terminal region 20, which only detaches from the projectile 4 when the sabot segments 8 have advanced in their folding process, as was described at the beginning (this is shown in Figure 4). In the simplest case, the holding element 44

could be designed in a sleeve-shaped, cylindrical manner and have weakening lines extending substantially in the firing direction or longitudinal direction as predetermined breaking points 46.

- 5 Figure 3 shows a partial sectional view of an annular closed guide band 50. The annular closed guide band 50 can be manufactured separately from the sabot segments 8 and can then be pushed from behind onto the sabot 2 already
10 accommodating and surrounding the projectile 4 until it reaches an intended mounting position radially on the outside of the pressure flange 16 under radial expansion and springback. As can be seen from the sectional view of Figure 3, the guide band 50 has wedge-shaped surface sections 52 which are aligned with each other and are
15 complementary to corresponding surface sections 54 formed radially on the inside of the pressure flange 16.

CLAIMS

1. A sabot (2) for a subcaliber projectile (4), in
5 particular a kinetic energy projectile, comprising a
plurality of sabot segments (8), which adjoin each
other in a circumferential direction (6) and which
each have a front part (12) with respect to a firing
direction (10), as a push part, and a rear part (14)
10 with respect to the firing direction (10), as a pull
part, between which a pressure flange (16) is located,
wherein the sabot (2) and the sabot segments (8) have
a front terminal region (22) with respect to the
firing direction (10) and a rear terminal region (20)
15 with respect to the firing direction (10), wherein the
front part (12) and also the rear part (14) of the
sabot segments (8) have recesses (24) which are open
radially outward, said recesses being arranged
consecutively in the circumferential direction (6) and
20 being delimited by struts (26, 28) extending in the
firing direction (10), wherein the struts (26, 28)
extend between the front terminal region (22) with
respect to the firing direction (10) and the pressure
flange (16) and between the rear terminal region (20)
25 with respect to the firing direction (10) and the
pressure flange (16), **characterized in that** a front
terminal strut region (30) of each of the struts (26)
in the front part (12) of the sabot segments (8) runs
radially outward and integrally transitions into an
30 externally cylindrical ring element segment (32) and

holds and supports said ring element segment (32), and the ring element segments (32) adjoin each other in the circumferential direction (6) and form a ring element (34), and the ring element (34) has through-
5 openings (36), which extend in the firing direction (10) and are located between the struts (26) with respect to the circumferential direction (6).

2. The sabot according to claim 1, characterized in that the respective front terminal strut region (30)
10 running radially outward has a greater wall thickness in the circumferential direction (6) concentric to the longitudinal direction than in an adjoining and rear region of the same strut.

3. The sabot according to either claim 1 or claim 2,
15 characterized in that the front or rear struts (26, 28) and preferably the front and rear struts (26, 28) are designed such that their wall thickness increases in the circumferential direction (6) concentric to the longitudinal direction in the direction of the
20 pressure flange (16).

4. The sabot according to any of claims 1, 2 or 3, characterized in that in the front part (12) of the sabot segments (26), exactly one strut (26) extending in the firing direction (10) is provided for each
25 sabot segment (8), so that the ring element segment (32) of each sabot segment (8) is held and supported by exactly one strut (26).

5. The sabot (2) according to one or more of the preceding claims, characterized in that a through-opening (36) is formed and delimited by ring element segments (32) of two adjacent sabot segments (8).
- 5 6. The sabot (2) according to one or more of the preceding claims, characterized in that in the front part (12) of the sabot segments (8) in the region of the pressure flange (16), curved pocket-shaped recesses (38) are formed opposite to the firing
10 direction (10), which are delimited in the circumferential direction (6) by the struts (26) in the front part (12) of the sabot segments (8).
7. The sabot according to claim 6, characterized in that the through-openings (36), when viewed in the firing
15 direction (10), are aligned with the pocket-shaped recesses (38) in the region of the pressure flange (16).
8. The sabot (2) according to one or more of the preceding claims, characterized in that the struts
20 (26, 28) of the sabot segments (8), when viewed in a longitudinal center plane enclosing the firing direction (10), are inclined from the pressure flange (16) to the firing direction (10) and slope inward to the rear and to the front along their extension.
- 25 9. The sabot (2) according to one or more of the preceding claims, characterized in that the struts (28) in the rear part (14) of the sabot segments (8)

have a rear terminal strut region (20) with a constant radial wall thickness.

10. The sabot according to one or more of the preceding claims, characterized in that the sabot segments (8) are surrounded in their rear terminal region (20) by an annular holding element (44) with predetermined breaking points (46), which only detaches from the projectile (4) at an advanced stage of the folding of the sabot segments (8) and by means of which the rear terminal of the sabot segments (8) can initially be held in contact and supported in a positive-locking manner in the firing direction (10) against the projectile (4), so that the sabot segments (8) can fold away from the projectile (4) at the front after passing through the muzzle, but initially remain held together at their rear terminal and are supported against the projectile (4), wherein the annular holding element (44) is finally broken open to allow the sabot segments (8) to be detached.
11. The sabot (2) according to claim 10, characterized in that the holding element (44) is designed in a sleeve-shaped, cylindrical manner.
12. The sabot (2) according to either claim 10 or claim 11, characterized in that the holding element (44) has weakening lines extending substantially in the firing direction (10).

13. The sabot (2) according to one or more of the preceding claims, characterized in that an annular closed guide band (50) is applied radially to the outside of the pressure flange (16), which is first
5 manufactured separately from the sabot (2) and is then pushed from behind onto the sabot (2) already accommodating the projectile (4) until it reaches an intended mounting position radially on the outside of the pressure flange (16) under radial expansion and
10 springback.
14. The sabot (2) according to claim 13, characterized in that the intended mounting position of the guide band (50) is formed in a positive-locking manner radially on the outside of the pressure flange (16).
- 15 15. The sabot (2) according to claim 14, characterized in that the pressure flange (16) has sawtooth-like or wedge-shaped surface sections (54) on the outer circumference which are aligned with each other and are complementary to corresponding surface sections
20 (52) formed radially on the inside of the guide band (50).
16. A sabot projectile with a projectile (4) and a sabot (2) connected in a positive-locking and detachable manner to the projectile (4) in a firing direction
25 according to one or more of the preceding claims.
17. Ammunition with a sabot projectile according to claim 16 and with a propellant charge.