Oct. 31, 1967 O. SCHWAGER ET AL 3,349,712

SABOT PROJECTILE

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Fig. 1

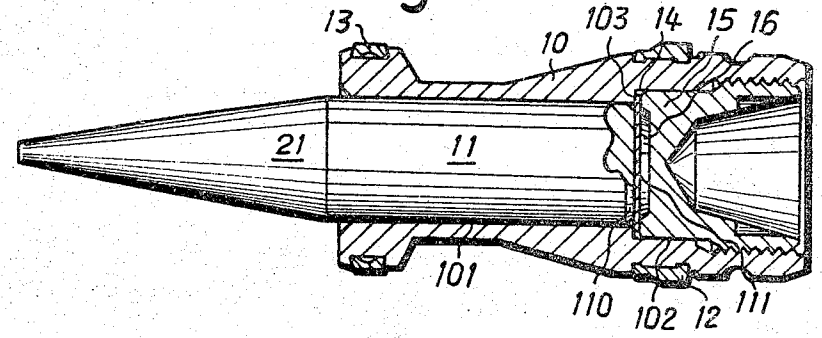

Fig. 6

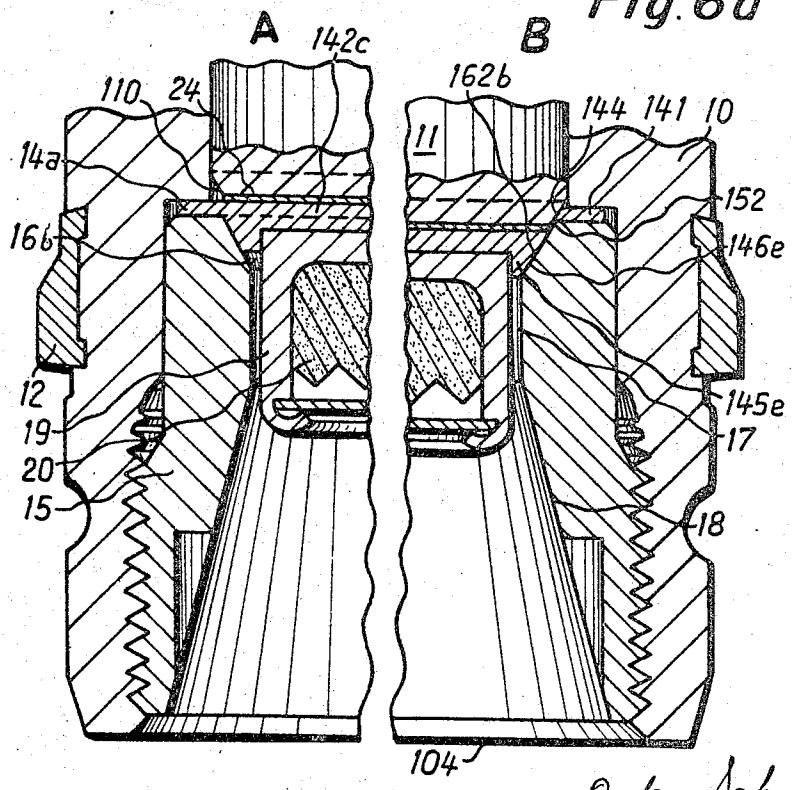

Fig. 6a

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SABOT PROJECTILE

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Fig. 2

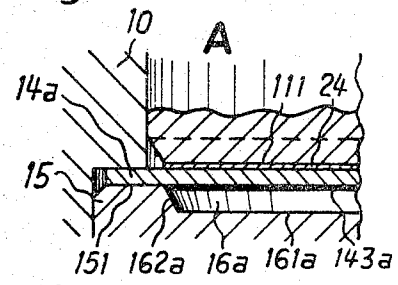


Fig. 2a

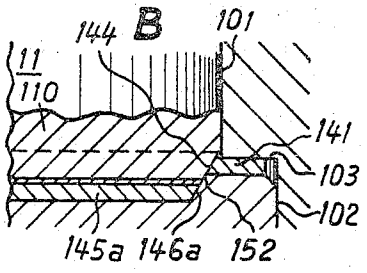


Fig. 3

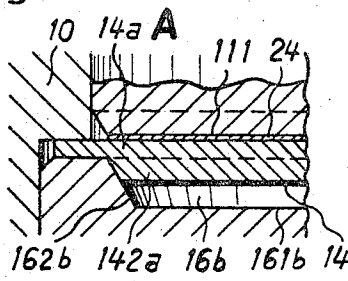


Fig. 3a

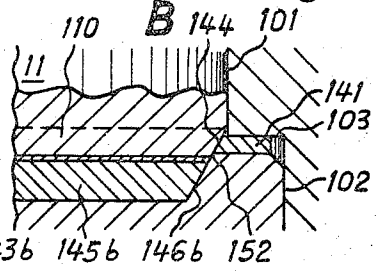


Fig. 4

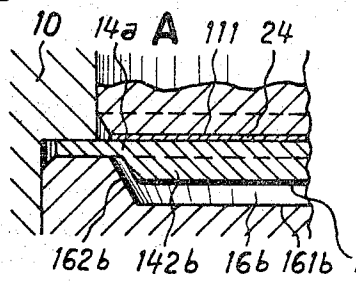


Fig. 4a

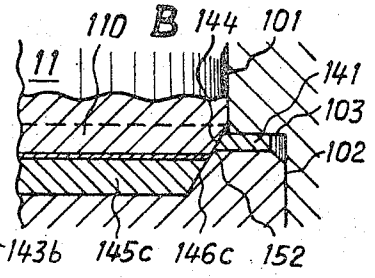


Fig. 5

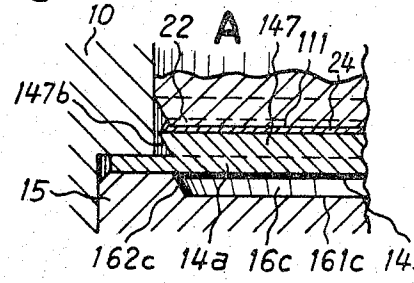
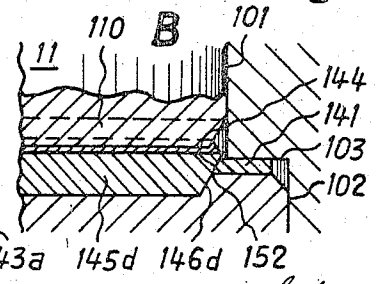


Fig. 5a



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3,349,712

SABOT PROJECTILE

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Filed July 21, 1966, Ser. No. 566,850
Claims priority, application Switzerland, July 22, 1965, 10,261/65
26 Claims. (Cl. 102—93)

ABSTRACT OF THE DISCLOSURE

A sabot projectile wherein the sabot is connected to the projectile body by a connecting piece which can be sheared due to the inertia of the projectile when fired. This is provided by shearing edges located upon the sabot and the projectile rear surface.

The invention relates to a sabot projectile of the kind in which a sabot is connected to a base surface of a projectile body by means of a connecting piece projecting over the base surface, which connecting piece, on discharge, owing to the load due to the inertia of the projectile body, is sheared off and causes severance of the connection.

In a sabot projectile of this kind disclosed in United States Patent No. 3,044,400 granted July 17, 1962 the connecting parts are constructed as threaded bolts with bonding connections which engage in holes which are formed in the projectile body parallel to the projectile axis. Such a projectile is difficult to produce and therefore also expensive, especially in the case of projectiles of hard metal such, for example, as tungsten carbide. A further disadvantage of such a projectile is that the holes serving for the engagement of the bolts can be the cause of cracks which occur when the bolts which, acting on the projectile body on feeding the sabot projectile into the chamber of the barrel of an automatic weapon, transmit forwardly directed inertia force to the sabot. As a result of such cracks arising on feeding, on the sudden acceleration of the projectile body and severance of the bolts on discharge, parts of the projectile body can flake off, cause an imbalance of the same and thus a reduction in accuracy of its flight. In the case of securing the projectile body for transport or loading through bolts of this kind provided at its rear part, such cracks radiating from the holes can, moreover, on impact of the projectile body, for example, on an armour plate representing the target, produce a weakening of the projectile body which considerably affects its penetrating power. With a sabot projectile of the above kind, the danger also exists that the connecting parts can break prematurely if a hard impact occurs in the chamber on loading. Here the determining factor is the shearing resistance of the adhesive bond. It is difficult to determine this resistance correctly between given edges on relatively small surfaces.

The invention overcomes the abovesaid disadvantages in that it provides a sabot projectile consisting of a projectile body having a base surface at one end, a disc-shaped connecting piece secured to the base surface by means of a bonding substance and constituting a rim extending circumferentially beyond the base surface, a sabot having the form of a sleeve in which the projectile body is received and which is closed at its rear end by a wall portion, a ring surface forming an inner surface part of the end wall portion and defining a circular recess in the said end wall, the said ring surface co-axially seating against the rim of the connecting piece and further defining a circular shearing edge around the periphery of the recess which edge shears through the connecting piece

when the sabot projectile is discharged due to the inertia of the projectile body causing the said body to enter the recess.

In accordance with the invention, owing to securing the disc-shaped connecting part to the base surface of the projectile body by adhesion, the occurrence of cracks in the latter and thereby the impairment of its efficiency, is avoided. Owing to the fact that holes and screw threads in the projectile body are avoided and thus no costly machining is necessary for the projectile body consisting either of hard metal or high-alloy steel, there results the cheapening of manufacture and improvement of the sabot projectile which are sought. When measuring the resistance of the severance the determining factor is no longer the adhesive bond, but the precisely dimensionable rim of the connecting piece.

Five preferred embodiments of the invention will hereinafter be described, by way of example, with reference to the accompanying drawings in which:

FIGURE 1 shows a first embodiment of a sabot projectile in longitudinal section and partial elevation,

FIGURES 2 and 2*a* show a greatly enlarged broken longitudinal section of the rear part of the sabot projectile shown in FIGURE 1, with section part A in FIG. 2 showing the sabot projectile in the condition prior to loading, and section part B in FIG. 2*a* showing the sabot projectile after discharge on passing through a gun barrel (not shown),

FIGURES 3 and 3*a* are a representation corresponding to FIGURES 2 and 2*a* of a second embodiment,

FIGURES 4 and 4*a* are a representation corresponding to FIGURES 2 and 2*a*, of a third embodiment,

FIGURES 5 and 5*a* are a representation corresponding to FIGURES 2 and 2*a*, of a fourth embodiment, and

FIGURES 6 and 6*a* are a representation corresponding to FIGURES 2 and 2*a* of a fifth embodiment.

In FIGURE 1, the sabot is marked **10** and the projectile body **11**. The sleeve-shaped sabot **10**, of light metal such as aluminium alloy, fits with its rear part into the mouth of a cartridge case (not shown), in a known manner, until discharge. The projectile body **11**, preferably wholly or in part consisting of tungsten carbide, is cylindrical in shape and is supplemented by a leading point **21** and a short projectile body boat-tail **110**, which is in the form of a truncated circular cone. The steel driving band **12** is secured to the sabot **10** and transmits to it the spinning impulse from the grooves in the gun barrel (not shown). Another similar driving band **13** is arranged at the front part of the sabot **10**. In order to save weight, the outside diameter of the sabot **10** lying between the two driving bands **12** and **13** is of smaller diameter than the base portion.

The front cylindrical hole **101** in the sabot **10** serves to centre and guide the projectile body **11**. This hole **101** opens out, forming a shoulder **103**, into a coaxial hole **102** of larger diameter, formed in the base of the sabot **10**, the rear portion of which carries a screw thread. A screw-in body **15**, with a recess **16** in it, is fitted into this screwed portion of the sabot **10** from the rear. Between this shoulder **103** and the screw-in body **15** there is clamped the disc-shaped connecting piece **14**, which is secured to the projectile base surface **111**.

FIGURES 2 and 2*a* show, in a first embodiment of the invention, the details of securing the projectile body **11** to the sabot **10**. A disc-shaped connecting piece **14***a*, made of brass or steel for example, is securely connected by hard soldering, by means of a layer of hard solder **24**, to the truncated circular cone **110** which forms the boat-tail of projectile body **11**, or to its end face presenting the base surface **111**. The part of the disc **14***a*, hereafter called the shearing rim **141**, projecting beyond the diam-

eter of the base surface **111** and the projectile body **11**, bears against the ring-shaped front surface **151** of the screw-in body **15** and is pressed by the latter against the shoulder **103** of the sabot **10** formed by the joint between the two holes **101** and **102**. From the front surface **151** of the screw-in body **15**, extending to the rear, a recess **16***a* is formed, bounding a truncated cone-shaped space, contracting towards the rear, the base **161***a* of which is arranged parallel to the rear end surface **143***a* of the disc **14***a*, therefore at right angles to the projectile axis. The line of intersection of the front surface **151** with the generated surface **162***a* of the recess **16***a* forms an edge which will hereafter be called the shearing edge **152**. Its diameter is at least as great as the diameter of the base surface **111** of the projectile body **11**.

The generatrices of the truncated cone of the projectile body boat-tail **110** and the generated surface **162***a* of the recess **16***a* essentially form an angle of the same size with the longitudinal axis of the projectile. It must, however, be greater than the angle at which jamming in regard to separation of the two cones in the axial direction occurs through friction.

The height of the projectile body boat-tail **110** is, moreover, at least equal to the thickness of the shearing rim **141** of the disc **14***a*. In the case of this version (FIGURES 2 and 2*a*) the height is for example, 1.4 times this thickess.

The distance of the base **161***a* of the recess **16***a* from the rear end surface **143***a* of the disc **14***a*, which in this example is the same as the depth of the recess **16***a*, is so dimensioned that it is at least equal to the thickness of the shearing rim **141**, but at most equal to the height of the cone-shaped projectile body boat-tail **110**. In the case of the above version, it is equal to half the sum of the height of this projectile body boat-tail **110** and the thickness of the shearing rim **141**.

In the case of the subsequently described embodiments shown in FIGURES 3 and 3*a* to 6 and 6*a*, corresponding parts are similarly numbered; parts altering in shape are supplemented with the letters *a* to *e* in such figures and, in addition, new accessory components receive a new number.

The second and third embodiments of a sabot projectile illustrated in FIGURES 3 and 3*a* and 4 and 4*a* differ from the previously described embodiment as shown in FIGURES 2 and 2*a*, in that the disc-shaped connecting piece secured to the projectile body boat-tail **110** is formed by the disc **14***a*, containing the shearing rim **141** and, superimposed coaxially on its rear side, a truncated cone **152***a* or **142***b*, tapering to the rear, combined into one body with the disc **14***a*. The base surface of the truncated cone **142***a* has a diameter which, in the case of the sabot projectile shown in FIGURES 3 and 3*a*, is the same size as, and with the truncated cone **142***b* shown in FIGURES 4 and 4*a* is smaller than, the diameter of the shearing edge **152** of the screw-in body **15**.

The depth of the recess **16***b* is here determined, following the example of the first embodiment in FIGURES 2 and 2*a*, by the requirement that the distance of its base **151***b* from the rear end surface **143***b* of the truncated cone **142***a* or **142***b* is at least equal to the thickness of the shearing rim **141**, but at most equal to the height of the coned projectile body boat-tail **110**. In the two embodiments shown in FIGURES 3 and 3*a* and 4 and 4*a* this distance is equal to half the sum of the projectile body boat-tail **110** and the thickness of the shearing rim **141**.

The angles of inclination of the generatrices of the truncated cone **142***a* or **142***b* and the recess **16***b* in relation to the base surface **111** of the projectile body are the same size.

Unlike the version as in FIGURES 2 and 2*a*, in which the front face of the shearing rim **141** lies in the same plane as the projectile base surface **111**, in FIGURES 5 and 5*a* a truncated cone **147**, widening to the front, is mounted on the front face of the disc-shaped connecting piece on

the disc **14***a* containing the shearing rim **141**, forming one piece with the disc **14***a*. The front end surface of this truncated cone is, as in the foregoing embodiments, secured to the projectile base surface **111** by a hard solder layer **24**. The rear end surface of this truncated cone **147** forms the transition surface to the disc **14***a* and has a diameter which is at most equal to the diameter of the shearing edge **152**.

The height of this truncated cone **147** is at least equal to the thickness of the shearing rim **141** and its cone angle is essentially the same as that of the recess **16***c* in the screw-in body **15**. The distance of the base **161***c* of the recess **16***c* from the rear end surface **143***a* of the disc **14***a* is at least equal to the thickness of the shearing rim **141**, but at most equal to the height of the truncated cone **147**. In the embodiment shown in FIGURES 5 and 5*a*, it is equal to half the sum of the thickness of the shearing rim **141** and the height of the truncated cone **147**.

The fifth embodiment of a sabot projectile shown in FIGURES 6 and 6*a* differs from the embodiments shown in FIGURES 3 and 3*a* and 4 and 4*a* described above in one way; that is, the recess **16***b* forms the front portion of a hole **17**, **18** completely and centrally piercing the screw-in body **15**, which opens out into the base opening **104** of the sabot **10**. The middle portion **17** of this hole is cylindrical, whilst its rear portion **18** widens out in a cone shape in the direction of the base opening **104**. Another difference is that the disc-shaped connecting piece **14***a*, **142***c* bonded to the projectile body boat-tail **110** is the carrier of a casing **19** arranged in the middle portion **17** of the hole and reaching through to its rear portion **18**, which contains, for example, a tracer composition **20**. On account of these through holes **17**, **18** during shot travel in the bore of the gun, the propellant gases do not only impinge on the base surface of the sabot **10**, but also on the base surface of the projectile body **11**. The relative magnitudes of these surfaces and the weights of sabot **10** and projectile body **11** are such that the acceleration to which the sabot projectile shaped as in FIGURES 6 and 6*a* is subjected during this movement is considerably greater than that imparted to the projectile body **11** by the gas force. The inertia of the projectile body **11** is therefore preponderant and, as in the previous embodiments, causes the shearing through of the connecting piece.

The material of that part of the screw-in body **15** of the five embodiments of the invention described, in which the recesses **16** are formed, has a higher strength than the material from which the connecting pieces **14** secured to the projectile body boat-tail **110** are made.

The mode of operation of the sabot projectiles will hereinafter be described, immediately before discharge, during the loading process, and during the discharge itself.

If a cartridge, of which the sabot projectile forms a part up to discharge is suddenly checked at the end of the feeding process on loading into the chamber of an automatic gun, as a result of its forward inertial force the projectile body **11** is supported, by means of the connecting piece **14** secured to it, through the shearing rim **141**, on the shoulder **103** of the sabot **10** (see FIGURE 1). In this connection, the shearing rim **141** is so dimensioned that it withstands this load caused by the inertial force, and thus no premature separation of the projectile body **11** from the sabot **10** can take place as a result of breakage of the connecting piece **14**.

After the ignition of the propellant charge, however, as a result of the enormous acceleration of the sabot projectile in the barrel of the gun, such a great inertial force acts on the projectile body **11** that, acting as a shearing punch to the rear in relation to the sabot **10**, and in conjunction with the shearing edge **152** and the front surface **151** of the screw-in body **15**, which represents a counterholding shearing ring, it shears through the shearing rim **141** along the circumference of the

projectile base surface **111** (see, for example, FIGURE 2*a*).

At the end of this shear movement, the projectile body **11**, together with the sheared-off component **145***a*, **145***b*, **145***c*, **145***d* or **145***e*, supports itself to the rear, that is, according to the design version in each case of one of the five examples, either (FIGURE 6*a*) through the intersecting plane **146***e* of the (thereby strongly compressed) component **145***e* against the generated surface **162***b* of the recess **16***b*, or (FIGURE 4*a*) through the rear end surface **143***b* of the component **145***c* (therefore without the compression of the previous example) against the base **161***b* of the recess **16***b* then acting as an abutment, or on the other hand (FIGURES 2*a*, 3*a*) through the component **145***a* or **145***b*, against these two supporting surfaces at the same time.

In each of the embodiments, the projectile body **11** is caused to rotate by the friction which acts between it and these supporting surfaces transmitting the spin of the screw-in body **15** or the sabot **10**.

In the case of the embodiment shown in FIGURES 6 and 6*a*, which is identical with the embodiment according to FIGURES 3 and 3*a* as regards the supporting of the projectile body **11** on the tapered recess wall **162***b* after discharge, the rearward movement of the projectile body **11** in relation to the sabot **10** on discharge comes to rest when the sum of the axial component of the reaction force transmitted by the recess wall **162***b* and the gas force acting on it through the casing **19** is of the same magnitude as the inertia force acting on it. The conditions can be so adjusted, as with the version under consideration, that this is the case when the relative distance covered by the projectile body is equal to half the sum of the height of the tapered projectile body boat-tail **110** and the thickness of the shearing rim **141**. The tracer composition **20** which may, for example, be contained in the casing **19**, is ignited by the hot propellant gases during the passage of the sabot projectile down the gun barrel.

During the rearward movement of the projectile body **11** moreover, the sheared-off ring-shaped shearing rim **141**, gripped between the shoulder **103** of the sabot **10** and the ring-shaped frame surface **151** of the screw-in body **15**, is also compressed on the surface of cut **144**, corresponding to the shape of the tapered boat-tail **110** of the projectile body **11** (see, for example, FIGURE 2*a*). Similarly, the sheared-off component **145***a*, **145***b*, **145***c*, **145***d* or **145***e*, hard soldered to the projectile body boat-tail **110**, situated in a shearing position on penetrating into the recess **16***a*, **16***b* or **16***c* of the screw-in body **15**, is also deformed into a truncated cone by compression on the intersecting plane **146***a*, **146***b*, **146***c*, **146***d* or **146***e*.

As a result of the selection of the height of the tapered projectile boat-tail **110**, together with the thickness of the shearing rim **141** on the one hand, and the clearance existing in the condition before loading of the recess base **161***a*, **161***b* or **161***c* from the rear end surface **143***a* or **143***b* of the connecting part on the other hand, the relative displacement path of the projectile body **11** in the sabot **10** is so dimensioned that the rear inside diameter of the surface of cut **144** of the shearing rim **141** is a little larger than the front outside diameter of the sheared-off component **145***a*, **145***b*, **145***c*, **145***d* or **145***e* secured to the projectile base surface **111** of the projectile body **11**. By this means, and furthermore owing to the smoothing of the surface of cut **144** and the intersecting plane **146***a*, **146***b*, **146***c*, **146***d* or **146***e*, the danger is eliminated with certainty that burns, or the like, arisen through dirty surfaces on the shearing rim **141** and/or on the cut-off component **145***a*, **145***b*, **145***c*, **145***d* or **145***e*, acting as resistances should check, or even completely prevent, separation movement of the projectile body **11** in relation to the sabot **10** to be carried out by the sabot projectile after leaving the gun barrel.

The forward inertia force acting on the projectile body **11** at the end of feeding in a cartridge into a chamber

(not shown in detail) causes in some cases a slight deformation of the shearing rim **141** between the place where it is gripped in the sabot **10** and the place where the soldered connection starts on the edge of the base surface **111** of the projectile body boat-tail **110**, that is, a forward bending deformation of the shearing rim **141** occurs. If through this the connecting piece **14** at the periphery of the base surface **111**, therefore at the most highly stressed point of the soldered connection, as a result of cracks in the latter, were to begin to come loose from the base surface **111**, for example, from the impact on the chamber or during transport, the danger would occur that, after further deformation of the shearing rim or of the connecting piece, the crack could progress radially inwards and the projectile body **11** would then prematurely separate completely from the connecting piece **14**.

With the versions as in FIGURES 3 and 3*a* to 6 and 6*a*, the truncated cone-shaped thickenings **142***a*, **142***b* or **142***c* and **147** now represent a strengthening compared to the disc **14***a* as in FIGURES 2 and 2*a* through which, after a possible tearing-off of the soldered connection, this additional deformation described, and therewith the danger of a complete separation of the projectile body **11** from the connecting piece **14**, are prevented.

With the arrangement of the soldered connection between the base surface **111** of a projectile body **11** and a connecting piece **14**, solder can accumulate between the front surface of the latter and the generated surface of the tapered projectile boat-tail **110** that again solidifies, namely either in isolated places, or in the most extreme cases on the whole circumference of the projectile boat-tail **110**. These accumulations of solder can impede the shearing-off of the shearing rim **141**. To prevent this, the connecting part can be constructed as in FIGURE 5.

With this construction, interference with the shearing process by an accumulation of solder on the outer edge of the base surface **111** of the projectile body **11**, such as is represented by ring **22** in FIGURE 5 for example, is prevented. Compression of the surface of cut **144** of the shearing rim **141** on the rearward movement of the projectile body **11** in the sabot **10** takes place here through the generated surface **147***b* of the truncated cone **147**.

Obviously the connecting pieces constructed as in FIGURES 3, 4 and 6 can also be supplemented with a truncated cone **147** which, as in the version as in FIGURE 5, lies in front of the plane containing the front surface of the shearing rim **141**.

We claim:

1. A sabot projectile comprising a projectile body having a base surface at one end, a disc-shaped connecting piece secured to said base surface having a rim extending circumferentially beyond said base surface, a sleeve shaped sabot for receiving said projectile body formed at one end by a wall portion, a ring surface on said wall portion defining a circular recess in said wall portion, said ring surface coaxially seating against said rim and defining a circular shearing edge around the periphery of said recess to shear through said connecting piece when the sabot projectile is discharged by the inertia of said projectile body causing said base surface to enter said recess.

2. A sabot projectile according to claim **1** wherein said connecting piece is secured to said base surface by a hard solder.

3. A sabot projectile according to claim **1** wherein said connecting piece is a disc of uniform thickness.

4. A sabot projectile according to claim **3** wherein said connecting piece is provided on its rear side with a tapering coaxial truncated circular cone.

5. A sabot projectile according to claim **4** wherein the depth of said circular truncated cone is at least equal to the thickness of said disc.

6. A sabot projectile according to claim **4** wherein the generating angle of said truncated cone is greater

than the angle of jamming in the axial direction of said truncated cone in relation to said recess.

7. A sabot projectile according to claim 4 in which the rear end surface of said truncated cone has a diameter which at most is equal to that of the base surface of said recess.

8. A sabot projectile according to claim 3 wherein said connecting piece is provided on its front side with a coaxial truncated circular cone tapering to the rear.

9. A sabot projectile according to claim 8 wherein the depth of said circular truncated cone is at least equal to the thickness of said disc.

10. A sabot projectile according to claim 8 wherein the generating angle of said truncated cone is greater than the angle of jamming in the axial direction of said truncated cone in relation to said recess.

11. A sabot projectile according to claim 3 wherein the clearance of the bottom of said recess from the rear side of said connecting piece is at least equal to the thickness of said disc.

12. A sabot projectile according to claim 1 wherein said base surface is formed as a coaxial truncated circular cone tapering to the rear.

13. A sabot projectile according to claim 1 wherein said recess is a circular cone-shaped coaxial recess tapering towards the rear whose upper periphery forms said shearing edge.

14. A sabot projectile according to claim 13 wherein said upper periphery has a diameter as large as the diameter of said base surface.

15. A sabot projectile according to claim 1 wherein a casing is mounted at the rear side of said connecting piece containing material for the production of gases.

16. A sabot projectile according to claim 15 wherein said wall portion has a hole, open to the rear, accommodating said casing.

17. A sabot projectile according to claim 16 wherein a truncated cone-shaped aperture is provided in said sabot communicating with said hole.

18. A sabot projectile comprising a projectile body having a rear surface, a sabot in which said body rests, a connecting part forming a separable mounting of said body in said sabot, said connecting part having an edge protruding beyond said body, means for fastening said connecting part to said rear surface, said sabot having a circular surface, means for supporting said edge adjacent said circular surface, said sabot having a recess surrounded by said circular surface and said recess forming jointly with said circular surface a circular coaxial edge to form a shearing means for said connecting part.

19. A sabot projectile as set forth in claim 18 wherein said rear surface of said body is a coaxial circular truncated cone tapering towards the rear and said circular surface on said sabot is a plane coaxial circular surface and said recess being formed as a coaxial truncated circular cone tapering towards the rear with the base located in the plane of said circular surface, said circular truncated cone forming an edge with said circular surface the diameter of which is at least equal to the diameter of said rear surface.

20. A sabot projectile as set forth in claim 18 wherein said means for fastening said connecting part to said rear surface is a soldered joint.

21. A sabot projectile as set forth in claim 18 wherein said connecting part is a disc having a uniform thickness throughout said edge and wherein said connecting part is secured to said rear surface by a hard solder.

22. A sabot projectile as set forth in claim 18 wherein said connecting part is a disc having a circular truncated cone on one of its sides tapering towards the rear.

23. A sabot projectile as set forth in claim 22 wherein said rear surface of said projectile body is shaped as a truncated cone and said circular truncated cone on said disc is at least equal to the thickness of the peripheral edge of said disc.

24. A sabot projectile as set forth in claim 18 wherein a coaxial plug is mounted in the rear of said sabot wherein said circular surface and said recess is provided.

25. A sabot projectile as set forth in claim 24 wherein a casing containing a material for producing gases is provided in said plug.

26. A sabot projectile as set forth in claim 25 wherein said plug is provided with a bore extending therethrough in which said casing is mounted.

References Cited

UNITED STATES PATENTS

388,413	8/1889	Hawley et al.	102—93 X
1,328,247	8/1943	Alexander	102—93
3,044,400	7/1962	Detwiler	102—93

FOREIGN PATENTS

496,991	10/1919	France.	

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