March 28, 1967 E. C. ROEHRDANZ 3,311,061

SABOT

Filed June 25, 1964

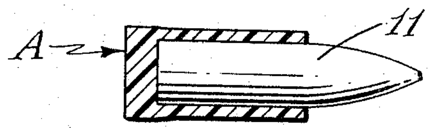

FIG. 1

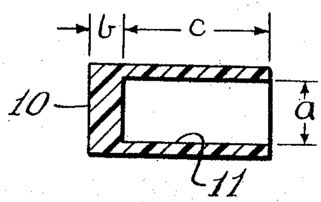

FIG. 2

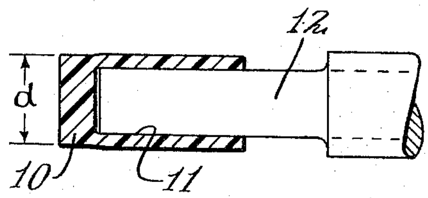

FIG. 3

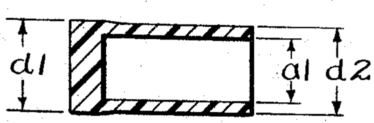

FIG. 4

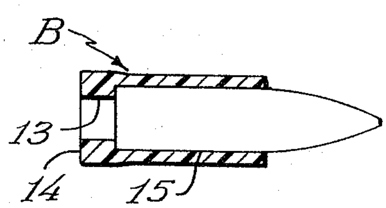

FIG. 5

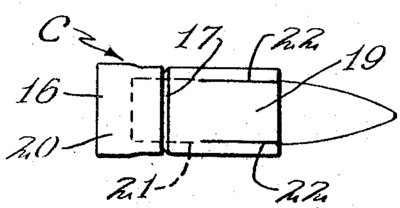

FIG. 6

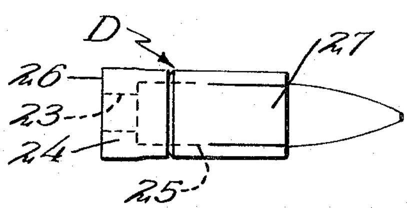

FIG. 7

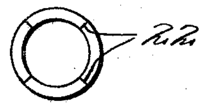

FIG. 8

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3,311,061
SABOT

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This invention relates to an improvement in sabots and deals particularly with a sabot which will spin away from the enclosed projectile smoothly and easily.

During recent years sabots have been produced which are normally molded about the base of the projectile. For example, the patent to Beeuwkes et al., issued January 21, 1958, as Patent 2,820,412, discloses a projectile including a bullet and a molded plastic carrier. In this case, it is stated that "generally the carrier **10** is molded well up on the ogive of the projectile." Patent 2,983,224, issued May 9, 1961, to Prosen et al., shows a mold for forming a plastic shell about a projectile. My previous application for patent, Serial No. 111,088, filed May 18, 1961, now U.S. Patent No. 3,141,412, for "Sabots" also discloses a structure in which the bullet is snugly engaged within a cavity in a plastic body. In this case, a cavity was provided at the base of the bullet which tended to split the shell of the sabot when the rear of the sabot was subjected to the pressure of the gases formed by the explosive charge.

In all such structures it has been felt necessary to firmly engage the sabot with the bullet in order to provide the necessary control of the bullet within the sabot. I have found, however, that if the sabot is made out of certain plastic materials which are slighly compressible but have a tendency to return to their original shape after compression or deformation, a structure may be produced which may accommodate a bullet which is of slightly smaller diameter than the sabot cavity. By making the outside diameter of the sabot slightly oversized, the wall of the sabot is compressed sufficiently to provide a firm grip upon the bullet as it passes through the gun barrel. However, as the projectile leaves the gun barrel, the sabot tends to return to its normal size, thereby permitting the air friction to smoothly drag the sabot off the bullet with no difficulty.

In comparative tests, the accuracy of the projectile has been found to be phenomenal, and to be equal to or superior to that of full calibre bullets fired from the same test rifle. In most tests, the projectile has been found superior.

One of the objections which have been found with most plastic sabots lies in the fact that they do not always split apart in exactly the same way, affecting the accuracy of the bullet. With the present structure, the air friction slips the sabot from the bullet smoothly and evenly, and even the distance which the sabot will be carried is quite uniform. In view of the fact that the sabots remain in one piece after firing, they can be located and examined.

With certain types of plastic which have the necessary "spring back" qualities, the base of the sabot is normally solid and imperforate. However, with plastics having somewhat less of the spring back qualities, an axial aperture may extend through the base of the sabot to aid in the removal of the sabot from the bullet. Furthermore, with the certain plastics possessing the proper qualities, the wall of the sleeve may be longitudinally split near its forward end, and the sabot may be externally grooved intermediate its ends. In this case, the forward end of the sabot cracks and splits away so that air friction may act against the base of the portion of the sabot to remove this relatively short end.

These and other objects and novel features of the present invention will be more clearly and fully set forth in following specification and claims.

In the drawings forming a part of the specification:

FIGURE 1 is a longitudinal sectional view through the sabot showing the preferred construction thereof.

FIGURE 2 is a sectional view through the sabot showing certain dimensions and connection therewith.

FIGURE 3 is a diagrammatic view showing the sabot mounted upon a mandrel for machining to the proper outside diameter.

FIGURE 4 is a sectional view through the completed sabot showing certain dimensions associated therewith.

FIGURE 5 is a longitudinal sectional view through a modified form of sabot.

FIGURE 6 is an elevational view of a second modified form of sabot.

FIGURE 7 is a side elevational view of a third modified form of sabot.

FIGURE 8 is an end view of the sabot shown in FIGURES 6 and 7.

The plastic with which I have had most accurate results is an acetyl resin produced by Du Pont under the trade name "Delrin." This material has a coefficient of friction on steel when dry of 0.19, and while it is relatively hard and brittle, it has a good tendency to return to its original size after being subjected to the tremendous force of the explosion. While Delrin is listed as having only 0.5 percent deformation under a two thousand pound per square inch load at 122° F., it will compress sufficiently to pass through a gun barrel which is perhaps five thousandths of an inch smaller in diameter than the sabot at the base end thereof. After being fired through the gun barrel, the sabot will return more than half way to its original diameter, this spring back being sufficient to smoothly release the bullet.

A second plastic which has been less successfully employed is a very tough plastic called "Lexan." Lexan has less spring back quality than Delrin, but its use has been successful, particularly with modified forms of sabots and solid steel projectiles.

The comparative properties of Delrin and Lexan are listed in a bulletin entitled, "Technical Data on Plastics," Manufacturing Chemists Association, February 1957, and "Modern Plastics Encyclopedia," Breskin Publications, Inc., September 1960, Lexan is a polycarbonate resin produced by General Electric.

With reference to the drawings, the sabot A may be cast in the proper shape. However, according to the present method a piece of rod is drilled out to a proper inside diameter which is slightly larger than the outside diameter of the bullet to be used. The difference in size provides a smooth easy fit so that the bullet may be inserted by hand, or without the use of special tools. I then prefer to place the plastic billet on a tight fitting mandrel which is of somewhat larger diameter than the inside diameter of the socket. While on this mandrel, the exterior surface of the billet is turned down to a diameter which is perhaps five thousandths of an inch larger in diameter than the interior grooved diameter of the barrel.

When the sabots are removed from the mandrel, the base portion remains the size to which it was turned. However, the body portion or sleeve portion of the sabot contracts back down to its original inside diameter to which it is drilled, and the outside diameter is perhaps three and one-half thousandths of an inch greater than the groove diameter of the barrel. If the sabot were squeezed down slightly to provide a close fit on the bullet, the outside diameter would be perhaps decreased one-thousandths of an inch.

With the bullets in place in the sabots, the projectile is fired through the gun barrel. If the sabots are recovered, they will be found to have a diameter which is slightly below the original diameter, but well above the grooved diameter of the barrel. Thus, after the sabot leaves the gun barrel, it expands to a point where air friction—combined with the centrifugal force—may easily and smoothly disengage the sabot from the projectile and allow it to spin away.

As a specific example, the following table will disclose certain of the dimensions, with reference to dimensions shown on the drawings. FIGURE 2 illustrates the billet body **10** having an axial socket **11** therein, the socket being about one-thousandths inch larger than the bullet **11** which is to be inserted. As a result, the bullet may be easily inserted and removed and does not have the tendency to cling to the bullet as in structures where the plastic is molded to the bullet. A loose fit of this type would normally be considered completely impractical as it is essential that the rotation of the sabot caused by the rifling in the barrel be transmitted to the bullet. This would not occur if the bullet were loosely engaged in the sabot during its travel through the gun barrel.

FIGURE 3 shows the billet **10** mounted upon a mandrel **12**, the mandrel being perhaps fifteen ten-thousandths of an inch larger in outside diameter than the inside diameter of the socket **11**. As a result, the sleeve portion of the sabot is stretched to larger diameter when on the mandrel **12**.

While on the mandrel **12**, the outside diameter of the billet **10** is turned until the outside diameter is perhaps five thousandths of an inch larger than the groove diameter of the gun barrel through which it is to be fired. When the billet **10** is removed from the mandrel, the shell will return to its original size. As a result, the billet will remain about five thousandths of an inch larger than the gun barrel at the base end of the sabot, but the outside diameter of the opposite end of the sabot will be about fifteen ten-thousandths of an inch less in diameter than the base.

The table of dimensions is as follows:

	Inches
(a) Inside diameter of wall	.244
(a1) Inside diameter of wall after machining	.244
(b) Length of base	.120
(c) Length of wall	.550
(d) Outside diameter of wall on mandrel	.313
(d1) Outside diameter of base after machining	.313
(d2) Outside diameter of wall after machining	.3115
Outside diameter of projectile	.243
Groove diameter of gun barrel	.308
Outside diameter of base after firing	.311

It will be recognized that the dimensions listed merely show a relationship of sizes which are designed for a predetermined size of gun barrel and predetermined size of bullet. It will be noted that the sleeve of the wall must compress three and one-half thousandths inches in diameter to pass through the barrel, while the base portion of the sabot must compress five-thousandths. As a result, the bullet is tightly compressed during its travel through the gun barrel. However, as soon as the sabot leaves the gun barrel, the spring-back of the plastic will permit air friction and centrifugal force to remove the sabot from the bullet.

Similar tests made with the Lexan plastic were much less successful. When identical sabots are used to those made of Delrin plastic, the base portion of the sabot has been found to contract after the sabot is released from the gun barrel. The reason for this can only be surmised, but it is known that the sabots made of Lexan contract to approximately .306 inch after the projectile has been fired. It is presumed that the high pressure in the barrel keeps the base of the sabot bulged tightly against the wall of the bore, and when the gas pressure is released, the base shrinks and tends to keep a tight grip on the base of the bullet. The action may be similar to that of squeezing a rubber ball or balloon tending it to bulge out at the sides, with the bulging vanishing when the pressure is released.

It has been found that this difficulty can be removed by providing an axial aperture through the base of the sabot, the aperture preferably having a cross sectional area equal to approximately one-half the area of the rear end of the bullet. Such a structure is very effective with a projectile made of steel or some other hard material. Obviously, if this structure is used with a soft lead core bullet which tends to bulge when subjected to the explosive force, the base of the bullet will tend to hold the sabot from separation.

FIGURE 5 discloses a sabot B which is identical with the sabot A with the exception of the fact that an axial aperture **13** is provided in the base **14** of the sabot communicating with the interior of the socket **15**. The aperture **13** is of a diameter substantially one-half the area of the base of the bullet **11**, and the bullet **11** is preferably made of a metal which is relatively hard such as steel.

When the aperture **14** is provided, the aperture assists the base to relax its grip on the bullet and the base end of the sabot will not compress to the same amount as where the base is imperforate. As a result, the spring-back tendency of the wall of the sabot will tend to release the bullet much in the manner previously described.

A third modification C is indicated in FIGURE 6 of the drawings which operates on much the same principle as the sabot A but which differs therefrom in some respects. The sabot C may be generally identical to the sabot A insofar as sizes and proportions are concerned. In other words, it comprises a body of generally cylindrical form but which is machined to be slightly smaller diameter forwardly of the base portion **16**. However, in the sabot C a peripheral groove **17** divides the sabot body into a forward part **19** which is of hollow tubular form and a rear portion **20** which is in effect merely a shortened version of the sabot A. The socket **21** in the sabot extends into the rear portion **20** so that a much shorter length of the bullet is enclosed with the sabot **20**. In other words, the forward portion **19** merely serves as a support for the bullet to hold the same axially aligned with the sabot.

A series of angularly spaced slits **22** extend into the forward portion **19** from the forward end of the sabot, these slits terminating short of the groove **17**. These slits facilitate the cracking of the forward portion of the sabot as the bullet leaves the muzzle of the gun.

When the sabot C is fired through the gun, the forward portion of the sabot splits into sections, there usually being four sections between the slots although this is somewhat of a matter of choice. These four pieces quickly spin away from the base portion of the sabot which then functions in exactly the same manner as the sabot A of which it is a shortened version. This structure may be used with longer projectiles. While it may not be quite as accurate as the sabot A due to the splitting of the forward end, apparently the sabot will stand up to greater stresses than the conventional sabot due to the fact that the stress is applied to the rear portion of the sabot which is of short length.

Sabot D is identical to sabot C with the exception of the fact that an axial aperture **23** extends through the base **24** communicating with the internal socket **25**. The rear portion **26** differs from the rear portion **20** in the sabot C in this respect. The forward portion 27 of the sabot D is identical to the forward portion 19 of the sabot C and functions in the same manner.

In comparing the four sabots, the highest accuracy has been found with the sabot A when made of a plastic such as Delrin plastic previously referred to. Where a tougher and less brittle plastic such as Lexan is used, much better results are produced by having the base of the sabot apertured in the manner described. This apparently reduces the tendency for the base portion of the sabot to contract after it leaves the gun barrel and allows the springback of the wall to release the projectile in the same manner as the sabot A. Where longer bullets are used where the sabot is to be subjected to greater stresses, the sabot C formed of Delrin plastic may be employed. In effect, the sabot C is merely a shortened version of the sabot A with a readily fracturable sleeve portion positioned forwardly thereof. The sabot D is merely a shortened version of the sabot B with a readily fracturable portion forwardly thereof.

The Delrin plastic sabots having the solid base are preferred, as they will function effectively even with conventional metal jacketed soft lead core bullets. These bullets have a tendency to bulge at the base even before the bullet leaves the cartridge. However, the oversize sabots can only be squeezed down to fit the surface of the bullet, and accordingly there is an actual extruding and reforming of the sabot. In other words, there is a genuine plastic flow and forcible reshaping of the sabot, which probably accounts for the failure of the sabot to return completely to its original dimensions.

If, for example, when the oversize Delrin sabot is squeezed down inside the 0.308 inch diameter barrel, bullet bulges to a diameter of 0.244 inch upon firing, all the squeezing down of the sabot wall must take place in the wall thickness and the solid base. The inner surface of the sabot base up against the base of the bullet cannot squeeze down so that only the rear portion of the sabot base can compress. For all practical purposes, the sabot has now been plastically reformed beyond the elastic limit of the material into a new 0.308 inch sabot, and any spring back will help release the sabot. When the plastically reformed sabot emerges from the barrel, it would be normally a tight exact form fit on the bulged bullet if there were no spring back and no centrifugal force. However, the rear portion of the base tends to expand when released, which also tends to expand the base portion of the sleeve, relaxing its grip on the bullet so that the centrifugal force, and air drag will pull the sabot free from the bullet.

Delrin sabots are also preferable due to the greater density of this material. For a representative 3,840 turns per second, the centrifugal force tending to expand Lexan is about 290 pounds per square inch. Delrin sabots spinning at the same speed exert a centrifugal force equivalent to about 350 pounds per square inch.

In accordance with the patent statutes, I have described the principles of construction and operation of my improvement in sabots, and while I have endeavored to set forth the best embodiment thereof, I desire to have it understood that changes may be made within the scope of the following claims without departing from the spirit of my invention.

I claim:

1. A sabot for use in a gun having a rifled barrel of predetermined inner barrel groove diameter, said sabot including:
(a) a body of generally cylindrical shape having a generally cylindrical axial socket of predetermined internal diameter in one end thereof,
(b) a generally cylindrical bullet in said socket, and having an outer diameter slightly less than the internal diameter of said socket,
(c) said body having a predetermined external diameter slightly greater than said groove diameter of the barrel,

(d) the difference being sufficient to temporarily radially compress said body to grip the bullet as the sabot is fired through the gun barrel,
(e) said body being formed of a plastic having sufficient springback properties to return said body toward said predetermined internal diameter upon ejection from the barrel to permit air friction to smoothly release said sabot after leaving the gun barrel.

2. The structure of claim 1 and including an aperture through the other end of said body communicating with said socket and being of smaller diameter.

3. The structure of claim 2 and in which the aperture has an area approximating one-half of the cross-sectional area of the bullet.

4. The structure of claim 1 and in which the exterior diameter of the portion of said body encircling said socket is greater than the groove diameter of the gun barrel and of greater diameter than the unsocketed portion of the body.

5. The structure of claim 1 and in which said body includes a fracturable portion including a circumferential groove defining a forward body portion and a rearward body portion whereby said forward body portion is adapted to be separated from said rearward body portion along said groove.

6. The structure of claim 5 and including angularly spaced slits in the forward end of the forward portion.

7. A sabot for use in a gun having a rifled barrel of predetermined inner barrel groove diameter, said sabot including:
(a) a body of generally cylindrical shape having a generally cylindrical axial socket in one end thereof,
(b) a generally cylindrical bullet in said socket having an outer diameter slightly less than the interior diameter of said socket,
(c) said body having a predetermined external diameter slightly greater than said groove diameter of the barrel,
(d) the difference being sufficient to temporarily radially compress said body to grip the bullet as the sabot is fired through the gun barrel,
(e) said body being formed of a plastic having sufficient springback properties to return said body toward said predetermined external diameter upon ejection from the barrel,
(f) said body including a fracturable portion including a circumferential groove defining a forward body portion and a rearward body portion,
(g) said forward body having a series of angularly spaced weakened areas extending longitudinally thereof said forward body portion,
(h) said weakened areas terminating at said fracturable portion, whereby
(i) said forward body portion is both adapted to split into a plurality of parts and to separate from said rearward body portion.

8. A sabot for use in a gun having a rifled barrel of predetermined inner barrel groove diameter, said sabot including:
(a) an elongated generally cylindrical body having a generally cylindrical axial socket in one end thereof,
(b) a generally cylindrical bullet in said socket and having an outer diameter slightly less than the internal diameter of said socket,
(c) said body in its normal uncompressed size having a predetermined external diameter slightly greater than said groove diameter of said barrel,
(d) said body being formed of a plastic having sufficient springback properties to return said body toward said predetermined external diameter upon ejection from the barrel,
(e) said body when in said barrel being temporarily compressed to grip the bullet whereby upon ejection from said barrel said grip is released,
(f) said body having a circumferential weakened con-

necting area dividing said body into a forward section and a rear section whereby said forward section is adapted to separate from said rear section along said weakened area.

9. The structure of claim **8** and in which the rear section of the body is provided with an axial aperture therethrough communicating with, and of smaller diameter than said socket.

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