May 8, 1962 J. L. CRITCHER ETAL 3,033,116

AMMUNITION

Filed May 20, 1958 2 Sheets-Sheet 1

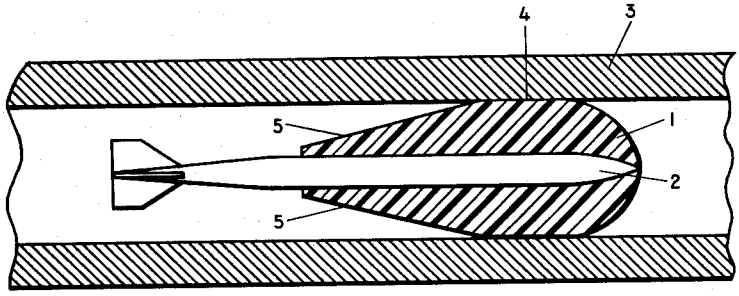


FIG. 1

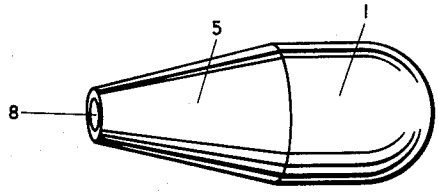


FIG. 2

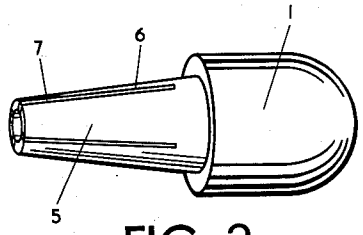


FIG. 3

May 8, 1962 J. L. CRITCHER ETAL 3,033,116

AMMUNITION

Filed May 20, 1958 2 Sheets-Sheet 2

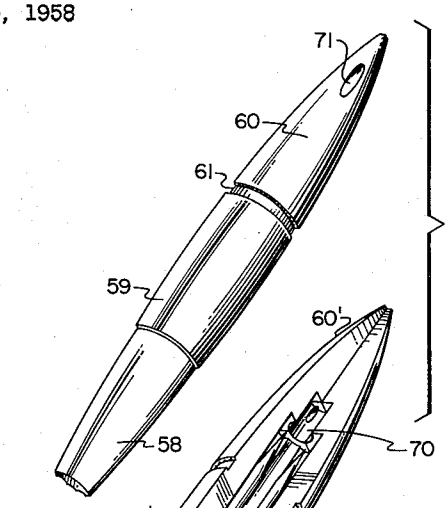
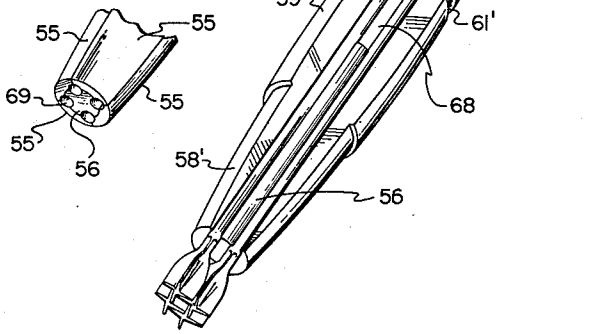


FIG. 4

FIG. 7



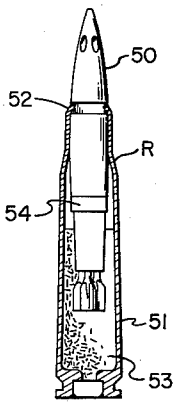


FIG. 5

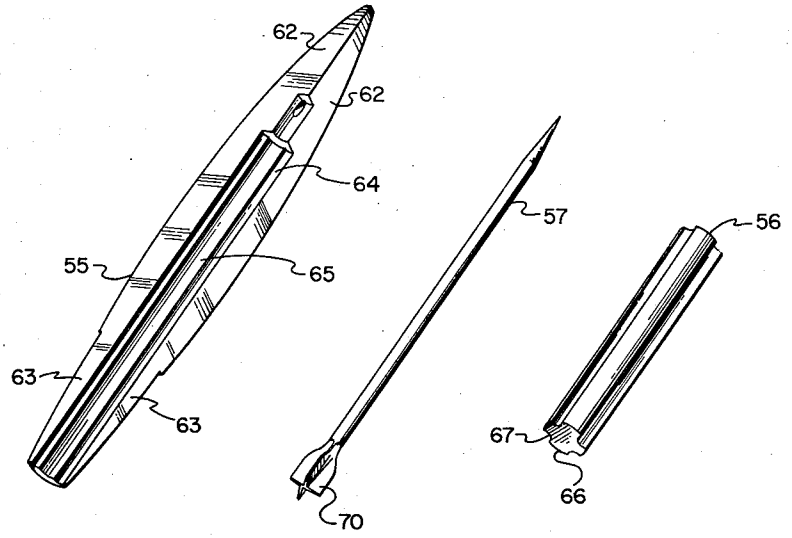


FIG. 6

United States Patent Office 3,033,116 Patented May 8, 1962

3,033,116

AMMUNITION

John L. Critcher, 701 S. Ellwood Ave., Baltimore 24, Md.; Nicholas J. La Costa, Kingsville, Md.; Patrick E. Sweeney, 1735 Wadsworth Way, Baltimore 14, Md.; and Irwin R. Barr, Kingsville, Md.

Filed May 20, 1958, Ser. No. 736,563
11 Claims. (Cl. 102—93)

This invention relates to an improvement in ammunition, and more particularly to an improvement in ammunition of the type having one or more sub-caliber projectiles carried by a destructible sabot. The invention contemplates the use of an improved sabot which pulls, rather than pushes such projectiles through a gun bore.

In order to improve the penetrating characteristics of a projectile, it is necessary to make the transverse dimension of the projectile small in comparison to its longitudinal dimension. However, a small transverse dimension results in a small area upon which gas pressure generated in a gun bore can act, thereby limiting the force applied to, and the resultant velocity of the projectile. To utilize the gas pressure most effectively, it has been the practice to attach a sub-caliber projectile to a sabot, which sabot substantially fills the bore and provides an enlarged area upon which the gas pressure can act to propel both sabot and projectile forward out of the bore. By making the sabot as light in weight as possible, acceleration and resultant muzzle velocity of the sub-caliber projectile is increased.

The resultant high muzzle velocity so obtained can be maintained at greater range by removing the sabot after it has served its purpose in the bore, and by providing on the projectile an exterior surface that is free from discontinuities. Stabilizing fins on the projectile also lend to such results. The requirement for making the sabot removable and the projectile streamlined, however, is contrary to the necessity for attaching the two elements together so that the force acting on the sabot can be transferred to the projectile. Previous to this, when a puller type of sabot was used, it was necessary to provide screw threads, grooves, lugs or the like, on the surface of the projectile in order to attach the same to the sabot. Such attaching means, in the event that the sabot is removed, constitute discontinuities in the aerodynamic surface of the projectile. Where fins are utilized to stabilize or rotate the projectile in flight, these discontinuities cause additional difficulties of an aerodynamic nature which result in a decrease in down range velocity and accuracy.

By attaching a plurality of sub-caliber projectiles to a sabot to form a configuration having a mass equivalent to that of a given conventional solid round, it is evident that there will be a significant increase in hit probability for weight of round of ammunition, if the sabot is stripped from the projectiles soon after the configuration leaves the bore.

The present invention contemplates an improved sabot for pulling projectiles through a gun bore which eliminates the need for providing means to attach the projectile to the sabot. Only a sliding fit between the parts is necessary. Thus, the sabot is adapted to be readily removable from the projectile after the combination leaves the gun bore, and the projectile can have a streamlined profile for effective down range velocity and accuracy. Such improved sabot utilizes gas pressure in a gun bore to provide not only the propelling force for a sub-caliber projectile, but to provide also a force producing a frictional or mechanical connection therebetween. Furthermore, the force producing the mechanical connection is proportional to the propelling force such that when the propelling force becomes ineffective, the sabot can be easily removed from the projectile. Furthermore, when

such improved sabot is formed of segments, the absence of a mechanical connection between the parts facilitates separation of the sabot from the projectile. In this case, gas pressure provides a force producing a frictional or mechanical connection between the segments themselves, thereby holding them together, and between the segments and the projectile. Thus, an exceedingly simple segmented sabot is contemplated which can be easily removed from a projectile by utilization of ram air pressure developed outside a gun bore.

It is accordingly an object of this invention to provide improved ammunition of the type described which eliminates the need for providing means to attach sub-caliber projectiles to sabots.

It is another object to provide improved ammunition of the type described which enables sabots to be easily detached from a sub-caliber projectile after the combination leaves a gun bore.

It is another object to provide improved ammunition of the type described which utilizes gas pressure in a gun bore to provide both a force for propelling a sabot and sub-caliber projectile combination and a force for frictionaly interconnecting the parts.

It is still another object to provide improved ammunition of the type having a plurality of sub-caliber projectiles carried by a sabot which eliminates the need for providing means to attach the parts together, and which provides for facility in detaching the parts after the combination leaves a gun bore.

It is accordingly an object of this invention to provide improved ammunition of the type having sub-caliber projectiles carried by a sabot which is easy to manufacture, simple to assemble, and well adapted to its intended purpose.

Other objects and advantages of the invention will become apparent from the following detailed description taken in connection with the accompanying drawings in which:

FIGURE 1 is a cross-sectional view showing a missile and a sabot of the type contemplated by this invention contained within a gun barrel.

FIGURE 2 is a perspective view of one embodiment of the sabot contemplated by this invention.

FIGURE 3 is a perspecive view of a second embodiment of a sabot of the type contemplated by this invention.

FIGURE 4 is a view of a segmented sabot for carrying a plurality of sub-caliber projectiles, and showing one segment removed for showing the interior.

FIGURE 5 is a view of the segmented sabot inserted in a cartridge case.

FIGURE 6 shows various elements of the sabot-projectile configuration.

FIGURE 7 shows an enlarged detail of the rear of the segmented sabot.

In FIGURE 1 there is shown a typical combination of a high velocity projectile and a sabot of the type contemplated by this invention. The projectile 2 is of the type which is made along with respect to its cross-sectional area to increase its mass and give it increased penetrating characteristics for any given velocity. Although the sabot herein disclosed is especially adaptable for use with this type of projectile, it is to be understood that the sabot may be used with any other type of projectile in order to increase its velocity and range.

As is shown in FIGURES 1 and 2, the sabot 1 includes an opening 8 extending longitudinally therethrough for receiving the projectile 2. A cylindrical portion 4 of the sabot is adapted to fit the bore of the gun 3 so as to prevent leakage of the propelling gases past the sabot when the gun is fired, and serves to keep the projectile 2 axially aligned with the bore of the gun during the travel of the

projectile therethrough. The rearward portion of the sabot, in the form shown in FIGURES 1 and 2, is tapered from the cylindrical portion 4 rearwardly to the end thereof to form a conical pressure surface 5 on which the propelling gases act. The total force acting on the pressure surface 5 may be considered to have two components, one acting parallel to the longitudinal axis of the gun barrel and serving to propel the sabot 1 through the gun barrel, and a second component acting normal to the longitudinal axis aforementioned and circumferentially around the pressure surface 5, thereby tending to constrict the after portion of the sabot and causing it to grip tightly the projectile 2, developing a frictional force between the sabot and the projectile sufficient to prevent relative motion therebetween while each is being propelled through the gun barrel by the propelling gases.

The after portion of the sabot may be made as long as necessary to increase the total frictional force developed. In practice it has been found that the form shown in FIGURES 1 and 2 is most suitable for use with sabots fabricated from non-metallic materials such as the various plastics, fiberglass, and the like. It should be noted that the exact configuration of the pressure surface 5 is not controlling, and any shape which will provide the necessary constricting force may be used. For some applications, sabots made of metallic material may be desirable, and the form shown in FIGURE 3 has been found to be more suitable for this purpose. Because of the increased stiffness of metal over plastics, in order to develop the required frictional forces between the sabot and the projectile, longitudinal slits 6, as shown in FIGURE 3, are formed in the after portion 5 of the sabot. To prevent escape of the propelling gases through the slits and along the projectile, the slits may be filled with a suitable resilient non-metallic material 7 which can be compressed to allow the gas pressure to constrict the after portion 5 of the sabot around the missile.

It is obvious that by use of the method of this invention, a large diameter lightweight sabot may be combined with a small diameter aerodynamically smooth high mass projectile, providing a method for the production of high velocities in such missiles by use of an inexpensive, light and simple sabot, without the necessity for modifying the projectile to provide means to fasten the sabot and the projectile together. The sabot contemplated by this invention is adaptable for use with projectiles of all sizes, being particularly suitable for use with armor piercing projectiles and with high velocity, low caliber personnel projectiles.

A separable sabot held together and to projectile means by gas pressure within a gun bore will now be described. When said gas pressure is no longer effective, as when the configuration leaves the bore, the sabot may easily be stripped from the projectile means. Such a scheme can be used with a single projectile or with a plurality of projectiles, and this latter embodiment is shown and described for purposes of illustration only. It is evident of course, that the invention could be used equally well with a single projectile.

Reference is now made to FIGURE 5, which shows a round of ammunition R incorporating the invention. Round R is composed of a sabot-projectile configuration indicated generally at 50, and a casing indicated generally at 51. The neck of the casing is crimped at 52 onto configuration 50 in the normal manner to hold the same in place. Contained within casing 51 is the usual powder charge 53. Round R is used in the normal manner as if configuration 50 were a regular bullet. In order to help seal the expandable gases formed behind configuration 50 when the round is fired, resilient seal 54, of rubber or the like, may be used.

Configuration 50 may comprise a plurality of individual sabot segments 55, a spacer core 56, and a plurality of sub-caliber projectiles 57. Each of segments 55 has a rear portion 58, a middle portion 59 and a nose portion 60. When assembled together, segments 55 form a separable sabot having an outer rear surface portion 58^1 which is formed of a composite of rear portions 58, an outer middle surface 59, which is formed of a composite of middle portions 59^1, and an outer nose surface portion 60^1 which is formed of a composite of nose portions 60.

Surface portion 58^1 is inclined with respect to the longitudinal axis of the configuration, and is acted upon by expandable gases generated when powder 53 explodes. Surface portion 59^1 is generally cylindrical in shape and is, of course, of a diameter to fit the bore of a given gun. This surface forms a bearing surface upon which the entire configuration rides during its passage through the bore, and no part of the projectile means can contact the bore. Sometimes the sabot imperfectly fits the bore, in which case leakage can occur generally across one side, resulting in erratic performance. For this reason, a seal 54 may be employed. Such seal is also useful when the configuration is used in a rifled bore for obvious reasons. Near the nose end of surface 59^1 is a crimping groove 61^1 into which the neck of casing 51 is crimped. Each sgment contains a segment of such groove as shown at 61. Surface 60^1 is generally conical or tapered to streamline the leading end of the configuration. Thus, as viewed in FIGURE 5, a round embodying the invention resembles a conventional round, and can be used as a substitute therefor.

On each segment 575, is an interior parting surface 62. When the segments are assembled, the parting surface on adjacent segments abut. While such surfaces are shown planar, they can be made non-planar and can have dimple joints to position the parts accurately and to help prevent relative movement between the segments while the configuration is in the bore and being acted upon by the gas pressure. The portion 63 of each parting surface extending the length of said rear portion is designated as a clinching surface for the reason to be described below. Formed within surface 62 are a plurality of projectile grooves 64, and a spacer groove 65. As in the case of the clinching surface, the important parts of the grooves are contained in the portion of the segment having surface 58 thereon. Spacer 56 is generally cylindrical in shape and has an outer surface 66 and a plurality of grooves 67 extending longitudinally therein.

When segments 55 and spacer 56 are assembled, grooves 64 are aligned with grooves 67 to form a plurality of apertures 69 as best seen in FIGURE 7. Surface 66 is in contact with surface 65. This particular orientation shown is merely for purposes of illustration and other orientations could be used so long as generally extending longitudinal surfaces are employed. Such surfaces are shown as being smooth, but could include positioning dimples as referred to above. As shown in FIGURE 4, an interior recess 68 is formed in the sabot ahead of spacer 56.

Slidably mounted within apertures 69 are projectiles 57, which have a point at one end and canted fins 70 at the other. Fins 70 are offset with respect to the centerlines of the projectile in order to cause the projectile to spin after it is freed from the sabot. The particular length and diameter of the projectile is governed by considerations which need not be described in order to understand this invention, it being sufficient to say that fins project beyond the rear portion 58^1 as shown in FIGURE 4. The surface of the projectile and the surface of aperture 69 are shown smooth for purposes of illustration, but they may be serrated without departing from the spirit of the invention. Also formed within surface 62 is an internal separation chamber 70. Interconnecting chamber 70 with the exterior nose portion 60^1 are separation ports 71.

In operation, segments 55 are assembled together with spacer 56, and projectiles 57 are easily slid into apertures 69. If a seal is to be used, that is put on next. The completed configuration is assembled in a cartridge casing as shown in FIGURE 5. When fired, the gases generated by exploding powder 53 act on the rear portion of the con-

figuration in a direction that is normal to the exposed surfaces thereof. The conical nature of the rear portion is such that the force exerted thereon by the gas pressure has a component parallel to the longitudinal axis and a component perpendicular thereto. The parallel component acts to propel the configuration forward through the barrel. The perpendicular component acts normal to the clinching surfaces 63 between segments 55, normal to the surface of groove 65 and the surface 66 of spacer 56, and normal to the surface of aperture 69 and the surface of projectile 57. Such normal force creates a frictional force between the various elements of the configuration which resists relative motion therebetween as the gas pressure propels the configuration through the bore. The frictional force is oppositely directed to the longitudinal gas force and can be adjusted for optimum results by a proper selection of material for segments 55, the slope of rear surface 58^1 and the surface conditions of the various surfaces in contact.

The material of the sabot is ideally made from a light material that will not deteriorate under the gas temperatures and pressures, as for example aluminum alloys, magnesium, Fiberglas or various well-known plastics or the like. The segments and spacer are ideally suited for injection molding. As stated above, the variables of material, slope and surface condition are dependent upon the coefficient of friction which is necessary in order to insure that there will be no relative motion between the parts, and the surfaces in contact may be serrated to insure a sufficiently high coefficient should it be desired to shorten the configuration in order to increase powder charge 53. In assembling the configuration, rubber cement or the like may be used between the parting surfaces exposed to the gases in order to eliminate leakage therethrough. Such cement also aids in handling the configuration in assembly into a casing.

After the configuration leaves the gun bore, the normal force acting to create the frictional force disappears and the sabot may then be stripped from the projectiles. This is accomplished by utilizing a separation chamber formed in each segment. Ram air pressure created as the configuration leaves the bore, enters the chamber through the separation parts, builds up air pressure therein, and separates the segments. As a result, the projectiles are then free and continue on at a high velocity, which is maintained at great range by the aerodynamics qualities of the projectiles.

We claim:

1. A sabot and sub-caliber projectile configuration comprising a plurality of individual sabot segments assembled together to form a separable sabot, each segment having a longitudinally extending parting surface in abutting relation to a longitudinally extending parting surface on an adjacent segment, said separable sabot having a rear portion formed of a composite of said individual sabot segments, longitudinally extending groove means of generally uniform cross-section in said parting surfaces to form at least a single longitudinally extending aperture in said separable sabot, a sub-caliber projectile of generally the same cross-section as the aperture slidably engaged in said aperture, and a pressure surface on the rear portion of each segment adapted to be acted upon by expandable gases, the pressure surfaces being responsive to the pressure of the gases for clamping said parting surfaces together and for clamping said groove means to said projectile to create frictional forces sufficient to prevent relative sliding movement between said projectile and sabot and to prevent relative longitudinal movement between the segments.

2. A sabot and sub-caliber projectile configuration comprising a plurality of individual sabot segments assembled together to form a separable sabot having a rear portion formed of a composite of said individual sabot segments adapted to be acted upon by expandable gases in a gun bore, each segment having a clinching surface in abutting relation to a substantially clinching surface on an adjacent segment, said planar parting surfaces extending at least the length of said rear portion, groove means of uniform cross-section in said sabot segments extending at least the length of said rear portion to form at least a single axially extending aperture of uniform cross-section in said separable sabot, sub-caliber projectile means having a portion thereof engaged in said aperture, said projectile portion being of substantially the same cross-section as said aperture, a second portion on said projectile extending rearward of said rear portion in the region of said gas pressure, stabilizing means on this second portion, and means on said rear portion responsive to said expandable gases to simultaneously clamp said groove means to said projectile and clamp said clinching surfaces together whereby said configuration is held together as a unit and is propelled by said expandable gases through said bore.

3. A sabot and sub-caliber projectile configuration comprising a plurality of individual sabot segments assembled together to form a separable sabot having a rear portion formed of a composite of said individual sabot segments adapted to be acted upon by expandable gases in a gun bore, a middle portion formed of a composite of said individual sabot segments and being of substantially the same diameter as said bore for forming a bearing surface thereupon, and a nose portion formed of a composite of said individual sabot segments adapted to be acted upon by air pressure after the configuration leaves said bore, parting surfaces on each segment, said parting surfaces on adjacent segments being in abutting relationship, clinching surfaces forming a portion of said parting surfaces and extending substantially the length of said rear portion, projectile groove means and spacer groove means in said sabot segments extending substantially the length of said rear portion, spacer means having a length substantially the same as the length of said rear portion and having an outer surface containing projectile groove means therein, said spacer means inserted into said sabot segments with said projectile groove means therein aligned with the projectile groove means in said sabot segments to form therewith a plurality of apertures, and said outer surface of said spacer means abutting said spacer groove means in said sabot segments, a plurality of sub-caliber projectile means engaged in said apertures, means on said rear portion responsive to said expandable gases in said bore to simultaneously clamp said clinching surfaces together, clamp said projectile groove means to said projectile, and clamp said spacer groove means to said spacer surface whereby said configuration is held together as a unit and is propelled by said expandable gases through said bore, said last named means becoming ineffective when said configuration leaves said bore, and means on said nose portion responsive to said air pressure when said configuration leaves said bore to strip said sabot segments and spacer means from each other and from said projectiles.

4. A sabot and sub-caliber projectile configuration comprising a plurality of individual sabot segments assembled together to form a separable sabot, each segment having a parting surface in abutting relation to a parting surface on an adjacent segment, said separable sabot having a rear portion formed of a composite of said individual sabot segments, said rear portion adapted to be acted upon by expandable gases in a gun bore, groove means of generally uniform cross-section in said sabot segments to form at least a single aperture in said separable sabot, a sub-caliber projectile of generally uniform cross-section slidably engaged in said aperture, and means on said rear portion responsive to said expandable gases to clamp said parting surfaces together and to clamp said groove means to said projectile whereby said configuration is held together as a unit and is propelled by said expandable gases through said bore.

5. A sabot and sub-caliber projectile configuration comprising a plurality of individual sabot segments assembled

together to form a separable sabot having a rear portion formed of a composite of said individual sabot segments adapted to be acted upon by expandable gases in a gun bore, each segment having a parting surface in abutting relation to a parting surface on an adjacent segment, said parting surfaces extending at least the length of said rear portion, groove means of uniform cross-section in said sabot segments, said groove means extending at least the length of said rear portion to form at least a single axially extending aperture of uniform cross-section in said separable sabot, sub-caliber projectile means having a portion thereof engaged in said aperture, said projectile portion being of substantially the same cross-section as said aperture, a second portion on said projectile extending rearward of said rear portion in the region of said gas pressure, stabilizing means on this second portion, and means on said rear portion responsive to said expandable gases to simultaneously clamp said groove means to said projectile and clamp said parting surfaces together whereby said configuration is held together as a unit and is propelled by said expandable gases through said bore.

6. Ammunition of the type described comprising an elongated projectile of substantially uniform cross-section, the longitudinal axis of said projectile being aligned with the axis of a gun bore in which the projectile is adapted to be propelled, and a sabot for pulling the projectile through the bore, said sabot comprising a plurality of axially extending segments, each of said segments having a front portion adapted to slideably engage the walls of the bore and prevent propellant gases in the bore from leaking past the sabot, each of said segments having a rear portion engaged around said projectile, each rear portion having a pressure surface and a mating surface thereon, the pressure surface of each rear portion being adapted to be acted upon by the gases, the mating surface of the rear portion of one segment abutting that of an adjacent segment, the action of the propellant gases on the pressure surfaces constricting the rear portions of the segments so that the abutting mating surfaces tightly grip each other and the rear portions tightly grip the projectile to develop frictional forces sufficient to prevent relative axial movement between the segments and between the segments and the projectile.

7. Ammunition of the type described comprising an elongated projectile of substantially uniform cross-section, the longitudinal axis of said projectile being aligned with the axis of a gun bore in which the projectile is adapted to be propelled, and a sabot for pulling the projectile through the bore, said sabot comprising a plurality of axially extending segments, each of said segments having a front portion adapted to slideably engage the walls of the bore and prevent propellant gases in the bore from leaking past the sabot, each of said segments having a rear portion engaged around said projectile, each rear portion having a pressure surface and a mating surface, the pressure surfaces of the rear portions of the segments defining a surface of revolution with the axis about which the surface of revolution is generated being coincident with that of the gun bore, said pressure surfaces being adapted to be acted upon by the gases, and the mating surface of the rear portion of one segment abutting that of an adjacent segment.

8. Ammunition of the type described comprising a plurality of cylindrical projectiles whose longitudinal axes are aligned with the axis of a gun bore in which the projectiles are adapted to be propelled, and a sabot for pulling the projectiles through the bore, said sabot comprising a cylindrical spacer having a semi-circular axially extending groove means in the outer surface for each projectile with one projectile being seated in each groove means, and a plurality of axially extending segments, each of said segments having a front portion adapted to slideably engage the walls of the bore and prevent propellant gases in the bore from leaking past the sabot, each of said segments having a rear portion, each rear portion having an axially extending spacer groove, a mating surface, and a pressure surface, each spacer groove being in contact with the surface of said spacer, the mating surface of one segment abutting the mating surface of an adjacent segment, and the pressure surfaces of the rear portions of the segments being adapted to be acted upon by the gases, said pressure surfaces defining a surface of revolution with the axis about which the surface of revolution is generated being coincident with that of the gun bore.

9. Ammunition of the type described comprising a plurality of separate sabot segments, a spacer, and a plurality of projectiles, each segment having a pressure surface adapted to be acted upon by gas pressure generated in a gun bore, each segment having a clinching surface abutting a corresponding surface on an adjacent segment, each segment having a portion engaging at least one projectile and a portion engaging said spacer, the pressure surfaces of said segments being responsive to the gas pressure for clamping said segments together and to the projectiles and spacer so that between the segments, projectiles and spacer, frictional forces are developed which cause the segments, projectiles, and spacer to move as a unit in the bore.

10. Ammunition of the type described comprising a plurality of elongated projectiles, each of which is of substantially uniform cross-section, the longitudinal axes of said projectiles being parallel to the axis of a gun bore through which the projectiles are adapted to be propelled, and a separable sabot for pulling the projectiles through the bore, said sabot being a plurality of separate segments, each segment having a front portion adapted to slideably engage the walls of the bore, each segment having a constrictable rear portion with longitudinal mating surfaces that contact like surfaces on adjacent segments and longitudinal groove means that contact at least one of said projectiles, the rear portions of said segments being exposed to propellent gases in the bore, the pressure of the gases on said rear portions causing them to radially constrict so that contacting mating surfaces are pressed together sufficiently to develop therebetween a frictional force that prevents relative axial movement of the separate segments as they are propelled through the bore by the propellent gases, the radial constriction of said rear portions also causing the groove means to be pressed against the projectile in contact therewith to develop therebetween a frictional force that prevents axial movement of the last-mentioned projectile relative to the groove means whereby the sabot and projectiles are propelled together through the bore.

11. Ammunition of the type described comprising at least one elongated projectile of substantially uniform cross-section, the longitudinal axis of said projectile being parallel to the axis of a gun bore through which the projectile is adapted to be propelled, and a separable sabot for pulling the projectiles through the bore, said sabot being made up of a plurality of separate segments, each segment having a front portion adapted to slideably engage the walls of the bore, each segment having a constrictable rear portion with longitudinal mating surfaces that contact like surfaces on adjacent segments, at least one segment having groove means that contacts said projectile, the rear portions of said segments being exposed to propellent gases in the bore, the pressure of the gases on said rear portions causing them to radially constrict so that contacting mating surfaces of the segments are pressed together sufficiently to develop therebetween frictional forces that prevent relative axial movement of the separate segments as they are propelled through the bore by the gases, the radial constriction of said rear portions also causing the groove means of said one segment to be pressed against said projectile to develop therebetween a frictional force that prevents axial movement of said projecticle relative to said one segment

whereby the sabot and projectile are propelled together through the bore.

References Cited in the file of this patent

UNITED STATES PATENTS

111,377	Paine	Jan. 31, 1871
136,336	Paine	Feb. 25, 1873
212,170	Barnard	Feb. 11, 1879
219,491	Mason	Sept. 9, 1879
448,057	Long	Mar. 10, 1891
620,400	Ahrens	Feb. 28, 1899
1,195,107	Sheriff	Aug. 15, 1916
2,767,656	Zeamer	Oct. 23, 1956
2,811,901	Barr	Nov. 5, 1957
2,820,412	Beeuwkes et al.	Jan. 21, 1958
2,939,395	Barr	June 7, 1960