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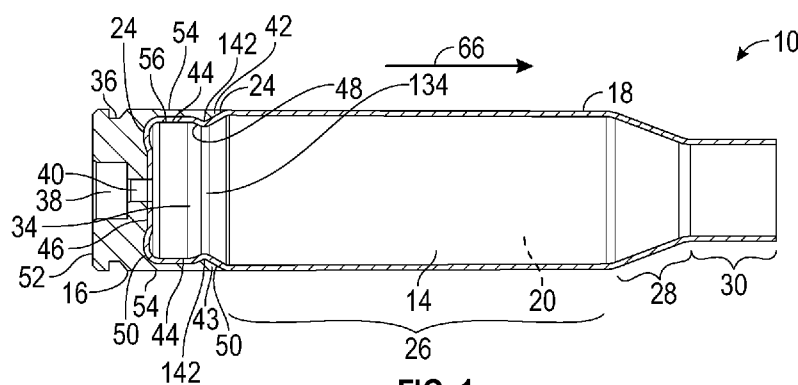


FIG. 1

(57) Abstract: Cartridges and cartridge cases adapted to be chambered in weapon systems are provided. In one example, a cartridge case includes a front shell having a case base end portion, a case body portion extending forward from the case base end portion towards a case mouth portion that is configured for holding a projectile. The case base end portion has a first interlocking feature. A reinforcing cap is disposed adjacent to the case base end portion on a side opposite the internal volume. The reinforcing cap has an annular extraction groove, a primer pocket, a flash hole for providing fluid communication between the primer pocket and the internal volume, and a second interlocking feature that engages the first interlocking feature to couple the reinforcing cap to the case base end portion.



CARTRIDGE AND CARTRIDGE CASE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is related to and claims all available benefit of U.S. Provisional Patent Application 62/767,795 filed November 15, 2018, the entire contents of which are herein incorporated by reference.

TECHNICAL FIELD

[0002] The technical field relates generally to cartridge cases and cartridges for weapon systems, and more particularly, relates to relatively lightweight cartridge cases including a front shell and a reinforcing cap that is coupled to the front shell for weapon systems, and cartridges including such cartridge cases.

BACKGROUND

[0003] Cartridges include a cartridge case that contains other major components of the cartridge used in weapon systems, including a propellant, a projectile or bullet, and a primer. Prior art small caliber cartridge cases can be divided into 3 groups; brass cartridge cases, other metallic cartridge cases that are lighter weight than brass cartridge cases, and polymer lightweight cartridge cases.

[0004] Conventional cartridge cases made of brass are typically deep drawn, resulting in good mechanical properties, but are relatively heavy. For example, typical conventional cartridge cases used by military forces and/or commercial users are often made from C26000 brass or other similar alloys, which is relatively heavy, since brass has a density of around 8.53g/cc. Furthermore, brass, containing about 70% copper and 30% zinc, is subject to frequent, rapid commodity market price fluctuations and is considered one of the costlier common use metals in ammunition products.

[0005] Lightweight cartridge cases have been of interest for many years, for example, to lessen the load on soldiers or to increase their ammo carrying capacity for a given weight to be carried into battle. A reduced load translates into less soldier fatigue and better mobility for the soldier, while more ammunition being carried into battle on the other hand increases the odds of successful combat engagements by allowing for more, heavy ammo-consuming strategies.

[0006] Prior art lightweight cartridge cases have been produced using various manufacturing processes with different materials, but all present some sort of trade-off when compared to conventional brass cartridge cases. For example, some of the more significant trade-offs are a reduced internal cartridge case volume and/or significant initial capital investment to industrialize a new manufacturing process.

[0007] Prior art lightweight cartridge cases made of polymers or combinations of polymers and metals may have varying levels of functional mechanical resistance. These varying levels depend on the weapon system used to fire the cartridge including all of the mechanical interactions that occur between the cartridge and the feeding, firing and extracting components in those weapon systems.

[0008] Typically, polymer cartridge cases require a thicker wall to compensate for reduced mechanical strength properties compared to conventional brass cartridge cases. This means a smaller inside diameter at the case body section is available for polymer cartridge cases. A reduced internal case volume is of concern for end users of polymer lightweight cartridge cases due to the performance specification requirements of each small caliber cartridge. Reduced internal case volume translates to less propellant powder capacity and therefore, reduced muzzle velocity, resulting in less kinetic energy in the projectile at any distance after firing.

[0009] Additionally, once a cartridge case is adopted by the military or even commercial markets, enormous quantities need to be manufactured to keep up with the demand. This makes the cartridge case manufacturing process critical to its viability for sustained use over time. Without adequate high-capacity and high-accuracy manufacturing equipment and processes, production costs and quality levels cannot be brought to a point where it is favorable to switch to polymer cartridge cases. Presently, polymer cartridge cases cannot be produced as quickly or as reliably as their conventional brass counterparts. Brand new, state of the art, controlled polymer injection molding machines could replace all currently existing brass cartridge case manufacturing equipment on a 1 to 1 ratio and still only generate just a fraction of the required production output required to sustain the world military and commercial demand. Currently, there is no polymer cartridge case manufacturing machinery capable of delivering the same production output provided by production equipment for conventional brass cartridge cases for the same shop floor space.

[0010] Because the military is unlikely to be reducing its ammunition consumption in the foreseeable future, more floor space would need to be dedicated to polymer cartridge case manufacturing. This means that much larger buildings would be required to house the

additional required machines, which represents a considerable initial capital investment. Furthermore, the overhead costs associated with these buildings would also be higher than current, smaller buildings used for manufacturing brass cartridge cases, as well as higher costs for heating, security, maintenance, and other related recurring costs.

[0011] Moreover, polymers are typically much weaker than metals and therefore, using polymers to form lightweight cartridge cases would normally require a thickening of the wall section along the length of a cartridge case to resist the forces imparted onto the cartridge case during weapon firing. This translates into a reduced cartridge internal volume, thus imposing a reduced maximum propellant charge weight that can be loaded into the cartridge case. In turn, this reduces the maximum velocity at which a projectile leaves a weapon system, resulting in reduced kinetic energy delivery to the target.

[0012] Another consequence of polymers typically being weaker than metals is that polymer lightweight cartridge cases can have a reduced safe maximum operating pressure due to the lower cartridge case mouth mechanical resistance. Along the shoulder and body of the cartridge case, the wall can be thickened to compensate for this weakness, trading off internal volume capacity for the propellant powder. However, because a conventional weapon chamber and corresponding projectile each have a fixed geometry, as determined by industry standards such as CIP (Commission Internationale Permanente Pour l'Épreuve Des Armes A Feu Portatives) and SAAMI (Sporting Arms and Ammunition Manufacturers' Institute), a physical constraint restricts the thickness of additional polymer material that can be used to achieve the desired mechanical resistance at the cartridge case mouth wall. This often translates into split cases around the case mouth area. To solve this problem, existing weapon systems would need to have their chambers reamed out to allow for increased polymer cartridge case thickness around the weaker case mouth areas.

[0013] Yet another consequence of polymers typically being weaker than metals is that polymer lightweight cartridge cases can have a reduced retention of the primer within the cartridge case primer pocket. Polymers normally do not offer enough press-fit mechanical resistance to suit this type of assembly without the use of an additional bonding agent.

[0014] Further, gluing projectiles to the cartridge case mouth of polymer lightweight cartridge cases to meet the CIP, SAAMI or military specification mandatory bullet extraction force requirements, such as the NATO (North Atlantic Treaty Organization) STANAG (STANdardization Agreement), is another concern with this sub-category of cartridge case designs. Without some sort of bonding agent, polymers do not offer enough

spring back force on their own as compared to metals to adequately hold a projectile in the case mouth using standard mechanical assembly methods. Projectiles held too lightly by the case mouth normally exhibit more variable bullet extraction forces and thus, tend to increase the projectiles' standard deviation with respect to muzzle velocity, which then negatively affects accuracy and dispersion on the target.

[0015] Additionally, heat removal from the weapon chamber is also a big concern with polymer lightweight cartridge cases. A brass or steel cartridge case effectively functions as a thermal sink in conventional weapon systems. When firing, heat generated from the burning gases gets absorbed by a highly conductive brass or steel cartridge case and the heat gets expelled out of the weapon with the brass or steel case during the post-firing extraction cycle. Since a polymer cartridge case does not conduct heat very well, the polymer case will not absorb the heat as efficiently as a brass or steel cartridge case and therefore, does not remove heat as effectively upon being ejected from the weapon system. This, in turn, causes the weapon system to heat up quicker and imposes a more controlled and shorter firing sequence in order to not overheat the weapon system components.

[0016] Once heated, polymers tend to rapidly lose their mechanical properties. This can be problematic when a weapon has been heated due to sustained firing and a polymer cartridge is then left for a time within the cartridge chamber. Past a certain temperature point, the polymer cartridge case could melt in the hot chamber or even rupture upon subsequent firing.

[0017] Unlike metals, there is also some uncertainty regarding creep resistance of polymer cartridge cases. Most conventional machinegun cartridges are assembled with metallic links that allow for high rates of feeding and firing. These links are typically made of spring steel and the cartridge is basically captured by the link in a press-fit condition. Linked cartridges can be stored for many years before being used. Once linked, cartridges are subject to a constant pressure along the surface area where the link holds the cartridge. Since the polymer cartridge case is much softer than the metallic link, the cartridge case may bulge or creep over time, causing the cartridge case to become permanently deformed, resulting in irregular diameters directly above and below the upper and lower edges of the link where the link is in contact with the cartridge case. In some instances, this creeping effect over time can result in cartridge case stress-induced failures upon firing.

[0018] Lastly, little is known about long-term storage behavior under various environmental conditions for polymer cartridge cases. For example, certain types of

polymers may be susceptible to UV radiation, which could become an issue if cartridges with polymer cartridge cases were to be left outside exposed to the UV radiation for prolonged periods of time. Further, solvent exposure is also of concern because some solvents are incompatible with certain grades of polymers and can completely dissolve the polymer. For example, if cartridges with polymer cartridge cases are left in the proximity of an open fuel tank, there could be possible interactions between the polymer cartridge case and the fuel or fuel vapors from the fuel tank.

[0019] Prior art lightweight metallic cartridge cases can be divided into two main categories. The first category includes a shell with an interior reinforcement and a second category includes a shell with an exterior reinforcement.

[0020] Lightweight metallic cartridge cases with an interior reinforcement may use lightweight aluminum for the interior reinforcement component. However, doing so may result in instances of aluminothermic reaction whereby the aluminum combusts when exposed to high temperatures and gas pressures above 40,000 PSI, which are typical conditions experienced during cartridge firing. The combusting aluminum can then no longer hold back the gas pressure and can split completely through the interior reinforcement, transferring the pressure to the outer shell which then stretches to failure.

[0021] Furthermore, obtaining a perfect gas seal between the outer shell and its interior reinforcement has proven to be unreliable. It is interesting to note that both the flash hole junction as well as the reinforcement junction are both equally susceptible to improper sealing. The slightest geometric defect in either component can result in an inadequate seal that can then cause a cartridge to swell, inducing extraction issues, or to completely fail upon firing.

[0022] Because the outer shells of lightweight metallic cartridge cases are stamped and formed using a set of dies and punches, rounded edges all around the cartridge case extraction groove may result at every bend in the metal. This makes extracting the fired cartridge cases more difficult because the weapon extractor cannot grab the cartridge case as firmly and “slips” on the rounder case base edges.

[0023] Since stainless steel, which is typically used for the shell material, is harder than the typical steels used in weapon extractors, a premature wear of the extractor is unavoidable when firing this design of interior reinforcement lightweight cartridges. This accentuates the “slipping” motion of the extractor as the gripping surface is further reduced over time.

[0024] Lightweight metallic cartridge cases with an exterior reinforcement often have assembly strength issues. Prior art designs, for example as disclosed in U.S. Patent No. 9,939,236 B2, use a small diameter hollow rivet through the cartridge case flash hole to hold both halves together. However, doing so severely limits the sectional area available to handle the stresses imposed on the cartridge case extraction post firing. This is because, during the extraction cycle, the firing pressure gases are not fully vented out when the weapon system starts to apply an extraction force on the cartridge case. This force increases until the cartridge case becomes free from the chamber but may induce separation of the two parts, and thus, a failure can occur before case extraction is complete. This greatly limits the viability for the use of this type of cartridge case in machine guns which experience high extraction forces.

[0025] Another prior art design, U.S. Patent Application Publication No. 2019/0226817 A1, utilizes a third component to achieve a strong coupling of two main components of the lightweight cartridge case. This additional third component is required to prevent a flange failure when under substantially maximum extraction or pressurization force(s) as it is not only the only deformation mechanism of the manufacturing process used to build such cartridge cases, but also the main stress reducing and therefore supporting feature of the design. Furthermore, this design fails to create an airtight seal between the two main components without the use of a fourth part, a gasket between the shell and the reinforcing cap, as no satisfactory definition of boundary conditions are given to achieve this mandatory goal. It is also to be noted that the manufacturing method disclosed is satisfactory to properly construct this prior art's cartridge case, but the opposite does not hold true; this prior art's described manufacturing process is insufficient to achieve the innovation discussed in the present disclosure. In a high rate manufacturing situation, it is desired to have fewer components to assemble to reduce costs and increase throughput.

[0026] Accordingly, it is desirable to provide relatively lightweight cartridge cases that address one or more of the foregoing concerns, and cartridges including such cartridge cases. Furthermore, other desirable features and characteristics of the various embodiments described herein will become apparent from the subsequent detailed description and the appended claims, taken in conjunction with the accompanying drawings and this background.

SUMMARY

[0027] Cartridge cases and cartridges adapted to be chambered in a weapon system are provided herein. In an exemplary embodiment, a cartridge case adapted to be chambered in a weapon system includes a generally cylindrical front shell having a shell wall that surrounds an internal volume for containing a propellant. The shell wall defines a case base end portion, a case body portion extending forward from the case base end portion towards a case mouth portion that is configured for holding a projectile. The case base end portion has a first interlocking feature. A reinforcing cap is disposed adjacent to the case base end portion on a side opposite the internal volume. The reinforcing cap has an annular extraction groove, a primer pocket, a flash hole for providing fluid communication between the primer pocket and the internal volume, and a second interlocking feature. The second interlocking feature extends inwardly towards the first interlocking feature to define a rib edge that is rounded, radiused, relatively sharp or pointed and engages the first interlocking feature to couple the reinforcing cap to the case base end portion of the generally cylindrical front shell.

[0028] In an exemplary embodiment, a cartridge adapted to be chambered in a weapon system includes a cartridge case. The cartridge case includes a generally cylindrical front shell having a shell wall that surrounds an internal volume. The shell wall defines a case base end portion, a case body portion extending forward from the case base end portion towards a case mouth portion. The case base end portion has a first interlocking feature. A reinforcing cap is disposed adjacent to the case base end portion on a side opposite the internal volume. The reinforcing cap has an annular extraction groove, a primer pocket, a flash hole for providing fluid communication between the primer pocket and the internal volume, and a second interlocking feature. The second interlocking feature extends inwardly towards the first interlocking feature to define a rib edge that is rounded, radiused, relatively sharp or pointed and engages the first interlocking feature to couple the reinforcing cap to the case base end portion of the generally cylindrical front shell. The cartridge further includes a projectile disposed in the case mouth portion. A propellant is disposed in the internal volume and is ignitable to propel the projectile from the case mouth in a forward direction. A primer is disposed in the primer pocket and is ignitable for igniting the propellant.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] The various embodiments will hereinafter be described in conjunction with the following drawing figures, wherein like numerals denote like elements, and wherein:

[0030] FIG. 1 is a side cross-sectional view illustrating a cartridge case in accordance with an exemplary embodiment;

[0031] FIG. 2 is a side cross-sectional view illustrating a cartridge in accordance with an exemplary embodiment; and

[0032] FIG. 3 is a side cross-sectional view illustrating a cartridge case in accordance with an exemplary embodiment.

DETAILED DESCRIPTION

[0033] The following Detailed Description is merely exemplary in nature and is not intended to limit the various embodiments or the application and uses thereof. Furthermore, there is no intention to be bound by any theory presented in the preceding background or the following detailed description.

[0034] Various embodiments contemplated herein relate to relatively lightweight cartridge cases as compared to conventional brass cartridge cases, and cartridges including such relatively lightweight cartridge cases. The exemplary embodiments taught herein provide a cartridge case for a cartridge adapted to be chambered in a weapon system. The cartridge case includes a generally cylindrical front shell having a shell wall that surrounds an internal volume for containing a propellant. The shell wall defines a case base end portion, a case body portion extending forward from the case base end portion, and a case mouth portion that extends forward of the case body portion and that is configured for holding a projectile. The case base end portion has a first interlocking feature. A reinforcing cap is disposed adjacent to the case base end portion on a side opposite the internal volume. The reinforcing cap has an annular extraction groove, a primer pocket, a flash hole for providing fluid communication between the primer pocket and the internal volume. A second interlocking feature engaging the first interlocking feature to couple the reinforcing cap to the case base end portion of the generally cylindrical front shell.

[0035] In an exemplary embodiment, the generally cylindrical front shell includes a first metallic material and the reinforcing cap includes a second, relatively lightweight metallic material that is different than the first metallic material. Advantageously, in an exemplary embodiment, this novel, bi-metallic, multi-part cartridge case including the reinforcing cap locked onto a relatively thin-wall front shell allows for a redistribution of mass to reinforce critical, stress supporting areas of the cartridge case as compared to conventional lightweight cartridge cases.

[0036] Another additional advantage of the cartridge case disclosed herein is that, in some embodiments, a significant weight reduction of the cartridge case is achieved. Additionally, as such, the cartridge including the cartridge case has a significant weight reduction while maintaining all appreciable features of the conventional brass design.

[0037] In an exemplary embodiment, the cartridge case includes the metallic reinforcing cap and the metallic front shell that has a relatively constant wall thickness through its entire length. Further, the front shell is dimensioned to fit properly into typical, existing small arms weapon system chambers and properly seals the chambers upon firing the cartridge. In an exemplary embodiment, the reinforcing cap is dimensioned to ensure that conventional weapon extractor systems can reliably grab and extract the spent cartridge case after firing. Further, the reinforcing cap is designed to prevent case failures at peak pressure and temperature during the firing cycle by effectively supporting the aft end of the steel case body of the front shell of the cartridge case. In an exemplary embodiment, both the front shell and the reinforcing cap are effectively joined together by means of plastic deformation of the front shell within the reinforcing cap.

[0038] Another additional advantage of the cartridge case disclosed herein is that, in some embodiments, the reinforcing cap, which may be made from aluminum, is isolated from the hot burning propellant gases. This provides a positive protection against possible “burn through” observed in many prior art interior reinforcement lightweight cartridge case designs.

[0039] An additional advantage of the cartridge case disclosed herein is that, in some embodiments, an overall weight of the cartridge case is reduced by roughly 50% while the internal volume available to receive the propellant powder charge is increased by about 8% as compared to conventional brass cartridge cases. Further, the cartridge including such cartridge case has an overall weight reduction of at least 10% as compared to cartridges that include conventional brass cartridge cases.

[0040] Another additional advantage of the cartridge case disclosed herein is that, in some embodiments, the front shell is formed of 305 stainless steel, which has a nominal density of 7.99 g/cc, and the reinforcing cap is formed of 7075-T6 aluminum, which has a density of 2.81 g/cc. While maximizing the aluminum to stainless steel volume ratio, the cartridge case has a weight reduction, when compared to a typical brass cartridge case, of about 50% for most conventional small arms ammunition.

[0041] An additional advantage of the cartridge case disclosed herein is that, in some embodiments, the cartridge case maximizes internal case volume by introducing a constant

wall thickness front shell, which is supported by the attached external reinforcing cap. Being deep drawn, conventional brass cartridge cases do not have a constant wall thickness. The typical brass case is thinnest at the mouth and shoulder region and becomes progressively thicker as it nears its base. This is a consequence of the progressive deep drawing manufacturing process itself and cannot be remedied. In order to produce a full, solid case base using brass, wall thickness must smoothly increase from the thin neck area to the thick base area. As such, the internal case volume of brass cartridge cases is less than the internal case volume of the cartridge case disclosed herein.

[0042] Another additional advantage of the cartridge case disclosed herein is that, in some embodiments, the cartridge case isolates the aluminothermic sensitive area of the cartridge case so the cartridge case will not be susceptible to an aluminothermic reaction. Prior art aluminum interior reinforcement metallic cartridge cases are susceptible to aluminothermic reactions by the nature of the sensitivity of aluminum to exposure to high temperatures and flame. By using a stainless steel front shell to fully enclose the propellant charge, the exterior aluminum reinforcing end cap becomes completely insulated from the high flame temperature exposure and hot gas pressure generated during the cartridge firing process and therefore, the reinforcing end cap will not be susceptible to an aluminothermic reaction.

[0043] An additional advantage of the cartridge case disclosed herein is that, in some embodiments, a stronger mechanical interlock is formed between the front shell and the reinforcing cap via the first and second interlocking features. As will be discussed in further detail below, by designing and exploiting a unique bulge feature near the base of the front shell which is securely mated to the reinforcing cap, a significantly increased stress supporting area is created. As such, the cartridge case is enhanced to withstand the weapon extraction forces that a cartridge case will be subjected to in a weapon system. In an exemplary embodiment, there is no longer any need to pass through the relatively small cartridge case flash hole to create the locking feature between the components as with some prior art cartridge case designs.

[0044] Another additional advantage of the cartridge case disclosed herein is that, in some embodiments, cartridge case splits are eliminated. In particular, prior art polymer cartridge cases are severely limited in respect to possible dimensional changes in the case mouth area because of the geometrical and physical limitations imposed by current industrial and military standards regarding the weapon chamber and the projectile dimensions. The exterior form of the cartridge case and the corresponding bullet are precisely defined to

ensure commonality and interchangeability between the various cartridges and weapons (for a given caliber) produced by the plethora of manufacturers around the world. Polymers, typically being mechanically weaker than metals, would normally require a thicker case mouth wall section to sustain the high pressures and stresses involved in firing a cartridge. However, the previously mentioned physical dimensional limitations preclude significantly increasing the case mouth wall thickness and result in a weak section that often fails on the polymer type of cartridge case when used in current small arms weapons. The cartridge cases disclosed herein solve this problem by using high-strength stainless steel in this area. This allows for an equivalent case mouth mechanical strength when compared to conventional brass casings.

[0045] An additional advantage of the cartridge case disclosed herein, is that in some embodiments, the cartridge case does not experience any material creep when linked. In particular, prior art polymer cartridges which have undergone material creep after being linked can be problematic and induce failures when going through a fully automatic machine gun firing cycle. For example, localized “bulging” of the polymer case, at sections directly adjacent to the metallic link edges may occur and generate irregular case exterior diameters, which may in turn reduce performance reliability. The material creeping phenomenon is the result of the constant pressure applied by a metallic link’s press-fit on a softer polymer cartridge case where the link firmly grabs the case. Polymer cartridge cases have been known to be more susceptible to material creep or flow when stressed by the metallic links after being stored for extended periods of time. The cartridge cases disclosed herein are creep-resistant, for example similar to the creep resistance of conventional brass cartridge cases.

[0046] Another additional advantage of the cartridge case disclosed herein, is that in some embodiments, the cartridge case is resistant to long-term ultraviolet (UV) light exposure. In particular, stainless steel and aluminum, for example, which form the front shell and the reinforcing cap, respectively, are impervious to UV radiation and as such, their mechanical properties are not affected by long-term exposure to UV radiation. This is however not the case with many polymeric materials, which may experience material strength degradation as a result of long-term exposure to UV radiation.

[0047] An additional advantage of the cartridge case disclosed herein, is that in some embodiments, the cartridge case is corrosion free. In particular, stainless steel and aluminum, for example, which form the front shell and the reinforcing cap, respectively, are corrosion-resistant metals. Galvanic corrosion between these two metals has been

extensively studied, for example, using accelerated aging methods and the minimal resulting corrosion does not exceed what is currently acceptable for the long-term storage requirements of a cartridge case.

[0048] Another additional advantage of the cartridge case disclosed herein, is that in some embodiments, the cartridge case is compatible with high capacity cartridge loading and packaging equipment. In particular, an important factor in the design of a new ammunition is its successful viability industrialization potential within existing industrial manufacturing facilities, thus obviating the requirement for new, specialized production equipment. The cartridge cases disclosed herein can be efficiently and effectively manufactured on current, existing high-capacity loading and packing production equipment that is typically used in ammunition manufacturing plants today. Production cadences for the cartridge cases disclosed herein are expected to be similar to those of cartridges made with conventional brass cartridge cases. This is however not the case with the more sensitive and complex polymer cartridge case designs.

[0049] An additional advantage of the cartridge case disclosed herein, is that in some embodiments, the cartridge cases can be efficiently manufactured at a competitive cost. In particular, being able to load the cartridge cases disclosed herein on existing production equipment means only a minimal tooling investment is required to get up to and achieve typical brass cartridge case level production rates. The production cadences for the cartridge cases disclosed herein are similar to those with brass cartridge cases while steel and aluminum raw base materials are less expensive than brass. As such, price-wise, the cartridge cases disclosed herein will be competitive with brass cartridge cases once fully industrialized. By contrast, polymer cartridge cases, even when fully industrialized, will still remain much more expensive due to their special manufacturing process requirements and resulting lower production cadence.

[0050] FIG. 1 is a side view illustrating a cartridge case 10 that is adapted to be chambered in a weapon system in accordance with an exemplary embodiment. FIG. 2 is a side cross-sectional view illustrating a cartridge 12 including the cartridge case 10 depicted in FIG. 1. The cartridge case 10 includes a generally cylindrical front shell 14 and a reinforcing cap 16 that is interlocked with the front shell 14.

[0051] The front shell 14 has a shell wall 18 that surrounds an internal volume 20 for containing a propellant 22. The shell wall 18 defines a case base end portion 24, a case body portion 26 extending forward (e.g., distal direction 66) from the case base end portion 24 towards a case mouth portion 30, and optionally a case shoulder portion 28

extending forward from the case body portion 26 and tapering inwardly to the case mouth portion 30. For example, the cartridge case 10 for a pistol may not include a case shoulder portion 28 and, as such, the case body portion 26 extends straight forward to and terminates at the case mouth portion 30 without tapering inwardly such that the case mouth portion 30 has a substantially similar diameter compared to the case body portion 26. In another example, the cartridge case 10 for a rifle may include the case shoulder portion 28 that tapers inwardly and that is disposed between the case body portion 26 and the case mouth portion 30 which has a narrower diameter than the case body portion 26. The case mouth portion 30 holds a projectile 32. As will be discussed in further detail below, the case base end portion 24 has a first interlocking feature 34.

[0052] The reinforcing cap 16 is disposed adjacent to the case base end portion 24 on a side opposite the internal volume 20. The reinforcing cap 16 has an annular extraction groove 36, a primer pocket 38, a flash hole 40 for providing fluid communication between the primer pocket 38 and the internal volume 20, and a second interlocking feature 42. The second interlocking feature 42 engages the first interlocking feature 34 to couple the reinforcing cap 16 to the case base end portion 24 of the front shell 14.

[0053] In an exemplary embodiment, the cartridge case 10 is a bi-metallic cartridge case. In particular, the front shell 14 is formed of a first metallic material and the reinforcing cap 16 is formed of a second relatively lightweight metallic material that is different than the first metallic material. In an exemplary embodiment, the first metallic material is selected from carbon steel, stainless steel, brass, aluminum, aluminum alloys, nickel, and nickel alloys, for example, stainless steel. In an exemplary embodiment, the second relatively lightweight metallic material is selected from aluminum and alloys thereof, titanium and alloys thereof, magnesium and alloys thereof, for example an aluminum alloy.

[0054] As illustrated, the shell wall 18 of the front shell 14 has a substantially constant wall thickness. As discussed above, advantageously having the front shell 14 with a substantially constant wall thickness allows the front shell 14 of the cartridge case 10 to have an enhanced internal volume 20 as compared to the internal volume of conventional brass cartridge cases that are formed by a deep drawing process or the like and therefore, can hold an increase volume of the propellant 22.

[0055] In an exemplary embodiment, the case base end portion 24 of the front shell 14 has an annular bulge section 44 that forms at least part of the first interlocking feature 34. As illustrated, the case base end portion 24 has a base 46, the annular bulge section 44 with an annular tapered forward section 48 (in the distal direction 66) and an annular flared distal

section 50 (in the distal direction 66) that extends to the aft section of the case body portion 26. In an exemplary embodiment, the first interlocking feature 34 is configured at least in part as an annular recessed feature 134, e.g., groove, annular V-shaped groove, or the like, that is defined between the annular tapered forward section 48 and the annular flared distal section 50 of the case base end portion 24.

[0056] Likewise, the reinforcing cap 16 has a reinforcing cap body portion 52 that includes the primer pocket 38, the annular extraction groove 36, and the flash hole 40. As illustrated, a reinforcing cap sleeve portion 54 extends forward from the reinforcing cap body portion 52. The reinforcing cap sleeve portion 54 and the reinforcing cap body portion 52 together form a pocket 56 that has the case base end portion 24 disposed therein. The reinforcing cap sleeve portion 54 has a locking rib 43 that forms at least part of the second interlocking feature 42. In an exemplary embodiment, the locking rib 43 is an annular locking rib that extends or tapers inwardly towards the groove or annular recessed feature 134, for example tapers inwardly to a rib edge 142 that is rounded, radiused, relatively sharp or pointed (e.g., slight radius or non-radius rib edge such as having a radius of from about 0 to about 0.5 mm), to substantially match the annular tapered forward section 48 and flares outwardly therefrom to substantially match the annular flared distal section 50, thereby defining a substantially V-shaped annular locking rib, and engages with the annular recessed feature 134 of the case base end portion 24 to securely interlock the reinforcing cap 16 with the front shell 14. In an exemplary embodiment, advantageously having the locking rib 43 extend or taper inwardly to a rounded, radiused, relatively sharp or pointed rib edge in which the locking rib 43 substantially matches and directly interfaces with the annular tapered forward section 48 and the annular layered distal section 50 of the first interlocking feature 34 ensures an air-tight seal between the reinforcing cap 16 and the front shell 14, for example without the use or presence of any liquid and/or solid seal(s).

[0057] As illustrated in FIG. 2, the cartridge 12 includes the cartridge case 10, the propellant 22, the projectile 32, and a primer 60. The projectile 32 is disposed in the case mouth portion 30. The propellant 22 is disposed in the internal volume 20 and is ignitable to propel the projectile 32 from the case mouth 30 in a forward direction (indicated by single headed arrow 62). The primer 60 is disposed in the primer pocket 38 and is ignitable for igniting the propellant 22.

[0058] Referring to FIG. 3, a cartridge case 110 is provided similarly configured as the cartridge case 10 illustrated in FIG. 1 including the front shell 14, the reinforcing cap 16,

the first interlocking feature 34, and the second interlocking feature 42 but with the exception that the interlocking feature 34 includes a plurality of annular recessed features 134 and 136 and the interlocking feature 42 includes a plurality of locking ribs 43 and 68. In an exemplary embodiment, the annular recessed features 134 and 136 are axially spaced apart by the annular bulge section 44 and are independently configured as a groove, annular V-shaped groove, or the like.

[0059] In an exemplary embodiment, the reinforcing cap sleeve portion 54 has the locking rib 43 and 68 that are axially spaced apart from each other and that extend inwardly to rib edges 142 and 144, substantially matching and directly interfacing with the annular recessed features 134 and 136 of the interlocking feature 34 of the case base end portion 24 to securely interlock the reinforcing cap 16 with the front shell 14. Advantageously, this ensures an air-tight seal between the reinforcing cap 16 and the front shell 14, for example without the use or presence of any liquid and/or solid seal(s).

[0060] While at least one exemplary embodiment has been presented in the foregoing detailed description of the disclosure, it should be appreciated that a vast number of variations exist. It should also be appreciated that the exemplary embodiment or exemplary embodiments are only examples, and are not intended to limit the scope, applicability, or configuration of the disclosure in any way. Rather, the foregoing detailed description will provide those skilled in the art with a convenient road map for implementing an exemplary embodiment of the disclosure. It being understood that various changes may be made in the function and arrangement of elements described in an exemplary embodiment without departing from the scope of the disclosure as set forth in the appended claims.

CLAIMS

What is claimed is:

1. A cartridge case adapted to be chambered in a weapon system, the cartridge case comprising:

a generally cylindrical front shell having a shell wall that surrounds an internal volume for containing a propellant, wherein the shell wall defines a case base end portion, a case body portion extending forward from the case base end portion towards a case mouth portion that is configured for holding a projectile, and wherein the case base end portion has a first interlocking feature; and

a reinforcing cap disposed adjacent to the case base end portion on a side opposite the internal volume, wherein the reinforcing cap has an annular extraction groove, a primer pocket, a flash hole for providing fluid communication between the primer pocket and the internal volume, and a second interlocking feature that extends inwardly towards the first interlocking feature to define a rib edge that is rounded, radiused, relatively sharp or pointed and that engages the first interlocking feature to couple the reinforcing cap to the case base end portion of the generally cylindrical front shell.

2. The cartridge case of claim 1, wherein the generally cylindrical front shell comprises a first metallic material and the reinforcing cap comprises a second relatively lightweight metallic material.

3. The cartridge case of claim 2, wherein the second relatively lightweight metallic material is different than the first metallic material.

4. The cartridge case of claim 2, wherein the first metallic material is selected from carbon steel, stainless steel, brass, aluminum, aluminum alloys, nickel, and nickel alloys.

5. The cartridge case of claim 4, wherein the first metallic material is stainless steel.

6. The cartridge case of claim 2, wherein the second relatively lightweight metallic material is selected from aluminum and alloys thereof, titanium and alloys thereof, magnesium and alloys thereof.

7. The cartridge case of claim 6, wherein the second relatively lightweight metallic material is an aluminum alloy.

8. The cartridge case of claim 1, wherein the shell wall has a substantially constant wall thickness.

9. The cartridge case of claim 1, wherein the case base end portion has a bulge section that forms at least part of the first interlocking feature.

10. The cartridge case of claim 9, wherein the bulge section comprises an annular bulge section.

11. The cartridge case of claim 9, wherein the reinforcing cap comprises a locking rib that includes the rib edge and that forms at least part of the second interlocking feature.

12. The cartridge case of claim 11, wherein the locking rib comprises an annular locking rib.

13. The cartridge case of claim 11, wherein the case base end portion has a recessed feature that forms at least part of the first interlocking feature.

14. The cartridge case of claim 13, wherein the recessed feature is an annular recessed feature.

15. The cartridge case of claim 13, wherein the first interlocking feature has a plurality of spaced apart recessed features and the second interlocking feature has a plurality of spaced apart locking ribs that correspondingly engage the plurality of the spaced apart recessed features.

16. The cartridge case of claim 1, wherein the first and second interlocking features are directly engaged with each other to ensure an air-tight seal between the reinforcing cap and the front shell without the presence of any liquid and/or solid seal(s).

17. A cartridge adapted to be chambered in a weapon system, the cartridge comprising:

a cartridge case comprising:

a generally cylindrical front shell having a shell wall that surrounds an internal volume, wherein the shell wall defines a case base end portion, a case body portion extending forward from the case base end portion towards a case mouth portion, wherein the case base end portion has a first interlocking feature; and

a reinforcing cap disposed adjacent to the case base end portion on a side opposite the internal volume, wherein the reinforcing cap has an annular extraction groove, a primer pocket, a flash hole for providing fluid communication between the primer pocket and the internal volume, and a second interlocking feature that extends inwardly towards the first interlocking feature to define a rib edge that is rounded, radiused, relatively sharp or pointed and that engages the first interlocking feature to couple the reinforcing cap to the case base end portion of the generally cylindrical front shell;

a projectile disposed in the case mouth portion;

a propellant disposed in the internal volume and ignitable to propel the projectile from the case mouth in a forward direction; and

a primer disposed in the primer pocket and ignitable for igniting the propellant.

18. The cartridge case of claim 17, wherein the reinforcing cap has a locking rib that includes the rib edge and that forms at least part of the second interlocking feature.

19. The cartridge case of claim 18, the case base end portion has a recessed feature that forms at least part of the first interlocking feature.

20. The cartridge case of claim 19, wherein the first interlocking feature has a plurality of axially spaced apart recessed features and the second interlocking feature

has a plurality of axially spaced apart locking ribs that correspondingly engage the plurality of the axially spaced apart recessed features.

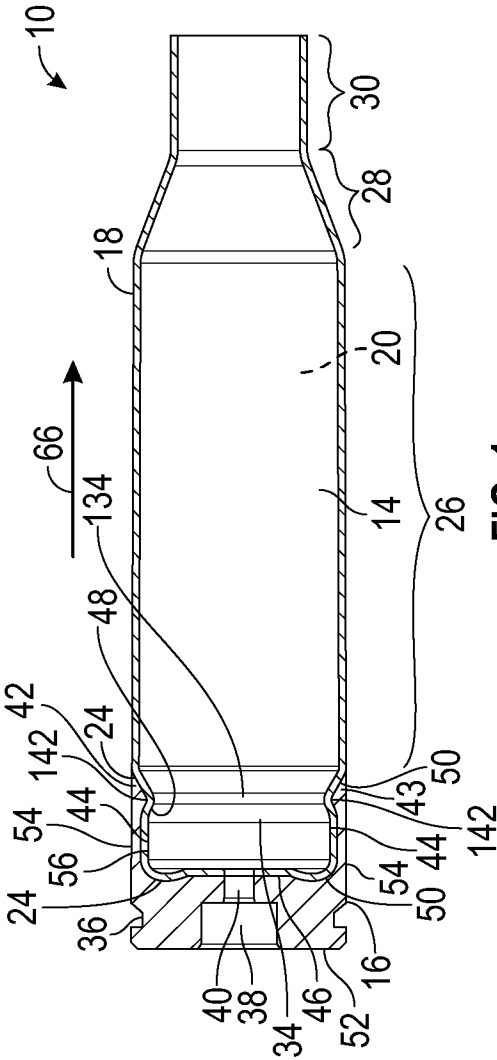


FIG. 1

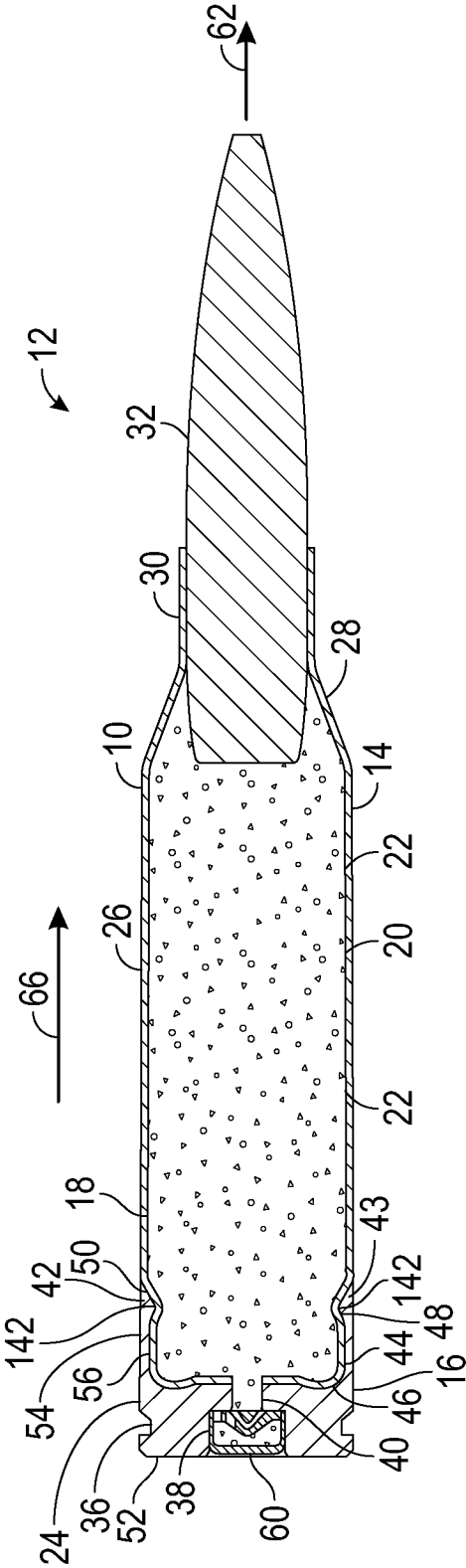


FIG. 2

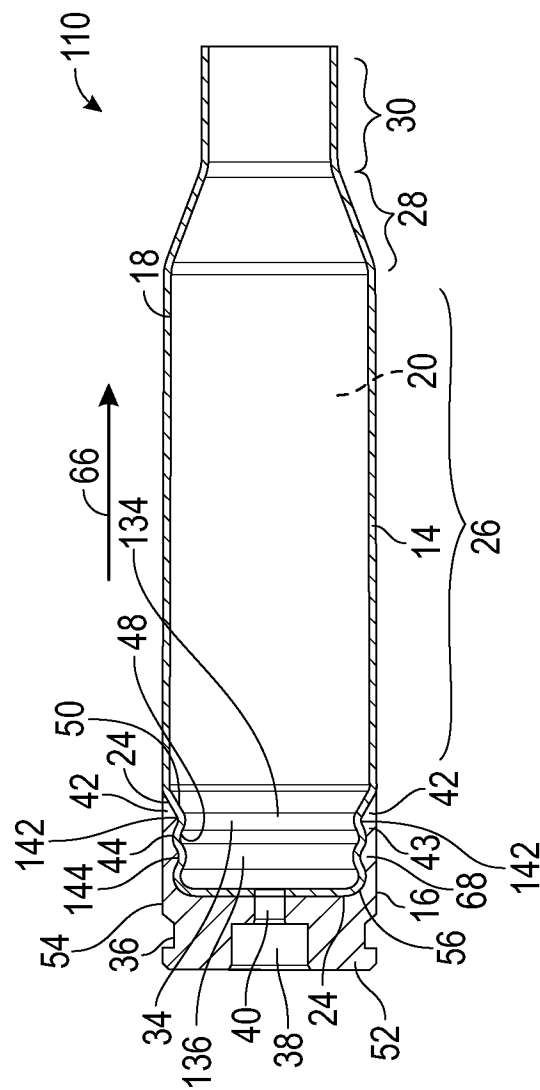


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CA2019/051636A. CLASSIFICATION OF SUBJECT MATTER
IPC: **F42B 5/285** (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC: **F42B 5/285** (2006.01), **F42B 5/26** (2006.01), **F42B 5/28** (2006.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
Questel Orbit (lock+, extract+, primer, flash, metal+)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* "A" "D" "E" "L" "O" "P"	Special categories of cited documents: document defining the general state of the art which is not considered to be of particular relevance document cited by the applicant in the international application earlier application or patent but published on or after the international filing date document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) document referring to an oral disclosure, use, exhibition or other means document published prior to the international filing date but later than the priority date claimed	"T" "X" "Y" "&"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art document member of the same patent family
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Date of the actual completion of the international search
15 January 2020 (15-01-2020)Date of mailing of the international search report
16 January 2020 (16-01-2020)Name and mailing address of the ISA/CA
Canadian Intellectual Property Office
Place du Portage I, C114 - 1st Floor, Box PCT
50 Victoria Street
Gatineau, Quebec K1A 0C9
Facsimile No.: 819-953-2476Authorized officer

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/CA2019/051636

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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