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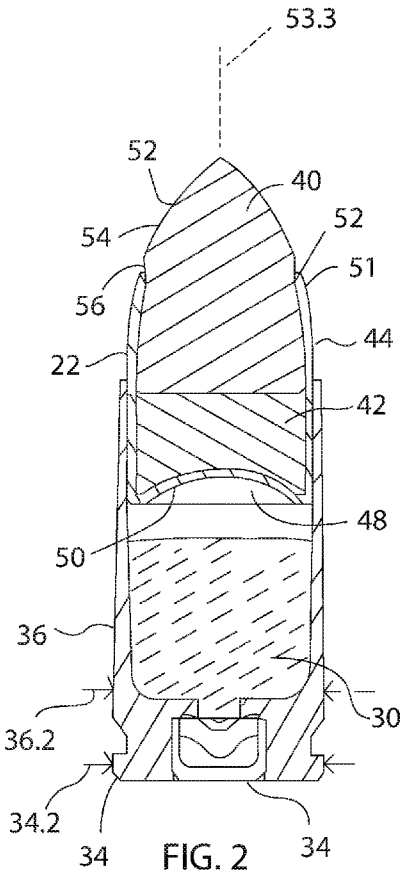


FIG. 2

(57) Abstract: A cartridge with a steel component bullet has desirable penetration capabilities and controlled separation of components upon terminal impact. In embodiments of the invention, the cartridge comprises a steel component, a lead core, and a copper jacket. The lead jacket having a leading edge portion that extends to the cylindrical mid portion. The steel component bullet may have a forward pointed ogive portion, a cylindrical mid portion, and a tapered rearward portion. The rearwardly facing surface may be concave. The leading edge portion may have a taper oriented in a direction opposite the taper of the ogive portion of the steel component. Structure to inhibit spin is positioned on a rearward face of the steel component. The bullet having a concave rear face.

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CARTRIDGE WITH IMPROVED PENETRATION AND EXPANSION BULLET

FIELD OF THE INVENTION

The present invention is generally relates to cartridges for use with handguns. More particularly, to a cartridge comprising a case with a jacketed bullet and a hardened forward steel component and a core component.

SUMMARY OF THE INVENTION

A cartridge with a improved bullet has desirable penetration capabilities and controlled separation of components upon terminal impact. In embodiments of the invention, the bullet comprises a forward component formed of steel, a lead core behind it, and a copper jacket. The forward steel component having a nose portion, a cylindrical mid portion, a rearward body portion that tapers forwardly. The copper jacket encompasses the lead core and extends forward to the cylindrical mid portion of the steel component and terminates at a leading edge portion. The leading edge portion may have a taper oriented in a direction opposite the taper of the ogive portion of the steel component whereby a forward facing annular recess is provided. The rearwardly facing surface of the bullet may be concave.

In embodiments of the invention, the bullet comprises a forward component formed of steel, and a copper core integral or unitary with a copper jacket.

A feature and advantage of embodiments is that the forward steel component may be formed with a spin inhibiting feature in the rearwardly facing end surface of the steel forward component. The feature may be protruding or recessed structure that conforms the lead or copper core during assembly to an inverse of such shape providing a locking feature between the core and the steel forward component. The feature on the rearward end may be a projection or an indentation, a plurality of such, or both, on the rearward facing surface of the steel component.

A feature and advantage of embodiments of the invention is that a concavity in the end of the jacket provides enhanced and more stable obturation of the projectile with the barrel resulting in increased accuracy. The concavity allows the propellant expansion to impart a radial force component acting on the rearward end of the projectile to deform the rearward end of the projectile outwardly providing more consistent engagement of the jacket with the barrel along the length of the projectile. Moreover, the rearwardly facing end of the jacket with the concavity provides an increased radial deformation capability compared to a flat end facilitating the radial expansion of the casing facilitating the sealing with the gun barrel.

The concavity allows the projectile to be slightly longer with the same weight, and providing the same propellant load. This is believed to improve accuracy as longer bullets are understood to generally enhance accuracy.

A feature and advantage of embodiments of the invention is that the steel component has a forward ogive portion, a unitary cylindrical mid portion, and a unitary rearward portion that increases in diameter rearwardly from the cylindrical mid portion. In embodiments, the rearward portion tapers forwardly and has an abbreviated rearward cylindrical end portion and a rounded end corner. Adjacent the rear end corner is the maximum diameter portion of the steel component; the maximum diameter dimension extends for a minimal axial distance, in embodiments less than 20% of the axial length of the forward component. In embodiments, the maximum diameter portion extends less than 15% of the length of the bullet. In embodiments, the maximum diameter portion extends less than 10% of the length of the bullet. The relative short full diameter portion is believed to keep barrel forces low, such as bullet to barrel friction, potentially reducing barrel wear.

A feature and advantage of embodiments of the invention is that the jacket forward edge or lip engages the cylindrical mid portion, allowing an axial extending range on the

cylindrical mid portion where the jacket edge may engage providing flexibility and an increased tolerance during manufacturing for the positioning of the forward edge of the jacket.

A feature and advantage of embodiments is that the forward edge of the jacket has a reverse taper, opposite to that of the overall taper of the projectile. This reverse taper positioned at a cylindrical mid portion of forward component, presents a forward facing circumferential scoop which has minimal or no effect on flight characteristics but facilitates the initiation of the outward expansion of the jacket on impact with a fluidic target. This further facilitates the stripping-off of the jacket from the steel component providing advantageous terminal effects such as fragmentation of the projectile and faster yawing. Both are associated with increased stopping power. A further feature and advantage of embodiments is that a forward tapered portion of the jacket may have axially extending skives that may facilitate opening of the jacket upon impact.

A feature and advantage of embodiments is that the forward component is retained in the jacket forward of the lead core, the forward component having a forward ogive portion, a cylindrical mid portion adjoined to and unitary with the forward ogive portion, and a rearward portion adjoined to and unitary with the cylindrical mid portion, the entirety of the rearward portion diametrically larger than the cylindrical mid portion, the entirety of the cylindrical mid portion diametrically larger than the forward ogive portion,

A feature and advantage of embodiments of the invention is that the forward ogived portion and mid portion of the steel component may have forward and outwardly facing cut-outs or divots that provide for a greater forward facing scooping area further enhancing the initiation of the opening of the jacket, the opening of the jacket, and the stripping off of the jacket from the steel component. The circumferentially arranged divots provide increased terminal performance while maintaining reliability of weapon system because the external

profile of projectile is left unchanged, for example, the feed ramp for the cartridges is not impacted by the circumferential divots.

A feature and advantage of embodiments is that a forward steel portion may be used essentially as a punch to conform a ball shaped lead portion to conform to the jacket and the rearward facing surface of the forward component.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1A is a front elevational view of a cartridge according to embodiments of the invention.

Figure 1B is a front perspective view of a cartridge according to embodiments of the invention.

Figure 1C is a front elevational view of the cartridge of Figure 2.

Figure 2 is a cross-sectional view of the cartridge of Figure 1.

Figure 3 is an exploded view of the cartridge of Figures 1 and 2.

Figure 4A is an exploded view of components of a bullet prior to assembly according to an embodiment of the invention.

Figure 4B is an exploded view of components of a bullet prior to assembly according to an embodiment of the invention.

Figure 5A is a perspective view of a bullet according to embodiments of the invention.

Figure 5B is a front elevational view of a bullet according to embodiments of the invention.

Figure 5C is a perspective view of a bullet according to embodiments of the invention.

Figure 6A is a cross-sectional view of the bullet of Figure 5A.

Figure 6B is a cross-sectional view of the bullet of Figure 7B.

Figure 6C is a cross-section view of a bullet having a recess in the rearward facing end surface of the forward component.

Figure 6D is a cross-section view of a bullet having a plurality of recesses in the rearward facing end surface of the forward component.

Figure 6E is a cross-section view of a bullet having a plurality of projections in the rearward facing end surface of the forward component.

Figure 7A is a perspective view of a forward component with a non-spin feature on the rearward facing end.

Figure 7B is a perspective view of a forward component with separate ribs as the non-spin feature on the rearward facing end.

Figure 7C is a perspective view of a forward component with a non-spin feature on the rearward facing end.

Figure 7D is a perspective view of a forward component with a non-spin feature on the rearward facing end and a pad for accommodating a tip of an adjacent bullet during manufacturing processes.

Figure 7E is a perspective view of a forward component with a plurality of divots providing the non-spin feature on the rearward facing end of a forward component.

Figure 7F is a cross-sectional view of a forward component with a plurality of divots providing the non-spin feature on the rearward facing end of a forward component.

Figure 7G is a cross-sectional view of a forward component with a plurality of divots providing the non-spin feature on the rearward facing end of a forward component.

Figure 7H is a cross-sectional view of a forward component with a plurality of forward flutes and a plurality of divots providing the non-spin feature on the rearward facing end of a forward component.

Figure 7I is a side elevational view of a forward component with suitable dimensions.

Figure 8 is cross-sectional detail view of the jacket front edge engaging the cylindrical end portion of the forward component according to embodiments.

Figure 9A is an illustration of a step in the process of manufacturing a bullet according to embodiments of the invention.

Figure 9B is an illustration of another step in the process of manufacturing a bullet according to embodiments of the invention.

Figure 9C is an illustration of another step in the process of manufacturing a bullet according to embodiments of the invention.

Figure 9D is an illustration of a bullet, according to embodiments of the invention, traveling down a barrel.

Figure 10 is a cross-sectional view of a bullet according to embodiments of the invention traveling down a rifled barrel of a handgun.

DETAILED DESCRIPTION

Referring to Figures 1A- 2, a handgun cartridge 20, for example a 9mm cartridge, has a bullet 22, a casing 24, propellant 30, and a primer assembly 34. The casing 24 has a rim 35 with a diameter 35.2 and a wall portion 36 having a diameter 36.2. In embodiments, the rim diameter is the same as the wall portion diameter. The bullet is comprised of a forward component 40, a core component 42, and a jacket 44. The forward component may be formed of steel but other materials are also suitable in particular embodiments. The jacket may comprise copper and the core may comprise lead. In embodiments the core can also be copper and may be unitary with the jacket. In the embodiment of Figure 2, the bullet is illustrated with a concavity 48 in the rearward facing end 50 of the bullet and in jacket. In other embodiments, the rearward facing end of the bullet may be flat or have other shapes.

Referring to 2, 5A-6E, and 8, the jacket has a leading edge portion 51, a leading edge 52, and a reverse tapered surface 52.2 that may be a frustoconical concave surface. In

embodiments, the leading edge is separated from the steel component such that a recess 53, in embodiments a V-shaped recess, in cross-section, faces forward defining a circumferential scoop. One leg of the V is directly in line with the axis 53.3 of the bullet as well as the trajectory path. The V-shaped recess promotes opening of the jacket when the bullet impacts fluidic material which then urges the jacket to open, essentially by hydraulic force. The opened jacket can release the steel component and also the lead core increasing the damage imparted to the target.

Referring to Figures 2-8, in embodiments, the forward component 40 has a forward ogive portion 54, a cylindrical mid portion 56 adjoining and unitary with the forward ogive portion, a rearward facing end surface 57, and a rearward portion 58 adjoining and unitary with the cylindrical mid portion 56. In embodiments, the rearward portion 58 of the forward component has a maximum diameter portion 59 rearwardly positioned on the rearward portion, the rearward portion then tapers forwardly to adjoin the cylindrical mid portion with a curved taper. In embodiments, the forward ogive portion of the forward component being contiguous, without any intermediate structure, with the mid portion, the mid portion being contiguous, without any intermediate structure, with the rearward portion. The maximum diameter portion may extend axially defining a maximum diameter cylindrical end portion 59.2. The forward component has an axial length *l*, and the forward ogive portion extends an axial distance of *l1*, the cylindrical mid portion an axial distance of *l2*, and the rearward portion extends an axial distance of *l3*. In embodiments, *l1* is 30 to 50% of *l*. In embodiments, *l2* is 5 to 20% of *l*. In embodiments, *l3* is 35 to 55% of *l*. In embodiments, *l1* is 35 to 45% of *l*. In embodiments, *l2* is 10 to 15% of *l*. In embodiments, *l3* is 40 to 50% of *l*. The cylindrical end portion, in embodiments, extends axially a distance *l4* of less than 10 % of the axial length *l* of the steel component. In embodiments, the maximum diameter cylindrical end portion of the forward component extends axially less than 20% of the axial

length *l* of the steel component. In embodiments, the axial length *l4* of maximum diameter cylindrical end portion of the forward component extends axially less than 30% of the axial length *l* of the steel component. In embodiments, the maximum diameter cylindrical end portion 59.2 of the steel component extends axially a distance *l4* less than 5% of the axial length *l* of the steel component. Forward of the maximum diameter portion is a tapering portion 60 that leads to the cylindrical mid portion 56. In embodiments, the tapering portion 60 is a curved taper with a compound radius. As best illustrated in FIG 7I, the tapering portion may have a first radius of curvature 60.2 with a greater radius positioned rearwardly of a second radius of curvature 60.3 having a second radius, less than the first radius, defining a curve with an increasing taper. The tapering portion 60 of the rearward portion and the cylindrical mid portion defining a radially outwardly facing recess 61.

In embodiments, the forward component is retained in the jacket forward of the lead core, the forward component having a forward ogive portion, a cylindrical mid portion adjoined to the forward ogive portion, and a rearward portion adjoined to the cylindrical mid portion, the entirety of the rearward portion diametrically larger than the cylindrical mid portion, the entirety of the cylindrical mid portion diametrically larger than the forward ogive portion,

In embodiments, the diameter of the cylindrical mid portion is 80 percent or greater of the diameter of the maximum diameter portion of the forward component. In embodiments, the diameter of the cylindrical mid portion is 85 percent or greater of the diameter of the maximum diameter portion. In embodiments, the diameter *dI* of the cylindrical mid portion is 70 percent or greater of the diameter *d* of the maximum diameter portion. In embodiments the ratio of the length of the forward component to the diameter of the forward component is in the range of 1.65 to 1.05. In embodiments the ratio of the length of the forward component to the diameter of the forward component is in the range of 1.50 to 1.20. In embodiments

the ratio of the length of the forward component to the diameter of the forward component is in the range of 1.32 to 1.40.

In embodiments, the mid portion rather than being cylindrical, may have a slight taper forwardly of, for example, 2 degrees or less, as measured from a line parallel to the axis. In such embodiments, the mid portion is conical. In embodiments the mid portion may be conical with a taper of 5 degrees or less, as measured from a line parallel to the axis. Such conical mid portions may be substituted for all embodiments described or claimed herein.

Referring to Figures 1B, 1C, 5B, and 5C, the jacket may have scores or skives 62 extending axially on the forward portion 63 of the jacket. In embodiments, the skives will terminate at a point before where the bullet will engage barrel rifling, before the cylindrical end portion of the bullet. The skives may be cuts extending partially or completely through the jacket, folds in the jacket, indentations in the jacket, or other weakening of the jacket axially to facilitate tearing and opening of the jacket. U.S. Pat. Nos. 6,805,057 and 6,305,292 illustrate such skives and these patents are incorporated herein by reference for all purposes.

Referring to Figures 4B, 5A, 5C, 6A, and 6B, an embodiment of the invention is illustrated. Figure 4A illustrates the use of a lead ball 66 to provide the lead core and a jacket cup preform 68. The lead ball and jacket are deformed during manufacturing as discussed below. The forward component, which may be steel, has recesses or divots 70 in the cylindrical mid portion 56 and into the ogive portion 54. The recesses or divots increase the forward facing area intermediate the outer surface 74 of the jacket and the forward component thereby increasing the hydraulic force for opening the jacket. Figure 6 illustrate the V-shaped recess and the enhanced "scoop" areas 77 provided by the divots and the resulting significant increase in hydraulic forces to open the jacket. Thus, embodiments of the invention include circumferentially distributed fluid scoop areas that facilitate jacket

pedaling. The fluid scoop area 77 may be defined by the gap or open region between the steel component and the leading edge of the jacket.

Referring to Figures 6B-7H, the forward component 40.1, 40.2, 40.3, 40.4, 40.5, 40.6, and 40.7 may have rotation inhibiting features 82, 83, 84 on the rearward facing end surface 57. The rotation inhibiting features may be configured as ribs 86 and project outwardly as shown in Figures 7A and 7B. Alternately, the feature may be a recess 87 in the surface as illustrated by Figures 7C, 77E, 7F, and 7H. Projections 87.5, such as nubs, partial spheres, or other surface structure may also be utilized to lock the forward steel component, or other material component, to the core. The bullets may be axially stacked during manufacturing processes, and the central pad 88 of Figure 7D can facilitate such stacking such that the bullets do not misalign. Figure 6B corresponds to the ribs of Figure 7A and Figure 6C corresponds to segmented recess, not shown in perspective. These interface feature will inhibit or prevent the steel component 40 from rotating with respect to the core 42.

Referring to Figures 4A-4B, 9A-9D, steps suitable for manufacturing the bullets described herein are illustrated. A jacket preform 68 is inserted into a die 90. A lead ball 66 is inserted into the jacket. A steel forward component 40 is held by a suitable tool 92 to punch down onto the ball in the jacket deforming the ball and deforming the rearward face of the jacket. The combined steel component, lead core, and jacket 94 are then removed and inserted steel component end first into a skiving die, and then a finishing die 96 to obtain the final bullet shape. Other and additional steps may, of course, be utilized. During this process, the features on the rearward facing end surface of the steel component, as illustrated in Figures 7A-7C, will be readily imparted in the forward facing surface 99 of the lead core which was the lead ball before deformation. In another embodiment of the invention, this would also occur in a bullet configuration with a jacket and a copper core in the jacket rather than the lead core.

Referring to Figure 10, a bullet according to embodiments of the invention traveling down a barrel 100 is illustrated. The concavity 48 allows the forces from the ignition of the propellant to present a radial component 106 at the rear end of the bullet that pushes against the barrel providing a radial expansion of the rear end 107 of the bullet resulting in a gas seal. Also, the maximum diameter cylindrical end portion 59.2 of the steel component 40 is minimally deformable and provides a "hard" ring of contact 110 with the barrel. The radial expansion at the rear end provides another ring of contact 112 is believed to minimize yaw as the bullet travels down the barrel. When viewed in cross-section, this provides four principle regions of engagement 114 of the bullet with the rifled barrel, resulting in very stable bullet trajectory traveling down the barrel and toward the target. It has been observed that performance of steel component bullets with the concavity compared to steel component bullets with a flat rearward surface provides a significant increase in bullet accuracy.

In embodiments of the invention, the lead core can weigh about 1.4 to 2.2 times the weight of the jacket. The steel component can weigh 1.3 to 2.4 times the weight of the lead core. Weight may be approximately (within 20%) of the following for a 9mm bullet:

Jacket = 19.3 grains

Lead Core = 36.2 grains

Steel Component = 47.5

Referring to Figure 7I, suitable dimensions for the forward component are provided. In embodiments, the dimensions may vary within 10% of the given dimensions. For different sized bullets and cartridges, the dimensions will vary proportionally. The bullets herein may also be formed of other materials other than those specifically.

All of the features disclosed in this specification (including the references incorporated by reference, including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any

combination, except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including references incorporated by reference, any accompanying claims, abstract and drawings) may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of the foregoing embodiment (s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any incorporated by reference references, any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed The above references in all sections of this application are herein incorporated by references in their entirety for all purposes.

Although specific examples have been illustrated and described herein, it will be appreciated by those of ordinary skill in the art that any arrangement calculated to achieve the same purpose could be substituted for the specific examples shown. This application is intended to cover adaptations or variations of the present subject matter. Therefore, it is intended that the invention be defined by the attached claims and their legal equivalents, as well as the following illustrative aspects. The above described aspects embodiments of the invention are merely descriptive of its principles and are not to be considered limiting. Further modifications of the invention herein disclosed will occur to those skilled in the respective arts and all such modifications are deemed to be within the scope of the invention.

CLAIMS

1. A pistol cartridge comprising a cartridge casing with open mouth and an interior, propellant in the interior of the cartridge casing, and a bullet secured in the mouth of the cartridge casing, the bullet comprising:

a forward component made of a first metal comprising steel, the forward component having forward ogive portion with a forward tip, a cylindrical mid portion adjoining the forward ogive portion, and a tail portion with a curved taper adjoining the cylindrical mid portion, the tail portion having a maximum diameter portion positioned at a rearward portion of the tail portion, the maximum diameter portion having a diameter greater than the diameter of the cylindrical mid portion; and

a jacket formed of a second metal comprising copper and defining a cup, the steel component seated in the cup.

2. The pistol cartridge of claim 1 wherein the bullet further comprises lead, the lead positioned rearwardly of the steel component in the cup and forming a lead core, the forward component in direct contact with the lead core.

3. The pistol cartridge of claim 1 or 2, wherein the jacket has a leading edge portion that engages the cylindrical mid portion of the forward component.

4. The pistol cartridge of claim 3 wherein the leading edge portion and the cylindrical mid portion define a forward facing annular recess that facilitated opening of the jacket upon impact with a target.

5. The pistol cartridge of claim 2 wherein a rearward facing end surface of the forward component has structural features thereon that are reflected in a forward facing surface of the lead core inhibiting rotation of the forward component with respect to the lead core

6. The pistol cartridge of claim 1, 4, or 5 wherein the bullet has a rearward facing concavity facing the propellant.

7. A pistol cartridge comprising a cartridge casing with open mouth and an interior, propellant in the interior of the cartridge casing, and a bullet secured in the mouth of the cartridge casing, the bullet comprising:

a steel component made of a steel, the steel component having a forward ogived portion with a forward tip, a cylindrical mid portion, and a tail portion; and

a jacket formed of copper and defining a cup, the steel component seated in the cup, the jacket having a forward edge portion extending to the cylindrical mid portion of the steel component;

wherein the forward edge portion of the jacket defines a V-shape groove at an acute angle directed forwardly.

8. A bullet for a handgun cartridge, the bullet comprising:

a jacket comprising copper, the jacket having a forward leading edge portion, an interior, and a rearward facing end piece;

a lead core portion in the jacket;

a forward component retained in the jacket forward of the lead core, the forward component having a forward ogive portion, a cylindrical mid portion adjoined to the forward ogive portion, and a rearward portion adjoined to the cylindrical mid portion, the entirety of the rearward portion diametrically larger than the cylindrical mid portion, the entirety of the cylindrical mid portion diametrically larger than the forward ogive portion,

the jacket forward leading edge portion engaging the cylindrical mid portion of the forward portion.

9. The bullet of claim 7 or 8 wherein the reward portion has a corner portion and then a cylindrical end portion at the rear end of the rearward portion, and then a tapered portion extending from the cylindrical end portion to the cylindrical mid portion.

10. The bullet of claim 7 or 8 wherein the bullet has a concavity at the rearward facing end piece of the jacket.

11. The bullet of claim 7 or 8 wherein the cylindrical mid portion has a plurality of divots arranged circumferentially around the cylindrical mid portion.

12. The bullet of claim 11 wherein each of the divots extends into the forward ogive portion.

13. The bullet of claim 11 wherein each of the divots has an arcuate shape in cross section.

14. The bullet of claim 11 or 12 or 13 wherein each of the divots extends radially inward of forward leading edge of the jacket.

15. The bullet of any one of claim 7 and 8 wherein the jacket extends onto the ogive portion and conforms thereto.

16. The bullet of any one of claim 7 and 8 wherein the jacket has an inner surface and an outer surface and the outer surface extends farther forward than the inner surface.

17. The bullet of any one of claim 7 and 8 wherein in a cross section the jacket has a taper with a forward most leading edge that is separated from the steel component.

18. The bullet of any one of claim 7 and 8 wherein the steel component has a rearward facing surface and said surface has a locking feature thereon to rotationally secure the steel component to the core.

19. The bullet of claim 18 wherein the feature is a projection.

20. The bullet of claim 18 wherein the feature is a recess.

21. The bullet of any of claim 7 and 8 in combination with a casing and propellant.

22. The combination of claim 21 wherein the cartridge is a 9mm cartridge.

23. The combination of claim 21 wherein the cartridge is a handgun cartridge

24. A method of manufacturing bullets for pistols comprising:

providing a jacket cup comprising copper;

placing a lead ball inside the jacket cup;

impacting the lead ball in the jacket cup with a steel forward component thereby conforming the lead ball into a shape conforming to the jacket cup and the shape of a rear face of the steel component;

retaining the steel component in the cup after the impacting;

deforming an upper portion of the jacket cup to conform to the steel forward component.

25. The method of claim 24 further comprising selecting a steel component with a non spin feature on a rearward surface of the steel component.

26. The method of claim 24 or 25 further comprising selecting a steel component with a cylindrical surface sized to retain the jacket to the steel component after the impacting.

27. The method of any one of claim 24 to 25 further comprising selecting a die to receive the jacket cup, the die having a convex protrusion for forming a concavity on a rearward facing surface of the bullet.

28. The method of any one of claim 24 to 26 further comprising deforming the jacket cup to have a concavity on a rearward facing surface.

29. A jacketed bullet comprising a forward steel component, a lead core, and a jacket encompassing the lead core and extending partially forward on the steel component, the bullet having a concave rear face, the forward steel component having locking features on a rearward face for rotationally locking the lead core to the steel component.

30. A pistol bullet comprising a forward component comprised of steel, a lead core rearward of the forward component, and a jacket comprising copper retaining the core and forward component, the forward component and lead core having interlocking features for preventing rotation of one with respect to the other, the bullet having a concavity in a rear face of the bullet, and having a forward facing annular groove defined by the forward component and the jacket.

31. The bullet of claim 30 wherein the forward component has a cylindrical mid portion and wherein the jacket has a leading edge engaged with the cylindrical mid portion.

32. A forward component for a bullet, the forward component having a forward ogive portion with a forward tip, a cylindrical mid portion adjoining and unitary with the forward ogive portion, and a rearward portion having a rearward facing end surface, the rearward portion adjoining and unitary with the cylindrical mid portion.

33. The forward component of claim 32 wherein the component has an axial length and the forward ogive portion has an axial length that is 30 to 50 per cent of the axial length of the component.

34. The forward component of claim 32 wherein the component has an axial length and the cylindrical mid portion has an axial length that is 4 to 20 per cent of the axial length of the component.

35. The forward component of claim 32 wherein the component has an axial length and the rearward portion has an axial length that is 35 to 55 per cent of the axial length of the component.

36. The forward component of any one of claims 32 to 35 wherein the ratio of the length of the forward component to the diameter of the forward component is in the range of 1.32 to 1.40.

37. The forward component of any one of claims 32 to 35 in combination with a casing and propellant.

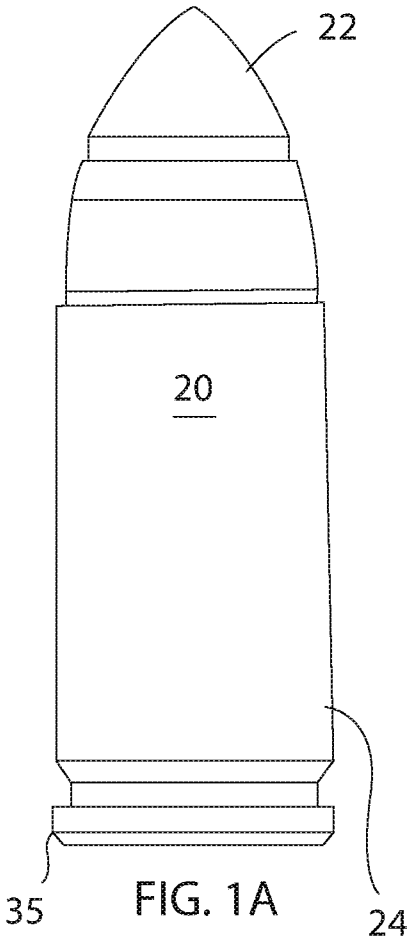


FIG. 1A

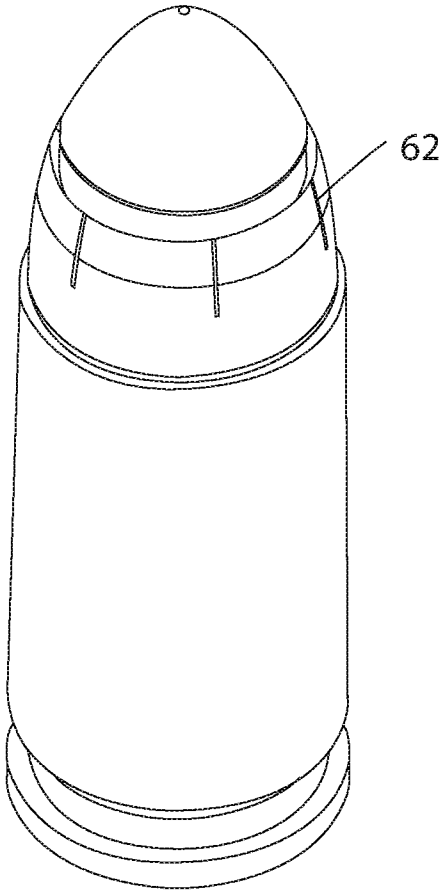


FIG. 1B

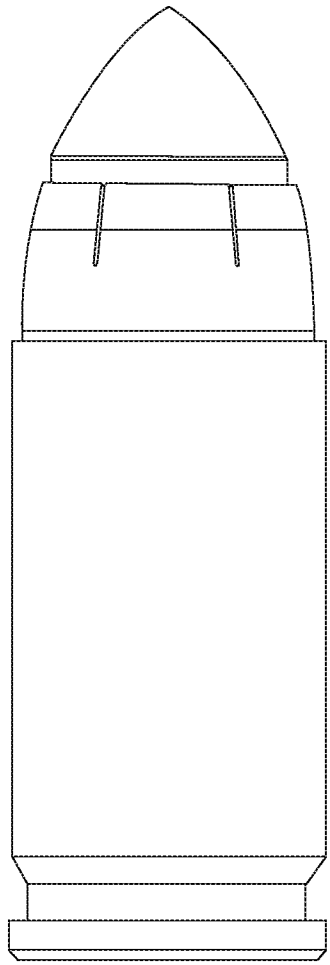


FIG. 1C

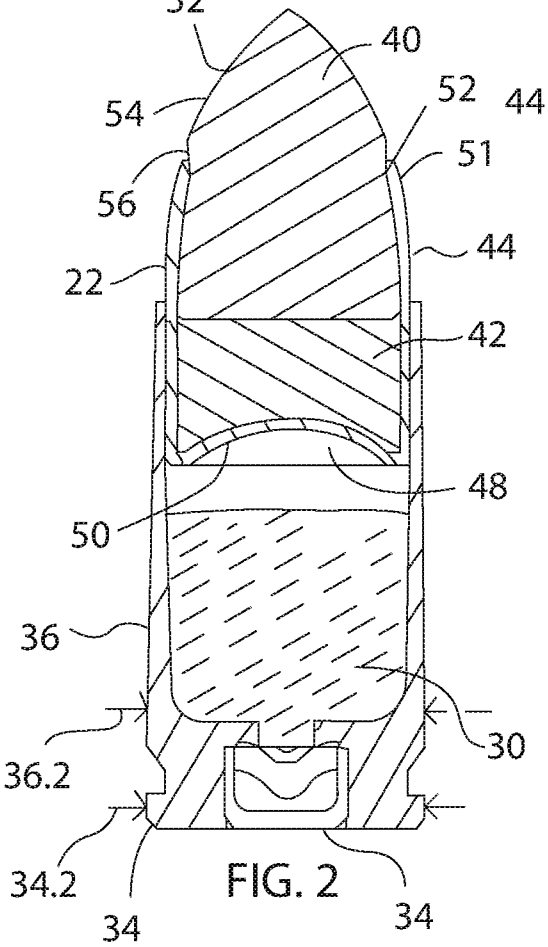

53.3
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36.2
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34.2
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FIG. 2

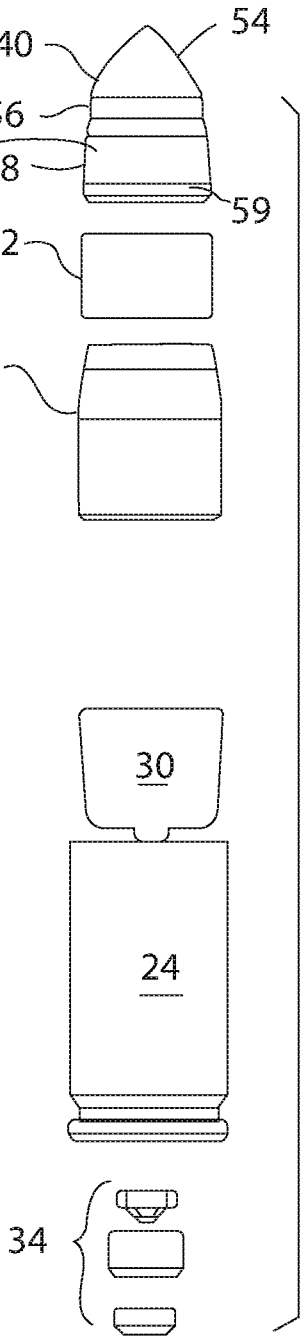

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FIG. 3

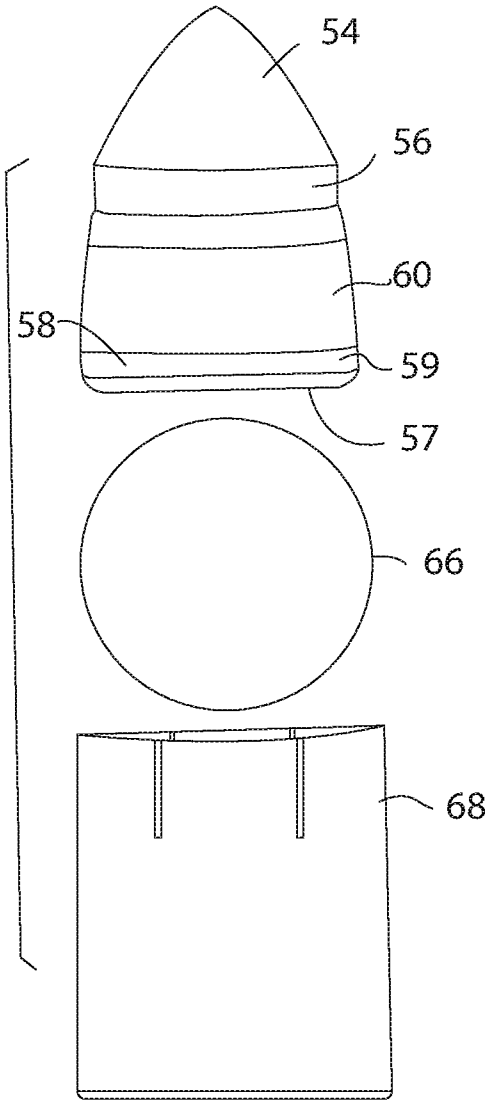


FIG. 4A

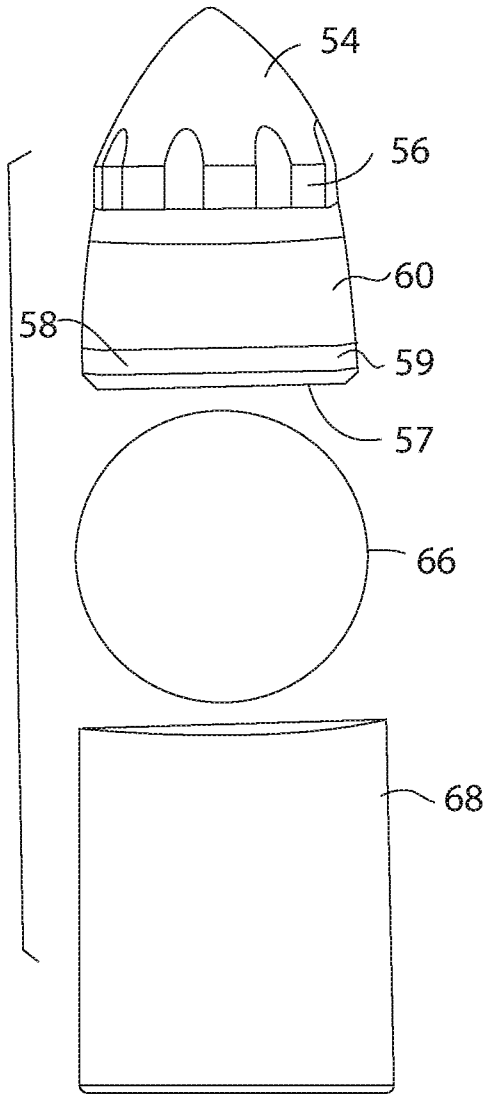


FIG. 4B

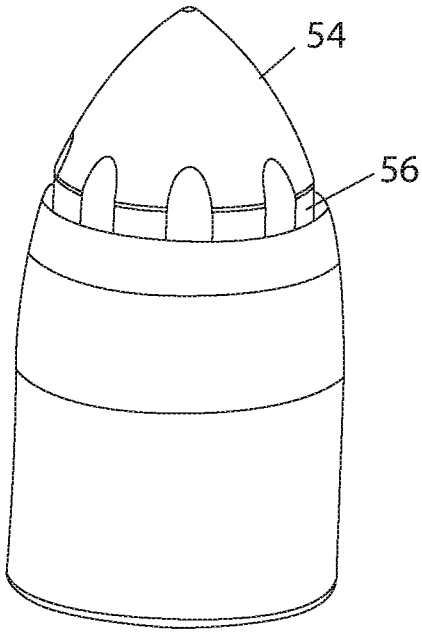


FIG. 5A

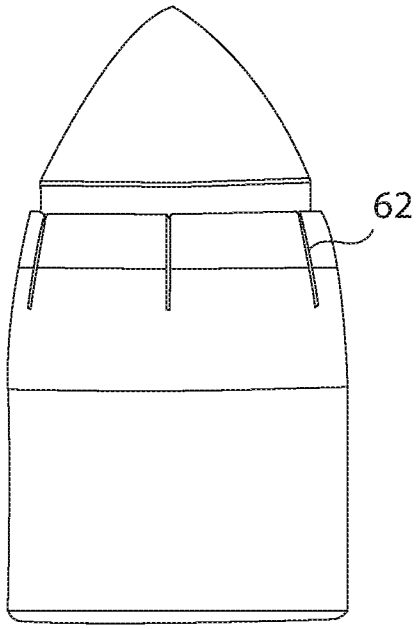


FIG. 5B

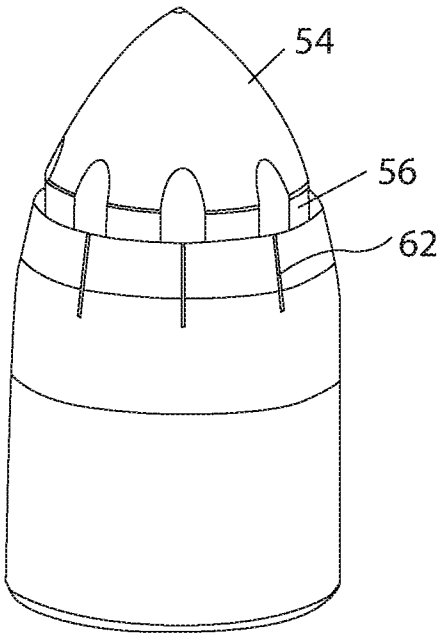


FIG. 5C

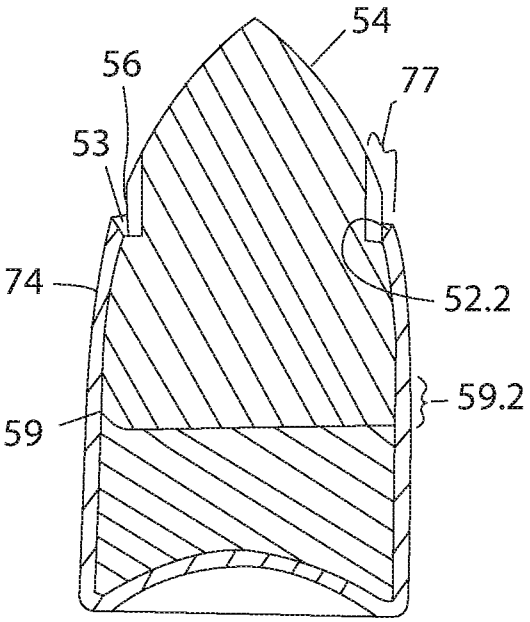


FIG. 6A

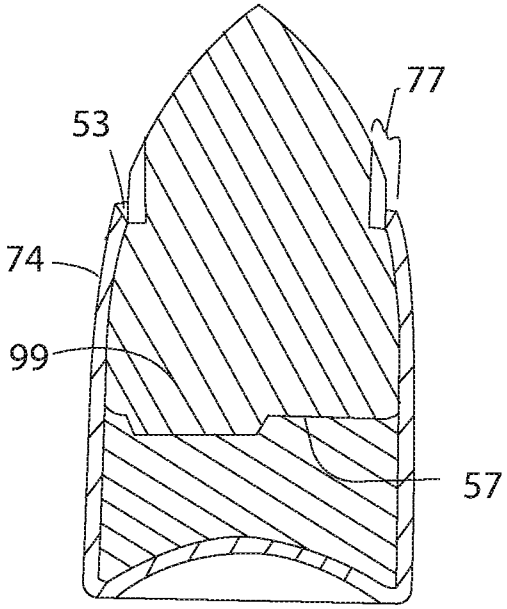


FIG. 6B

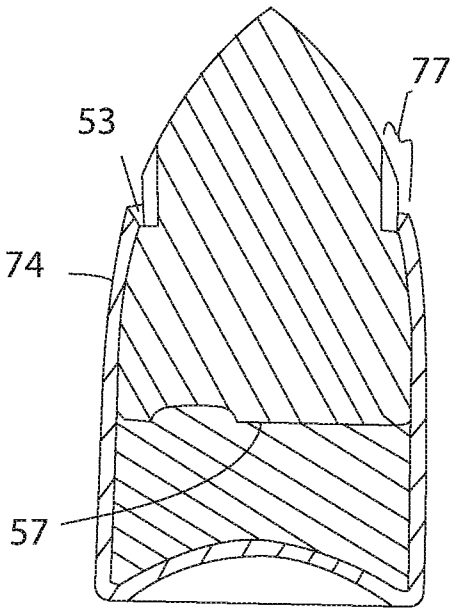


FIG. 6C

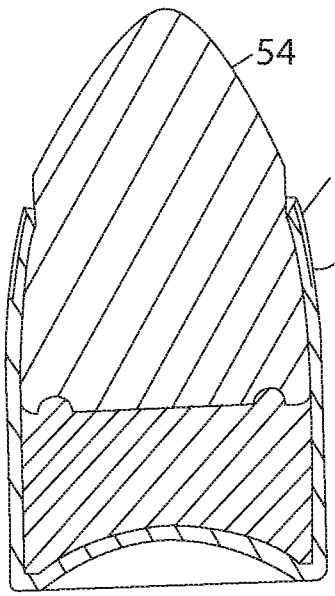


FIG. 6D

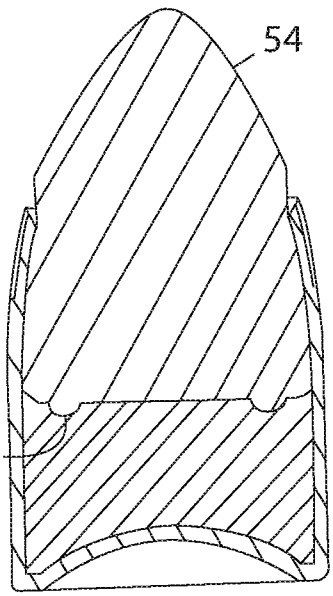


FIG. 6E

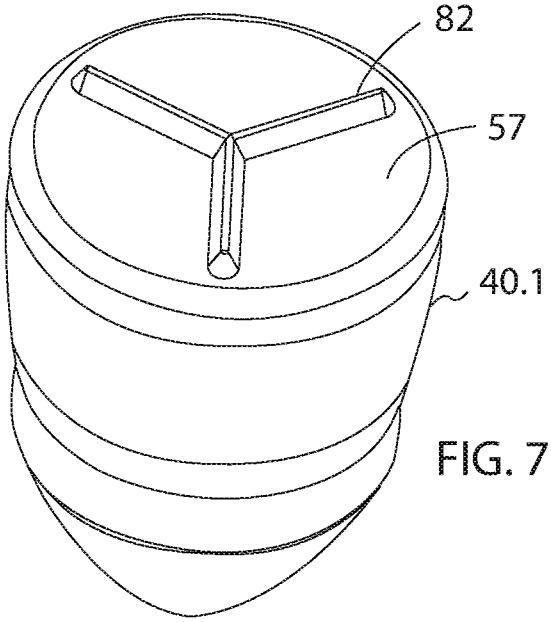


FIG. 7A

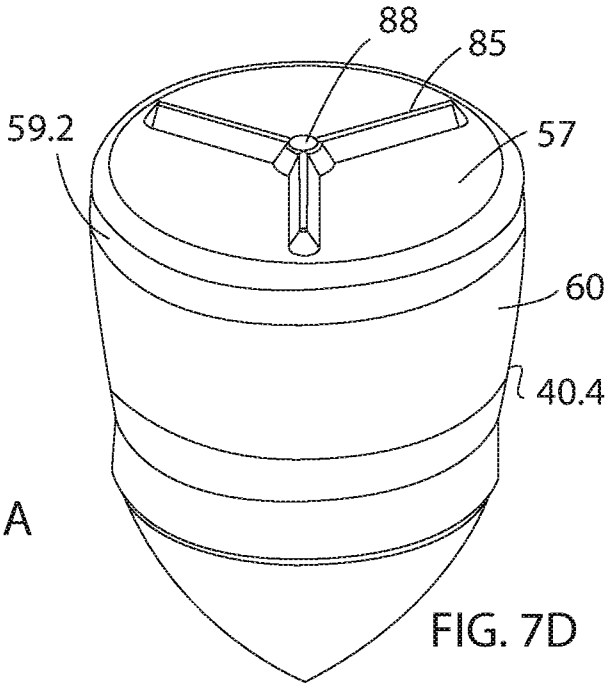


FIG. 7D

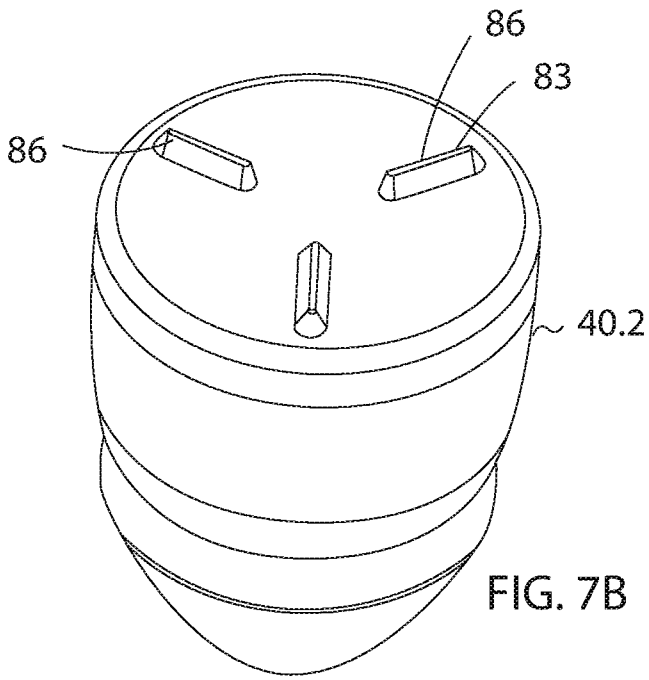


FIG. 7B

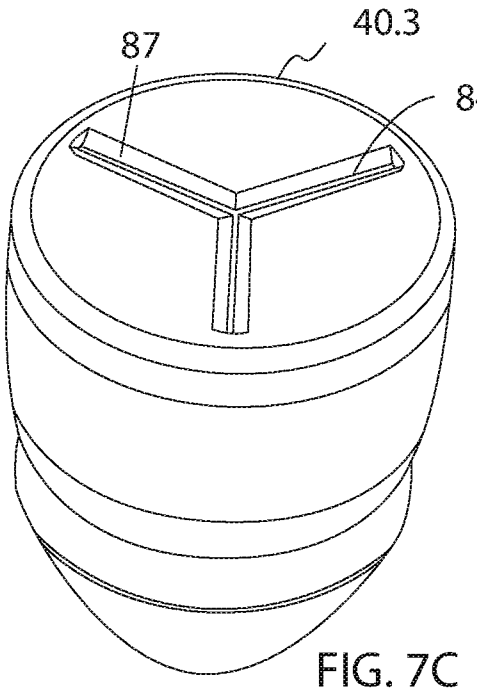


FIG. 7C

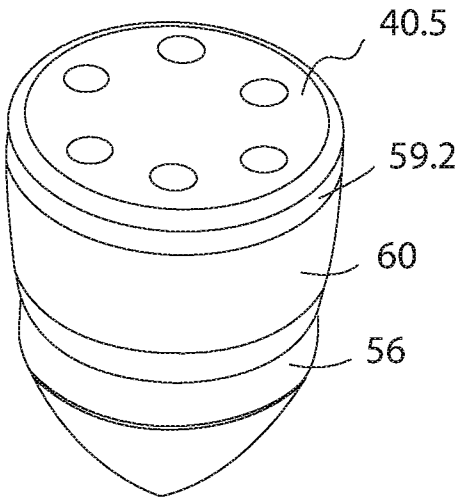


FIG. 7E

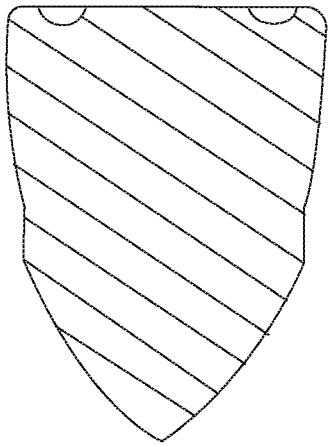


FIG. 7F

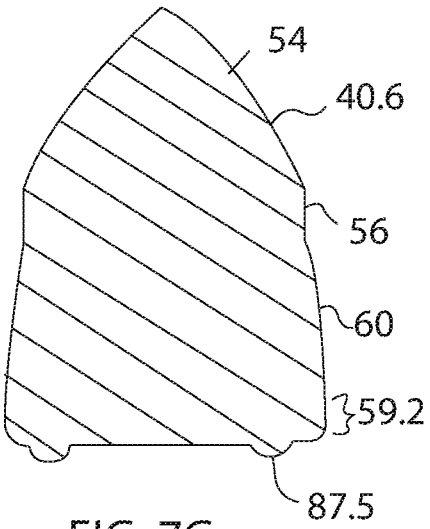


FIG. 7G

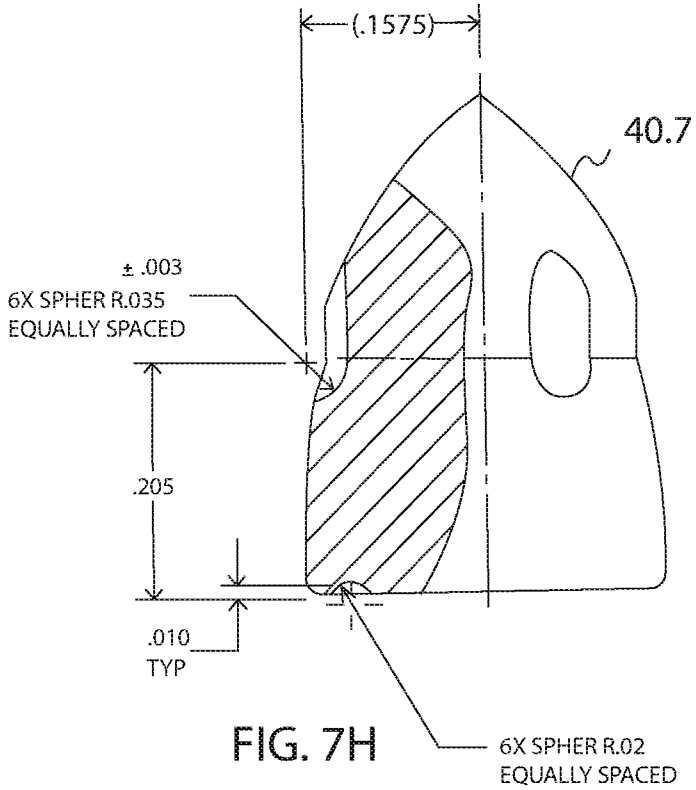


FIG. 7H

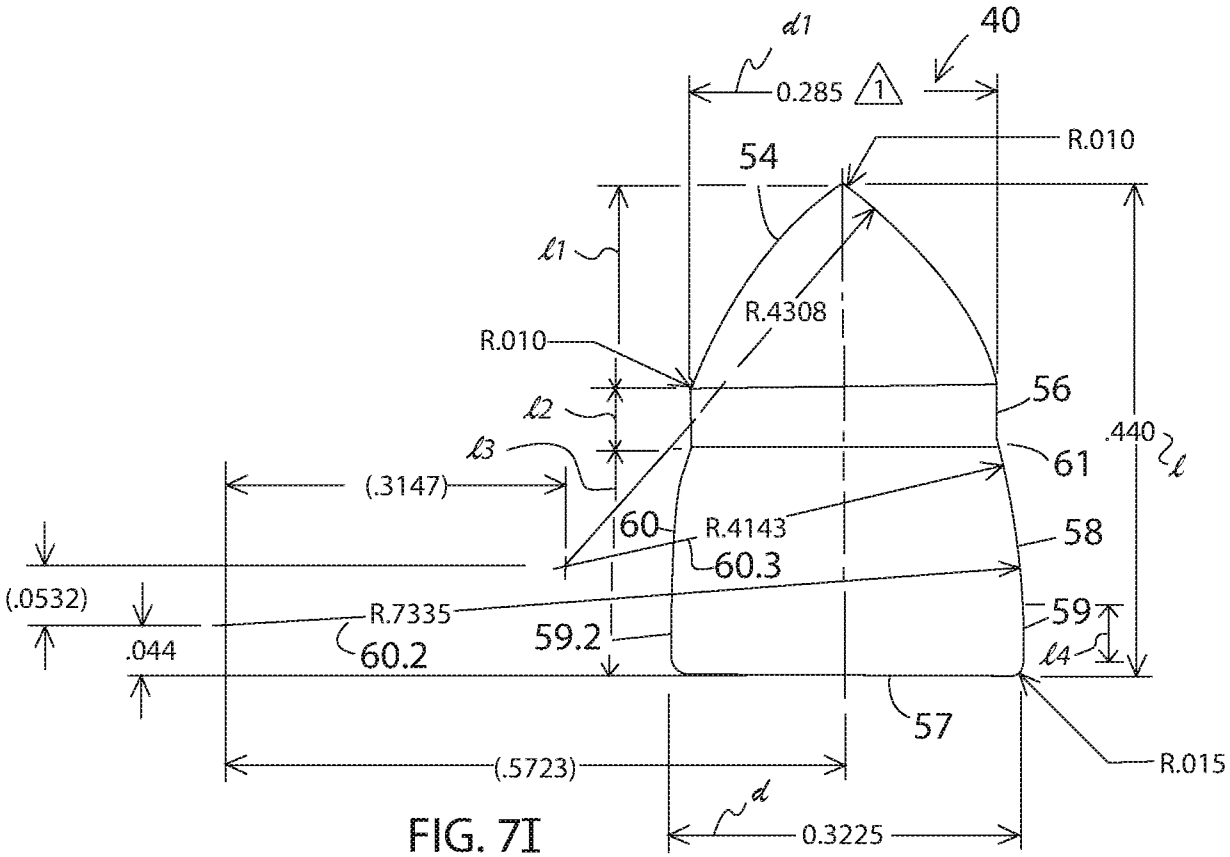

d1
40
0.285
1
R.010
54
ℓ1
R.4308
R.010
56
ℓ2
ℓ3
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.440
ℓ
(.3147)
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R.4143
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(.0532)
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60.2
59.2
ℓ4
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R.015
(.5723)
d
0.3225

FIG. 7I

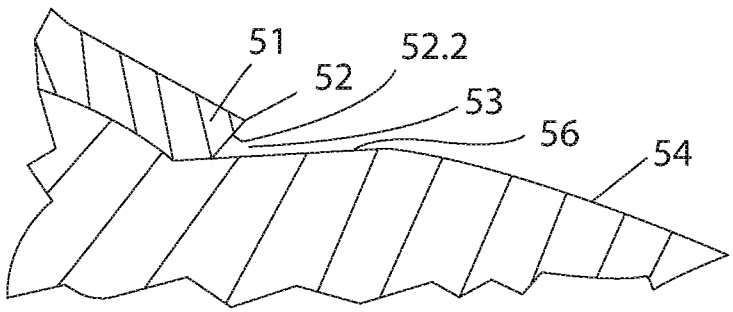

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52.2
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FIG. 8

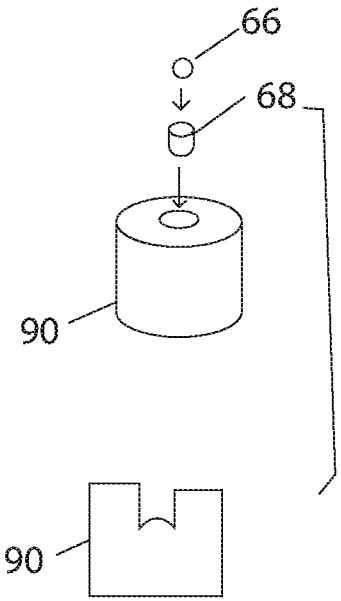


FIG. 9A

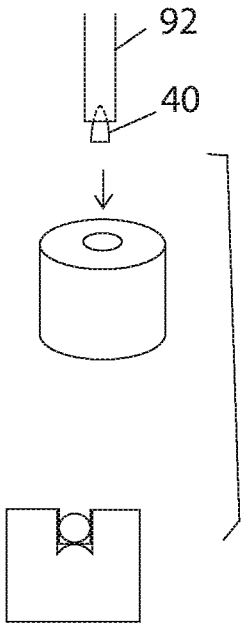


FIG. 9B

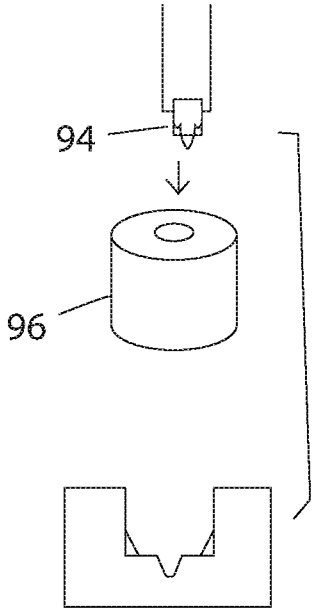


FIG. 9C

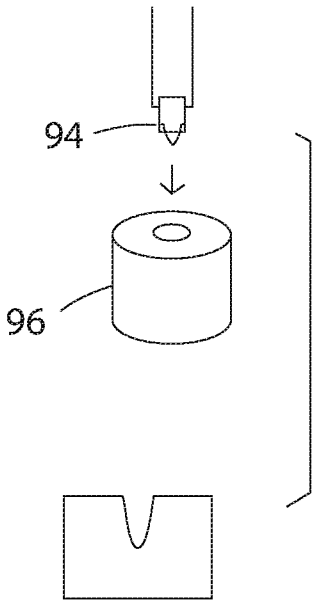


FIG. 9D

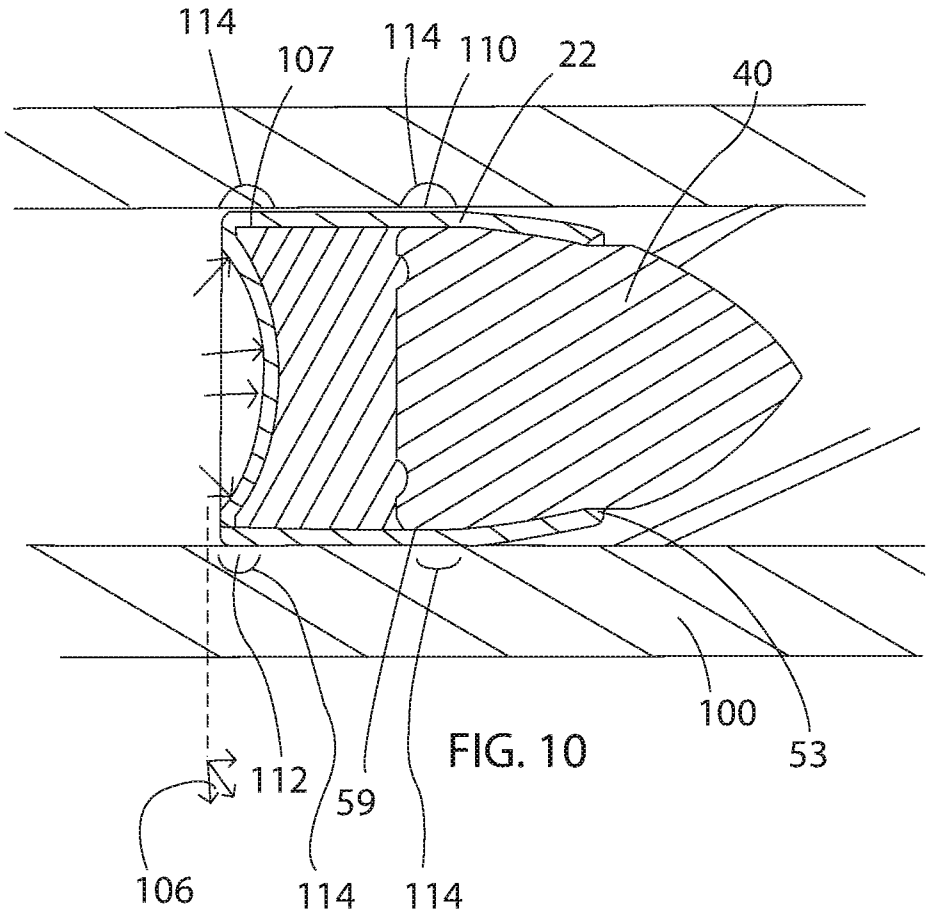


FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 16/43898

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - F42B 33/00, F42B 30/02, F42B 5/26, F42B 12/78, F42B 5/00 (2016.01)
CPC - F42B33/00, F42B30/02, F42B5/26, F42B5/00, F42B12/78
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(8) F42B 33/00, F42B 30/02, F42B 5/26, F42B 12/78, F42B 5/00 (2016.01)
CPC: F42B33/00, F42B30/02, F42B5/26, F42B5/00, F42B12/78

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
IPC(8) B21K 21/04, F42B 33/00, F42B 30/02, F42B 5/26, F42B 12/78, F42B 5/00, F42B 12/00, F42B 12/34, F42B 12/02 (2016.01)
CPC: B21K21/04, F42B33/00, F42B30/02, F42B5/26, F42B5/00, F42B12/78, F42B12/00, F42B12/34 (keyword limited; terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PatBase; Google Patents; Google Scholar; Google Web;
Search terms used: Bullet steel copper propellant pistol cartridge bullet jacket cup forward ogive lead core steel forward tip front leading handgun small gun firearm casing ammunition pointed gothic arch

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3,756,158 A (Anderson) 04 September 1973 (04.09.1973), entire document, especially Fig. 1, 2, 3; col 2, ln 14-16;	32-37
---		---
Y		1-3
---		---
A		4-5, 7-13, 15-23
Y	US 5,094,169 A (Evitts) 10 March 1992 (10.03.1992), entire document, especially Fig. 1, 2; col 3, ln 6-10; col 3, ln 21-22;	1-3
---		---
A		4-5, 7-13, 15-23
A	US 6,971,315 B2 (Knappworst et al.) 06 December 2005 (06.12.2005), entire document, especially Fig. 1; col 4, ln 10-14;	4, 7, 9-13, 15-23
A	US 2008/0156222 A1 (Orlanov) 03 July 2008 (03.07.2008), entire document, especially Fig. 1, 2; para[0024];	8-13, 15-23
A	US 6,862,993 B1 (Cudazzo) 08 March 2005 (08.03.2005), entire document	1-5, 7-13, 15-23, 32-37
A	US 3,142,256 A (Mack) 28 July 1964 (28.07.1964), entire document	1-5, 7-13, 15-23, 32-37
A	US 2,958,287 A (Auxier) 01 November 1960 (01.11.1960), entire document	1-5, 7-13, 15-23, 32-37
A	US 2006/0278117 A1 (Emary) 14 December 2006 (14.12.2006), entire document	1-5, 7-13, 15-23, 32-37
A	US 682,364 A (Mangon) 10 September 1901 (10.09.1901), entire document	1-5, 7-13, 15-23, 32-37

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" 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)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" 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
"X" 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
"Y" 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

Date of the actual completion of the international search	Date of mailing of the international search report
29 November 2016	15 DEC 2016
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 16/43898

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 6, 14, 28
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I: Claims 1-5, 32-37 directed to a pistol cartridge forward component arrangement.

Group II: Claim 7-13, 15-23 directed to a pistol cartridge forward component and jacket design.

Group III: Claim 24-28 directed to a method of manufacturing bullets.

Group IV: Claim 29-31 directed to a jacketed bullet.
*Note: See Note Below

--- Continued in supplemental box ---

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☒ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
1-5, 7-13, 15-23, 32-37

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 16/43898

--- Continuation of Box No. III Observations where unity of invention is lacking ---

The inventions listed as Groups I-IV do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

SPECIAL TECHNICAL FEATURES

The invention of Group I includes the special technical features of a pistol cartridge having a forward component having a tail portion with a curved taper adjoining the cylindrical mid portion, and the tail portion having a maximum diameter portion positioned at a rearward portion of the tail portion, not required by the claims of Groups II, III and IV.

The invention of Group II includes the special technical features of a pistol cartridge having a jacket with the forward edge portion defining a V-shape groove at an acute angle directly forwardly, and a forward component having the entirety of the cylindrical mid portion diametrically larger than the forward ogive portion, not required by the claims of Groups I, III and IV.

The invention of Group III includes the special technical features of a method of manufacturing a bullet including placing a lead ball inside the jacket cup, conforming the lead ball into a shape conforming to the jacket cup and the shape of a rear face of the steel component, and deforming an upper portion of the jacket cup to conform to the steel forward component, not required by the claims of Groups I, II and IV.

The invention of Group IV includes the special technical features of the jacket bullet having a concave rear face, the forward steel component having locking features on a rearward face for rotationally locking the lead core and the steel component, not required by the claims of Groups I, II and III.

COMMON TECHNICAL FEATURES

Groups I-III share the common technical features of a pistol cartridge comprising a cartridge casing with open mouth and an interior, propellant in the interior of the cartridge casing, and a bullet secured in the mouth of the cartridge casing, the bullet comprising: a forward component made of a first metal comprising steel, the forward component having forward ogive portion with a forward tip, a cylindrical mid portion adjoining the forward ogive portion, and a tail portion, the tail portion having a diameter portion greater than the diameter of the cylindrical mid portion; and a jacket formed of a second metal comprising copper and defining a cup, the steel component seated in the cup.

However, this shared technical feature does not represent a contribution over prior art as being anticipated by US 5,094,169 A (Evitts) in view of US 3,756,158 A (Anderson), which discloses a pistol cartridge (10, Fig. 1, 2; col 3, ln 6-10, 'bevel belted cartridge case (10)') comprising a cartridge casing with open mouth (Fig. 2 - see cartridge case 10 and the open mouth that receives bullet 20) and an interior (Fig. 2), propellant in the interior of the cartridge casing (39, Fig. 2; col 3, ln 21-22, 'the gun powder is depicted by (39)'), and a bullet (20, Fig. 2; col 3, ln 6-10, 'a bullet (20)') secured in the mouth of the cartridge casing (Fig. 2 - see how the bullet 20 is secured within the mouth of the cartridge 10), but Evitts does not specifically teach the bullet comprising: a forward component made of a first metal comprising steel, the forward component having forward ogive portion with a forward tip, a cylindrical mid portion adjoining the forward ogive portion, and a tail portion, the tail portion having a diameter portion greater than the diameter of the cylindrical mid portion; and a jacket formed of a second metal comprising copper and defining a cup, the steel component seated in the cup. However, Anderson does teach a bullet (14, Fig. 1, 2; col 2, ln 14-16, 'the bullet 14') comprising: a forward component (16, Fig. 2) made of a first metal comprising steel (16, Fig. 2; col 2, ln 14-16, 'a steel nosepiece 16'), the forward component having forward ogive portion (Fig. 1, 2 - see how the forward component 16 has a forward ogive portion) with a forward tip (Fig. 2), a cylindrical mid portion (24, Fig 2) adjoining the forward ogive portion, and a tail portion (Fig. 2 - see the tail portion of the forward portion 16 on the opposite side of the cylindrical mid portion 24), the tail portion having a diameter portion greater than the diameter of the cylindrical mid portion (Fig. 2 - see how the tail portion has a greater diameter than the cylindrical mid portion 24); and a jacket (22, Fig. 1, 2) formed of a second metal comprising copper (22, Fig. 1, 2; col 2, ln 14-16, 'a copper jacket 22') and defining a cup (Fig. 1, 2 - see how the copper jacket 22 forms a cup), the steel component seated in the cup (Fig. 2 - see how the steel component 16 is seated within cup 22). Accordingly, it would have been obvious to one of ordinary skill in the art to have modified the bullet of Evitts' assembly by employing the bullet as taught by Anderson in order to have allowed for a more efficient and dangerous bullet configuration.

Groups I-IV share the common technical features of a pistol bullet comprising a forward component comprised of steel, a lead core rearward of the forward component, and a jacket comprising copper retaining the core and forward component.

However, this shared technical feature does not represent a contribution over prior art as being anticipated by US 5,094,169 A (Evitts) in view of US 3,756,158 A (Anderson), which discloses which discloses a pistol cartridge (10, Fig. 1, 2; col 3, ln 6-10, 'bevel belted cartridge case (10)') comprising a bullet (20, Fig. 2; col 3, ln 6-10, 'a bullet (20)') secured in the mouth of the cartridge casing (Fig. 2 - see how the bullet 20 is secured within the mouth of the cartridge 10), but Evitts does not specifically teach the bullet comprising a forward component comprised of steel (16, Fig. 2; col 2, ln 14-16, 'a steel nosepiece 16'), a lead core rearward of the forward component (20, Fig. 2 - see lead core 20 and how its rearward from the forward component 14; col 2, 14-16, 'a lead intermediate piece 20'), and a jacket comprising copper (22, Fig. 1, 2; col 2, ln 14-16, 'a copper jacket 22') retaining the core and forward component (Fig. 2 - see how the jacket 22 retains the core 20 and the forward component 14 via the crimped portion 28). Accordingly, it would have been obvious to one of ordinary skill in the art to have modified the bullet of Evitts' assembly by employing the bullet as taught by Anderson in order to have allowed for a more efficient and dangerous bullet configuration.

As the common technical features were known in the art at the time of the invention, these cannot be considered special technical feature that would otherwise unify the groups.

Therefore, Groups I-IV lack unity under PCT Rule 13 because they do not share a same or corresponding special technical feature.

*Note: Claims 6, 14 and 28 are unsearchable because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).