United States Patent

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[54] COMPOSITE METAL CARTRIDGE CASE

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[52] **U.S. Cl.** ..... **102/43 F**, 29/1.3

[51] **Int. Cl.** **F42b 5/28**, F42b 9/28

[58] **Field of Search** ..... 102/43, 43 F, 38; 29/1.3

[56] **References Cited**

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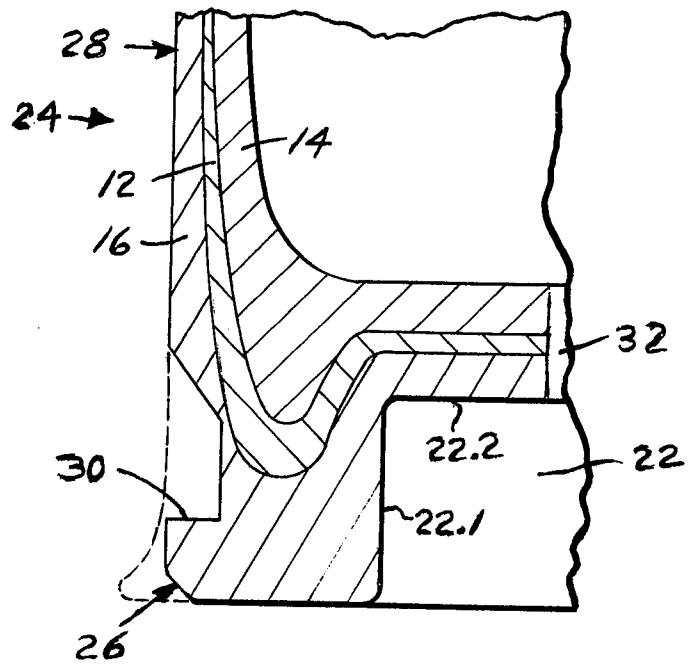
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[57] **ABSTRACT**

An ammunition cartridge cause is shown to comprise a deep, open-ended cup having a base of substantial thickness, having a relatively thin, generally cylindrical wall upstanding from the base and having an annular, peripheral, extraction groove formed in the base, the base having a recess which opens oppositely of the open cup end for receiving a primer cup therein. The cartridge case if formed of a composite metal laminate material having a core metal layer sandwiched between and metallurgically bonded to outer layers of other metal materials. The core metal layer of the laminate material extends as a core throughout the wall of the cup and the base of the cup and is disposed within the cup base to surround the bottom and lateral walls of the primer cup recess to provide adequate case strength in the primer cup area. The core material is arranged within the cup base so that the core material is completely covered by the outer layer material of the laminate at the location of the cartridge extraction groove.

9 Claims, 4 Drawing Figures



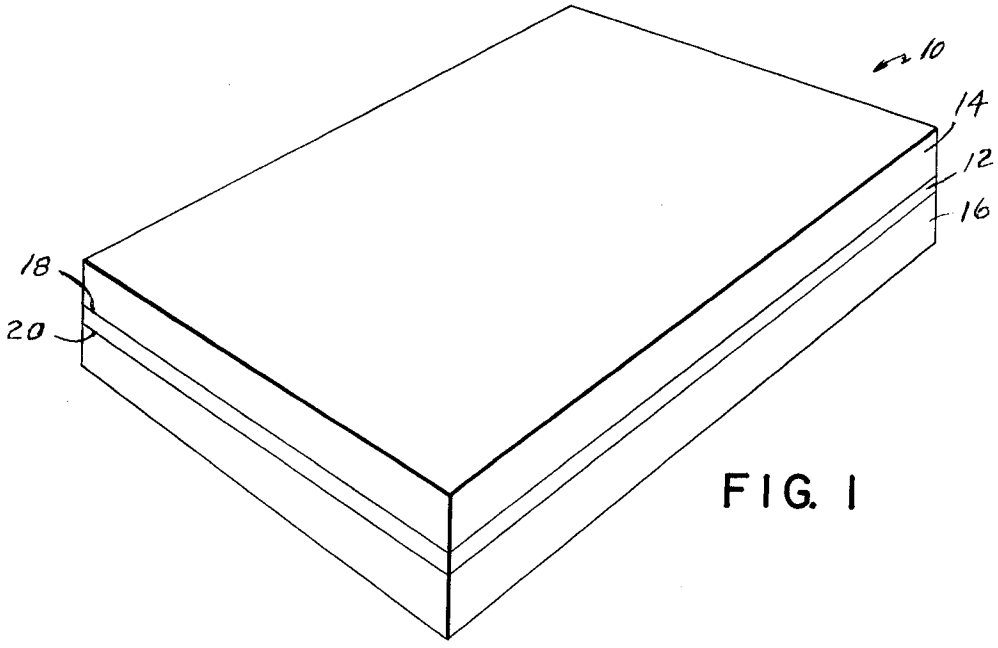


FIG. 1

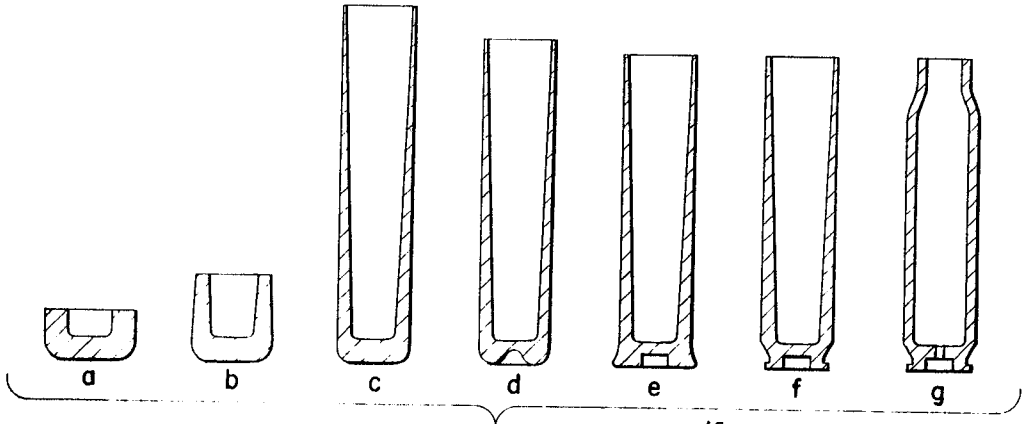


FIG. 2

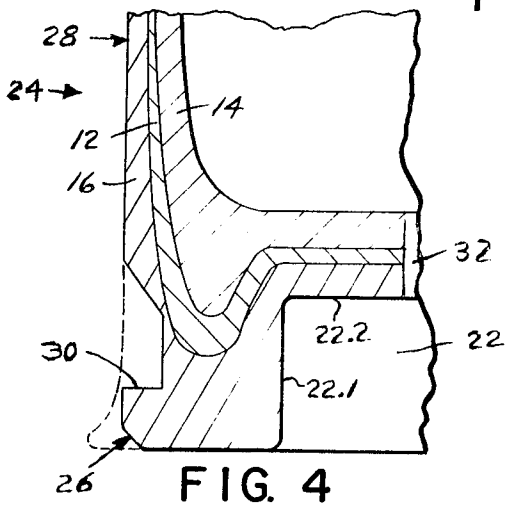


FIG. 4

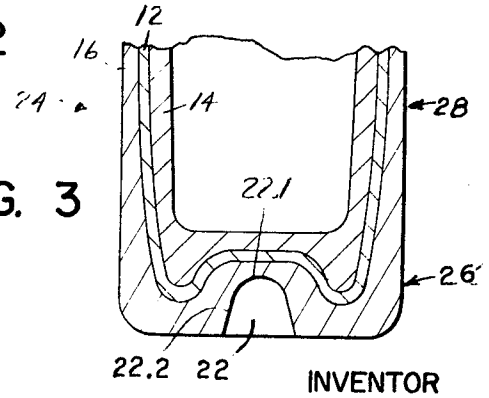


FIG. 3

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COMPOSITE METAL CARTRIDGE CASE

Cartridge cases for small arms ammunition and the like are conventionally made from brass strip material. The brass strip is cut into round disc-like blanks which are then deep-drawn to form open-ended cartridge cups. Each cartridge case has a relatively thick base and has a much thinner, generally cylindrical wall upstanding from the base. The base has a recess which opens oppositely of the open cup end to receive a primer cup therein, this recess being connected to the inside of the cup portion of the cartridge case by a small axial passage. The base of the cartridge case also has an annular, peripheral groove which can be engaged by a cartridge extraction mechanism.

Such cartridge cases must meet very stringent specifications if they are to be effectively used. For example, the wall of the cartridge case is peripherally supported in a firing chamber but is subjected to substantial force which tends to expand the cartridge case to fill the firing chamber when the cartridge is fired. The wall of the cartridge case must therefore display excellent spring-back characteristics in order to avoid jamming or freezing of the cartridge case within the firing chamber. On the other hand, the base of the cartridge is sometimes not supported in the firing chamber. The unsupported base must therefore be adapted to withstand the forces developed during firing of the cartridge and must not expand to such an extent as would permit gasses to escape from the cartridge around the primer cup held in the cartridge base. The cartridge cases must also be characterized by good corrosion resistance to permit cartridges to be stored for long periods of time under adverse conditions prior to use. It is found that while brass cartridge cases effectively meet these stringent specifications, the cartridge case materials are heavy and expensive, and brass is a material which would be a critical material in the event of a national emergency.

It is an object of this invention to provide a novel and improved cartridge case; to provide such a cartridge case which is of light weight as well as of rugged and inexpensive construction; to provide such a cartridge case which displays sufficient resistance to corrosion to permit storing of cartridges embodying the cases; to provide such cartridge cases which embody readily available materials; and to provide such cartridge cases which have springback, yield strength properties and the like which permit use of the cartridge cases interchangeably with brass cartridge cases.

Other objects, advantages and details of the cartridge cases of this invention appear in the following detailed description of preferred embodiments of the invention, the detailed description referring to the drawings in which:

FIG. 1 is a perspective view of a sheet of composite metal laminate material used in cartridge cases in accordance with this invention;

FIG. 2 is a diagrammatic view illustrating stages in the process of making cartridge cases of this invention;

FIG. 3 is a partial axial section view through a partially formed cartridge case of this invention; and

FIG. 4 is a partial axial section view similar to FIG. 3 but to enlarged scale illustrating the cartridge case of this invention.

Referring to the drawings, 10 in FIG 1 illustrates a composite metal laminate material used in making cartridge cases in accordance with this invention. As shown in FIG. 1, the composite material 10 includes a layer 12 of core metal material which is sandwiched between and metallurgically bonded to outer metal layers 14 and 16, the metallurgical bond between the core and outer metal layers preferably comprising solid-phase metallurgical bonds and extending substantially throughout the interfaces 18 and 20 between the core and outer metal layers. Such composite laminate materials 10 are made in accordance with conventional roll-bonding techniques or the like such as those illustrated in U.S. Pat. Nos. 2,691,815 and 2,753,623 although laminate materials made by other methods are also within the scope of this invention.

In a preferred embodiment of this invention, the layer 14 of composite material 10, which layer will ultimately form the inner surface layer of a cartridge case made from the composite, is preferably formed of an age hardenable, preferably high purity, aluminum alloy, commonly identified as CK47 or 7075 HP Aluminum Alloy having a nominal composition by weight as as follows:

Zinc	5.1–6.1%
Magnesium	2.1–2.9%
Copper	1.2–2.0%
Chromium	0.18–0.40%
Aluminum	Balance

The core layer 12 of the composite material is then preferably formed of a low carbon steel such as SAE 1006 steel, preferably with a relatively low sulfur content suitable for deep-drawing, having a nominal composition by weight as follows:

Carbon	0.08 Max.
Manganese	0.25–0.45
Phosphorous	0.040 Max.
Sulfur	0.050 Max.
Iron	Balance

The layer 16 of the composite material is then preferably formed of the same aluminum alloy as the layer 14. In this arrangement, the layers 14 and 16 are preferably of substantially equal thickness comprising about 85 percent of the total composite thickness with the core layer 12 comprising about 15 percent of the total layer thickness. Preferably the total composite thickness is on the order of 0.170 inches to provide a cartridge case for 5.56 mm caliber small arms ammunition. Preferably, the composite laminate material 10 is subjected to a conventional heat treatment for providing the composite material in suitable condition for subsequent deep-drawing thereof. For example, the composite material is preferably subjected to bell annealing at a temperature of about 900°F. for a period of about 2–3 hours followed by slow cooling for providing the outer material layers 14 and 16 in annealed condition while providing the core steel layer, which is in cold-worked condition following roll-bonding of the composite, in at least partially recrystallized, condition.

In an alternate embodiment of this invention, the composite metal layer 16 is preferably formed of conventional cartridge brass having a nominal composition by weight as follows:

Copper	70%
Zinc	30%

The core layer 12 of the composite in this alternate embodiment is then formed of SAE 1006 low carbon steel while the opposite outer layer of the laminate material is formed of an aluminum alloy commonly identified as Alloy 5456 having a nominal composition by weight as follows:

Magnesium	4.7–5.5%
Manganese	0.50–1.0%
Chromium	0.05–0.20%
Aluminum	Balance

In this alternate embodiment of the composite material 10 to be used in cartridge cases according to this invention, the core layer 12 preferably comprises about 15 percent of the total composite thickness while the outer laminate layers 14 and 16 are of equal thickness each comprising about 42.5 percent of the total composite thickness. This alternate composite material is also preferably subjected to suitable heat treatment to provide the outer laminate layers in annealed condition while at least partially recrystallizing the steel core layer which is in cold-worked condition as roll-bonded.

In another alternate embodiment of this invention, both of the outer laminate layers 14 and 16 are formed of cartridge brass while the core layer 12 thereof is preferably formed of SAE 1006 low carbon steel, the composite being subjected to heat treatment for annealing the outer laminate layer materials and the steel core layer.

In forming the cartridge cases of this invention from the composite laminate material **10**, the general procedures conventionally used in forming brass cartridge cases are employed as is indicated diagrammatically in FIG. **2**. That is, the composite material is cut into the form of round discs or blanks which are then subjected to a series of deep-drawing steps which are alternated with heat treatment steps appropriate for the composite material as required. However, while the cartridge forming steps are of conventional nature, it is found that, where the starting material is in the form of the composite laminate material as described above, the conventional cartridge forming steps result in a novel cartridge case structure. Note that FIG. **2** illustrates the cartridge case of this invention by showing axial section views of the cartridge case in various stages of the conventional deep-drawing, cartridge-case-forming process, the separate nature of the layers of the case material being omitted in FIG. **2** for greater clarity of illustration.

In the first step of the case forming procedure, as is illustrated diagrammatically at *a* in FIG. **2**, the composite material **10** is subjected to a conventional blanking step to form round discs or blanks of the composite material **10**. These round blanks are then subjected to a first, conventional deep-drawing step. Usually, as is illustrated at *a* in FIG. **2**, the blanking step and the initial deep drawing step in the process of cartridge case manufacture are readily combined in a known manner to be performed in a single step. As is shown at *a* in FIG. **2**, the initial case drawing step forms an open-ended cup having a base portion which is of a thickness substantially the same as the thickness of the initial composite blank material and having a generally cylindrical wall portion of about the same thickness upstanding from the base. Then, during subsequent drawing steps in the process of case manufacture as illustrated at *b* and *c* in FIG. **2**, a deeper cup is formed while leaving the base thickness of the cup substantially at its original thickness by substantially thinning out and tapering the upstanding wall of the cup. Although two additional drawing steps *b* and *c* are shown, it will be understood that as many drawing steps as may be required can be utilized and that, where required, the cups are subjected to appropriate heat treatments between the various drawing steps. In making 5.56 mm caliber cartridge cases as previously discussed, for example, sufficient drawing steps are used as described to form a cup having a total height on the order of about 2.25 inches.

In the conventional cartridge making process as used in making the cartridge case of this invention, the fully drawn cup as illustrated at *c* in FIG. **2** is then trimmed around the open end of the cup to provide a straight cup edge and to provide the desired cup height. At this point, the base portion of the drawn cup retains substantially the thickness of the starting composite material. A recess is then formed in the bottom of the base of the drawn cup as illustrated at *d* in FIG. **2**, any conventional press-forming process being employed for this purpose. In this process step, as is illustrated more clearly in FIG. **3**, the formation of the recess **22** deforms the core layer **12** of the composite material embodied in the drawn cup so that the core layer **12** is disposed in surrounding relation to the bottom **22.1** and side walls **22.2** of the recess **22**. That is, in the conventional press-forming operation in which the cup is supported from within the cup as well as from around the base portion of the cup, press forming of the recess **22** deforms the core layer **12** within the cup base so that the core layer is moved from its original disposition extending substantially straight across the cup base in equally spaced relation to the top and bottom of the base to a new disposition in which the core layer material is moved upwardly at the center of the cup base to be positioned in spaced, surrounding relation to the recess **22**. In this way, the core layer **12** becomes a substantial reinforcing element for the cup base for retarding lateral or radial expansion of the cup base.

In accordance with the conventional cartridge forming process used in making the cartridge case of this invention, additional conventional steps in forming the cartridge case are performed as illustrated at *e*, *f* and *g* in FIG. **2**. That is, the bottom end of the drawn cup is flattened as indicated at *e* while the recess **12** formed in the cup base is provided with a configuration more nearly corresponding to its final configuration. Then, the bottom of the drawn cup is machined to provide a cartridge extraction groove, to provide the final base recess dimensions and to provide a small passage connecting the base recess to the inside of the drawn cup as indicated at *f* in FIG. **2**, the top of the drawn cup being swaged inwardly as indicated at *g* in FIG. **2**.

After completion of the cartridge case formation steps, the cartridge case is then preferably subjected to a heat treatment procedure appropriate for optimizing the various properties of the cartridge case materials. For example, where the cartridge case material embodies a core layer of SAE 1006 and outer laminate layers of CK47 Aluminum as previously described, the finished cartridge case structure is subjected to a suitable solution annealing step and to an aging heat treatment for establishing the desired high yield and tensile strength in the CK47 Aluminum Alloy while leaving the steel core layer of the cartridge case in cold-worked condition.

The features of the cartridge case **24** of this invention resulting from the process steps discussed above are best illustrated by reference to FIG. **4**. Thus, as shown in FIG. **4**, the cartridge case **24** of this invention comprises an open-ended cup-shaped member having a base portion **26** of substantial thickness and having a relatively thinner, generally cylindrical wall **28** upstanding from the base. The base has a recess **22** which opens in a direction opposite from the open end of the cup portion of the case **24** and has an annular, peripheral extraction groove **30** formed in the base. As shown in FIG. **4** the case embodies a composite metal laminate material having a core layer **12** of a metal material sandwiched between and metallurgically bonded to two outer layers **14** and **16** of other metal materials. The core layer **12** of the laminate material extends as a core throughout the wall **28** of the cartridge case **24** and across the base **26** of the case. This core layer is disposed within the base of the cartridge case so that the case layer surrounds the bottom **22.1** and lateral walls **22.2** of the base recess **22**. The core layer is also positioned within the base so that some of the material of the outer layer **16** of the original laminate material entirely covers the core layer of the laminate material at the location of the extraction groove **30** formed in the cartridge case. Passage **32** connects recess **22** to the inside of the case cup.

In this consturction, the novel cartridge case **24** of this invention is made entirely or primarily from materials such as aluminum and steel which are much more readily available and which are substantially less expensive than the brass conventionally used in cartridge cases. Further, the cartridge cases **24** are substantially lighter than conventional brass cases so that it is not only possible to make a greater number of cartridge cases from a given weight of material but it is also possible for military personnel to carry a substantially greater number of cartridges embodying the cases **24**. On the other hand, the cartridge cases are adapted to meet the stringent operating specifications of conventional brass cartridge cases without tending to jam or freeze the cartridge cases in firing chambers and without tending to permit expansion of the bases of the cartridge cases to the extent that gasses are permitted to escape from the cases around the primer cups mounted in the base recesses **22** of the cases. The cartridge cases which have outer surface materials formed of brass provide the cases with substantial corrosion resistance properties or the cartridge cases may be provided with suitable protective lacquer coatings. For example, the substantial interchangeability of the cartridge cases of this invention with conventional brass cartridges is indicated in Table I which sets forth the estimated properties of the composite materials of

the cartridge cases of this invention as relative percentages of the properties of the brass material conventionally used in cartridge cases:

TABLE I

Layer	Material	Percent Volume	Spring back	Modules of elasticity	Yield strength	Weight per unit volume
Single	Cartridge brass	100	100	100	100	100
14	CK47 aluminum	42.75				
12	SAE 1006 steel	13.25	10	80	85	40.6
16	CK47 aluminum	44.00				
16	Cartridge brass (cold worked condition)	40.00				
12	SAE 1006 steel	10.00	88.5	90	80	64.3
14	5456 aluminum	50.00				
14	Cartridge brass (cold worked condition)	10.00				
12	SAE 1006 steel	60.00	80	140	110.5	96.2
16	Cartridge brass (cold worked condition)	40.00				

As is illustrated in Table I, the aluminum-steel-aluminum composite material used in the cartridge case of this invention provides the cartridge case with spring back properties which are superior to those of cartridge brass material so that the invented cartridge case has no tendency to jam or freeze in a firing chamber during firing of the cartridge. The composite material has a modulus of elasticity and yield strength equal to at least 80 percent of cartridge brass so that the base of cartridge cases made from the composite material do not tned to expand excessively during firing of the cartridge. In this regard, note that the configuration of the core layer in the base of the cartridge case of this invention adds additional strength tending to resist undesirable expansion of the cartridge core base. The composite material is also substantially lighter than cartridge brass so that 5 cartridge cases of this invention weight approximately the same as 2 brass cartridge cases. The alternate composite materials whose properties are indicated in Table I are shown to have suitable spring back, modulus of elasticity, yield strength and weight characteristics as compared with brass. In the case of the latter composite material shown in the table, the composite material shows even greater tendency to resist cartridge case base expansion than is displayed by brass cartridges.

It should be understood that although the laminate material used in the cartridge cases of this invention are described as having a core layer and outer layers, each of the core and outer layer means could be formed of two or more metal layers which are metallurgically bonded together. For example, where the laminate layer 14 to be disposed on the inside of the cartridge case is to be formed of aluminum, a surface layer of another material such as brass may be metallurgically bonded to the aluminum layer to protect the aluminum layer from hot gasses developed during firing of the cartridge. It should also be understood that although particular embodiments of the cartridge case of this invention have been described by way of illustrating the present invention, this invention includes all modifications and equivalents thereof which fall within the scope of the appended claims.

I claim:

1. A cartridge case comprising an open-ended cup having a base of selected thickness and having a relatively thinner, generally cylindrical wall upstanding from said base, said case being formed of a composite metal laminate material having metal core layer means of steel sandwiched between and metallurgically bonded to outer metal layer means one of which is disposed as an exterior surface layer of said case and one of which is disposed as an inner surface layer of said case, said exterior surface layer means being of selected thickness around said cylindrical wall and having relatively thicker portions thereof disposed around the periphery of said base and across the bottom of said base, said exterior surface layer means having an annular groove in one of said relatively thicker portions thereof extending around the periphery of said base, said exterior surface layer means having a recess in one of said relatively thicker portions thereof extending into the bottom of said base, said recess having lateral and bottom walls and having an open end facing away from said cup, said core layer means of said laminate material extending as a core throughout said cylindrical cup wall and extending into said base between portions of said groove and recess, said core layer means being disposed in spaced, surrounding relation to bottom and lateral wall portions of said base recess, said case having a passage therein extending from the bottom of said base recess through said laminate material into said cup.

2. A cartridge case as set forth in claim 1 wherein said core layer means within said base is spaced from said base groove.

3. A cartridge case as set forth in claim 2 wherein said cartridge case laminate material has a central core layer of low carbon steel sandwiched between and metallurgically bonded to outer metal layers of aluminum alloy.

4. A cartridge case as set forth in claim 3 wherein said aluminum alloy has a nominal composition, by weight, of 5.1–6.1 percent zinc, 2.1–2.9 percent magnesium, 1.2–2.0 percent copper, 0.18–0.40 percent chromium and the balance aluminum.

5. A cartridge case as set forth in claim 1 wherein said core layer of steel comprises a layer of low carbon steel which is sandwiched between and metallurgically bonded to outer metal layers of cartridge brass.

6. A cartridge case as set forth in claim 1 wherein said core layer of steel comprises a layer of low carbon steel which is sandwiched between and metallurgically bonded to outer metal layers of cartridge brass and aluminum alloy respectively.

7. A cartridge case as set forth in claim 6 wherein said aluminum alloy has a nominal composition, by weight, of 4.7–5.5 percent magnesium, 0.50–1.00 percent manganese, 0.05–0.20 percent chromium and the balance iron.

8. A cartridge case comprising an open-ended cup having a base of selected thickness, having a relatively thinner wall upstanding from said base and having an annular, peripheral groove formed in said base, said base having a recess which opens oppositely of said open cup end and having a passage connecting said recess with the inside of said cup, said case being formed of a composite metal laminate material having a core layer of low carbon steel having a nominal composition, by weight, of 0.08 percent (max.) carbon, 0.25–0.45 percent manganese, 0.040 percent (max.) phosphorous, 0.050 percent (max.) sulfur, and the balance iron, said core layer being sandwiched between and metallurgically bonded to outer metal layers of aluminum alloy having a nominal composition, by weight, of 5.1–6.1 percent zinc, 2.1–2.9 percent magnesium, 1.2–2.0 percent copper, 0.18–0.40 chromium, and the balance aluminum, said core layer extending as a core throughout said cup base and wall and being disposed within said base to surround bottom and lateral wall portions of said base recess.

9. A cartridge case as set forth in claim 8 wherein said core layer of steel has a thickness comprising approximately 15 percent of the total thickness of said composite material.

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