United States Patent

Hilton et al.

[15] **3,706,118**

[45] **Dec. 19, 1972**

[54] **METHOD FOR THE MANUFACTURE OF AN ALUMINUM CARTRIDGE CASE**

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[22] Filed: **June 16, 1971**

[21] Appl. No.: **153,826**

Related U.S. Application Data

[60] Continuation-in-part of Ser. No. 801,892, Dec. 16, 1968, abandoned, which is a division of Ser. No. 744,182, July 11, 1968, Pat. No. 3,498,221.

[52] **U.S. Cl.** **29/1.3**, 72/267

[51] **Int. Cl.** **B23p 15/22**

[58] **Field of Search** 29/1.3, 1.31; 72/256, 267

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Primary Examiner—H. A. Kilby, Jr.

Attorney—I. William Millen et al.

[57] **ABSTRACT**

A high-strength cartridge case made of an Al-Cu-Mg-Si type alloy is fabricated by backwardly extruding a deep drawn cylindrical blank into a cup-shaped member with a resultant movement in the metal blank of at least about 70 percent, the walls of the cup-shaped member are thinned and elongated by drawing the same through a die aperture of reduced diameter to effect a total metal movement in the original blank of at least about 90 percent, the resultant drawn member is solution heat treated and quenched in cold water to strengthen the metal, and a primer cavity is then forged in the base portion of the member to impart thereto at least about 15 percent cold work.

11 Claims, 17 Drawing Figures

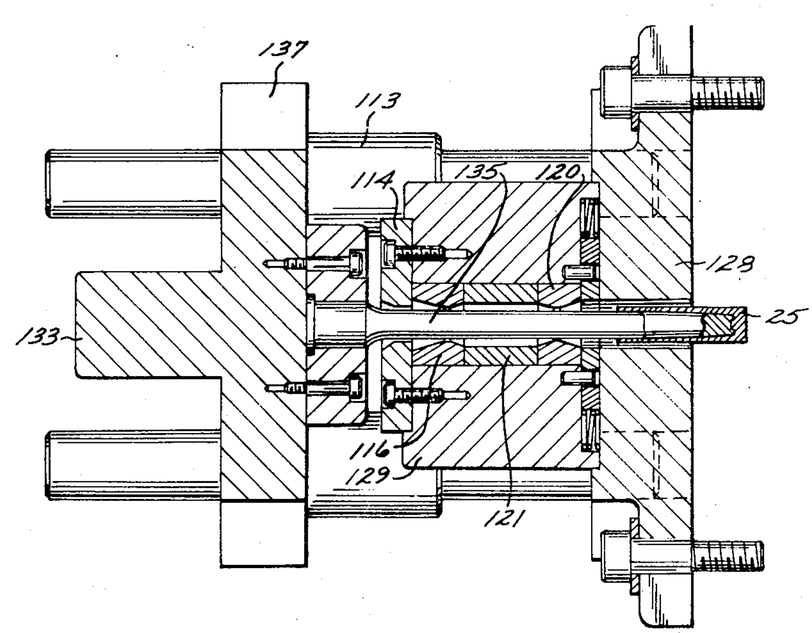


FIG. 1

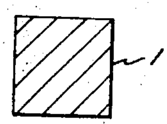


FIG. 2

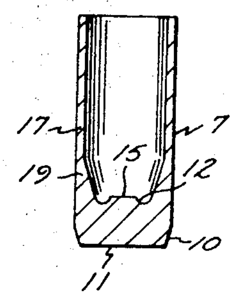


FIG. 3

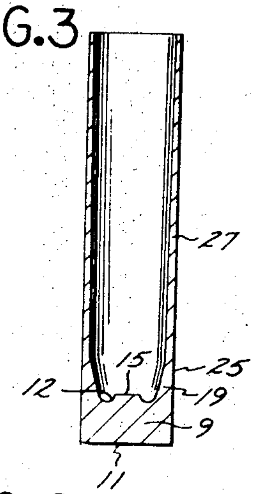


FIG. 4

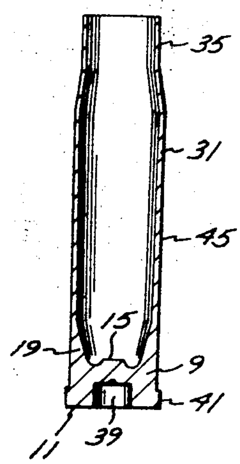


FIG. 5

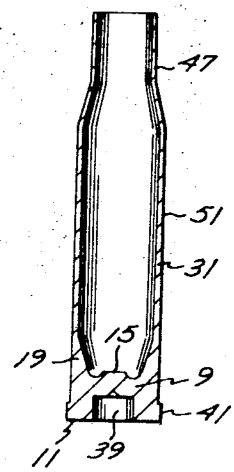


FIG. 6

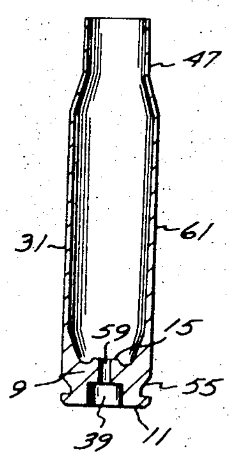


FIG. 7

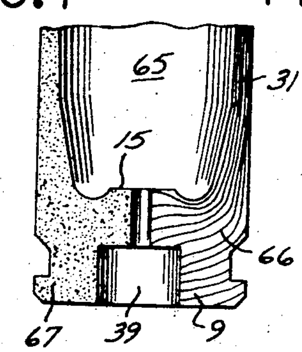


FIG. 8

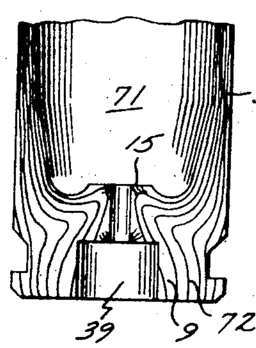
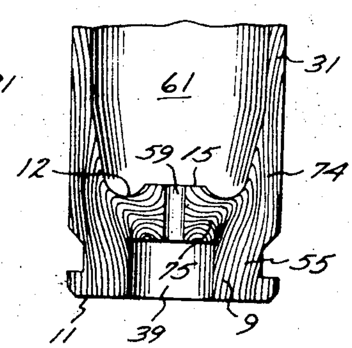


FIG. 9



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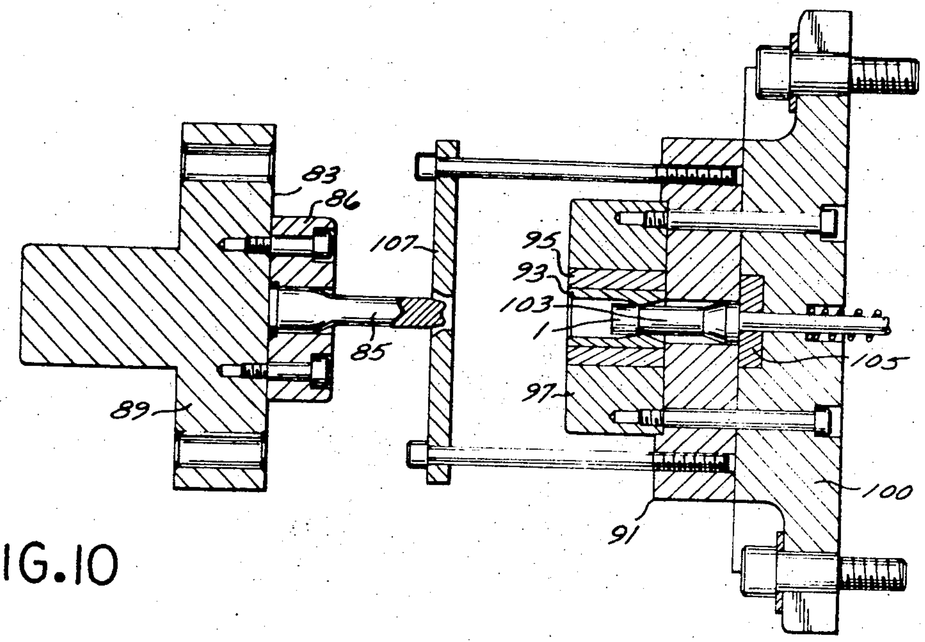

FIG. 10

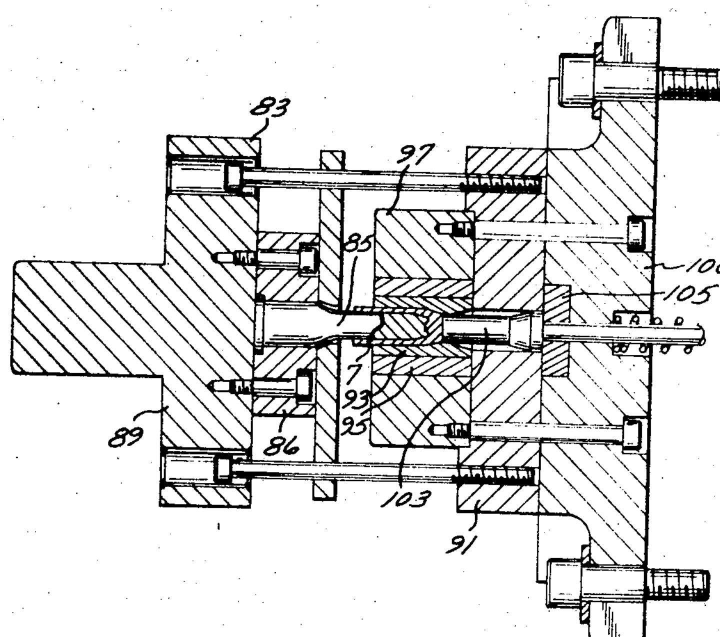

FIG. 11

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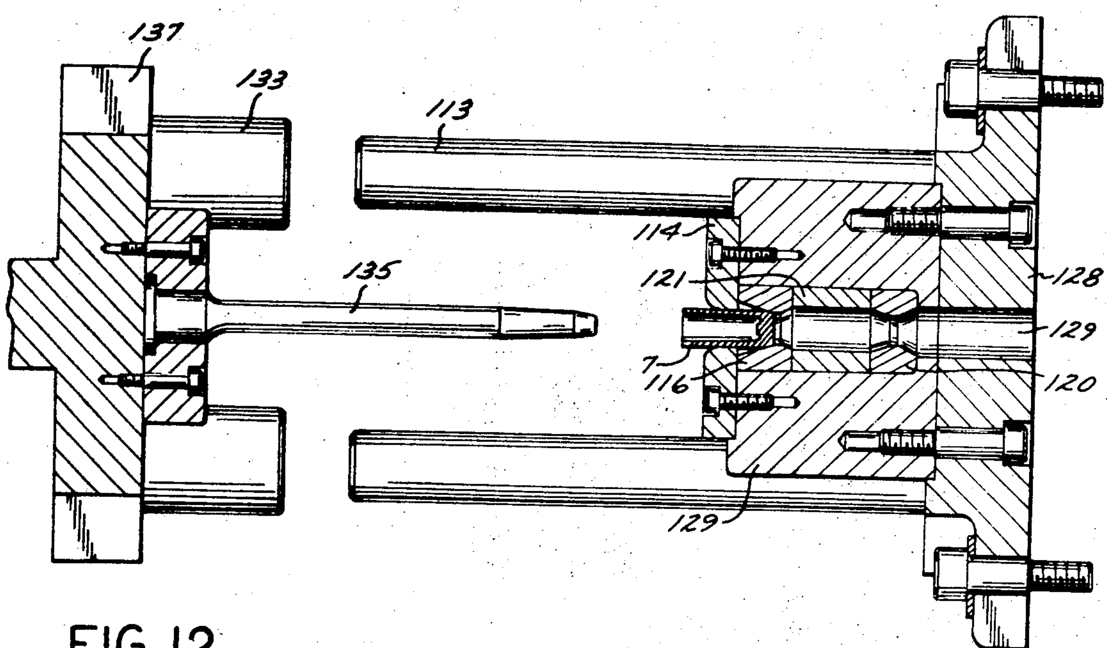

FIG.12

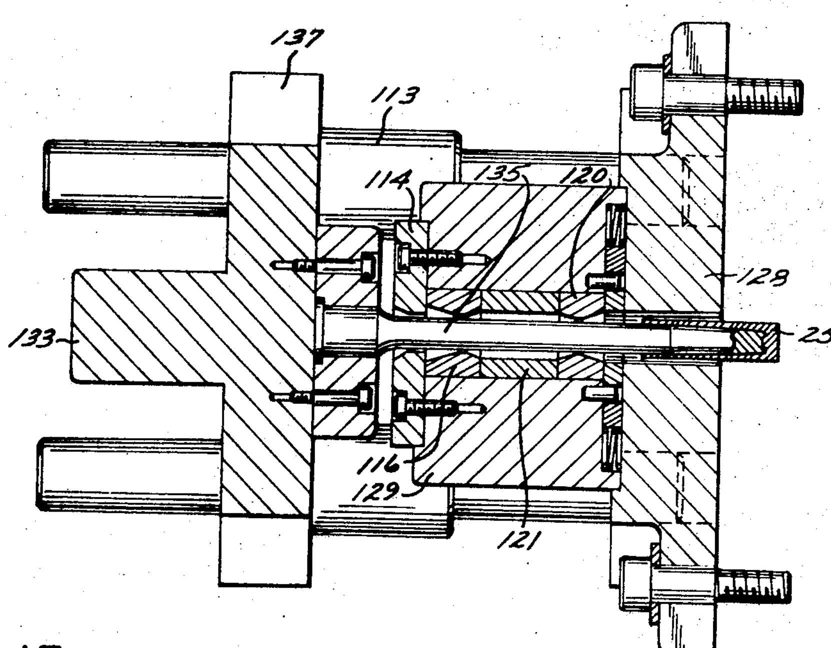

FIG.13

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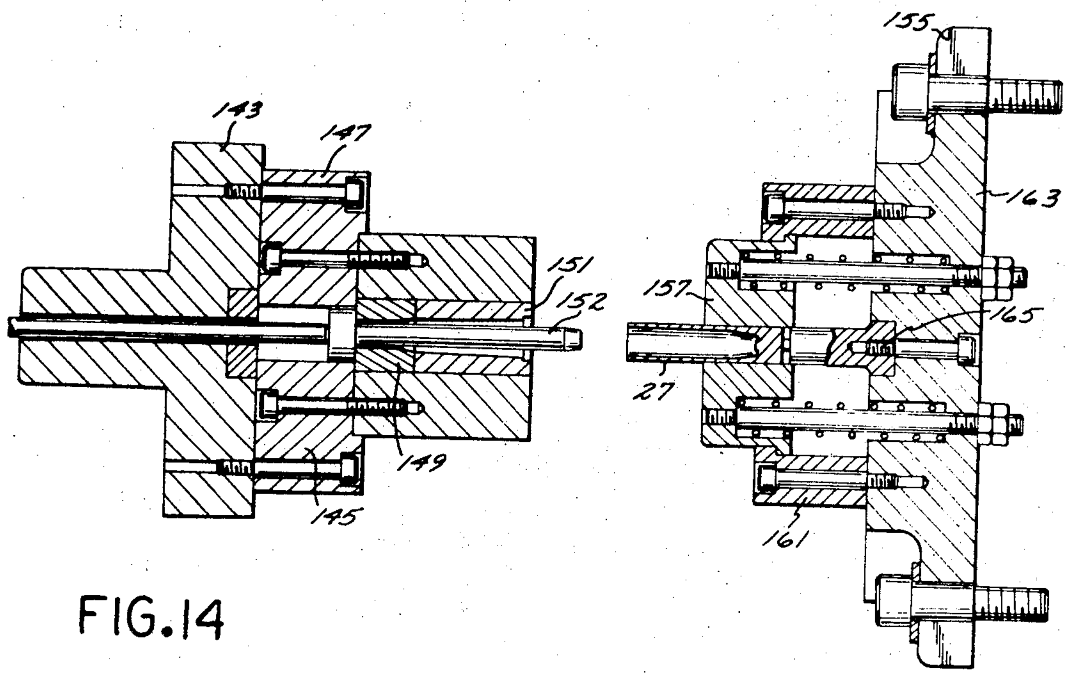

FIG.14

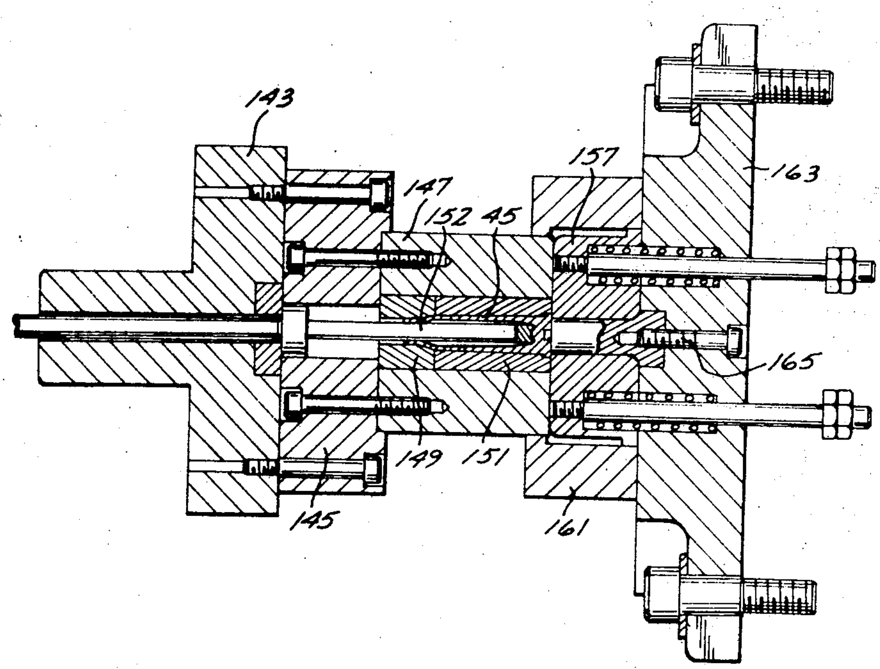

FIG.15

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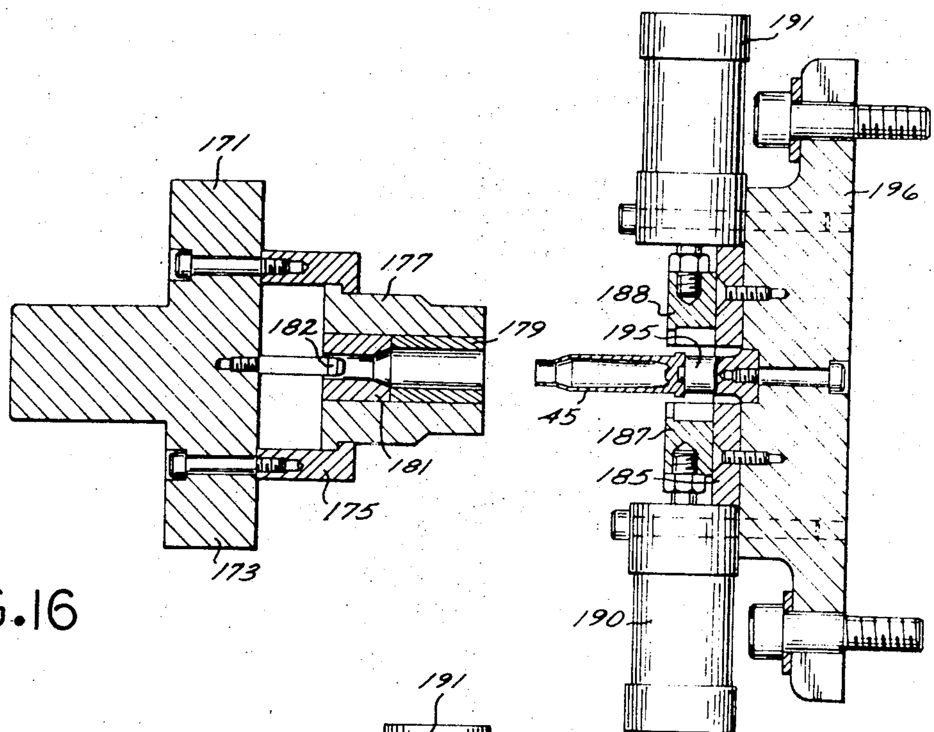

FIG. 16

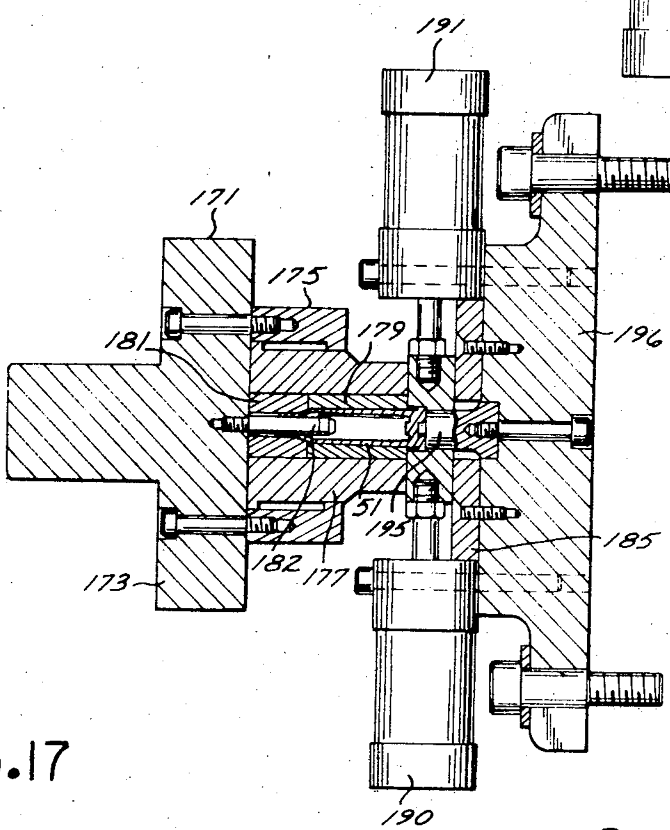

FIG. 17

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METHOD FOR THE MANUFACTURE OF AN ALUMINUM CARTRIDGE CASE

This application is a continuation-in-part of application Ser. No. 801,892, filed Dec. 16, 1968, which now abandoned was a divisional application of application Ser. No. 744,182, filed July 11, 1968 which issued as U.S. Pat. No. 3,498,221 on Mar. 3, 1970.

With the range and fire power of any given military aircraft being dependent to a considerable extent upon the weight of the ammunition being delivered to the target, it is extremely important to reduce as much as possible the weight of the individual ammunition round. Such light weight rounds are likewise valuable to the infantryman who must, in most instances, carry his own ammunition supply to the combat area. For these reasons, it is important to reduce the weight of the individual round and maximize the fire power per unit weight of ammunition delivered to the target area.

In this connection, it has been proposed to fabricate cartridge cases from a light weight aluminum alloy containing not over about one-half percent silicon, up to 8 percent copper, and up to 12 percent of magnesium (see U.S. Pat. No. 1,510,590). During the fabrication of a cartridge case from such aluminum alloys, it is necessary to employ a relatively large number of separate shaping steps, care being taken to stress relieve the metal by annealing between many of the separate shaping steps. Even with a relatively large number of incremental steps being used to shape the metal, cartridge cases produced in this manner are unreliable and often crack or rupture in the barrel when fired. Where such cartridge cases are loaded with a more powerful military charge, it is often necessary to reinforce the base of the case with a cup or ring of a harder material such as steel or bronze.

It has previously been suggested to fabricate an aluminum cartridge case having continuous metal flow lines which extend along the sidewalls and turn in the shape of an S inwardly within the base portion of the case (see U.S. Pat. No. 2,349,970). Although a cartridge case with such a continuous flow pattern appears desirable, it has been found that such cases often lack the needed strength in the base portion. As a consequence, the metal partition separating the primer cavity from the interior of the shell often expands or dishes outwardly during firing which in turn expands the primer cavity and allows the escape of gases from the rear of the case.

It is therefore a principal object of the invention to provide an improved light weight aluminum cartridge case suitable for use in both sporting and military applications.

Another object is to provide an improved and reliable aluminum cartridge case which can be manufactured with ease in production lots.

Yet another object is to provide an aluminum cartridge case fabricated in such a manner that the metal flow lines reinforce and strengthen the base portion of the case.

Still another object is to provide suitable aluminum alloys from which the improved cartridge case can be fabricated.

These and other objects and advantages of the invention will become apparent by reference to the following description, drawings, and claims appended hereto.

To attain the foregoing objects, a high strength cartridge case can be fabricated from an Al-Cu-Mg-Si type alloy by first backwardly extruding a solid cylindrical blank into a cup-shaped member followed by drawing to thin and elongate the walls thereof. It was surprisingly discovered that by using a blank of an aluminum alloy described hereinafter, at least about 90 percent of the metal in the original blank can be moved in the foregoing two operations and at least about 70 percent of the metal can be moved in the first extrusion operation. Many of the previously required metal working steps can thus be eliminated and it is now possible to successfully fabricate an aluminum cartridge case using less than half of the operations heretofore required.

A number of attempts have been made to fabricate a cartridge case from an Al-Cu-Mg-Si type alloy containing a miximum of about 0.5 percent silicon. Such cartridge cases, however, develop splits or cracks during either fabrication or firing, and cartridge cases made of such alloys are unsatisfactory in most instances due to their low strength and brittleness. It was, therefore, unexpected to discover that a high strength cartridge case having the desired ductility can be fabricated from an Al-Cu-Mg-Si type alloy when the silicon content thereof is at least about 0.9 percent by weight. Advantageously, a sufficient amount of silicon is used to react or combine with the magnesium to form the intermetallic compound Mg_2Si. Billets containing a relatively high concentration of silicon, above about 2.7 percent by weight, are difficult to form and it is therefore preferred to employ no more than about 2.2 percent by weight of silicon.

It has also been found that splitting and cracking of the case occurs during fabrication when any substantial amount of magnesium is present in a free and uncombined form. When substantially all of the magnesium is present as the intermetallic compound Mg_2Si in a precipitated form uniformly distributed in the alloy matrix, the alloy possesses satisfactory mechanical properties to be worked by the process herein. It is therefore preferred to employ in the alloy about 10 mole percent excess of silicon over and above the stoichiometric amount needed to react with the magnesium, thereby insuring that all magnesium present is combined in the form of the intermetallic compound Mg_2Si.

The incorporation of copper into the alloy also has been found to be important in providing the needed high strength, it being preferred to employ at least about 0.9 percent by weight of copper. In most cases, it is preferred to incorporate into the alloy a sufficient amount of copper to form from about 1.5 to 4.2 percent by weight of the intermetallic compound $CuAl_2$. When the copper is present in the form of $CuAl_2$, the alloy possesses the requisite strength without exhibiting undue brittleness which hampers fabrication.

Although the aluminum alloy composition can be varied to satisfy the requirements of strength and ductility for any given caliber of cartridge case, it is preferrable to employ for cartridges cases with calibers of from about 5 to 106 mm. an aluminum alloy containing from about 0.9 to 2.2, more preferably from about 1.2 to 2.0 percent by weight silicon; from about 0.6 to 1.5, more preferably from about 0.85 to 1.0 percent by weight magnesium; and from about 9.0 to 2.1, more preferably from about 1.2 to 1.8 percent by weight copper.

A particularly satisfactory aluminum alloy for use herein comprises, in percent by weight, about 1.5 percent silicon, 1.6 percent copper and 0.9 percent magnesium. As in the case of most of the conventional aluminum alloys trace amounts of iron, chromium, nickel, zinc, titanium, and other common trace impurities can be present in the alloys.

The invention is illustrated further in several typically preferred embodiments in the accompanying drawings in which:

FIG. **1** is a sectional view of a solid metal blank from which the cartridge case of the present invention is fabricated.

FIGS. **2** to **5** are cross-sectional views of some of the intermediate shapes formed from the metal blank.

FIG. **6** is a sectional view of a cartridge case fabricated according to the present invention.

FIGS. **7** and **8** are fragmentary sectional views of several cartridge cases produced according to the prior art, each of these views showing a conventional pattern of metal flow lines in the end portion of the case.

FIG. **9** is a fragmentary sectional view showing the metal flow lines in the end portion of a cartridge case produced according to the present invention.

FIGS. **10** and **11** are side elevational views partly in cross-section of apparatus for backwardly extruding a cup-shaped member from a solid blank.

FIGS. **12** and **13** are side elevational views partly in cross-section of apparatus for drawing the sidewalls of the cup-shaped member.

FIGS. **14** and **15** are side elevational views partly in cross-section of an apparatus for tapering and necking the sidewalls of the member as well as forging a primer cavity in the end portion thereof.

FIGS. **16** and **17** are side elevational views partly in cross-section of a sizing punch and necking die in which the final necking operation is carried out.

Referring now to the drawings, the cylindrical blank indicated generally at **1** in FIG. **1** is backwardly extruded into a cup-shaped member **7** (FIG. **2**). The blank **1** which is sized to fit snugly into an extrusion die cavity is cut to length from an extruded rod which has preferably been deep drawn to effect an elongation thereof to at least about 15 percent. The cup-shaped member **7** comprises a base portion **9** having a boss **15** on its inner surface **12** with a bevelled sidewall **10** adjacent the circular end surface **11**, and cylindrical sidewalls **17** with a thickened portion **19** adjacent the base portion. By drawing member **7** through a die aperture having a reduced diameter, an elongated cup-like member **25** is produced with relatively thin cylindrical walls **27** such as shown in FIG. **3**. Before any further shaping, excess metal is preferably removed from the open end of member **25** by trimming off the end, the case then being solution heat treated and quenched in cold water to metallurgically strengthen the case.

Thereafter, in a combined operation, the walls **27** of member **25** are tapered as at **31**, the open end is sunk to form neck **35** having a reduced diameter, a primer cavity **39** is forged in the end surface **11** of base portion **9**, and an outwardly projecting flange **41** is formed on the sidewall at the end of the base portion, the resultant shaped member **45** being depicted in FIG. **4**. Another separate sinking operation can then be carried out on member **45** to form a smaller neck **47** having a contour as shown in FIG. **5**, the finally necked member **51** then being machined to form groove **55** in the base portion **9** and a central bore **59** extending from primer cavity **39** through boss **15** into the interior of the completed cartridge case **61**, as shown in FIG. **6**.

When metal is deformed or worked in order to form for example, the cartridge case **61**, the grains of metal are established along the lines of flow which are oriented in the direction of working. These flow lines are sometimes sufficiently distinct as to be visible to the eye, although they are most often made visible by etching a cross-section. To better illustrate the cartridge case **61** of the present invention, the flow line pattern thereof is compared with the flow line pattern of cartridge cases produced by conventional methods.

The prior art cartridge case **65** illustrated in FIG. **7**, and having the same reference numerals indicated in FIG. **6**, is made by the conventional methods of cupping and drawing rolled stock. Starting with a rolled plate having a substantially uni-directional grain orientation lying in the direction of rolling, the case **65** is produced with only a portion of the flow lines of the metal extending along the cross-section of the case parallel to the longitudinal axis, such as the flow lines **66** on the right side of case **65** in FIG. **7**. The remaining flow lines are transverse to the longitudinal axis of the case and lie normal to the cross-section thereof, the ends **67** of these flow lines being illustrated as on the left side of FIG. **7**. Cartridge cases lacking bilateral symmetry in the metal flow lines are unreliable in many instances due to the variation in strength and ductility of the case.

FIG. **8** illustrates yet another conventional cartridge case **71**, made by extruding a slug having a central aperture therein. Although the flow lines **72** are bilaterally symmetrical, only a relatively few flow lines can be seen in the boss area of the head where high strength is needed. Without a relatively high concentration of such flow lines in the head area, deformation and/or dishing of the boss area of the base can occur during firing.

By carrying out the manufacture of a cartridge case according to the methods of the present invention described hereinafter, the metal flow lines are bilaterally symmetrical and concentrated in the base portion as shown in FIG. **9**. In this cartridge case **61**, the metal flow lines extend to and terminate at the end surface **11** of base portion **9**, one set of flow lines **74** extending parallel to the longitudinal axis of the case from end surface **11** and along sidewall **31**, another set of flow lines **75** extending in a curved pattern from the surface **12** of boss **15** and central bore **59** to the end surface **11** of the base. To provide the needed strength in the base portion **9**, a majority of the flow lines **75** follow the contour of the walls of primer cavity **39**.

Satisfactory reinforcement of the base portion **9** between the primer cavity **39** and the interior of the case can be achieved by having a boss **15** formed on the inner surface **12** of the base as shown in FIGS. **6** and **9**. Dishing of the base, even with such a boss, can occur unless the boss is of sufficient size and strength to provide the needed reinforcement of the base **9** to use a volume of metal in forming the boss which is at least about equal to the volume of the central bore **59**. Although the size of central bore **59** varies with the caliber of the cartridge case, it was found that dishing of the base was prevented by having a boss on inner surface **12** with at least that volume of metal which is removed from the base in forming central bore **59**.

In repeated firing tests with 7.62 caliber cartridge cases of the present invention, using both civilian primers as well as more powerful military primers, no more than the normal deformation of the metal occurred in the head area and dishing of the head which is so prevalent in prior art cases was eliminated. Without the advantageous metal flow lines as shown in FIG. **9**, the splitting and cracking of the case occurs, and, in such instances, the case becomes jammed in the barrel and often cannot be ejected.

Fabrication of the cup-shaped member **7** can be carried out in a die set such as shown in FIG. **10** which comprises a punch assembly indicated generally at **83** and a die assembly **91**. A die insert **93** in which blank **1** rests is held securely in die retainer **97** by means of armor ring **95**. These stacked die members are held securely on a lower die shoe **100** which is preferably provided with a reciprocating spring-loaded lower punch **103** to hold the blank positioned in die **93**. Also mounted on lower die shoe **100** is a hard plate **105** to eliminate brinelling of the lower die shoe, and a stripper **107** for removal of the resultant cup-shaped member **7** from extrusion punch **85** which is secured to upper die shoe **89** by punch holder **86**. In this first shaping operation, the head of punch **85** moves through an aperture in the stripper **107** into contact with blank **1**, the blank being backwardly extruded and flowing in the annulus between the cavity in die **93** and the surface of the punch as shown in FIG. **11**. According to the present invention, at least about 70 percent of the metal in blank **1** is moved in this backward extrusion to form the resultant cup-shaped member **7** (FIG. **2**).

Removal of cold work stresses in member **7** resulting from the extrusion can be effected in a partial annealing step by heating to from about 600° to 725° F. for from about one-fourth to one-half hour. Advantageously, the cup-shaped member **7** is lubricated before elongation with a conventional lubricant such as a drawing compound.

Drawing of member **7** to thin and elongate the sidewalls thereof can then be carried out in a draw punch assembly, such as shown in FIGS. **12** and **13**, which comprise a die assembly **113** and a reciprocating punch assembly **133**. The cup-shaped member **7** is first inserted into the aperture in the nest member **114** which hold a first and second die insert **116**, **120**, respectively. A die spacer **121** intermediate the die inserts hold them stationary in retainer member **129** which is affixed to lower die shoe **128**.

In operation, the draw punch **135** affixed to upper die shoe **137** moves into the open end of the cup-shaped member **7** and forces it through the tandem die lands of the first and second dies **116**, **120**. As the sidewalls of member **7** are forced between the die lands and the surface of the punch, the yield point of the metal is exceeded and the sidewalls are permanently deformed. The resultant drawn member **25** then exits through aperture or hold **129** in die shoe **128** as shown in FIG. **13**. According to the present invention, the above-described drawing step can be carried out using either one die or several tandem draw dies, it being preferred to effect in the drawing operation a total metal movement of the original blank **1** of at least about 90 percent. In most cases, the drawn member **25** has been elongated to a length slightly greater than desired to permit more accurate subsequent cutting of the member to the desired length.

After drawing, member **25** is then preferably solution heat treated to obtain the optimum metallurgical and mechanical properties. Although the conditions of the heat treatment can be varied to effect the desired mechanical properties of the metal, it is preferred to heat treat members fabricated from the above-described alloys at a temperature of from about 990° to 1,015° F., and particularly at about **1,000**° F. for about 10 minutes to 2 hours, more preferably from about 15 minutes to 1 hour.

According to a preferred embodiment of the present invention, a combined shaping operation can then be carried out to head, taper, neck, and forge a primer cavity in the heat treated member **25**. The punch and die assembly used in this operation and as shown in FIG. **14** comprises an upper die shoe **143** having connected thereto a die spacer **145**, a die retainer **147** which holds neck die insert **149** with body die insert **151**, and a movable heading punch **152**. Member **25** is first inserted into and held by a die assembly indicated generally at **155** which comprises a nest **157**, index ring **161**, lower die shoe **163**, and punch **165**.

With the strength resulting from the previous cold work having been removed or neutralized by the solution heat treatment, it is desirable to increase the strength in the base portion of the case in the remaining shaping operation. This can be conveniently accomplished by forging a flange **41** together with a primer cavity **39** in the base portion of member **25**. It has been found that a cartridge case with an exceedingly strong base portion can be produced by imparting to the base during the forging operation at least about 15 percent cold work, and preferably between about 15 and 22 percent cold work. Cartridge cases produced in this manner are found to be highly reliable and failures about the base portion and particularly in the primer pocket area have been eliminated.

The combined operation is commenced by moving the inner surface of boss **15** into engagement with punch **152** and simultaneously forcing the sidewalls **27** of member **25** to assume the shape of dies **149** and **151**. At the same time, punch **165** moves forward in lower die shoe **163** to form flange **41** on the base as well as primer cavity **139**, thereby producing member **45** (FIG. **15**). As can be seen, the sidewalls in contact with die **151** taper slightly and the end portion of the sidewalls are sunk considerably in die **149** to form neck **35** having a substantially reduced diameter.

The diameter of the primer cavity formed in the base of conventional brass cartridge cases is ordinarily from about 0.1 to 0.4 percent smaller than the diameter of the brass primer to be sunk therein. When a series of test firings were made using military brass primers in aluminum cartridge cases with these same tolerances, it was found that a substantial number of the rounds were defective in that the propellant gases escaped rearwardly from the primer cavity. It was unexpectedly discovered, however, that gas leaks around the primer could be completely eliminated by sizing the diameter of the primer cavity from about 1.0 to 1.5 percent smaller than the diameter of the primer to be sunk therein. By employing such a smaller size of primer cavity, it was found that conventional brass military primers are compatible with the aluminum cartridge case of the present invention.

The resultant forged member **45** is then preferably precipitation heat treated at a relatively low temperature of from about 310° to 350° F. for from about 10 to 24 hours to increase the hardness and strength thereof.

Thereafter, member **45** is subjected to a final necking operation in the apparatus shown in FIGS. **16** and **17** which includes a punch assembly **171** having an upper die shoe **173**, index ring **175**, die retainer **177**, retaining die insert **179**, final sizing and necking die **181**, and a sizing punch **182**. The forged member **45** is held against the head of lower punch **195** which is movable in lower die shoe **196** and nest **185**. A pair of plates **187**, **188** which are actuated by hydraulic cylinders **190**, **191**, respectively, or other mechanical means, hold member **45** securely against the head of the lower punch. As member **45** moves into the die cavity in dies **179**, **181**, punch **182** moves forward into the neck thereof to maintain the proper shape and thickness of the wall portion being sunk, the resultant finally necked member **51** being produced as in FIG. **17**.

Structurally adequate and reliable cartridge cases are produced by the method of this invention, whereas conventional prior art methods described heretofore have produced cartridges which are unreliable in many instances. One of the basic reasons for the reliability of the cartridges of the present invention is the flow line pattern obtained in the cartridge cases by the methods employed by this invention. Essentially, the flow line pattern is obtained by the fact that the cartridge production is accomplished basically in two steps, i.e., the backward extrusion and the drawing steps, the combination of which results in a total metal movement in the original blank of at least 90 percent. By these two steps, many of the previously required prior art metal working steps are eliminated. Due to the process design of the tools described herein, it is possible to move sufficient heat treated metal in the two steps which strengthens the critical areas of the cartridge case, i.e., the head and primer cavity.

The contour of the nose of the punch and the size of the die cavity is determinate of the true metal flow. When the punch comes into contact with the blank and continues therethrough, the area ahead of the punch increases whereby the metal becomes plastic and consequently flows up and around the punch. The metal is severely worked and due to this cold working, the metal is further refined. The fact that the total metal movement is at least 90 percent and thereby almost all of the metal has some cold work refinement of the grain structure, the shape and curvature of the plunger or impact punch in conjunction with the die cavity are important for maximum metal movement to obtain the structural reliability of the cartridge case.

Another advantage of the present invention is that the method only requires two annealing steps, i.e., on the original blank and the cup-shaped member formed from the backward extrusion. All of the remaining shaping operations are accomplished in the solution heat treated condition.

Reference herein to a percentage movement of metal in the extrusion and drawing steps is defined as a percentage reduction of the original cross section of the blank. Thus, when 70 percent of the metal in the blank is moved during the backward extrusion, this means that there is at least 70 percent reduction in the original cross-section of the blank.

The cartridge cases produced heretofore by the various manufacturing techniques all require that the neck portion of the case be selectively annealed to soften the metal and facilitate flexing thereof during firing. As a result of this latter annealing step, the hardness of the case varies considerably between its ends. For example, most military specifications require a selective annealing of the neck so that the base portion of the cartridge case will be at least about 50 percent harder than the neck portion. It was therefore unexpected to find that a high strength and reliable cartridge case could be produced according to the present invention without such a selective annealing of the neck, and with no more than about an 8 percent variation in hardness the case would possess the required strength and ductility. Using the alloys and fabrication techniques of the present invention, a reliable cartridge case can be produced having a base portion which is about 5 percent harder than the sidewall portion.

From the foregoing description, one skilled in the art can easily ascertain the essential characteristics of this invention, and without departing from the spirit and scope thereof, can make various changes and modifications of the invention to adapt it to various usages and conditions. Consequently, such changes and modifications are properly, equitably, and intended to be, within the full range of equivalence of the following claims.

What is claimed is:

1. A method for the manufacture of an elongated, cup-shaped aluminum member having a base portion and a side wall portion comprising the steps:
   a. forming a cup-shaped member from a cylindrical, aluminum blank by movement of at least 70 percent of the total metal in said blank by backward extrusion;
   b. partially annealing said cup-shaped member;
   c. drawing said annealed cup-shaped member through a die aperture of reduced diameter to thin and elongate the walls thereof,

whereby the effect of the backward extrusion step combined with the drawing step results in a total metal movement in the original blank of at least 90 percent.

2. The method of claim 1 wherein the aluminum blank is an extruded rod which has been deep drawn at least about 15 percent.

3. The method of claim 1 wherein the said aluminum blank is an aluminum alloy comprising, in percent by weight, from about 0.9 to 2.1 percent copper, from about 0.6 to 1.5 percent magnesium, and from about 0.9 to 2.2 percent silicon.

4. The method of claim 1 wherein said annealing step (b) comprises heating to from about 600° to 725° F. for from about one-fourth to one-half hour.

5. The method of claim 1 wherein said elongated cup-shaped member produced from step (c) is solution heat treated at a temperature of from about 990° to 1,015° F. for from about 10 minutes to 2 hours.

6. In a method for the manufacture of an elongated metal cartridge case formed from aluminum comprising a base portion having a primer cavity and a boss on its inner surface, and a side wall portion, said base portion being significantly harder than said side wall portion, the steps comprising:

a. forming a cup-shaped member having a base portion with a boss on its inner surface from a cylindrical aluminum blank cut from a deep drawn extruded rod, by movement of at least 70 percent of the total metal in said blank by backward extrusion;
b. partially annealing said cup-shaped member by heating to from about 600° to 725° F. for from about one-fourth to one-half hour;
c. drawing said cup-shaped member through a die aperture of reduced diameter to thin and elongate the walls thereof, whereby the effect of the backward extrusion step combined with the drawing step results in a total metal movement in the original blank of at least 90 percent;
d. solution heat treating the elongated cup-shaped member by heating at a temperature of from about 990° to 1,015° F. for from about 10 minutes to 2 hours; and
e. forging a primer cavity in the base portion to impart at least about 15 percent cold work thereto.

7. A method for the manufacture of an elongated metal cartridge case formed from aluminum comprising a base portion having a primer cavity and a boss on its inner surface, a central bore passing through said boss, and a side wall portion, said base portion being significantly harder than said side wall portion, the steps comprising:

a. forming a cup-shaped member having a base portion with a boss on its inner surface from a cylindrical aluminum blank by movement of at least 70 percent of the total metal in said blank by backward extrusion;
b. partially annealing said cup-shaped member by heating to from about 600° to 725° F. for from about one-fourth to one-half hour;
c. drawing said cup-shaped member through a die aperture of reduced diameter to thin and elongate the walls thereof, whereby the effect of the backward extrusion step combined with the drawing step results in a total metal movement in the original blank of at least 90 percent;
d. solution heat treating the elongated cup-shaped member by heating at a temperature of from about 990° to 1,015° F. for from about 10 minutes to 2 hours;
e. shaping said solution heat-treated elongated, cup-shaped member in a combined operation comprising tapering of the side wall portion, sinking the open end to form a neck of reduced diameter, and forging a primer cavity and flange in the base portion to impart at least about 15 percent cold work thereto; and
f. forming a central bore through said boss extending from said primer cavity.

8. The method of claim 7 wherein said cartridge case produced from step (g) is precipitation heat treated at a temperature of from about 310° to 350° F. for from about 10 to 24 hours.

9. The method of claim 7 wherein said aluminum blank is an extruded rod which has been drawn at least 15 percent.

10. The method of claim 7 wherein said blank is an aluminum alloy, comprising in percent by weight, from about 0.9 to 2.2 percent silicon, from about 0.6 to 1.5 percent magnesium, and from about 0.9 to 2.1 percent copper.

11. In a method for the manufacture of an elongated metal cartridge case from aluminum wherein said cartridge case comprises a base portion having a boss on its inner surface with a central bore passing through said boss, and a side wall portion, the flow lines extending to and terminating at the end surface of the base portion, one set of flow lines extending substantially parallel to the longitudinal axis of the case from the end surface and along the side wall portion, another set of flow lines extending in a curved pattern from the surface of the boss and central bore to the end surface of the base, said base portion being significantly harder than the side wall portion, the steps comprising:

a. forming a cup-shaped member having a base portion with a boss on its inner surface from a cylindrical aluminum blank cut from a deep drawn extruded rod, by movement of at least 70 percent of the total metal in said blank by backward extrusion;
b. partially annealing said cup-shaped member;
c. drawing said cup-shaped member through a die aperture of reduced diameter to thin and elongate the walls thereof, whereby the effect of the backward extrusion step combined with the drawing step results in a total metal movement in the original blank of at least 90 percent;
d. solution heat treating the elongated cup-shaped member by heating at a temperature of from about 990° to 1,015° F. for from about 10 minutes to 2 hours;
e. forging a primer cavity in the base portion to impart at least about 15 percent cold work thereto; and
f. forming a central bore through said boss extending from said primer cavity.

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