

Sept. 22, 1959

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2,904,873

DRAWN STEEL CARTRIDGE CASE AND ITS MANUFACTURE

Filed Sept. 12, 1956

3 Sheets-Sheet 1

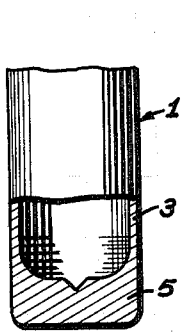


FIG. 1

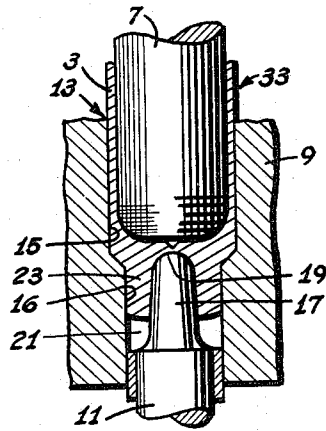


FIG. 2

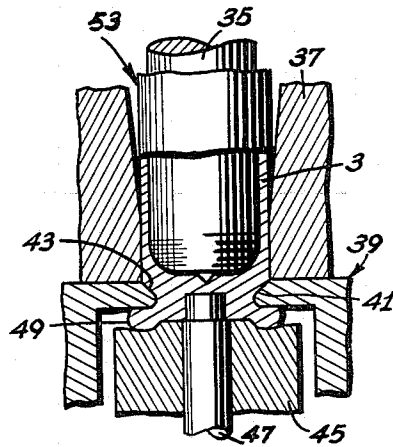


FIG. 3

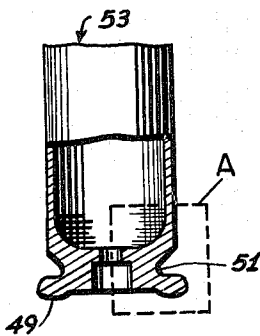


FIG. 4

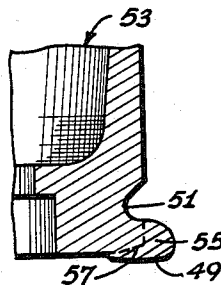


FIG. 5

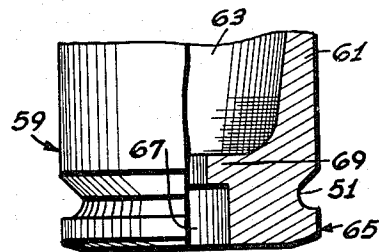


FIG. 6

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3 Sheets-Sheet 2

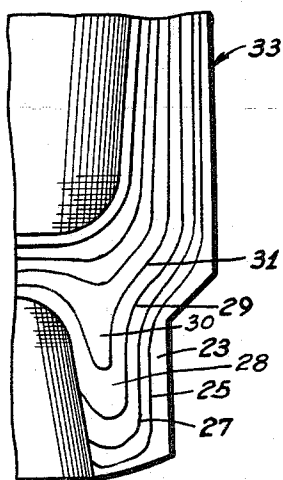


FIG. 7

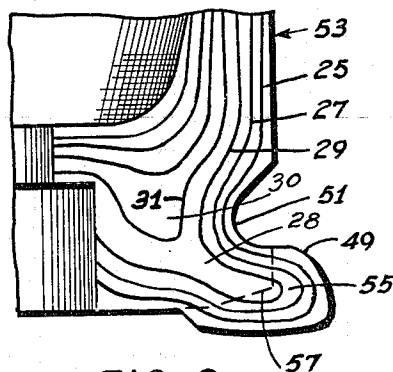


FIG. 8

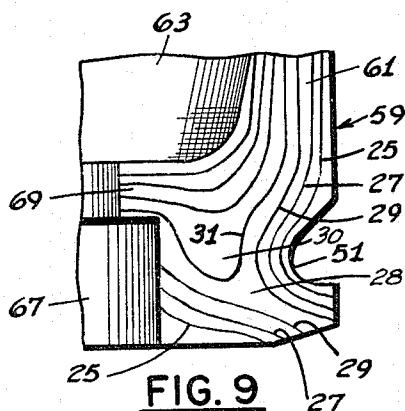


FIG. 9

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3 Sheets-Sheet 3

Fig.10

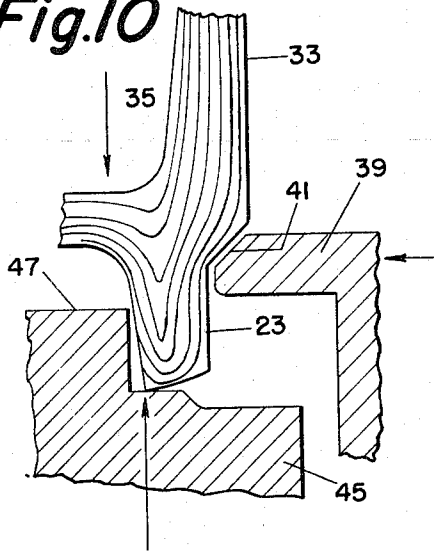


Fig.11

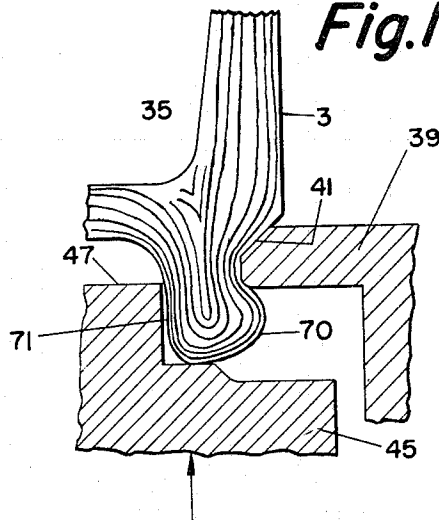


Fig.12

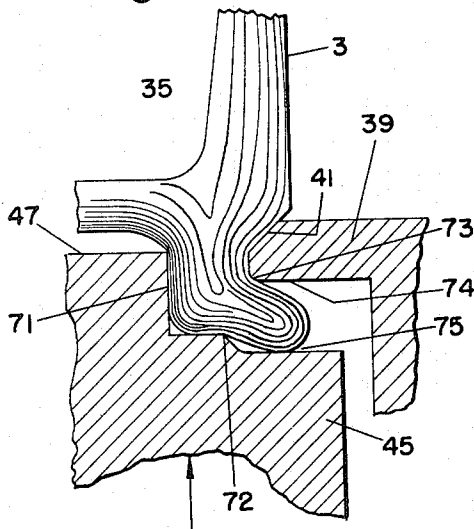
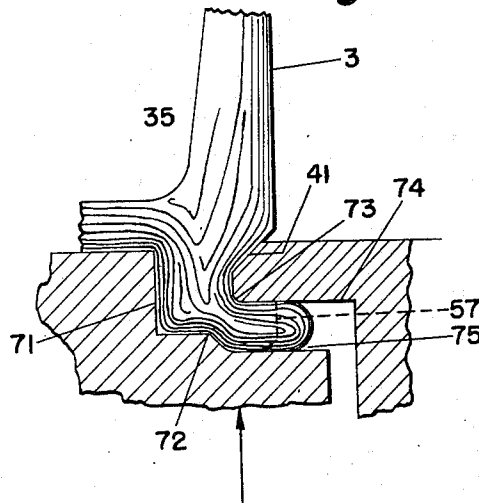


Fig.13



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1

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DRAWN STEEL CARTRIDGE CASE AND ITS MANUFACTURE

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Application September 12, 1956, Serial No. 610,047

5 Claims. (Cl. 29—1.3)

This invention relates to a drawn steel cartridge case and its process of manufacture and has for an object to provide a cartridge case of steel which is adapted to be extracted from a gun after firing, without danger of rupture of the base flange engaged by an extractor especially at low temperatures. Another object is to provide a method of manufacture for such a cartridge case.

The most common type of cartridge case has been of brass because of its ability to be worked and because brass seems to retain its ductility throughout the fabrication of such a case. For well over three decades there has been a need for a steel cartridge case due to the possibility of the supply of the components of brass being stopped when largely from out of this country, and the realization that in time of national emergency steel would be available where brass might not be plentiful. In the face of that old need no satisfactory steel cartridge case has been developed probably due to the fact that no satisfactory way of manufacturing it has been devised. The present invention fills that old need better than have any of the many prior art attempts. One evidence of this fact is found in ability of the extractor flange on the base of this steel cartridge case to withstand the stress of extraction after firing a 20 mm. cartridge case at an extremely low sub-zero temperature without fracture. On firing, the gas pressure of the exploding propelling charge swells the steel cartridge case into tight contact with inner wall of the chamber making extraction of the case difficult. With the development of higher gas pressures in anti-aircraft ammunition the problem became still more difficult. A common way that a steel cartridge case of the prior art failed was by rupture of the base flange engaged by the extractor.

It is known that when almost any cartridge case of steel after being cold worked is longitudinally cut in halves and the cut face etched and polished, that the flow lines revealed therein indicate the strength or weakness of the metal and the direction under which fracture may occur. Rupture under shear or flexure in a base flange would be likely to occur along or longitudinally of the flow lines. In drawn metal cases it is not feasible to have the flow lines all parallel to the opposite faces in the base flange and also parallel to the curvature of the extractor groove.

According to this invention the base flange is made under conditions of free and unimpeded yet directed or controlled radial outward flow of metal to minimize the danger of the flow lines not being in the right direction. The flow lines in the flange being formed have U-shaped bends in a radial outer portion, such bends connecting generally parallel lines about equally distant from each face. Each such U bend is the radial outer terminus of almost each flow line. It is appreciated that each U bend in the flow lines has too large a part of its length at an angle to the opposite faces of the flange to make the flange as strong as it should be. Therefore, to enhance the flange strength, the radial outward guided but free flow of metal has been continued until a major portion

2

of all such U bends in the flow lines are radially outside the diameter of the cartridge case walls, thus leaving a majority of the flow lines within that diameter parallel to the opposite faces of the base and conforming to the curvature of the groove. To remove the weakness, the outer part of the flange containing a majority of such U bends has been cut off and scrapped. While a small minor part of the former total number of horizontally disposed U bends remain, they are not on an outer surface of the flange so that the inherent weakness in U bends in the flow lines is located in a transverse mid-portion of the flange where fiber stresses in flexure are smaller than on the flange faces, unlike the prior art.

Features in the process of forming the stronger steel cold worked cartridge case of this invention include not only the controlled free radial outward flow of base material and the cutting off of most of the weak U bends, but also a preliminary free flow of metal longitudinally for a twofold purpose. One of those is to have the flow lines in a position ready for the radial outward free flow of metal. The second is to have this longitudinally flowed metal in position for strengthening primer pocket.

Fig. 1 shows the work after it has been preliminarily cupped and drawn.

Fig. 2 shows the work after it has been preheaded.

Fig. 3 shows the work at substantially the conclusion of the heading operation.

Fig. 4 shows the work at the end of the heading operation after it has been removed from the tools and die in which formed.

Fig. 5 is an enlarged longitudinal section of a lower portion of the cartridge case before the outer part of the flange is cut off.

Fig. 6 is a view of the base end of the finished cartridge case partly in section after the flange has been partly cut off.

Fig. 7 is an enlarged view of the prehead in longitudinal section after the section has been polished and etched to show the flow line structure.

Fig. 8 is an enlarged view corresponding to Fig. 5, showing the general flow line structure as it was believed to be about four years ago.

Fig. 9 is a view corresponding to Fig. 8 after an outer portion of the base flange has been cut off.

Figs. 10 to 13 show successive steps in formation of the head from the prehead and show in greater detail the approximate flow line structure at each step.

To form the drawn cartridge case of this invention a disc of SAE 1030 steel known as MILS 3289 containing .25 to .35 carbon is cupped and drawn in a manner well-known to those skilled in this art, to form the hollow cylindrical body 3 having a thick base 5 closing one end as shown in Fig. 1. After the cupping operation the work is annealed and it is likewise annealed after each of the first and second drawing operations, but no more annealing takes place later. After the second drawing operation and annealing, the open end of the cartridge case is trimmed, after which it is subjected to a third and fourth drawing to lengthen the same. There is then a second trimming operation. These operations need not be illustrated or described since they are well-known in the art.

A preheading operation is performed as shown in Fig. 2 with the head of a stationary anvil 7 snugly fitting within the hollow body 3, which is surrounded by a die or matrix 9, a movable punch 11 engages the opposite side of the base from that on which the hollow body was formed, such punch moving into the base causes the metal of the base to be cold flowed longitudinally. The walls 15 of the cylindrical cavity 13 in the die 9 preclude the metal bulging radially outwardly. In the die

9 is shown a cavity 16 of reduced diameter so that as the metal is flowed longitudinally it is guided in its free flow by the upper end of the punch 11 in the walls 16 of the cavity. The tip 19 of the punch 11 is rounded to facilitate the flow of metal and it is important that a space 21 always remain at the extremity of the annulus or prehead 23 to insure the longitudinal flow of metal being as free as is possible without any compacting of the metal or congestion of the flow lines 25, 27, 29 and 31. This is shown in Fig. 7. There may be additional flow lines in the spaces 28 and 30 of the preheaded case 33 as shown in Figs. 7 to 9.

In Fig. 3 during the heading operation illustrated, another anvil 35 is inserted within the cartridge case surrounded by the die 37. At the end of the prehead a pair of semicircular jaws 39 engage the work to constitute a sizing ring. The curved walls 41 of these jaws are provided with the chamfer 43 to engage the corresponding bevel shown in Fig. 2 for the purpose of preventing any distortion of the work in the portion engaged between said semicircular jaws 39. For engaging the longitudinal end of the prehead, there is providing a sizing punch 45 having an insert 47 which latter limits the radial inward flow of metal in the formation of the primer pocket 67 shown in Figs. 6 to 9. At the conclusion of the heading operation shown in Fig. 3 a flange 49 is formed.

The semicircular jaws 39 when removed from the finished product result in a groove 51 having been formed just above the base flange 49 as shown in Fig. 4 in which this flange 49 is larger than is desired. The enlarged longitudinal section shown in Figs. 5 and 8 is that within the rectangle A in Fig. 4. The reference numeral 53 designates the unfinished cartridge case. The outer end portion 55 of flange 49 is later cut off along the broken line 57 to form the finished cartridge case 59 as shown in Figs. 6 and 8. This finished product has the usual propellant chamber 63 and is provided with a flange or head 65 radially within which is a primer pocket 67, with the wall 69 between the primer pocket 67 and propellant chamber 63 having been pierced as illustrated.

A reason for cutting off the radially outer end portion of the base flange is shown in Fig. 9. It is known that a maximum resistance to flexure and shear is offered where the flow lines in the flange 65 are normal to the applied force in extraction and parallel to the groove curvature or in other words when the flow lines are substantially parallel to the curvature in the base of the groove and to the forward and rearward faces of the base flange. The metal of the base would be weakest where the flow lines to extend longitudinally of the cartridge case. In the outer cut off portion of the flange the flow lines have a portion extending longitudinally, that is at the tip of the U-shaped bends in these flow lines. The curved portions of the flow lines each side of the centers of the U bends are weaker in shear and flexure than the portion of the base flange remaining. This is why it is necessary to cut off the radially outer part of the base flange. While it is true there may be additional flow lines within the spaces 28 and 30, any U bends in these inner flow lines being midway between the flange faces are protected by a strong metal portion adjacent the forward and rear surface of the flange. The former Figs. 8 and 9 exemplify the reason for cutting off the outer portion 55 but are not nearly as accurate in portrayal of flow line congestion around the primer pocket 67, as is the showing in Figs. 10 to 13.

Referring to the newly added Figs. 10 to 13 it will be seen that in Fig. 10 with the sizing jaws 39 in position, the anvil 35 within the preheaded case 33, the die 37 surrounds the work as shown in Fig. 3 but this die is not shown in Figs. 10 to 13 for the purpose of clarity. Fig. 10 thus shows the beginning of the heading operation after formation of the prehead shown in Fig. 2 when the sizing

punch 45 with its insert 47 is moved into engagement with the outer end portion of the prehead or annulus 23 causing the metal in this annulus to be compressed and cause a bulge radially both inwardly and outwardly. In Fig. 11 the inward bulge has been impeded by the end of insert 47 acting as an abutment to limit radial inward flow of metal. However, radial outward flow of metal as shown at the bulge 70 is free and not impeded. The result is that the abutment 47 causes the flow lines adjacent to it to be compacted or moved closer together as shown at 71 as the prehead is upset. In Fig. 12 the insert 47 continues to act as an abutment causing the flow lines adjacent to it to be moved still closer together while the radial outward bulge is much more pronounced with the flow lines following the pattern illustrated. The edge 72 on the sizing punch 45 and the edge 73 on the sizing ring 39 together cooperate to constitute a constriction through which the metal freely flows radially outward. Fig. 12 also shows how the radial outward flow of metal is not impeded by any radial outer wall. Fig. 13 corresponds to Figs. 10 to 12 but with the heading operation having reached its termination. This figure of the drawings shows how the flow lines have been moved together from the metal having been compacted around the primer pocket making it stiffer and stronger to resist gas pressure on firing. It will be seen from Fig. 13 how the adjacent guide surface 74 comes into full frictional contact with the metal only just before the completion of the heading operation. The outer part of the flange is cut off along the broken line 57 as previously mentioned in Fig. 5.

Among the advantages of the present invention may be mentioned first the providing of a stronger than usual base flange due to the absence of U bends in the flow lines and the presence of compacting of metal around the primer pocket and the free radial outward flow of metal. Where the radial outer flow is not impeded by any radial outer wall, the flow lines adjacent the forward and rearward surfaces of the flange are generally parallel to those surfaces and to the curve in the groove 51 indicating maximum resistance to the stress of extraction after removal of the portion 55. Although there may be a horizontal U bend in some remaining portion of the flange flow lines, such weaker portion is protected by the stronger outer surfaces of the flange faces after a major portion of the U bends have been cut off. In Fig. 13 it will be seen the free radial outward flow of metal is continued until the majority of the U bends in the flow lines are radially outside the outside diameter of the cartridge case walls. Another advantage of the present invention not shown in Figs. 8 and 9 but better presented in Figs. 10 to 13 inclusive, is the compacting of the metal and flow lines to strengthen the metal in the side walls of the primer pocket. The radial outward flow of metal in Fig. 12, encounters more frictional contact with the face 75 of the punch 45 than with the face 74 of the jaws 39. This results in slightly more compacting of the metal against face 75 than against face 74.

The process of this invention, so far as is known, is useful only for production of the product herein claimed, and the product of this invention is capable of being made in no other way than by the herein process, so far as is known.

This application is a continuation-in-part of prior application Serial Number 301,823 filed July 31, 1952, now abandoned, for Plastically Formed Head for a Cartridge Case.

I claim:

1. In the process of forming a steel cartridge case comprising cupping and drawing a disc into a hollow cylinder having sidewalls and a closed base, said disc initially having grain flow lines parallel to said disc's faces thereby resulting in continuous and unbroken grain flow lines in said base and sidewalls, the steps of: flowing the metal of said base in a longitudinal direction away from said sidewalls free of contact with any end abutment to

form a prehead section, the grain flow lines in said prehead section being continuous and unbroken and forming longitudinally inwardly facing U bends at the extremity of said prehead section; forming a peripheral outer flange by extruding said prehead section radially outwardly under controlled flow free of contact with any radial end abutment; continuing said extruding until substantially all of said U-bends are outside a finished diameter of said flange; then cutting said flange to finished diameter thereby removing substantially all of said inwardly facing U bends.

2. A process according to claim 1 in which said radial outward flow of metal from said prehead section is through a constriction, then successively reducing the size of said constricted portion with outward flow of metal.

3. A process according to claim 2 which includes clamping said case circumferentially on said prehead section adjacent said constriction, then guiding the metal extruded through said constriction by radial guides on each side of the extruded metal but not in contact with one of said guides substantially before that metal has reached its desired radial outer diameter.

4. In the process of forming a steel cartridge case comprising cupping and drawing a disc into a hollow cylinder having sidewalls and a closed base, said disc initially having grain flow lines parallel to said disc's faces thereby resulting in continuous and unbroken flow lines in said base and sidewalls, the combination therewith of the steps for forming a peripheral outer flange and a primer pocket having increased strength, said steps including: flowing the metal of said base in a longitudinal direction away from said sidewalls, free of contact with any end abutment, to form a prehead section, the grain flow lines in

said prehead section being continuous and unbroken and forming inwardly pointing U-bends at the extremity of said prehead section; compressing said prehead section to press an inner wall against an abutment to form said primer pocket while simultaneously: bulging an outer wall of said prehead section radially outwardly free of contact with any abutment on said outer wall radial outer edge, further compressing said prehead section and forming said peripheral outer flange by flowing metal from said prehead section radially outwardly through a successively narrowing constriction free of contact with any radial end abutment until a major portion of said U-bends are radially outside a finished diameter of said peripheral outer flange; then cutting said flange to finished diameter, thereby removing a major portion of said inwardly pointing U-bends.

5. A process according to claim 4 which includes clamping said case circumferentially on said prehead section adjacent said constriction, then guiding the metal extruded through said constriction by radial guides on each side of the extruded metal, said extruded metal being free of contact with one of said guides substantially before that metal has reached its desired radial outer diameter.

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