May 24, 1955 G. R. ECKSTEIN 2,708,878

CARTRIDGE AND METHOD OF PRIMING SAME

Filed May 16, 1950 2 Sheets-Sheet 1

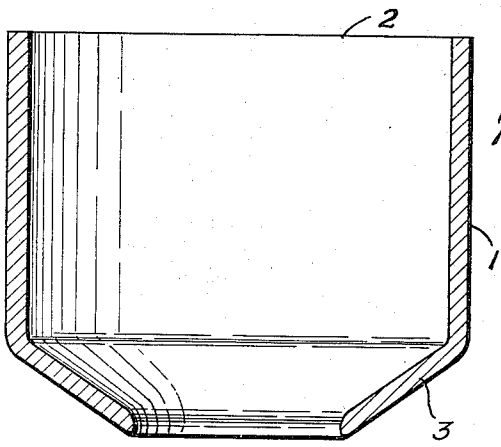


Fig. 1

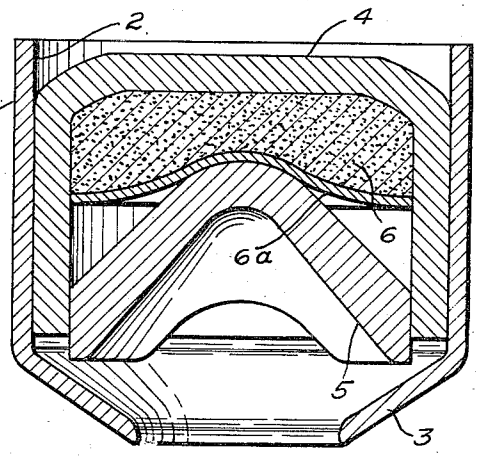


Fig. 2

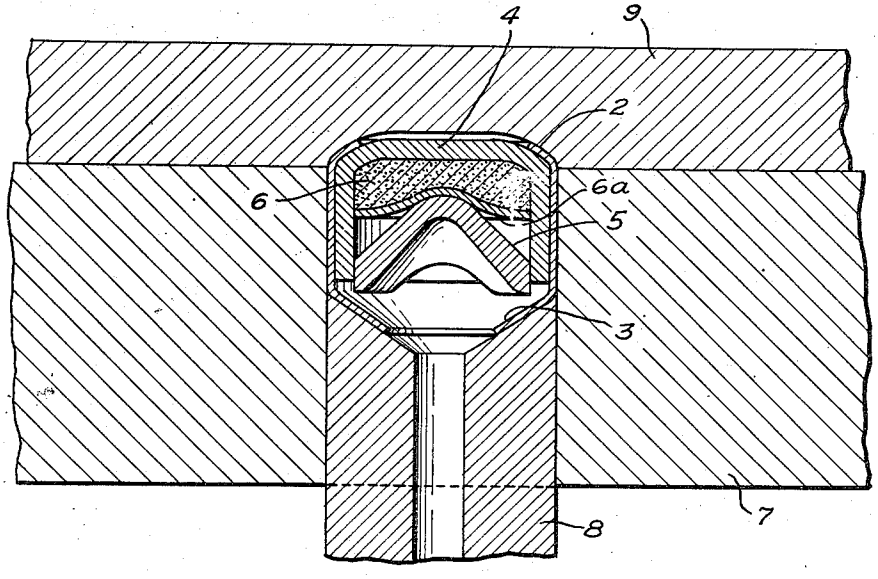


Fig. 3

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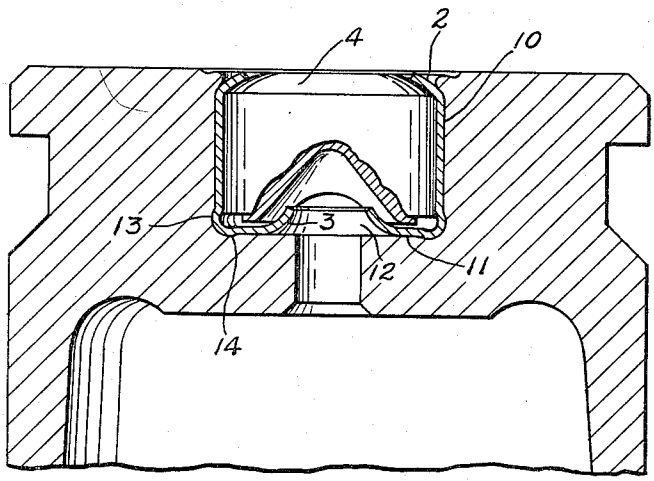


Fig. 4

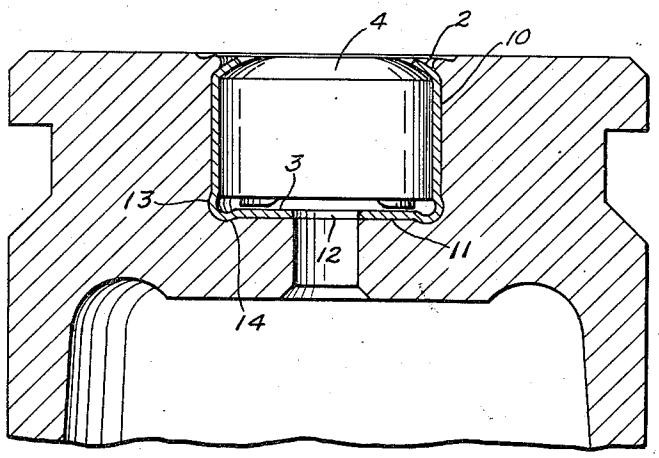


Fig. 5

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CARTRIDGE AND METHOD OF PRIMING SAME

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Application May 16, 1950, Serial No. 162,355

11 Claims. (Cl. 102—45)

This invention relates to an improved construction for primed cartridge cases and to an improved method of priming such cartridge cases.

In my copending application, Serial Number 607,951, filed July 31, 1945, now abandoned, I have disclosed a related method which involves reforming the shape of a frusto-conical lip on the primer cup per se as an incident of inserting the cup into the head of a cartridge case. Although that construction served to provide an excellent seal between the primer cup and the cartridge head, the deformation of the primer cup associated with the flattening of the frusto-conical lip sometimes resulted in shifting the anvil in the primer or in deforming the base of the cup against which the pellet of priming composition is seated. For the sake of safety, the priming composition is loaded wet and dried in place. The resulting pellet is therefore brittle and likely to fracture or flake out if disturbed by deformation of the primer cup. This invention has particular application to aluminum cartridges in calibers which find their greatest application in aircraft machine guns. Obviously, for this and other military applications, it is desirable to reduce the possible causes of mulfunctioning to the absolute minimum.

Accordingly, the principal object of this invention is the provision of a new method of priming cartridges, particularly aluminum cartridges, which will effectively retain the primers and the gases resulting from ignition of the charge without affording any opportunity for prematurely deforming the priming composition.

An additional object is to provide a much more effective gas seal.

It is contemplated that this objective may be best attained by the use of an intermediate retaining cup between the primer cup and the primer pocket in the cartridge head. This retaining cup is itself secured in the primer pocket in a manner somewhat similar to that disclosed in my prior application above referred to.

The exact nature of my invention, as well as other objects and advantages thereof, will become more apparent from consideration of the following specification referring to the attached drawings, in which:

Fig. 1 is a vertical sectional view through a primer retainer cup.

Figs. 2 and 3 are vertical sectional views illustrating successive steps in the assembly of the primer and primer retainer.

Fig. 4 is a vertical sectional view through the head of a cartridge case including the improved assembly.

Fig. 5 is a view similar to Fig. 4 after firing of the primer.

Referring to the drawings by characters of reference, it may be seen that the primer retainer 1 comprises a drawn cup open at the top edge 2 and having a bottom portion defining a generally conical lip 3 formed as the result of blanking the central portion out of the base of the cup and appropriately shaping the remainder. Preferably, the retainer cup should be formed of a strong, relatively stiff material permitting a fairly thin section to develop the

requisite strength, steel having been found highly satisfactory. Since the conical lip is a portion of the base of the cup, it will not have been work-hardened appreciably in forming and will remain at substantially the full uniform thickness and hardness of the original stock material. For its lubricating effect in drawing and for protective purposes, strip steel, if that material is chosen for the retainer, should preferably have at least a thin plating of copper. In view of considerations which will be discussed in more detail hereinafter, it is desirable that the retainer cup be thin enough to expand radially in case the primer pocket expands on firing, that the slant height of the conical lip be not much less than about four times the thickness of the lip portion, and that the angle included within the frusto-conical lip be between about 90° and about 150°.

A substantially conventional percussion primer comprising a cup 4, anvil 5, charge 6, and sealing member 6a, may be inserted into the retainer 1 with a relatively tight fit as shown in Fig. 2, the top edge 2 of the retainer cup projecting slightly above the head of the primer. This assembly may then be positioned in a die 7 and supported on a punch 8, preferably substantially matched to the contour of the conical lip 3 and a top die 9 employed to crimp the edge 2 of the retainer cup into close engagement with the corner of the primer cup. Obviously, with suitable equipment, the die 7 and punch 8 may have also been employed to support the retainer cup while the primer is inserted and crimping performed by pushing the assembly upward with punch 8 into a crimping die of shape similar to the die 9. This operation completes the assembly of the primer and primer retainer. Obviously, these operations may be as readily applied to electric primers as to the percussion type of primer illustrated herein.

The assembled primer may be seated in the primer pocket 10 in the head of a cartridge by any convenient and conventional means capable of exerting sufficient force to overcome the frictional resistance with the walls of the primer pocket and to re-form the conical lip 3. The action on seating the primer is believed to be substantially as follows: As the edge of the conical lip 3 contacts the flat bottom 11 of the primer pocket, the edge bends in toward the flashhole 12. At this point it should perhaps be noted that the design of the head of the cartridge should be such as to provide a flat bottom 11 of sufficient extent to oppose the conical lip 3 at every stage of its reforming on insertion. Further movement continues this bending and the edge of the lip tends to roll back into the primer and away from the bottom 11. As this bending progresses radially outward, the remainder of the lip becomes so thick in relation to its slant height that no more bending will take place at the point of contact with the bottom 11, and further deformation tends to upset and thicken the lip in the region between the zone in which upturning of the lip ceases and the juncture of the lip with the sidewall of the retainer cup. The reaction from this upsetting tends to enlarge the retainer in outside diameter and actually produces an indentation of the wall of the primer pocket at 13. At the same time, that portion of the lip which has not been turned up away from the bottom of the pocket is, partly as a result of the upsetting action referred to, indented into the pocket bottom, producing a primary sealing area 14. In effect, an annular bead is formed by the corner of the primer retainer cup and that bead is wedged between an indentation in the bottom of the primer pocket and a similar indentation in the wall thereof. Although the amount of the indentation has been slightly exaggerated in the drawings, the effect is a very real one and a perfect seal is effected even with primer pockets which expand and become oversized on firing. For greater security, the head of the cartridge may be "ring-staked" in the

usual manner of military cartridges so that a flange integral with the cartridge head overlies and offers additional mechanical support to the crimped edge 2 of the retainer cup.

The copending application of John P. Catlin, Serial Number 599,081, filed June 12, 1945, relates directly to, and my own copending application, above referred to, illustrates, a conical washer which is inserted in the bottom of a primer in such a way as to be flattened and radially expanded by the blast of the primer. This expansion forces the edge of a primer cup into more intimate gas sealing contact with the wall of the primer pocket. The construction described in this application accomplishes a similar purpose when the primer blast flattens the lifted edge 3 of the retainer lip into contact with the base of the primer pocket. This effect tends to further expand the retainer cup and enhances the sealing effect.

The importance of maintaining a perfect seal with the wall of the primer pocket cannot be over-emphasized. My copending application discusses in some detail the effect of a leak with an aluminum cartridge of the type for which these primers are especially intended. It will here suffice to say that the propellent gases are extremely hot and under extremely high pressure. Any leakage where one or both surfaces are aluminum results in severe erosion, fusion, and probably some combustion of the aluminum head. Invariably, primer leak erosion of an aluminum head will disable the gun and it is extremely dangerous to the gunner.

The retainer cup seals perfectly to the aluminum cartridge, and in sectioning many fired cartridges, no case has been found where the telltale smudge of hot gas penetration has extended beyond the primary seal 14 on the bottom surface of the pocket. The retainer cup also seems to have the ability to expand with the head of an aluminum cartridge and to maintain the seal even in those cases where over-pressure or deficient strength in the aluminum have resulted, on firing, in expansion of the head to a degree making the primer pocket grossly oversized.

It may seem that very little emphasis has been placed upon stopping primer leaks between the primer cup per se and the retainer, and that is so. The crimp and ring stake at the upper edge of the retainer provide sufficient mechanical strength to retain the primer and the obturating action of the primer cup generally stops gas leakage between primer and the retainer. However, it should be noted that, providing neither of these surfaces is aluminum, magnesium, or metal of similar properties, primer leaks of considerable extent could be tolerated in this region without endangering or inconveniencing either gun or gunner.

A number of factors influence the behaviour of the conical lip upon seating in the primer pocket and determine the mode of its deformation. Of these factors, the shape and dimensions of the conical lip and the characteristics of the metal itself are most important. A strong stiff metal permits the use of desirably thin sections while maintaining adequate strength.

For an approximate analogy which seems to agree fairly well with the observed facts, we may consider that the conical lip is made up of a number of radially extending inclined elements, any one of which may be considered as a column extending between the point of contact with the bottom of the primer pocket and its point of juncture with the side wall of the retainer cup. As the retainer cup is forced into the primer pocket, a compression load is applied to each of these elemental columns, tending to cause each column either to buckle or to upset and thicken. Obviously, a relatively long thin column will be more inclined to buckle than to upset and thicken.

Although the simple column formulas cannot be strictly applied to this situation, the analogy is close enough to show the effect of thicker sections and stiffer metals. Of

the usual column formulas, Rankine's formula is the most nearly valid for short and medium length columns. In this formula P/A is the unit load applied to the end of a column at which the column will ultimately fail by buckling, S is the yield point of the particular metal, q is a constant, which is usually determined experimentally and depends upon the particular material, the method of loading the column, and the condition of its end supports, L is the length of the column, and R is the least radius of gyration of the cross-section concerned.

Rankine's formula:

$$\frac{P}{A}=\frac{S}{1+q\left(\frac{L}{R}\right)^2}$$

Although q is usually determined experimentally "Ritter's rational constant" is generally accepted as a valid value for q. For a column having one end fixed and one end round, q may be considered to be determined by the following expression:

$$q=\frac{S}{\frac{1}{2}\pi^2 E}$$

where again S is the yield point and E is the modulus of elasticity.

If, for simplicity, we consider our elemental column to be of rectangular form having a breadth equal to its thickness, T

$$R=\frac{T}{\sqrt{6}}$$

Substituting these valumes in Rankine's formula,

$$\frac{P}{A}=\frac{S}{1+\frac{4S}{\pi^2 E}\left(\frac{L}{T}\right)^2}$$

Since S and E are known properties of the various metals, we may readily solve Rankine's formula for values of the ultimate unit load P/A in terms of the length-thickness ratio L/T for any metal. When values so obtained are plotted against each other in appropriate curves, it will be seen that at an L/T ratio of zero, the ultimate unit load is the yield strength, or stated otherwise, the column will fail by compression or upsetting. At very low values of L/T the ultimate unit load remains at substantially the yield strength and the type of failure is not readily predictable. At values of L/T above about 4, the ultimate unit load is sensibly less than the yield strength and the column will buckle when it fails.

Caution must be observed in using these values, for they are only theoretically applicable to an isolated column of uniform, rectangular cross-section fixed at one end, pivoted at the other end, and loaded symmetrically relative to its long axis. In the instant case, the loading is obviously eccentric and each incremental column is influenced by the behaviour of the adjoining increments. Nevertheless, as shown below, the values of L/T calculated by these formulae seem to agree well with the phenomena observed in connection with the practice of this invention and that disclosed in my copending application previously referred to.

Applying this analogy to the conical lip of the primer retainer, it can be predicted that whenever the slant height/thickness ratio of the lip is four or higher and the metal properties throughout the lip are uniform, the edge against the bottom of the pocket will progressively buckle and turn inward as the cup is forced down. As the slant height/thickness ratio of the remaining portion drops to three or less, this buckling no longer occurs and the remaining movement in flattening the lip tends to upset or thicken the portion of the lip wedged between the corner of the sidewall and the bottom of the primer pocket. It is this last action which produces the highly effective primary and secondary seal zones and secures the cup within the primer pocket. As previously men-

tioned, the flattening of the upturned lip by primer blast effects a third sealing action similar to that of the conical washer in the copending Calin application above referred to. It has been noted that the height to which the lip will turn up is a function of the included angle of the cone. An included angle of 90° usually turns up to an extent sufficient to interfere with the anvil while an included angle as great as 150° results in very little lifting away from the base of the primer pocket. For optimum effectiveness, the lip should be turned up as far as possible without contacting the anvil or blocking the flash holes therein, and the optimum angle will be the minimum included angle which will produce that result.

The conicatl lip may be designed to deform in this way with any metal but obviously the lower strength materials would require quite thick walls to have enough strength to accomplish the objective. With these thicker walls, it may often be difficult to find space to accommodate the desired L/T ratio. Further, thick sections of any material are undesirable because they lack the freedom to expand radially and maintain obturation in case the shell head tends to expand radially under the stress of firing. The requirement that the lip flatten under primer blast also sets an upper limit on thickness. Relatively thin sections of the stronger materials like steel or hard brass are therefore preferable. Another argument in favor of the stronger stiffer materials is the steeper curve of L/T plotted against P/A and the resulting cleaner differentiation between a compression failure and a buckling failure in the conical lip.

It will probably be noticed that in my copending application, frequently referred to herein, the conical lip of the primer cup per se did not buckle and lift up in the center away from the bottom of the primer pocket. To forestall future questions, it may be noted here that the L/T ratio of the lip shown there is less than three and there would be little difference between the ultimate unit load which a column would sustain and the yield strength. Another factor not discussed or appreciated at the time that application was prepared involves the non-uniform strength characteristics of the lip there shown. The primer cup shown in that application was made of drawn brass and the conical lip was formed from the edge and most severely work-hardened portion of the piece. After the primer had been charged with explosive composition and while that composition was still plastic, the conical lip was turned in by forcing the edge into a conical die. The result was that there was a progressively greater work hardening toward the edge of the lip. Further, in reshaping the lip in this way it was necessary for the metal to upset and thicken in those portions most severely reduced in diameter. The combined effect of work hardening and upsetting produced a conical lip which was thicker, harder, and stronger at the edge of the flashhole than at the juncture of the lip with the sidewall. Hence, the edge resisted deformation better, did not buckle, and exhibited no inclination to turn up away from the bottom of the pocket.

Although I have hereinabove quite specifically described my preferred construction, it will be obvious that variations may be made within the limits of the claims appended hereto.

I claim:

1. In a cartridge having a head formed to define a primer receiving pocket with a cylindrical wall and with a substantially flat transversely extending bottom surface; a primer assembly comprising a charged primer; a retainer cup secured to said primer and received in said pocket in substantially continuous engagement with the cylindrical wall of said pocket, said cup being provided at its inner end with an annular corner bead indented into and interengaged between both the inner portion of the cylindrical wall of said pocket and the outer circumferential region of the said bottom surface, said cup also being provided with a lip having a central pierced portion turned back into said cup toward said primer and spaced away from said bottom surface of the pocket.

2. In a cartridge, a primer assembly as defined in claim 1, said retainer cup being formed of a thin flexible material capable of expanding with said head and maintaining obturation therewith as said cartridge is fired.

3. In a cartridge, a primer assembly as defined in claim 2, said retainer cup being provided with a lip at its exposed outer end overlying a portion of the end of said charged primer.

4. A primer assembly for insertion into the flat bottomed primer pocket of a cartridge, said assembly comprising a charged percussion primer; a retainer cup in which said primer is seated; a lip formed by one end of said retainer cup and overlying a portion of the head of said primer to secure same within the cup; and a frusto-conical lip portion formed by the other end of said retainer cup and extending outwardly away from the mouth of said primer, said frusto-conical lip defining a substantially centrally disposed flash opening and being characterized by a slant height not substantially less than four times the thickness of the material forming said lip.

5. A primer assembly as described in claim 4, said frusto-conical lip being further characterized by an included angle between diametrically opposed portions of said lip of between substantially 90 degrees and substantially 150 degrees.

6. A primer assembly as described in claim 5, said frusto-conical lip being, throughout its extent, substantially uniform in thickness.

7. A primer assembly as described in claim 6, said frusto-conical lip portion having throughout its extent, substantially uniform properties in regard to resistance to plastic deformation.

8. A primer assembly as described in claim 7, said retainer cup being formed of copper plated steel.

9. The method of priming a centerfire cartridge case which comprises the steps of forming in said cartridge case a primer pocket having substantially straight sides and a flat transversely extending bottom; forming a retainer cup having sidewalls which may be frictionally received in said pocket and also having an integral frusto-conical lip; securing a charged primer within said retainer cup; and pressing said assembly of primer and retainer cup, frusto-conical lip first, into said pocket until the lower portion of the sidewall portion of the retainer is in substantial contact with said transversely extending bottom, while so doing reforming said frusto-conical lip by engagement with said transversely extending bottom to provide an annular corner bead indented into the sides and transversely extending bottom of said primer pocket and to provide a centrally disposed inturned frusto-conical lip raised above said transversely extending bottom.

10. The method described in claim 9, said method being further characterized by forming the frusto-conical lip portion of the retainer cup to have a slant height not substantially less than four times the thickness of said lip.

11. The method described in claim 10, said method being further characterized by forming the frusto-conical lip portion of the retainer cup to have an included angle between substantially 90 degrees and substantially 150 degrees.

References Cited in the file of this patent

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