Nov. 5, 1940. R. IRMANN 2,220,652

MANUFACTURE OF CARTRIDGE CASES FROM ALUMINUM ALLOYS

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Fig. 1.

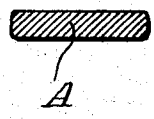


Fig. 2.

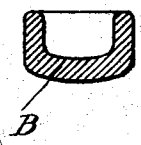


Fig. 3.

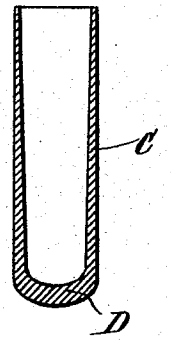


Fig. 4.

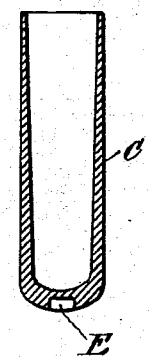


Fig. 5.

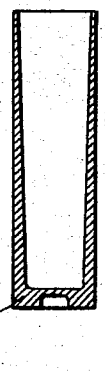


Fig. 6.

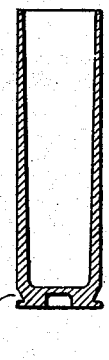
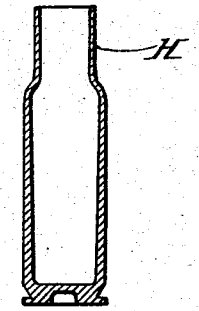


Fig. 7.



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MANUFACTURE OF CARTRIDGE CASES FROM ALUMINUM ALLOYS

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7 Claims. (Cl. 29—1.3)

This invention relates to the manufacture of cartridge cases from aluminum alloys, and makes use of such alloys as are capable of being improved, hardened and straightened, by solution heat treatment. The use of such alloys differs essentially from the use of brass in that the aluminum alloys must be subjected to solution heat treatment in order to afford requisite strength.

The solution heat treatment available for this invention may consist in annealing, quenching and aging the aluminum alloy, either at ordinary or room temperature, as with alloys of the aluminum-copper-magnesium type such as those known under the trade names "Avional" and "Duralumin," or at an elevated temperature, as with alloys of the aluminum-magnesium-silicon type or of the aluminum-copper-silicon type, for strengthening and hardening of the product.

The usual mode of treatment of various articles made of aluminum alloys that are capable of being improved by solution heat treatment, is to subject them to such treatment only after their shaping has been wholly completed; this being for the reason that the material is hardened by the heat treatment so that it can no longer be easily worked by cold deformation, and for the further reason that when intermediate soft-annealing has to be undertaken during the shaping steps the effect of a previous hardening or heat treatment would be substantially neutralized. For these reasons, in previous proposals to make cartridge cases from aluminum alloys which are capable of being improved by heat treatment, the solution heat treatment has been performed on the cartridge case only after it had been brought to its final shape. It has been found, however, that the strength of a cartridge case so made is not then satisfactory, because the case, and particularly its lower part, does not possess the mechanical strength which is necessary to withstand the strains occurring when the cartridge is fired. Considerable efforts have, therefore, been directed to obviating this disadvantage, namely, by the selection and trial of various alloys, but wholly satisfactory results have not as yet been achieved. The object of the present invention is to make practical the manufacture of cartridge cases from suitable aluminum alloys.

The accompanying diagrams Figs. 1 to 7 indicate in central section views some of the successive steps or stages through which the initial blank passes in being shaped into a cartridge case, the application thereto of the present invention to be described in connection with said diagrams.

The process may commence with a circular disk A, Fig. 1, of the selected alloy, from which by many operations the cartridge case is shaped. The disk is first struck or worked into the form of a cup B, Fig. 2. Then, by successive working or drawing steps, with intermediate soft annealing operations, there is obtained an elongated cylindrical case C, Fig. 3, having a thick rounded bottom D.

In former practice, the recess E for the reception of the percussion cap is next pressed in the bottom and the bottom F is reshaped and the neck H reduced. After the shaping of the case is complete, vent holes are bored in the bottom, an ejector groove G is formed, as by milling, and the reduced neck is cut off at the proper length. The sequence in which some of the operations were performed, was, however, sometimes varied; as also was the type or design of case.

According to the present invention, by improvement in the manufacturing process, cartridge cases can be manufactured, of various designs, having the necessary mechanical strength. This result is obtained, in accordance with the invention, by performing the solution heat treatment before the final plastic shaping of the lower end of the case. The heat treatment at the latest takes place before the lower part of the case is pressed into its finished shape, and preferably before the recess for the reception of the percussion cap is pressed in the bottom. The entire case is, of course, subjected to this relatively early solution heat treatment, while the following pressing operations are conducted cool, or at room temperature.

Owing to this special order of operations, an increase of strength by the cold working of the metal in its heat-treated condition is obtained. The high values for the proof stress and tensile strength obtained equal or exceed those values which the lower parts of the cartridge case and in particular the bottom end are required to have. The procedure of this invention, therefore, is such that the cold working on the lower part of the case, which is carried out after the solution heat treatment, is sufficient to effect the necessary increase in strength. This is the important feature, and the invention is not necessarily concerned with the number of operations performed in the plastic shaping or pressing which precede or follow the solution heat treatment.

Explaining the invention by the diagrams, which show an example, the heat treatment is applied following the attainment as in Fig. 3 of the general shape of the case C by shaping steps as in Figs. 1 and 2 and soft annealings. The entire article C is heat treated, by treatment appropriate to the aluminum alloy used. The case has then the cap recess E struck or pressed into the bottom end (Fig. 4). In some cases it might be preferable to begin to form the recess E before the heat treatment. After this step the lower end is plastically reshaped, as at F Fig. 5, to its final shape. The corners are squared and the desired sectional design attained. The press-

ing of the recess and the final shaping being cold operations, performed by heavy die pressure, they greatly increase the strength. Now or later may be formed the ejector groove G Fig. 6, as by milling or rolling; but if the bottom reshaping has produced an ejector flange, as sometimes used, the groove is omitted. Next, the neck H is contracted to a form such as Fig. 7 indicates, in the instances of cartridge cases having reduced necks. This however may be preceded by a heating confined to the upper end such as to afford a better plasticity for the cold working or spinning of the neck metal to the desired shape without impairing the tensile strength as in the ordinary soft-heat treating. Such top end heating is preferably at relatively low temperature, below the point of recrystallization of the metal, and applied for 3 or more minutes, not above about 30 minutes, avoiding the risk of neutralizing the effect of the previous heat-treatment of the case. This heat-treatment may be performed after the reducing of the neck instead of before, as later explained, or before and after this reducing operation.

In general, it is preferable to undertake all the cold pressing operations on the bottom, including the beginning of the pressing of the recess E for the reception of the percussion cap, after the solution heat treatment, since in this way the greatest increase in strength is obtained. The simplest method is to shape the bottom at room temperature after the cartridge case has been subjected to solution heat treatment. Obviously, it is also within the invention to press the recess or pocket for the percussion cap or primer, and also to carry out other of the plastic shaping operations on the lower part of the case, either at a lower or at a higher temperature, provided a sufficient increase in strength is still obtained. Vent holes in the bottom of the primer recess may be drilled later, after the described operations, as also may be the final trimming or cutting off of the neck.

The described invention is readily adapted to any particular conditions. The necessary strength increase cannot conveniently be expressed numerically because the proof stress and tensile strength of the lower part of the case, particularly of the bottom, cannot be accurately determined by usual methods owing first to the small dimensions of this part of the case and second to the fact that the increase in strength will tend to be irregularly distributed. Whether the increase in strength afforded by this invention is sufficient or not in any case can readily be determined by testing by firing the cartridges. As is well known, the lower part of the cartridge case is not supported over its entire area in rifles and machine guns. If the material of the case is not sufficiently strong at the lower part of the case, the bottom of the case may expand under the pressure of the explosion; and this frequently leads to the percussion cap becoming loose or falling out, and if this occurs, jamming is likely to result, and this is more likely to occur in machine guns than in rifles.

By means of the process of this invention, described above, it is possible to avoid the troubles which have arisen with cartridge cases heretofore made of aluminum alloys owing to their being of insufficient mechanical strength. The strengthening by the cold deformation of the lower part of the case after the solution heat treatment may, therefore, be considered sufficient if, when the cartridge is fired, no troublesome widening or expansion of the bottom of the case occurs.

The ejector grooves, instead of being milled, can be cold pressed or rolled after the solution heat treatment, whereby a still greater increase in strength is obtained by such further cold deformation in the heat-treated condition.

In practice, the upper part of the case, particularly the neck, as above explained, is reduced after the bottom has been pressed. This upper part of the case, and particularly the neck and shoulder, is, therefore, also subjected to cold working in the heat treated condition when the process of the present invention is carried out. The increase in the proof stress and tensile strength which is thereby produced, is, of course, accompanied by a decrease in elongation. The elongation, particularly that at the neck of the cartridge case, is thereby reduced to such an extent that the plasticity may become insufficient; which becomes apparent, when the bullet is inserted in the case and afterwards when the cartridge is inserted in the gun and fired, by the formation of cracks. The elongation at the neck may be reduced, for example from 16% to less than 2% in the case of a cartridge case made of alloys of the type Al-Cu-Mg, which are known in commerce under the trade names "Avional" or "Duralumin."

A further feature of the invention, in relation to contracted neck cases, is the supplemental heating of the part of the neck which has become insufficiently plastic, namely, in such a manner that a sufficient increase in elongation is obtained. Preferably, care is taken that the proof stress and tensile strength are not reduced too much by this heating. In practice, this can be easily performed by heating the cartridge case during a short time, say from 3 to 30 minutes, at a temperature which is below the recrystallization temperature; the temperature must, however, not be too low, as the improvement in the elongation would then take too long. As a modification a very short heating, of for instance several seconds, to a temperature somewhat over the recrystallization temperature can give the required results.

Excellent results have been obtained with cartridge cases made of alloys of the Al-Cu-Mg type, for example Avional and Duralumin, as well as with other copper-containing aluminum alloys, by heating the upper part of the case, and especially the neck, which may have become too hard, for a short time to a temperature below the recrystallization temperature. For this purpose a heating of 10–20 minutes duration at a temperature of approximately 150–170° C. has been found to be particularly suitable. When the heating is performed in an air bath, there are difficulties in employing higher temperatures, for example 200° C., owing to the difficulty of determining correctly the most favorable duration for the treatment. If lower temperatures, for example 120° C., are employed, the duration of the heating may be too long for practical requirements. In cartridge cases made of Avional, which have been manufactured in accordance with the present invention, the tensile strength at the neck has been increased by cold working of the upper part of the neck from 46.5 to 51.5 kilograms per square millimeter. The proof stress increased from 34 to 54 kilograms, while the elongation fell from 16.3 to 2 per cent. By heating at a temperature of 160° C. for 15 minutes the elongation again increased to 6 to 8 per

cent, while the tensile strength was reduced only by about 2 to 4 per cent, and the proof stress by about 5 to 10 per cent.

After these described treatments it was found that the values obtained for the proof stress, tensile strength and elongation at the neck of the cartridge cases showed relatively little variation.

For these operations upon the upper ends of the cases, an apparatus was used in which the lower ends, which were not required to be heated with the upper parts, were placed in a chamber supplied with water at a lower temperature than the annealing chamber into which extended the upper parts of the cases to be heated; and the upper parts were then heated by means of hot air or gases. This supplemental treatment may be performed after the neck and shoulder have been partially formed, the completion of contraction following the treatment.

During the brief heating for increasing the elongation of the upper part of the case which has become too hard, care should be taken that the lower part, which should have a particularly high mechanical strength, is protected from being heated to too high a temperature. Nevertheless, it is generally advisable to maintain the bottom part at a temperature which is slightly higher than room temperature, in order that the derivation of heat by the cooled bottom part may not be too great.

The process according to the main feature of the present invention is not limited to the prevailing or usual order or sequence of manufacture, which has been referred to merely by way of example. The important consideration is that the increase in strength of the lower part of the case is obtained by interposing the solution heat treatment before the case has been pressed or formed into its final shape; and as regards the aforesaid supplemental feature of the invention, the improvement is the local heating for improving the elongation of the upper parts of the case which had become insufficiently plastic owing to the cold working.

I claim:

1. The method of making a cartridge case from a blank of a light aluminum alloy that is heat-treatable for hardening, comprising the preliminary operations of partially shaping such blank by a series of working and annealing steps into a hollow elongated piece of the general cylindrical form and size of the finished case and having its closed lower end relatively thick walled but of uncompleted rounded form; and said method being characterized in that its remaining operations comprise the following steps: after such working and annealing steps, hardening such incompletely shaped piece by solution-heat-treatment thereof comprising heating, quenching and aging, at an antecedent stage; and at a subsequent stage, after the completion of such heat-treatment including aging, extensively cold working the lower end of the hardened piece to complete the plastic shaping thereof, thereby to increase substantially the strength of the finished case, while preserving substantially its previously acquired hardness.

2. The method as in claim 1 and wherein the cap recess in the bottom is cold-pressed after the step of hardening including aging.

3. The method as in claim 1 and wherein the ejector groove is cold-worked in the lower part after the step of hardening including aging.

4. The method as in claim 1 and wherein the cap recess in the bottom is cold-pressed after the step of hardening including aging, followed by the extensive general reshaping of the lower end, followed by the cold pressing of the ejector groove.

5. The method of making a cartridge case from a blank of a light aluminum alloy that is solution-heat-treatable for hardening, comprising the following recited stages performed in the order stated: (1) partially shaping such blank by a series of working and annealing steps into a hollow elongated piece of the general cylindrical form and size of the final case and with its closed lower end relatively thick-walled but of uncompleted or rounded bottom contour extensively short of attaining the final contour; (2) followed by hardening such incompletely shaped piece by solution-heat-treatment comprising heating, quenching and aging the same; and (3) thereafter, following the termination of such heat-treatment stage including such aging, completing the plastic shaping of the lower end by extensive cold working steps upon the same in its hardened condition, thereby to improve substantially the strength of the finished case to resist the stresses of explosion within it while preserving substantially its hardness acquired in said solution-heat-treatment stage.

6. The method of making a cartridge case with contracted neck from a blank of a light aluminum alloy that is solution-heat-treatable for hardening, comprising the following recited stages: (1) partially shaping such blank by customary working and annealing steps into a hollow cylindrical piece of the general cylindrical form and size of the final case and with its closed bottom end relatively thick-walled but of rounded bottom contour extensively different from the final contour; (2) followed by hardening such incompletely shaped piece by solution-heat-treatment comprising heating, quenching and aging the same; and (3) thereafter, following the completion of such heat-treatment including such aging, extensively cold working the bottom end of the hardened piece to complete the plastic shaping thereof, thereby to increase substantially the strength of the finished case, while preserving substantially its hardness acquired in said solution-heat-treatment stage; and thereafter supplementally subjecting the upper end only of the case to a soft-annealing operation by heating to a relatively low temperature substantially not above the recrystallization point of the alloy, and for a brief duration of heating, between a few seconds and about 30 minutes, thereby to improve elongation in connection with the step of shaping the upper end to its contracted form, and without impairing substantially the previously acquired hardness and strength of the lower end, and applying to the upper end working steps to contract it to the desired shape of neck, of which at least the final working steps are performed after such supplemental soft-annealing thereof.

7. The method as in claim 6 and wherein the upper end soft-annealing is performed with duration and temperature so coordinated that the yield point is reduced under 10% and the tensile strength under 4% while elongation is increased by a percentage greater than the loss of elongation during the previous recited steps.

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