METHOD OF MAKING STEEL CARTRIDGE CASES

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References Cited
UNITED STATES PATENTS
2,207,289 7/1940 Fleischmann………………… 148/16.5
2,351,731 11/1950 Hibbert………………… 148/16.5
2,881,109 4/1959 Thern………………… 148/12.1
2,997,774 8/1961 Lyon………………… 29/1.21

3,614,816 10/1971 Weyhmuller et al.………………… 29/1.3

Other Publications

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ABSTRACT
A cartridge case is formed from C1008 steel strip. The cartridge case is heated in a carbon rich atmosphere to increase the carbon content of the steel to approximately 0.55% and is furnace cooled so that it has a ferrite and pearlite structure and exhibits a uniform hardness and has a tensile strength similar to that of a brass cartridge case.

8 Claims, 2 Drawing Figures
METHOD OF MAKING STEEL CARTRIDGE CASES

This invention relates to the manufacture of ammunition components from steel and more particularly to a method of manufacturing from low carbon steel a rim fire cartridge case which functions in a manner substantially the same as a brass cartridge case.

Prior to this invention, cartridge cases have generally been manufactured from brass because it has been the only metal satisfactorily meeting the requirements of ammunition components in regard to cost, shaping, strength, corrosion resistance and extractability from a gun. However, brass has many disadvantages amongst which are the tendency toward stress corrosion cracking, the tendency to react or cause the primers or powder contained therein to become unstable, and a steadily increasing cost.

For this reason, many attempts have been made to manufacture cartridge cases from other materials, one of the most popular materials having been steel. Because steel does not work harden to the extent that brass does, prior art methods have used steel having a sufficiently high carbon content to provide the hardness and strength required for a cartridge case. However, this hard steel caused unacceptably high tool wear with the result that this manner of cartridge case manufacture was found to be impracticable. Low carbon steels could be used for cartridge case manufacture without the excessive tool wear caused by high carbon steels. However, the low strength and poor recovery characteristics of the resulting cartridge cases rendered them unsafe and unacceptable for use. Thus, prior to this invention, no satisfactory method of manufacturing an acceptable steel cartridge case has been devised.

In accordance with this invention, readily commercially available low carbon steel strip is manufactured into a rim fire cartridge case while in its relatively soft condition so that tool wear is minimized. Carbon content of the steel is then raised to increase the tensile strength and improve the recovery of the cartridge case. It is then cooled slowly to give the steel a ferrite and pearlite structure which exhibits strength and ductility substantially the same as cold worked brass.

It is an object of this invention to provide a method of producing steel cartridge cases which exhibit the physical characteristics of brass cartridge cases but tend not to split during firing.

It is another object of this invention to produce steel cartridge cases by a method which provides a sufficiently hard and strong cartridge case while minimizing tool wear during manufacture.

These and other objects and advantages of this invention can best be described with reference to the appended drawings wherein:

FIG. 1 is a sectional view of a rim fire cartridge case with an exaggerated clearance between the case and the chamber of the gun. The bulging of the shell due to firing pressures and a split in the body of the case are also exaggerated.

FIG. 2 illustrates a flow sheet of the improved method of making steel cartridge cases showing the steps thereof.

The purpose of a cartridge case is to serve as a container or carrier for the powder and the priming mixture which initiates the combustion of the powder. The projectile is placed in the mouth of the cartridge case and is propelled from the barrel by expanding gas after the primer of the cartridge has been struck by the firing pin to ignite the propellant powder. When in position in the gun, the shell is located in the chamber thereof; the shell must of course be properly sized during manufacture so that it will fit into the chamber. It is obvious, however, that a certain clearance will always be present between the outside of the case and the chamber; also, there is a variation in the snugness of the fit of the case in the chamber and the relative roughness of the chambers in different guns. All of these factors affect the operation of the cartridge and extraction thereof.

Referring to FIG. 1, in which a conventional rim fire cartridge case is shown, a bolt 10 of a gun is shown closed against the head 11 of the case 12, the case 12 fitting within the chamber 13 of the barrel 14. An extractor 15 of a conventional type engages the rim of the case 12 as it is pushed into the chamber 13. A suitable striker or firing pin 16 is provided to strike the rim of the case 12 wherein the priming mixture is contained.

It is necessary that the material of the case have sufficient strength and a sufficiently high yield point so that upon the combustion of the propellant charge and under the high pressure developed thereby it will not be forced a substantial amount beyond this yield point, because this would cause the sides of the shell to permanently expand, producing a bulge, such as is shown in exaggerated form at 17. It is desirable, however, that at the time of firing the shell be resilient enough so that it will spring outwardly and seal the chamber to prevent the escape of gases rearwardly from the chamber of the barrel. In the event that the pressure is such as to exceed the yield point of the metal in the body of the shell and allow too great a permanent deformation to take place, it is obvious that the bulging portion of the shell will tightly engage the side of the chamber 13. The frictional force caused by this engagement will require that an unusually high extraction force by exerted by the extractor 15. This force may be sufficiently great to cause the extractor to pull over the rim of the shell as the bolt is moved backwardly, leaving the expended shell within the chamber and causing great inconvenience and operational difficulty. Even if the extractor does engage and withdraw the bulged shell, an excessive force is required to operate the gun which is, of course, undesirable.

It is seen, therefore, that the yield point of the metal bears an important relationship to the extraction force necessary to withdraw the shell and also to the sealing of the powder gases and the prevention of the escape thereof through the mechanism of the gun and into the face of the operator. Such leakage of gas is also undesirable inasmuch as it detracts from the power propelling the projectile through the barrel of the gun.

An additional requirement of the metal of the case is that its ductility be such that, upon the firing of the cartridge, splits, such as the one indicated in exaggerated form at 18, will not occur. The base of the shell must also be sufficiently yielding that the blow of the firing pin will be properly transmitted to the priming mixture within the rim and cause the same to be ignited.

Referring now to FIG. 2, ASI C1008 steel strip, that is, carbon steel strip having a carbon content of about 0.08%, which has been copper coated, normalized and spheroidized is used, in accordance with this invention, for the manufacture of cartridge cases. This material is sufficiently soft so that tool wear, although greater than experienced in the manufacture of brass cartridge cases, is minimized. It should be noted that while other
low carbon steels may be used, C1008 steel is used in the preferred embodiment because of its low cost and commercial availability.

The steel strip is blanked and cupped in a manner well known to those skilled in the art. The cups are then washed and dried, to remove any lubricant which may have been applied during blanking and cupping operations, and furnace annealed to eliminate work hardening and put the steel in its softest possible condition for the remaining operations.

Each cup is drawn, to extend its length and provide the proper wall thickness, and trimmed, to remove the rough edge formed at its mouth. The drawn and trimmed cup is then headed whereby it attains the final shape and dimensions of a rim fire cartridge case; the finished steel cartridge cases are degreased, washed and dried.

As has been previously indicated, because steel does not work harden nearly as much as brass, a C1008 steel cartridge case would be unable to withstand the pressures generated during firing of a cartridge constructed therefrom. Accordingly, the steel must be sufficiently strengthened after the cartridge cases have been formed so that the steel will exhibit those physical characteristics required for safe and efficient operation.

The C1008 steel cartridge cases are, therefore, placed in an oven and heated in a carboneous atmosphere at a temperature in the austenitic region, preferably about 1,650°F, for about ninety minutes. This carburization of the cartridge cases causes carbon diffusion to occur, increasing the carbon content of the steel from 0.08% to an amount preferably not substantially less than 0.47% nor substantially greater than 0.62%, or about 0.55%. At 1,650°F, the carburizing temperature, the steel is in its austenitic state. After the cartridge cases have been fully carburized, they are moved to a cooling chamber and cooled in an oxidation-preventive atmosphere at the most rapid rate possible without the formation of martensite. In the preferred embodiment, the carburized cartridge cases are cooled in a nitrogen-hydrogen atmosphere to a temperature of about 200°F in one hour to form a ferrite and pearlite structure which has the maximum hardness and strength obtainable with that structure and carbon content.

The cartridge cases are then brass plated to prevent oxidation and may then be primed and loaded by any desired method.

The method of forming small articles, such as intricate stampings, from low carbon steel and subsequently carburizing the objects to increase their carbon content and, accordingly, their hardness is known. However, such a process has not heretofore been usable in the manufacture of steel cartridge cases.

The teaching of the prior art is to heat the objects in a carboneous atmosphere and then quench and temper them to further enhance their hardness and strength. Although this process is ideal for the production of decorative steel objects, it does not produce acceptable cartridge cases.

It has been shown herein that the steel cartridge cases are not carburized until after all forming steps have been completed so that the excessive tool wear which would occur from working high carbon steel is avoided. It is well known that when carbon steel is austenitized and then quenched, some distortion of the quenched object results from the transformation of austenite to martensite. Although this distortion may not be readily noticeable in small decorative objects, it cannot be tolerated in the manufacture of cartridge cases wherein dimensional tolerances are very small.

Additionally, cooling the steel by quenching produces a martensitic structure which inherently has a low ductility. When subjected to the pressures produced when a cartridge is fired, a steel cartridge case with such a martensitic structure would have an even greater tendency to split than a brass cartridge case. Of course, the ductility of the martensite could be increased by tempering for extended periods of time. However, such tempering would also decrease the strength of the material.

The hardness of the quenched and tempered martensitic structure causes another problem in that it produces excessive wear of gun parts, such as the firing pin and extractor, and reduces the sensitivity of the rim of the cartridge case so that misfires may occur due to the resulting inability of the firing pin to apply sufficient compressive force through the case to explode the primer. For these reasons, the carburization process, as disclosed in the prior art, has never been adaptable for the production of steel cartridge cases.

Steel cartridge cases made in accordance with this invention avoid the problems heretofore encountered with steel cartridge cases. In fact, these cartridge cases exhibit physical properties very similar to those of brass cartridge cases.

In the method of this invention, the carburized steel cartridge cases are furnace cooled to have a ferrite and pearlite structure. Because of this slower cooling procedure, the distortion which occurs when austenite is quenched to produce a martensitic structure is prevented and the cartridge cases have the same dimensions after carburization as they did when they were formed.

Unlike martensite, the ferrite and pearlite structure has very high ductility. Steel cartridge cases made in accordance with this invention exhibit an extremely low incidence of splitting. During comparison firing tests of 22 caliber rim fire cartridges in twelve different rifles, no splits were recorded for steel cartridge cases made in accordance with this invention whereas splits were observed in 0.17% of the brass cartridge cases and 0.46% of the quenched and tempered steel cartridge cases tested. During the entire test, in which 4,400 cartridges, having steel cartridge cases made in accordance with this invention, were fired in both rifles and pistols, only one cartridge case showed any evidence of splitting. In a later test, 6,200 such cartridges were fired in rifles and pistols without the occurrence of a single cartridge case split.

Steel cartridge cases made in accordance with this invention have been found to produce only slightly more wear to firing pins and extractors than do brass cartridge cases and significantly less wear than do quenched and tempered steel cartridge cases. The ferrite and pearlite steel cartridge cases have a hardness range of about 155–200 KHN which is substantially the same as the hardness range exhibited by brass cartridge cases. Because the steel cartridge cases are heat treated during the carburization process, after the completion of all cold working, the hardness tends to be more uniform over the length of these cases than the hardness of brass cartridge cases which are used in their cold worked state. The average tensile strength of the ferrite
and pearlite steel cartridge case of this invention is about 90,000 psi, substantially identical to the average tensile strength of a brass cartridge case. It has been found that the tensile strength exhibited by the steel cartridge cases was generally constant in value throughout the 0.47% to 0.62% range of carbon content.

It should be apparent from the foregoing description that a new method has been disclosed for manufacturing a novel steel cartridge case structure which incorporates the advantages of brass cartridge cases without their inherent splitting tendency and at a lower cost.

We claim:

1. A method of manufacturing a cartridge case from low carbon steel comprising the steps of forming the steel into the shape of a cartridge case, carburizing the cartridge case to increase the carbon content of the steel, and cooling the cartridge case in a gaseous medium to give the steel a ferrite and pearlite structure.

2. The method of claim 1 wherein said cartridge case is carburized to a carbon content not substantially less than 0.47% and not substantially greater than 0.62%.

3. The method of claim 1 wherein said cartridge case is carburized to a carbon content of approximately 0.55%.

4. The method of claim 1 wherein said cartridge case is carburized at a temperature of approximately 1,650°F.

5. The method of claim 4 wherein the cooling of said cartridge case is to a temperature of about 200°F. in one hour.

6. The method of claim 1 wherein said cartridge case is cooled in a gaseous medium comprising a mixture of nitrogen and hydrogen.

7. A method of manufacturing a cartridge case from steel strip having a carbon content of about 0.08%, said method comprising the steps of cutting a blank from the steel strip, forming the blank into tubular member closed at one end, heading the tubular member to form a cartridge case with a peripheral rim at the closed end, heating the cartridge case in a carbonaceous atmosphere at a temperature of about 1,650°F. to increase the carbon content of the steel to a value not substantially less than 0.47% and not substantially greater than 0.62%, and cooling the cartridge case to a temperature of about 200°F. in 1 hour.

8. The method of claim 7 wherein the carbon content of the steel is increased to approximately 0.55%.

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