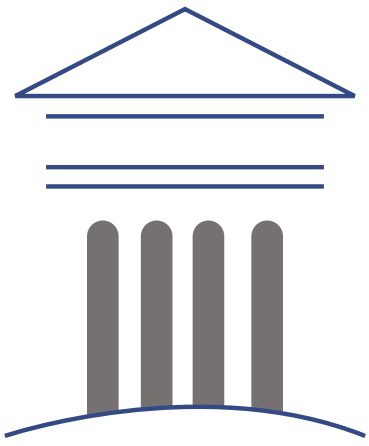
Development of the Modern Cartridge Lesson: 2198

OBJECTIVES	3
INTRODUCTION	3
CARTRIDGE DEVELOPMENT	4
Blank Cartridges	9
Reloadable Cartridge Cases	11
Solid-Head Cartridges	12
Rimless Cartridges	12
Self-Test Questions	13
CARTRIDGE IDENTIFICATION	14
Cartridge Collecting	14
Self-Test Questions	15
MODERN BULLETS	16
Lead Bullets	16
Jacketed Bullets	16
Full Metal Jacket	16
Soft-Point Bullets	16
Hollow-Point Bullets	17
Wad-Cutting Bullets	17
Metal-Piercing Bullets	17
Self-Test Questions	17
ANSWERS TO SELF-TEST QUESTIONS	18
LESSON QUESTIONS	19



Objectives

In this lesson, you will learn

1. The components of the first black powder cartridge.
2. What the letter H stamped on the base of Winchester rimfire ammunition means.
3. The name of the first rimfire cartridge introduced by Smith and Wesson.
4. The meaning of the word "Krag" in the .30-40 Krag cartridge.
5. What the number .50 means in the .50-110-300 Winchester cartridge.

Introduction

Guns and ammunition are integral parts of shooting and can hardly be considered separately.

Until about 125 years ago, a cartridge was a lead ball or bullet plus a charge of powder wrapped in a paper case, called a *cartouche*, the French word for cartridge. These early cartridges, like the one shown in Figure 1, were usually carried in a cartridge pouch. To load them into the rifle or musket, the shooter would tear off the end containing the powder charge, dump the powder down the muzzle, and, using the torn paper as a wad, ram the remainder with the bullet down the barrel with the ramrod. If the shooter was using a flintlock, he would pour a small amount of fine powder into the "pan." If he had a percussion gun, he would slip a cap on the nipple. In either case, he would be ready to fire when the hammer was thumbed back to full cock.



Cartridges went through several stages of development before becoming today's self-contained cartridge, in which the projectile or small shot, powder, and the primer are all cased together. Modern rifle and pistol cartridges have metallic cases and use either a rimfire or centerfire ignition system, depending on the type of priming.

Cartridges come in a variety of sizes and calibers. Usually, modern cartridges have descriptive names that were assigned by the original manufacturer. The caliber of the cartridge is indicated either by hundredths or thousandths of an inch in the United States and Canada, by thousandths of an inch in the United Kingdom, and by millimeters elsewhere. The caliber figure sometimes refers to the bore diameter between the lands of the rifling or between the grooves, and it sometimes refers to the diameter of the bullet.

The object of this lesson is to trace the development of the modern cartridge, including its primer, powder, and bullet. In doing so, you will learn about the initial development of metallic cartridges. You should then be able to identify most cartridges and the firearms for which they were developed. You will also be introduced to collector cartridges and will learn how to appraise them. Finally, you will receive an introduction to the lessons on advanced ballistics and handloading ammunition that follow.

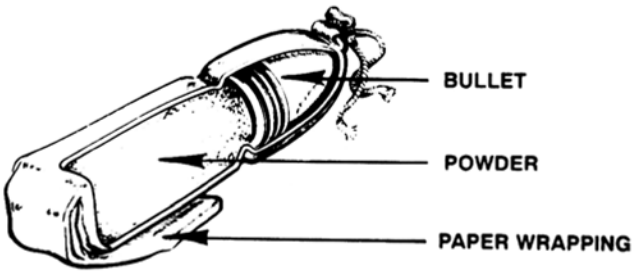


***Figure 1**: Muzzleloading cartridge for military rifle/musket.*

Cartridge Development

One of the first self-contained cartridges to gain success was the .44 Henry rimfire cartridge, developed by B. Tyler Henry of New Haven, Connecticut. It was originally chambered for the Henry lever-action rifle, which was the forerunner of the first Winchester — the Winchester Model 1866 lever-action rifle. The bullet was roughly 0.44" in diameter.

Henry was a shop superintendent for the New Haven Arms Company in 1859 when he was given the task of redesigning their Volcanic rifle action. The new action had to be suitable for use with rimfire metallic cartridges. The first public record of Henry's direct participation in the design of the repeating action appears in U.S. Patent No. 30446, granted to Henry on October 16, 1860, for an "improvement in magazine firearms."

New features of the Henry rifle consisted principally of the addition of a two- prong firing pin, which struck on opposite sides of the flanged head of the rimfire cartridge; an extractor; and changes in the bolt and feeding mechanism. The system satisfactorily handled the loading and firing of the rimfire cartridge and the extraction and ejection of the empty, fired shell. The slotted tubular magazine under the barrel held fifteen 44-pointed rimfire cartridges. Henry later developed the .44 Henry flat cartridge, which was the answer to metallic cartridge arms. This cartridge was important to the development of firearms, especially repeating firearms. All successful guns on the market at the time, such as the Sharps, were single-shot weapons. Henry and Oliver Winchester wanted to develop a repeater, because they recognized the advantages of this type of weapon.



***Figure 2**: Every rimfire cartridge developed by Winchester has an H stamped on the cartridge head as a tribute to B. Tyler Henry.*

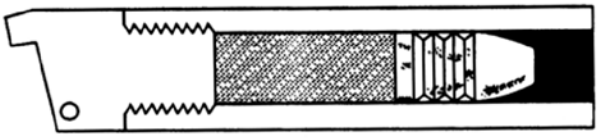


***Figure 3**: The famous Minié ball was a great improvement over earlier projectiles used in firearms.*

As a result, B. Tyler Henry completely revolutionized the firearms industry, and Henry rifles immediately became popular. The name Henry has been perpetuated in still another manner. If you buy a box of Winchester rimfire cartridges of any caliber, you will notice a trademark, a simple H, stamped on the head of each case. This is Winchester's tribute to B. Tyler Henry, and since that first .44 Henry rimfire cartridge was produced, every Winchester rimfire has been identified with an H (Figure 2).

Until the introduction of the self-contained cartridge to America, firearms development had been extremely slow. The major problem was in the method of charging a gun, which could mean the difference between life and death in the heat of battle. Even early muzzleloading cartridges had their problems. Although they offered a great advantage over the loose powder-and-ball system, they were still extremely slow.

A brief resumé of military developments shows the general trend of the firearms field in this respect. Until 1844, all military arms used a round ball. Smooth bores used just the ball, but when used in rifled barrels, the ball was wrapped in some sort of a patch cloth — linen, leather, or some similar material. The problem with the rifled barrel was that it was hard to find a bullet which would expand to fill the grooves, reducing the loss of powder gases that would leak past the bullet. To get a bullet to fit so tightly in the bottoms of the grooves required an oversized barrel, which created the problem of the shooter having to shove the bullet through the muzzle and down the whole length— sometimes nearly 4' — of a fouled barrel.

One early development in firearms was the Minié rifle. Designed in 1847 by French army captain Claude-Etienne Minié, the rifle fired a conical ball with an iron cup in the base (Figure 3). The conical ball had a somewhat hollow base with a wedge-shaped cup, and it could be made slightly undersized. The blast of the powder gases upon ignition forced the iron cup into the base of the bullet, expanding it to fill the rifling promptly. This increased the speed of loading as well as accuracy.

Another early development dates back to 1826, when Captain Henri-Gustave Delvigne of France introduced to the French government an improved form of rifle capable of being loaded as quickly as a musket. The improvement consisted of giving the powder chamber a reduced diameter to form a shoulder on which the ball rested when seated to its full depth. When struck two or three times with a ramrod, the ball expanded to completely fill the grooves upon being shot.

The Delvigne system of chamber was adopted by France in 1838. In 1840, Delvigne took out an additional patent on an explosive bullet with an elongated, cylindrical design, which later proved unsuitable for general military use.

In 1844, Colonel Thouvenin of the French Army proposed an improvement to the round ball. This improvement consisted of a short pillar screwed into the breech plug on which the ball could rest, and which upon being struck by the ramrod would expand like the Delvigne chamber system. Captains Minié and Tamasier of the school of musketry of Vincennes suggested the use of a cylindro-conoidal bullet with a solid base. This was adopted by the French government in combination with the pillar breech in 1846.

Captain Tamasier also reduced the depth of the grooves from the breech to the muzzle. This greatly increased accuracy. This system was used almost all the way through American arms developments. Therefore, the development of American shoulder arms can be traced to the French rather than to the English.

Captain Tamasier also developed the idea of grooving the bullet with two or three sharp-edged channels on the cylindrical rear end, reducing the resistance and permitting easier expansion to fill the grooves. It is not known whether his ideas included the addition of lubricant to these grooves.

Minié's most important contribution to the problem concerned the bullet. His first pattern had a solid cone base united by a short, grooved neck to a rounded head. After Tamasier proved the advantage of more grooves with shoulders like saw teeth, to act more or less as dirt scrapers, Minié combined two of these with a hollow base in which an iron cap was inserted and driven halfway up the bullet on firing. This had a sphere-conodial head.

In the English edition of the Minié rifle, the exterior grooves characteristic of the Delvigne-Tamasier-Minié bullet were omitted. In this rifle, the bore of the barrel was about 0.577 inch, with three grooves having one turn in 6 feet, 6 inches. The conical bullet had no grooves, but a hollow base in which a conical slug was placed. Initially made of boxwood, it later was made of baked clay to allow for expansion. This made an excellent weapon for a muzzleloader and was supplied to all troops in the British service.

Between 1849 and 1855, the U.S. government experimented with firearms, using the Model 1841 rifle, then the 1842 musket with the .69-caliber round ball, and the 1854 conversion of the 1822 and 1842 muskets to a .58-caliber rifle, using the conical bullet. Finally, in 1854 they began preparation for replacing (in 1856) the smoothbore with a rifled barrel in all branches of service.

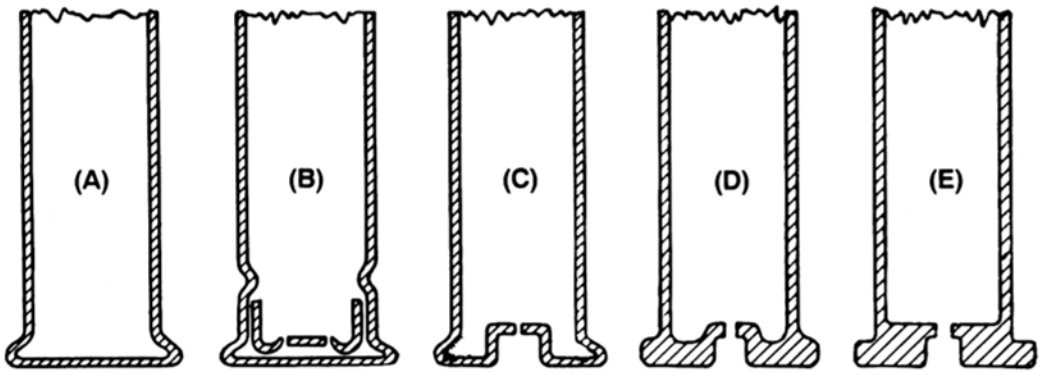


***Figure 4**: Evolution of the cartridge case. (A) Rimfire. (B) Benét cup-type inside primer. (C) Original folded head with centerfire. (D) Original solid-head centerfire, sometimes called semi-balloon primer pocket. (E) Modern, solid-head solid web.*

After experimenting with Capt. Minié's bullet containing an iron wedge, Assistant-Master Armorer Burton of the Harper's Ferry Armory found that a plug was unnecessary because the gases from the explosion sufficiently expanded the hollow base. The plugless bullet was adopted and used thereafter in all new muzzleloading rifles.

Although the extremely slow loose powder-and-ball loading system was still used, some progress was being made (Figure 4). For example, in the paper cartridge unit, the conical ball was wrapped in a patch with a properly measured amount of powder and inserted in a paper tube behind the ball.

Although the idea of wrapping the ball and powder together was not new, many authorities still believe that the United States developed it. However, records show that King Gustavus Adolphus of Sweden ordered his soldiers to carry their powder and ball together in the form of a cartridge in the early 1600s. This cartridge consisted of a cylinder of paper that was twisted on both ends with a round lead ball in one end and a measured charge of black powder poured in on top of it.

The next major development was the unit cartridge with a combustible envelope, which was manufactured by Colt and others, both for early handguns and for rifles. The paper was heavily nitrated, making it extremely combustible. The entire unit, paper and all, was dropped in the muzzle of the gun and seated with a ramrod. If the paper broke open in the seating operation, it was perfectly all right. If not, it would ignite anyway and no traces were left in the barrel.

Next came the development of the famous Sharps linen. This was similar to the combustible envelope or paper cartridge, but the cartridge was wrapped in linen and thoroughly sealed. These cartridges withstood far more abuse than the paper variety and proved extremely popular when used in Sharps rifles.

The Sharps was a breechloader, and the early linen cartridges were shoved, bullet first, into the chamber with the breech cam open. The closing of the breech caused the block to rise up and a sharp edge sheared the end off the linen powder chamber. The muzzle was usually lowered during this operation to prevent powder spillage. Once closed, the percussion cap—the Maynard tape primer—formed ignition through the customary flash hole in the breech.

In 1851, Maynard patented the brass cartridge. This consisted of a tubular brass case with a wide, flat base soldered to the body. In the center of the head of the case was a small needle hole, and the case was used in conjunction with the Maynard tape primer as a breechloader (Figure 5).

In England, the .577 Snider incorporated this coiled cartridge case, which consisted of a combination brass and steel head with the body built up of thin layers of brass foil and paper. This was rolled around in a mandrel to form a paper-metal "sandwich" with the edge solidly glued and was used from 1867 to 1871 as the official firearm of the British military forces. According to *The British Small Arms Manual*, it was designed by Colonel Boxer of the Royal Laboratory at Woolwich Arsenal.



***Figure 5**: The Maynard cartridge had a tubular base with a wide, flat base soldered onto the body.*

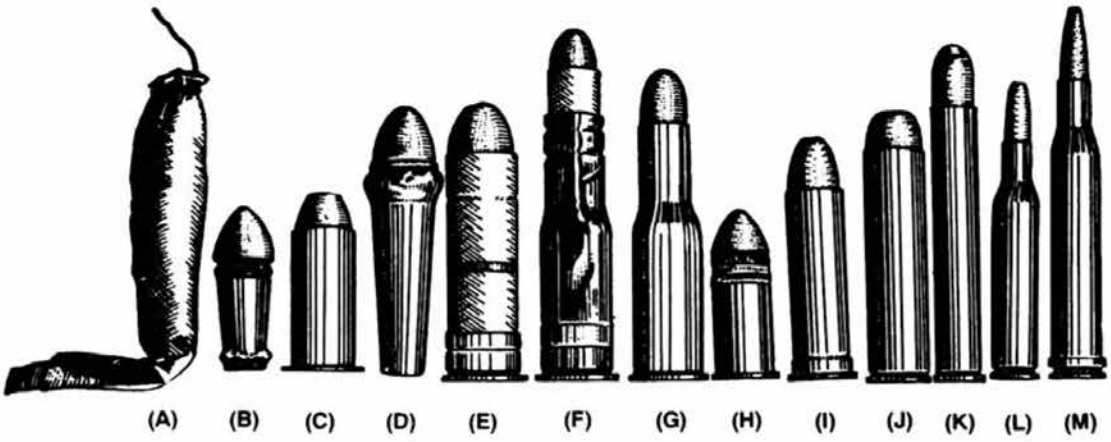


Figure 6: *Evolution of the modern cartridge case. (A) The old paper cartridge for muzzleloading percussion muskets. (B) The paper cartridge for Colt revolvers. (C) The Maynard percussion rifle cartridge with wide thin rim soldered to the base of the shell. (D) The Burnside percussion carbine. (E) The .577 Snider coiled cartridge case. (F) The .557/.450 Martini-Henry coiled case. (G) A solid drawn .577/.450 Martini-Henry. (H) The .58 musket rimfire. (I) The .50/.70 Springfield Armory. (J) The .50/.115 Bullard centerfire with semi-rimmed head. (K) The .405 Winchester. (L) The .257 Roberts rimless. (M) The .300 H&H Magnum belted head.*

In 1871 the Snider was dropped in favor of the .577/450 Martini-Henry, one of the first attempts in England to bottleneck a cartridge case. The case had a .577-caliber Snider body necked down to hold a .45- caliber bullet, as shown in Figure 6.

One of the earliest American brass cases was the Burnside. This carbine, which was used in tremendous quantities during the Civil War until the time of the Custer Massacre, used a straight shell tapered from front to rear, with a large conical bullet that had a bulge or heavy ring on its rear end. Around this ring the neck of the case was formed and crimped. The cartridge was loaded from the front of the tilting chamber, similar to the early Hall rifles described previously. It is quite possible that Burnside got his idea from Hall. Since the mouth of this shell was formed around the base of the bullet and securely crimped into position, its design was unique.

The Burnside carbine used external ignition in either the form of a percussion cap or the Maynard tape primer. The base of the cartridge had a flash hole perforated to line up with the nipple in the breech so that it would ignite the powder charge inside.

The rimfire cartridge was the first truly successful metallic cartridge because it was fairly moisture-proof and its three major components — powder, primer, and bullet — were entirely self-contained. All of the early rimfires had copper cases. Burnside, Maynard, Sharps, and other old gun inventors had to depend upon some form of percussion-cap ignition with the cartridge case containing only powder and ball and ignited through the head of the cases.

A French gunsmith, Louis Flobert, pioneered the now famous BB (bullet breech) caps. Smith & Wesson was the first in the United States to develop a successful rimfire cartridge — the now-common .22 short, first produced for revolvers in 1858.

The rimfire used today is essentially the same as at the time of its origin. A copper disc is punched from sheet metal and then drawn by means of punches and dies into a closed-in tube. The rim is then bumped on. This hollow rim is filled with a mixture of priming compound, originally pure fulminate of mercury. This explodes when the rim is pinched between the face of the barrel and the firing pin or hammer nose.

B. Tyler Henry adapted the famous .22 rimfire to a larger size, producing the .44 Henry cartridge, the first successful "high-power" magazine arm. The development of ammunition was also progressing rapidly at this time. Rimfires had their weak points — they were inclined to blowout at the rim upon receiving the blow of the hammer, greatly limiting their power.

Many interesting developments in metallic cartridges have been made. Morse's cartridge, patented in 1858, was made in Frankford Arsenal in 1860 in small quantities. This distinctive device had a brass cartridge case, the rim of which was folded on the outside to make a tube. The head itself was of gum elastic inserted in the base in the form of a stopper. Into this was inserted a primer similar to a percussion cap. A large anvil, curved to fit the inside of the case, was securely attached, and a flash hole perforated the center. Very little data are available on this, and it is somewhat doubtful if it worked.

Records show that Frankford Arsenal made the Burnside cartridge in 1860 using a 400-grain, .45- caliber ball. Although thousands of these cartridges were made later, at Frankford, various commercial enterprises also manufactured it.

Frankford Arsenal also manufactured the Maynard in .45 caliber. Although this was also commercially manufactured in several other calibers, and Maynard later introduced a series of cartridges of his own, the original Maynard was first made at

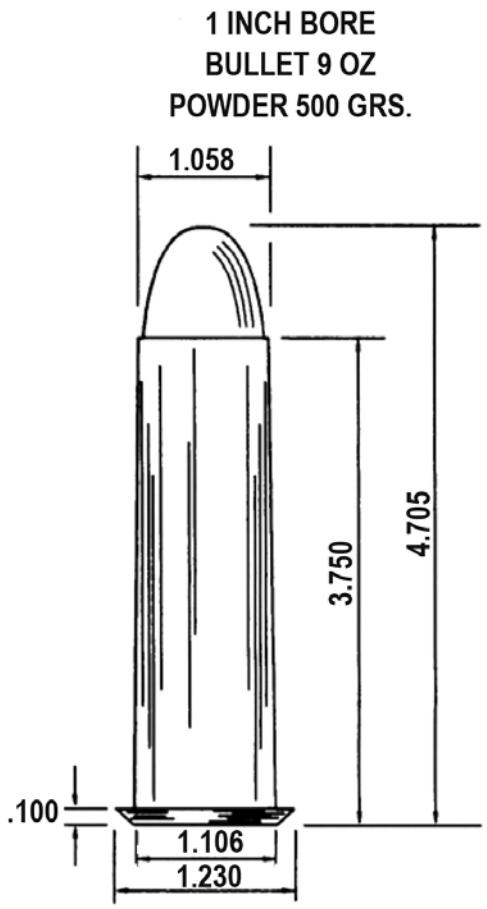


Figure 7: *The 1"-caliber Gatling cartridge was one of the largest until the development of cannon shells.*

Frankford Arsenal in 1860, using a .45-caliber bullet, 40 grains of black powder, and a 343-grain slug.

The Spencer cartridge, patented in 1860, was another of the first successful rimfire cartridges. It was first made experimentally by Smith & Wesson in 1857. It consisted of a .50-caliber bullet weighing 450 grains, backed by 40 grains of black powder. About 50,000 were manufactured at Frankford Arsenal in 1864 and 1865, and they were primed by one of the early centrifugal machines which spun the wet composition into the rim. They used the mixture specified by Sharps: six parts (by weight) of mealed powder, three parts fulminate of mercury, and three parts powdered glass.

Prior to 1866, the Frankford Arsenal had only manufactured the Morse, Burnside, Maynard, and rimfire cartridges of various sizes. The largest of these, shown in Figure 7, was the experimental 1"-caliber Gatling gun cartridge, a large rimfire made to test an experimental Gatling gun. Early tests showed that the centerfire had the greatest possibilities, so efforts were concentrated in this direction.

The first experiment with centerfires at Frankford began in 1864. Two attempts were made with a rimfire cartridge head. The first, with an anvil inserted in the center of the case head, was supported in the center of the powder charge and against the base of the bullet. However, it proved to be unsatisfactory.

The second attempt used a flat bar anvil with a bulge on the head. This anvil pressed solidly against the base of the cartridge, acting as a gas check or reinforcement and at the same time as an anvil. Two flash holes permitted ignition to the powder charge.

The third attempt used external priming. The head of the rimfire cartridge case was bumped into a pocket similar to the present-day pocket and was perforated with two flash holes. The priming mixture was then thrust into this pocket with a thin copper disc pressed overall to seal the pocket completely. It worked, but it leaked gas badly, and the copper disc invariably blew out.

A further development used the standard rimfire case with star-shaped punching with a pocket in the bottom. This star-shaped punching was crimped into the rim to form a suspended pocket. A small anvil with a regular percussion cap over it was previously inserted in this pocket. Striking the apparent rimfire cartridge in the center of the head jammed the copper cap against the anvil. Tests show that 50 of these were fired and there were no failures. It was the best development to that date.

In 1865 Colonel Laidley patented a design that used a large, thin H of sheet iron with an anvil formed on the crossbar. A standard rimfire case was used that was tapered at its forward end so that the anvil could not be blown out and get lodged in the barrel.

This was modified with Laidley's second development, which had straight sides to the anvil rather than the H construction. A deep crimp in the side of the case secured the side walls, thus eliminating the necessity of continuing the iron support to the base of the bullet.

The Ordnance of 1870 gives a description of another priming development. In 1866, a wet composition was deposited centrally on the bottom of the case, adhering sufficiently to the metal when dry, and surrounded by compressed gunpowder. The Ordnance describes it as follows:

> *The powder itself formed the anvil and the priming was ignited with the regular firing pin blow. Twenty cartridges were fired, with one failure. The composition was very sensitive and great care was necessary in loading to avoid explosion. It could become detached in transportation and in service.*

One of the most practical developments of a centerfire primer was the standard Martin bar anvil, shown in Figure 8. This was first manufactured in the .50/70 Government musket caliber in which a 450-grain, 3-groove bullet was propelled by 70 grains of black powder.

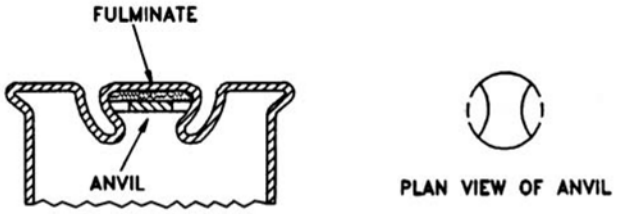


Figure 8: One of the most practical developments of a centerfire primer was the Martin bar anvil.

The bar anvil was made of iron and consisted of a bar with a groove in its rim. In the top center was a cavity to hold the priming composition, which was placed in the bottom of the cartridge case against the head. The case was then crimped into the rim to hold it in place. This was first manufactured at Frankford Arsenal in 1866, and was discontinued in 1868, due to the large number of defects associated with it. The chief problem was in the manufacture. Many of the anvils would tip upon being seated by machinery and explode.

Some of these bar-anvil cartridges were used in the 1"- caliber Gatling gun cartridge. The semi-conical nose bullet weighed 8 oz. and had a diameter of 1.025 inches. Official reports show that it was first made as a rimfire in 1865 for an experiment. A tinned-iron bar anvil was used in the manufacture of about 100,000 ball-and-canister loads in 1867.

According to the Ordnance report of 1873, the bar- anvil cartridge was first made at the national armory in Springfield, Massachusetts, in 1866. E. H. Martin, an armory employee, invented it for experimental purposes. The Ordnance states:

It consisted of a copper case and a rigid tinned-iron anvil recessed at the center to hold the percussion composition and grooved in the ends for crimping and securing it in place. Several million were manufactured at Frankford from October 1866 to March 1868 when it was replaced by Colonel Benét's cup-anvil cartridge.

Several problems were associated with the bar anvil. It was occasionally thrown into the barrel of the gun when firing; it could be turned upside down; and crimping the case close to the head drew in the flange, producing tension and causing occasional bursting. In 1867 a cup reinforcement made from thin metal was applied to the inside of the metallic cartridge case to prevent the gases from reaching the fold. This remedied the problem that caused bursting, but caused occasional misfires from two thicknesses of metal at the point of impact on the firing pin.

This was alleviated by a cup or reinforcement that was inserted within the flange cartridge case in such a manner as to rover and protect the flange.

BLANK CARTRIDGES

It is believed that the first of the military blank cartridges like the one shown in Figure 9 were manufactured at Frankford Arsenal in 1868. The 1873 report shows a drawing of a .50/70 musket blank cartridge using the Benét cup-type primer, and the report states:

The above service blank cartridge was adopted September 1868. The end was tapered to assist its entrance into the gun chamber and to have the smallest wax seal possible. The wax is composed of 15 pounds beeswax, 1 pound resin, and 1 gallon North Carolina pine tar melted together; and is applied cold by pressing in by hand. Cartridges have been made for the following arms: the Navy rifle, the Spencer rifle, Gatling guns, and Colt, Remington, and Smith & Wesson pistols. This metal is from .022" to .025" of copper.

Another experimental center-primed cartridge was designed by Benét and manufactured at Frankford Arsenal from January to April 1866. In this particular cartridge the case was formed like a rimfire but the primer pocket was shaped as a continuous drawing with the head of the case. In other words, it was "bumped-in" in the conventional fashion.

This particular idea was one of the principal features of the Berdan cartridge. Colonel Berdan came to the arsenal and obtained the necessary information to apply to his own cartridge, which previously had a separate cup inserted at the head. In the Benét cup the anvil was inserted separately and a percussion cap then pressed in on top. This used a single, central flash hole.

Still another development, the Crispin, a combination paper-and-metal wrapped cartridge case, was manufactured in 1867 at Frankford Arsenal for experiment based on plans submitted by Colonel Cyrus Crispin of the Ordnance Department.

The plans specified that a strip of thin sheet of brass about .002" thick be rolled by hand on a roller along with a sheet of paper, forming a case of three thicknesses of paper and two of metal. The paper was to cover the inside and the outside of the case, with the metal between. The case was to be held to a brass head or capped by the friction of a paper wad in the head.

Although a number of these Crispin cases were fired and proved to be easy to extract, this mode of attaching was not

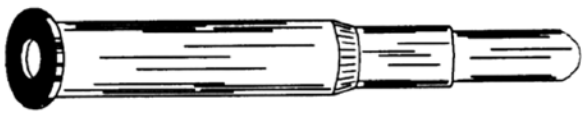


Figure 9: It is believed that blank cartridges were first manufactured around the late 1860's.

considered reliable, because the case frequently came loose from the head. The head, which was similar to Colonel Benét's center-primed design, had the primer pocket folded into the original head, along the lines of a modern shotgun shell.

Another development of the metallic cartridge was for the Thuer alteration of the Colt revolver. This was a rimless metallic cartridge with a primer located in the center, but the case itself was tapered slightly toward the rear and was loaded from the front of the cylinder. A number of these used a standard center fire primer, as is evidenced by specimens in collections. The early development used the Benét cup-type primer and was made as an experiment at Frankford Arsenal for use in the first alteration of the Colt Army revolver in November 1868. It was inserted in the chamber in the front end, held in place by the friction of the bullet, and ignited at the center by a firing pin. The friction of the bullet, however, was not always sufficient to ensure ignition, resulting in many misfires. A cartridge made with a thin cap and outside priming was much more efficient.

Another development was that of the Martin cartridge, patented and manufactured experimentally in 1869.

The Martin cartridge had a complicated system in which the copper case was folded so that it appeared to have an inserted centerfire primer. Actually, the primer was a part of the original case drawing. The case was first drawn along the lines of a rimfire, a very large primer pocket almost the full diameter of the head was bumped in, and the primer pocket was then pushed upward by a small center punch to form a flat surface with the head of the cartridge. This resulted in a fold or copper case, which projected into the powder chamber. Into this pocket an anvil was inserted and hollowed out which contained the priming composition. The composition was seated into this special pocket with the folds crimped around the anvil to hold it in position.

The patent claims granted to Edward H. Martin in 1869 follow:

> *U.S. Patent No. 88,191. Claim: First, an interior conical-shaped pocket or receptacle containing the fulminate and anvil where the wall of said pocket is formed in two thicknesses of metal contiguous to each other substantially as described.*
>
> *Second, turning over the upper part of the conical portion of the reinforcing cup upon and into the pocket or receptacle for the fulminate an anvil forming a gas check substantially as described.*

A number of these cartridges were made at Frankford Arsenal in 1871 for the Navy carbine, Remington pistol, and Colt revolver, calibers .44 and .50. The unique feature of the cartridge was the formation of an inside pocket from one continuous piece of metal and is performed at two operations.

During 1870, Martin received a patent for a modified design in which another fold was added under the head to prevent burst rims. This was patented under U.S. No. 111,856.

Frankford Arsenal records show that a large number of the Martin cartridges caliber .50/70, shown in Figure 10, were made from May to December 1871. The formation of the fold required two operations, and the inventor used a single-indented bar anvil that was primed by hand plates and was used until the machine charger was finished.

A double-indented bar anvil replaced the single bar in September 1871, and in October 1871, Colonel Treadwell suggested a double-indented disc anvil with one vent.

The hand-priming often caused the composition to burn when closing the pocket on the anvil on the double-indented, machine-primed bars. The disc had the advantage of a larger surface to resist the pressure of crimping or fastening the anvil, reducing the burning to a minimum. The bars exploded upon loading at a rate of 1-5 in each 1,000, while the use of the disc reduced this rate to 1 in 10,000.

A unique feature of the cartridge was the formation of the inside pocket to hold the anvil in a fold of one continuous piece of metal. The double fold at the head gave elasticity at the weakest point. Early experiments showed that occasionally the crimp on the bullet would pull the case body off the head and drag it into the barrel before the pressure of the cartridge could expand the case. Manufacture of this type of cartridge was abandoned in December 1871.

Another development was the Corliss needle cartridge with the Springfield breechloading rifle. The needle was attached at the base to a disc crimped into the flange of the case. The point was made to conform with that of the service firing pin, and the fulminate was held in a copper capsule seated in the base of the bullet, open to the rear and covered with tinfoil. A blow from the standard firing pin against the priming composition ignited the powder charge from the front.

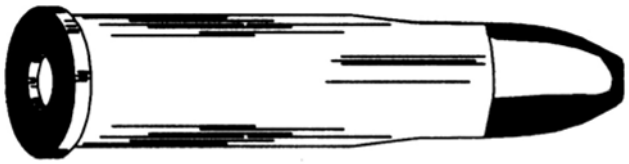


***Figure 10**: The .50/.70 government cartridge was one of the first successful centerfire cartridges.*

Most of these early experimental cartridges were handmade and were held to very close precision requirements. Official tests show that the first 25 cartridges tested failed entirely to explode in the gun. On examination, the fulminate was found to have been forced into the bullet instead of being crushed by the needle point.

An additional 30 cartridges were made with the front of the needle flat and squared. Out of 18 tested, 5 exploded. Average velocity with the same weight of powder and bullet charge of the service number with a cup primer was 1,320 feet per second; with the needle it was 1,336 feet per second. The variation in the standard service (rear ignition of powder charge) was .3 percent and of the needle 1.1 percent. The front ignition gave slightly higher velocity but no uniformity.

In an accuracy test of 500 yards, average deviation with the service cartridge was .856 inch, with the needle it was 2.169 inches. The fouling from 14 shots was removed and weighed. In the service cartridge it amounted to 6 grains; with the needle cartridge it was 5 grains. Of the 13 needle cartridges used in this test, one cartridge exploded on the first blow, 3 on the second blow, 6 on the third blow, 2 on the fourth blow, and 1 on the fifth blow. Five needle cartridges failed entirely after five blows. This particular idea was never placed into practical application.

Further experiments were conducted with a new type of reloadable centerfire cartridge, with a primer designed by Milbank and patented in May 1870. A number of these manufactured by the Winchester Repeating Arms Company of New Haven, Connecticut, and labeled "solid head, central-fire reloading cartridges" were tested at Frankford Arsenal in April 1873. The head was claimed to be a solid one, which was presumed to mean one fold, similar to that used in the standard Dutch carbine cartridge (Beaumont).

According to Frankford Arsenal, this did not fulfill the conditions of solid head as they rated it. The metal of the case was quite thick, measuring .05 inch. The flanges or rims had a greater variation in thickness than any other cartridge previously tested at Frankford and ran from .062 to .079 inch. Frankford reported that they even varied in thickness on the same rim at different points, showing bad work at a very important point.

The primer was made similar to a rimfire case, and a pocket was bumped into the standard case head for insertion of this separate primer.

The official Frankford Arsenal report shows that the composition "is of a dark color resembling that in the Eley cap and is covered by a paper wad, the open end being slightly closed to facilitate its insertion into the pocket of the case." In submitting this, Winchester claimed superiority in the following points: first, certainty of fire; second, no escaping gas at the primer; third, resistance to moisture. Fourth, facility in reloading.

RELOADABLE CARTRIDGE CASES

Frankford Arsenal developed an interesting experimental case for reloading. One of these experiments, conducted in 1872, used a conventional folded-head cartridge case built like a rimfire but with a large opening in the center. Into this was inserted a cup also open in the center, to serve as a gas check. Through the opening, a special pocket was riveted into position. A separate anvil of brass used a percussion- cap type of primer curved to hold the anvil in position. Twenty cartridges were made from brass rather than copper, and a Remington gun was used for experimental purposes in .50/70 musket caliber. The results showed no signs of swelled heads, and extraction was extremely easy.

Within a year many of these Frankford Arsenal experimental features appeared in a patent granted to Milbank No. 131,017, dated September 1872.

Another Frankford Arsenal experimental case for reloading had the primer pocket formed as a part of the original draw and a special gas-check cup perforated in the center and forwarded around the primer pocket and the rim of the case to give added strength. In these tests, twin flash holes were used and two types of anvils were tested - one a cube and the other a sphere.

The idea was to secure a proper position in the pocket when machine loaded without careful inspection. Experimental spheres were made by casting ordinary type metal (a hard lead and antimony mixture). Twenty were fired with one failure. The alloy proved too soft and difficult to mold.

The cube was made of brass, .12" on its edge, by punching in a double-action press, and the flat surface was toward the priming composition, but was not as sensitive as the pointed anvil. The cap surface was spherical along the lines of the Winchester primer today. The priming mixture was thickest in the center.



Photo of Frankford Arsenal Government Loading Bullets

Moist priming was used to charge these little cups, and a mixture of glass and tinfoil was varnished on after they dried. The tinfoil was secured by a varnish cement and could be revarnished on the top of the tinfoil to seal against moisture absorption. The diameter of the pocket cap was .22 inch and depth of the pocket .19 inch. The thickness of the metal was .036 inch.

It was intended to use a punch to remove this anvil and the fired cap, whereupon the brass anvil could be reinserted and reused.

A third idea experimented with at Frankford Arsenal is a type today known as the Berdan anvil, in which the anvil forms a definite part of the primer pocket and thus is not removable. This proved to be a very reliable cartridge.

A large number of these cartridges were made for the Russian government for use as a reloader. The cartridge has a very different value from the center- anvil type and its effectiveness as a reloader is questionable.

The original Frankford Arsenal off-center anvil used a single large flash hole whereas the Berdan used two small flash holes located on opposite sides of the pocket bottom.

Many ideas for both inside and outside primers were tested at Frankford Arsenal, with varying degrees of success.

SOLID-HEAD CARTRIDGES

It is believed that the Hotchkiss was the first true solid- head cartridge. This had a solid head with no folds at the rim. The sharp corners were not the product of stamping or drawing but more or less of lathe turning. The primer pocket was not visible from the exterior. The pocket consisted of a cup formed in the bottom of the head on the inside.

An inverted anvil containing the priming composition was dropped into this cup. The pocket was then crimped to the anvil to prevent the anvil from blowing out. A blow of the firing pin on the outside of the head indented the head against the priming composition. The anvil thus exploded the mixture and permitted it to escape through a central flash hole in the powder charge. However, the cartridge was not reloadable.



***Figure 11**: Winchester claims their 6 mm Lee Navy was the first rimless cartridge developed in the United States.*

Cartridge development continued in various ways. Numerous commercial developments (too many to recount here) proved to be successful mainly on paper, since in actual tests they usually failed. The majority of those ideas that proved to be reasonably practical were probably submitted for government testing, since every inventor, whether commercial or individual, was interested in securing development of his or her ideas by the government for possible adoption. This would result in excellent revenue for the manufacturer or inventor.

RIMLESS CARTRIDGES

The history of the first rimless cartridge is uncertain. Winchester takes credit for producing the first successful rimless cartridge in this country, the 6 mm Lee Navy, shown in Figure 11. It is also quite possible that the .50/115 Bullard was the first rimless cartridge.

Regardless of which came first, the rimless cartridge presented additional problems for cartridge-case manufacture.

Essentially, a rimless cartridge case is the same as the rimmed type, but with the rim lathe turned off and an extractor groove cut into the brass head. The solid- head construction did not have sufficient metal to permit this.

This resulted in the development of solid-web construction, which is used in most of today's cartridge cases. With the exception of cases for a few small pistols and revolvers, all automatic pistol cartridge cases are solid web, as are those of the majority of modern revolvers.

The primer used these days is not really new. For nearly 50 years it has been constructed essentially the same way. Only minor changes in developments have been made. Some primers use two-legged anvils, some use three-legged ones, and some use four-legged ones. Some early Savage primers made over 75 years ago show brass cups with four-legged brass anvils.

The major change caused by smokeless powder was the elimination of mercuric fulminate for the priming mixture. Mercury attacks brass, causing the metal to become brittle and dangerous for reloading purposes. Frankford Arsenal developed the first successful priming mixture, H-48, which was designed for the .30/40 Krag cartridge and first produced around 1898. This was the standard government primer for many years. The priming was nonmercuric and was copied by many commercial ammunition makers almost from its introduction.

The mercuric primer worked fairly well with black powder, but this powder left a heavy residue inside the brass case, which minimized the problem of the mercury attacking the brass. With smokeless powder this residue was not present and destruction was rapid, so the mercuric primer went out of existence, particularly on shells designed to be reloaded.

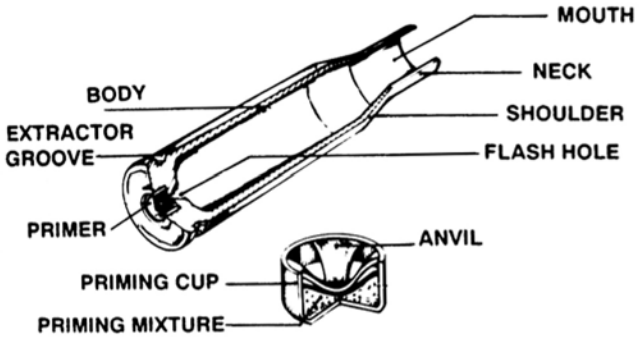


Figure 12: Components of a modern centerfire cartridge case and primer.

There has been little development of the cartridge case in recent years. Early cases were either straight or straight taper. Modern high-power rifle cartridges are more or less of bottleneck type of construction, allowing a much larger space for powder in a given caliber. Figure 12 shows a cutaway of a modern cartridge and primer.

Brass has remained the standard for centerfire cases although experimental materials have been tried. Due to a shortage of brass during World War I, Germany used steel cases. Although these were expensive to manufacture, they worked fairly well. Many soldiers brought back samples of these. Most of the steel cases were heavily copper plated to prevent rust.

Frankford Arsenal also experimented with steel cases to determine if they could be manufactured under wartime requirements in case of a brass shortage. Experimental samples were found to be entirely practical, but the manufacturing expense along with the failure of the cases to expand properly in the gun eliminated them as a possibility.

SELF-TEST QUESTIONS

Please check your answers on page 18.

1. ***True or False*. The word cartridge came from the French word *cartouche*.**
2. **What was the name of one of the earliest successful centerfire cartridges?**
3. **What company claims the invention of the first rimless cartridge in the United States?**
4. ***True or False*. The early .22 Short rimfire cartridges are similar to those manufactured today.**

Cartridge Identification

Because cartridges vary so widely in origin, characteristics, and description, no universal or standard naming system has ever been adopted.

In the early days, centerfire cartridges were designated by a system of two or three numbers. For example, the .45-70-500 cartridge told the shooter that the bullet was .45 caliber, the powder charge was 70 grains, and the bullet weighed 500 grains. The .32-20 was approximately .32 calibers and contained 20 grains of black powder. The .44-40 was approximately .44 calibers and contained 40 grains of black powder.

The .30-40 Krag is a little different. It was a .30-caliber cartridge backed with 40 grains of smokeless powder, and its inventor's name (Krag) was added.

The .30-06 Springfield is an example of cartridges named according to date or origin. The .30-caliber Springfield rifle, first adopted by the U.S. government in 1903, was modified in 1906 to take the present cartridge. This explains the "06" in the name.

Sometimes, the name of the maker or manufacturer is added to a cartridge designation, distinguishing it from another cartridge of the same caliber but different makeup. For example, the .25-20 Winchester was named to distinguish it from the .25-20 Single Shot — an entirely different cartridge.

In the .270 Winchester, the manufacturer's name (Winchester) is added after the caliber designation. The .257 Roberts is named after its inventor, while the .303 British is named for the country in which it was developed.

Because foreign countries use a different system of weights and measures, some foreign cartridges are designated in millimeters instead of inches, as with the 7 x 57 mm Mauser. In this cartridge the bullet diameter is approximately 7 mm, the length of the cartridge case is 57 mm, and the inventor's name was Mauser (he was also the manufacturer). Almost all European rifle cartridges are designated in this manner. Foreign rimmed cartridges carry the letter R following the cartridge designation.

Typical of European rimless cartridges is the 8 x 57 mm cartridge, which has an 8 mm bullet and a case 57 mm long. The same cartridge in the United States is referred to as the 8 mm Mauser, or the 8 x 57 or 7.9 Mauser, to avoid confusion with the 8 x 56 Mannlicher-Schöenauer. Both cartridges are rimless and closely resemble each other.

Several American calibers have become popular in Europe, and guns to match them have been made in those countries—usually with a different name, as shown in the chart in Figure 13. It is difficult to determine the interchangeability of American and European cartridges because many cartridge names between the two countries are totally different. A wrong choice could cause a serious accident.

It is a good idea to check any foreign gun thoroughly especially if caliber and condition are not readily known before you attempt to fire it. Follow these procedures when checking the gun:

- Slug the barrel to determine the exact bore diameter. This is done by pushing a slightly oversized pure lead bullet down the bore with a rod. Then, with calipers or a micrometer, carefully measure the diameter of the lands and grooves cut into the lead bullet.

- Make a chamber cast using Cerrosafe compound and take all measurements with a micrometer. By comparing these dimensions, you should be able to determine the cartridge type from reference books. Cartridges of the World: A Complete and Illustrated Reference for Over 1500 Cartridges by Frank C. Barnes is one of the better references. A three-volume set of books titled Cartridges for Collectors by Fred A. Datig is another excellent reference source.

- Check the headspace with the proper headspace gauge.

Many foreign rifles, especially those made during wartime, were often made by slave labor, of shoddy materials, and many were assembled from scattered parts — some of which may not have been fitted properly. Improper headspace and even more serious problems may be present.

CARTRIDGE COLLECTING

Collecting cartridges is an interesting hobby, and such a collection will also prove invaluable to the gunsmith in identifying foreign and obsolete cartridges. You can identify many unmarked obsolete firearms by using cartridges in your collection as references. Now would be a good time to start such a collection.

Most cartridge collections probably evolved by the accumulation of odds and ends that accompanied collector firearms. Consider the following example: A collector purchases a Winchester Model 1886 rifle chambered for a .40-82 Winchester. Along with this rifle comes a partial box of original, factory-loaded ammunition. Later, the collector sells or trades the rifle, but keeps the cartridges. The collector purchases another firearm, for example a Remington Rolling Block single-shot rifle chambered for the Remington .44-100-500 cartridge. Again, a few cartridges are included in the deal. Eventually, after several purchases of this nature, the gun collector or dealer has what could be considered a cartridge collection, which grew more or less by accident.

Let's stop and see if you can identify the two cartridges mentioned in this example. How would you describe the .40-82 Winchester? If you said a .40-caliber cartridge containing 82 grains of powder and introduced by Winchester Repeating Arms Company, you are right! Now how about the Remington .44-100-500? This is a .44-caliber cartridge containing 100 grains of powder behind a 500-grain bullet. It was introduced by Remington Arms Company.

RIFLE CARTRIDGES	
American	**European**
22 Hornet	5.6 x 35R
22 Savage	5.6 x 52R
25 Remington	6.5 x 52
25-35 Winchester	6.5 x 52R
7 m/m Mauser	7 x 57
30-30 Winchester	7.62 x 51R
7.62 Russian	7.62 x 53R
30-06 Springfield	7.62 x 63
303 British	.303 Inch Mark VI or VII
8 m/m Mannlicher-Schoenauer (M/1908)	8 x 56
8 mm Mauser	8 x 57

PISTOL CARTRIDGES	
American	**European**
25 Automatic	6.35 Browning
30 Luger	7.65 m/m (Parabellum)
30 Mauser	7.63 m/m Militaire
32 Automatic	7.65 m/m Browning
38 Automatic	9 m/m Browning
380 Automatic	9 m/m Browning Short (Corto, Kurz)
9 m/m Luger	9 m/m Luger (Parabellum)

***Figure 13**: A comparison of some American and European rifle and pistol cartridges.*

If the collector has enough interest in old or unusual ammunition, he or she will probably specialize in one area of cartridge collecting; for example, cartridges grouped by brand, country of origin, caliber, or perhaps in military ammunition. The study of only one small group of cartridges will reveal information previously unknown to the collector. He or she will learn facts that will help identify headstamps, case metals, bullet shapes, and designs, just to name a few.

At this point, the cartridge collector will start investigating the best methods to catalog and store the collection, build up trading stock, maintain the collection, and similar details. He or she will also be looking for methods of evaluating the worth of the collection.

Not too many years ago, obsolete cartridges of all types could be found in attics, basements, at flea markets, gun shows, and other places...all for a relatively reasonable price. However, many of the early obsolete cartridges have risen in value to the point where many beginning collectors are eliminated at the outset. The investment required to purchase and maintain such a collection can be very discouraging to the would-be collector. Still, these rare specimens can be found from time to time, and rather than collect them, the finder may wish to sell them to an established cartridge collector.

Price guides are available that give the worth of collector cartridges, but since prices are changing on a continual basis, these references should be used only as guides. Look in some of the shooting publications, like *Shotgun News*, *Gun Digest*, and *American Gunsmith*. Locate antique cartridge dealers online or in the classified ads in these publications and request their current price lists, which will give you a relatively accurate value of collector cartridge. Another reference for antique cartridge prices, as well as antique firearms, is ***Antique Guns — The Collector's Guide***, published by John E. Traister, available at online book retailers.

SELF-TEST QUESTIONS

Please check your answers on page 18.

5. **If a foreign firearm is stamped "5.6 x 35R" on the barrel, what American ammo would you buy for the gun?**
6. **What is the weight of the bullet (in grains) in a cartridge marked .45-70-405?**
7. ***True or False*. The metric designation of the .30-30 Winchester cartridge is 7.62 x 51R.**
8. **What is the European designation for the .25 automatic pistol cartridge?**

Modern Bullets

The samples shown in Figure 14 illustrate the wide variety of bullets made for rifle and handgun ammunition. There are bullets for target shooting, big- game shooting, small-game hunting, self-defense, police work, and even for special gallery use. Each is discussed in the paragraphs that follow in order to familiarize you with the various types and their uses.

LEAD BULLETS

Lead bullets are made of an alloy — in this case, a mixture of lead and antimony — that produces a harder bullet than one of pure lead.

Plain lead bullets must be greased or lubricated either "inside" or "outside" to prevent leading or fouling of the gun bore. Bullets lubricated inside are provided with grease retaining knurls that are filled before the bullet is loaded into the case. This lubrication is covered by the case after loading so that the lubrication does not pick up grit or other foreign matter.

Outside-lubricated bullets are greased after loading, and the bullet is generally completely covered with lubricant.

All factory bullet lubricants are combinations of waxes and grease that give maximum accuracy, prevent fouling or leading, and prevent the tendency to melt or run during hot weather.

JACKETED BULLETS

A jacketed bullet has a lead core covered by an outside jacket of gliding metal. These jackets are especially alloyed for toughness and non-fouling characteristics. This prevents the bullet from deforming after firing and sends it out of the bore entirely free of unwanted fouling. The jackets and cores are assembled into several styles of bullets — full metal case, soft point, hollow point, etc.

FULL METAL JACKET

The full metal jacket or case has a metal jacket completely enclosing the tip of the bullet, preventing it from expanding when it reaches a target.

The pointed or spitzer type of bullet is used in target shooting. The sharp profile gives less wind resistance, flatter trajectories, higher remaining velocities, minimum wind drift, and top accuracy. Round-nosed bullets with lower velocities are used for sure functioning in semiautomatic firearms.

SOFT-POINT BULLETS

When a jacketed bullet is closed at the base and has a part of its core exposed at the point, it is called a soft- point bullet. In factory-loaded bullets and those for use in hand-loading, the amount of lead exposed at the tip, jacket thickness, and hardness of the core are controlled carefully for proper performance within the velocity range of each cartridge.



***Figure 14**: Several types of bullets currently available to shooters and reloaders.*

When a soft-point bullet strikes game, the point expands and upsets or mushrooms. The energy of the bullet is expended quickly within the animal, creating shock and a large wound. In medium calibers and at ordinary ranges, the soft point is very effective on thin- skinned game. In heavy calibers, these bullets are de- signed for positive performance on larger game.

HOLLOW-POINT BULLETS

As Figure 14 shows, the hollow-point bullet has a cavity at the tip which gives it expansion characteristics different from the soft point. Hollow- point expansion is delayed, giving deep penetration. Its explosive opening action causes great tissue destruction. For positive stopping power of heavy, thick-skinned game, the hollow point has no equal for preference — particularly when the trophy is more valued than the meat and destruction of tissue is of little importance.

WAD-CUTTING BULLETS

These bullets were designed especially for target shooting, but in recent years, law enforcement agencies have found that these blunt, sharp-shoulder bullets tend to ricochet less than round-nosed bullets, and consequently are safer for use where a stray bullet may injure an innocent bystander. These bullets cut a clean hole through target paper and are therefore easier to spot and score.

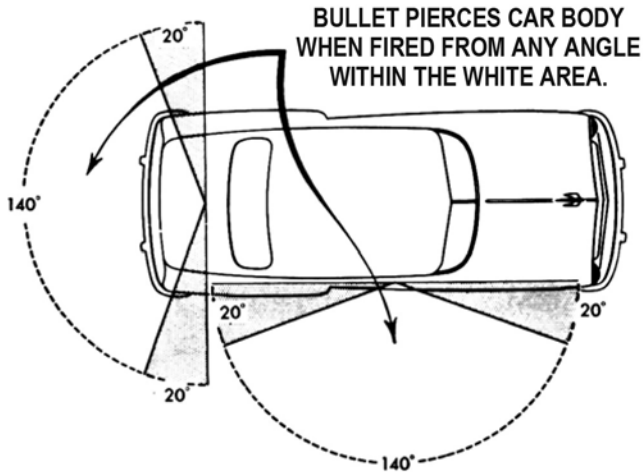


***Figure 15**: Despite the sloping designs of today's automobiles, metal-piercing bullets will penetrate from any side, even at a 20° angle.*

METAL-PIERCING BULLETS

Developed especially for law enforcement officers, the metal-piercing bullets are used to stop criminals escaping in fast automobiles. The bullet's nose is conical in shape and is made of tough gliding metal. It punches its way through the steel body of the car and is carried on by the weight of the lead core or body of the bullet. This bullet does an effective job of stopping a criminal. Refer to Figure 15 on the next page.

SELF-TEST QUESTIONS

Please check your answers on page 18.

9. **What is the name of a bullet that has the front of the lead core completely covered by a metal jacket?**
10. **What is the name of the bullet that has a blunt point and sharp shoulders for cutting clean holes in paper targets?**
11. ***True or False*. A hollow-point bullet's expansion is a little slower than that of a soft-nosed bullet.**
12. **What is the name of the bullet used by law enforcement officers for piercing automobiles?**

Answers to Self-Test Questions

1. True.
2. The .50/70 government cartridge.
3. Winchester Repeating Arms Company.
4. True.
5. .22 Hornet.
6. 405 grains.
7. True.
8. 6.35 Browning.
9. Full metal jacket.
10. Wad cutter.
11. True.
12. Metal-piercing bullet.

Lesson Questions

THIS IS LESSON NUMBER 2198.

Make sure you print your name, student number, and lesson number in the space provided on the Lesson Answer Form. Be sure to fill in the circles beneath your student number and lesson number.



REMINDER: A properly completed Lesson Answer Form allows us to evaluate your answers and send the results and additional study material to you. Do not hold your Lesson Answer Forms to send several at one time. You may run out of study material if you do not send your answers for evaluation promptly.

You may also complete your exam online at www.sdi.edu, click on the *online exams* tab.

1. **What components made up the first muzzleloading cartridges?**
   a. Powder, lead ball, and primer wrapped in paper.
   b. Powder and lead ball wrapped in paper.
   c. Lead ball, powder, and primer contained in a copper case.
   d. Lead ball, powder, and primer contained in a steel case.

2. **What does the letter H stamped on the base of Winchester's rimfire ammunition stand for?**
   a. High velocity.
   b. Heat treated.
   c. Winchester's shop superintendent, B. Tyler Henry.
   d. Heavy duty.

3. **When lead balls were used in rifled barrels, what was the ball wrapped in?**
   a. Tallow.
   b. Paper containing priming compound.
   c. A cloth or leather patch.
   d. Beeswax.

4. **Which of the following was the first successful rimfire cartridge, introduced by Smith & Wesson?**
   a. .22 CB.
   b. .22 Short.
   c. .22 Long.
   d. .22 Long Rifle.

5. **How many grains of black powder are used in the .50-110-300 Winchester cartridge?**
   a. 50 grains.
   b. 110 grains.
   c. 300 grains.
   d. 460 grains.

6. **What weight bullet is used in the .50-110-300 Winchester cartridge?**
   a. 50 grains.
   b. 110 grains.
   c. 300 grains.
   d. 500 grains.

7. **What caliber bullet is used in the .50-110-300 Winchester cartridge?**
   a. 50 caliber.
   b. 110 caliber.
   c. 300 caliber.
   d. .223 caliber.

8. **What does the word "Krag" stand for in the .30-40 Krag cartridge?**
   a. The type of powder used.
   b. The manufacturer's name.
   c. The type of bullet used.
   d. The inventor's name.

9. What year was the .30-06 cartridge modified and adopted by the U.S. government?

a. 1806.

b. 1906.

c. 1936.

d. 1930.

10. Which of the following bullets would you use in a .38 Special revolver for target work?

a. Full metal jacket.

b. Hollow point.

c. Soft point.

d. Wad cutter.