CARTRIDGES, CAPS, AND FLINTS: A PRIMER FOR ARCHAEOLOGISTS

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ABSTRACT

Gunflints, percussion caps, cartridge cases, and bullets are durable artifacts that may provide temporal and functional data. Loaded metallic ammunition was introduced in the 1860s and quickly replaced muzzle loaded flintlock and caplock ammunition. Loaded or self-contained metallic cartridges consist of a metal case, primer, powder charge, and bullet. The American caliber identification or cartridge designation standards are a complex, confusing, and inconsistent series of nonsystematic conventions. The development and changes in cartridge cases, ignition or priming systems, powder, and bullets are documented, and some of the changes are time markers. Cartridge cases with or without headstamps can be identified, and the process for doing so is presented. Once identified, the date of introduction, period of manufacture, intended use, and firearm(s) for which the cartridge was designed can be determined.

INTRODUCTION

The archaeological recovery of elements of firearm use from field surveys and excavations on historic era sites is not uncommon. Artifacts such as gunflints, percussion caps, spent bullets, cartridges, and cartridges cases are durable and potentially diagnostic. Identification and description of these firearm elements, particularly cartridge components, using proper terminology can be a vexing problem.

This paper addresses this problem, with an emphasis on the loaded or self-contained metallic ammunition period from the advent of such cartridges in the 1860s through World War II. Most commercial ammunition loading was halted during World War II for the war effort. Subsequent to World War II, cartridge design has become more standardized. The archaeological recovery of firearms, i.e., parts or fragments of guns, is not common. Unlike information about cartridges, an astounding amount of detailed information has been published about firearms. Even with the amount of information available, accurate identification of gun parts may best be left to an expert. Summaries of firearms used in the West, including Indian trade guns, are in Hamilton (1960), Mails (1972), Markham (1991), Rosa (1985), Russell (1977), and numerous other sources.

Firearms have obviously had a substantive and dramatic impact on cultural developments and historical events in America. Wallack (1977:71) asserts that the American Industrial Revolution developed around two industries, firearm manufacture and textile machinery, with firearms being the earliest industry. The archaeological presence of firearm elements has the potential to provide functional and temporal information regarding the site. The

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assemblage of cartridge cases or bullets at a particular site or component can provide direct data regarding what types of activities were occurring, as well as information about the socioeconomy of the inhabitants (e.g., Horn et al. 1986; Scott 1989).

Gunflints, percussion caps, and loaded metallic cartridges also provide temporal data. Period of use for flintlock and caplock guns is well established. Date of introduction or period of manufacture of a particular cartridge can be ascertained. Since the brand and model of firearm used can be determined from spent cartridges, the period of manufacture of that firearm can also be documented. Date of use is more difficult, particularly in light of the practice of handloading or reloading. Commercial production of cartridges often continues for many years after the gun they are made for is obsolete, i.e., no longer manufactured. Cartridges may be used many years after manufacture. Cartridge cases can be reloaded and reused long after they were manufactured, even long after commercial manufacture has ceased. The particularly American practice of handloading adds complexity to the interpretation of archaeological cartridges. The issue of lag time—the time between manufacture and deposition in the archaeological record—is compounded by handloading. An assemblage of cartridge components at a site may provide data pertaining to the advent and length of occupation (Berge 1968, 1980; Fontana et al. 1962; Smith 1954, 1955). Cartridge cases and bullets can also be intrusive at a site, occurring from transitory reuse of the locale. Caution must be used in the interpretation of archaeological cartridges.

Identifying and documenting the archaeological occurrence of self-contained metallic cartridges is also important to understanding the evolving technology of firearms and loaded metallic ammunition. As Barnes (1989:11) points out regarding cartridge types, "Cartridges don't just happen, they evolve in response to some need or use requirement." Moreover, archaeological studies will provide detailed knowledge and specific understanding of the access, spread, and use of this technology. For example, while no gun parts were found during the excavation of Johnny Ward's Ranch in Arizona, the recovery of 31 identifiable cartridge cases, representing 16 types of ammunition, indicated the number and types of firearms used. At least four kinds of rifles, five kinds of handguns, and two kinds of shotguns were used to fire the cartridges (Fontana et al. 1962:79–83). Thus, a distinct record of firearm use at a Southern Arizona ranch between 1854 and 1903 was constructed.

Accurate identification of cartridge components is integral to battlefield studies. Such studies include determining the type of ordnance used, defining the location of events, and understanding the sequence of events. Examples are the studies of the Sand Creek Massacre locale (Dawson 1999; National Park Service 2000), and the Battle of the Little Big Horn (Scott 1989; Scott et al. 1989).

The brand and model of firearm used can also be ascertained from bullets recovered archaeologically. The firearm leaves signature marks on the fired bullet, from the lands and grooves and type of rifling. Signature marks are also left on cases from the firing pin and extractor. Using forensic ballistic techniques devised for law enforcement, the number of firearms can be determined, and individual firearms can be identified and typed by an expert (Scott 1989).

FIREARM DEVELOPMENT

Firearms are basically pipes which use gunpowder to propel a projectile. When the gunpowder is ignited, the powder is converted to a rapidly expanding greater volume of gas. The expanding gas exerts pressure, projecting the bullet out of the muzzle of the firearm. The original powder used was black powder, a mixture of potassium nitrate (saltpeter), charcoal, and sulfur. Black powder has been used for centuries, perhaps millennia. The date and place of origin are unclear. Incendiary mixtures were used by the Greeks and Romans in war. True gunpowder was apparently developed in China, and explosive devices were used there by AD 1000. Written references to gunpowder occur in Europe in the 1200s (Barnes 1976; Logan 1959). By the late 1300s gunpowder, guns, and cannons were well-known.

A variety of ignition systems has been used to ignite the powder and fire the bullet. Muzzle-loading firearm ignition evolved from matchlock in the late 1400s, to wheellock by 1530, to flintlock by around 1630. Matchlocks used a burning wick to ignite the powder. Wheellock and flintlock guns used sparks. Flintlocks were the standard until the caplock system was developed in the early 1800s. Loaded metallic cartridges were in use by the 1860s. There are two principal types of loaded rifle/pistol cartridges, centerfire and rimfire. Rimfire cartridges have the primer compound contained in the folded rim of the case. Centerfire cartridges have a separate component, the primer, pressed into a receptacle in the center of the case head. Caplock firearms and loaded cartridges use percussion to explode the primer, igniting the powder. The difference is that caplocks use a separate element, the percussion cap, as the primer, while loaded cartridges contain the primer in the cartridge (self-contained).

Firearms evolved from smoothbored muzzle loaders, termed muskets, to rifled muzzle loaders to breechloaders. Muzzle loaded firearms were extant by the late fourteenth century. Rifling refers to spiral grooves in the gun barrel which impart a rotational spin to the projectile, increasing accuracy. Rifling was in use by about 1500. Muzzle loaded flintlock rifles were developed and used from the early to mid 1600s, until the first half of the nineteenth century, when the percussion "cap and ball" muzzle-loaded system was used. Smoothbored muskets continued to be manufactured until at least 1842. While there were earlier breechloaders, the development of effective breech loaded firearms went hand-in-hand with the development of loaded metallic cartridges. The development of shotguns is discussed at the end of this paper.

Muskets and rifled muzzle loaders used lead balls as bullets, and until 1844 all military arms used a round or spherical ball (Sharpe 1987:28). Loading spherical balls into rifled barrels required the ball to be wrapped in a cloth or leather patch. The problem was to have a bullet that would fill the rifling grooves and prevent the loss of the propellant gas. The problem was solved by Chas. Minié of France, who devised a conical bullet with a hollow base in 1846.

The bullet was sized slightly under-bore for easy muzzle loading, and the hollow base expanded under powder gas pressure, filling the rifling. Minié balls became the standard for cap and ball rifles, and the Civil War was fought primarily with Minié bullets.

Elongated or conical bullets, sometimes termed slugs, have far superior ballistics than spheres. Round balls are now used almost exclusively in shotgun shells and muzzle-loaded replicas. Note that the term "ball" does not refer solely to spherical bullets.

FLINTS AND CAPS

Archaeological manifestations of firearm use prior to the self-contained metallic cartridge era are limited in the Western United States. Use of flintlock and caplock firearms may result in the deposition of gun flints, black powder containers, percussion caps and cap containers, and bullets. Such artifacts may be present at the earlier historic sites, and sometimes co-occur with self contained metallic cartridges from sites dating to the 1860s or 1870s.

Flintlocks used a flint clamped in a hammer, which when released struck sparks into a flash pan containing a priming charge of loose powder. The flash from the priming powder ignited the main charge. The flint was a square to rectangular piece of cryptocrystalline stone. Gunflints usually have a steep edge angle or a bevel, and are readily identifiable by their square shape. Holland, France, and England were major producers of flints, with French flintknappers dominating the trade from 1750–1800, and English flints becoming prevalent after 1800. French flints were characterized by a blond or honey color and a sub-angular or rounded edge or heel. English flints were dark colored and had four distinct corners. Almost equal numbers of French and English flints were recovered from Bent's Old Fort in southeast Colorado (Moore 1973:99–100).

Flints varied in size according to the intended gun. Musket flints ranged from 1.25″ in length and width to 1.5″. Rifle flints ranged from slightly under to just over an inch square (Moore 1973:101). The pistol gunflints in Figure 1 range from .530 ×.585 in. to .645 × .780 in.

Use of fulminate of mercury mixed with other compounds as a priming device began in 1807. The fulminate was detonated by a blow, igniting the gunpowder. Efforts to place the fulminate mixture inside a tiny metal cup were first made in 1814. Originally the cups were iron or steel, then pewter, and in 1816 copper cups or caps were devised, and patented in 1822 (Sharpe 1987:19). Commercial percussion caps were marketed by 1830, and most gun makers were producing percussion cap arms around that time. The cuplike portion of the cap fit on a nipple attached to the breech. When the hammer struck the cap, the fulminate exploded and the flame flashed through a hole in the nipple to the powder charge and fired the gun. The ignition system was so superior to flintlocks that by the early 1840s flintlocks were obsolete (Rosa 1985:34), although the U.S. government did not manufacture copper caps on a large scale until 1845. Many flintlock guns were converted to caplocks in the 1840s. American Indians often continued to use flintlocks, since they could make their own gunflints and not have to procure percussion caps. (It was not unusual for

FIGURE 1. Percussion caps and gunflints. Caps at left are musket caps, on right are pistol/rifle caps. Cap at upper right has been fired. Bottom row of gunflints are at the small end of the range of flint sizes. Scale in inches.

old Indian guns sold at gun shows before World War II to contain a fragment of an arrowhead as the gunflint).

Percussion caps were produced in at least 25 sizes, from large musket caps 0.24″ diameter to pistol caps 0.16″ diameter (Figure 1). Large musket or "hat type" caps are no longer produced in the United States. The percussion cap ignition system was used for about 35 years, marking the transition from flintlocks to self-contained metallic cartridges. Markham (1991:90) asserts that caplocks were used by some civilians in remote parts of western America almost into the twentieth century. Bullets from the flintlock/caplock era were primarily spherical balls or conical Minié balls.

CARTRIDGES

Prior to the adoption of loaded metallic cartridges, "cartridges" were produced consisting of a measured charge of black powder and a round lead ball, wrapped in a paper cylinder. These were used by biting off the end, pouring a bit of the powder into the priming pan and the rest down the barrel, and ramming the bullet and paper down the muzzle. Paper cartridges were introduced in Sweden about 1600, but loose powder and ball remained standard, except for the military, until the 1800s. In the first half of the nineteenth century combustible cartridges were made for caplocks, using conical bullets and a powder charge contained in nitrated material such as paper, linen, or skin. In 1845 the

Frenchman Flobert introduced his BB (bullet breech) Cap. This led to the development of the .22 Short by Smith & Wesson in 1857.

This was the first really successful U.S. metallic cartridge. This rimfire with a copper case was designed for use with the Smith & Wesson First Model revolver in .22 caliber. This invention revolutionized the firearm industry. Other metallic cartridges had been developed and were briefly used. They are described in the section on primers, below.

The nomenclature of a loaded metallic cartridge, also called fixed ammunition, is as follows: A complete unit, out-of-the-box and ready to fire, is a cartridge, or round in military language. This unit consists of a metal case, primer, powder charge, and bullet (or shot). The term "shell" for a cartridge case applies *only* to shotgun shells and artillery shells. A shotgun cartridge is called a shell even if it is metallic.

Caliber

Cartridges may be commercially manufactured in standard calibers, or they may be created by individual designers or handloaders, termed wildcat cartridges. Cartridge identification or caliber designation is perhaps one of the most confusing, least consistent nomenclature systems extant. There is absolutely *no* rhyme or reason for the American cartridge identification system, even up to the present. Caliber designation can be defined by several different methods, including bore (land) diameter of the barrel, groove diameter of the barrel, bullet diameter, inside diameter of the cartridge case mouth, or an arbitrary figure chosen by the manufacturer (White and Munhall 1948, 1949; as referenced in Bearse 1966:15).

Caliber is designated in 100ths or 1000ths of an inch in the United States and British Commonwealth countries. Cartridge designations often include caliber compounded with other information, such as powder load of the cartridge case, case length, date of adoption, proprietor, muzzle velocity, etc.

Generally the centerfire black powder cartridges used caliber and powder weight in grains (7,000 grains/lb.) as the .45-70, .38-55, etc. A .45-70 cartridge means a .45-caliber bullet with 70 grains of black powder. Some black powder cartridges appended a third figure, bullet weight. A .45-70-500 was a .45-caliber cartridge with 70 grains of black powder and a 500 grain bullet. Some early rimfires used only caliber and a name, such as .44 Henry, .56-56 Spencer, or caliber and relative length, such as .32 Short, .32 Long, etc.

Then came the smokeless powder era, at the end of the nineteenth century, and with it more confusion. Some new calibers were designated by the British system—bore diameter, such as the .405 WCF (Winchester Center Fire), .348 Winchester, etc.

There was a race by manufacturers to push proprietary cartridges resulting in duplication and utter confusion in cartridge designations, especially in centerfires. For example, there were so many .45 caliber cartridges that further differentiations were necessary for example, .45-78 Wolcott, .45-70 Morse, .45-100 Ballard Everlasting, etc. (Logan 1959:140–146).

Some cartridges were designated by the caliber × case length, which is similar to the European system, resulting in .40 × 2 1/2 Remington-Hepburn, .40 × 3 1/4 Sharps, etc. The European system uses bullet diameter, case length and type, given in millimeters.

In 1903 the United States adopted a new service rifle designated the Springfield model 1903 with a new smokeless bottlenecked cartridge with a round nose jacketed bullet of .30 caliber, called .30-03. It was not successful and was redesigned and adopted in 1906, and was and still is known as the .30-06.

In the 1920s came more trouble: Savage Arms Co. introduced a new cartridge and started a new trend. The .250-3000 was a .25 caliber bore diameter bullet, and the first cartridge to reach a velocity of 3,000 ft/sec. The cartridge became known as the .250 Savage, and descriptive names entered the picture along with bore or bullet diameter for cartridge designation, resulting in the .22 Savage Hi-Power, .22 Hornet, .218 Bee, .219 Zipper, etc. Caliber and designer's name were used, such as the .220 Swift, .256 Newton, .257 Roberts, etc, and of course caliber and proprietor or manufacturer, like the .351 Winchester Self Loading, .35 Remington, etc.

In 1912 the .375 H&H Magnum was introduced (O'Brien 1994). The Holland & Holland (H&H) Magnum was a British round which featured more power and higher velocity that found favor in the United States during the 1920s. Magnum rifle cases have a "goiter" or belt around the base of the case, for headspacing. After World War II "Magnumitis" hit the country, and the big belted case started a family that is still growing. The magnum craze caught on with handguns too. The first was the .357 Magnum in 1935 by Smith & Wesson, still popular today. Belted magnum rifle cases are distinctive and easily identified. Magnum pistol cases are not belted.

Some cartridges with different names or caliber designations will interchange with some guns. For example, the .50-100-450 Winchester Express and the .50-110-300 Winchester Express used the same case, only the powder charge and bullet weight differed. The .30-40 Krag was the same as the .30 US Army, as another example.

The same caliber bullet may be used in several different cartridge cases. The same case may be used for several different bullet weights or powder charges (Figure 2). A cartridge may have several different designations; e.g., Bearse (1966:15) points out that there are nearly 40 synonyms for the .44-40 Winchester.

The above discussion of caliber/cartridge designations hopefully points out the lack of systematics. There are exceptions and variances from all of the cartridge designation standards or conventions. Even the orthography for designating cartridges is not consistently applied or agreed on. Knowing what any given caliber designation means relies on personal knowledge of the cartridge or a thorough reference book.

Cases

Rimfire and centerfire cases may be made of copper, brass, nickel-plated brass, or (rarely) steel or aluminum; and contain the primer, powder charge, and the bullet. The case usually bears a headstamp (manufacturer's identifica-

FIGURE 2. Example of variety of cartridges in the same caliber. These are all .44-40 caliber. Note differences in bullets, cases, and headstamps. Two cartridges on left are the same, except the bullets are jacketed in different metals. Cases at right and third from right are loaded with round balls. Case fourth from right has shot enclosed in a paper "bullet."

tion) and nearly all military cases have a date of manufacture. The body of the case may be straight, as in the 22 L.R. rimfire, or taper slightly from the base to the mouth, as the .45-70, or bottlenecked with a distinct shoulder, like the .30-30.

Cases are further classified by rim type, which are rimmed, rimless, semi-rimmed, and belted. The rim is the edge of the head of the case. Rimmed cases have a rim that is of greater diameter than the rear or base of the case, to stop the case from propelling forward into the chamber, and for the extractor to grip. All rimfires and some centerfires are rimmed. Rimless centerfires have a base or head the same diameter as the case, with an extractor groove machined around the base. In between these two types are semi-rimmed, with the case body just slightly smaller than the rim, and an extractor groove. A belted case has a thickened strip or belt around the base of the case, above the extractor groove. A rebated rim case exists, used by one modern American cartridge, the .284 Winchester, introduced in 1963, with the rim smaller than the case body.

The original United States centerfire cartridge was a copper "folded head" case with an interior primer, used from about the late 1860s to the 1880s (Wallack 1977). These cartridges look like rimfires, since the primer can't be

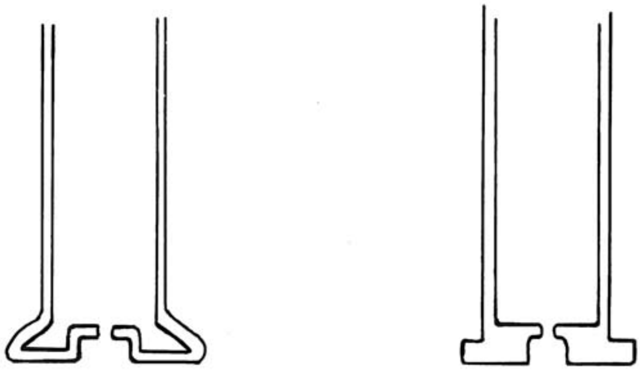

FIGURE 3. Case head types: left, solid head; right, balloon head.

seen. They can be distinguished from rimfire cartridges by the presence of crimps in the case just above the rim, which hold the primer in place.

Early external primer centerfire cases had a primer pocket that ballooned or extended into the powder chamber of the cartridge (Figure 3). As smokeless powder succeeded black powder around the turn of the century, the increased pressures in the popular old cartridges, including revolver loads, necessitated replacing the old folded head "balloon head" cases with stronger solid heads. The thicker solid heads have the primer pocket limited to the case head, so the powder chamber is flat at its base (Figure 3). Some examples of cartridges produced with folded head cases and subsequent solid head cases are the .45-70 and .38-55 rifle cartridges, and the .44-40, .32-20 and .38-40 which were used in both revolvers and rifles and are still made today.

Folded head cases are easily distinguished from solid head cases by looking at the inside of the case head, through the case mouth. The balloon head will have a rounded, raised platform with the flash hole centered in it while the solid head case will have a flat, solid base with the centered flash hole.

The early cartridge cases were copper. Brass cases began to be commercially produced in the early 1870s, and some brass cases were purchased by the government for military use in the mid 1870s. Copper cases remained prevalent in the military, but the failure of the copper cased, inside primed .45-55 cartridge at the Battle of the Little Big Horn in 1876 led the military to convert to brass cases and external centerfire primers. The case failure was because the soft copper folded head case with inside primer often lost its head when fired, and fouled chambers caused extraction problems (Bearse 1966:156; Rosa 1985:110–113).

Commercial use of brass cases pre-dated government military production by 10 years, and brass alloy cases became standard, comprised of 70 percent copper and 30 percent zinc. Centerfire primers became standard in brass cases except for some low powered copper cased pistol cartridges such as the .22 rimfire line, the .32 rimfire, .41 rimfire, and a few odd rifle rimfires like the .25 Stevens and the .41 Swiss copper case bottleneck rimfire cartridge; all now obsolete (no longer manufactured) except the .22 line.

The .22 rimfire copper cases gave way to brass and nickeled cases in 1927 (Warner and Shrader 1971:17) as smokeless powder and higher pressures made stronger cases necessary. Nickel plated cases were originally used for .22 caliber, and then were used for pistol cartridges, particularly premium quality cartridges. In the last 10 years they have been produced for rifle cartridges.

Steel was used during World War II when brass shortages occurred. After World War II, aluminum cases were produced. Aluminum cases are cheap but too weak to be safely reloaded and reused. CCI currently manufactures a complete line of aluminum cased centerfire handgun cartridges, but uses the Berdan primer to stymie reloading.

Headstamps

Headstamps are elements of information stamped onto the case head by the manufacturer. Early rimfire cartridges were copper cased with no head stamps or a single letter or symbol stamped in the center of the head. Winchester used an H, in honor of B. Tyler Henry, Winchester's chief engineer. Union Metallic Co. used a U early on, then a UMC until its merger with Remington.

Most commercial American centerfire cartridges have been headstamped from before the turn of the twentieth century. Commercial cartridges usually have the initials or symbol of the manufacturer and the caliber designation. Sometimes other elements of information are present, such as the letters S H, indicating a solid head case. American military cartridges are identified by the code of the arsenal or ordnance plant of manufacture and usually the last two numerals of the year of manufacture.

Headstamps varied over the years as manufacturers changed and new loads developed, and as copper cases and black powder loads were dropped. Thus Union Metallic Cartridge Co. (UMC) became REM-UMC, Remington and Peters merged and became REM-PETERS, Winchester bought the Western Cartridge Co. (WCC) and became WIN-WESTERN, etc. Few dates are available for advent or duration of particular headstamps. Data regarding manufacturer's use of headstamps has generally not been gathered, and many ammunition manufacturers may not have records of initial use for headstamps. The same manufacturer's mark may be used for numerous different cartridges, with only the caliber designation changing. A headstamp and caliber can lead to data about the period of manufacture for that cartridge, or period of manufacture for the firearm(s) chambered for that cartridge.

Barnes (1989:419) states that there are at least 400 commercial headstamps and over 800 military headstamps worldwide. Logan (1959) provides a list of over 200 headstamps. Cartridges for a given caliber may be produced by numerous manufacturers or have different headstamps for variations in powder charge or bullet weight. For example, Bearse (1966:104) lists over 70 headstamps for .30-06 caliber cartridges.

A headstamp alone should not be relied on for caliber determination. The case may have been reformed by a handloader to a different standard caliber or to a wildcat caliber. Measurements should be taken to confirm the caliber. Presence of a headstamp is not necessary to identify a cartridge. A list of common and useful commercial headstamps is presented in Table 1, military headstamps in Table 2. Illustrations of headstamps are presented in Figures 4 and 5.

Primers

Rimfire ignition cartridges contain the priming compound in the rim of the case head, and ignition comes from pinching or hitting the rim with the firing pin. After the introduction of the .22 Short in 1857, the development of the rimfire advanced rapidly.

The Civil War made the advantages of a self-contained, waterproof cartridge quite evident. The .44 Long was developed by 1860, as was the .56-56 Spencer round, used by the Union from 1862. The .44 Henry cartridge was manufactured by the New Haven Arms Company in 1861, for the Henry lever action repeating rifle, forerunner of the Winchester rifles. The rimfire cartridge made repeating rifles practical. Pistol cartridges such as the .30 Short, .32 Long, .38 Short , .38 Long, and .41 Short were all available by the early to mid-1860s (Barnes 2003). The military had used some loaded metallic rifle cartridges during the Civil War, but despite the availability of revolver cartridges, caplock pistols were used throughout the Civil War. It wasn't until 1871 that the Ordinance Department decided to introduce cartridge pistols for the military (Rosa 1985:70).

Some 75 rimfire cartridges have been loaded by American companies, but only about 42 were still around by the turn of the century. By the 1930s only 17 survived, and after World War II the count was down to 10 or fewer (Barnes 1989:356). Most had been replaced by centerfires or made obsolete by smokeless powders. Rimfire cartridges are still manufactured and used worldwide—mostly in .22 caliber.

The folded head and copper case of rimfires made a weak container for the pressures involved with high velocity loads, and limited cartridge development. More importantly, rimfire cartridges cannot be reloaded. These problems were solved by the brass centerfire case. There are two principal types of centerfire primers. The Boxer primer was invented by Col. Edward Boxer of the British Army in 1867. The Berdan primer was invented by Col. Hiram Berdan of the American Army in 1866 (Barnes 1976:301). The Boxer primer is self-contained, with a cup, priming compound, and anvil. The Berdan primer does not contain an anvil, but uses a small projection in the bottom of the primer pocket, a part of the cartridge case (Figure 6).

The centerfire system as we know it today was developed by the 1880s. Prior to the adoption of the Boxer and Berdan primer systems, a variety of experimental primer/case head configurations were patented. Logan (1959: 77–87) illustrates and describes several.

The (British) Boxer system is the easiest and most practical for reloading,

TABLE 1. Headstamps

STAMP	MANUFACTURER
Acorn (symbol)	Gustav Genschow (Germany)
Diamond (symbol)	Western Cartridge Co. (rimfire cases)
C (raised)	Kynoch Cartridge Co. (England)
C (impressed)	Creedmore Cartridge Co. (1890–1892)
ELEY	Eley Brothers (England)
F. (impressed)	Federal Cartridge Co. (rimfire cases)
H.	Winchester Repeating Arms (rimfire cases)
H (raised)	Winchester Repeating Arms (rimfire, ~1860–late 1880s)
P. (raised)	Phoenix Cartridge Co.
P (impressed)	Peters Cartridge Co. (rimfire); (Peters, 1887–1934, merged with Remington)
P	Peters Cartridge Co. (centerfire)
PC	Peters Cartridge Co. (centerfire)
P.C.	Peters Cartridge Co.
PCCO	Peters Cartridge Co.
PETERS	Peters Cartridge Co.
PETERSHV	Peters Cartridge Co. (rimfire)
R-P	Remington–Peters (adopted 1960)
REM	Remington Arms Co.
RAH	Remington Arms Co.
REM-UMC	Remington Union Metallic Co. (adopted 1911)
R	Robin Hood Ammunition Co.
RHA	Robin Hood Ammunition Co.
R.H.A. Co	Robin Hood Ammunition Co.
S.A.W.	Sage Ammunition Works
S.A. CO	Savage Arms Co. (1897–1917)
SAVAGE	Savage Arms Corp. (1921–1963)
S.R.A.C.O.	Savage Repeating Arms Co. (1895–1897)
SUPER SPEED	Winchester Repeating Arms (about 1930 on)
super speed	Winchester–Western (about 1930 on)
SUPER X	Western Cartridge Co.
SUPER-X	Western Cartridge Co.
U	Union Metallic Cartridge Co. (1867–1911, merged with Remington)
UMC/U.M.C.	Union Metallic Cartridge Co.
U HiSpeed	Remington Union Metallic Co. (rimfires since WW II)
U.S.	United States Cartridge Co. (company existed from 1869–1936)
US (raised)	United States Cartridge Co. (stamp used from 1869–1875)
U.S.C. CO	United States Cartridge Co.
WCC	Western Cartridge Co.
W.C. Co.	Western Cartridge Co. or Winchester
Western	Western Cartridge Co.
W	Winchester or Western
WRA	Winchester Repeating Arms
WRA CO/W.R.A. CO.	Winchester Repeating Arms
W-W	Winchester–Western
XL	Federal Cartridge Co. (rimfire cases)

and thus became the most popular type in the United States, supplanting the Berdan system. The (American) Berdan system is easier and cheaper to manufacture, and is used in most foreign nations. The Berdan primer is difficult to remove and those cases are seldom reloaded. Barnes (1976:302) states that

TABLE 2. United States Arsenal Headstamps

STAMP	ARSENAL
Den (plus date)	Denver Ordnance Plant (1941–1944)
DM (plus date)	Des Moines Ordnance Plant (1941–1945)
EW (plus date)	Eau Claire Ordnance Plant (1942–1943)
ECS (plus date)	Evansville Ordnance Plant (1942–1945)
CF (plus date)	Frankford Arsenal (.45 Govt. in 45-55-405 load)
F (plus date)	Frankford Arsenal (pre-1902)
FA (plus date)	Frankford Arsenal (1902 on)
KS (plus date)	Alleghany Ordnance Plant (1942–1943)
LC (plus date)	Lake City Arsenal (1941–1944, 1950s on)
LM (plus date)	Lowell Ordnance Plant (1942–1943)
M (plus date)	Milwaukee Ordnance Plant (1942–1943)
RF (plus date)	Frankford Arsenal (.45 Govt. in 45-70-500 load)
SL (plus date)	Saint Louis Ordnance Plant (WW II)
TW (plus date)	Twin Cities Ordnance Plant (1943 on)
U (plus date)	Utah Ordnance Plant (1941–1943)
UT (plus date)	Utah Ordnance Plant (1941–1943)

Note: Dates are given as the last two numbers of the year, e.g., "44" = 1944. If a third number is present it is the month of manufacture. The elements are equally spaced around the head, with the month on the left and the year on the right of the head (Figure 5). The month designation was discontinued in late 1917.

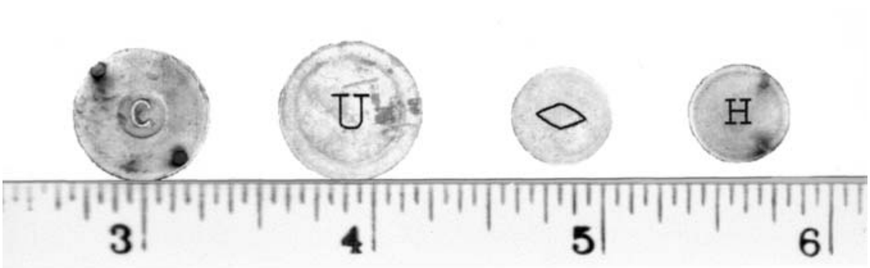

FIGURE 4. Examples of rimfire headstamps, left to right: C = Kynoch Cartridge Co. (England); U = Union Metallic Cartridge Co.; Diamond symbol = Western Cartridge Co.; H = Winchester Repeating Arms. Scale in inches.

FIGURE 5. Examples of centerfire headstamps. Headstamp at right indicates cartridge manufactured at Frankford Arsenal (F) in February (2) of 1892 (92). Scale in inches.

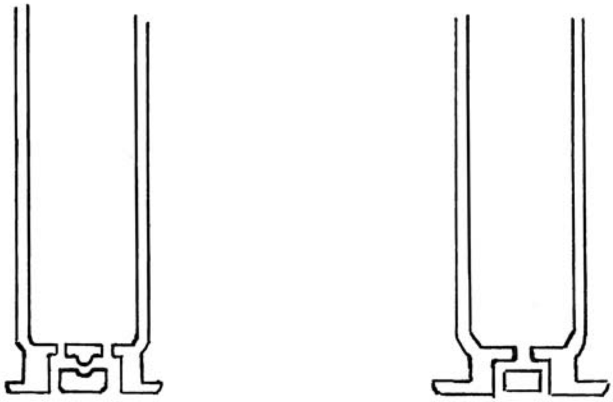

FIGURE 6. Primer types: left, Boxer; right, Berdan.

Berdan primers have not been manufactured in America since the 1920s. This may have changed with the recent production by CCI of aluminum cased revolver ammunition with Berdan primers.

Identification of the primer type is simple. The Boxer system has a single hole from the primer pocket through the head of the case to ignite the powder charge. The Berdan system requires two small holes through the case head. By looking down inside the case the holes, single or double, may be seen on the inside of the head at the bottom of the case.

Centerfire primers may be copper, brass, or plated steel. Early primers were copper cased, and some copper primers continued to be used through World War I. Early primers contained fulminate of mercury. Mercury residue attacks brass, weakening the cases and making them unsuitable for reloading. A later priming mix was potassium chlorate, which leaves a salt residue in gun barrels, causing corrosion. In the late 1920s non-corrosive lead styphnate was substituted for chlorate, and by the 1950s even the military stopped using corrosive primers (Wallack 1977:143). Currently all primers are non-mercuric and non-corrosive, labeled NM-NC. Current primers are standardized sizes; large rifle and large pistol are .210″, small rifle and small pistol are .175″. While the large rifle and large pistol primers are the same size, they are different in priming charge, as are the small rifle and small pistol primers. Unfortunately, primers of a given size are visually indistinguishable as to being designed for rifle or pistol. Obsolete and discontinued primer types and sizes are listed in Barnes (1976:306).

Shotgun shells made of paper or plastic with a brass head use a separate brass cup, the battery cup, which contains the primer cap and anvil. For reloading the primer cap alone may be replaced, or the entire battery cup removed and replaced.

Primers may be recovered archaeologically, particularly spent primers if the site was inhabited by handloaders.

Oddities

Rarely an old case or cartridge may turn up that is neither rim- nor centerfire. These variations in the quest for an ignition system for self-contained cartridges include the following, which may be found in any good reference book.

1. Maynard — early 1860s Maynard cases had large flat disk with pin hole covered by wax paper. Primer was paper type like modern cap pistol (Figure 7). Later Maynard cases were centerfire with a distinctive bulging head (Figure 7).
2. Pin fire — the primer is inside the case and is actuated by a pin protruding from side of base of the case (Figure 7).
3. Burnside — a very early brass case, tapered with an annular receptacle for lubricating grease, which shows as a bulge around bullet, has no head or rim.
4. Teat fire — mouth of case flared out with bullet totally contained and the priming was in a teat protruding from the base, has no head or rim (Figure 7).
5. Mule Ear or Flop Ear — head of brass case has no rim, instead there is a flange protruding from one side of the head like a tab. There is a pinhole in center of case head for ignition from paper or percussion cap.

FIGURE 7. Oddities, left to right: .32 teatfire patent 1864; .50 Maynard 1865; .44-60 Maynard Model 1873 (centerfire); 7mm pinfire; .32 pinfire. Scale in inches.

Powder

Black powder was used in self-contained metallic cartridges until the development of smokeless powder. The saltpeter, charcoal, and sulfur are generally mixed in a 75-15-10 proportion, although other proportions have been used.

Barnes (1976:310) has the discovery that the burning rate of black powder was affected by compressing the powder into grains of various sizes occurring in 1860. Finer granulations burn faster, while coarser granulations burn slower. The burning speed of powder affects the rate of formation of the explosive gas, thus controlling the velocity of the projectile. However, Rosa (1985:16) states that frontiersmen using Kentucky-type rifles manufactured their own powder by the late 1700s, and were aware that different granulations of gunpowder burned at different rates. They used fine grained powder for priming, and coarse grained powder for the main charge. During the Lewis and Clark Expedition, Meriwether Lewis, in his journal entry for February 1, 1806, mentions the supplies of best rifle powder, common rifle powder, glazed powder, and musket powder (DeVoto 1953:317). It is unclear what the difference is. It may refer to proportional mix, purity of the ingredients, or quality of production.

Black powder is currently manufactured in a variety of grain sizes, with the larger grain used for larger caliber cartridges. At the turn of the century a number of special purpose black powders were marketed, none of which are now manufactured. The resurgence of interest in black powder firearms has stimulated the manufacture of different powders.

Smokeless powder is cellulose nitrate, created by the chemical action of concentrated nitric and sulfuric acid on cellulose fiber such as cotton. The nitrated cellulose can be compounded with other chemicals to control the burn time. Straight nitrocellulose powder is termed single base, and nitrocellulose colloided with nitroglycerin are double base powders.

Nitrated compounds were developed in the 1840s. Alfred Nobel created dynamite in 1867. European chemists spent considerable time and effort in developing nitrated organic compounds with controllable burning speeds. Single base smokeless powder existed by the early 1860s, and Nobel created a double base smokeless powder in 1887. Smokeless powder began to replace black powder in the 1890s (Barnes 1976:311).

European militaries had replaced large-bore black powder cartridges with small-bore smokeless cartridges using metal jacketed bullets before 1890, when United States Army Ordinance began experimenting with smokeless .30 caliber cartridges (Bearse 1966:107). The .30-40 Krag, a military round loaded with smokeless powder, was introduced in 1892. The 1894 Winchester Lever Action rifle, designed by Browning, was created for smokeless powder cartridges (Markham 1991:142). The .30-30 WCF and .25-35 WCF, designed for this rifle, were introduced in 1895, and were the first sporting smokeless cartridges developed in the United States.

Use of black powder cartridges dropped off after 1910 (Barnes 1976:69). Commercial production of some black powder cartridges continued until the mid 1930s. Many popular old black powder cartridges were loaded with smokeless powders into the 1920s and 1930s, with jacketed bullets, and a few originally black powder cartridges, such as the .45 Colt, are still active, manufactured with smokeless loads.

Smokeless powder is manufactured in different grain types, including flake, disc, ball, and tubular. The grain types are made in different sizes. The chemical content of the grain as well as its size and shape affect the burning speed. There are several manufacturers of smokeless powder, and each brand makes several types of powder for specific use with different cartridges.

Smokeless powder came into general use after 1900 (Smith 1954:25). At that time, Boxer centerfire primers, brass bottleneck cases, swaged (pressure formed) crimp, and jacketed bullets were the norm, and case headstamps were standard, except on some rimfires.

Gunpowder may be recovered archaeologically in unfired cartridges, or powder containers may be recovered. The powder in a cartridge can be identified as black or smokeless and to grain type, but smokeless powder decomposes over time, turning to dust.

Bullets

Here things get interesting. The projectile or bullet is after all what firearms are about. Cartridge cases, primers, and powders have been fairly standardized since the development of smokeless powder and the Boxer primer, but development of the bullet continues yet today, trying to find the ultimate in efficiency as to trajectory, accuracy, and expansion.

Early lead bullets were made by pouring melted lead into a mould. The mould was usually made with two mating blocks, and mould and sprue marks are sometimes visible on the bullet. The sprue is the mark where the stem, from the filler hole in the mould, was cut off. Lead bullets commonly have one or more cannelures, or grooves, around the circumference for grease lubricant to reduce leading and help prevent black powder fouling the bore. A narrow groove near the top of the bullet, and above the grease grooves was common to crimp the mouth of the case to prevent the bullet from "jumping" forward in the case under recoil in repeaters and revolvers.

Bullets had flat bases, hollow bases, and convex bases. Some of the old large caliber black powder bullets were "paper patched," i.e., had a strip of stiff paper around the body of the bullet and under the mouth of the case to fit the bore, shoot cleaner, and facilitate reloading in the field. The famed "Buffalo" Sharps .45-120-550 was one of these.

Later lead bullets were swaged in dies from lead wire instead of poured into moulds, and are yet today, such as the .38 Special revolver cartridge. Pure lead gave way to lead alloys. Lead bullets declined in usage except for .22 rimfires and centerfire revolvers. Lead bullets often have a gilding metal (a copper and zinc alloy) base attached, called a gas check, to prevent the lead from melting from the hot propellant gas.

Bullets were retained in the mouth or neck of the case by crimping, which was accomplished by several methods. A "stab" crimp was common early on and consisted of three or four indentations, as with a center punch, spaced around the circumference of the case neck to secure the bullet in the case. This system was used primarily on lead bullets. Later a rectangular flat punch was used, instead of the round punch. A rolled cannelure was also used but the cannelure was more commonly used to establish bullet seating depth and still is—especially in handgun cases. The final and present crimp is swaging the case mouth to the bullet.

By the 1880s, rifle action had been made stronger and longer, allowing higher velocities that caused lead bullets to strip in barrels. This severe leading impaired accuracy and made gun cleaning difficult. Accordingly, efforts were started to cover the lead bullet with a metal "jacket." The first metal jacket bullet was developed in Switzerland in 1880 (Logan 1959:9). By the mid-1880s jacketed bullets, using a copper and nickel alloy, were produced in the United States (Wallack 1977:156). The switch to smokeless powder hastened the change to jacketed bullets. After World War I the continued acceleration of muzzle velocities stimulated switching jacketing material to gilding metal. Mild steel, brass, and other alloys are also used for jackets. This jacketing helped the issue of barrel leading, but at a cost of bullet efficiency, constraining bullet expansion.

To rectify this, jackets were designed to have lead exposed at the front of the bullet. Bullets with a rounded point of lead exposed at the nose are termed "soft points," bullets with the exposed lead truncated or flattened are "flat noses" and bullets with a hollow cavity in the nose are "hollow points." A fully jacketed bullet with a sharp point is termed a "spitzer" (Figure 8). In the 1920s the base of the jacketed bullet was tapered to reduce drag and increase velocity, termed "boat tails." A spitzer boat tail was usually a military bullet.

SHOTGUN SHELLS

Shotguns have been used for hunting and sport shooting, as well as for military and law enforcement purposes. Double barreled shotguns, mainly 10 gauge but some 12 gauge were commonly used by stagecoach guards, and Colt produced shotguns termed "Coachguns." The phrase "riding shotgun" is still used by teenagers today. Shotguns were also used by gunfighters and lawmen in the West and by the military during the Indian Wars.

Single and double barrel muzzle loaded flintlock shotguns were prevalent in the late eighteenth and early nineteenth centuries. Shot of uniform size and quality was produced by the late 1700s. When the percussion system was developed, single and double barrel muzzle loaded percussion shotguns were manufactured and popular until the early twentieth century. A pinfire shotshell was patented in France in 1836, and is still used in Europe today. Breech loaded shotguns were developed and appeared between the late 1840s and 1870s. The shotgun was the first firearm to use smokeless powder. Smokeless powder made from nitrated wood pulp was commercially loaded into shot shells in 1864.

The shotgun gauge system is a throwback to muzzle loaded muskets centuries ago. The "gauge" of muskets referred to the number of lead balls of the bore diameter that weighed a pound. A 10 gauge gun thus had a bore diameter

FIGURE 8. Bullet types, left to right: unjacketed lead bullet; flat nose; soft point; spitzer boat tail; hollow point.

that a lead ball weighing 1/10 pound would enter the barrel; a 12 gauge gun has a bore that allows a lead ball weighing 1/12 pound, etc. The system is still used, for shotguns only. Exceptions to the gauge system are the 410 gauge, which is actually a caliber (.410-inch), and the 9mm rimfire shotshell, also a caliber.

Shotguns were manufactured in every gauge from 1 gauge down to 32 gauge, however commercial American shells are no longer loaded larger than 10 gauge. Barnes (1989:375) states that prior to World War I the different combinations of shot size, loads, shell length, and powder resulted in 6,500–7,000 different factory loads, and the custom, special-order, and wildcat loads doubled that figure. After 1920 the number of commercial loads was greatly reduced, and now some 160 commercial loads are available.

Self contained shot shells for breech-loaded guns were made of paraffin-impregnated paper with a crimped-on brass head and center-fire primer. All-metal shells were also made, of brass or aluminum. Metal shells are superior for preventing moisture from entering the shell, and make reloading practical. Remington introduced plastic shells in 1958, and most shells are now plastic with metal heads. All-metal shells are still made, and were used during the Vietnam War, for example, where paper and plastic were inferior.

Rifled slugs for shotguns were introduced in Germany in 1898, termed the Brenneke. The American or Foster type rifled shotgun slug was introduced by Remington about 1936.

CARTRIDGE CASE IDENTIFICATION PROCEDURES

How do we identify specimens found in the field and come by an approximation of age? Here is where the fun starts!

It is hoped that the foregoing discussion will help to simplify the arduous task of tracking down the field specimen's identity. Some immediate information can be derived from even a basic examination of a case; however, reference texts are necessary for detailed data regarding a cartridge (see bibliography). To be *sure* of a very old artifact, it should be checked against a sample in a comparative collection. Once a case has been identified, date of introduction and period of manufacture can be determined. Discrepancies of a few years for date of introduction are common in the reference texts, due in part to differences in date of development, date of patent, date of trial production, and date of common availability. It must be remembered that guns last a long time, and cartridges are manufactured for guns long after the gun is obsolete. Cartridges may be used years or even decades after manufacture, and may be reloaded after manufacture has ceased.

Useful Equipment

- Micrometers or dial caliper graduated in thousandths
- Magnifying lens
- Six-inch scale graduated in thirty-seconds of an inch
- Log sheet

Identification Log

Determine and log the following:

- Ignition type: rimfire or centerfire
- Centerfire: internally primed or externally primed
- External primer: Berdan or Boxer; copper, brass, or steel
- Case: shape, rim type, material (copper, brass, steel, nickel)
- Head Stamp
- Measure *all* dimensions: Measurements are the primary key to identifying a case. Measure length, body diameter at head (base), head diameter (rim), body diameter at mouth (neck), and shoulder diameter (if bottlenecked). Careful measuring is important but a variance of a few thousandths of an inch in dealing with old cases must be expected, compared to book specifications, because of looser tolerances in manufacturing long ago and lack of standards between factories.

Refer to Barnes (2003:504–520), Cartridge Identification by Measurement, for identification (see bibliography).

Three examples are given: 1) a case without a headstamp; 2) a case headstamped with a maker's mark but no caliber; and 3) a case headstamped with maker and caliber.

Example 1: 5BL2712, case: copper, corroded and bent; rimfire, no head stamp
case length: .912″
body diameter at head: .555″
body diameter at mouth: indeterminate
head diameter: .645″ approx.

FIGURE 9. Example 1: .56-56 Spencer, case and comparative cartridge. Scale in inches.

The specs match the .56-56 Spencer, original cartridge for the first Spencer rifle, patented 3-6-1860. Manufactured in quantity beginning in 1862. Frankford Arsenal made ca. 50,000 in 1864–1865. Cartridge was commercially loaded until 1920. Loaded with a 350 grain conical, pointed, lead bullet, .540-.555″ diameter, using 42-45 grains of black powder (Figure 9).

Example 2: case: copper, rimfire, with a headstamp SAW
case length: 1 5/32″ with a slight taper
body diameter at head: .555″
body diameter at mouth: .545″ average, not perfectly round
head diameter: .646″
mouth of case crimped into bullet
interrupted cannelure around circumference of case, consisting of three rectangular punch marks, evenly spaced, about 5/16″ long, and about 5/16″ below mouth of case

The specs match .56-50 Spencer, loaded with a 350 grain conical, flatnose, lead bullet, using 45 grains of black powder. SAW is the stamp of Sage Ammunition Works, Middletown, Conn. The cartridge was used in the Spencer Repeating Carbine, Model 1865, used in the Indian Wars, including by Custer in the Battle of Washita, 1868 (Figure 10).

Example 3: case: brass, tapered, rimmed, centerfire, boxer primer without markings
headstamp: WRA CO, 40-65 WCF
case length: 2.105″
rim diameter: .600″–.603″
rim thickness: .063″–.065″
base diameter: .500″–.503″
neck diameter: .430″ average (not round)

FIGURE 10. Example 2: .56-50 Spencer, case and comparative cartridge. Scale in inches.

FIGURE 11. Example 3: .40-65 Winchester Center Fire, case and comparative cartridge. Scale in inches.

Surface find on sage flats, purple-brown patina, excellent condition. This case has a solid head, and lack of corrosion indicates it was loaded with smokeless powder, thus dates post-1900. Measurements confirm it was a .40-65, not reformed. The .40-65 W.C.F. (Winchester Center Fire) was introduced in 1887, used a .404″ diameter, 260 gr bullet, and was loaded with black and then smokeless powder. It was used in the Model 1885 Winchester, 1886 Winchester, and 1895 Marlin rifles. It was not manufactured after World War II (Figure 11).

CONCLUSIONS

Elements of firearm use recovered from archaeological contexts have the potential to provide a variety of important information. Bullets, gunflints, percussion caps, and cartridge cases, when correctly identified and analyzed, provide temporal and functional data. They also serve to document the adoption and use of firearm technology. Gunflints and percussion caps are elements of the ignition systems of, respectively, flintlock and caplock guns. Flintlocks were used through the 1840s, and later by indigenous people into the 1870s or 1880s. Caplocks replaced flintlocks, were prevalent from about 1830 until the late 1860s or early 1870s, and were used later in some remote Western areas. Caplocks were replaced by firearms using loaded or self-contained metallic ammunition, which was developed rapidly from the early 1860s.

The cartridge case of loaded metallic ammunition developed from copper cased black powder rimfire to copper cased black powder centerfire to brass cased smokeless powder centerfire, with a number of other changes in primer, bullet, and case, some of which are time markers. Cartridge designation conventions are complex, inconsistent, and nonsystematic, but cartridge cases can be identified by using headstamps and taking measurements. With a reference book, date of introduction and period of manufacture of a cartridge can be determined. Determination of caliber is possible from spent bullets, including spherical balls, and the type of firearm used to fire the bullet can often be deduced. Advent and period of manufacture of a firearm can be ascertained. Temporal interpretation of cases and bullets is made more complex by the American practice of handloading, and suitable caution is necessary.

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BIBLIOGRAPHY FOR CARTRIDGE IDENTIFICATION

There are three principal references for cartridge identification. These compilations are rather amazing, because manufacturers do not provide data on cartridge measurements.

* Barnes (various editions), *Cartridges of the World* has been the basis and stimulus of this paper. Each edition of Barnes provides the same encyclopedia of data about cartridges, and each edition has chapters on cartridges unique to that edition. The tenth edition is in print, and contains a comprehensive table of cartridge identification by measurement, as well as historical notes and comments, illustrations, loading data, and ballistics for over 1500 cartridges, current and obsolete.

* Bearse (1966), *Centerfire American Rifle Cartridges, 1892–1963.* Out of print. Bearse provides information on centerfire smokeless rifle cartridges, including outline drawings of the case, dimensions, synonyms, bullet data, representative headstamps, rifles adapted to, history and development, and notes and comments.

* Logan (1955), *Cartridges.* Out of print. Logan provides a list of chronology of cartridge development; information about paper, combustible, and early metallic oddities; drawings of cartridges and headstamps; dimensions, and some history of each cartridge; illustrations of caps, primers, and bullets; and a partial list of manufacturers' headstamps.

Other cartridge identification references exist, such as White and Munhall (1948, 1949), cited above, but the authors have been unable to obtain copies.

ERRATA

In the Fall 2005 issue of *Southwestern Lore* (Vol. 71, No. 3), the article "Cartridges, Caps, and Flints: a Primer for Archaeologists," by Peter J. Gleichman and Dock M. Teegarden was published with incorrect captions on two figures. The captions for Figures 3 and 6 identify cartridge feature types in reversed order. For Figure 3 on page 11 the correct caption is, "Case head types: left, balloon head; right, solid head." For Figure 6 on page 16 the correct caption is, "Primer types: left, Berdan; right, Boxer." We regret the errors.

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