This sneak preview of your study material has been prepared in advance of the book's actual online release.
About the Author

If you’re having a conversation about muzzleloaders or blackpowder, sooner or later the name Sam Fadala will come up. Sam is a leading authority on blackpowder and blackpowder firearms. He serves as feature editor for Muzzleloader Magazine and blackpowder editor (writing monthly columns) for Guns Magazine. Muzzle-loading enthusiasts consider his books on blackpowder required reading. Sam’s books include: The Blackpowder Handgun, Blackpowder Hunting, The Complete Blackpowder Handbook (editions 1 and 2), The Gun Digest Blackpowder Loading Manual (editions 1 and 2), and Sam Fadala’s Blackpowder Notebook.
As its title suggests, we’ve dedicated this unit to muzzleloaders. These old “sootburners” represent tradition. Although muzzleloaders are technically inferior to today’s modern firearms, millions who take the time to understand them and learn to use them well, cherish them. This study unit will provide you with an in-depth understanding of muzzleloaders and their characteristics. From the discovery of blackpowder to the earliest muzzleloaders, to the discrediting of blackpowder myths, you’ll learn all you need to know to approach these primitive works of art from the gunsmith’s point of view.

**When you complete this study unit, you’ll be able to**

- Summarize the history of muzzleloaders, identifying important hallmarks in their evolution
- Differentiate between blackpowder and smokeless powder
- Explain loading and firing procedures for various types of muzzleloaders
- Identify the contents of the blackpowder shooting bag
- Identify blackpowder accoutrements
- Describe troubleshooting and repair methods for muzzleloaders
## BLACKPOWDER
- Introduction: 1
- Blackpowder-What It Is: 7
- Pyrodex: 19
- Pyrodex Pellets: 23

## TYPES OF MUZZLELOADERS
- Replicas: 25
- In-line Muzzleloaders: 25
- Muzzleloader Lock Types: 28

## LOADING METHODS FOR MUZZLELOADERS
- The Percussion Cap: 34
- Loading the Percussion Rifle: 39
- Loading the Elongated Projectile: 43
- Loading the Flintlock: 43
- The Pistol: 46
- Loading the Blackpowder Revolver: 46
- The Caplock Shotgun: 48
- The Custom Load: 51

## THE BLACKPOWDER BULLET
- Accuracy: 58
- Trajectory: 58
- Penetration on Game: 59
- Conicals, Round Balls, and Rifle Twist: 59
- Final Choices: 61

## MUZZLELOADER RIFLING
- Rate of Twist: 64
- The Smoothbore: 66
- Blackpowder Ballistics: 70

## TROUBLESHOOTING
- Frizzen Repair: 73
- Stuck Ball Removal: 75
- Removing the Breech Plug: 76
- Shooting a Ball Free: 77
- The Kit: 77
- Embellishment: 79
Muzzleloaders

BLACKPOWDER

Introduction

Blackpowder shooting never died in America. The official journal of the National Rifle Association (now called the American Rifleman) has chronicled the practice of shooting in America for over 100 years. Articles on muzzleloaders often filled their pages along with accounts of late developments in modern arms. Of course, smokeless powder eventually took over toward the end of the nineteenth century, but not entirely. Even then, the reliable, graceful, and beautiful firearm carried by early Americans didn’t pale into the mist of antiquity. Outdated? Of course. The modern firearm replaced the muzzleloader. However, the muzzleloader isn’t obsolete. Firearms enthusiasts wouldn’t let Grandpa’s muzzleloader go to rust. Gun builders handed their skills down to protégés. Protégés then became experts, and in turn, taught newcomers the trade secrets of gun building. There remains today a viable market in blackpowder arms making and repair because of such people, many of whom work in one-person gun shops all over the land. In the beginning, there were no factory rifles. After all, there were no factories in America. All rifles were custom rifles. The same is true of pistols and many fowlers (shotguns). Masters handcrafted the blackpowder rifles of yesteryear one at a time. Today, factories build frontloaders. So do custom gun makers—one at a time (Figure 1).
The old guns survived for many reasons. They survived because muzzleloaders represent a tangible piece of American history. A shooter can hold in his or her hand a piece of the past. Blackpowder guns are interesting. They can be handsome, accurate, and powerful. While presenting new challenges, they don’t represent a threat to the furtherance of modern firearms. Frontloaders are simply another way to enjoy the shooting sports. The modern firearm is the best shooting machine we have. But shooting the old way—successfully—takes special understanding and skill. Astute gun makers realized that modern shooters would not elect to search for original muzzleloaders that remained in shootable condition. If they were to appreciate and enjoy blackpowder shooting, guns would have to be available. Not that originals are hard to find; surprisingly large numbers of original muzzleloaders do exist, and often at reasonable prices. Many of these are better as collector’s items and shouldn’t be fired. Those who wish to fire primitive muzzleloaders should acquire fireable replicas (Figure 2).
Turner Kirkland (Dixie Gun Works) and Val Forgett (Navy Arms Company), as well as many others, got into the business of building and importing copies of the old-time soot-burner. Look-alike replicas were joined by loosely copied frontloaders that worked like the old guns, but in truth looked little like them. These nonreplicas became more popular than replicas, spurred into production by another phenomenon that promoted blackpowder shooting—the special “primitive” big-game hunt, which allowed only blackpowder arms. Call them opportunists if you must, but a few million shooters decided to partake of these excellent seasons, held at special times and in special places. To enter the primitive hunt, these hunters had to have a blackpowder firearm—so they bought one. It was most often a nonreplica model. For all of these reasons the muzzleloader would not say die. In an era that may have marked its eclipse, the blackpowder firearm radiated a new life.

Modern hunters can enjoy blackpowder shooting at many different levels. The occasional hunter has a nonreplica. The history buff can buy an original or a replication of an original. The person interested in emulating the past can join the
ranks of the “buckskinner,” with blackpowder rendezvous to attend all over America (Figure 3). The rendezvous offered much more than interesting games. It carried the pageant of the past-dressing the way pioneers dressed and, of course, shooting the way pioneers shot—with guns frozen in time. Blackpowder shooting caught on because it’s a refreshing break from our fast-paced lives. The deliberate process offers a welcomed slowdown, with hands-on experience and a lot of “do-it-yourself” rewards—one shot at a time. Handload takes on its full meaning in the truest sense as the shooter’s own hand introduces each powder charge and projectile to the bore, “unpackaged,” as it were. Shooters can do a lot with a muzzleloader such as tin can rolling, purposeful plinking, bench rest quests for tight groups, target competition, and skill games. They can also participate in blackpowder rendezvous or harvest game from rabbit to moose, cleanly and personally, with one well-placed shot from a firearm that was “old hat” before the invention of the airplane.

FIGURE 3—The “buckskinner” is a blackpowder shooter who has adopted, part-time, the ways and dress of yesteryear
All of this enjoyment with excellent performance promotes the sport of muzzle-loading. Shooting blackpowder guns would be boring if they were inaccurate, weak, or incapable of doing the work of a firearm. The luster of romance would soon tarnish. Initially, shooting a muzzleloader is fun just because of its long-ago style. Making smoke is enough compensation for having to clean the guns afterwards, but the honeymoon phase passes quickly. A muzzleloader must do a job well if it’s to become a partner. If it fails, it’s sent to a dark closet to spend the rest of its days gathering dust and rust. For a frontloader to function, the shooter must first understand all of its properties. Second, the shooter must handle it correctly, from load to cleaning. Third, he or she must maintain it in all facets. Blackpowder gun pros understand the muzzleloader and its propellants. They know how to handle the system correctly. They can fix problems that may arise. When they have reached the apex of muzzleloader understanding, they can build their own smokepole, perhaps from a kit to begin with, but later from a plank of wood and a bench full of parts.

Gun building is challenging, interesting, and fun. You must look at it as a professional by assessing its moneymaking potential. There are financial rewards for you to earn, but it isn’t easy. Simply duplicating what’s available over-the-counter won’t work. If you look at the price spread between some popular kits and the same finished gun you’ll see why. These “mostly completed” kits are for hobbyists who have no interest in being paid for their labor.

The trick is to find something that isn’t readily available but still has a potential market. I’ll cite two possibilities that may or may not apply to your situation. The idea isn’t to tell you what to do, but rather to get your own thinking process going.

Check the hunting laws in your state for special muzzleloader hunts. Then, create a gun to perfectly meet the requirements, such as an Elk gun.

Now to be blunt, a bull Elk is a big, strong, stubborn critter that may take a lot of killing. Back in the “old days,” Plains Rifles like the famous Hawken did the job, but circumstances weren’t necessarily the same. A hunter tended to move in close, carefully place his or her shot, and if the animal didn’t
go down, the hunter didn’t feel obligated to find it. He or she could simply shoot another one if an opportunity presented itself.

So, you can do research and then build an ideal “elk rifle.” You can get pointers from Fish and Game Departments who have monitored past hunts. They’ll know what worked and what didn’t. If you come up with something that makes their life easier, they’ll likely pass the word. Big manufacturers aren’t likely to have interest in so limited a market. That leaves a void that’s perfect for a one-gun-at-a-time builder.

Competition shooters are always easy marks. Join the clubs in your area, see what members are shooting (and how well they’re doing) and then come up with something better. If the rules specify round balls, but the shooters are using guns barreled with fast twists, try making (or converting) a rifle to use a slow one. If you come up with a winning answer, practically every shooter from that group will show up on your doorstep with money in their hands.

There’s a heritage involved in blackpowder shooting and gun handling. Early craftspeople in America built guns using traditional hand tools. Today, custom craftspeople continue the American way of hand making the graceful longarm and pistol of the past, along with the necessary accoutrements, from artistic powder horns to fine leather shooting bags. Masters of blackpowder live in the present. *Foxfire 5*, the fifth title in a series of American folklore books, describes the continuance of muzzle-loading and the people who hand-built antique-style firearms before the factories took over with replicas. These gifted craftsmen shared their knowledge of the art with upcoming arms builders. Now, in the midst of the space age, we have gunsmiths who not only challenge the artistic levels of past gun makers, but who, in some instances, surpass the old masters. This small body of blackpowder purveyors is bolstered by a larger factory-manufactured muzzle-loading trade, offering excellent over-the-counter firearms, as well as ready-made projectiles, and geared to serve thousands of blackpowder enthusiasts. Blackpowder shooting remains vibrant. Millions of modern shooters have answered the call from the past, firing the old-time muzzle-loader with appreciation for its aesthetic beauty, romance, pageant, and antiquated charm.
**Blackpowder-What It Is**

*Warning:* People have found original blackpowder arms loaded. Consider them extremely dangerous. *The powder charge is probably still alive, and the firearm can go off* (Figure 4).

Blackpowder is an ancient chemical mixture, not a compound, which people generically referred to for centuries as “gunpowder.” It’s a simple, albeit ingenious, mixture of charcoal, saltpeter and sulfur blended mechanically to make an explosive. No one knows who invented blackpowder, nor where that invention took place. China? India? Possibly. Greece is also a reasonable guess. The birth of blackpowder may have been as early as the seventh century A.D. *The Book of Fires for Burning the Enemy*, by Marcus Graecus, contains a mention of “Greek Fire,” a substance that could have been a seventh-century explosive, probably a mixture of potassium nitrate, sulfur and oil; no one is certain. There was a combustible called “Greek Fire,” but it may have been more like coal oil than an explosive.

Roger Bacon, the English scientist, described a gunpowder in the thirteenth century—according to some accounts. Some credit Bacon with discovering the blackpowder formula we use today. However, blackpowder, as we know it, probably occurred long before the time of Bacon. The Chinese employed a propellant of uncertain nature on the battlefield in the 1200s. Early European powders were crude mixtures of finely ground potassium nitrate, charcoal, and sulfur. These are the same ingredients used today to make blackpowder in mixtures of approximately three parts potassium nitrate, two parts charcoal, and two parts sulfur. By the 1400s, gunpowder achieved a useful potency. Large-bore missiles of fifteenth century warfare hurled stones that battered walls to the ground. Records show that the people of the time improved walls with more elasticity, which was an attempt to strengthen them against such a barrage.
Gunpowder of the fifteenth century was faster-burning, probably an eight-part potassium nitrate, three-part charcoal, and three-part sulfur mechanical mixture blended by simple mixing and called “meal powder.” Meal powder was unreliable, with a tendency to separate into its original component parts. Historical notes show the recombining of powder in the battlefield before it could be used was more than inconvenient.

The basic ingredients of blackpowder and their proportions remained essentially the same for eons. With the advent of smokeless or “white” powder, in reference to the new powder’s lack of smoke, gunpowder took on the name of “blackpowder” to differentiate it. Blackpowder continued to be used, with much experimentation concerning its proportion of ingredients. Saltpeter (in the form of potassium nitrate or sodium nitrate), charcoal, and sulfur in a 75/15/10 structure is ancient, but there were other proportions. There was also a major breakthrough in the early 1500s—granulation. Granulation was an extremely important step in blackpowder advancement because such powder mixed better and tended to remain in combination. Because blackpowder is a mechanical mixture, combining saltpeter, carbon, and sulfur in a wet mixture (called canning) aided in keeping the ingredients permanently mixed when the mixture was sieved into granules.

Granulation as a means of controlling powder configuration continued throughout the development of smokeless powder. Producing a powder in granule or kernel form delivered a product that had many advantages. One was integrity; the powder remained intact rather than returning to its basic ingredients. Another was better storage properties. Granulated fuel was less susceptible to moisture. It was less hygroscopic. (*Hygroscopic* refers to a material’s ability to absorb water.) Soldiers could carry granulated powder onto the battlefield ready for use. Sieving produced a more uniform kernel, roughly speaking, which improved ignition for caked/granulated powder. The powder burned more completely than the old propellant and more efficiently in smaller-bored arms, which promoted its use in sporting rifles. Most importantly, the burning rate was better controlled. This is why smokeless powder retained the kernel process. Extruded or ball/spherical in nature, smokeless propellants still depend to a degree on shape for their unique burning characteristics.
Ballistic properties varied greatly with the composition of black-powder. Even different woods for charcoal altered the powder’s efficiency. Powder burned differently according to bore size (and bore volume). Gunners soon recognized that large-granulated powder yielded less energy behind the missile than finer-grain powder. Experimenters learned, too, that breech pressures increased with finer granules. Ignition systems, chamber configurations, and even barrel lengths were altered to take advantage of the new pyrotechnics—ways the propellants burned and transformed from a solid state to a semigaseous state. Perhaps the Chinese first used gunpowder in fireworks. India had tons of saltpeter, making the key ingredient for gunpowder readily available. Some historians believe the people of India used gunpowder for deep ore mining. Fireworks and blasting powder existed, but launching projectiles was the major use of the propellant from early times. Ivan the Terrible had 200 blackpowder cannons in the fifteenth century, and gunpowder was the only firearms propellant used until the close of the nineteenth century. However, it didn’t die then; many shooters stayed with blackpowder long after smokeless was available.

Blackpowder retained many valuable assets. When made correctly, it didn’t deteriorate with age. It wouldn’t weaken when subjected to heat that altered smokeless powders. Gunpowder, kept dry and under reasonable care, remained powerful for years. It was also readily accessible and inexpensive. Humidity, however, ruined it, but precautions thwarted moisture invasion. A shooter could reload cartridge cases or shotgun hulls with a dipper. In fact, the dipper could be eliminated with most cartridges, whereby the case was filled with powder, leaving only enough room for bullet seating. Furthermore, early smokeless powders weren’t wonderful. Schultze powder was a fine-grained, almost dustlike smokeless propellant (sometimes called a blackpowder), made from nitrated wood fiber. It destroyed some breech-loading shotguns when the shotgun shelltop wad crimp was too constrictive.

Blackpowder detriments also remained, in spite of several transitory improvements (such as brownpowder). Blackpowder was corrosive; at least it promoted corrosion, partially due to the high volume of salts left behind after combustion. It was
hygroscopic, attracting moisture. It fouled the bore, caking in the grooves, thus requiring rigorous cleaning. Cartridge cases also had to be washed after use. Rifles that required a heavy charge of powder delivered strong recoil, because the weight of the charge is a major element of recoil development. J. H. Walsh notes this factor in his text, Modern Sportsman’s Gun and Rifle. Walsh presents a chart showing that C & H blackpowder renders higher recoil per charge than Schultze smokeless powder. Blackpowder also left a cloud of smoke in the air, especially when high humidity reduced oxidation. Also, it was inefficient compared with smokeless powder, performing less work per charge. Consider efficiency as energy output divided by energy input. In a way, the last bad point was a good point.

Blackpowder was forgiving of a few grains more or less per charge weight because of its inefficiency. However, in the nineteenth century, Noble and Abel of England proved false the published opinion that blackpowder couldn’t develop more than 25,000 pounds per square inch (psi) pressure (no matter what the condition of combustion). The United States Navy later proved it in tests conducted from 1874-1878. Low-energy yield per grain weight made bulk-loading possible. A charge varying by a few grains still allowed for accuracy. Muzzleloader fans may have pet loads in half-grain increments, such as 55.5 grains, for example. These are ludicrous. A sensitive modern chronograph can’t detect the difference between 55.0 grains and 55.5 grains of FFFg blackpowder in terms of muzzle velocity in medium bore sizes.

Compared with smokeless powder, blackpowder produces low pressure per grain weight, which was perfect for early guns that couldn’t withstand high pressure. Ignition was, and still is, superb. That’s why the matchlock functioned with a mere coal at the end of a burning “rope” igniting the main charge in the breech. A spark scraped from a frizzen by a flint secured in a cock ignited pan powder, which in turn set off the main charge (flintlock). Later, a mere flame emanating from a percussion cap was used for ignition because blackpowder “touched off” readily (the caplock). The blackpowder cartridge primer didn’t have to be “hot” because the least spark set off a blackpowder charge in the cartridge case or shotgun hull. So, the facile ignition of blackpowder was an important attribute.
As noted, many nineteenth-century shooters stayed with blackpowder. In *Fifty Years a Hunter and Trapper*, E. N. Woodcock said in 1913, “But if you should ask me what kind of gun I use, I would not hesitate to say that I prefer the 38-40 and blackpowder. This gun shoots plenty strong to do all the shooting as to distance or penetrations that the deer hunter will require. . . Besides, from an economical point of view, the ammunition for the 38-40 blackpowder gun costs only about one-half that of the smokeless or high-power guns.” Walsh, in *Modern Sportsman’s Gun and Rifle*, said, “I may clear the ground by at once stating that up to this present date [circa 1882] no explosive yet devised can equal black gunpowder for rifle purposes” (p. 307 of Wolfe reprint).

The three basic ingredients of true gunpowder are saltpeter, charcoal, and sulfur. Saltpeter, potassium nitrate or KNO₃, renders the “power” of the fuel. Original sources of KNO₃ include earth containing decayed vegetation or animal tissue, decayed building foundations, and cave floors, especially those frequented by bats. Bat excreta produces potassium salts, while bird excreta produces sodium salts. Saltpeter was the combination of urine and manure with water in a large cement tank with a drainpipe and valve. The mixture was covered with a lid for about a year, and the resulting liquid filtered through ashes into trays, where evaporation left a sediment of potassium nitrate crystals. Later, one could purchase saltpeter from a druggist.

KNO₃ is the oxidizer of blackpowder-its “go.” Its oxygen content has a rating of almost 40 percent. The tendency for each element in a fuel to gain or lose electrons during the chemical reaction primarily governs pyrotechnic and explosive behavior. KNO₃ worked with low cost, low hygroscopicity, good ignition, a low melting point (334 degrees Celsius), and proper decomposition at high temperatures in an endothermic reaction. In short, KNO₃ plus “fuel” (carbon provided the body for blackpowder) burned hot with good energy. Alone, KNO₃ doesn’t make gunpowder. KNO₃ plus charcoal becomes an explosive when ignited by a flame. It also becomes explosive when struck, because KNO₃ + charcoal is percussion sensitive.
Charcoal is underrated as an integral part of blackpowder. It’s the “body” of the fuel, and vital to the burning nature of the powder. Charcoal provides carbon, the element C, and the best charcoal comes from softer woods. Hardwoods have too much ash. You’ll often find willow labeled among the best woods for blackpowder charcoal. Cottonwood, chinaberry, redwood, some pines, cedar and alder are some of the woods also used successfully for blackpowder charcoal (Figure 5).

Charcoal was prepared for blackpowder with wood chips in a metal container or drum, the drum cover having a small vent hole. A fire was started beneath the drum. When the chips in the container smoked heavily, they were set aflame briefly by a match dropped through the vent hole—a method of historical interest only, never for modern use. There’s no need to risk burns (or worse) making charcoal when prepared blackpowder is available, since it’s safer and preferred. Discourage all homemade blackpowder; it’s dangerous. Prepared blackpowder was even available to the pioneers through gunsmiths and the “general store,” or carried west in trade wagons.

Sulfur, the third major ingredient, isn’t an active part of the blackpowder mixture for explosive purposes. We can make a low-grade blackpowder without sulfur. Sulfur is important to the mixture because it acts as a binding agent, providing consistency and longtime interval integrity. Sulfur also lowers the ignition temperature of the final product.

Water is another important ingredient of blackpowder. Blackpowder is somewhat organic, because charcoal comes from what was once plant life. Water may contain microbes, “little animals,” that might survive in blackpowder and cause decomposition, especially in atmospheres of high humidity that provide an environment for their growth. Rubbing alcohol and/or whiskey could be part of the blackpowder formula, introduced during corning when blackpowder is a wet paste. These agents can sterilize the powder. Distilled water or ammonia additive can also help purify water for blackpowder.
The mechanical intimate mixture of gunpowder’s ingredients was a 75/15/10 ratio for ages: 75 parts saltpeter, 15 parts charcoal and 10 parts sulfur by weight. However, formulas have varied not only in proportion, but also in nuance of chemical additions or deletions. For example, one blackpowder formula called for 72 parts potassium nitrate, 6.5 parts sulfur, 21 parts charcoal, and .5 up to 2 parts of Turkey Brown Oil to slow the rate of combustion (Figure 6).

Another formula isn’t in proportions, but in actual pounds of substance: 60 pounds of sodium nitrate (note-not potassium nitrate), 10 pounds of sulfur, 17.9 pounds of charcoal, 10 pounds of ammonium nitrate, 1.2 pounds of calcium carbonate, and 1 pound of urea. This formula, incidentally, carries U.S. Patent No. 2,030,096. A more recent blackpowder was 74 percent potassium nitrate, 15.6 percent charcoal, and 10.4 percent sulfur, essentially the old 75/15/10 mixture. Another is 1,500 pounds of potassium or sodium nitrate, 300 pounds of charcoal, 200 pounds of sulfur, and 20 pounds of graphite. Sodium nitrate often replaced potassium nitrate in blackpowder; KNO3 is more prominent.
The burning of blackpowder provides a very complex structure. Many compounds form at various stages of combustion. Permanent gases emanating from the explosion are carbon dioxide, carbon monoxide, and nitrogen. Other gases include hydrogen sulfide, hydrogen, and methane. Hydrogen sulfide is responsible for the “rotten egg” aroma. About half of blackpowder remains in a solid state after ignition, rather than going from a solid to a gas. The percentage of solid vs. gas varies widely, with as much as 56 percent of the propellant remaining in solid form. Except for carbon and sulfur, the rest of the solids are ionic salts that dissolve best in polar solvents, such as many commercial blackpowder chemicals and water. Some of the salts are potassium carbonate, potassium sulfate, potassium sulfide, potassium thiosulfate, potassium thiocyanate, and ammonium carbonate.

A tremendous improvement in burning characteristics occurred through corning, a process where a wet mixture of saltpeter, carbon, and sulfur is poured into a cake, and then broken up into granules and sieved. The ideal product was a dense, hard kernel of powder. As stated earlier, blackpowder is a mechanical mixture, not a compound. Corning aided in keeping the ingredients permanently mixed. Granulations made a vast difference in burning characteristics and a system of noting granule size then developed. Chemicals and formulations were essentially the same for all granulations. Only kernel sizes varied to alter burning rate. Exact kernel sizes have never been standardized. One company’s FFg may be another’s FFFg.

The smallest kernel size in normal use is FFFFg. It’s always been considered a fine “pan powder” for the flintlock to create a flash to detonate the main charge in the breech. Certain strongly constructed revolvers used FFFFg as a main charge until liability precluded such recommendations. FFg is next in coarseness; it yields more energy per grain weight than Fg. However, FFg is popular in large-bore rifles and well-made shotguns that can handle heavy powder charges. Fg is good in rifle cartridges. Some say Sharps cartridges create best accuracy with Fg. Fg is also useful in the 10-bore shotgun. Fg delivers comparatively good velocity with mild pressures when projectile mass is high. But Fg is of little value in the average muzzle-loading rifle, shotgun, or sidearm. “Life Saving”
was another granulation, larger than Fg. Larger was the “Whaling” granulation, and still larger was “Cannon” kernel size. Later, manufacturers introduced glazing in the final phase of production. They tumbled the powder to coat it with graphite, a process that goes back far in gunpowder history. Glazing supposedly retarded spark problems. However, glazing wasn’t a part of every blackpowder recipe (Figure 7).

Shooters in the years following the invention of reliable test devices were cautious about brands and powder types. The western fur trapper (mountain man) knew good blackpowder from poor grade. The famous Lewis and Clark Journals of 1804-1806 make note of this fact. In 1803, Lewis supposedly asked for a supply of “Best rifle powder.” The “Best” wasn’t a brand name, but was a way of describing the particular grade of powder that worked well in a rifle. Lewis’s journal entry of February 1, 1806, as noted by Carl P. Russell, states that there were 27 canisters of best rifle powder, four of common rifle powder, three of glazed powder, and one of musket powder. Also, the waterproof, four pound canisters were made of sheet lead.

The mountain men paid dearly at rendezvous for the better grades of powder. Many brands were available. English-made powders included Curtis & Harvey Diamond Grade, Colonel Hawker’s Duck Powder, Pigou, Wilks, Laurances, and others. In nineteenth-century America, you could buy Hazard’s Kentucky Rifle & Sea Shooting, Laflin & Rand’s Orange Extra, Lightning, Ducking, Du Pont Diamond Grade, Eagle Duck, Eagle Rifle, Oriental and many more. Ned Roberts noted in *The Muzzle-Loading Cap Lock Rifle* that a favorite was Curtis & Harvey Diamond Grade. It was, Roberts said, of uniform strength and burning rate, “just right for the muzzle-loading rifles.” Roberts concluded that “the chief reason for its superiority is in the charcoal used in its manufacture that’s made from English willow trees.”

**FIGURE 7—The four major kinds of granulations for blackpowder shooters are FFFFg, FFFg, FFg, and Fg: the more Fs, the finer the kernels.**
Accurate testing devices helped enlighten shooters about blackpowder superiority and inferiority. The *ballistic pendulum*, supposedly a product of 1742, aided greatly in measurement of powder efficiency, because comparisons of velocity per powder charge could be established with the mechanism. The *electric chronograph* gave an even more precise and viable means of measurement. In 1861, the *Rodman pressure gauge* added to measurability. If you recall, Noble and Abel, as well as ballistics experts of the United States Navy, established high blackpowder pressures. These scientists stated that certain blackpowder propellants under specific test conditions could generate pressures of 100,000 psi.

Rodman learned that compression of the granules during manufacture could improve blackpowder. Compression of the kernels made them impermeable, with a harder surface, so that each kernel burned “from the outside in” until consumed during combustion. Shooters preferred surface burning over the granules going whoosh! in one big flame. Surface burning and more specific kernel sizes helped to control the rate of consumption.

Manufacturers of blackpowder learned about the uniformity from one batch of powder to another during the manufacturing process. They also found out that pure ingredients (uncontaminated) were best, including clean water, and they agreed that a constant source of *good charcoal* was vital to good powder. Mixing times had to be constant from one batch of powder to the next. They had to maintain a consistent level of moisture in the finished product. Companies that were scientific about their product made good powder. As Colonel Whelen pointed out in his book *Small Arms Design and Ballistics*, in 1885 the British introduced their “Express Train” cartridges, later abbreviated to Express. These were rounds of higher-than-usual velocity. “In attaining these higher velocities the British makers were helped by their superior blackpowder. Their Curtis & Harvey No. 6 blackpowder was a very clean-burning powder of such strength that 90 grains of it would give the same velocity to a bullet as 120 grains of the usual American Fg blackpowder” (p. 159).

Others invented offshoots of blackpowder. Lamont du Pont, in 1857, obtained a patent on a blackpowder that used sodium nitrate (NaNO₃) in place of potassium nitrate KNO₃.
Sources disclose many sodium nitrate powders; however, du Pont’s patent is valid. The sodium nitrate was cheaper, being mined in Chile at a modest cost and called “Chile saltpeter.” Conversely, another source notes that Chile saltpeter was expensive due to shipping costs; choose your story. Potassium nitrate, mostly from India, was much slower to obtain, one expert declared, and was therefore more expensive than Chile saltpeter. The sodium nitrate molecular weight was 85 as compared with 101 for KNO3, yet it worked at about the same level of efficiency. It took less sodium nitrate to achieve useful energy levels. Sodium nitrate was far more hygroscopic than KNO3, which meant that the powder made with it had a shorter shelf life.

*Brownpowder* differed from blackpowder mainly because of its wood charcoal, which was purposely underoxidized. Also, brownpowder had only a three percent sulfur content. Ignition was excellent, and brownpowder was about as powerful as the first smokeless powders. Nonetheless, brownpowder didn’t last long. Smokeless *Schultze powder* came along in about 1867, soon after the birth of brownpowder. Even though a need for a blackpowder still existed, brownpowder didn’t survive. Blackpowder, of course, did, to this day igniting the huge charges of smokeless powder used in naval guns, as well as serving many other purposes (Figure 8).

There was a search to find a *clean propellant* that would burn like blackpowder, allowing bulk or volumetric loading, while at the same time working safely in a muzzleloader. Ideally, this powder would be noncorrosive with a long shelf life. Propellant manufacturers realized that a noncorrosive powder with blackpowder pyrotechnic nature was important to many modern shooters. However, no one ever made a noncorrosive blackpowder. None of the early offshoot powders are safe in any muzzleloader. Never use anything in a muzzleloader except blackpowder or Pyrodex. Forget all the rest-period. Watch out for false claims concerning substitute powders.

Smokeless powders came along that were supposed to be like blackpowder. There was *dense powder*, which, according to *Gun Week* newspaper, December 22, 1978 edition, “is a modern smokeless powder, frequently combined with nitroglycerin, that gives ballistic results identical to those obtained with blackpowder.” However, *Gun Week* didn’t suggest using dense powder in a muzzleloader.
Gun Week also noted a Ballistite powder. “Ballistite powder, also known as Nobel powder, was the first of the modern smokeless powders. First made in 1887, it consists of 40 percent nitroglycerin and 60 percent nitrocellulose.” There were real inherent dangers in some of these early powders. For the first time, shooters had to concern themselves with overcharging a cartridge case, something very hard to do with blackpowder. This was because the case had a finite capacity and held only so much blackpowder, which wasn’t efficient enough as a fuel to blow the gun up in such small quantity. Be aware that overcharging a muzzleloader with blackpowder was quite possible, due to the lack of an exact breech dimension. So it was possible to use huge powder charges in a muzzleloader.

Gun Week also mentioned a bulk powder. Bulk powder is now an obsolete, smokeless, nitrocellulose-based propellant powder. Bulk powder enabled shooters reloading their gun to switch from black to smokeless powder by simply measuring
the amount of powder bulk for bulk. Again, there were some grave problems with treating any smokeless powder as a blackpowder in terms of loading quantities.

Du Pont marketed bulk powder from 1893 into the 1960s. It carried a serious warning. *While Bulk Smokeless is intended for volumetric loading by drams, it’s not suitable for use as a replacement for blackpowder in the older guns.*

Du Pont intended Bulk Smokeless for use in modern shotgun shell reloading, not for muzzleloading. The confusion arose from the statement describing the powder as “taking the place, bulk for bulk, of blackpowder.” It did, in modern hulls, but not in muzzleloaders.

The search for a workable powder that differed from blackpowder resulted in Pyrodex, which we’ll discuss in the next section. We’ll sound the worthwhile warning again: *Only use blackpowder and Pyrodex in a muzzleloader. Smokeless powder of any kind can blow a muzzleloader up, and possibly injure the shooter or spectators.*

**Pyrodex**

*Pyrodex* is a replica blackpowder for muzzleloaders. At the time of this writing, only Pyrodex and blackpowder are safe in frontloaders. There are no exceptions. Pyrodex is a high-class propellant from the Hodgdon Powder Company. The latest Pyrodex in all granulations offers excellent ignition qualities, although we still don’t recommend Pyrodex for flintlock firearms. The current Pyrodex is less dense than previous formulations. For example, a volumetric charge of 100 RS granulation (the powder measure set at 100) provides an actual weight of 71.5 grains by scale. In the past, the ratio was closer to 100 volume of RS equaling about 80 grains weight.

Pyrodex is a potent fuel yielding at least the same, but usually more, ballistic impetus than the same *volume* of blackpowder when loaded bulk for bulk. You always load Pyrodex by volume—*never* by weight. Use a blackpowder measure only. Never use a scale to produce a Pyrodex load. Loading with Pyrodex is a simple matter of using the same volumetric powder measure-see accoutrements section for Pyrodex
and blackpowder. For example, if a muzzleloader has a recommended charge of 100 grains of blackpowder, in this case FFg blackpowder, you would set the powder measure, obviously, at 100. This setting provides a volume of 100, not an exact weight of 100 grains of blackpowder. With FFg blackpowder in this instance, weight for volume was close. The powder measure set at 100 achieved a weight of 99.2 grains. The blackpowder load was 100, so the powder measure was left at the 100 setting. However, the actual weight of the charge was considerably less than FFg blackpowder (only 71.5 grains weight for Pyrodex) for the same volume because Pyrodex is less dense than blackpowder (Figure 9).

Pyrodex comes in granulations, but not in the same granulations as blackpowder. Blackpowder granules are Fg, FFg, FFFg and FFFFg, which is the order of kernel or granule fineness—Fg the most coarse, FFFFg the most fine. Pyrodex is available in the following grades:

- **Pyrodex P**, for use in all pistols and in smaller bore rifles
- **Pyrodex RS**, for use in all calibers of percussion muzzleloading rifles and shotguns
- **Pyrodex Select**, which is an enhancement of the RS grade
- **Pyrodex CTG**, for use in blackpowder cartridges (Figure 10)
After a shooting session with Pyrodex, you must scrub the bore in the same fashion as if you fired blackpowder because Pyrodex is corrosive. Some shooters seem to believe otherwise. However, Pyrodex will etch the bore if you don’t clean the firearm after use. The good news is that firearms using Pyrodex don’t need to have their bores scrubbed in-between shots. This fact allows continued shooting without between-shot bore swabbing. Naturally, common sense prevails. Even with modern rifles using nonfouling powder, you do have to attend to the bore after a lot of shooting; the same with Pyrodex. For a normal shooting session, you don’t have to touch the bore until you finish shooting. It’s impossible to say how many shots you can or should fire before scrubbing the bore when you use Pyrodex. It depends on the size of the powder charge and how large the bore is. A small bore has less volume than a big bore. It takes less powder to foul a smallbore. On the other hand, far less powder generally burns in the smaller bore. So, exact rules of guidance are impossible to list.

Thirty-two and .36 caliber caplock squirrel rifles using 10 to 15 grains volume of Pyrodex P have been known to fire thirty shots before the bore needed swabbing. In larger bores, you would have to swab the bore after shooting fewer shots if you used heavy powder charges. Light powder charges cause less fouling in the bore, so fewer swabs are necessary. A dozen shots in a .54 caliber rifle loaded with 120 volume of RS usually dictates swabbing the bore. There’s no standard number of shots for bore cleaning when using Pyrodex. Bore dimension and powder charge size dictate how many shots you can fire before bore swabbing is necessary. Smaller bores have less volume; therefore, they foul faster than larger bores. But big bores often use large powder charges, which may deposit over 50 percent of the charge in the bore as fouling. Furthermore, firearms vary in smoothness/roughness of bore, depth of groove, rate of twist, and general condition and configuration of rifling. All of these alter how many shots you can fire with Pyrodex before you need to swab the bore.

When shooting Pyrodex, dress the bore to ensure uniformity within the bore and better accuracy. Dressing the bore pertains to target shooting or match shooting, where precise groups are essential. Dressing the bore isn’t essential for
preparing a hunting load or for “plinking.” Dressing is also called “fouling” the bore. However, you’ll find the term dressing preferred. Dressing the bore requires “preshots,” which are shots sent downrange for warm-up only, not competition. A standard of four shots with Pyrodex to dress the bore for serious target work with a .50-.54 caliber rifle is acceptable, especially when testing for bench rest accuracy. We can’t give the prescribed number of shots, however, since it’s a matter of bore size, mass of the powder charge, bore drag (friction), weight of the bullet, and other factors. In the hunting field, bore dressing with Pyrodex isn’t necessary. Dry the bore thoroughly before loading, load the rifle, and shoot.

Pyrodex is safe to transport, within the codes of transporting propellants, of course. It gives consistent pressures in the bore, shot after shot. Once you dress the bore properly, which may take one to possibly four shots depending upon the firearm and other factors mentioned above, the firearm tends to register the same pressure from shot to shot. Pyrodex offers consistent velocity, shot after shot, once you dress the bore. This is shown by the low (excellent) standard deviation for Pyrodex. Pyrodex gives more shots per pound because it’s less dense than blackpowder and somewhat more efficient, yielding greater energy per grain weight than blackpowder. One pound of Pyrodex provides approximately 20-30 percent more shots than a pound of blackpowder, depending upon granulation. As noted, Pyrodex doesn’t require swabbing between shots, a time-saver at the range.

Pyrodex does require post-shooting cleanup. You employ the same methods for Pyrodex maintenance as you would after shooting blackpowder. A solvent and bristle-brush cleaning method is acceptable, but shooters living in high-humidity areas may wish to remain with the old-style hot-water cleaning method, flushing the bore to remove fouling.

Like blackpowder, Pyrodex is capable of achieving high pressures. Overloading is strictly forbidden. Furthermore, the laws of diminishing returns apply to Pyrodex as they apply to blackpowder. At some point, loading more fuel gives more recoil and smoke, but little to no velocity advantage. So as
with all loading, you must follow the rules. Use only those loads allowed by the gun maker. Never exceed a recommended maximum load. Safe shooting is the only worthwhile shooting.

**Pyrodex Pellets**

There’s a convenient form of Pyrodex available called *Pyrodex Pellets* (Figure 11). Each pellet is a premeasured charge, so no measuring or pouring is necessary. You drop one 50 grain pellet down the barrel of a muzzleloader for target loads and two pellets for hunting loads. Using your ramrod, you seat the sabot (sah-bow) firmly in place. After you cap it, you’re ready to fire. In addition to the convenience of no pouring or measuring, the pellets provide faster loading, sharper ignition, less waste, increased safety, and less fouling.

*FIGURE 11—Pyrodex Pellets*  
(Photo courtesy of Hodgdon Powder Co., Inc.)
Self-Check 1

At the end of each section of Muzzleloaders, you'll be asked to pause and check your understanding of what you have just read by completing a “Self-Check” exercise. Answering these questions will help you review what you’ve studied so far. Please complete Self-Check 1 now.

1. Is blackpowder an explosive or a propellant?

__________________________________________________________________________

2. Why do we call Pyrodex a “replica blackpowder”?

__________________________________________________________________________

3. Why isn’t Pyrodex always effective in the flintlock?

__________________________________________________________________________

4. How did granulation affect the blackpowder burn rate?

__________________________________________________________________________

5. Why will the same volume of Pyrodex weigh less than blackpowder?

__________________________________________________________________________

6. Why is blackpowder hygroscopic?

__________________________________________________________________________

7. What two advantages of blackpowder kept it in use even after smokeless powder was available?

__________________________________________________________________________

8. Is Pyrodex more powerful than blackpowder?

__________________________________________________________________________

9. Why is it wise to “dress the bore” when shooting Pyrodex for scores or groups?

__________________________________________________________________________

10. What are five advantages of using Pyrodex Pellets?

__________________________________________________________________________

Check your answers with those on page 103.
TYPES OF MUZZLELOADERS

Replicas

Many types of muzzleloaders are available to twentieth-century shooters. Originals like Great Granddad’s abound. A gun enthusiast recently located an original in almost perfect condition for under $400. There are replicas (copies) of originals (Figure 12). Factories can make replicas or gun makers can handcraft them. There are nonreplicas, working models that don’t copy any firearm of the past. There’s also the “rifled musket,” seemingly a contradiction in terms, but this longarm is a hard-working and accurate piece. Examples of the rifled musket are the Whitworth and Volunteer models from the Navy Arms Company.

FIGURE 12—The matchlock rifle shown here is a replica offered by the Navy Arms Company. The matchlock was a workable design, but was far surpassed by the lock styles that followed.

In-line Muzzleloaders

New to the world of muzzleloaders is the “modern muzzleloader,” or in-line muzzleloader, a unique blackpowder firearm gaining wide popularity. Traditionalists generally prefer replicas. However, modern shooters often lean toward nonreplicas and modern muzzle-loaders, the latter for their familiar look,
feel, and easy cleanup. Since the modern muzzleloader is the newest of the blackpowder breed, here are five criteria of recognition.

1. The modern muzzleloader has in-line ignition.
2. It’s drilled and tapped for a scope sight.
3. It has a rapid rate of twist.
4. You may clean it from the breech end (with exceptions).
5. The modern muzzleloader wears a modern-style stock (Figure 13).

\textit{In-line} ignition means that the jet of flame from the percussion cap (these are all caplock arms) darts directly into the waiting powder charge in the breech, as opposed to winding through a vent system. Underhammers and sidehammers had in-line ignition in the old days, so the concept is nothing new. An in-line muzzleloader tapped and drilled for a glass sight states boldly that the owner isn’t the least embarrassed about using a scope on his or her blackpowder rifle. Since the barrel has a “fast twist,” it’s best to use conicals and not patched round balls. To clean the in-line muzzleloader, you employ \textit{breech cleaning}. This means that you don’t run jags, patches, worms, and similar hardware down the muzzle to coax fouling out. Instead, you break down the rifle, removing
its breech plug, and clean it from the back end with a bristle brush followed by cleaning patches. Forget water in cleaning the modern muzzleloader; there’s no need for it. Modern solvents work well in concert with a bristle brush and cleaning patch.

In-line muzzleloaders may have, in addition to the five criteria previously cited, a contemporary safety as well as a trigger. Along with being drilled and tapped for scopes, the modern muzzleloader may be fitted with adjustable iron sights with aperture sight options in many instances. Recoil pads are common, as well as carrying slings attached via QD swivels. The in-line rifles are muzzleloaders. They accept powder and projectile from up front only, with a percussion cap to ignite the powder charge in the breech. You should only use blackpowder or Pyrodex. Bore sizes are normal for blackpowder: 45, 50, and 54, with smallbores, such as the Knight MK-85 available in 36 caliber.

In-line muzzleloaders are capable of shooting up-to-date blackpowder bullets, such as those from the Buffalo Bullet Company. The quick-twist bore of the modern muzzleloader handles conicals, especially those from Hornady, Thompson/Center, Bor-Clear, Mushroom Express, and others. Some models are designed to shoot jacketed pistol bullets as well. Of course, this normally undersized projectile doesn’t match the bore. You shouldn’t load a jacketed bullet directly down bore without the rifle manufacturer’s expressed consent. The pistol bullet fits into a sabot (sah-bow). The word comes from the French, pertaining to “shoe.” In this case, the shoe is a plastic cup of bore size. Into the cup goes the jacketed bullet. The cup translates the rotational value imparted by the rifling to the bullet.

The light plastic cup falls away soon after it’s airborne, leaving the bullet to take its course to the target, spinning on its axis. The plastic sabot is similar to Remington’s Accelerator ammo, in which the 30-30, 308, and 30-06 are loaded with .22 caliber jacketed bullets in a plastic sabot. Ballistically, it’s difficult for a jacketed bullet/sabot to whip a lead conical out of a muzzleloader because the jacketed bullet doesn’t fly that much faster than the lead conical. However, some rifles shoot sabot/bullets quite accurately and with more than ample power for big-game hunting.
Barrels on in-line muzzleloaders may be long or short. The barrel of the Thompson/Center Scout is only 20.5 inches long. This rifle has a $1:20$ rate of twist. Barrels on Knight’s Modern Muzzleloaders vary in length from 20 to 26 inches. The shorter barrels in calibers 45, 50, and 54 give up some velocity, but many shooters prefer the handiness of these truncated barrels in trade for a modest velocity loss. In-line muzzleloaders are here to stay. They represent another way to shoot blackpowder, and the gunsmith of today will be dealing with these blackpowder rifles of modern design (Figure 14).

Note: As with all firearms, check your state and local laws before purchasing and using any firearm.

Muzzleloader Lock Types

Many different muzzleloader lock styles existed over the years. The five major types are matchlock (also called firelock), wheel-lock, snaphaunce (snaphance), flintlock, and percussion. Percussion is also called caplock (or cap’n’ ball for the percussion revolver). The first three are of historical value, but not of major practical concern. The matchlockignition system dates back to the 1400s, if not earlier. It used a slow-burning match or wick (ropelike) attached to a necklike device that moved forward when the shooter wished to discharge his or her firearm. The lighted end, burning somewhat like punk, fell against the priming powder, igniting the powder, which in turn set off the main charge.
The wheel-lock was an ingenious ignition system constructed around a revolving, spring-loaded metal wheel. The wheel’s edge was abrasive. As it spun around, as if it were powered by a runaway alarm clock spring, the abrasive edge rubbed against pyrites (sometimes flints), which caused a shower of sparks. These sparks in turn fell into priming powder. The flash from the priming powder entered a touchhole leading to the powder charge, setting it off. This system of the 1500s wasn’t truly surpassed in quality by the next two types, the snaphaunce and flintlock (Figure 15).

Arguably, the snaphaunce (an invention of the 1500s) and the flintlock were less positive than the wheel-lock, for neither one ensured the shower of sparks caused by the wheel-lock. Yet, the history books considered the snaphaunce an improvement. Certainly, the snaphaunce was less expensive to make and, in the sense of being simpler and perhaps faster to operate, it was ahead of the wheel-lock. Again, the snaphaunce used pyrite or flint, held in a jaw, which was activated by a spring. In firing the snaphaunce, the spring propelled the cock (later called a hammer) forward with the pyrite or flint in its jaws. The pyrite of flint struck an anvil that caused a spark, which set off ignition powder.
The two ignition systems that are of interest to us are the flintlock and the caplock or percussion (Figure 16). Both are still in use today. The caplock is more popular by far, but there are a good number of blackpowder enthusiasts who consider the flintlock more romantic and interesting than the caplock. The flintlock followed on the heels of the snaphaunce. There was a cock (hammer) with jaws, and held fast in the jaws was a flint. There was also a frizzen (also known as the frizzle), which was part of a pan cover. Underneath the pan cover rested, as one might suspect, a pan, and in the pan was a charge of fine-grain powder (FFFFg). The shooter pulled the trigger, which in turn released the cock so that it could fall forward. The edge of the flint struck hard against the metal frizzen, scraping tiny curls of molten metal from it, while forcing it upward and forward and lifting the pan cover. The molten metal then fell into the exposed powder pan. The idea was to ignite the pan powder, which in turn sent a flash through a channel called a touchhole. From there the flash went into the main charge of powder in the breech of the firearm.

**FIGURE 16**—The caplock, or percussion lock, shown here reveals the tumbler along with a bridle and the sear.
There were rifles, pistols, and shotguns (fowlers) of flintlock style. A good flintlock “went off” much more reliably than modern critics like to suggest. Soldiers won wars with flintlocks. Settlers with flintlocks set up housekeeping in many parts of the land, providing food for the table and protecting the family with the “sparktossor.”

The world of early ignition systems gave us several interesting terms that remain useful to know. A *flash-in-the-pan* referred to the pan powder going off, but the flame ended there, rather than proceeding through the touchhole. There were also hangfires and misfires. A *hangfire* referred to a delay in ignition, but the firearm did go off. In a flintlock, the hangfire sounded like a fttttt-boom! sound. A percussion rifle sounded more like snap!-bang! The sound was created by the hammer falling, the cap detonating, and then a delay before the powder charge ignited. The *misfire* was simply a click of the hammer with the firearm not going off at all.

Flintlocks didn’t give way to percussion firearms all at once, any more than blackpowder moved over for smokeless powder immediately. However, the percussion cap was destined to rule and so it did. The percussion cap is vital to blackpowder shooting, as we’ll discuss in the next section.

The whole idea of the percussion system was to encapsulate in a container some sort of percussion-sensitive substance. In this case, fulminates were used. The container of fulminate became the percussion cap. It rested atop a device that served as a nipple. The nipple had a cone for the percussion cap to rest on and an interior channel or flash channel. When the hammer of the percussion-style rifle smacked the top of the percussion cap, the fulminate went off and sent a spark down through the body of the nipple.

The spark then found its way to the main charge in the breech of the firearm. How the flame got there depended upon the type of system used. One style had a bolster or lump of metal housing the nipple, and a channel from there to the breech. Sidehammer and underhammer models ushered the spark directly into the breech of the gun.
One of the simplest locks is the Ethan Allen design, like the modern Mowrey replica shown in Figure 17. The sideplate is removed to reveal the inner workings of the lock; a simple tumbler device and mainspring are major parts of the lock.

*FIGURE 17—The Ethan Allen Design on a Modern Mowrey Replica*
Self-Check 2

1. Name five types of muzzleloaders used today.

__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

2. What are the five major types of muzzleloader locks?

__________________________________________________________________________

3. Why is it unwise to shoot some original muzzleloaders?

__________________________________________________________________________

4. What made the matchlock work?

__________________________________________________________________________

5. Why has the modern muzzleloader caught on?

__________________________________________________________________________

6. What is a sabot?

__________________________________________________________________________

7. What made the wheel-lock function?

__________________________________________________________________________

8. Why do modern muzzleloaders often carry a comparatively fast rate of twist?

__________________________________________________________________________

9. The wheel-lock wasn’t, in a very real sense, outclassed by the flintlock. Why did the flintlock take over?

__________________________________________________________________________

10. Why did the percussion system finally overtake the flintlock?

__________________________________________________________________________

Check your answers with those on page 104.
LOADING METHODS FOR MUZZLELOADERS

The excellent blackpowder cartridge rifles, namely the Sharps and Remington Rolling Block, are not included in this unit, which is devoted to muzzleloaders only. Therefore, the following loading procedures include only flintlock and caplock firearms.

The Percussion Cap

We credit Reverend Alexander Forsyth with the invention of the percussion cap. Some historians claim, however, that the cap was invented long before the good reverend submitted his idea. Be that as it may, the concept of installing fulminate within a small metal container was ingenious. It changed shooting forever because the modern primer is essentially a different style of percussion cap. Fulminates are percussion sensitive. That’s why we use the term “percussion” cap to describe them. When a fulminate is struck, it explodes, producing a flame. Once fulminate was harnessed within a container, its powers could be controlled and channeled. In this scenario, the idea was simple: situate a percussion cap so when struck by a hammer it ignites, sending a flame through a channel into a waiting charge of powder. This is all the percussion cap does, but its work is vital. When struck, it explodes, sending a flame of ignition into the breech of the muzzleloader (Figure 18).

The cap must provide a strong flame capable of traveling through the nipple vent (a channel or passage) into the main charge in the breech of the firearm, detonating the powder therein. To do this, the spark must be hot enough to get the job done, but that’s not enough. A good cap must also be consistent. It should offer similar duration of flame from one cap to the next from the same box. The duration of flame must also be of a sufficient time interval to promote ignition. In other words, the cap shouldn’t go “bang!” and be done with its mission. It should emit a spark lasting long enough to reach the powder charge. So a proper percussion cap is more than a little unit that goes “pop!” It has to be a precise detonator with specific properties.
The big push for years was the “hot” cap. “Hot” meant that the cap expelled a strong flame. The logic of the hot cap didn’t hold up under comparison with so-called “cool” caps, found to be as effective as hot ones. A. C. Gould, an old-time blackpowder expert, was a champion of the cooler cap. The ideal cap delivers adequate spark for ignition, but not an excessive explosion. A cap more powerful than necessary causes pieces of the cap’s body to fly in all directions. The too-hot cap may also “blow itself out.” It goes crack! on the nipple, but the flame “spatters,” for lack of a better term, rather than the flame channeling under control through the vent and into the powder charge. Excessive cap debris also clogs the nipple, impeding the progress of flame when the shooter fires the next cap.

Such a situation can cause a misfire or hangfire. Once there were many different cap styles and brands in many degrees of “power.” Today, percussion caps have been standardized—up to a point. So, the hot cap/cold cap problem isn’t prominent today. The best cap offers a sustained spark, instead of an instant but short-lived blast. There remain examples of caps that are too explosive. If cooler, they would ignite the powder charge perfectly without overt cap debris or cap
blowout. Brands vary. Furthermore, cap performance is associated with the nipple that the cap is used with. The Hot Shot nipple, for example, is vented so that excess explosiveness is bled off instead of channeling into the breech of the firearm.

A shooter may think a corrosive or noncorrosive cap shouldn’t matter. Blackpowder and Pyrodex foul the bore, so the shooter must clean the firearm whether or not the cap is corrosive. Noncorrosive vs. corrosive does matter, though. In the process of readying a caplock muzzleloader, the shooter may fire one or more percussion caps on the nipple to clear oil away and to ensure a clear channel from the cone of the nipple into the breech. What may happen is this: After the caps clear the nipple, the shooter carries the firearm out hunting, for example, rather than immediately firing it. Meanwhile, the fouling from a corrosive cap is at work in the nipple channel, but more detrimentally on the nipple seat and in the flash channel of the firearm. A noncorrosive percussion cap avoids this problem. Of course, for target shooting and plinking the corrosive cap is fine.

Some caps are waterproofed, others aren’t. To test a cap, put it under running water, shake off the excess moisture, install it on the nipple, and pull the trigger. Waterproof caps will fire. Waterproofing is of little consequence for target work, but for hunting, the waterproof or “lacquered” cap is a good investment. Caps that weren’t waterproofed a decade ago are now waterproofed. Waterproofing is a current trend.

Just as all caps aren’t created equal in terms of waterproofing and degree of potency, neither are they the same size. The No. 11 percussion cap is the size most used today. It fits most nipples. A No. 10 is often better on some revolvers. The No. 11 is a modern standard, but caps may vary from brand to brand. A No. 11 cap in Brand A may be identical in size to a No. 12 cap in Brand B. Caps should be checked by putting them carefully on the nipple cone to see how they fit. They should fit snugly. But the body of the cap must not split when the cap is put on the nipple cone, nor should it take force to put a cap on the nipple. The correct cap will slip on the nipple readily, but won’t fall off.
There are two types of caps in wide use today: the standard cap for rifles, shotguns, pistols and revolvers, and the English musket cap, also known as the top-hat cap. You'll see this cap used most often on the “rifled musket” firearm, such as the Navy Arms Whitworth or Volunteer rifles. Top hats, or English musket caps, are much larger than standard caps and throw a big spark. If you have trouble finding top-hat caps, investigate the possibility of a conversion nipple. A conversion nipple has a large threaded base section that fits the seat of the musket, but the cone of the nipple comes sized for a standard cap instead of a top-hat cap.

Another percussion cap criterion is construction of the body, basically ribbed or smooth. Both work equally well. A more important cap body difference is malleability. Some caps are brittle; they fragment upon firing. Others are more malleable. They tend to smash against the cone of the nipple where they either fall off of their own accord, or can be flicked away. The latter is preferable. You should check a cap after shooting to see if it’s missing, tattered and shattered with bits of metal scattered here and there, or fully intact and resting smashed on the cone of the nipple.

As noted, an accepted practice of clearing the nipple of the firearm prior to loading is for the shooter to pop percussion caps on the nipple before he or she loads the gun. However, some caps, especially those with brittle bodies, may deposit bits of metal within the channel or vent of the nipple. In this scenario, the process of popping a cap to burn off oil in the nipple vent or to remove debris may create the opposite and undesirable result-cap fouling within the nipple vent. This fouling could prevent the clear passage of flame from the next cap—a misfire. After caps detonate on the nipple, the shooter should push a pipe cleaner through the cone of the nipple to pick up any bits of cap body or fouling.

The shooter can test and evaluate percussion caps by using a screwbarrel pistol, such as Dixie Gun Works’ .44 caliber. Keep all parts of the body clear of the pistol in this test. Don’t allow anyone else in the area when you test caps. The use of the pistol is entirely safe unless the shooter does something outrageously foolish. Here’s a proper method of evaluating various percussion caps of the No. 11 size.
1. Unscrew the barrel from the pistol. This exposes the breech.

2. Place a percussion cap on the nipple.

3. Fire in a darkened place, such as a garage or tool shed at night. A flame/spark will jet from the pistol.

4. Visually inspect the cap to determine the duration of the spark and its size, as well as the shape of the flame long and slender, short and wide, or in between.

You can readily compare brands using this visual inspection method (Figure 19).

As already noted, selecting the nipple is just as important as deciding which cap to use. There are many excellent nipples on the market. You should avoid straight-through types. These have a large orifice from the base of the nipple to the cone, as opposed to nipples that have a flat base with a pinhole. The flat-based nipple with the pinhole offers better control of gases. Although the Venturi principle (the basis of the ramjet) will prevent most gas from escaping through the small port in a nipple, nipples with larger holes may still leak gas, causing excessive cap debris and velocity loss.

There are dozens of different nipple threads today, from the standard 1/4-28 thread to 6-.75 metric, 6-1mm, 12-28 thread and other sizes. The nipple must fit the nipple seat perfectly. If you have to force a nipple into place, it’s the wrong one. The nipple could blow right out of the gun if it’s not properly engaged in the threads of the nipple seat.

You should never prime a nipple by pouring powder into the cone. Priming of the nipple may cause flying cap debris. A flash cup, such as the Tedd Cash cup, fitted around the base of the nipple, contains and directs cap debris from the exploded cap.
The percussion cap is the spark plug of the caplock firearm—rifle, pistol, shotgun, or revolver. Without that little flame, there’s no ignition. Know your percussion caps and the nipples that they rest on.

**Warning:** Before attempting to load any blackpowder firearm, be certain that the gun is unloaded to begin with. It’s possible to put a fresh load on top of a former load.

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**Loading the Percussion Rifle**

**Step 1. Remove oil, and clear the bore and the nipple.** Treat the frontloader with a trace of oil on the lock and in the bore to thwart rust. Before loading the rifle, remove the oil, along with any dust or other materials. Run a fresh cleaning patch downbore with a few strokes. Run a pipe cleaner into the nipple vent to soak up any oil that could retard the spark from the percussion cap.

**Step 2: Detonate the cap on the nipple.** Percussion cap flame helps burn out minute traces of leftover solvent or oil in the nipple of the unloaded percussion rifle. To test for a clear channel, aim the muzzles of the rifle at a leaf on the ground or other light object and fire. The leaf should move aside from percussion cap gas expelled through the muzzle if the way is clear. Movement of the object shows that the channels through the vent of the nipple, into the breech of the rifle, through the bore, and out the muzzle are clear. Listen for a thump! or a crack! The thump, a somewhat hollow sound, is an all-clear signal. A sharp crack signals that energy from the percussion cap is trapped within the vent of the nipple.

As noted earlier, run a pipe cleaner into the vent of the nipple after popping caps to pick up any possible cap residue that may be left behind.

**Step 3: Charge the rifle.** Point the muzzle away from yourself and toward a safe place, such as the sky. Pour a premeasured charge of blackpowder or Pyrodex directly down the center of the bore. Use only the powder granulation and amount allowed by the gun maker. Smack the side of the barrel with your hand to settle the powder in the breech.
**Step 4: Buffer large powder charges.** For hunting charges only, a buffer between the powder charge and the patch in a round-ball load is wise. Use hornet nesting as a buffer. Abandoned hornet nests provide this material, which is unique. In the open air, a match incinerates hornet nesting. But downbore, this material is like asbestos. Recovered hornet-nesting layers expelled downrange from a heavy, hunting charge look like new. Hornet nesting won’t prevent patch cutting, but will prevent patch burnout. Sharp lands cause patch cutting. A couple of thin sheets of nesting material will do the job. One hornet nest lasts a long time. A note of caution is in order here. You should approach nests only in the winter when it’s cold, or after a frost. Otherwise, you may encounter residents.

To test for patch cutting, use an *empty* rifle. Force a patched ball downbore without powder. Withdraw the ball with a screw on the end of a loading rod. Check the condition of the patch. If you find that the rifling cut the patch, there are two cures—one fast, the other slow. The fast cure is to lap the bore to smooth the lands’ sharp edges. The slow cure is to shoot. Repeated shooting laps the bore, the cloth patch polishing the rifling slightly at every fired shot.

No buffer of hornet-nesting material is required for target loads, even in big-bore rifles. For example, a .54 caliber long rifle with 70 grains of FFg blackpowder doesn’t require a buffer. The same applies to .32 or .36 caliber smallbore squirrel rifles. A buffer is necessary only with strong powder charges that may burn a patch out.

**Step 5: Patch the round ball.** Center a precut and lubed patch on the muzzle. The shape of the patch makes no difference. Square patches work as well as round ones. Center the ball on the muzzle over the patch. There are many ways to start the ball downbore. One way is to use the wooden handle of the short starter, not rapping, but pressing with it. The idea is to get the ball downbore without deforming it. Place the stub, or short stem, of the starter directly on the
face of the ball. The stub pushes the ball downbore below the crown of the muzzle. Next, use the long stem of the short starter to drive the ball deeper into the bore. If you place a large piece of cloth over the muzzle instead of a precut patch, remove excess patching material the traditional way, with a patch knife. In this method, you place lubed patching material over the bore and center the ball on the material and press downbore with the stub end of the short starter. The sharp patch knife slices away all the material that remains above the muzzle of the rifle. Precut and prelubed patches are much more popular than cutting patch cloth with a patch knife.

**Step 6: Seat the round ball on the powder charge.** At this point, the patched ball is down the muzzle to the depth allowed by the length of the longer stem of the short starter. You must still ram the ball all the way down on top of the powder charge by using a ramrod or loading rod. See the section on black-powder loading accessories for more information on loading rods and ramrods. The ball firmly seats without rapping, tapping, or pounding the rod. Smashing the nose of the ball serves no purpose. Instead, maintain the shape of the ball during the seating process. It’s true that minor ball deformations cause no problems; however, major nose deformation can damage accuracy. Guard against separated powder charge/projectile loads. This warning is important. Separated charge/missile loads may cause a “walnut” or lump in the bore. Separated charge/projectile loads may also crack a barrel.

**Step 7: Install the percussion cap.** The rifle is now fully loaded except for a source of ignition. Use an in-line or magazine capper to mount a cap on the cone of the nipple. A capper is a good cap container and dispenser, and it removes all chance of a percussion cap going off in the fingers. The capping tool introduces one cap at a time to the cone of the nipple. Safety dictates that the muzzle of the rifle be aimed in a safe direction at all times, and especially during the capping process.
Step 8: Maintain the bore during shooting. The frequency of cleaning between shots depends upon how much powder you used in the charge. A .32 caliber squirrel rifle loaded with only 10 grains of FFFg blackpowder may shoot a couple dozen times before bore swabbing is necessary. This is especially true if you used a liquid lube on the ball patch, for such lube acts to soften and remove blackpowder. The process of loading the new lubed patch promotes cleaning because the clean patch on the ball, impregnated with lube, attacks fouling. Heavy charges of large-granuled blackpowder require more frequent bore swabbing during shooting because of two reasons. (1) The large granulated powder isn’t as thoroughly consumed as small-granuled powder. (2) The amount of the charge is great, and more than 50 percent of that charge may remain in the bore as solids that you’ll have to remove. If considerable force is needed to seat a patched ball, that may indicate severe bore fouling and you should swab the bore before the next load.

A bristle brush coupled with modern solvent works well for in-between-shot bore conditioning. Most shooters get by with a cleaning patch soaked with solvent, followed by a drying patch. If the bore is left wet, or if lube invades the vent of the nipple, a misfire or hangfire is in the making. Ensure a dry bore after swabbing.

Pyrodex doesn’t demand in-between-shot bore swabbing for a dozen shots or so. We can’t give a set figure because there are too many variables in bore size and powder charge. Dress the bore with one to four fouling shots, depending on caliber. Larger calibers may require up to four shots, because the volume of the bore is greater than small calibers. In 50s and 54s with target loads in the 70 grain volume range, four shots will generally stabilize the bore. A dirty bore won’t deliver best accuracy. A dirty bore can also raise pressures. We can’t always rely on a chronograph to reveal rising pressures from a fouled bore because it’s possible for pressures to increase even though velocity doesn’t increase.
Loading the Elongated Projectile

A bullet is a projectile fired from a gun. There are round bullets and conical or elongated missiles. We don’t use a patch with conicals, only with round balls. The lead bullet is lubed, with a grease or cream generally. You install it into the bore of the rifle and ram it home fully upon the powder charge in the breech of the rifle.

Loading the Flintlock

A good flintlock “goes off” with regularity but not perfection. Hangfires and misfires are possible and best avoided with a proper loading method.

**Step 1: Clear the bore of oil-dry the flint and the frizzen.** Run a clean patch through the bore of the rifle to soak up any leftover oil. Wipe the face of the frizzen and the flint with a dry cloth. The flint must scrape tiny curls of hot metal from the frizzen, which requires friction. An oily surface retards friction—no friction, no fire; no fire, no ignition. Match the edge of the flint with the face of the frizzen before attempting to shoot. Loosen the jaws of the cock so that the flint can move. Ease the hammer or cock forward, allowing the edge of the flint to match up with the face of the frizzen and only after the two match, tighten the jaws of the cock again. This will leave the flint and frizzen matched (Figure 20).

**Step 2: Try for a spark.** Cock the unloaded rifle. Pull the trigger so that the flint falls on the face of the frizzen. A shower of sparks should emerge and fly directly into the open pan. If this doesn’t occur, there’s little hope of ignition. Replace the flint and check the face of the frizzen for wear.
**Step 3: Block the touchhole.** Block the touchhole of the flintlock rifle by inserting a pipe cleaner, vent pick, or wire into the touchhole. An open touchhole can allow powder from the main charge to enter an otherwise clear channel. If the touchhole is full of such powder, the fuel must be burned out of the way by the flame from the pan before the flame can reach the main charge in the breech. This is a slow fuse. An open channel is a much faster route for the flame to travel through. So, block the touchhole before installing powder downbore.

**Step 4: Charge the rifle.** Use the same procedure for charging the flintlock as described for the caplock rifle. Tap the sides of the barrel to settle the main charge in the breech. Keep the touchhole blocked during this step.
**Step 5: Seat the ball.** Use the same process for both the percussion rifle and the flintlock rifle in seating the patched ball (Figure 21). Make certain the patched ball remains firmly on top of the powder charge until it fires away. Use this safety precaution as previously stated (Figure 22).

**FIGURE 21**—You initially seat a projectile with a short-starter, as shown here. Note the muzzle protector, the cone-shaped device that rides on the rod of the short starter. It centers the rod in the bore so that the jag can’t scrape and damage the rifling.

**FIGURE 22**—Shown is the Hawken Shop in-line capper dispensing a percussion cap on the nipple of a shotgun. Note that the hammers are at half-cock during this process for safety.
**Step 6: Prime the pan.** Remove the obstruction from the touchhole. Do not, as sometimes advised, twirl the pipe cleaner or vent pick in an attempt to draw powder into the touchhole. The whole idea of the blocked touchhole was to prevent powder from entering so that the way would be clear for the flash from the pan to reach the charge of powder in the breech. Now, prime the pan with FFFg granulation blackpowder (pan powder). Don’t overfill the pan; one-half to three-fourths pan of powder is plenty in most rifles. Place the pan powder to the outer side of the pan, away from the touchhole, to keep the touchhole clear of powder. Carry the flintlock rifle tilted so that the powder stays to the outside of the pan until ready to shoot.

**Step 7: Shoot the flintlock.** Close the pan cover, cock the rifle, and shoot. Maintain a clear touchhole between shots by using a pipe cleaner doused with solvent followed with a dry pipe cleaner. Clean between shots as usual and with the frequency demanded by the individual firearm. Clean the flintlock as you would the percussion rifle after the shooting session.

### The Pistol

Caplock and flintlock pistols are in reality short rifles as far as lock styles and loading methods are concerned. Use the same steps for pistols as you used for rifles.

### Loading the Blackpowder Revolver

The blackpowder caplock revolver requires its own loading procedure as follows.

**Step 1: Ensure an oil-free firearm.** Wipe away preserving chemicals. Clear oil and any foreign matter from each nipple channel with a pipe cleaner.

**Step 2: Fire the caps.** Pop one or two caps on each nipple to dry up moisture and lubricant. Point the muzzle in a safe direction at all times. After firing the caps, run a pipe cleaner into each nipple to pick up any cap debris or cap fouling that the caps may have deposited.
**Step 3: Charge the cylinder chambers.** For safety, carry the black-powder revolver with the hammer over an empty chamber. You can load all six chambers on the 1858 Remington revolver. Most, but not all, of the original 1858s had safety notches between the chambers of the cylinder. Modern replica Remingtons have this feature. The hammer nose falls into these notches so that no chamber aligns with the bore, nor is the hammer able to strike a percussion cap. You may use a flask to meter out a measured powder charge. An adjustable powder measure will also serve; so will a nonadjustable measure precalibrated for a specific powder charge. Prevent air space between the powder and the projectile. Ram the ball all the way down on the powder charge. Or use a filler, such as cornmeal, in between powder and ball to take up the space not occupied by the powder.

**Step 4: Place the ball or conical on top of each charge.**

After charging the chambers of the cylinder, ram a round ball or conical home on top of each charge. Don’t place lube on these projectiles or use a cloth patch. However, you can insert a cardboard wad (disc), greased felt wad, or plastic wad on top of the powder charge before seating the bullet. This will place a buffer between the powder and the bullet. Such a buffer prevents *chainfiring*, where all of the chambers go off simultaneously, an undesirable occurrence. If you use wads, no over-the-ball grease is necessary. In an unchamfered chamber mouth, a tiny ring of lead will slice away from the perimeter of the round ball. This is normal. A chamfered chamber mouth with beveled edge prevents this, but target shooters disagree concerning any accuracy advantage of the chamfered chamber mouth.
**Step 5:** Apply over-ball grease. A dab of grease over the top of the ball or conical is necessary if you don’t use between-powder-and-ball wads. The grease prevents the chainfire effect mentioned previously. Also, grease over the ball provides important lubrication and aids in keeping fouling soft. An ungreased blackpowder revolver can lock up from fouling. A modern commercial cream or grease works well in cutting blackpowder fouling (Figure 23).

![FIGURE 23—Use proper wads in the blackpowder shotgun. Shown are an over-powder wad (dark) and an over-shot wad (white).](image)

**Step 6:** Install the cap and fire. Use a capper to install a percussion cap on each nipple of the revolver for each loaded chamber. The Cash Manufacturing Company capper is made especially for the blackpowder revolver. The shape of this capper’s nose allows for easy placement of caps on the nipples of the gun. The revolver is now ready to shoot.

### The Caplock Shotgun

Fowling pieces, or flintlock shotguns, are rare, but a joy to shoot. Use the following procedures for a fowler (flintlock shotgun). However, remember to follow the flintlock procedures for blocking the touchhole, aligning the flint and the frizzen, and partially filling the pan.

Loading the blackpowder caplock shotgun demands special rules as follows.

**Step 1:** Clear the gun of oil, grease, or residue. You can’t count on an oily shotgun. Wipe the bores out with cleaning patches and clear the nipple vents with pipe cleaners.
**Step 2: Pop the caps.** As with other percussion guns, popping the caps helps to clear the nipples. The hollow thump indicates a clear channel from the nipple vent all the way to the muzzle of the shotgun, while the sharp crack suggests blockage. Point the muzzle at a light object while popping caps to see if the blast from the cap will move the object.

**Step 3: Charge. Use only volumetric loads. Do not weigh shot or powder.** A volume-for-volume shot/powder load is acceptable. You may reduce the powder charge, which sometimes gives better shot distribution (improved pattern). Pour the correct charge of powder downbore at this juncture and go to the next step.

**Step 4: Insert the over-powder wad.** A wad is run downbore on top of the powder charge. This wad, which can be a simple card wad, serves to keep the powder confined and under pressure. The cardboard wad can also aid in the prevention of cushion fiber burnout. It acts as a buffer, just as hornet-nesting material creates a buffer zone between the powder and patched ball in the rifle. While running this over-powder wad downbore, leave the hammer eared back on half-cock. In this way, air is more easily expelled from the nipple. Air sometimes becomes trapped between the card wad and the nipple vent. But as the card wad is seated, that air pushes through the powder charge and out of the nipple cone.

An over-powder wad isn’t necessary if you use a modern one-piece plastic wad. But some shooters prefer the over-powder wad to the one-piece plastic wad because it maintains pressure on the blackpowder charge. Blackpowder is supposed to burn more uniformly when confined under a little pressure.

**Step 5: Insert the wad column.** You now ram a cushion fiber wad down on top of the over-powder wad. Naturally, you wouldn’t use this wad if a one-piece plastic wad was installed in the bore(Figure 24).
Step 6: **Measure the shot charge.** You may use a proper and safe premeasured shot charge, or you may leave the powder measure on the setting that you employed and the same VOLUME of shot measured out (Figure 25). In this method, the powder measure is also the shot measure. Drop the shot downbore now on top of the over-powder wad, or into the seated one-piece plastic wad (Figure 26).

Step 7: **Insert the over-shot wad.** A cardboard over-shot wad holds the shot in place and also aids in keeping the load uniform in the bore. This wad fits tightly to the bore so that when you ram it home on top of the shot, it tends to remain there until fired away.

Step 8: **Cap and fire.** Cap the nipple, preferably with a capper. The gun is now ready to shoot.

*Warning:* After firing one barrel, check to see that the load in the other (unfired) barrel is intact. Be certain that the load remains seated downbore, and that it hasn’t crept forward from the recoil of the gun.
A shotgun’s load must be able to move upbore. The over-powder wad or any of the wads in the column must never bind in the bore to the extent of impeding the movement of the entire load column. If you used an overly tight wad system, the load may not be free to ride up the bore in front of the expanding gases of the detonated powder charge. This can cause increased pressure. Use only those wad sizes and styles intended for the specific blackpowder shotgun.

The Custom Load

A “pet” load for a blackpowder rifle, handgun, or shotgun should develop in time. You build a custom load through testing (Figure 27). However, it’s never acceptable to load beyond a manufacturer’s suggested maximum powder charge with a given projectile. You can safely juggle the elements of the load chain as long as you don’t use an appreciably heavier bullet than called for in the loading data without reducing the powder charge to account for the extra mass of that projectile (Figure 28).
FIGURE 27—This schematic reveals the working parts of a Ruger Old Army blackpowder cap ’ n’ ball revolver.
FIGURE 28—A metal powder flask is used to install a measured charge of powder into the cylinder chamber of a blackpowder revolver.
1. What blackpowder firearm type was left out of the “Loading Procedures” section?
__________________________________________________________________________

2. How do percussion caps work?
__________________________________________________________________________

3. Why would you run a pipe cleaner into the vent of the nipple after popping caps to clear the nipple on an empty firearm?
__________________________________________________________________________

4. What value is there in a noncorrosive percussion cap when blackpowder and Pyrodex are corrosive anyway?
__________________________________________________________________________

5. When wouldn’t you use hornet-nesting material as a buffer?
__________________________________________________________________________
__________________________________________________________________________

6. What is a safe way to compare percussion caps?
__________________________________________________________________________

7. What can happen when a projectile/charge load separates?
__________________________________________________________________________

8. What are two popular sizes of percussion caps used today?
__________________________________________________________________________

9. Why is it necessary to check the unfired barrel of a double-barreled shotgun after shooting one barrel only?
__________________________________________________________________________

Check your answers with those on page 105.
THE BLACKPOWDER BULLET

Bullet means any projectile that leaves the muzzle of a firearm. In blackpowder shooting there are round bullets and conical bullets. Ball has changed meaning over the years. Originally, the term ball translated into bullet. So, there were round balls or conical balls. Today, shooters often refer to balls as round and bullets as conical, which isn’t technically correct nomenclature. You should know the properties of each, because blackpowder shooters use both round and conical balls to this day.

Round ball or conical? That question has been around longer than the horseless carriage, singing wire, flying machine, or indoor privy. The question should be as irrelevant as last year’s lottery ticket. The five million modern shooters who have fanned the glowing embers of old-time blackpowder shooting into full flame won’t let the question die. There’s a place for both in modern muzzle-loading.

First, how good is the round ball? On paper, the round ball is only a shade better than a rock (Figure 29). Only a contrived disc would be ballistically inferior to it. The sphere sheds velocity like a cowboy’s yellow slicker sheds rain. It has a low sectional density and a poor ballistic coefficient. The ball loses velocity and energy rapidly. The new (larger) Oehler Skyscreens have allowed 100 yard direct velocity testing. Round balls at that distance from the muzzle shed about half of their original velocity, depending upon the caliber of the ball (individual mass of the projectile).

The conical retains much more of its original force, ballistically speaking. Compare three bullets: first, a .45 caliber round ball, with a .445 inch diameter, and 133 grains weight starting at 2025 feet per second (fps) muzzle velocity. It’s only chugging along at about 1100 fps at 100 yards from the muzzle. Second, consider a .45 caliber Minie conical of 220 grains weight starting at about 1750 fps at the muzzle. It has a retained velocity of 1100 fps at 100 yards.
1100 fps at 100 yards. Third, a modern 500 grain .45 caliber bullet starting at 2000 fps still does over 1750 fps at 100 yards even though it has a blunt round-nose shape. The round ball lost 46 percent of its velocity. The Minie ball conical lost 37 percent of its velocity, but the modern bullet lost only 13 percent of its velocity.

Although these figures are true, a well-placed round ball of reasonable caliber will drop big game in its tracks. The American mountain man truly “won the West” with a lead sphere. Consider the many nineteenth-century British hunters afoot in Africa, India, Ceylon, and other parts of the world during the era when “the sun never set on the British Empire.” They chose the lead globe for their big-game hunting—really big game, such as Cape buffalo, lion, and elephant.

The famous hunter/explorer, Sir Samuel Baker, wrote The Rifle and the Hound in Ceylon, a book on big-game hunting. He said, “With these elephants the four ounce rifle (rifle firing a projectile of four-ounce weight) is an invaluable weapon; even if the animal is not struck in the mortal spot, the force of the blow upon the head is so great that it will generally bring him upon his knees, or at least stop him. It has failed once or twice in this, but not often; and upon those occasions I had loaded with the conical ball. This, although it will penetrate much farther through a thick substance than a round ball, is not so effective in elephant-shooting as the latter.”

Those are the words of a man who hunted ivory as a business, who dropped more elephants in a season than most of us modern hunters bag deer in a lifetime. He had to know a little bit about the shooting of conical vs. round balls (Figure 30).

**FIGURE 30**—This is a close-up view of starting a patched round ball with a short starter using the stub or short end of the starter.
Of course, Baker was speaking only of huge calibers. He often used a 4 bore, for example. How big is a 4 bore? It only takes four round balls of 4 bore size to equal a pound of weight. Four to the pound, think about that. Your 30-06 firing a 150 grain bullet shoots “47 to the pound.” So Baker’s 4 gauge rifle fired a round ball that weighed about 1750 grains. Your blackpowder rifle isn’t going to throw a ball anything close to that size, but bore diameter remains vital to round ball efficiency in the big-game field, and for “ballistic carry-up.”

What about the blackpowder conical? A .570 inch round ball for the .58 caliber muzzleloader has a ballistic coefficient of about .085. The Lyman .58 caliber Minie, Mould No. 577611, has a ballistic coefficient a shade above .180-still poor compared with a modern missile, but a lot better than the same caliber round ball. A 7mm, 162 grain HPBT Hornady bullet has a BC (ballistic coefficient) of .560. Ballistically, the 7mm bullet compares to the 58 Minie like an atomic warhead to a steel BB. Ballistically, the 58 Minie is light-years ahead of its round brother. That means the conical retains a lot more of its original “power” downrange than the ball will retain of its starting force.

Knowing that, the conical is ballistically better than the ball, but the ball works curiously well on big game. Some points to consider about the round and conical balls in blackpowder shooting follow (Figure 31).
Accuracy

Forget trying to prove that the ball is more accurate than the conical or the conical more accurate than the ball in muzzleloaders. The most accurate blackpowder rifles ever were slug guns and they shot conicals. They gained accuracy as much from the design of the rifle as from the bullet they shot. The slug gun was a huge, bench rested longarm with a heavy barrel. It produced 200 yard groups smaller than most modern factory rifles make-excluding, of course, the bench rest-type rifles, such as the Sako 6mm PPC and similar arms. The average ball-shooting long rifle does as well as the conical-shooting long rifle in accuracy. A .54 caliber custom rifle was temporarily scope-mounted (as a test) with a 24X target scope. It created 1 inch center-to-center 100 yard groups with the round ball. There are modern conical shooters that will also do this. So, neither round nor conical gets the nod. Both missile types are potentially accurate.

Trajectory

The average parabola (trajectory curve) described by the ordinary ball-shooting rifle and ordinary conical-shooting muzzleloader is about the same for all practical purposes. The ball loses its initial velocity more rapidly than the conical, but the conical starts out considerably slower from the blackpowder rifle—so, it’s a tossup. Both types of projectiles have a practical trajectory limit of about 125 yards, although shooters do learn to hit with either at much greater distances. For example, there’s a regular gong shoot at one blackpowder club, which only allows the round ball. The distance to the gong is 500 yards and club members have learned to hit quite regularly at that range with their round-ball rifles.

However, a properly constructed ball-shooting big-game rifle fires its round projectile at 1900 to 2000 fps muzzle velocity (mv), while most Minie or Maxi ball-shooting rifles start out at about 1500 fps muzzle velocity. The elongated missile retains far more of its original speed than the ball, but neither round ball nor conical is a paragon of stretched-string trajectory patterns. If the shooter sights the round ball with a 2000 fps mv to strike the center of the bull’s-eye at 75 yards,
the ball drops about a half foot below the line of sight at 125 yards. If the shooter sights the conical with a 1500 fps mv to hit the bull’s-eye at 75 yards, the conical drops about six inches low at 125 yards. That’s why the practical field range for Minie and Maxi balls is 125 yards.

Penetration on Game

Which bullet penetrates the best? The conical wins; the ball loses. It’s that simple, almost. The same caliber conical generally penetrates more. However, the round ball has been known to penetrate the entire depth of a bull elk’s chest cavity, and the same lead sphere has totally passed through a deer or antelope. Therefore, while the conical penetrates more than the ball, this doesn’t mean that the round ball fails in this department. At short to modest range, the round ball, properly loaded, has good penetration qualities.

Conicals, Round Balls, and Rifle Twist

The Hawken rifle was pitched with a turn in 48 inches. The Hawken brothers used this spiral in their smallbores and in their bigbores. This led many modern shooters to think there was something magical about the 1:48 rate of twist—that it was proper for all calibers. If so, science is all wet and there’s no such thing as gravity; the moon is made of cheese, and a Volkswagen car will knock a Union Pacific diesel engine off the railroad track. There’s no way one rifling twist can serve all calibers. It’s scientifically impossible. As the caliber grows, the missile grows. As the projectile gets larger, it acquires more mass. As it acquires more mass, it requires fewer revolutions per second (rps) to stabilize it. These are the facts.

Hawken rifles had a turn in 48 inches for all calibers because the Hawken shop had a rifling machine so gauged and nobody bothered to change it. Many astute English gun makers knew better. The big round-ball rifles of Baker’s era had very little spiral in the bore. Baker, Forsyth, Major Shakespear, and the finest English gun makers of the day all studied and arrived at the same conclusion—the round ball requires very few rps to stabilize it. The conical requires many more.
For example, a .54 caliber ball-shooter handles charges of 40 grains FFFg to 120 grains FFg with accuracy. It has a twist of 1 : 79, a turn in 79 inches. On the other hand, another big .54 caliber rifle meant to shoot the conical projectile has a twist of one turn in 34 inches. Furthermore, the accurate Whitworth blackpowder target rifles of the nineteenth century have a twist of one turn in only 20 inches because they shoot a long .45 caliber projectile. Each projectile demands its own rps for stabilization, in other words. However, there is a range. That’s why a modern 30-06 with a 1 : 10 rate of twist will stabilize both 150 and 180 grain bullets. If that same 30-06 were built with a 1 : 30 rate of twist, its bullets would tumble. That slow rate of twist wouldn’t impart sufficient rps to stabilize those bullets.

Revolutions per second is a function of rate of twist (that is rate, having nothing to do with barrel length) and exit velocity. So, a rifle with a faster twist will shoot a ball with accuracy if you slow the ball down. And a rifle with a twist a bit too slow for a conical will improve in accuracy as the conical gains muzzle velocity, hence increasing its rps. When modern gun makers got into the business of building frontloaders, they turned to a few models from the past to learn about twist. Unfortunately, their studies didn’t go far enough. The 1 : 48, which is an excellent rate of twist, was considered correct for all calibers, which is impossible.

Today, there’s a new trend, the in-line muzzleloader, which we already discussed. The in-line muzzleloader offers to the shooting public a much faster rate of twist than was common over the past few decades. The in-line muzzleloader rifles use conical balls and they carry a rate of twist correct for conical. For example, the Thompson/Center Scout modern muzzleloader has a 1 : 20 rate of twist, a complete revolution of the bullet in 20 inches of travel (Figures 32 and 33). The Knight MK-85 modern muzzleloader has various rates of twist per caliber. One of its .50 caliber rifles carries a 1 : 28 rate of twist. The latter is designed for “modern blackpowder conical,” which are lead bullets that have both Maxi and Minie properties as well as modern nuances of design. The 1 : 28 twist .50 caliber rifle will also shoot modern jacketed pistol bullets by first placing the bullets in a sabot, a plastic cup of bore size. The Navy Arms Company replicas of the .45 caliber...
Whitworth and Volunteer target rifles, intended to shoot conical, have the 1 : 20 rate of twist. Modern gun makers now pay attention to proper rate of twist for the specific type of bullet.

**Final Choices**

You must make the final choice between round ball, Minie, Maxi, modern conical, or jacketed pistol bullet/sabot on the basis of which shoots best in a particular rifle (Figure 34). You also choose on the basis of which is dictated in part by the rate of twist of that firearm. While the round ball is ballistically inferior to the conical, in larger calibers it is effective for big game within proper blackpowder range. Those who select the round-ball rifle for big-game hunting should hold...
themselves to shorter shots. That’s good sportsmanship. With the exception of the rifled musket that may shoot a .45 caliber 550 grain bullet, the shooter should consider his or her muzzleloader’s maximum effective range as 100-125 yards, whether using the round ball or the conical.

**FIGURE 34**—Several projectiles used in muzzleloaders today include: plastic sabot, far left; round ball; plastic sabot with jacketed pistol bullet seated in the sabot; jacketed bullet; Buffalo Bullet Company modern conical; and Bor-Clear modern conical, far right.
Self-Check 4

1. What is a bullet?
__________________________________________________________________________

2. Which is more accurate in the muzzleloader, a round ball or a conical?
__________________________________________________________________________

3. How did the old-time hunter of big game increase the effectiveness of a round-ball gun?
__________________________________________________________________________

4. Why did both the round ball and conical receive the same effective hunting range?
__________________________________________________________________________

5. What is the function of rps?
__________________________________________________________________________

Check your answers with those on page 106.
MUZZLELOADER RIFLING

Rate of Twist

The previous section introduced rate of twist. We’ll now present additional information to strengthen that discussion. The whole idea of rifling was to impart rotation to a missile. By rotating the missile on its axis, we could achieve greater accuracy because the projectile was stable. Stabilizing projectiles requires revolutions per second (rps). There is a range for stabilization. In other words, a specific bullet will stabilize over a range of rps. A bullet rapidly loses forward velocity primarily due to air drag (gravity is a lesser force). Rotational velocity or rps doesn’t decrease easily. Therefore, if a bullet is properly stabilized near the muzzle, it will stabilize out to normal shooting distances. Naturally, rps will eventually fall off and the bullet will tumble, just as a top falls over when its rate of spin falls too low to keep it upright (Figure 35).

The round ball requires much less rps to keep it on track than the conical projectile. Also, as the ball grows in caliber, it becomes much heavier and needs even less rps. For example, a “pure” lead ball of .350 inch diameter weighs 65 grains. If we double the size of the ball to .700 inch diameter, the weight soars to 516 grains weight, or roughly eight times heavier. The smoothbore could shoot a round ball with fair accuracy with a properly cast ball and precise loading methods. When the round ball was rotated, accuracy improved greatly, partly because any imperfections within the lead sphere now averaged out as the ball spun on its axis. There’s no such thing as a perfect lead ball, so spinning the ball paid off in accuracy. The larger the ball gets, the more mass it has, and the more mass it has, the better it retains rps. So, as the ball grows larger, it takes less rps to stabilize it.

FIGURE 35—Rifling twist varies according to the shape of the projectile and its caliber. This is a view through the bore of a muzzle-loading rifle.
If rps is the key to bullet stabilization (round ball and conical), how do we achieve rps? By rifling, of course, as there’s spiraled rifling in the barrel so that the projectile turns. The more spiral, the faster the twist. We measure twist in “turns per inch,” which in a way is unfortunate because it gives the idea that the length of the barrel dictates rps. The length of the barrel doesn’t dictate rps. The rate of twist and the velocity of the bullet dictate rps. Using a modern example because of its familiarity, consider a 180 grain .30 caliber bullet fired from a 30-06 rifle. The velocity is 2700 feet per second at the muzzle; the barrel is 24 inches long. Suppose the barrel length was 30 inches, but the velocity of the bullet remained 2700 feet per second. Would the bullet have more rps if shot from a longer barrel? No, it wouldn’t. Just speculate that for some reason the bullet could travel at 2700 feet per second from a 12 inch barrel. Would rps fall off because the bullet was shot from a shorter barrel? No, barrel length is important because velocity can change with the length of the barrel, but the length of the barrel has nothing directly to do with rps.

A long streamlined bullet requires more rps to keep it stabilized than a shorter “fatter” bullet. Therefore, as agreed on earlier, the squat round ball doesn’t need very many rps to keep it on track, but a 500 grain .45 caliber bullet fired from a Whitworth muzzle-loading target rifle needs many more. A .45 caliber round ball will stabilize with a 1 : 60 rate of twist, only one turn in five feet of travel. However, a .45 caliber 500 grain bullet needs much more rps. Therefore, the Whitworth rifle has a 1 : 20 rate of twist, whereby the bullet turns one complete revolution in under two feet of travel (every 20 inches).

If you’re going to work on blackpowder guns, you must understand the basics of rifling twist. You may have to order a drop-in barrel for a customer who wishes to add a new barrel to his or her old muzzleloader. Or, you may be building a custom rifle, in which case you’ll have to order a barrel with the correct rate of twist. The correct rate of twist will depend upon the specific bullet to be stabilized. It’s a simple matter of telling the barrel maker that you want a barrel of .50 caliber to shoot the patched round ball. In this instance, a 1 : 66 rate of twist would be excellent. On the other hand, if the customer wishes to shoot a conical bullet in his or her .50 caliber barrel,
a rate of 1 : 30 would be more nearly ideal. Always remember that there's a range of rps and not just one rps. Because of this, a .50 caliber muzzleloader with a 1 : 70 rate of twist would also stabilize a conical ball, and a .50 caliber muzzleloader with a 1 : 28 rate of twist will also stabilize a round ball.

The Smoothbore

Rifling was a tremendous advancement. However, smoothbores dominated the early world of blackpowder shooting. Furthermore, when rifled arms became readily available, some shooters stayed with the smoothbore. William Cotton Oswell, one of the first professional ivory hunters in Africa, preferred his smoothbore for elephant hunting. It was easier to reload than a rifled arm because rifling held fouling more than a smoothbore barrel. It was also easier to clean for the same reason. Purdey made Oswell’s favorite smoothbore. It was 10 pounds, 10 gauge, and charged with “six drachms of fine powder” according to Baker, who borrowed the piece from Oswell for an African hunt. Incidentally, the term drachm was synonymous with dram, 27.34 grains weight, so the load was about 164 grains of powder. S. W. Baker said, “There could not have been a better form of muzzleloader than this No. 10 double-barrel smoothbore. It was very accurate at 50 yards . . .” (Big Game Shooting, 1902).

General George Washington often replaced rifled arms with muskets, believing the smoothbore a better tool for battle. The smoothbore musket was easier to keep in repair, simpler, and faster to reload for rapid fire. It also carried a fixed bayonet better than a rifle (Washington believed). The Brown Bess smoothbore musket remained Britain’s first choice of arms, too, for a very long time, firing a .753-inch ball (11 bore) with 70 grains of powder. General George Hanger reported that “a soldier’s musket, if not exceedingly ill-bored (as many of them are), will strike the figure of a man at 80 yards; it may even at 100. . .” He concluded that “firing at a man at 200 yards with a common musket, you may just as well fire at the moon” (American Rifleman, August 1947). Colleagues considered General Hanger, who served with Hessian Jaegers during the Revolution, the best shot in the
British Army. However, the dichotomy remained even with Hanger, who thought that smoothbores were inaccurate, but more easily managed than rifles; hence, more suited for warfare.

You may be thinking, why smoothbores now? The modern gunsmith should have a basic knowledge of smoothbore to add to his or her historical perspective, but also because the smoothbores remain in use in small numbers. Certain special blackpowder-only hunts demand the smoothbore. Such hunts don’t allow a rifled arm. Do hunters with smoothbore muzzleloaders have a prayer of cleanly dropping a deer, even at ranges of 50 or 60 yards? Even the longbow outshot the common musket back in 1792 in a match on Pacton Green, Cumberland. The range was “over 100 yards” and the bowman placed 16 arrows out of 20 on target (size not given). Meanwhile, the best musketeer only hit the target 12 for 20 tries. As Karl Foster (of rifled slug fame) said, “Round balls in smooth barrels have lacked accuracy since guns were first made” (*American Rifleman*, October 1936, p. 23). In Scotland, in 1803, soldiers practiced to meet Napoleon by firing their muskets. However, they were content when “. . . every fifth or sixth shot is made to take place in a target of three feet diameter at the distance of 100 yards” (*American Rifleman*, August 1947, p. 8).

The question to answer is this: What can a modern shooter do with a smoothbore blackpowder longarm? First, the power is there. In one test, a caplock blackpowder shotgun, 12 gauge with 28 inch barrels, was loaded with 80 grains of GOEX FFg for 927 fps average muzzle velocity, with a .695 inch patched ball averaging 502 grains weight. That is sufficient power for deer at close range. Using 100 grains of FFg blackpowder, a muzzle velocity of 1190 fps occurred for three quarters of a ton muzzle energy (1579 foot-pounds). The big round ball penetrated a couple feet of test media at 50 yards, greater penetration than provided by a 30-06 with handloads on the particular test media. The smoothbore does have power. However, can we make one to shoot with accuracy?

A sphere, in theory, is less sensitive to rotational stabilization than a conical ball, as described, but a “round bullet” should stay on track fairly well without spin. W. W. Greener said,
“Rifling, therefore, is of greater importance when a conical or elongated projectile is used than when the bullet is spherical” (The Gun). The principle of rotating an elongated missile for stabilization was a phenomenon tested hundreds of years ago. There are even relics of crossbow bolts grooved to create a spiral motion. The big ball has a lot of mass, and the greater the mass, the greater the inertia. The heavier the projectile, the less rotation on its axis necessary to stabilize it. For big-game hunting with the smoothbore muzzleloader, missiles of at least a half-inch diameter prevail. The .690 inch ball for the 12 gauge, for example, weighs 454 grains. Thompson/Center's (T/C) .56-caliber ball for their popular smoothbore caplock weighs 252 grains.

The sphere, if perfect, would theoretically fly true from a smoothbore. The first rule, then, in achieving better smoothbore accuracy with the patched round ball is to sort and separate the balls to obtain greater uniformity if the missiles aren’t already uniform in weight. The greatest variation in random sampling of 10 Thompson/Center (T/C) commercial round balls for their smoothbore longarm was only .9 grains weight. The heaviest in the string was 252.1 grains, the lightest 251.2. The micrometer gave an average diameter of .552 inches. If the T/C ball were pure lead, it would weigh 253 grains. Weighing proved that the T/C ball was precise, and of “pure lead,” not an alloy. Weighing proved uniformity, not homogeneity.

Deer hunting accuracy was still the goal. With careful loading and presorted missiles, the shooter could count on the sightless shotgun striking a six inch bull’s-eye at 40 paces. However, the Thompson/Center Renegade .56 caliber smoothbore with its adjustable rear sight did better. From a bench rest, T/C test-fired a total of 80 .550 inch cast 265 grain projectiles. The actual dimensions of these projectiles, incidentally, was .551-.552 average diameter with a weight of 252 grains. Loads were selected from the T/C manual, Shooting Thompson/Center Black Powder Guns. Three were given, all using T/C patch material, a No. 11 cap, and Maxi-Lube. Tests included three patch types and three lubes. The shooting patches were .005 inch, .010 inch, and .013 inch, the first two from Gunther Stifter’s West German supply house, the last pure Irish linen. The .010 inch patch proved
best of the three, but only because it loaded with comparative ease and still offered a tight bore fit. A patch isn’t a true gasket because no cloth patch by itself seals hot-expanding powder gas behind the ball. However, it’s still best to have a tight ball/patch fit to detain the ball on the powder charge and maintain a consistent load pressure. Pressure on the ramrod (an N & W steel loading rod) was maintained at 45 pounds using a special tool that spring-collapses when 45 pounds of pressure occurs.

Three lubes were used: grease, cream, and liquid-RIG, Young Country Lube 103, and Falkenberry Juice. All worked equally well in terms of accuracy. Initially, shooting from the 50 yard bench, the balls struck the black with a six inch center-to-center group. At first, it was decided that test-firing with open iron sights didn’t warrant 100 yard shooting. That would change. No accuracy difference was found among the three allowed powder charges, 80, 90, and 100 grains of FFg. One hundred grains of FFg was used for testing because it developed only about 6000 lead units of pressure (lup) pressure, which is mild, and recoil was manageable. Muzzle velocity averaged 1366 fps with the load in the Thompson/Center .56 caliber smoothbore. Muzzle energy of the load was a bit over a half ton, 1044 foot pounds, with a 252 grain projectile. At 50 yards, the Oehler chronograph showed a retained velocity of 1101 fps for the 56 caliber ball, with a retained energy of 678 foot pounds. This doesn’t sound like much, but it’s certainly ample for deer with a big round ball that produces an entrance hole over half an inch across.

The ball-shooting smoothbore proved amply accurate for deer hunting in woods and timber. At 50 yards, three inch center-to-center groups were common. At 100 yards, eight inch groups were made. However, the shooter could obtain such groups only with a careful loading regimen, which follows.

Rules for smoothbore accuracy:

1. Sort and weigh the round balls to ensure uniformity.

2. Maintain a consistent powder charge by overfilling the measure, tapping the barrel of the measure 10 times. Then, swipe off excess kernels of powder by swinging the funnel section of the measure into line with the barrel.
3. Place a buffer between the patched ball and the charge. The shooters used hornet-nesting material in the tests to prevent patch burnout. Moreover, the buffer between patch and charge serves to absorb excess lube, which might attack the powder charge.

4. Using a cleaning patch, wipe excess lube from the bore after you seat each load in the breech of the rifle. A greasy bore can cause change of impact at the target. A series of four shot groups was fired, first with a greasy bore, then a swabbed bore. The swabbed bore gave more consistent results. The final sight-in was accomplished with a lube-free bore, so you can maintain a point of impact by always wiping the bore free of excess lube after loading the rifle.

So, you can obtain woods and brush deer hunting accuracy using a smoothbore with precise spherical missiles, especially if the smoothbore has decent sights and you follow a precise loading regimen.

Blackpowder Ballistics

There are several ways to gauge the “power” a bullet delivers to the target, including momentum figures and relatives of momentum. However, only one method of computation is standard, and that’s the derivation of Newton’s formula: \( F = ma \), which became the formula for kinetic energy: \( KE = \frac{1}{2} mv^2 \). Every ammunition factory in the world uses it. Lovers of big and sometimes slow bullets say that the formula robs the heavy projectile of its deserved place in power ranking because velocity is squared in the formula, but bullet mass isn’t. Kinetic energy is the only way to talk about bullet power. The results are expressed in foot-pounds of energy. Following is a brief look at blackpowder power.

One of the best means of gaining a mental picture of ballistic force is by comparison. Most shooters know the power of a 22 Long Rifle rimfire cartridge, a 22 Winchester Magnum Rimfire, a 308 Winchester, and a 30-06 Springfield big-game cartridge in the field. Following are the four rounds with their energy figures for ready reference. Examples of blackpowder rifles include smallbore, “medium” bore with ball, big-bore round ball, big-bore conical, and big-bore jacketed bullet/sabot.
**Smallbore Mowrey Squirrel Rifle, 29 inch barrel**
- .32 caliber
- 45 grain round ball
- 30 grains by volume, FFFg GOEX blackpowder
- 1878 feet-per-second muzzle velocity
- 376 foot-pounds muzzle energy

*Comparison:* 22 Long Rifle, 40 grain bullet at 1250 feet-per-second muzzle velocity: 139 foot-pounds energy

**Smallbore Hatfield Squirrel Rifle, 39.5 inch barrel**
- .36 caliber
- 35 grain round ball
- 40 grains by volume, FFFg GOEX blackpowder
- 2023 feet-per-second muzzle velocity
- 591 foot-pounds muzzle energy

*Comparison:* 22 Winchester Magnum Rimfire, 40 grain bullet at 1900 feet-per-second muzzle velocity: 321 foot-pounds energy

**Medium Bore CVA Kentucky Rifle, 33.5 inch barrel**
- .45 caliber
- 75 grains by volume, FFg GOEX blackpowder
- 1856 feet-per-second muzzle velocity
- 979 foot-pounds muzzle energy

*Comparison:* 308 Winchester, 150 grain bullet at 2800 feet-per-second muzzle velocity: 2612 foot-pounds energy

**Big Bore Tryon Trailblazer, 32 inch barrel**
- .54 caliber
- 225 grain round ball
- 120 grains by volume, FFg GOEX blackpowder
- 1815 feet-per-second muzzle velocity: 1646 foot-pounds muzzle energy

*Comparison:* 30-06 Springfield, 180 grain bullet at 2700 feet-per-second muzzle velocity: 2914 foot-pounds energy
**Big Bore Knight Modern Muzzle-loading Rifle MK-85, 24 inch barrel**

- .54 caliber
- 460 grain Buffalo Bullet conical
- 110 grains by volume, Pyrodex RS
- 1433 feet-per-second muzzle velocity
- 2098 foot-pounds muzzle energy

*Comparison:* 30-06 Springfield, 180 grain bullet at 2700 feet-per-second muzzle velocity: 2914 foot-pounds energy

**Big Bore Knight Modern Muzzle-loading Rifle MK-85, 24 inch barrel**

- .54 caliber
- 45 caliber Hornady pistol bullet/with sabot
- 120 grains by volume, Pyrodex RS
- 1682 feet-per-second muzzle velocity
- 1571 foot-pounds muzzle energy

*Comparison:* See the 30-06 Springfield and 308 Winchester previously listed.

The power in muzzleloaders comes from large calibers and heavy bullets, because high velocity, in the modern sense, is out of the question with blackpowder. The only way to make up for the lack of speed in the bullet is with bullet weight. For example, the old four bore elephant rifle shooting a pound round ball at around 1200 feet-per-second muzzle velocity was far more powerful at close range than most of our modern big-game cartridges. Naturally, the trajectory of that ball was poor and recoil was terrible. A four bore shooting a 1750 ball at 1200 feet-per-second produced a muzzle velocity of almost 5600 foot-pounds. The same rifle shooting the same round ball at 1400 feet-per-second would show a muzzle energy of over 7500 foot-pounds.
Self-Check 5

1. What two factors affect rps?

__________________________________________________________________________

2. Why is rate so important when we speak of twist?

__________________________________________________________________________

3. Why do we use the term range of twist?

__________________________________________________________________________

4. The round ball isn’t elongated, so what good does spinning it on its axis do?

__________________________________________________________________________

5. Why does the gunsmith have to know about rate of twist?

__________________________________________________________________________

6. What are two advantages of the smoothbore?

__________________________________________________________________________
__________________________________________________________________________

7. What value does current smoothbore knowledge have?

__________________________________________________________________________

8. What are four ways to improve smoothbore accuracy?

__________________________________________________________________________

Check your answers with those on page 106.
TROUBLESHOOTING

You should learn all of the basic parts of the muzzleloader thoroughly. Then, minor repair and troubleshooting will be less threatening. For example, if a hammer won’t remain in the cocked position, you may assume that the notch in the tumbler is worn smooth. To make such an assumption, knowledge of a tumbler and its notches is paramount. Use a diagram of the muzzleloader as a guide. Once you understand the components of the frontloader, replacing parts will be easy with the correct tools and the ability to use them.

Frizzen Repair

The frizzen can break or discontinue sparking. If cleaning the face of the frizzen with solvent doesn’t remedy the problem, you should replace it.

Installing a New Frizzen

The steps for installing a new frizzen are simple and direct. You won’t require any special tools. The steps are as follows.

1. Remove the lock from the firearm. This step ensures that you won’t scratch the firearm during the removal of the frizzen, as from a screwdriver slipping.

2. Remove the frizzen spring screw by simply screwing it out from the lockplate.

3. Remove the frizzen spring by lifting it away from the lockplate.

4. Remove the frizzen from the face of the lockplate.

5. Install an identical frizzen in its place by reversing the removal process just described.

Original frizzens were made from case-hardened iron. Modern ones are usually investment cast, and in the case of cheaper guns, may not be properly hardened. If a question of sparking comes up, find out whether it sparked and then quit or if it wouldn’t spark in the first place. If it never worked right, the frizzen probably needs to be case-hardened. Use the following directions to check for proper hardening.
1. Be sure to firmly clamp the flint in the hammer and that the flint’s front edge is parallel with the frizzen’s face. You should wrap the portion of the flint that’s inside the jaws in lead sheet (the best) or leather (more common).

2. Try turning the flint over so that its leading edge is higher or lower as the case may be.

3. Try to cut the frizzen’s face with a file (very lightly on a small surface). If the file will cut, reharden the frizzen.

Avoid cheap locks if you’re building or selling a shooter. They’re less expensive initially, but will cost more in the long run.

**Hardening the Frizzen**

A new frizzen should come properly hardened from the manufacturer. The process may include case hardening with case-hardening compound. The frizzen must be properly hardened so that it will yield a spark. A superhard frizzen, on the other hand, would resist the striking of the flint and thereby fail in making a spark. This is why a professionally built frizzen should include proper hardening in the first place. It’s up to you to inquire about the hardness of the frizzen you supply to your customer.

**Stuck Ball Removal**

One of the most hair-raising problems for any gunsmith is having a broken firearm brought in with a load in it. A stuck ball may constitute such a problem. Sometimes, the shooter forgets to put powder downbore. He or she then seats the ball firmly into the breech of the firearm. Since there’s no powder column, the ball squeezes into the breech section and may get stuck there. This is the less serious of the two stuck-ball situations, since the firearm isn’t loaded. However, treat all firearms with a stuck ball as loaded guns. It’s the only safe way to handle the problem.
You remove a stuck ball with a special screw. This is a tool that resembles a wood screw with the head cut off. The shank section of the screw is threaded so that it will fit into the end of a loading rod. Don’t use a wooden ramrod for this job—it may break. Use the metal loading rod with the screw attached. The plan is to center the screw in the bore, turn the rod until the screw becomes firmly imbedded in the lead ball, and then withdraw the stuck ball.

A device known as a **muzzle protector** is essential in centering the cleaning rod in the bore. This device is a conelike device that slides on the shaft of the cleaning/loading rod. You center the screw in the bore so that the screw makes solid contact with the middle of the ball instead of the edge of the ball between the projectile and the barrel walls. When the screw is off-center in this manner, it may damage the rifling. However, when you use the muzzle protector, it automatically forces the screw to go down the center of the bore.

Some loading rods have a knocker unit, which is a weighty piece of metal that slides on the loading rod. The knocker helps remove a stuck ball as you tap it against the handle of the loading rod a number of times, inching the stuck ball towards the muzzle. If these procedures don’t work to withdraw the stuck ball, you may have to debreech the firearm.

### Removing the Breech Plug

The breech plug does just that—it plugs up the end of the breech. There are various types, but essentially they all serve the same purpose—to screw into the open end (opposite the muzzle end) of the barrel to form a breech section. You remove the breech plug by first detaching the barrel from the stock. Firmly place the barrel in a padded vice to hold it. Then, you use a wrench (sized to fit the breech plug) to turn (unscrew) the breech plug from its seat in the barrel. Obviously, the wrench must fit the breech plug correctly. B-Square offers a special wrench for this job. There’s a special wrench designed for the Thompson/Center muzzleloader. This wrench correctly fits the T/C breech plug so that no damage occurs when the gunsmith removes the plug from the barrel.
Now, you can hammer out the stuck ball from the breech end by inserting a long, stiff metal rod down the muzzle. Then, carefully tap the stuck ball until it emerges from the open breech end of the barrel.

**Shooting a Ball Free**

It may be possible to remove the cleanout screw and install a modest quantity of fresh FFFg blackpowder into the breech, in which case it’s safe to shoot the stuck ball free. Also, you could remove the nipple and trickle a small amount of powder into the breech through the nipple seat. *Be certain to replace the cleanout screw before attempting to shoot the ball free.* Ask the owner of the firearm if he or she lost any implements, such as a screw, in trying to pull the stuck ball free. If so, you’ll have to debreech the firearm. There could be a broken screw or other tool stuck in the bore, in which case shooting the ball free may score the bore and ruin the rifling.

Oftentimes, shooting a ball is a problem when there’s already a load in the firearm because the shooter has already tried this at the range without success. In other words, the gun was loaded but wouldn’t go off. Then, the shooter tried to remove the ball but failed to do so. So, the shooter brought the firearm to someone who can rectify the situation. Therefore, if a small quantity of powder installed through the nipple seat or cleanout screw doesn’t work to shoot the ball free, you’ll have to try the other methods described.

**The Kit**

One good way to learn about all the parts and inner workings of a muzzleloader is to make one. An aspiring blackpowder gun maker would do well to begin with a kit. Just about every major muzzleloader manufacturer offers kits for sale. CVA has a handsome Pocket Remington revolver in kit form, and also a Wells Fargo Colt revolver kit. Thompson/Center company offers several kits, including various Hawkens, Renegades, and New Englanders (Figure 36). Kits contain all necessary parts to assemble a fine finished product. T/C kits, for example, offer all metal parts completely finished.
These kits contain a barrel already blued, color case-hardened locks and lockplates, and semi-inleted stocks. They do require final fitting and sanding. You have to finish the stock and stain and finish the ramrod. Other kits come to the buyer in various degrees of completeness. Some kits offer metalwork “in the white,” along with instructions for browning the steel. There may also be additional inletting to accomplish (Figure 37).

**FIGURE 36**—The Thompson/Center Renegade is a version of a nonreplica Hawken-style rifle. This style of muzzleloader remains the most popular today, but the in-line muzzleloader is also gaining in popularity.

**FIGURE 37**—Shown is a CVA St. Louis Hawken rifle kit, 50 caliber, pre-assembled except for fittings.
Embellishment

Embellishment of the muzzleloader stock is similar to embellishment of the modern stock using inlays, carving, and (rarely) checkering to dress the wood. You accomplish checkering, when used at all, precisely as described in *Customizing Gun Stocks*. Install inlays as described in the same unit. Wire inlay, however, is mainly from the “old school” and you’ll seldom find it on modern muzzle-loading stocks.

*Warning:* Wire inlay is for advanced gunsmiths only.

Wire inlay includes the careful scribing of lines with pencil to determine where to imbed the wire in the stock. Although wire inlay is the name of this embellishment, you use a thin metal for the process. The ribbon may be of gold or silver. Using the penciled lines as guides, you cut a trough that will accept the wire ribbon. Generally, you do the cutting with a special cutting tool, sometimes a reworked hacksaw blade. The idea is to make a trench in the wood that’s wider at the bottom than at the top. When you insert the metal ribbon and pound it into place, it widens out in the lower portion of the trough, and remains there forever. You place the ribbon into the trough, then, and carefully force it into place by judicious work with a hammer. The end result is a permanent wirelike inlay.
1. What can make a frizzen unworkable?

__________________________________________________________________________

2. What implement or tool can you use to remove a stuck ball?

__________________________________________________________________________

3. What is the purpose of the breech plug?

__________________________________________________________________________

4. A customer brings you a loaded firearm with a stuck ball. Can you shoot the ball free? How?

__________________________________________________________________________

5. What other implement could stick downbore aside from the stuck ball?

__________________________________________________________________________

Check your answers with those on page 107.
BLACKPOWDER SAFETY RULES AND MYTHS

Safety Rules

The following are some safety guidelines to follow when loading and firing blackpowder arms.

Don’t short-start a load. This means not to install the projectile only partway down the bore. Be certain to seat the projectile firmly on the powder charge. Short-starting may cause a lump (walnut) in the barrel or may even cause barrel failure (rupture).

Don’t use multiple projectiles. Regardless of what you may have read, using two patched balls downbore instead of one is a poor practice. It can result in deteriorated accuracy and a possible barrel failure or blowing a nipple out of its seat. Load only one patched round ball or any other type of bullet in the barrels of rifles and handguns.

Be careful firing. Point the muzzle away from yourself, other people, and anything else other than clear sky or a safe backstop when loading the smokepole.

Don’t overload. Just as with smokeless powder, never overload a muzzleloader either. Follow only the loads prescribed by the gun maker. If no loading data comes with your firearm, see your dealer or write the manufacturer. It’s possible to overload blackpowder. High and dangerous pressures can result.

Don’t proof-test your gun. You may read of shooters proofing their blackpowder firearms with heavy overloads to ensure that the gun is strongly built. This is a bad practice. While the gun may hold up to severe overloads, it could later rupture from the previous abuse. Gas cutting and strain may not show immediately, but could show up later. Forget proofing.
Use the correct blackpowder shotgun wads. Be certain to use the right wad column. A wad column that gets stuck in the barrel can raise pressures. Be certain that the load in the unfired barrel hasn’t shifted upbore, causing a short-started effect (load shift). Use only proper wads made for your muzzleloader, not pieces of rag or other materials.

Always use a patch. The patch is not a true gasket. It does not seal the bore. There’s no cloth patch that you could count on to stop hot burning gas. However, always use a patch. The patch serves several vital functions. Don’t load a bare ball. Always patch the ball.

Following are the purposes of the cloth patch.

- It takes up windage in the bore to ensure that the ball stays down on the powder charge and to translate rotation from rifling to ball.
- It keeps pressure on the powder charge for better consumption of the propellant.
- It provides uniform pressure on the powder charge to ensure a better-regulated burning rate.
- It prevents bore leading. This is a minor point, but the patch does, after all, come between bore and lead.
- It holds lubrication. Lubrication is important in blackpowder shooting, not only for ease of loading, but because lube helps to keep fouling soft.

Keep your gun clean. A dirty gun may be an unsafe gun. Heavy fouling in the bore can raise pressures. Use the hot water cleaning method, or if your area is of low humidity, the bristle brush and modern solvent method will serve to keep the bore clean.

Handle blackpowder carefully. Don’t smoke near any powder. Store powder in a dry area away from a source of heat. Don’t store it in glass containers; use the original container only. Keep blackpowder away from children.

Use the proper granulation. Don’t switch granulation at will. Finer granulations generally develop more pressure than coarser granulations.
Use a capper. A capper is a good way to store and carry percussion caps for safety. A capper also keeps the percussion cap away from fingers during the capping process.

**Keep your firearm in good condition.** Fix, or have repaired, any and all broken parts. Don’t shoot a firearm that’s in less-than-perfect working order.

Follow all shooting rules. You must treat the muzzleloader exactly like any other firearm. Follow all NRA safety rules at all times.

**Don’t use smokeless powder in a muzzleloader.** Use only blackpowder or Pyrodex.

## Blackpowder Myths

Blackpowder shooting was born before science was a science. Therefore, the game has a great many shooter’s myths or “old wives’ tales.” Here are some that you might find repeated to this day.

1. A properly patched ball load leaves the patch with a cross on it. **False.** A perfectly loaded round ball patch seldom carries the mythical cross.

2. Shoot over snow to get a good load. The idea is to add powder to the load a little at a time while shooting over clean snow. When you see unburned kernels of powder on the snow, you’ll know when to stop adding powder. **False.** Blackpowder may leave over 50 percent of itself behind as solids. Also, an undersized ball may allow gas blow-by and unburned powder particles. Also, how would you know you’ve reached a perfect load if you never shoot over snow?

3. Blackpowder just blows away if you load too much downbore. **Not necessarily.** Blackpowder can generate 100,000 pounds per square inch (psi) pressure.

4. Cover the ball with powder for your best load. **False.** The idea here is to put a ball in your hand and cover it with powder and you’ll have a good charge for that ball. Never. This is haphazard to begin with and no two people would come up with the same charge.
5. The blackpowder charge doesn’t have to be exact. 

**True and false.** It’s true in that no rifle can tell the difference in a half-grain weight (7000 grains weight/pound) of blackpowder because it’s not that efficient as a propellant. It’s false in that you should use only approved loads. A law of diminishing returns regarding blackpowder states that at some point, more powder increases recoil, smoke, noise, and maybe pressure, but not velocity.

6. Light loads are always more accurate than heavy ones. **False.** The right load is the most accurate in a given muzzleloader. In the blackpowder revolver, lighter loads have shown greater accuracy, but you can’t take the statement at face value all the same.

7. The patch is a gasket. False. Edward Yard, in *Gun Digest* (1980) showed in his tests that patches aren’t gaskets. They don’t seal gas in the bore(Figure 38).

**FIGURE 38—Patches aren’t gaskets in the bore.** They may leak gas. The patch on the left shows burn-through along the groove of the rifling. The patch on the right is more intact, with only one small spot burned through. Hornet-nesting material prevents patch burnout.
8. Blackpowder is all alike. **False.** Blackpowder differs greatly by brand, by granulation, and even a little by “lot,” or the specific run of the powder. Blackpowder also differs over time. The formula has stayed fairly much the same for blackpowder, but at various times, different methods of manufacture resulted in a different product. So, blackpowders aren’t all alike by any means.

9. Use a powder scale for precise blackpowder loads. **False.** Do not use a powder scale. Use a powder quantity measure only. It’s best to load blackpowder by volume, not weight. The same applies for Pyrodex. Follow all loads carefully.

10. Only tight patches give accuracy. **Not necessarily.** Accuracy in the round-ball rifle seems to depend more on ball fit than patch fit. Greatly undersized round balls don’t usually deliver best accuracy no matter how tightly the patch makes the ball fit the bore.
Self-Check 7

1. What happens to accuracy when a shooter uses double round balls in the barrel?
__________________________________________________________________________

2. Why not proof-test a muzzleloader?
__________________________________________________________________________

3. In regard to safety, why must the wad column in the shotgun fit properly?
__________________________________________________________________________

4. What does a capper have to do with safety?
__________________________________________________________________________

5. What powder can you use safely in the muzzleloader?
__________________________________________________________________________

6. What does a proper pattern look like on a fired patch?
__________________________________________________________________________

7. Will shooting over snow work to find a good load?
__________________________________________________________________________

8. Why won’t covering a round ball with powder in one’s hand produce a good load?
__________________________________________________________________________

9. What is the most accurate powder charge for a muzzleloader?
__________________________________________________________________________

10. Why not use a powder scale for precision blackpowder loading?
__________________________________________________________________________

Check your answers with those on page 108.
MUZZLELOADER ACCOUTREMENTS

The muzzle-loading rifle, shotgun, or sidearm may be the most important ingredients to successful blackpowder shooting, but a “sootburner” is nothing without its accessories, also called *accoutrements*. We can’t load, clean, or work on the blackpowder firearm without the right tools. The little things in muzzleloading can make or break the game. Here we’ll discuss some of the major accoutrements and what we use them for. They cost little, but they work big. Most are compact and easy to store and carry.

**The Shooting Bag**

Possibles bag is the term for a shooting bag that has caught on with modern shooters. It’s not quite right. The possibles bag was a catchall sack that might contain extra balls and powder, a few tools, additional tubes (a word used for nipples in the early days), another knife or two, flint ‘n’ steel, and a host of hardware to use mainly on the back trail. The shooting bag or pouch was entirely another affair, and still of utmost importance to the modern muzzle-loading enthusiast. Although many shooters have a shooting box to hold gear from extra cans of powder to screwdrivers, the shooting bag is essential in the field and on the range.

Shooting bags go so far back in time no one can date their beginning. Kauffman says, in *The Pennsylvania-Kentucky Rifle*, “Because hunting bags were used in Europe prior to the English and German settlements of Pennsylvania, it must be presumed that they were used here in the earliest times.” All historical data shows that hunting or shooting bags were used from the beginning of pioneer settlement in Early America. They were often simple, no more than a leather “purse” with one or two compartments inside and a flap to keep rain and dirt out. The bag held flints, touchhole pick, bullet mould, linen for patches, a priming horn, and later on, percussion caps. Some of the bags had a knife scabbard attached to the shoulder strap as well.

It’s easy to see that the shooting pouch was of utmost importance to early rifle shooters; however, these bags are also necessary for today’s blackpowder shooting (Figure 39).
Shooting pouch and hunting bag are two names for the same thing. You slip the bag’s strap over your shoulder. A powder horn may rest atop the bag via its shoulder strap. The shooting pouch is an essential blackpowder kit. It’s wise to have one bag for each rifle. You keep every item essential to shooting that one particular rifle in that single bag. In this manner, there’s never a chance of reaching the field or the range lacking a percussion cap, a nipple wrench, powder, balls, or patches—or any other piece of hardware essential to firing that one rifle. As for a pistol or revolver, you can keep a separate bag, or you can include the items of necessity for the sidearm in the rifle bag.

**FIGURE 39**—Shown is a shooting bag, widely called a “possibles bag” these days, with some of its contents on display, including a small powder flask, eyedrop container filled with solvent, nipple wrench, cap box filled with percussion caps, ball bag with round balls, an in-line capper, screw, worm, jag, bristle brush, patches, cleaning cloth, and readyload in lower right-hand corner.
In the old days, the shooting pouch was individualized. Each shooter had someone make a bag to his or her own specifications. Today, the same is true, with the exception that there are excellent shooting bags available commercially. Makers of the bags often added embellishments-leather carvings, leather lacing, personal “brands,” dyed porcupine quillwork, beadwork, silver ornaments, and so forth. But most were quite simple and unadorned. Ned Roberts, in his book *The Muzzle-Loading Cap Lock Rifle*, shows many original hunting pouches. All of them were of leather, all had powder horns accompanying them, some had attached hunting knives and some didn’t, all were very plain, without hint of adornment. Naturally, these old bags are now highly prized as collector’s items.

Roberts points out that while the vast majority of bags were made of tanned leather, there were also hunting pouches put together from tanned fox or raccoon pelts. Often, these were made so that the upper end of the tanned hide served as a flap, sometimes held down with a wooden button. Anyone with the least bit of do-it-yourself ability can make his or her own hunting pouch. Materials are readily available. Embellishment is also simple. Many of Sid Bell’s Originals are now available with lug heads. The little metal figure is attached to the bag permanently by pushing the lug head through an appropriately small hole in the leather flap of the bag, and then flattening the stud on the other side.

Blackpowder shooting is essentially hand-loading. The shooter puts home each round individually. That’s why the shooting bag is so vital to the sport. The shooter uses so many components, small tools and gun parts at the shooting range or in the field. To have these stuffed in a coat pocket makes them inaccessible at best, even if the shooter could find them. The shooting bag serves to keep all of those can’t-do-without-it items handy for use. The contents of each shooter’s pouch is individual to the firearm. A flintlock rifle shooting pouch has extra flints, a touchhole pick, and tools for flintlocks. The shooting pouch for a percussion rifle is outfitted, of course, for that type of muzzleloader. What does a typical shooting kit contain? Following is a list of the contents of a hunting/shooting pouch for a .54 caliber ball-shooting percussion muzzleloader.
1. Ball bag with 20 .535-inch round balls

2. Small metal powder flask with FFg blackpowder, in case the shooter forgets the powder horn

3. A short-starter

4. An adjustable Uncle Mike's powder measure

5. Tedd Cash capbox with about 100 No. 11 percussion caps

6. Two Butler Creek readyloads, which the shooter switches to a shirt pocket when hunting (for a fast second shot)

7. Fifty prelubed Irish-linen shooting patches

8. Fifty cleaning patches

9. Small gun rag (silicone-impregnated) for wipe-down of metal

10. Small container of solvent/patch lube (plastic eyewash bottle)

11. Two extra 54 jags and a bristle brush

12. A screw for pulling stuck balls (these fit ramrod tip)

13. Pipe cleaners

14. Extra nipple and nipple wrench

15. A worm for removing stuck patch

16. Straight-line capper

A shooter new to muzzle-loading may not see the value in a hunting bag. However, he or she may learn the hard way that keeping track of the few but vital accoutrements is a job for a shooting pouch. The shooting bag isn't a kit for carrying a lot of extras. A possibles bag is for that. The shooting pouch allows a muzzle-loading rifle shooter to grab his or her firearm along with the appropriate leather pouch without hesitation, knowing that at the range every necessary item of shooting and cleaning will be found in that one container. The original concept of the shooting pouch hasn't yet been bettered by technology. The bag worked well a few hundred years ago. It works just as well today.
Blackpowder Accoutrements

The Powder Horn

The powder horn is a romantic accoutrement, but also one of the best blackpowder storage and dispenser containers ever devised. Despite its ancient origin, the horn has many superior attributes. With a tight stopper, it can be waterproof. It’s rugged and won’t break easily; therefore, it’s good for carrying blackpowder into the hunting field or onto the range. Should a spark or ash hit the stoppered powder horn, the cargo inside won’t go boom! The horn itself is nonsparking. The shooter can have the horns shaped to suit the shooter’s desire, too. So, the powder horn of old is a lot more than a decorative item. It’s a hard-working, powder-carrying device that has few equals.

Priming Horn

This is a miniature powder horn with, generally, a spring-loaded spout protruding from its end. The shooter presses spout down on the hard surface of the flintlock pan, thus depressing the spring and allowing a trickle of FFFFg powder to flow. The priming horn dispenses just the right amount of powder right where you want it, toward the outside of the pan.

Priming Tool

The priming tool serves the same purpose as the priming horn, which is containing and dispensing FFFFg pan powder. However, it’s not a priming horn; it’s more like a small metal flask.

The Powder Measure

The powder measure may be fixed or adjustable (Figure 40). Fixed powder measures need be no more than metal tubes, or for that matter, tubes of any nonsparking material. Once the shooter decides on the proper volume, he or she cuts the tube to length. The shooter pours powder from a horn into
the tube and he or she has a volumetric load ready to go. The adjustable powder horn may have a swing-away funnel. It’s adjusted with a sliding rod that changes the volume (capacity) of the measure. It’s marked in degrees by grains. Of course, it works by volume, not grains weight, since it’s not a scale.

Generally speaking, most powder measures are calibrated for FFg granulation, and can be used for all blackpowder loads and Pyrodex by volume. We recommend the measure, fixed or adjustable, with or without funnel, because it’s not wise to pour powder directly from a horn or can into the muzzle of a gun. The theory is that a lingering spark downbore may ignite the powder, and if so, it’s better to ignite a small tube of powder rather than a whole powder horn or can. Besides, such direct loading without a measure would produce haphazard loads. Never hurry in loading. Ensure that there’s no spark downbore. Always use a measure, however. You can’t create good loads with random powder charges. The measure affords a proper volume of powder for a correct and safe load.

The Flask

The flask is a powder container made of metal, hard leather, or even cloth, rather than horn, incorporating a metering device of one type or another. The shooter may carry a flask into the hunting field and leave the larger powder horn in camp. Even a small flask holds enough powder for several shots from a big game rifle or shotgun, and a number of shots from a small game rifle or sidearm. There are many kinds of flasks, even hard leather shot flasks. Some flasks
have interchangeable tubes or spouts of various lengths to alter the powder charge. A short spout is used for a light charge, a longer tube for a heavier charge. A flask is rugged and certain. And with multiple tubes or spouts, it’s also versatile.

The Readyload

A shooter can get by without a powder horn or flask by carrying a readyload (Figure 41). These are commercial or homemade devices used to contain premeasured powder charges, as well as appropriate shot charges or single projectiles. For shotgunning, readyloads may be no more than plastic 35mm film containers, some for powder, some for shot. The shooter premeasures and loads powder and shot into these small containers. In the field, the shooter pops the top of the container off and puts the contents down the muzzle of the shotgun barrel. Just about any nonsparking tube can be worked into a readyload. Commercial models include plastic tubes with partitions to separate powder from bullet. These even have slots to hold percussion caps.

The Ramrod

The original wooden ramrod is workable in the field. Synthetic ramrods are stronger, but nonhistorical. A true ramrod rests in the pipes (also called thimbles) of the gun, usually beneath the barrel, and that makes it handy. In the field, the shooter uses the rod for putting loads downbore or for cleaning purposes. A ramrod should have a threaded end that accepts various accessories, including worms, screws, and jags.

The Loading Rod (or Wiping Stick)

A loading rod is longer than a ramrod, easier to use, and more rugged. The shooter uses loading rods for loading and cleaning. They’re unbeatable on the target range and in the
hunting camp. The metal loading/cleaning rod is perfect for its dual jobs of seating projectiles, delivering brushes, cleaning patches, and other tools downbore. Those with muzzle protectors are especially good because the rod, often constructed of steel, can’t rub against the interior of the bore, since the muzzle protector centers the rod by virtue of its cone shape. Another (older) name for the loading/cleaning rod is “wiping stick” (Figures 42, 43, and 44).

**FIGURE 42**—Shown is an Uncle Mike’s steel loading rod. It will withstand loading and cleaning much longer than a wooden-type cleaning/loading rod.

**FIGURE 43**—This is a metal loading rod of the breakdown type, with a jag on the end of the upper unit as well as a sliding cone-shaped bore protector.

**FIGURE 44**—This is an N & W loading rod with knocker and muzzle protector.
The Short Starter

Accuracy calls for a patched ball that fits fairly closely to the bore. That means that pressure is required to seat the projectile. The long wooden ramrod may break, seating a tight ball (or even a conical) with it. Besides, the long loading rod is unwieldy for this operation. That’s where the short starter comes in. It generally has two rods: the stub rod and the starter rod. The stub is just that—very short. It fits over the nose of the projectile, and with pressure on the ball of the short starter, the missile pushes past the crown of the muzzle. However, this isn’t good enough because the ramrod or loading rod still won’t seat the ball easily from this position. So, the longer rod can push the projectile still farther into the barrel. Now the patched ball or conical is ready to be driven fully down upon the powder charge with either a ramrod or loading rod. A short starter is an essential tool.

Bullet Starters

A variation on the short starter, bullet starters can drive all manner of bullets downbore, including conicals of various styles. An example is the Buffalo Bullet Company Universal Bullet Starter. It’s tough synthetic material, and is especially useful for starting conicals and sabots. It protects the nose of the lead projectile from deforming. Although designed to seat conicals, the unit is excellent for round balls too.

The Combo Tool

Over the years there have been many combination tools offered to blackpowder shooters. One perfect example of the spirit of the combo tool is the “Ball Buster.” This one tool contains screwdrivers, three powder measures, a light-duty hammer, signal whistles, short starter, and more. The combination tool spirit lives in various other tools, including the October Country Adjustable Powder Measure with Funnel and Nipple Pick. This beautifully made tool has a threaded vent pick in the base of the sliding measure bar. Such a pick is perfect for clearing a fouled nipple or touchhole, and also serves to block the touchhole when loading the flintlock (Figure 45).
The Vent Pick

The vent pick, also called a nipple pick, is a simple bit of wire useful for clearing a clogged nipple vent or flintlock touch-hole. A shooter can also use it to block the flintlock's touch-hole prior to pouring the powder charge downbore. This ensures a clear touchhole for the passage of flame from the pan into the breech of the firearm.

The Nipple Wrench

If the nipple wrench fits perfectly, it will install or remove a percussion nipple without marring it in any way. This is an essential tool for the caplock (Figures 46 and 47).
FIGURE 46—The nipple wrench shown is in use on a Ruger Old Army “cap’ n’ ball” revolver.

FIGURE 47—Shown is a nipple wrench being used on a double-barrel blackpowder caplock gun.
The Pipe Cleaner

A pipe cleaner isn’t a muzzle-loading tool, of course. It’s a wire device with cloth wrapping meant to clean the smoking pipe. However, it serves many blackpowder shooting functions—blocking the touchhole, as mentioned earlier, and swabbing oil or other products from any part of the firearm.

The Capper

There are two basic kinds of cappers. One is the magazine model. It holds many caps, and gravity-feeds them one at a time for seating on the cone of the nipple. Cash Manufacturing Co. makes a magazine capper for the rifle and another type for the revolver, the latter with an appropriately long nose to reach into the recess of the cylinder. The other kind of capper is the in-line model. Caps are held, as the name implies, one after another, in a line. One cap at a time goes to the cone of the nipple. Cappers offer a handy way to carry percussion caps. They’re also a safety device, as already noted.

The Screw

As described earlier, a screw looks like a wood screw with a threaded shank. The threaded portion goes in the ramrod or loading rod tip. The screw removes a stuck ball by being screwed into the lead ball and then pulling out the ball—not always easily.

Jags

Jags are small metal devices, generally with an hourglass shape. They screw into the tip of the loading rod or ramrod to grip a cleaning patch. They usually have a concave nose so that they can be left in place to seat the round ball, as well as the conical projectile. It’s important to match the jag not only by caliber size, but also by style. A specific breech shape may require a special jag shape. Other jags may get stuck (seriously) downbore (Figure 48).

FIGURE 48-This is a close-up look at a cleaning jag fitted to the end of a metal loading rod. The jag has a concave nose so that it can also seat a round-ball projectile..
**The Worm**

The worm is also a threaded device that fits the end of a ramrod or wiping stick. But instead of a screw, it has tiny protruding wires that can withdraw a patch that may be stuck in the bore. It’s not made to pull a stuck ball.

**Ball Bag**

Some ball bags are made from the tanned scrotum of a buffalo or other large bovine. A ball bag made from the scrotum of the bison, elk, or other large quadruped is made by first skinning the area, which leaves a pouch. The pouch is tanned, then fitted with a drawstring of leather lacing. Lacing can be purchased at any leather shop. An awl can be used, or the point of a sharp knife, to make evenly spaced slits, about three-eighths inch to one-half inch apart and the lacing is threaded through these slits to provide a drawstring.

These bags can hold a number of round lead balls. There are many commercial models today and these are made of tanned leather.

**The Flash Cup**

This is a device for the caplock rifle. It’s a metal unit that fits on the nipple seat, which also holds it in place. It diverts flame away from the wood parts of the rifle, thereby saving the wood from being burned and marred (Figure 49).

*FIGURE 49—Shown are flash cups from Cash Mfg. Co. The flash cup fits at the base of the nipple and directs debris away from the shooter and the wood of the firearm.*
Cleaning Gear

Cleaning gear includes the wiping stick mentioned already, patches, solvents, and especially, well-fitted bore brushes. We recommend you use modern blackpowder solvent with a bristle brush instead of water as the cleaning liquid. A bristle brush used with solvent removes bore fouling from rifling grooves. In high-humidity areas, however, shooters often prefer the hot water method of cleaning. Their idea is to heat the interior of the bore so hot that any leftover liquid will evaporate. Cleaning gear includes everything from rags and toothbrushes to pipe cleaners.

So we conclude a brief look at some of the major blackpowder accessories. A complete list would fill a book. Blackpowder shooters, like trappers, are industrious souls with a lot of do-it-yourself ingenuity in their souls and plenty of imagination. They have come up with some of the most fanciful, outlandish, interesting as well as useful (and now and then useless) gear you ever saw in your life. Without this hardware and software, blackpowder shooting would be no more possible than keeping your car running without any tools.

Reading Resources

The following books contain additional information for blackpowder shooters:

Dillin, John G. *The Kentucky Rifle*. Shumway Press.


Self-Check 8

1. What do we call the bag used to carry extra shooting accoutrements?
__________________________________________________________________________

2. What is another name for a shooting bag?
__________________________________________________________________________

3. Why have a separate shooting bag for each firearm?
__________________________________________________________________________

4. Instead of a powder horn, what can you put into the shooting bag for carrying powder?
__________________________________________________________________________

5. What do we call the container used to carry extra caps?
__________________________________________________________________________

6. A powder horn has a special safety feature to protect its material. What is this safety feature?
__________________________________________________________________________

7. What are two devices used for carrying and dispensing FFFFg blackpowder into the flintlock pan?
__________________________________________________________________________

8. What accoutrement enables you to install a fast second shot into a muzzleloader?
__________________________________________________________________________

9. What does the muzzle protector do?
__________________________________________________________________________

10. What is the one thing that a nipple wrench must do for it to function properly and not damage the nipple?
__________________________________________________________________________

Check your answers with those on page 109.
**Self-Check 1**

1. Blackpowder is both an explosive and a propellant. It’s been used for years in blasting, but has also been employed to drive bullets from guns.

2. We call Pyrodex a replica blackpowder because its ingredients and formulation aren’t the same as blackpowder, yet it performs safely in blackpowder guns.

3. Pyrodex has a higher flash point than blackpowder, and this makes for possible ignition problems in the flintlock.

4. Granulation altered the burn rate of blackpowder for better control. Because of granulation, the four prominent shooting grades, Fg, FFg, FFFg, and FFFFFg offered a wide choice of application, with Fg the slowest-burning of the four, and FFFFFg the fastest-burning.

5. Pyrodex is less dense than blackpowder. You can think of it as being “lighter” for its kernel size. Therefore, a 100 volume of blackpowder may weigh 100 grains on the scale, but the same 100 volume setting of the powder measure will yield a much lighter charge of Pyrodex by weight.

6. Hygroscopic means that blackpowder “attracts” moisture.

7. One advantage is that the shooter can load blackpowder by bulk. Even in the field, a shooter could fill a cartridge case by hand, leaving room to seat a bullet in the cartridge case, and there would be no problem. Secondly, blackpowder was more economical than smokeless powder, as pointed out by E. N. Woodcock, the well-known trapper/hunter.

8. Weight for weight, Pyrodex is more powerful than blackpowder, but volume for volume, Pyrodex and blackpowder yield about equal pressures.

9. Dressing the bore is a means of establishing uniformity in the bore. Uniformity of the bore promotes consistency in muzzle velocity from shot to shot.

10. You should have five of the following advantages in your answer: No pouring, no measuring, faster loading, sharper ignition, less waste, increased safety, and less fouling.
Self-Check Answers

1. Originals, replicas, nonreplicas, rifled muskets, and modern muzzleloaders are all types of muzzleloaders used today.

2. Matchlock, wheel-lock, snaphaunce, flintlock, and percussion are all muzzleloader locks.

3. The first reason is safety. An original may look fine, but the metal could be fatigued. The second reason is value. Shooting an original could decrease its value.

4. It worked by virtue of a burning “rope” or wick that was attached to a hammer-like device. The wick made contact with ignition powder.

5. The general opinion holds that modern muzzleloaders caught on because shooters of smokeless-powder arms are familiar with them and the shooters feel comfortable with the muzzle-loaders of modern design.

6. A sabot is a bore-sized unit that contains a subbore-sized projectile. It’s usually made of plastic today.

7. The wheel-lock worked somewhat like a wind-up clock, with a spring-powered wheel of pyrites or flints creating sparks for ignition.

8. Modern muzzleloaders have a fast rate of twist because their manufacturers intend them to shoot conicals rather than round balls. The faster rate of twist imparts enough rps to stabilize the conical.

9. The wheel-lock was expensive to make and somewhat complicated, while the flintlock cost less to make and was simpler.

10. Although good flintlocks had reasonably sure ignition, a good caplock or percussion firearm had even more reliability.
Self-Check 3

1. Left out of the section was the blackpowder cartridge type. There are many of these, including the Sharps and Remington “buffalo” rifles, but also a great number of early single-shot and repeating rifles used blackpowder cartridges—the famous 44-40 Winchester is only one example.

2. Percussion caps work because of fulminates, which are percussion-sensitive chemicals that give off a flame when struck.

3. The pipe cleaner picks up bits of debris from the exploded cap, plus any excess fouling left by the cap.

4. To clear nipples and check for bore obstructions, you fire percussion caps prior to loading the firearm. A non-corrosive cap doesn’t deposit materials that could etch the metal of the firearm while the shooter carries it in the field.

5. Smallbores and light loads in large-bore firearms generally don’t require a hornet-nest buffer between the powder charge and the round ball patch.

6. Of course, shooting different caps to see if they make a difference in the ignition of a particular muzzleloader is useful for comparison, but so is a screw barrel pistol with the barrel removed. You can safely fire caps in a darkened safe area for visual inspection and comparison.

7. A walnut or lump in the barrel may occur, and in some cases gun barrels have been known to rupture from separated charges. However, so far there has been no proof given of the exact cause of these problems.

8. The No. 11 cap is the most popular size used today, with No. 10 being useful also. However, a second important size is the musket cap, also known as the top hat or English cap. It’s larger than either the No. 10 or 11 cap.
9. You should check the unfired barrel with a ramrod to ensure that the load remains downbore, because the firing of one barrel may cause the load in the other barrel to move forward. This generally doesn’t occur after only one firing, but can be a problem when one barrel is fired several times in a row without the other barrel being fired at all.

**Self-Check 4**

1. A bullet is any missile that’s fired from a gun. It may be round or conical, but it’s still a bullet.

2. For all practical purposes in muzzleloaders commonly used today, it’s a tossup. However, the most accurate muzzleloaders were bench guns that did shoot conicals. These slug guns were highly accurate.

3. Because high velocity was and still is out of the question with blackpowder, the only way to get more power was to increase bore size. As the ball grows in diameter, it gains in mass manyfold.

4. Although the conical retains its velocity and energy far better than the round ball, both round ball and conical from ordinary muzzleloaders have similar trajectories. Projectiles from either fall about a half foot low at 125 yards when the rifles are sighted dead on for 75 yards, depending on the caliber of the ball, of course.

5. Revolutions per second (rps) of the projectiles brings about stabilization of the projectile as it spins on its axis. The projectile must spin sufficiently to maintain this stabilization on its axis as it flies toward the target.

**Self-Check 5**

1. The rate of twist of the rifling in the bore and the exit velocity of the missile are the two major factors affecting revolutions per second.
2. Rate is important because it’s not the length of the barrel that affects rps, but the rate of the twist in that barrel and the velocity of the bullet. A short barrel gives just as many rps to a bullet as a long barrel, if the rate of twist is identical and the muzzle velocity of the bullet is identical in both.

3. It’s important to remember that a projectile may be stabilized within a range of twist, and that each bullet doesn’t require one and only one specific rate of twist to stabilize it. That’s why a modern rifle, such as the 30-06, can stabilize bullets of different weights in one given barrel, such as a 1 : 10 rate of twist.

4. No round ball is perfect. By spinning the round ball, imperfections are averaged around the axis, which helps to stabilize the missile.

5. Aside from the fact that you should understand the basics of twist to better your own general knowledge of firearms, you may also have to help a customer decide upon a certain rate of twist to stabilize a projectile of choice.

6. The smoothbore is easier to clean than a rifled arm, and it’s also easier to load. Furthermore, it fouls less rapidly than a rifled barrel.

7. First, there remains some smoothbore shooting in America. Second, any blackpowder shotgun is also a smoothbore round-ball gun. Third, there are a few smoothbore-only hunters.

8. Sort balls to improve load uniformity; use a consistent powder charge; use a buffer between powder charge and round-ball patch; and remove all excess lube from the bore.

**Self-Check 6**

1. A frizzen can break or discontinue sparking.
2. You can use a ball remover screw.
3. It closes the rearward portion of the barrel to form a breech.
4. You would remove the cleanout screw or nipple, trickle a small amount of fresh powder into the breech, and fire the gun.

5. A broken screw or other implement may be stuck in the bore. The implement could score the bore if the muzzle-loader is fired in this condition. Ask the owner of the rifle if anything is stuck in the bore. If so, you’ll have to debreech the firearm.

**Self-Check 7**

1. Accuracy deteriorates, plus pressures may rise.

2. Proofing can do damage that may not show up for a long while, but it’s there.

3. A restricted wad column could raise breech pressures.

4. A capper installs a percussion cap on the cone of the nipple so that the shooter’s fingers don’t force a cap on the nipple.

5. Use only blackpowder or Pyrodexas smokeless powder can destroy a muzzleloader.

6. It doesn’t look like a cross. A patch that works properly generally has a dark place in its center, but there’s no perfect fire patch pattern.

7. No, this is an imprecise and unscientific method for making a blackpowder load.

8. There’s far too much variation in the method and it’s unscientific.

9. The most accurate charge isn’t always the light charge, but rather the right one, and never an overload. Muzzle-loaders often vary, and the best way to find a good load is through safely working one up from a light load, but never exceeding the gun maker’s maximum load.

10. In the first place, this might encourage the loading of Pyrodex by weight, which is wrong. Pyrodex should be loaded volume for volume with blackpowder, not weight for weight. In the second place, blackpowder is not efficient enough to benefit from scale-weighted charges.
**Self-Check 8**

1. Possibles bag
2. Shooting pouch, hunting bag, and hunting pouch are all names for a shooting bag.
3. Hunters can take the muzzleloader and its appropriate bag into the field knowing they'll always have what they need to load that particular firearm.
4. A small metal flask can carry powder.
5. A cap box
6. A powder horn is nonsparking.
7. A priming horn and priming tool
8. A readyload
9. The muzzle protector is cone-shaped. It keeps the loading rod centered in the bore so the shaft of the rod can’t scrape the rifling.
10. It must fit properly. There are many different styles of nipples, and the wrench must be appropriate.
NOTES
When you feel confident that you have mastered the material in this study unit, complete the following examination. Then submit only your answers to the school for grading, using one of the examination answer options described in your “Test Materials” envelope. Send your answers for this examination as soon as you complete it. Do not wait until another examination is ready.

Questions 1–20: Select the one best answer to each question.

1. The composition of blackpowder is
   A. a chemical compound.
   B. an ancient fuel made with nitrocellulose.
   C. a mechanical mixture.
   D. a charcoal, sulfur, and graphite mixture.

2. What major breakthrough occurred in the early 1500s that allowed blackpowder to be better mixed and remain in combination?
   A. Corning
   B. Sulfur
   C. Saltpeter
   D. Granulation
3. It has been shown that blackpowder
   A. can never generate above 25,000 pounds per square inch (psi).
   B. can generate at least 100,000 psi under certain test conditions.
   C. may generate high pressures, but the tests occurred before the days of science and no one is certain.
   D. can be loaded in any amount in a rifle because excess powder just “blows away.”

4. All of the following are true about blackpowder except which one?
   A. It has been used to “kick off” large charges of smokeless powder in the guns of modern-day battleships.
   B. It may have been used in India for deep ore mining in ancient times.
   C. It sometimes had to be remixed in the field for a battle.
   D. It's not at all the same composition today that it was 100 years ago.

5. It has been shown that blackpowder
   A. is just about as efficient as smokeless powder.
   B. never generates very high pressures.
   C. can be loaded by volume.
   D. produces an excellent round-ball load when fired over snow.

6. All of the following are true of saltpeter except which one?
   A. It has been collected from caves.
   B. It can be noted as KNO₃.
   C. It makes up about 10% of blackpowder.
   D. It's the “oxidizer” or “go” of blackpowder.

7. Which of the following statements about blackpowder substitutes is true?
   A. They've been used safely for years.
   B. You should avoid and never use them.
   C. They are generally dangerous and shouldn't be used in a muzzleloader, except for Pyrodex.
   D. They're safe in muzzleloaders, but don't generate enough power in them.

8. The usual ratio of the three main ingredients of blackpowder is
   A. 75% saltpeter, 15% charcoal, 10% sulfur.
   B. 75% charcoal, 15% saltpeter, 10% sulfur.
   C. 70% saltpeter, 20% charcoal, 10% sulfur.
   D. unknown because it always varies.

9. Which of the following statements best describes blackpowder?
   A. It's very difficult to ignite.
   B. It's very easy to ignite.
   C. It can be stored almost anywhere because of its high flash point.
   D. It's unstable and doesn't last very long.
10. Which of the following statements about Pyrodex is true?
   A. It’s identical to blackpowder.
   B. The shooter must clean it from the bore after almost every shot.
   C. The shooter must load it by volume, not by weight.
   D. It comes in the same granulations as blackpowder.

11. All of the following statements about blackpowder are true except which one?
   A. The charcoal used to make blackpowder is thought of as the body of the fuel.
   B. The type of saltpeter used is meaningless because all saltpeter is about the same.
   C. Sulfur is considered a binding agent in blackpowder.
   D. Different woods used to make the charcoal can change the nature of blackpowder.

12. How do you measure a load of Pyrodex?
   A. You measure Pyrodex by weight.
   B. You measure Pyrodex by volume.
   C. You don’t have to measure Pyrodex; it only comes premeasured from the factory.
   D. You measure Pyrodex by using half the load of blackpowder.

13. Which of the following is a true statement about the wheel-lock?
   A. It was vastly inferior to the matchlock.
   B. It was vastly inferior to the snapance.
   C. It was a good lock design, but cost too much to make.
   D. It preceded the matchlock.

14. All of the following are attributes of the round-ball patch except which one?
   A. It takes up windage (space) in the bore.
   B. It serves as a gasket to seal the bore.
   C. It helps to maintain constant pressure on the powder charge.
   D. It holds lubrication and helps to contain the ball down on the powder charge in the breech.

15. Suppose you pull the trigger on a caplock muzzleloader and it fails to go off. This is called a
   A. flash in the pan.                      C. misfire.
   B. hangfire.                            D. slowfire.

16. The name “percussion cap” pertains to
   A. the fact that it contains powder.
   B. the fact that it goes off from a blow.
   C. the fact that it sends out a spark or flame.
   D. the fact that it fits on a nipple.
17. Why would you use hornet-nesting material between the powder charge and the patched round ball?
   A. To buffer the ball so it won’t get smashed out of shape
   B. To keep the ball down on the powder charge
   C. To prevent patch cutting
   D. To prevent patch burnout

18. Why would you use a pipe cleaner or touchhole pick to block the touchhole on a flintlock firearm?
   A. To prevent a flash in the pan
   B. To keep the touchhole powder-free and to prevent a fuse situation
   C. To keep powder out of the touchhole to lower breech pressure
   D. To make the rifle easier to clean later

19. Which of the following statements about the round ball is true?
   A. It’s ballistically superior to the conical.
   B. It’s useless.
   C. It’s inaccurate.
   D. It’s ballistically inferior to the conical.

20. Revolutions per second of a projectile (rps) results from
   A. the speed of the bullet alone.
   B. how long the barrel is and no other factor.
   C. muzzle velocity and rate of twist.
   D. the rifling twist and no other factor.