The Study of Gunsmithing



Sonoran Desert Institute
1921

MODULE NUMBER 2

Sights, Accuracy, and Black Powder



2012. All rights reserved. Except for use in a review, no portion of this book may be reproduced, stored in or introduced into a retrieval system, or transmitted in any form without the express written permission of Sonoran Desert Institute. The scanning, uploading, and distribution of this book by the Internet or any other means without the permission of Sonoran Desert Institute is illegal and punishable by law. Please respect Sonoran Desert Institute's rights and don not participate in any form of electronic piracy or copyrighted material.

Sonoran Desert Institute does not assume any responsibility for the use or misuse of information contained in this book.

MODULE NUMBER 2

Sights, Accuracy and Black Powder

2169 Care, Cleaning, and Storage of Firearms

2170 Metallic Sights: Design and Application

2171 Telescopic Sights: Design and Application

2172 Accurizing Firearms

2173 Black Powder Gunsmithing (#)

2484 Cleaning Firearms Lab (#)

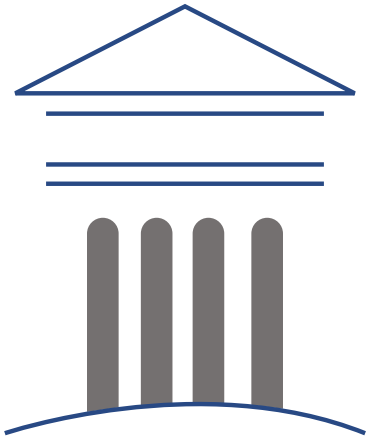
(#) Indicates point in your program at which additional lesson materials will be sent as you complete and return the lesson exams for grading.

Sonoran Desert Institute

1921

Care, Cleaning, and Storage of Firearms Lesson: 2169

OBJECTIVES	3
INTRODUCTION	3
BASIC GUN MAINTENANCE AND CLEANING	4
Basic Gun Cleaning	6
Gun Cleaning Accessories	7
METAL FOULING	8
Holding Guns For Cleaning	10
Cleaning Encrusted Parts	10
Removing Rust	11
Ultrasonic Cleaners	11
Cold-Weather Precautions	12
Storage	12
Long-Term Storage	12
Visual Inspection During Cleaning	13
Making Your Knowledge Payoff	13
Self-Test Questions	14
CLEANING BLACK POWDER WEAPONS	15
Black Powder Cleaning Aids	15
Caring For Antique Firearms	16
Solving The Rust Problem	16
Self-Test Questions	17
ANSWERS TO SELF-TEST QUESTIONS	18
LESSON QUESTIONS	19





Objectives

After completing this lesson, you should

1. Be familiar with the basic procedure for cleaning firearms.
2. Know how to prevent rust from forming on a gun.
3. Understand how leading is removed from the barrel of a handgun.
4. Know how and where to store your firearms.

Introduction

Part of the pleasure, as well as the responsibility of owning a gun, is its proper maintenance and care. Maintenance and care are necessary to keep a gun in a reliable and safe operating condition. A gun that is rusty and dirty will not look good, may not operate properly, and may actually be unsafe.

The cleaning of a firearm at regular intervals takes only a few minutes and ensures accuracy, good working order, and a long-lasting gun finish. On the other hand, a neglected firearm will be difficult to clean and will often be badly pitted — sometimes beyond repair. Therefore, if shooters keep their guns in first-class condition at all times, they can expect the guns to function properly and last several lifetimes.

Weapons firing cartridges with smokeless powder and noncorrosive primers need not be cleaned immediately after firing. But do not put the job off any longer than necessary, because the chance of rust forming increases with time. A pitted bore can render a shotgun or rifle useless. Ideally, a firearm should be cleaned after every shooting session.

All that is required to clean a firearm is one of the basic cleaning kits available on the market. These kits contain a cleaning rod, rod tips, oil, powder solvent, and gun patches. Some include a wire brush. These kits are compact and easily transported to the field for cleaning weapons immediately after a hunt or while on the range.

This lesson is designed to show you how to clean rifles, shotguns, and handguns properly. A comprehensive section is included on cleaning black powder arms. You will also learn how to prepare firearms for storage and how to preserve antique weapons.

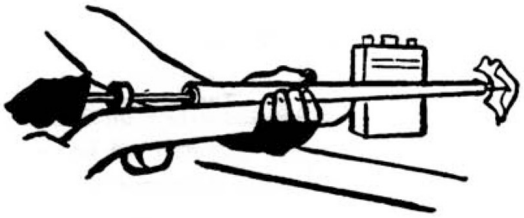
Basic Gun Maintenance and Cleaning

A gun is a beautiful thing when it leaves the factory. It has many metal parts that have been carefully machined, inspected, tested, polished, and given an attractive finish. The wooden parts have been made from a piece of carefully selected wood, turned precisely to shape, carefully sanded and smoothed, and given a handsome protective finish. A new gun is a delight to see and a delight to handle.

It only takes a little ordinary care to keep a gun from getting marred, dented, and scratched. Guns should be carried in a case when possible. They should never be thrown down carelessly or placed in a position where junk gets piled on them, for example, in a car trunk. Just a little care will work wonders and will identify the person using this care as a knowledgeable, expert gun handler.

Most gun parts are made of steel, and many of them are blued. In any event, whether blued or not, all the metal parts need a light protective coat of oil to prevent rust due to atmospheric conditions. When a gun is being used on the range or carried in the field, the oil should be wiped off so it will not gather dust and dirt. But oil should again be applied when the gun is returned to the gun rack. It is also a good idea to have a silicon cloth or a very lightly oiled wiping rag stored in a metal container near the gun so that finger marks can be wiped off after the gun has been handled. The salty perspiration from fingers and hands is likely to cause rust. Like any other piece of machinery, the gun's mechanism should occasionally be cleaned and lubricated. A gun that is used in the field will get dusty, and some of this dust will get into the working parts. During shooting, bits of unburned powder or carbon may work their way into the action. Previous lubrication will dry up and get gummy or sticky. If a gun is used frequently, the mechanism should be cleaned often. But if the gun is used rarely, a once-a-year cleaning should be enough. Before you start to work on a gun or clean it, be sure that it is unloaded and there is no ammunition in the magazine. Remember, *safety first.*

Be very careful to follow the manufacturer's directions in taking the gun apart and putting it back together again. It is not necessary to take the gun down to the last pin and part, just far enough that the gun can be cleaned properly. The less you take apart, the better off you are.



Clean barrel and metal parts with a good commercial solvent.



All metal parts should get light coat of oil.



Clean bore until dry patch comes through as clean as possible.



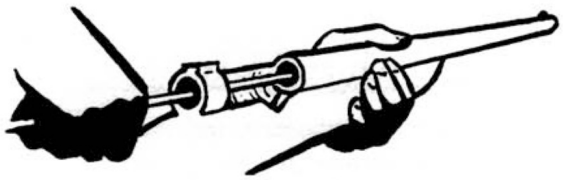
Store in horizontal position.



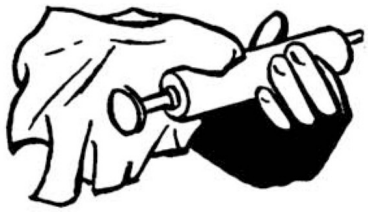
Run oily patch through barrel.



After storage, run clean patch through bore before firing.



Bore should be cleaned through breech end where possible.



Remove all excess grease and oil.

Figure 1: Eight basic steps to proper firearm maintenance

BASIC GUN CLEANING

The first step to basic gun cleaning is to open the gun's action, inspect the chamber and magazine, and remove any ammunition from the gun. Leave the action open during the cleaning operation. For break- open single-shot rifles and shotguns, depress a lever or button to open the action. The same is true for double-barrel shotguns, either side-by-side or over/under types. When cleaning bolt-action rifles and shotguns, remove the bolt from the receiver prior to starting the cleaning operation. All of the above firearms can be cleaned from the breech (chamber) end without further disassembly.

Most lever-actions, semi-automatics, and slide-action firearms will have to be disassembled further or else the tip of the cleaning rod will have to be inserted into the muzzle end of the barrel. One way to avoid disassembling the gun and still be able to insert the cleaning tip from the chamber end is to use a flexible cleaning rod. This is nothing more than a long, heavy coil spring that allows bending. In either case, the action must be opened before the cleaning operation begins.

Barrels are usually easy to remove from semi-automatic pistols for cleaning; just follow the manufacturer's field stripping (basic disassembly) instructions exactly. If you are cleaning a revolver, it will take a little more time, since you should clean all cylinder chambers in addition to the bore. Remove the cylinder from the frame, if possible, for easier handling, and the barrel will then be readily accessible. See Figure 1 for an overview of firearm maintenance.

If at all possible, always insert the cleaning rod tip into the breech end of the barrel. Primarily, this is to prevent wear on the rifling at the muzzle from the cleaning rod. This last fraction of an inch of a rifle's barrel is very important, as any wear at all will reduce the rifle's accuracy. Another reason for cleaning any gun from the chamber end toward the muzzle is to keep debris out of the receiver. If you clean from the muzzle to the chamber, the cleaning patch will push all the gunk out of the bore and right into the action, making additional cleaning necessary.

To use a gun cleaning kit, soak a gun patch in powder solvent (bore cleaner) and push the patch through the slotted tip attached to the end of the cleaning rod. Insert the tip into the barrel from the breech end, and run the patch the full length of the barrel. This first patch usually contains the bulk of the loose residue in the bore, and if you pull it back through the barrel on the return stroke, you will redeposit some of it back in the bore. Therefore, always discard the first patch when it comes out of the muzzle (the chamber, if you have to insert the tip into the muzzle end). Insert a new patch through the slotted tip, saturate it with bore cleaner, and again run the patch the full length of the bore, and back again. Repeat this operation as many times as necessary, usually 15 or 20 times. Then use a dry patch to dry the bore. Change patches often until the last one comes out clean and dry. Finish the bore cleaning by lightly oiling a clean patch and running it up and back through the bore.



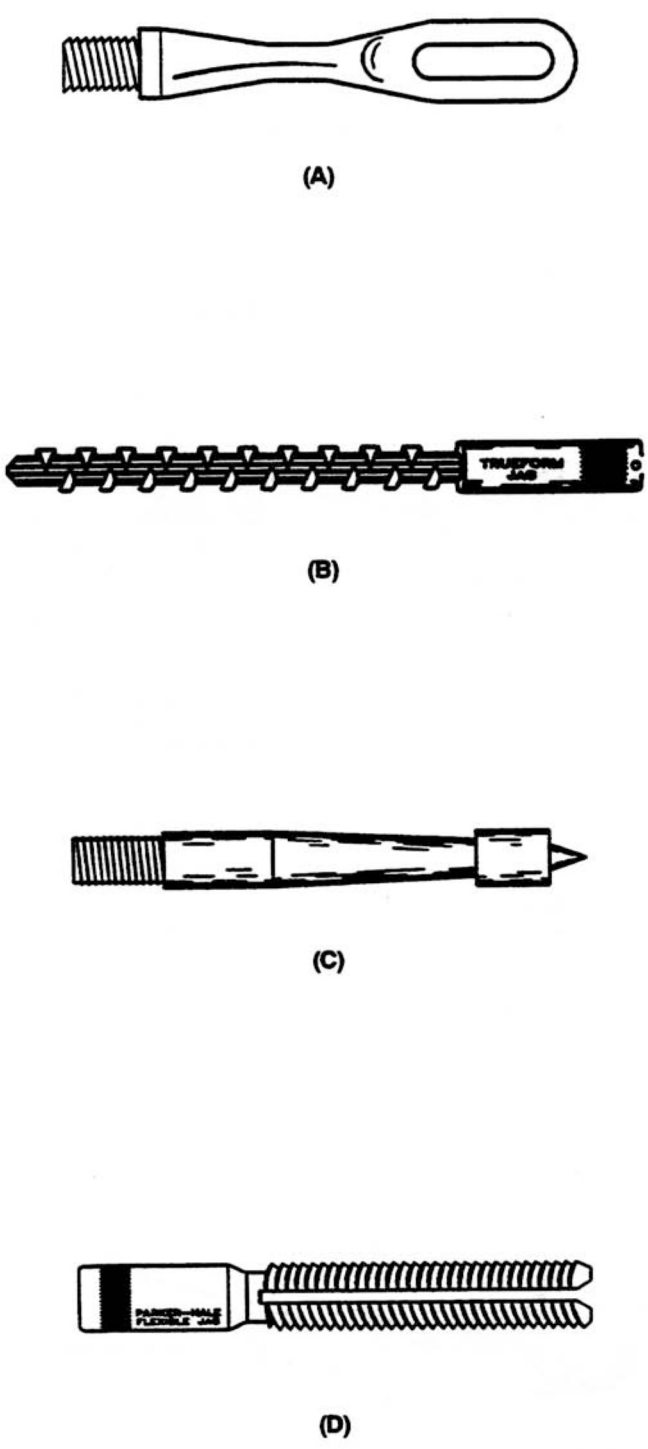


Figure 2: *Types of cleaning tips: (A) a single-slotted tip, (B) a roll jag tip, (C) a plain jag tip, and (D) a flexible jag tip.*

Extra-dirty bores require the use of a bronze bristle brush. Soak a clean patch with powder solvent (bore cleaner). Push the patch through the slotted tip of the cleaning rod and run it up and down the bore until the bore is saturated with the cleaner. Remove the slotted patch tip from the cleaning rod, insert the brush, and dip it into the powder solvent. Then push the brush up and down the bore about a dozen times to loosen the dirt and grime. Finish by drying the bore with clean patches until the last patch comes out clean and dry.

The outside of the gun should be wiped off with a silicone cloth to prevent rust and corrosion and also to remove fingerprints and eliminate salt-spray damage. This cloth may also be used on the gunstock.

The receivers of semi-automatic, slide-action, and lever-action firearms collect all sorts of debris and must be cleaned periodically to ensure proper functioning. An old toothbrush or other soft nylon bristle brush can be used to get into actions and other hard-to-reach places. A little WD-40 (a standard cleaner) sprayed into the action, followed by a good scrubbing with the brush, will do wonders to keep actions clean and in first-class operating condition.

When cleaning revolvers, always give the front of the cylinder and the rear of the barrel careful attention. A lot of powder residue builds up in these areas and should, therefore, be cleaned frequently.

The frequency of the cleaning will vary with the use of the guns and the weather to which they are subjected. A good rule of thumb is to clean them after each firing. Also, when a gun is used or stored near salt water or in humid areas, it should be cleaned, or at least wiped off, every few days.

When cared for as described, guns will rarely be injured from rust, fouling, or corrosion from routine handling.

GUN CLEANING ACCESSORIES

Figure 2 shows the different types of gun cleaning tips. Of the various types of cleaning tips, the single- slotted tip shown in Figure 2(A) is the most popular. Its advantage is that it holds onto a patch under all conditions. One disadvantage is that sometimes the patch jams when reversed inside the bore, and often the cleaning action is one-sided, permitting the bare sides of the tip to rub against the rifling and perhaps cause damage. The patch used with single-slotted tips should be large enough to require about 4 pounds of pressure to force it through the bore of the rifle.

The *roll jag tip,* shown in Figure 2(B), is used with rolled or wrapped patches and is the type preferred by many shooters for cleaning rifles that have to be wiped out from the muzzle end, such as lever-action and semi-automatic rifles. The rolled patch bears against the rifling equally and does not have to

be dragged into the bore. Accordingly, the rifling is preserved instead of being worn away in a vital spot.

Plain jag tips, as shown in Figure 2(C), are also very good for cleaning from the muzzle end. They give a uniform cleaning action and reverse perfectly inside the barrel. The patch sticks to the tip as long as it is inside the barrel, but any movement beyond the muzzle or chamber will cause the patch to come loose. A pointed jag tip has the advantage of centering the patch before being inserted into the bore.

Many shooters prefer to use *flexible jag tips* like the one in Figure 2(D), especially for cleaning shotgun barrels. A patch is slipped into the slot of the jag and wrapped around it. The slot, which imparts a measure of flexibility, causes the patch to press evenly on the bore, thereby squeezing the oil into the pores of the steel. The slot also permits the cleaning patch to be compressed by the choke, insuring a thorough cleaning throughout the entire bore. This jag is also good for holding steel wool and crocus cloth for polishing shotgun bores.

Wool and cotton mop tips are fine for oiling the bores of shotguns. However, these tips must be kept clean since damage may result from the fouling of the wool, which will neutralize the preserving powers of the oil.

The leather shotgun bore polisher is made up of several buff leather disks that absorb polishing material, such as Clover abrasive compound, and aid in repolishing the bores of shotguns that have been neglected. Since no metal touches the bore, the disks can be used without fear of damage, even on the more expensive weapons. Just be careful not to polish too much around the muzzle end of the shotgun, because a change in choke pattern could result.

No attempt should be made to polish rifle barrels, because the rifling will be damaged, leaving the barrel inaccurate and worthless. Rifle barrels can sometimes be restored by lapping, but this is a job for a very experienced gunsmith. Lapping involves polishing the gun with a material that has fine abrasive particles incorporated into it. Most of the cleaning rods on the market today are made of aluminum. This soft metal picks up bits of dirt, which may have an abrasive effect on the bore. If possible, try to find a brass, fiberglass, or wooden cleaning rod to fit your rifle or shotgun.

The cleaning rods used on rifled barrels should have a swivel joint so that the patch will rotate inside the bore while being run back and forth, following the twist of the rifling. Without this rotation, the patch will drag at right angles across the lands and will destroy the sharp edges of the rifling, impairing accuracy.

A shotgun-cleaning rod does not require a swivel joint because there is no rifling in a shotgun. Many experienced shooters prefer to use a high-quality, all- wood cleaning rod on shotguns. In most cases, these are made from prime, well-seasoned hickory wood. Not all woods make suitable shotgun cleaning rods, nor is kiln-dried wood satisfactory, since it tends to be too brittle. For this reason, the hickory used for better rods is air dried to prevent warpage and ensure the finish quality.

METAL FOULING

Metal fouling is not common, except in the small- caliber, high-velocity rifles, but when it does occur, you should know how to handle it. When the fouling of metal is caused by jacketed bullets, the term *metal fouling* is used. However, when caused by lead bullets, it is called leading.

A rifle barrel that is smooth and well cared for will seldom have any problems with metal fouling. On the other hand, a neglected barrel will always develop metal fouling to some extent.

Regardless of the cause, metal fouling can disrupt accuracy. Examine the bore with a bore light. Any fouling will be visible as long streaks, flaky deposits, or lumps of metal particles sticking to the lands and grooves of the barrel.

To correct metal fouling, many shooters use a solution of ammonium persulfate, ammonium carbonate, stronger ammonia,



Figure 3: *Corbin Bore Cleaner is a commercial cleaner available for cleaning rifles and handgun bores.*

and distilled water. However, this solution will damage the gun's finish if allowed to come in contact with it (which is easy to do since the solution is poured into the bore and allowed to soak for a period of time). Consequently, it is not a recommended procedure for the beginner. Instead, J-B Non-Imbedding Bore Cleaning Compound can be used. Besides removing lead, metal, and powder fouling from rifles, pistols, and shotguns, this compound is guaranteed to improve the accuracy of your present firearm. It will not injure the finest bore and will also help guard against rust. Other commercial solutions that are highly recommended for removing all traces of lead, copper, powder, and plastic fouling are Corbin Bore Cleaner, shown in Figure 3, and Hoppe's Benchrest-9 Copper solvent.

Even the best match ammunition will cause leading in the finest target handguns, and this leading can have a disastrous effect on accuracy. However, a perfect cleaning job on any handguns can be accomplished in a few minutes with a Lewis Lead Remover. This tool will remove lead from the forcing cone (or bullet seat), chamber(s), and bore with ease.

In revolvers, the forcing cone can be cleaned by first swinging the cylinder out of the firing position, then inserting the handle (with the tip and cloth patch removed) through the barrel from the muzzle end. Screw the cone tip through the cloth patch into the handle until it is hand-tight, as shown in Figure 4. Hold the revolver with the left hand, and with the right hand, pull the cone tip and patch snug into the forcing cone. It will not go very far—just a fraction of an inch. Maintaining this pressure, turn the handle in a clockwise direction four or five turns; then push the cone back and examine the brass cloth patch. If the forcing cone is badly leaded, repeat this operation after cleaning the lead off the patch with a thumbnail, pocket knife, or similar object.

Clean the revolver barrel with the rubber tip unit. First remove all grease and solvent from the barrel, and then insert the handle through the barrel from the muzzle end as before. Screw the rubber tip with the formed brass cloth patch into the handle, hand-tight, and examine the knurled (ridged) nut to see that it is backed one-half turn away from the rubber portion of the tip. This allows the assembly to turn with the rifling. Hold the revolver as described before and pull the tip through the barrel, allowing the handle and tip assembly to turn with the rifling. Repeat this operation until all lead is removed.

Revolver cylinders may be cleaned in a similar way to the barrel; that is, insert the handle from the forward end of the cylinder and screw the rubber tip with formed brass cloth patch into the handle. Hold the cylinder with the left hand and pull the rubber tip with the formed patch into the cylinder. When the tip engages the narrower, front end of the cylinder, begin turning it in a clockwise direction.

The brass cloth patch should be good for several cleanings. Should it become clogged with grease and lead, it can be cleaned with a solvent and a toothbrush. If any of the above

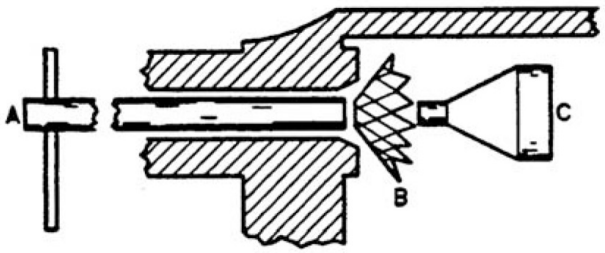


Figure 4: *To assemble the Lewis Lead Remover rod, pass the rod body through the barrel and screw the cone tip (C) through the brass cloth patch (B) into the rod body (A). Then bend the patch back over the taper of the screw-cone tip, and you are ready to remove lead from a revolver's forcing cone using the tip shown.*

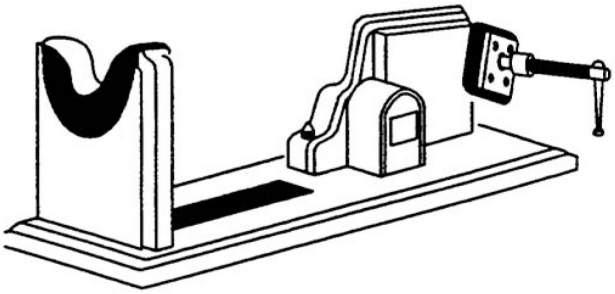


Figure 5: The Decker Vice is a solid vice used to hold rifles and shotguns for scope mounting, cleaning, etc. The padded rests and clamp jaw protect the gun's finish.

operations tighten the tip too much for it to be released by hand, a key is provided to loosen them.

HOLDING GUNS FOR CLEANING

Firearms can be held for cleaning in a convention- al bench vise as long as padded vise jaws are used to protect the finish. However, guard against tightening the vise jaws too much, as you can bend receivers and damage other parts, especially thin shotgun barrels. When using a bench vise, clamp the firearm into the vise in a horizontal position with the butt resting on the bench top. You will then have access to the bore to push a cleaning rod through it. Some people prefer to clamp the rifle or shotgun in a vertical position with the butt resting on the floor directly under the vise.

For very little expense, you can build a suitable gun-cleaning rack similar to the wooden cleaning racks made available at one time to all military recruits. These racks were merely notched wooden frames that held rifles securely while they were being cleaned. A commercial shooting vise, such as the Decker Shooting Vise in Figure 5, is reasonably priced and greatly simplifies the gun cleaning operation. When the vise is used properly, all scratching and marring are eliminated, because the Naugahyde covering over the sponge padding is all that comes in contact with the gun. The base can be mounted



Figure 6: Brownells d'Solve Gun Cleaner helps remove dirt and grime from guns and can be mixed to various strengths depending on the need.

permanently to a workbench or secured with C-clamps. You can also use this vise when boresighting, mounting scopes, and zeroing or adjusting sights for rifles.

CLEANING ENCRUSTED PARTS

All gunsmiths occasionally run into a firearm that has been neglected for a very long time. The dirt on these firearms is crusted and the actions are covered with grime. Cleaning, as discussed earlier, will either not remove all of the dirt and grime or will be very time-consuming. The best cleaning method for these abused firearms is soaking them in a solvent.

Brownell's D'Solve Gunsmith Cleaning Fluid (Figure 6) is an excellent, nonhazardous, nonflammable, odor- free, and inexpensive solvent — just the thing for a gunsmith. This solvent is available in one-gallon containers, which makes five gallons of bench cleaner, and can be mixed stronger for tough jobs and diluted for less demanding cleaning operations.

It is simplest to use a clean, plastic bluing tank such as those supplied by Birchwood Casey. If one of these is not available, buy a 4' length of 4" PVC (plastic) pipe, an end cap, and some jointing compound from your local plumbing supplier. Cap one end of the PVC pipe and set it in a vertical position. Fill it

with the cleaning solution and dip the gun parts into it. Allow the parts to soak. The grimiest parts will come out clean and ready to dry, oil, and assemble.

When used as a brush-on cleaner, the cleaning solution rapidly removes dirt and grime from actions and chambers. Some cleaner on a toothbrush will clean old checkering, and a small amount on a pad wiped across a gunstock will remove grime. However, if the gun is going to be soaked, remove all wood first. If you have compressed air available, use it to blow loose grime from the gun immediately after it is lifted out of the tank. Set the pressure at about 30 psi and let it do the work for you. Compressed air is also excellent for drying gun parts.

REMOVING RUST

One of the most difficult problems confronting gun owners is how to remove rust from firearms without damaging the bluing finish. Light rust can be removed quite easily with WD-40, but heavy rust is another story.

The first attempt should be made with a rough bath towel coated with WD-40. Rub the rusted area vigorously for as long as necessary to remove all rust. If the bluing comes off with this method, it probably was bad anyway and the firearm should be reblued. In fact, this is probably the reason the gun rusted in the first place.

When a lot of rust is present, use No.0000 steel wool dampened with WD-40 or a similar gun cleaner. Rub the rusted area lightly until all rust is removed. Various companies offer nontoxic products (Figure 7) that have been developed to clean and remove oxidation, rust, grease, body oils, etc. safely from gun barrels and gun parts with professional results. Most of these products are concentrated and mixed with water. They can be used safely on any surface to which you can apply water.



Figure 7: *Birchwood/Casey is just one maker of rust remover, there are many products available to help remove rust from your gun metal.*

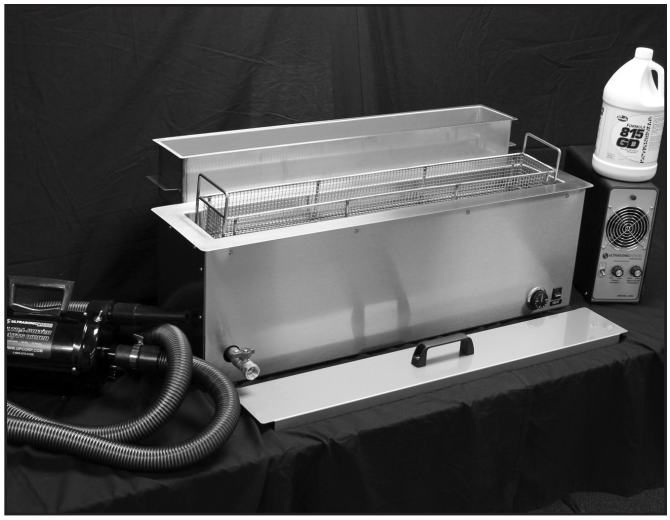


Figure 8: Ultrasonic cleaning machines come in various sizes.

Light rust will come off immediately with no damage to the gun's finish. Heavier rust will take a little longer. Do not expect miracles.

ULTRASONIC CLEANERS

Another method for cleaning firearms — and perhaps the most sophisticated — is through the use of ultrasonic technology. Ultrasonic cleaners (Figure 8) were first used in the industry around 1950, but the technology has become more commonplace with smaller, more cost effective units available since about 1970. Ultrasonic cleaners use ultrasound (usually from 20–400 kHz) and a special cleaning solvent to clean delicate items right down to the micron level, and they are much faster than traditional firearm cleaning methods, usually only 3-5 minutes for most weapons. When using an ultrasonic cleaner, gunsmiths should always use a cleaning detergent specifically designed for use with weapons and includes a rust prohibitor. One proven ultrasonic cleaning system for weapons is the GunSonic™, which provides gunsmiths with a complete ultrasonic gun cleaning and lubrication system for all of their



Figure 9: Get a gun rack that permits the guns to rest either vertically or horizontally

weapons cleaning needs. GunSonic is made in America by Ultrasonic Power Corporation and comes in sizes that accommodate handguns and rifles.

COLD-WEATHER PRECAUTIONS

Weapons exposed to extremely cold temperatures require special handling. An inferior oil or excessive lubrication could cause jamming. If in doubt, it is best to completely remove the old oil by flushing with bore cleaner. Dry all parts thoroughly and apply a very light coating of gun oil — a type that is specially formulated to remain effective in subzero temperatures.

Ideally, guns should be warmed gradually and not carried directly into a heated room after being outdoors in cold weather. Since this is not always practical, be sure to check both the bore and action for condensed moisture.

STORAGE

A tight-fitted wooden cabinet or security chest is the best storage medium for the average gun owner. A steel cabinet is also good and offers some protection against fire and theft. If a cabinet is not available, a gun rack is the next best way to store firearms. Get a rack that permits the guns to rest either vertically or horizontally, but be certain that it is a plain wooden rack (Figure 9). Those made of iron, deer feet, and other materials may look impressive but they tend to damage the bluing. If you have to use an open rack, do not forget to dust the guns regularly, and keep them well oiled in humid weather.

You should not keep guns in clothes closets, in damp basements, or under the bed, even if the guns are cased. Canvas, leather, sheepskin, fiberglass, and wooden gun cases are good for transporting firearms, but if used for storing firearms it is necessary to inspect the guns frequently to be sure that rusting has not started. Wool-lined cases are especially susceptible to moisture. Some cases have been treated with a rust inhibitor, but that is no guarantee that in humid weather the bluing will not suffer, inviting rust. If guns are stored for long periods, clean them from top to bottom before shooting.

Use moisture-absorbing silica gel when guns are stored in high-humidity areas. Silica gel packs are one of the most effective moisture absorbers ever developed. These synthetic crystals prevent rust, mildew, corrosion, and tarnish before they start, by literally "sucking up" and safely holding the moisture that causes these kinds of damage. Yet, the crystals stay dry to the touch and will not harm or dampen any surface even when saturated. Most have a built-in indicator that changes from blue to pink when the crystals have absorbed all the moisture they can hold. However, they are easily activated by heating the packs in a conventional oven for 3 hours. The crystals can be reactivated over and over again, giving a lifetime of protection from the destructive effect of dampness.

LONG-TERM STORAGE

Guns that are to be stored for long periods of time need special attention. They should first be disassembled as far as practical and then thoroughly cleaned as discussed previously. All metal parts should then be greased, especially the bore. Rig Rust Preventive is still the most popular solution for this purpose. This easy-to-apply, clean, viscous grease has been around for a long time and will provide absolute rust prevention to any firearm. It's also unaffected by long storage periods.

For added protection, Brownells Gun Wrap Paper is recommended. This tough, tear-resistant paper is saturated with VCI solution and is designed to be wrapped around metal gun parts for protection from moisture and rust. Actual tests show 10-15 years protection when steel parts were wrapped with this oiled

paper, sealed in plastic, and stored in a cool place. If possible, gunstocks should be removed from the metal parts for long-term storage to prevent the wood soaking up oil, which eventually will stain or darken the wood.

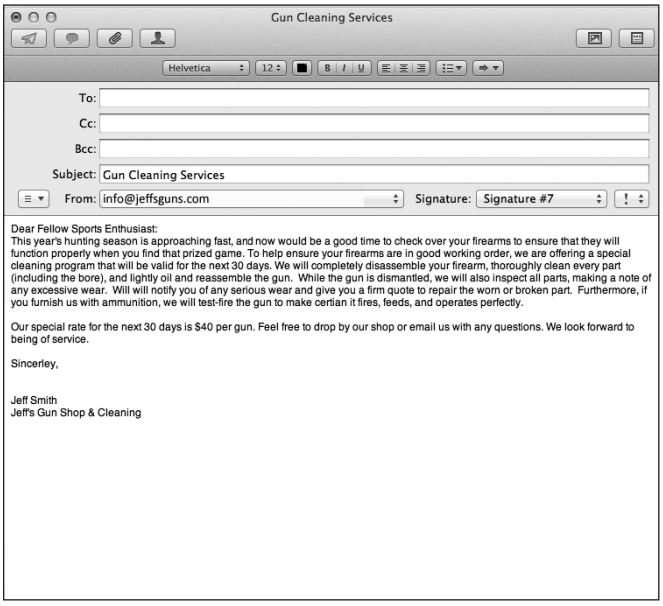
VISUAL INSPECTION DURING CLEANING

While giving firearms a thorough cleaning, carefully examine all parts for wear. This can save you from much disappointment later when you are in the field and the gun stops operating. Once all parts are thoroughly clean, examine the bore with a bore light. Is the barrel pitted? Should it be lapped? What is the general condition of the rifling, shotgun bore, and other parts? Examine each smaller part under a magnifying glass. Look for hairline cracks and excessive wear. If any are found, now is the time to replace or repair the part — not when the owner has a target lined up in the sights and the gun fails. At the same time, check the condition of the gun's finish and decide if any parts should be touched up or completely refinished. If you are working on a customer's gun, note what you find, and have these notes — and an estimate — ready when your customer picks up the gun.

MAKING YOUR KNOWLEDGE PAYOFF

In the majority of cases, it is seldom necessary to disassemble the entire gun when cleaning — at least not more than once or twice each year. Few shooters are really qualified to disassemble a firearm right down to the last screw and drift pin. This is where you can make your knowledge payoff!

Each year, hundreds of guns wind up in a professional shop, usually in many pieces in paper bags and cigar boxes, because the owner disassembled the weapon and then could not reassemble it. These same shooters want their firearms to have at least one thorough cleaning each year, which requires at least a partial dis- assembly of the weapons. Many beginning


Gun Cleaning Services

Helvetica 12

To:
Cc:
Bcc:
Subject: Gun Cleaning Services
From: info@jeffsguns.com Signature: Signature #7

Dear Fellow Sports Enthusiast:
This year's hunting season is approaching fast, and now would be a good time to check over your firearms to ensure that they will function properly when you find that prized game. To help ensure your firearms are in good working order, we are offering a special cleaning program that will be valid for the next 30 days. We will completely disassemble your firearm, thoroughly clean every part (including the bore), and lightly oil and reassemble the gun. While the gun is dismantled, we will also inspect all parts, making a note of any excessive wear. Will will notify you of any serious wear and give you a firm quote to repair the worn or broken part. Furthermore, if you furnish us with ammunition, we will test-fire the gun to make certian it fires, feeds, and operates perfectly.

Our special rate for the next 30 days is $40 per gun. Feel free to drop by our shop or email us with any questions. We look forward to being of service.

Sincerley,

Jeff Smith
Jeff's Gun Shop & Cleaning

Figure 10: Sample email that can bring in new business.



Figure 11: Sample ad that can bring in new business either through internet advertising or through a display ad in a local publication or newspaper.

gunsmiths have made good use of their knowledge by offering a special gun-cleaning service at the beginning of and after the normal hunting season. If a mailing list is available, such as from local hunting clubs, an email or letter sent to each of the members can bring in a lot of this type of work. The second-best means of contact is to run a small display ad in local newspapers or take advantage of the internet with a pop-up or banner ad. One type of banner ad is shown in Figure 11, while a sample email appears in Figure 10.

However, before you may do any work on a firearm, you must have a Federal Firearms License (FFL) and any county, city, or state licenses that may be necessary. To apply for an FFL, contact your nearest Internal Revenue Service office and request an application. Also, see the lesson "Types of Firearms."

Assuming that you already have an FFL or plan to obtain one, you might want to proceed with a gun- cleaning service as described in the following paragraphs. You will need cleaning rods, brushes, tips, etc., for all the calibers and gauges of firearms you anticipate having to clean. Of course, you will also need bore solvent, gun oil, patches, etc. Just as important are detailed instructions describing how to disassemble the firearms you will be cleaning correctly. There is a definite sequence in the assembly and disassembly of any firearm, and one step out of order can cause many problems.

At this time, it is highly recommended that you write to all gun manufacturers and request their price lists on disassembly instructions and gun parts of every weapon they manufacture. Some of the manufacturers will provide these at no cost, while others will charge for this material; still other firearm manufacturers will not cooperate at all and are not willing to supply this information. Obtain as many of these instructions as possible.

When firearms arrive at your shop for cleaning, carefully study each and every one before you even loosen a screw. Some screw heads may already be damaged; if so, make a note of these so the present owner of the weapon will not blame you for the damage. Also note any other defects in the overall appearance.

At this stage, try the action of the firearm for correct functioning. If the gun is already malfunctioning when it arrives at the shop, you need to know this as soon as possible. Otherwise, the owner may be able to claim that these malfunctions were the shop's fault, so try to detect these before beginning the disassembly.

Once the preliminary examination has been made, choose the correct screwdriver blades to fit all screw slots exactly. If the firearm is unfamiliar to you, your next step is to do research on its correct disassembly. When you feel that you thoroughly understand the procedure, then proceed with caution. By caution, we mean so that no harm comes to either you or the gun. Many people have had their eyes damaged by flying springs when the springs whizzed loose from their position in the firearm. It is imperative that you always wear safety glasses when working with guns.

As you start to disassemble a customer's gun, remember that you are responsible for it, and if you damage any parts of it during your work, the owner is going to expect you to correct it — and rightly so — at your own expense. Again, proceed with caution. If you should become puzzled about a certain part, stop immediately and do further research before proceeding with the disassembly.

As you disassemble and assemble various weapons, you should make notes of any broken or worn parts and then clean all parts as previously described in this lesson. During the reassembly, use the same precautions as described for disassembly. Then, once you have a dozen or so of these projects successfully under your belt, the work will become almost second nature and you will be able to proceed at a much faster rate.

A thorough cleaning of firearms is an excellent project for the beginning gunsmith to undertake. First of all, it gives the student a means of making money with little initial investment. Then, as you disassemble and assemble the firearms, the whole theory of the gun's mechanical operation becomes ingrained in your mind. Further handling of the more popular guns soon leads you to know almost automatically which pieces are worn and which pieces should be replaced.

Therefore, cleaning firearms is an excellent way to learn about the operation of all firearms and to recognize parts that will cause trouble. When you find worn or defective parts, and make notes, you stand a good chance of getting more work from your customer, since he or she will more than likely want you to do the repairs on the defects you found while cleaning the gun. So, you have the opportunity to learn how firearms operate, you have a chance for more business, and you are getting paid for it at the same time... a sound investment indeed!

Here's what you need to get started:

- Obtain an FFL and any other license necessary.
- Obtain cleaning supplies.
- Obtain customers by advertising in the local newspaper or by direct mail.
- Obtain disassembly instructions for each weapon you undertake to clean.
- Proceed with caution and do your best work.

Here's what you can get from the project:

- A good knowledge of firearm operation.
- You learn to detect worn or broken parts in a gun.
- A chance for more work from the customers if you do a good job.
- A chance to make money with little investment.

SELF-TEST QUESTIONS

Please check your answers on page 18.

1. ***True or False*. For general cleaning, all firearms must be completely disassembled.**
2. **What type of cleaning rod tip is normally found in commercial gun cleaning kits?**
3. **What type of tip should be used on the cleaning rod for extremely dirty rifle bores?**
4. **Into which end of the barrel should the cleaning rod be inserted (if at all possible)?**

Cleaning Black Powder Weapons

Black powder firearms should be cleaned as soon as possible after firing. Both black powder and its substitute, Pyrodex®, are highly corrosive and will cause the bore of the gun to rust if not cleaned properly.

Our ancestors relied upon warm water and homemade lye soap for cleaning their muzzleloaders, and this combination is still hard to beat. Soak a patch in warm water and some detergent. Since homemade lye soap is rare today, any commercial detergent will do. Then, run the patch the full length of the bore. Replace this first patch with another saturated with the water/detergent mixture and repeat the former operation. Again change patches and repeat until the wet patches come out clean. Then dry the bore thoroughly using clean, dry patches.

After the bore is completely dry, soak a clean patch with a good gun oil and run this in the bore several times. Wipe around the lock and hammer with a wet patch, then dry and oil all metal parts. Check the gun in several days and run another oiled patch through the bore. The gun should be further checked every week or two thereafter.

Cap and ball revolvers should be disassembled and the cylinder flushed with detergent water or a detergent and water-based solvent such as Hodgdon's Spit Bath. Clean the bore as described above.

When you run across a black powder bore that is extremely dirty, try the "pumping" cleaning method. Fill a two-gallon pail with warm water and about ¼ cup of dishwashing detergent. Cock the hammer and attach a piece of small-diameter rubber or flexible plastic tubing to the nipple. The tubing must be long enough to reach from the nipple, with the gun standing upright, to the bottom of the pail. It should also fit the nipple tightly so it will not easily be forced off from pumping pressure. Holding the gun in this position, attach a tight patch to your cleaning rod, insert the patch into the muzzle, and slowly push it all the way to the breech. Pull the patch back toward the muzzle, but not all the way out. This suction action will draw the detergent water into the bore through the nipple. Pushing the rod toward the breech end will discharge the water back into the pail. Keep this back-and-forth pumping motion going for about 5-10 minutes. Change the water, if necessary. Then clean, dry, and oil the bore as described previously.

BLACK POWDER CLEANING AIDS

The Hodgdon Powder Co. offers black powder accessories that will make cleaning black powder arms easier (Figure 11).

Spit Patch. This is a nonfouling lube for rifles. It improves accuracy and gives more shots between cleanings. This lube makes cleaning simple, because it deposits lube in the bore while firing. Spit Patch dissolves fouling and helps the bore resist corrosion.

Spit Ball. This is a nonfouling lube for pistol shooters. It will also minimize chain firing in pistols and allow more shots between cleaning, because lube is deposited in the bore while firing.

Spit Bath. A cleaner for both rifles and pistols, Spit Bath removes fouling and replaces moisture with light gun oil. It's good for cleaning between shots with black powder arms and excellent for final cleanup after a shooting session. Furthermore, it kills all black powder odors.



Figure 12: Hodgdon Powder Co. makes cleaning products that make cleaning black powder arms easier.



CARING FOR ANTIQUE FIREARMS

All firearms collectors and museums have one problem in common: how best to clean and preserve their prized possessions. Not only do cleaning and pre- serving enhance the aesthetic appearance of a firearm, but also they protect the monetary investment that a gun represents. When properly carried out, they frequently increase a firearm's economic value. We are not talking about restoring a badly abused firearm to new condition. Rather, we want to preserve as much of the original existing finish as possible and prevent — or at least retard — further deterioration.

In all aspects of cleaning and treatment of any antique firearm, there is a single watchword: caution. Go slowly. Except for the treatment of a gunstock infested with powderpost beetles, there is seldom any need to hurry. Therefore, study the situation well before you take any action. Make sure that you understand the problems fully and that you know the effect that you wish to produce; then proceed slowly. Hasty over-cleaning with harsh abrasives, strong chemicals, or improper solvents can ruin a gun just as completely as the unchecked ravages of time.

Before beginning to seriously clean any antique firearm, you should disassemble the gun as far as necessary to separate the metal parts from the wood that is, if this is possible without damaging any of the existing parts. Once separated, dirt and remnants of previous preservatives should be removed from the metal parts. Use a warm water/detergent mixture for removing dirt; oils and grease may be removed with such solvents as kerosene or acetone.

SOLVING THE RUST PROBLEM

Unless protected, all metal parts will rust. Once the process of rusting has begun, all active rust must be removed, or the process will continue under any preservative coating that is applied. The old theory that a coat of oil or lacquer on a rusty gun barrel will prevent furthering deterioration is completely false. There is enough oxygen and moisture within the rust to continue the process.

If the gun parts were blued or browned and there is any chance of retaining a large portion of the original finish, cleaning will be a slow and delicate process.

Most bluing and browning processes involve artificially induced oxidation. Therefore, most chemicals that will remove rust will also remove the gun finish.

Blued or browned metal parts should be soaked thoroughly in kerosene to soften the rust, and then the individual areas should be treated with a rust remover as discussed previously in this lesson. For heavily scaled areas of rust, first use a single-edged razor blade, a dull knife, a strip of brass, or fine steel wool to chip off the larger pieces. All of these methods are acceptable, and it is surprising how much of the original finish can be retained if you are careful. The principal danger lies in accidentally scratching the good surface near the rust spots.

After the metal portions of the gun are finally cleaned, you must choose the proper preservative. There are several types to choose from, including greases, oils, lacquers, and waxes. The decision depends to great extent on how the gun is going to be used and under what conditions it will be stored.

Oils and Greases as Protective Coatings. Oils and greases are the old standbys. When applied to warm metal, they quickly penetrate the pores and provide a good preservative coating. On moving parts they also provide lubrication. Generally, the bore of a gun and the mechanism should always be coated with an oil or grease.

To be a good preservative, oil should be stable. It should cling to the surface to which it is applied and not tend to run. Some oils and greases contain paraffin in a relatively volatile solvent, which eventually evaporates, leaving a waxy coating behind.

Oils and greases also have their disadvantages. If a gun is to be handled, much of the coating comes off on the hands. This not only leaves the handler with dirty hands, but also gradually removes the protective coating from the gun.



Figure 13: Rifle, Gun & Knife Wax can help protect your gun.

Lacquer as a Protective Coating. Another protective coating is lacquer. This is somewhat more difficult to apply than either oil or wax, but it does provide a good invisible covering. Clear vinyl lacquers are best. Lacquer has few, if any, advantages over wax as an external preservative for metal. Its chief asset lies in its ability to prevent the corrosion of other metals.

It is extremely important to understand the difference between lacquer and varnish when these agents are considered for preservative purposes. Lacquer will adhere tightly to metal. Varnish will not. Lacquer is waterproof. Varnish is hygroscopic and readily admits moisture. Lacquer will remain clean and completely transparent. Varnish will turn yellow and hide the advances of rust underneath its coating.

Wax as a Protective Coating. Wax (Figure 13) has long been a favorite preservative for external surfaces on antique firearms. It will not come off on hands, clothing, or backgrounds, and it withstands considerable wear. At the same time, wax provides an attractive finish that is slightly dust repellent.

If a gun is to be waxed, it is necessary to select the wax carefully. Choose a good grade of vegetable wax and avoid synthetic acid waxes. Simonize is an excellent choice for most purposes. Its only drawback is that on a heavily pitted or engraved surface it remains an opaque white in the bottom of the indentations. Other waxes, such as transparent shoe polish, do not have this drawback. However, care should be taken to select a good shoe polish that contains neither water nor tannic acid. Esquire transparent polish is one safe choice.

With all waxes, it is necessary to build up a good, hard covering. Apply the wax and let it stand at least 30 minutes before polishing, and put on at least two coats.

With all of these protective methods, grease, lacquer, and wax, one thing is imperative: make sure the surface to be coated is clean and thoroughly dry.

Wax as Preservation. When you prepare an antique firearm for a preservation treatment, first remove the dirt by washing the piece in warm water and detergent, then remove any loose, scaly rust. Finally, smooth the surface with steel wool, taking care at all times to stop before reaching bare metal.

When cleaning has been completed, the object is ready for preservation. You can best preserve the gun by immersing it in melted wax. For preparation, first put the firearm, to which a piece of wire about a foot long has been attached, in an oven and "bake" it for a time sufficient to drive all the moisture out of the remaining rust. The time, naturally, will vary with the size of the object, ranging from a minimum of 1 hour to 8 or 10 hours. Set the oven on low heat when you first insert the object, then raise the temperature gradually until it approximates the temperature of the melted wax in which the object will be placed.

When you remove the gun from the oven, submerge it immediately in the melted wax and suspend it in the wax with the wire. The gun should remain submerged until all bubbling has ceased; then, withdraw the gun and hang it up by the wire so that the excess wax will drain off. The resulting finish will be a pleasing, uniform dark tone, and the piece will be strengthened and preserved from further rusting.

These are the basic methods that the average gunsmith will find useful for cleaning and preserving antique guns. Those methods that require special equipment or unusual skill or fall under the heading of "restoration" are covered in a later lesson. Remember: proceed slowly and cautiously until you are thoroughly familiar with the techniques and materials you are using. Make sure you understand the problems you are facing and know exactly what result you are seeking. Read the labels carefully on all chemicals you use, and obey the warnings. The techniques described above will enable even the beginner to clean and protect antique firearms adequately and safely.

SELF-TEST QUESTIONS

Please check your answers on page 18.

5. **What old cleaning solution is still excellent for cleaning black powder arms?**
6. **Name three preservatives that may be used on antique firearms.**
7. **To mix your own black powder cleaning solution, how much detergent should be added to two gallons of warm water?**
8. **Once a black powder arm has been cleaned, how often should it be checked for rust?**

Answers to Self-Test Questions

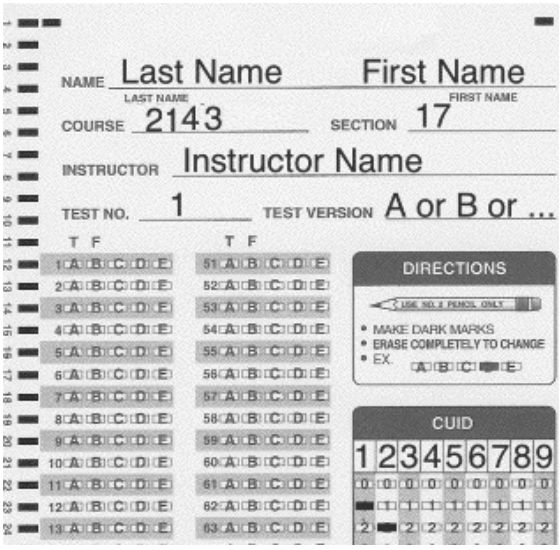
1. False.
2. Single-slotted tip.
3. Bronze bristle brush
4. Chamber or breech end.
5. Warm water and soap (detergent).
6. Oil or grease, wax, and lacquer.
7. ¼ cup.
8. Every week or two.

Lesson Questions

THIS IS LESSON NUMBER 2169.

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

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



You may also complete your exams and submit them online via the SDI Student Services page at www.sonoranlearning.com.

1. **Ideally, any gun should be cleaned**
   a. Once a year.
   b. Twice a year.
   c. After every shooting session.
   d. Every 1,000 round.

2. **The first thing you should do prior to cleaning any firearm is**
   a. Load the gun to see if it functions okay.
   b. Make sure there is no ammunition in the chamber or magazine.
   c. Disassemble the gun down to the last screw and drift pin.
   d. Disassemble the gun only as far as necessary.

3. **If at all possible, always insert the cleaning rod tip in**
   a. The chamber or breech end of the barrel.
   b. The muzzle end of the barrel.
   c. The gun's magazine tube.

4. **One way to prevent rust and corrosion on the outside of a gun is to wipe the gun off with**
   a. Bore cleaner.
   b. A solution of warm water and detergent.
   c. A silicone cloth.
   d. Steel wool.

5. **Name two areas on revolvers where powder residue builds up the most.**
   a. Front and rear sights.
   b. Trigger guard and grip.
   c. Front of cylinder and rear of barrel.
   d. Front of barrel and rear of cylinder.

6. **When it is necessary to wipe out rifle and pistol barrels from the muzzle end, which of the following cleaning rod tips is best for the job?**
   a. Roll jag.
   b. Single-slotted cleaning tip.
   c. Double-slotted cleaning tip.
   d. Bronze brush.

7. **When barrel fouling is caused by firing lead bullets, the term is called**
   a. Metal fouling.
   b. Leading.
   c. Leade.
   d. Carbon fouling.

8. **One commercial tool available for cleaning lead from handguns is the**
   a. Lewis Lead Remover.
   b. Smith's Screw-Cone Tip.
   c. Brownell's Lead Buster.
   d. Hoppe's brass cloth.

9. When preparing firearms for cold weather use, do the following:

a. Coat all parts with as much oil as possible.

b. Remove all oil and grease; then apply a very thin coat of oil.

c. Coat all metal parts with wax.

d. Totally remove all oil and leave the gun dry.

10. One of the best places to store firearms for long periods is

a. In wool-lined gun cases.

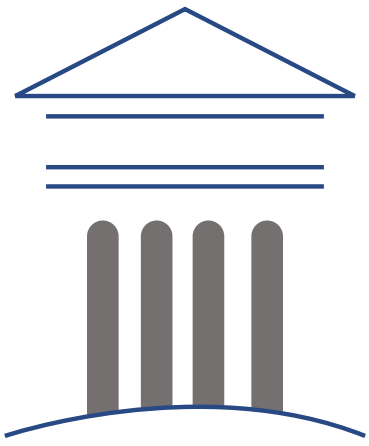
b. In a wooden cabinet.

c. In a leather gun case.

d. In a cool basement.

Metallic Sights: Design and Application
Lesson: 2170

OBJECTIVES	3
INTRODUCTION	3
SIGHTING FUNDAMENTALS	4
Sight Styles	4
Adjusting Sights	4
Micrometer Adjustment	5
Sight-Setting Charts	6
Self-Test Questions	9
DEVELOPMENT OF METALLIC SIGHTS	10
Sight Hoods	11
Mounting Metallic Sights	11
Rear Sights	11
Peep Sights	12
Target Sights	13
Installing Metallic Sights	15
Self-Test Questions	15
CUSTOM SIGHT INSTALLATIONS	16
Slide Pre-Assembly Preparation	20
Self-Test Questions	20
ANSWERS TO SELF-TEST QUESTIONS	22
LESSON QUESTIONS	23





Objectives

After completing this lesson, you should

1. Understand the term "trajectory."
2. Know the purpose of a sight hood.
3. Be familiar with the colors and sizes of front beads of different conditions.

Introduction

Most rifles with iron sights are sighted carefully at the factory by teams of expert target shooters as part of the final inspection. These sharpshooters fire several series of shots at targets, then make any necessary sight adjustments to ensure that the sights are in proper alignment.

However, no two shooters have identical eyesight, and everyone has a different method of sighting a rifle. Even if a rifle fresh from the factory is sighted satisfactorily, the new owner must find his or her proper rear-sight setting to ensure correct high and low shooting at various ranges.

Unfortunately, most shooters do not know how to properly sight a rifle. As a professional gunsmith, you can instruct shooters on any indoor or outdoor range; that is, you can first get a rifle approximately in line and then look over the shooter's shoulder as he or she fires. This lesson will teach you how to make the proper adjustment for the individual shooter. Once you learn this skill, you can charge from $20 or more per hour for your time. And, in most cases, all the tools you will need to make the adjustments can be carried in your pocket.

Sighting Fundamentals

Rifle sights are manufactured in what appears to the beginner as a bewildering variety. To understand the simplest of sights, you need to know the basic principles of sighting. The two most common sights are the bead front sight and the notched, open rear sight.

In aiming with these sights for target shooting, the top of the bead on the front sight should be held directly at the bottom of the target's bull's-eye, as shown in Figure 1. The rifle should be held so that the notch in the rear sight is in line with the front sight bead, with the front bead centered in the notch and the top of the bead level with the top of the notch. Experience will enable the shooter to vary elevation, but at the start it is best to adopt a regular way of sighting.

Hunting requires a different sight alignment: either the top of the front sight or the entire bead should be held on the exact spot the bullet is to strike (Figure 2). As long as the shooter is not holding the rifle high to make allowance for range differences (holding high), this method of sight alignment will prove satisfactory.

A peep rear sight, instead of an open sight, gives the shooter a better combination when used with the bead front sight. An open rear sight, when used at long range and in combination with the bead front sight, may hide too much of the target. In any case, a shooter's method of sighting with both types of sights should be uniform.

By knowing the simple details of sighting, a shooter will be able to concentrate more on his or her target or game and increase shooting accuracy.

SIGHT STYLES

If the shooter is using a simple blade front sight in combination with either the peep or open rear sight, the sights should be aligned as described in the instructions previously given, following either the hunting procedure or the target-shooting procedure. If the shooter is using an aperture front sight, also called a hooded front sight (Figure 3), with a peep rear sight (Figure 4), the aperture should "ring" the bull's-eye in such a way that a thin, white ring shows around the bull's-eye, as shown in Figure 5.

When using a peep rear sight with a ramp or post front sight, the front sight should be held on the target as described previously, with one exception: now only the front sight is seen, and there is not a notch in the rear sight to align the sight to the target. Because the shooter's eye is so close to the peep sight, he or she will tend to look through the center of the hole(Figure 6). Here again, it is important to establish a firm regular habit of sighting through the rear sight. The eye should always center the top of the front sight in the center opening of the rear sight.

To prevent injury from recoil when shooting a high-powered rifle, do not hold a peep sight too close to your eye. The same precaution applies when using a telescopic sight.

ADJUSTING SIGHTS

Most sights have some means of adjustment for both windage, or sideways movement, and elevation. Most adjustments are made at the rear sight. On some rifle and handgun sights, windage adjustment can be made by moving the rear sight to the right or left in its slot. Use a brass drift punch and a hammer. If your gun is shooting to the right, move the rear sight to the left. Always move the rear sight in the direction you want the shot to go. In rare cases, it may be necessary to move the front sight, too. Always move the front sight in the opposite direction you want the shot to go. To make this adjustment, "zero-in" your rifle for windage. When shooting in the field, you must allow for wind drift by pointing the rifle right or left of the target.

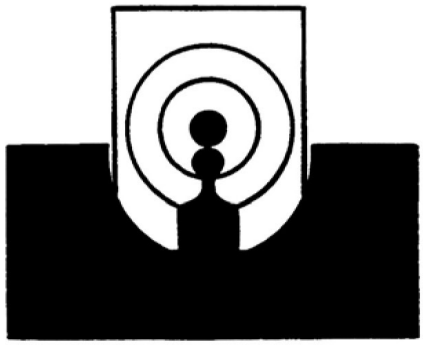


Figure 1: *Open rear sight and bead front sight correctly aligned on target.*



Figure 2: *Peep rear sight and bead front sight on game.*



Figure 3: *Hooded or aperture front sight.*



Figure 4: *Micrometer receiver target sight, a form of peep rear sight.*

On the ordinary open rear sight, elevation adjustments are made by means of a notched slide, or elevator, moving forward or backward in line with the barrel. Remember that raising the rear sight raises the point of impact of the bullet on the target. The notches on the elevator provide the simplest form of indicator scale for elevation. For example, if the shooter finds that for correct elevation in shooting at 100 yards, the rear sight must be set in the second notch of the sight's elevator, that notch becomes the 100-yard notch.

Peep sights are equipped with an elevator scale and are raised or lowered by means of either a screw or a slide and clamp. After zeroing, or sighting, at the desired range, the shooter notes the reading on the elevator scale. This becomes the rifle's zero for that range.

MICROMETER ADJUSTMENT

Most aperture or peep rear sights and all telescopic sights have a micrometer caliper graduated in ¼-, ½-, or full-minute divisions. A change in elevation or windage of 1 minute, or $^{1}/_{60}$ degrees, will move the point of impact of the bullet 1" at 100 yards, 2" at 200 yards, 3" at 300 yards, and so on. For a ¼-minute change, one click will move the bullet ¼" for each 100 yards of range. With this precise method of changing sights, it is easy to get an exact adjustment.

First, fire a group of at least three shots. Determine the center of this group and measure the distance in inches from this center to the center of your target (for example, 6"). Divide each distance in inches by the range in hundreds of yards (for example, 200) to get the number of minutes change in sight needed (6/2 =3). Move the rear sight the proper number of divisions in the direction you want the shot to go. Figure 7 illustrates lateral movement, or windage; Figure 8 illustrates elevation. If your sight is graduated in 14 minutes, you will need four times as many clicks as you have minutes (3 x 4 = 12 clicks).

In many cases, both windage and elevation will be off. When this is the case, measure the vertical distance from the center of the group to the vertical centerline of the target to determine the elevation change.



Figure 5: *Micrometer, peep rear target and aperture front sight on target.*



Figure 6: *Peep rear sight and blade front sight aligned on target.*

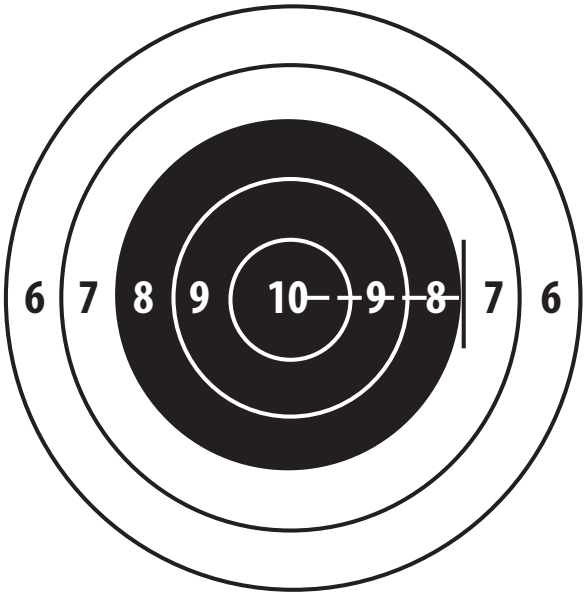


Figure 7: Target showing need for windage adjustment of sights.



Figure 8: Target showing need for elevation adjustment of sights.

Measure the horizontal distance from the center of the group to the horizontal centerline of the target to determine the change in windage. This is shown in Figure 9.

After changing sights, it is a good idea to fire another group of three to five shots to verify your settings.

Most hunting telescopes have interior adjustments for sighting. Knobs or screws are provided for changing adjustment and are marked Right or Left, Up or Down. Divisions are usually in minutes. Target telescopes have exterior adjustments in the mounts, with thimble and barrel calibrations similar to those on the micrometer caliper. Divisions are ¼ or sometimes $^1/_8$ minute, with an audible click marking each division.

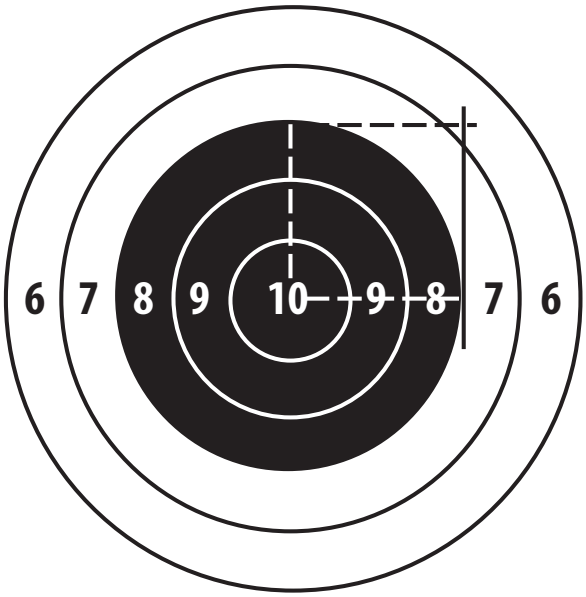


Figure 9: Target showing need for both elevation and windage sight adjustments.

SIGHT-SETTING CHARTS

Suppose your gun is sighted at one range, but you want to shoot at a longer or shorter range. You can do this by holding high or low the proper amount on your target or by adjusting the sights.

The path, or trajectory, of a bullet is given in terms of the average drop in inches of the bullet from the horizontal line of the rifle bore at various ranges. While these values are only absolutely correct when the bore of the rifle is perfectly horizontal, for all practical purposes the ballistic data can be used at angles of up to 10° from the horizontal.

Drop values, as stated in ballistic or bullet-drop tables, are based on information from individual cartridges, and such information is helpful in comparing various types of cartridges. However, hunters and target shooters are more concerned with how this trajectory data can be applied to their sighting problems, so the simple calculation necessary is discussed and outlined below.

The drop values quoted in most ballistic tables are related to the line of bore or, more correctly, to the initial line of travel of the bullet, but the shooter aligns his or her rifle by use of the sights. The difference between the line of sight before firing and the initial line of travel of the bullet is complicated by the jump and recoil of the rifle. Consequently, the shooter adjusts the sights by trial and error to be correct at one fixed range. Having done this, the shooter needs to know the sighting error at other ranges in order to aim high or low accordingly.

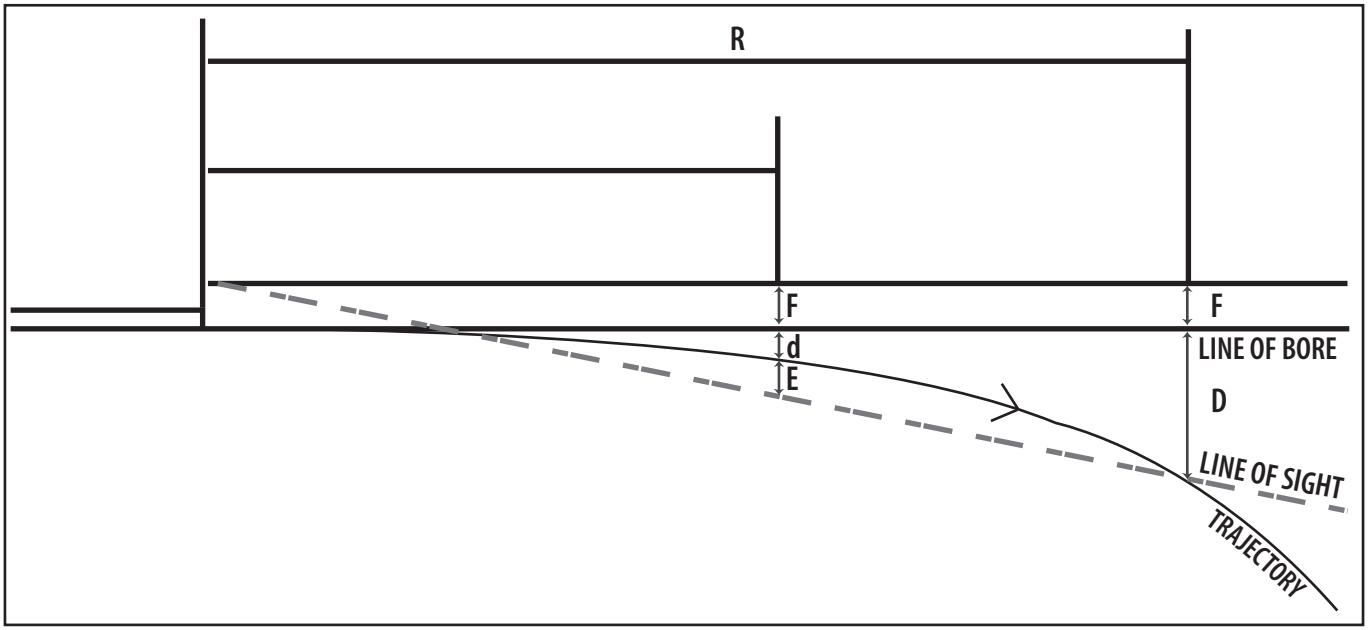


Figure 10: *Illustration showing a bullet's trajectory in relation to the line of bore.*

Refer to Figure 10 and the following equation to see how to calculate sighting errors.

E = r(D + F)/R–(d + F) Where:

R = the range in yards at which the rifle has been correctly sighted.

r = the range in yards in which the sighting error is required.

F = the height of the front sight (or axis of a telescopic sight) above the bore axis in inches.

D = the drop of the trajectory in inches at the range chosen for zero sighting error at the range R.

d = the drop of the trajectory in inches at the range r.

E = sighting error in inches.

If E is positive, then the trajectory at the range r is above the line of sight; to correct this, the shooter should aim low. If E is negative, then the shooter should aim high. For example, if a rifle with a front sight 1" above the axis of the bore has been sighted to give 0 error with a .22-caliber Long Rifle cartridge at a range of 100 yards, how much should the shooter aim high or low at a target at 50 yards?

To solve the problem, refer to the ballistic chart in Figure 11, then proceed as follows:

R = 100 yards and F = 1 inch

D (from the data in Figure 11) = 11.2 inches
r = 50 yards, d (Figure 11) = 2.5 inches

E = r(D + F)/R-(d + F)

= 50(11.2 + 1)/l00 -(2.5 + 1)

= 50x 12.2/100-3.5

= 12.2/2- 3.5

= 6.1-3.5

= +2.6

E = 2.6 inches

Thus, for a target at 50 yards, with the rifle sighted at 100 yards, the shooter should aim 2.6" low for the bullet to strike the target.

Now let us assume that the shooter desires to hit a target at 150 yards.

r = 150 yards; D (from Figure 11) = 27 inches

E = 150(11.2 + 1)/100 -(27 + 1)

= 3 x 12.2 / 2- 28

= 18.3 -28

= -9.7

E = -9.7 inches

Thus, for a target at 150 yards, with the rifle sighted at 100 yards, the shooter should aim 9.7" high.

It is important to remember that the 0 error setting must be carried out with the actual cartridge and bullet types to be used. It is not sufficient to sight with cartridges having a different bullet weight or different muzzle velocity.

Due to the differences among rifles in barrel length, recoil, and other factors, the calculated sighting errors should be regarded as approximate average results which may differ from actual practice.

The rifle-sighting table in Figure 12 will help determine the proper amount of change to make for various ranges with all of the standard center-fire cartridges. Remember, these figures are only approximate. Different guns, due to differences in barrel length, barrel weight, amount of wear, and other factors, may show somewhat different results in actual usage.

These tables are based on center-fire rifles sighted at 100 and 200 yards. These figures show the distance in inches above or below the line of sight. Positions above the line of sight are indicated by a plus sign; those below the line of sight are indicated by a minus sign. Hold under the amount indicated by a plus sign, over the amount indicated by the minus sign, or make the corresponding sight corrections.

Description	Bullet Weight (grams)	Velocity (ft./sec.)							Energy (ft. lb.)							Drop (in.)					
		Muzzle	25 yd.	50 yd.	75 yd.	100 yd.	150 yd.	200 yd.	Muzzle	25 yd.	50 yd.	75 yd.	100 yd.	150 yd.	200 yd.	25 yd.	50 yd.	75 yd.	100 yd.	150 yd.	200 yd.
22" Long Rifle High Velocity	40	1375	1280	1195	1130	1075	1000	935	168	145	126	113	103	88	77	0-6	2-5	6-0	11-2	27	52
22" Long Rifle High Velocity	35	1375	1260	1170	1095	1045	965	890	147	124	106	93	84	72	62	0-6	2-6	6-2	11-5	28	55
22" Long Rifle Target	40	1100	1055	1015	980	950	890	840	107	99	92	86	80	71	63	0-9	3-8	8-8	16-0	38	71
22" Long Rifle Standard	40	1050	1015	980	945	915	865	—	98	91	85	80	75	66	—	1-0	4-1	9-5	17-4	41	—
22" Long Rifle Standard Hollow	35	1050	1005	965	930	895	835	—	86	79	73	67	62	54	—	1-0	4-2	9-7	17-7	42	—
22" Short High Velocity	30	1125	1050	990	935	—	—	—	84	73	65	58	—	—	—	0-9	3-8	8-9	—	—	—
22" Short Standard	30	950	900	860	820	—	—	—	60	54	49	45	—	—	—	1-3	5-2	12-0	—	—	—

Figure 11: Ballistic chart of one brand of rimfire ammunition.

Cartridge	Bullet Weight	Type	Path of Bullet Above or Below Line of Sight in Inches					
			50 yds.	100 yds.	200 yds.	300 yds.	400 yds.	500 yds.
.222 Rem.	50	S.P.	+.0.5	+	-4.9	-17.50		
.222 Rem.	50	S.P.		+2.45	+	-10.15	-32.3	-73.8
.22-250	55	S.P.						
.223 Rem.	55	S.P.		+1.9	+	-8.5	-26.7	-59.6
.270 Win.	100	S.P.	+0.4	+	-3.4	-11.5	-25.0	-46.0
.270 Win.	130	H.P.	+0.5	+	-4.2	-13.8	-29.4	-52.5
.270 Win	150	S.P.	+0.7	+	-6.2	-19.8	-43.4	-80.0
.270 Win	150	S.P.		+3.0		-10.5	-31.0	-64.5
7 x 57 m/m	175	S.P.	+0.8	+	-7.3	-24.2		
.30-30	170	S.P.	+1.2	+	-9.1	-31.4		
.30-06	150	S.P.	+0.6	+	-5.2	-17.2	-38.1	-71.0
.30-06	180	S.P.	+0.07	+	-6.5	-21.0	-47.0	-87.0
.30-06	180	S.P.		+3.1	+	-11.3	-34.0	-70.8
.30-06	220	S.P.	+0.8	+	-7.6	-25.4	-54.7	-101.0

Figure 12: *Table showing the bullet drop of several popular centerfire cartridges.*

SELF-TEST QUESTIONS

Please check your answers on page 22.

1. *True or False.* **The two most common sights are the bead front sight and the notched, open rear sight.**
2. **What is the correct view of the bull's-eye that you should obtain with an aperture front sight?**
3. **How should the rear sight always be moved when adjusting for a different bullet impact?**
4. **What is the name given to ballistic tables that show how far above or below the target a bullet strikes at different ranges?**

Development of Metallic Sights

Perhaps the most useful item in connection with the rifle is the sighting equipment. Without sights, even the finest rifle would be virtually useless. The average shooter pays too little attention to sighting equipment. The target shooter knows that sights can add or subtract many points from a score. While each expert has his or her individual ideas, all know what type of sight will perform best with their individual eyesight and method of handling a rifle.

The idea of sights is not new; it dates back over 500 years. The open, or regular V-type, sights were used on the earliest muzzleloading rifles — wheel locks, flint- locks, and even the earliest matchlocks.

The earliest guns were smoothbore, using a round ball. Not very accurate, they shot in the general direction the shooter aimed. Then came rifling, which gave the shooter a reasonable amount of control over the gun and where it shot. However, there was no value in this control without a better method of aiming. Consequently, sights were introduced.

Sights were used on guns dating back to 1475. However, the first official recognition of gun sights by an army dates to 1598, when Maurice of Orange ordered that the army of the Netherlands be equipped with muskets having sights.

Modern sights are grouped into two general categories: iron or metallic, and telescopic.

In the past, a wide variety of hunting sights were used. Some were streamlined, while others were very crude. The original hunting sight was probably a simple brass bead similar to that used in all low-priced shotguns today.

Various materials have been used for front sights. The Lyman factory introduced an ivory bead front sight in the late 1870s. Another material often used was "German silver," which was simply an alloy of copper and nickel similar to the metal used in the U.S. five- cent piece.

Next came the so-called "gold" bead. There have been gold beads manufactured from real gold, but most gold beads are actually bronze. Most silver beads are made from various white metals, although there have been sights made from pure silver. Of course, almost any color imaginable can be made today. A bakelite-type substance is used for many types of sights and comes in a variety of colors, including red.

While the choice of a front sight for hunting is more or less a matter of personal choice, the type of hunting to be done greatly influences this choice. For woods hunting, where the background will be green or brown, a white bead of ivory or some ivory substitute is a good choice. A gold bead is also a good choice.

Red beads are gaining in popularity every day. They stand out against a woody green background, against the gray found in hardwood territory in the late fall, against the brown of fallen leaves, and against snow. Many shooters now prefer the red bead front sight for all types of hunting.

Beads come in various shapes, including square and round, and an almost unlimited variety of sizes. While there is a great difference in opinion as to which may be best—the square or round bead—square beads usually yield better results. They are just as visible as round beads and can also be used for target shooting.

Bead size is another factor to consider when choosing the proper sight for a rifle. The choice of a bead size is not only a matter of taste, but also of shooting conditions. For the hunter who does a lot of quick, short-range shooting in poor light, a large bead front sight, either round or square, is a good choice, because it is easy to see.

For shooting at longer ranges—at 100 yards or greater—a small bead is best, since it does not obscure as much of the target. A $^{1}/_{10}$" bead on a 24" barrel will completely cover the vital portions of a deer at 200 yards. A smaller bead should be used for such shooting.

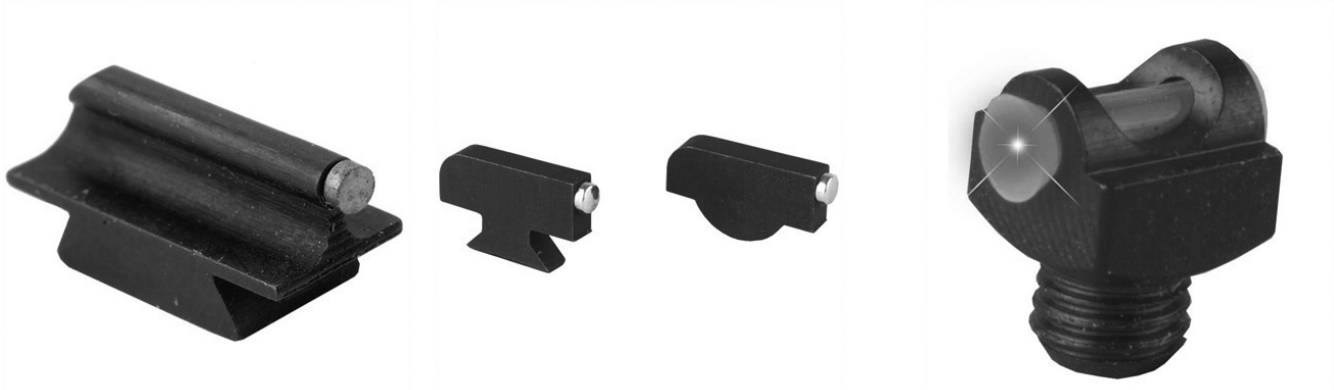


Figure 13: *Several types of bead front sights.*

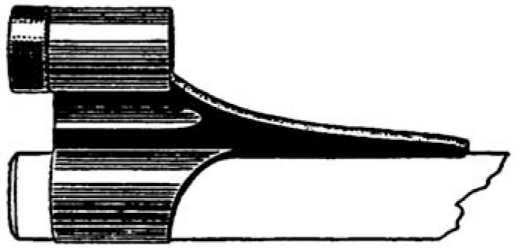


Figure 14: This detachable front-sight hood is designed specifically for protecting the front sight.

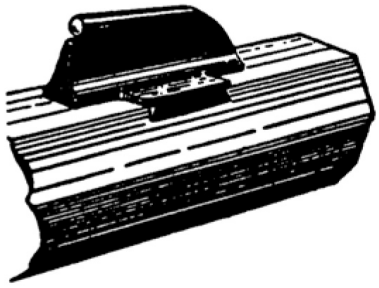


Figure 15: Many front sights are mounted by means of a dovetail slot..

However, when considering bead size you need to realize that beads of the same size may look different, depending on what type of gun they are used on. A $^{1}/_{10}$" bead on a 30" .30-40 Krag barrel looks a great deal smaller than that same bead on a Winchester Model 94 20" carbine.

Another important factor to consider when choosing a front sight for hunting is the type of bead face (Figure 13). Beads are manufactured with oval faces, slightly rounded faces, hemispherical faces, and true flat faces. Many shooters prefer the flat face because any sight with a curved-face surface is inclined to create errors in aim. For example, if you are shooting in normal daylight, with the sun practically overhead at noon, the top portion of the bead will reflect the rays of the sun, and you will unconsciously use this bright spot when you aim. This will cause you to aim as if you were using a higher front sight, causing the shot to strike low at a normal range.

If the sun strikes the left side of the sight and is reflected from that point, the normal error of aim will cause the shot to strike to the right and vice versa.

These facts are extremely important for hunters shooting in the woods. Hunters searching for big game do not get many shots at their quarry. In many cases, a missed shot may be the only shot the hunter will get during the hunting trip. Accordingly, the hunter should not be handicapped with sights that reflect light, causing an optical illusion. The flat-surface front sight will not reflect light.

SIGHT HOODS

Aside from sight beads, one of the most useful accessories on a front sight for hunting is a detachable hood (Figure 14). These hoods should not be used in the woods or fields; they should be detached and carried in the hunter's pocket. A hood will protect the corners of the sight from being knocked off if the gun is bumped during normal handling or while in the gun case.

Most of the better centerfire rifles produced over the past 50 years or so have these detachable metal hoods. The rifle can be used with the hood, but most hunters obtain a better view with the hood off. The hood should always be replaced each time the gun is returned to its case. It only takes a minor blow on a front sight to break off the bead or to bend the sight beyond repair. A bent front sight should never be straightened; replace it as soon as possible.

MOUNTING METALLIC SIGHTS

Front sights are attached to rifle barrels in several ways. The simplest way is by means of a dovetail slot in the barrel with the sight driven in. This dovetail is tapered, and the sight should always be driven in from left to right and driven out from right to left, if you are viewing the sight from the breech end. Keep this in mind or you might damage both the sight and the dovetail slot (Figure 15).

Another method of mounting a sight to the rifle barrel is to install a sight ramp or sight base by means of threaded screws or by soldering. However, the blades themselves usually are attached in the dovetail slot on the base. Some have a setscrew to further secure the sight blade.

REAR SIGHTS

There are two distinct forms of rear sights used for hunting — the open sight and the peep sight. We will discuss open sights first. See Figure 16 for a few examples of open rear sights.

The open sight, invariably located on the rear of the barrel just ahead of the receiver, is the most popular form of metallic sight. It is made in two varieties - adjustable and nonadjustable. Every hunting rifle uses an adjustable form of sight. Some of these rear sights have adjustments for both windage and elevation, while others have adjustments for elevation only. In this latter group, if the shooter needs to adjust for windage, he or she must move the rear sight in the dovetail slot in the barrel.

The open sight is the least accurate of the two, but it does have some good points. In the hands of the experienced shooter who must shoot running game in heavy cover, the open sight performs nicely. Shooting of this nature is frequently a case of pointing the rifle rather than actually aiming, particularly at short range.

Rear sight notches consist of V types and U types. One of the best rear sight notches for snap shooting is absolutely flat on the top with a small, vertical white line in the center. The bead front sight is merely leveled off even with the top of the rear sight and centered by means of that white line. In the hands of an expert hunter, this is not only a fast means of aiming, but also an unobstructed view of the game. This is particularly important when shooting at moving game.

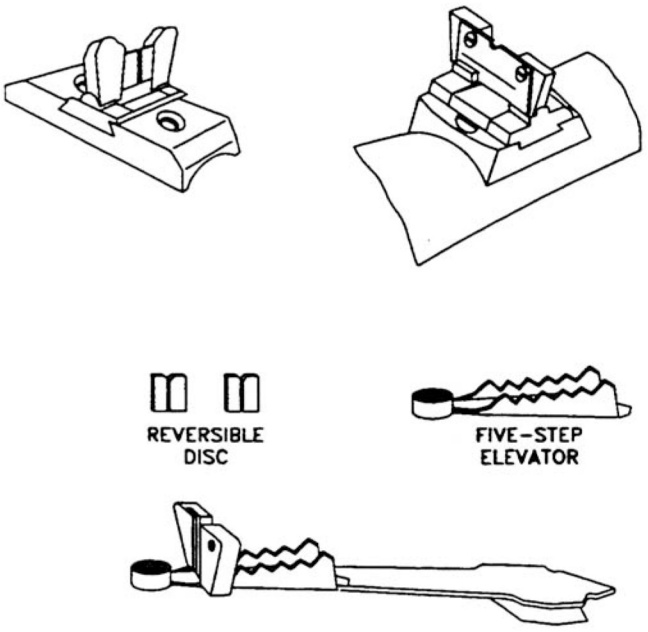


Figure 16: A few types of open rear sights for use on rifles.

The U-notch rear sight is designed for use with a round-bend front sight, and the U notch should be big enough so that just a faint trace of white light is seen on either side of the bead. This permits easy centering. If this U notch is too small, and the entire bead does not show up properly, shooting will be inaccurate.

V notches consist of fairly deep, narrow Vs and wide, shallow Vs. For snap shooting, the wide, shallow V is the one to choose. A V notch should always be used with a round bead sight if the best results from the rear sight are to be obtained.

One type of sight, introduced around the turn of the century, is the buckhorn rear sight. This type of sight uses both V notches and U notches. It has a very large U notch frequently in the form of a half-circle ¼" or 3/8" wide. In the bottom of this deep U is a small U or V notch. The existence of these buckhorn sights has never really been explained, since they offer nothing of value to sighting with metallic sights.

A better rear sight is the adjustable folding leaf sight, in which one or more leaves of different types are used. Many hunters assume that this type of sight is fairly new, but folding leaf sights have been around since the 1500s. In practice, each folding leaf has a different sighting range; that is, the first leaf may be for shooting at 100 yards, the second for shooting at 200 yards, and the third for shooting at 300 yards. This type of sight is frequently used on safari-type rifles used to shoot big game.

There are also numerous types of military sights that are located on the barrel with leaves that can be folded up and adjusted either by means of a micrometer screw or by sliding the rear notch. This type of sight is useless for practical hunting purposes and, therefore, will not be discussed in this lesson.

PEEP SIGHTS

Peep sights fall into two distinct groups: those used for hunting and those used for target shooting. Some peep sights used for target shooting are also ideal for hunting, but others would be a handicap in the woods. In addition, there are three different types of hunting and target peep sights: the receiver type; the bolt, or sleeve, type; and the tang type. Of these three, the receiver peep sight is most widely used on hunting and target rifles.

Contrary to popular belief, the peep sight is easier to use than the conventional open sight, because you do not really use the rear sight. You look through it and merely line up the front sight with the target. To demonstrate, form the thumb and first finger of one hand into a circle. Look at an object across the room, preferably something quite small. Hold the ring (circle formed with the thumb and finger) in front of your eye with your gaze concentrated on the distant object, not your hand. You will discover very quickly that you are looking through the ring, not at it. Shorten the focus of your gaze to concentrate on your hands and you will find that you have your "target" in the exact center of the ring or peep. In other words, your eye centered the object automatically.

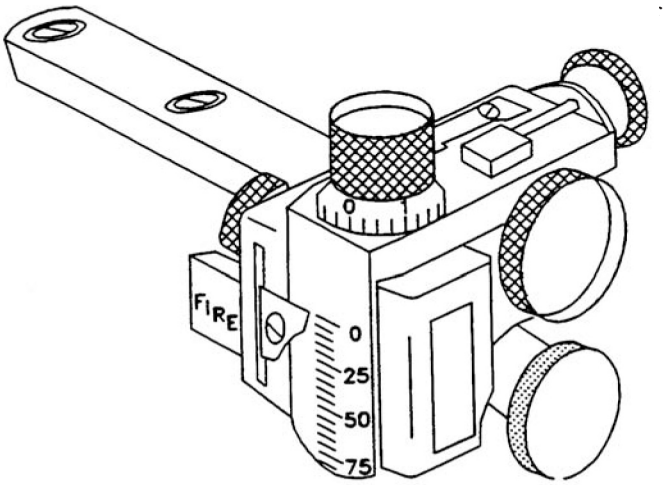


Figure 17: Micrometer adjustment on a typical peep sight.

Another reason the peep sight is more accurate than the conventional metallic sight is that the distance from the rear peep sight to the front sight is longer; the longer the distance between sights, the less margin of error.

For hunting, as well as for target shooting, the peep sight should be located as close to the eye as the design of the mechanism and sight will permit. In most cases, the receiver peep sight is located on either the left or right side of the receiver. Some rifles offer a choice of mounting on either side, even in the same make and model of rifle. The left side is usually the best choice, since, for most right-handed shooters, the receiver sight located on the right would be in the way in rapid-fire manipulation of the bolt handle.

A peep sight offers a great deal of advantage for hunting because there is no ordinary barrel-type rear sight to obstruct the shooter's view of the game. The muzzle of the barrel appears to stick up into the air, and the shooter can see around, above, and practically below the game being shot at. This is particularly important when shooting at running game.

Peep-Sight Adjustment. The peep sight may be micrometer adjusted (Figure 17) or equipped with crude, simple forms of moving the rear sight to compensate for various changes in range. Some peep sights have adjustments for both elevation and windage, while others have adjustments for elevation alone. One type of peep sight, used on the first U.S. Ml carbines, used a flip-type adjustment. Consequently, the sight could be changed instantaneously from one sighting range to another. However, for practical purposes the average hunter would do well to sight his or her rifle in at any reasonable range at which game is expected, and then leave it alone when in the field. Hunters, unless they are skilled target shooters, rarely have the ability to make quick adjustments with any reasonable degree of success.

If a rifle shoots high, the peep sight should be lowered accordingly. Conversely, if it shoots low, the rear peep sight must be raised. Windage adjustments are made in a similar fashion; that is, if the rifle shoots to the right of the target, the peep sight should be moved to the left; if it shoots to the left, the sight should be moved to the right.

Hunting sights should have adjustments which, once made, can be tightened securely to prevent them from being changed accidentally if the rifle is jostled.

TARGET SIGHTS

A variety of target sights have been manufactured over the years, and new ones are constantly being developed. Let us look once again at the front sight.

Most target sights in use today are blade, or post, sights, which use no form of bead. The round bead is extremely difficult to use for serious target work, and no expert sharpshooter would consider using it.



Figure 18: *Globe front sight with removable inserts.*

Next comes the globe sight. Dating back over 100 years, this sight is by no means new. The most common globe sights have removable inserts with different faces, as shown in Figure 18.

The chief advantage of using one of these globe sights with inserts is that the inserts can be changed to meet existing conditions. Where an aperture or peep front sight is used, this aperture should just encircle the bull's-eye with a faint white ring around the edges. It is therefore necessary to change the inserts when shooting at various ranges if satisfactory results are to be obtained.

The same is true of changing the post inserts. For short-range targets, a thick post can be used; for long-range targets, the post should be narrowed down as much as possible. Changing the inserts in globe sights usually takes less than a minute.

One main advantage of the globe front sight is that, regardless of the angle of shooting and the direction of the sun, the part that actually serves as the sighting point is well shaded. This prevents any change in point of impact due to an optical illusion.

The most useful target rear sights are usually peep sights. There are two general types of receiver sights: the *standard type* and the *extension type*. The latter has an arm of some sort extending the peep sight as close to the eye as possible. Some of these are nonadjustable; others permit positioning to meet individual requirements. The latter type is useful when shooting in different positions. It can be extended further to the rear for offhand work and moved up for shooting in the prone position.

For serious shooters, the target peep rear sight has very definite requirements. First, it must have some sort of eyecup so that different sizes of apertures can be used. Second, it must be micrometer adjustable for both elevation and windage. (Figure 19).



Figure 19: *Target receiver sights with positive-click, micrometer adjustments on both windage and elevation.*

Generally speaking, any sight with a micrometer adjustment adjusts by means of a screw thread. The following explanation will seem elementary to the advanced shooter, but it is a good idea for beginners to understand the principle.

Assume that you are adjusting for elevation. Different screw threads are used for easy calculations. Suppose the thread is very fine, running 50 threads per inch. The elevation screw is given one complete revolution, and the sight, therefore, is elevated $^{1}/_{50}$ of an inch. If given one-half revolution, the elevation is $^{1}/_{100}$ of an inch or .002 inch. The shooter does not have to figure this out. Various target sights are figured out into minutes of angle.

A minute of angle equals 1" at 100 yards and 2" at 200 yards. If a sight is graduated thus, the makers advise the buyer that with the sight mounted properly, the shooter will have ¼-minutes of angle of adjustment. This means that the shooter can change the sights in elevation or windage by such a minor degree that it will represent only ¼" in impact at 100 yards. This is extremely important for precision shooting. In small- bore work at 25 yards or at 50', the expert shot frequently has to change his or her sights enough to move the point of impact of the bullet over by less than the width of the bullet to make perfect scores. Too great a movement would place the shooter on the opposite side of the bull's-eye.

A click-adjustment rear sight is one in which the various adjustments are made through an attachment to the screw thread, which gives a distinct click, usually in ½-minute and ¼-minute increments.

Bear in mind that when adjustments are in the rear sight, you must always move the rear sight in the direction that you want your shot to move.

Assume that the shooter is capable of fine shooting and desires to sight-in his or her rifle for shooting at 100 yards. Further assume that a steady wind is causing the shooter some problems. The light on the target changes the appearance of things, and other range problems have come up. Accordingly, the shooter tries two sighting shots, both very carefully aimed with the conventional six o'clock hold at the bottom of the bull's-eye. Let us assume that both shots cut into the same bullet hole at about seven thirty o'clock, 1" low and 1" to the left.

To get the shots into the bull's-eye, using a peep sight with ¼-minute click adjustments, rotate the windage knob to move the sight to the right four clicks. This represents one minute of angle. Then turn the elevation knob four clicks to raise the rear sight. The net result puts the remaining shots in the bull's-eye — provided, of course, proper holding and accurate ammunition is used.

Herein lies the advantage of a micrometer-click rear sight. Accurate adjustments can be obtained very quickly without using large quantities of ammunition by making adjustments using the "trial-and-error" system. Also, the trial-and-error system is never permitted in target-shooting matches.

With an adjustable sight, the shooter can place his or her shots properly at a different range without wasting ammunition. An accurate log is kept showing what the adjustment should be on the rifle's sight and the micrometer scale.

This whole process may seem complicated, but it really is not. It is the only practical system of sight adjustment when fine adjustments are necessary.

INSTALLING METALLIC SIGHTS

Most modern metallic sights are designed to be used on a sight base that is attached to the rifle barrel by two or more screws. The next lesson covers complete drilling and tapping operations, so in this lesson we will discuss mainly the tools specifically designed for installing iron or metallic sights.

The B-Square sight drill jig, shown in Figure 20, is excellent for installing both front and rear metallic sights. The jig is based on a precision V-block drill guide with two #31 bushings located .5625" apart to match the Williams Guide sights, along with those on Remington and Winchester rifles. The tool can also be used to install shotgun, front bead sights as well as ramp-type sights for rifles. This jig is easy to use and will center one or both holes on any round barrel up to a 1" diameter.

Many modem gun shops use a dovetail cutter in a milling machine to cut dovetails in rifle barrels. However, a dovetail can be cut with hand tools. All you need is a small mill file to start the cut in the metal; then use a triangle dovetail file (one cutting side and two safe, or smooth, sides) to finish the dovetail cut.

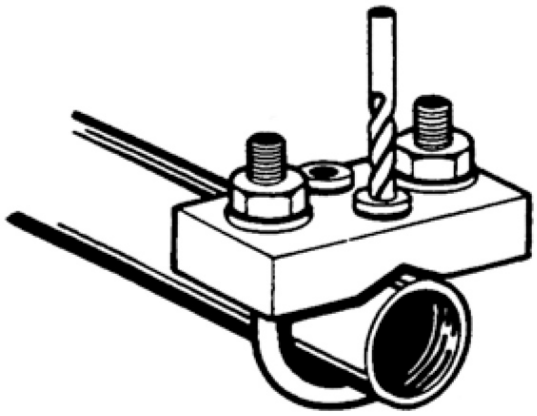


Figure 20: *B-Square sight jig is a great help when installing metallic sights .*

SELF-TEST QUESTIONS

Please check your answers on page 22.

5. **What are the two general types of target peep sights?**
6. ***True or False*. A peep sight is harder to use than a regular rear sight mounted on the barrel.**
7. **What is the general name of a target front sight with detachable inserts?**
8. **What is used normally in conjunction with sight blades to secure them in place?**

Custom Sight Installations

Custom sight installations can be addressed in any one of several stages during the production or customization of a firearm. The choice and style of sight, along with the type of firearm, will determine the appropriate time to consider installation. However, if the chosen sighting system involves additional machining, this should be done prior to any final finish.

The style and intended use of the weapon should dictate the type of sight to be used. For example, consider the popular Colt Model 1911 semiautomatic pistol. The recommended sight configuration on a combat weapon is a high-visibility, fixed-sight system. Many are available, and most popular models feature a broad, serrated rear blade with a recessed notch.

Blade enhancements are offered with either a white outline or the European dot system. Some of the available configurations are shown in Figure 21.

NOTE: Color-enhanced sights and inserts offer a quick sight reference at short range under limited light conditions. But this advantage is negated at longer distances when the colored enhancement causes varying sight pictures under changing light conditions. Make your choice accordingly, knowing that this trade-off exists.

Most of these fixed sights do not require additional machine work unless they are of the new generation extended variety. A target-style weapon will require a suitable adjustable sight to accommodate various loads. There are many such sights available, and most require extensive machining. The blade enhancements include both white outline and dot systems. But for the target shooter, the traditional black-on-black configuration is equally as popular (D in Figure 21). The recommended and preferred configuration is the low-pro- file configuration. This is also the popular choice of combat shooters who prefer an adjustable sight. In the "custom" category, where the shooter's preference is considered more heavily in equipment selection, the chosen sight configurations vary greatly.

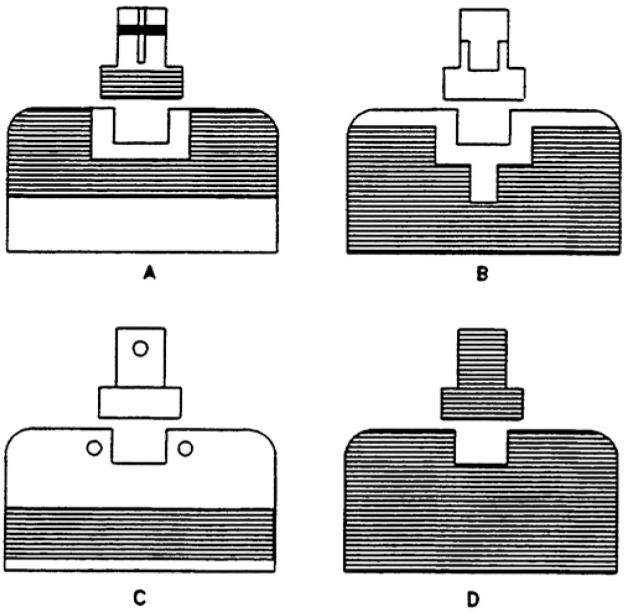


Figure 21: *Several types of iron sights for the Colt Model 1911 semiautomatic pistol.*

NOTE: There are many high-quality custom sights available. However, if your customer indicates a preference for a specific model with which you are unfamiliar, research the product thoroughly before agreeing to install it. Even though the product may be your customer's choice, you are, in essence, endorsing it when you agree to use it. Avoid potential problems involving premature product failure by installing only those components with which you are familiar and willing to endorse. Whatever the chosen sighting system may be, follow the manufacturer's installation recommendations.

Since gunsmiths are still frequently asked to install the S&W K-frame sight on a Colt 1911 semi-automatic, we will address that installation procedure. This adjustable revolver sight was the primary consideration when preforming this popular conversion prior to the availability of specialized custom sights. Because of the nature of this modification, there are no manufacturer's installation instructions available; for that reason, we will outline this procedure.

If the slide being used has been cut for a standard fixed sight, that dovetail must be filled before performing any machining operations. See the close-up in Figure 23. Since the slide has under- gone numerous modifications and will require refinishing, this slot-filling method is open to several options. Both swaging and welding are recognized methods. To adhere to our policy of avoiding heat whenever possible, cut a slot blank and fit it carefully to the dovetail. When an interference fit is achieved, press the blank into the slot and peen it in place. Using a mill file, contour the blank to conform to the profile of the slide. Lightly peen the area again to ensure uniform contact. Remove any remaining irregularities by draw filing.

The next stage of this modification is best pre- formed with a milling machine fitted with a ¼" carbide end mill, as shown in Figure 22. The setup requires that the slide be centered and positioned level for a longitudinal pass. Elevate the table to engage the top surface of the slide and make a cut from the hammer recess to the ejection port as indicated by arrow X. This cut (Figure 22 inset) is made to a depth of 0.017", dimension A, and then widened to a final dimension of 0.280", dimension B. This finished width is achieved by removing 0.015" from each side of the channel. Next, the end of the slide must be relieved above the hammer to accommodate the sight's windage housing as indicated by arrow Y in Figure 21. This cut can be executed by making several horizontal passes with the cutter set at a depth of 0.175", dimension C in Figure 22 inset. Repeat as necessary until a 0.250" recess has been cut, dimension D. This completes the required milling procedure on the Colt Model 1911.

Both the front retaining screw and the elevation screw of the new sight will be replaced with heavier and harder screws to better handle the shock in the cycle of the automatic action

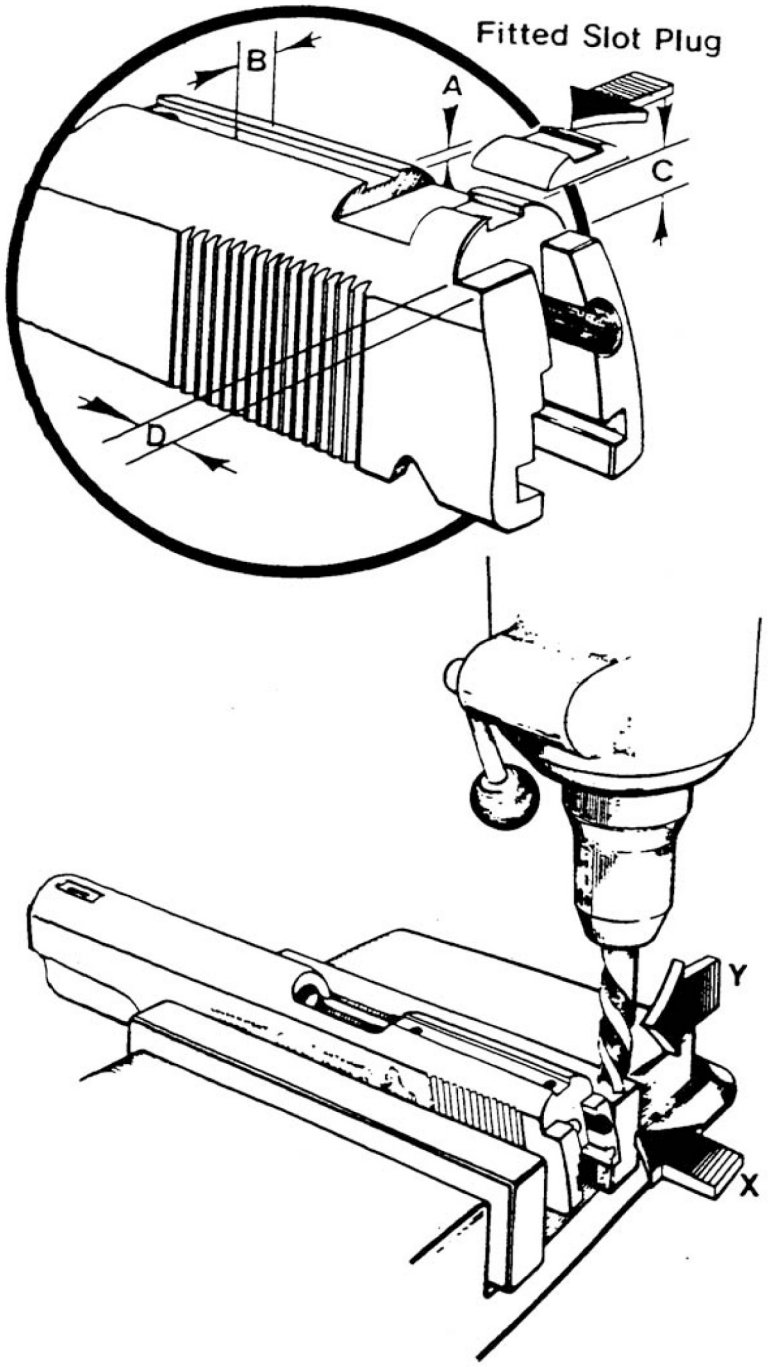


Figure 22: *A milling machine with a ¼" carbide end mill is ideal for sight modification*

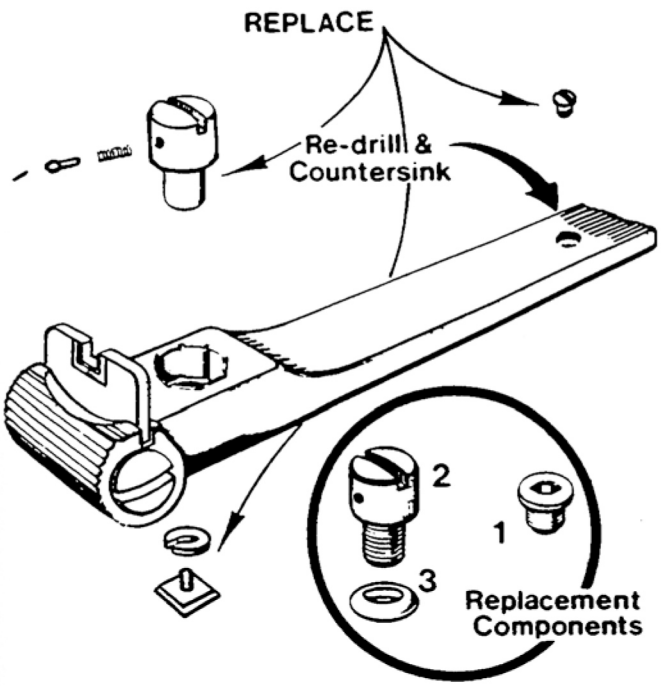


Figure 23: Certain parts are replaced to better handle the shock in the cycle of automatic firing.

(Figure 23). The front hole for the retaining screw in the sight tang should be redrilled to a 0.1495" diameter with a #25 drill bit.

NOTE: Carbide machine tools are recommended when working with the hardened component parts of the sight and slide.

The redrilled hole should then be clearanced with an 82° countersink to accept a #6 flat-head, socket cap screw (#1). The rear adjustment screw should be replaced with a #6 fillister screw fitted with a detent plunger and spring (#2). The head of the fillister may be cross-drilled with a #55 drill bit to accept the detent. The spring and plunger housed in the S&W sight nut can be used. Next, position the sight on the modified slide and mark the location of both holes.

NOTE: The #6 screws are available in several thread dimensions. The recommended threads per inch for both screws is 48, although a lesser TPI is acceptable.

If a 6-48 screw is used, select a #31 tap drill to pre-pare the slide. Use a #33 drill bit if you intend to tap it 6-40 or a #36 for a 6-32 tap. With the slide properly drilled and deburred, select the appropriate tap to cut the thread. After the threading is completed, clear the taped holes of all chips and residue. Place the sight in position and insert both screws to confirm that you have a full range of adjustment. Remove the sight to shorten and re-dress both the screws and the tang as required.

NOTE: In the final stage of assembly, when you reinstall the sight, place a small rubber o-ring (#3) between the sight and slide and then thread the adjustment screw through it. This will function as a buffer to absorb shock and prevent the sight from rebounding, a common cause of sight failure.

Before installing the front sight, you may wish to do additional machining to add cosmetic details. Serrating the top of the slide is a popular enhancement and can be accomplished with a veining cutter using multiple passes. An alternate method employs a horizontal mill fitted with a special veining cutter to address the entire surface of the raised rib on a Gold Cup" or "custom" slide, as shown in Figure 24.

NOTE: To ensure a fine cut and to protect the cutting tools, the use of coolant fluid is recommended to dissipate heat generated when machining harder metals at high speeds.

The rear slide serration may be best accomplished by hand using a checkering file, as shown in Figure 25, also on the next page. This procedure is initiated by laying out a master line and using each successive cut as a guide. When the grid is laid out completely, the serration may be cut to its final depth with a 60° pointing file. Please note that this operation is completed with the extractor in place so that the pattern is extended over and uniformly covers the extractor base.

NOTE: These special checkering files are available in specific lines-per-inch patterns. For aesthetic appeal, duplicate the pattern used on the rear blade. For example, the S&W K-frame sight exhibits a 30 LPI pattern and is easily duplicated using the appropriate file.

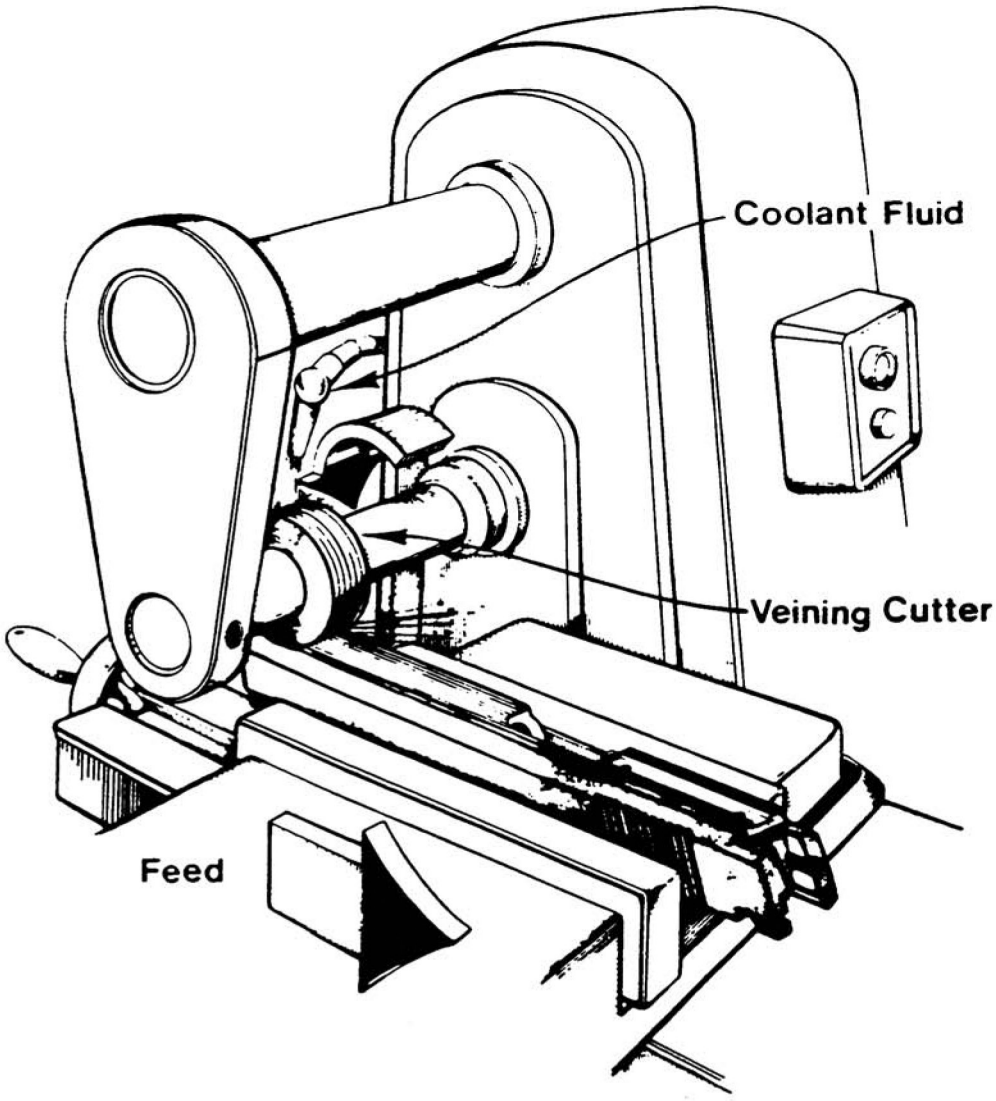


Figure 24: *A horizontal mill fitted with a special veining cutter is sometimes used to dress the metal surfaces.*

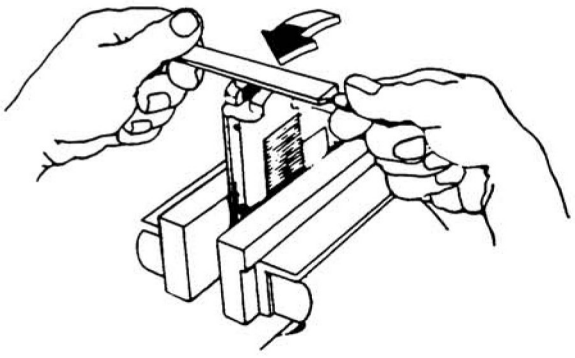


Figure 25: *A metal checkering file may be used for most of the serrating operations required to install custom sights on a Colt Model 1911 pistol.*

SLIDE PRE-ASSEMBLY PREPARATION

Following basic milling operations, clear the slide of all remaining chips and residue produced by the machine procedures. Check all of the internal machined areas of the slide to ensure that they are blemish-free. Refer to Figure 26 on the next page. Clear and deburr the channel that houses the firing pin stop indicated by arrow A.

Next, check the firing pin tunnel, indicated by arrow B, to ensure that it is free of obstructions that could interfere with the firing pin spring or obstruct the firing pin movement. If the slide has been in service, inspect the breech face, indicated by arrow C, and remove any existing irregularities. Arrow D shows the extractor tunnel, which must be cleared and deburred before installing the extractor. Finally, the surface of the disconnector rail, indicated by arrow E, should be polished to ensure that it is free of any wear or rub marks.

SELF-TEST QUESTIONS

Please check your answers on page 22.

9. **Are color-enhanced sights for pistols better at close range or long range?**
10. ***True or False*. A target-style semi-automatic pistol should have nonadjustable, or fixed, sights.**
11. **What type of milling-machine cutter is used to serrate Colt 45 pistol slides?**
12. **What type of hand tool is used to cut rear slide serrations on a Colt .45 pistol?**

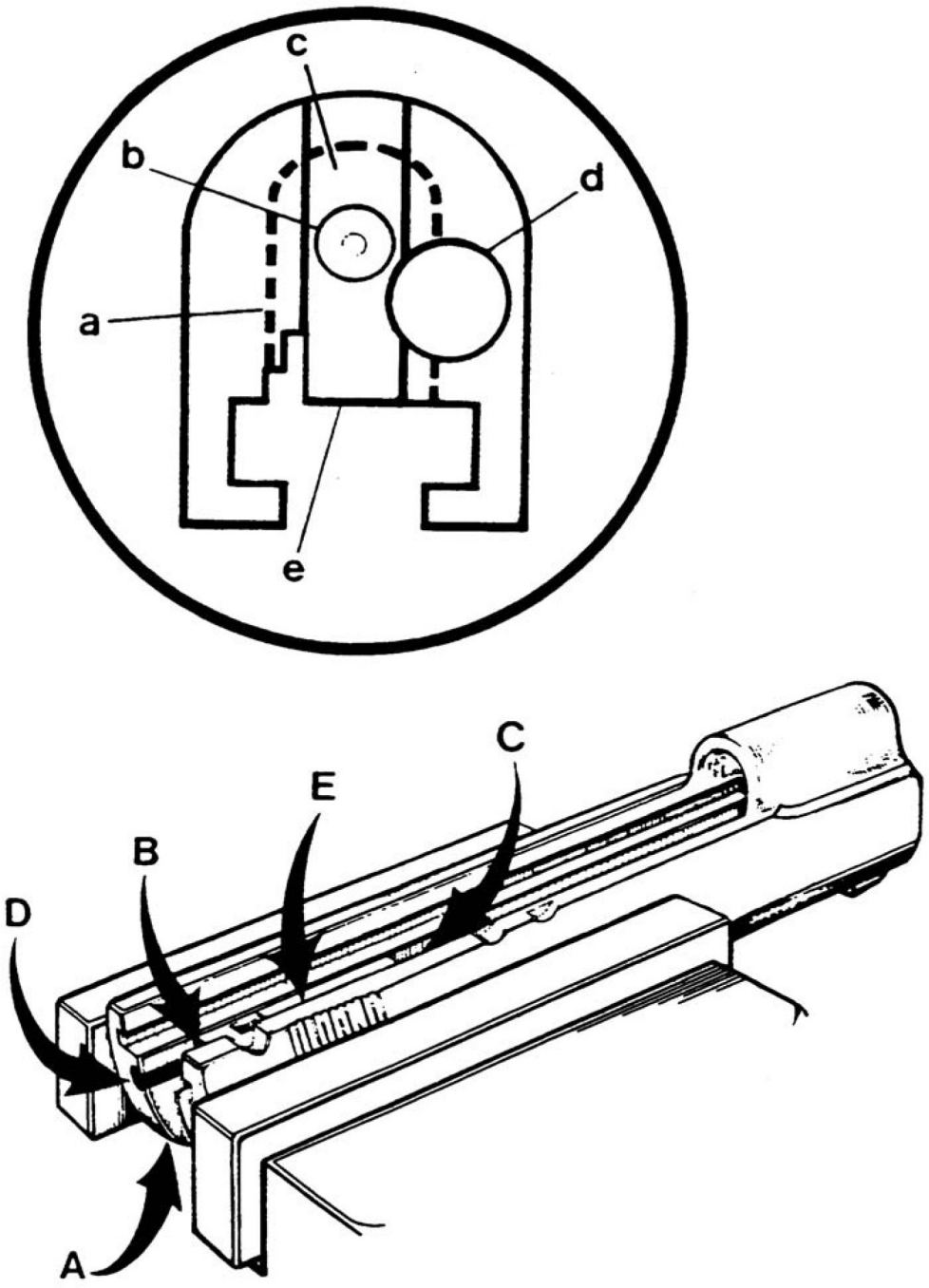


Figure 25: Check all of the internal machined areas of the slide to ensure that they are blemish-free

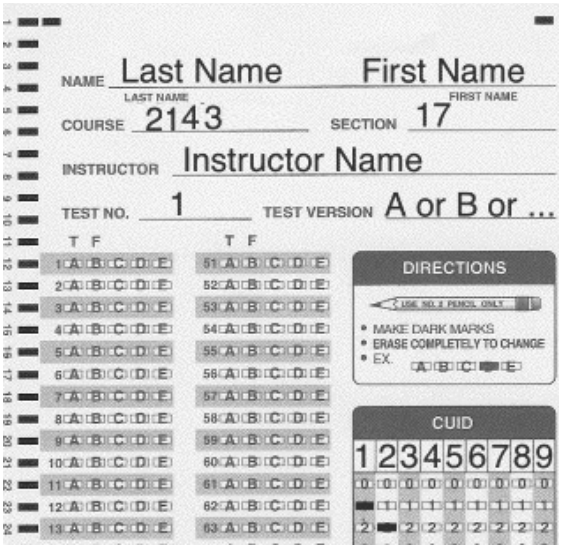
Answers to Self-Test Questions

1. True.
2. The aperture should "ring" the bull's-eye so that a thin, white ring shows equally around the bull's-eye.
3. Move the sight in the direction you want the bullet to go.
4. Bullet drop tables.
5. Standard and extension.
6. False.
7. Globe front sight.
8. A sight base or ramp.
9. Close range.
10. False.
11. A veining cutter.
12. A checkering file.

Lesson Questions

THIS IS LESSON NUMBER 2170.

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



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

You may also complete your exams and submit them online via the SDI Student Services page at www.sonoranlearning.com.

1. **When sighting at a bull's-eye in a paper target, where should the front sight bead be held?**
   a. In a position where the bead will completely cover the bull's-eye.
   b. Directly in the center of the target's bull's-eye.
   c. Directly at the bottom of the target's bull's-eye.
   d. Directly at the top of the target's bull's-eye.

2. **When sighting a rifle, what should you do to change the point of bullet impact on the target?**
   a. Adjust the rear sight.
   b. Adjust the front sight only.
   c. Adjust both the front and rear sights.
   d. Use "Kentucky windage."

3. **What distance, in inches, will a change in elevation of 1 minute move the point of impact of a bullet at 100 yards?**
   a. ½ inch.
   b. 1 inch.
   c. 2 inches.
   d. 3 inches.

4. **What is the path of the bullet's flight called?**
   a. Line of flight.
   b. Ignition.
   c. Internal ballistics.
   d. Trajectory.

5. **Which of the following is a correct statement about metallic sights on firearms?**
   a. Rifle sights have been used on firearms for over 500 years.
   b. Open sights are usually more accurate than peep sights.
   c. Sights are grouped into two general categories— iron or metallic.
   d. Open rifle sights are useless at ranges beyond 50 yards.

6. **When hunting in snow, which of the following front sight bead colors should not be used?**
   a. Red.
   b. White or ivory.
   c. Gold.
   d. Yellow.

7. **What size front sight bead should be used for shots over 100 yards?**
   a. A large bead
   b. An extra-large bead
   c. A small bead
   d. No bead at all

8. **What is the main purpose of a sight hood?**
   a. To protect the front-sight bead.
   b. To encircle the target for aiming.
   c. To make the front sight darker.
   d. To make the front sight show up better.

9. How should a dovetail sight be removed?

a. It should be driven out from right to left.

b. It should be driven out from left to right.

c. It should be driven out from either the left or right.

d. It should be twisted with a wooden dowel and then lifted upward.

10. What are the two types of notches usually found in open metallic sights?

a. T and I types

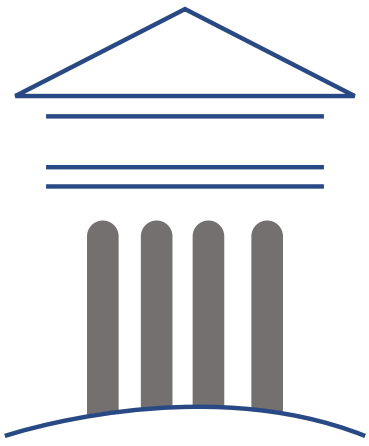
b. X and Y types

c. V and U types

d. C and F types

Telescopic Sights: Design and Application Lesson: 2171

OBJECTIVES	3
INTRODUCTION	3
MOUNTING SCOPE SIGHTS	3
Bore-Sighting	5
Collimator	6
Sighting-In	7
Top-Ejecting Rifles	7
Drilling And Tapping For Scope Mounts	8
Drilling Hardened Receivers	10
Sight-Mounting Jigs	12
Self-Test Questions	13
AMERICAN GUNSMITHING	14
Investment Casting	16
Self-Test Questions	17
ANSWERS TO SELF-TEST QUESTIONS	18
LESSON QUESTIONS	19





Objectives

When you have completed this lesson, you should:

1. Know how to 'zero in' a rifle.
2. Know the techniques to install a telescopic sight.
3. Be familiar with the investment casting process for making gun parts.
4. How to use a collimator.
5. Understand the difference between windage and elevation.

Introduction

Installing telescopic sights on a rifle can be either easy or difficult, depending upon many factors. Most rifles manufactured after World War II were factory drilled and tapped (or grooved) to accept telescopic sights and mounts; few rifles manufactured prior to World War II had these provisions.

Rifles that have been drilled and tapped at the factory for scope sights are easy to work with, and an amateur should experience little difficulty in doing a good job — provided the project is done in the recommended sequence.

The installation of telescopic sights, or scopes, on rifles that have no factory provisions can be quite a task for both amateurs and professionals. Poor workmanship in this phase of gunsmithing is common. In most cases, poor sight work usually results from trying to align the sight mounts in their correct position by the eye alone, or in marking the location for screw holes by crude and inaccurate methods. This lesson is intended to supply the ground work for the proper methods and principles, which, if adhered to, will always result in a properly installed scope.

Mounting Scope Sights

Mounting scopes on rifles that have been drilled and tapped at the factory is usually a simple job, requiring few tools. Still, certain procedures and pre- cautions should be followed to obtain a good installation that will not fall out of line after a few shots, especially on rifles with a heavy recoil.

Most .22 rimfire rifles—including the .22 Winchester Magnum—have grooved receivers to accommodate scope mounts designed especially for these rifles. Since a slight recoil is experienced with the .22 rimfire, only a firm turn of the mount screws is required to mount a scope securely. Scopes designed for .22 rim fire rifles—such as the Weaver D4 and V22 models—are furnished with mounts at no extra cost, and the installation of these require only the aligning of the mount clips in the receiver groove, tightening the retaining screws by hand, and exerting a final twist with a screwdriver. However, before final tightening, secure the screw clamps so that the scope and mounts will slide in the groove. Then, test the scope for correct eye relief. Once found, tighten as described previously.



Figure 1: *Typical two-piece scope mounts.*

Other scopes require mounts to go with the scope sight, the majority of these are 7/8" or 1" in diameter. These mounts and rings are designed especially for grooved receivers on .22 rifles so the mounting seldom poses any problem.

Scope mounts for .22 rimfire rifles normally use universal clamps that fit into the factory-grooved receivers, centerfire rifles are different. With only a few exceptions, receivers on centerfire rifles are drilled and tapped for specific bases and mounts.

The most popular scope bases are those manufactured by Weaver and Redfield. Depending on the rifle to be used, the Weaver mounts can either be a single base, or a two-piece base, as shown in Figure 1. Other companies offer the same combination.

To select the proper base for a given rifle, refer to a chart, like the one in Figure 2. Then find the make and model of the rifle and obtain the catalog or model number of the scope base; this is the one you need for your particular rifle. You will also need scope rings to match both the scope and base mounts.

For best accuracy, a telescope sight must be mounted solidly to the rifle so that it stays secure, shot after shot. It does not make sense to spend a lot of money for a scope and then secure it with a cheap mount. Precision-machined mounts that are designed for a particular scope and rifle cost more than some of the imported varieties, but the extra cost will payoff handsomely in dependability and increased accuracy.

A one-piece mount, such as the Redfield JR system, is the most dependable scope mounting system available. Of course, this type of mount cannot be adapted to all rifles, but it is the recommended mount when it can be used. The rotary dovetail feature acts as a cam to hold the ring into a mating dovetail in the base for a good, solid fit. This type of mount also allows you to remove the scope (but not the base), and replace it without losing the zero.

The split rings that hold the scope to the mount should be precision-bored to the exact diameter of the telescope sight, which is usually a 1" diameter. If the rings are precision-bored so that a full radius contact with the scope is maintained, an even pressure will be provided around the tube, thereby eliminating the problem of squeezing the tube out of round, which sometimes happens with strap-type mounting rings. The Redfield JR base features an outside windage adjustment that overcomes scope mounting problems caused by drilling the mounting holes out of alignment with the bore, or where barrels have been threaded into the action at an angle.

Once the scope and mount have been obtained, remove the tap screws that prevent dirt and other foreign material from entering the screw holes. In most cases, there will be four. Position the mount or mounts in place, use the screws that accompany the mount, and loosely secure these screws to hold the mount or bases in place. Now, operate the action of the rifle to see if it functions smoothly. Often, in the case of bolt- action rifles, the factory-supplied screws are too deep and will jam the bolt,

AVAILABILITY & STOCK # CHART

	Micro Dial STOCK # (Buehler #)	Short 1-Pc Base STOCK # (Buehler #)	2-Pc Base STOCK # (Buehler #)
BRNO Mauser Commercial			
Flat Top	#110-000-003 (BLU-WCC)		#110-200-201 (B2)
Round Rec Ring	#110-000-006 (SR-U*4)		#110-200-207 (H2)*1
BROWNING			
FN Action 264 thru 458	#110-000-005 (FI-U)	#110-100-104 (FI-S)	#110-200-206 (F)
Automatic Rifle (All Grades)			#110-200-202 (BA-2)
Lever-Action High Power			#110-200-203 (BL2)
A-Bolt Rifle – Long			#110-200-233 (ABL)
A-Bolt Rifle – Short			#110-200-234 (ABS)
Bolt-Action Rifle. BBR Long Action			#110-200-232 (BRL)
Bolt-Action Rifle. BBR Short Action			#110-200-204 (BRS)
B.S.A. Monarch Round Receiver			#110-200-215 (R)
COLT SAUER			#110-200-205 (C2)
ENFIELD Remington 30 Conversion			#110-100-103 (E-S)
Bridge flat up to 075 low	#110-000-004 (E-U)	#110-100-102 (E7-S)	
Bridge shaped like M70	#110-000-070 (70-U)		#110-200-228 (W)
Brdige shaped like R700	#110-000-021 (21-U)	#110-100-121 (21-S)	#110-200-215 (R)
HARRINGTON & RICHARDSON. 22's			#110-200-223 (S3)
H&R 300 Ultra Bolt F N Action	#110-000-005 (FI-U)	#110-100-104 (FI-S)	#110-200-206 (F)
H&R 300. 301. Sako cal 270 up			#110-200-208 (HS)
HERTERS J9			#110-200-206 (F)
HIGGINS-SEARS ROEBUCK			
50 & 51½ Bridge Hole Spacing	#110-000-005 (FI-U)	#110-100-104 (FI-S)	#110-200-206 (F)
51L. 51C. 52C	#110-000-008 (SR-U)*4		#110-200-207 (H2)
53C	#110-000-070 (70-U)	#110-100-170 (70-S)	#110-200-228 (W)
237C. 238C		#110-100-136 (36)	
29. 31. 33		#110-100-160 (60)	
HUSQVARNA			
HVA crown grade rifles	#110-000-008 (SR-U)*4		#110-200-207 (H2)
8000 & 9000 Series			#110-200-289 (8-9)
HVA – Carl Gustaf			#110-200-289 (8-9)
JAPANESE ARISAKA		#110-100-103 (E-S)*4	
KLEINGUENTHER K15			#110-200-209 (K5)
MARLIN			
1894		#110-100-106 (M9)	
336,1985 444 375		#110-100-136 (36)	
455	#110-000-005 (FI-U)	#110-100-104 (FI-S)	#110-200-206 (F)
56, 57, 62		#110-100-136 (36)*6	
39A		#110-100-139 (39)	
MAUSER			
M98 Military Com (1.4–1 42 dia.)	#110-000-005 (F1-U)*4	#110-100-104 (F1-S)	#110-200-298 (98)
M91 M98 Small Ring (1.3 dia.)	#110-000-008 (SR-U)*4		#110-200-295 (95)
1891	#110-000-008 (SR-U)*4		#110-200-206 (91)
FN & Mark X-Actions (W4)	#110-000-005 (FI-U)	#110-100-104 (FI-S)	#110-200-206 (F)
Min Mauser (Interarms)			#110-200-290 (MM)
Mauser 3000 RH. LH Models			#110-200-213 (M3)
MOSSBERGS – Most 22 Cal			#110-200-215 (R)
PARKER-HALE Super 1200 '6	#110-000-005 (F1-U)*4	#110-100-104 (F1-S)	#110-200-206 (F)
REMINGTON			
Model7 600. 660 & XP100		#110-300-310 (XP-1)	
M700 721 725 long actions	#110-000-021 (21-U)	#110-100-121 (21-X)	#110-200-215 (R)
M700 722 725 short actions		#110-300-310 (XP-1)	#110-200-215 (R)
M700 LH short or long actions			#110-200-215 (R)
760 740 742		#110-100-160 (60)	
7400 7600		#110-100-174 (74)	
FOUR SIX		#110-100-146 (4-6)	
510 511 512 513 514 521 550 560			#110-200-223 (S3)
541S			#110-200-224 (S4)
40X 40XB			#110-200-215 (R)
RUGER 44 CARBINE			#110-200-218 (RC2)
M77 Round Receiver Long Act	#110-000-021 (21-U)	#110-100-121 (21-S)	#110-200-215 (R)
No. 3 Carbine Single Shot			#110-200-217 (R3)
No. 1 Varminter		#110-100-108 (RN-1)*10	
SAKO Long Action			#110-200-230 (SDL)
Short & Medium Action			#110-200-231 (SDS)
SAVAGE			
110 111 112 RH LH short or long			#110-200-227 (V2)
110 111 112 RH long action only	#110-000-010 (10-U)		#110-200-227 (V2)
SCHULTZ & LARSEN 54,60,64,65,68			#110-200-211 (L2)
SCHILENDGA Single Shot			#110-200-220 (SH)
SMITH & WESSON Model 1500			#110-200-215 (R)
SPRINGFIELD			
1906 03 A1		#110-100-110 (S-S)	
A3		#110-100-100 (A3-S)	
STEYR-MANNLICHER Modl L SL (metric screws)			#110-200-221 (SL)
Models M S ST 79 (metric screws)			#110-200-222 (SM)
Mannlicher Schonauer M72 All models (metric screws)			#110-200-272 (72)
THOMPSON CENTER			
TCR 83 single short rifle		#110-100-112 (TS)	
WEATHERBY F N Actions	#110-000-005 (FI-U)	#110-100-104 (FI-S)	#110-200-206 (F)
Mark VRH LH long action			#110-200-215 (R)
Mark VRH long action only	#110-000-021 (21-U)	#110-100-121 (21-S)	#110-200-215 (R)
Mark V Varminter 224 22 250			#110-200-212 (MV)
Vanguard (all calibers)	#110-000-021 (21-U)	#110-100-121 (21-S)	#110-200-215 (R)

Figure 2: *Sight-base charts are necessary to match the mounts to the rifle.*

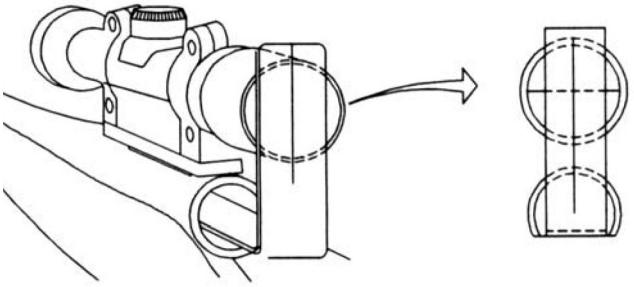


Figure 3: B-Square cross-hair square lets you square up a scope or front sight in seconds.

preventing it from sliding smoothly. In this case, the screws will have to be shortened, either by cutting or grinding. Be sure to try the action again to make sure it works smoothly.

Remove the screws and mount bases from the receiver, and then clean the screw holes and screws thoroughly with a degreaser, such as the solution that comes with instant bluing kits.

At this point, fasten the mounting screws as firmly as possible in the screw holes to prevent them from coming loose during firing with a heavy-recoil rifle. Loctite is a commercial product that is recommended for such applications, and several types are available. Lock N' Seal, for example, can be applied to the screw threads to obtain a tight fit. The solution flows into and fills up to 0.015" gaps, then hardens into a tough solid with 1,700 psi (pounds per square inch) strength. Apply this solution to the threads of the screw, before tightening them. Wipe off any excess solution before it hardens. This should keep most of scope mount screws tight at all times.

For worn or extra-loose screws and rifles with an extra-heavy recoil, you might want to try Loctite Stud N'Bearing Mount solution. This sets up to 3,400 psi and usually requires heavy tools to remove the screw once it has set.

If you do not have any of the Loctite compound available, good results can be obtained with fingernail polish. Again, clean the threads, apply a small amount of fingernail polish to each thread, and tighten as before. It will harden quickly and lock screws in place.

With Weaver mounts, once the base is in position, the scope rings are installed on the scope, but the screws are not tightened down completely. The rifle should be secured in a padded bench vise during this operation. You want them snug, but not so tight that you cannot turn the scope. Secure the rings with the scope to the base mount, and then move the scope backwards and forwards, and rotate it until it is perfectly aligned and with the correct amount of eye relief. When aligned perfectly, carefully tighten the scope ring screws (one turn or less on each screw until all are snug) to hold the scope firmly in the desired position. If you tighten one screw more than another, the scope will be pulled out of line. Therefore, the main objective is to tighten all the screws evenly. The scope should now be mounted correctly.

Use B-Square's crosshair square, shown in Figure 3, to align the crosshairs vertically and horizontally. It accurately sets the scope's vertical *reticle*, or line, in position and can also be used to align front sight ramps in a vertical position. It is not necessary to remove the action and barrel from the gunstock when using the scope since it fits into the receivers of most bolt-action centerfire rifles. Furthermore, it is made of optical clear plastic that will not harm the finish of the gun. The B-Square crosshair square also squares the vertical index line with the bore.

BORE-SIGHTING

Some shooters mount their scope, take the rifle to the range, and attempt to sight it in. If a large enough target is available, this will sometimes work, but usually at the cost of many rounds of ammunition. A better way is first to bore-sight the rifle so the scope will be approximately lined up prior to shooting with live ammunition; the first one or two shots should be at a 12"x 12" target.

The optical boresighter provides a fast, accurate way to sight-in a rifle. It will give a lifetime of performance for a modest cost that is easily recovered in savings of ammunition alone.

If you are sighting-in a bolt-action rifle, you might want to do the bore-sighting the old way. Place the rifle on a steady rest, such as sandbags or a Decker Shooting vise, shown in Figure 4, remove the bolt from the receiver and, looking down the bore from the receiver end, move the rifle around until the target, which should be placed at least 25 yards away, is centered in the bore. Without moving the rifle, glance through the scope, making reticle adjustments with the knobs on the scope until the reticle is centered on the target. Look through the bore

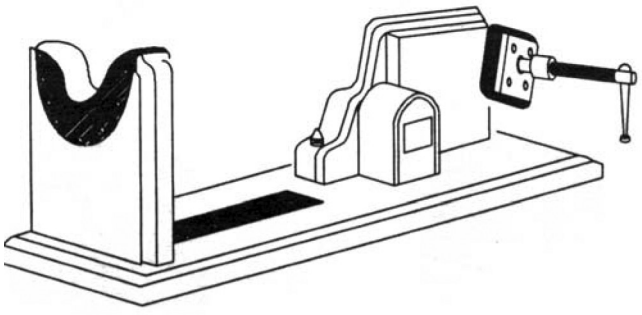


Figure 4: The Decker vice is a solid vice to hold rifles and shotguns for scope mounting, cleaning, etc. Padded rests and clamp jaws protect the gun's finish.

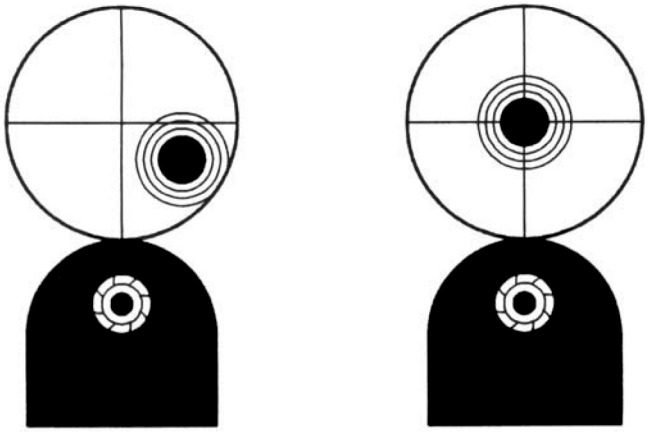


Figure 5: When boresighting a rifle, first sight through the bore rifle and line up your target. The target will appear as in the left hand drawing. Then, adjust the scope until the target is centered in the cross hairs as shown in the right hand drawing.



Figure 6: Photo of modern collimator.

again to make certain that the rifle has not moved off target; if so, adjust it accordingly, as in Figure 5. If you are firing at a target beyond 25 yards, move the scope adjustments so the crosshairs appear about 1" below the center of the tar- get. This will allow for bullet drop at the longer distance. Adjust the scope so the bore will be above the center of the target when the crosshairs are placed dead center.

COLLIMATOR

If you use the optical boresighter, clamp the boresighter, or collimator (Figure 6), to a stud that is the correct size for the bore of the rifle being sighted-in; this stud will align with the axis of the bore (Figure 6a). The collimator is a simple optical device having an objective lens with a target grid. To the scope looking into it, the target is in focus, as in Figure 7. In use, this sighting grid is viewed in relation to the crosshairs of the scope, the windage and elevation adjustment of the scope mounts, and/or the internal fine adjustments that bring the sights into alignment with the bore of the firearm.

Once the boresighter is in place, remove the adjustment turret caps on the scope. The elevation knob is marked UP on most scopes, with an arrow indicating the direction, which will move the point of impact up on the target. The windage knob is marked R (right), with a similar arrow marking.

The increments marked on the graduated scale around the knobs indicate the amount of point-of-impact movement in minutes of angle (MOA). One MOA equals $^{1}/_{60}$ degrees of arc. Since point-of-impact change is measured in angles, the amount of actual movement on the target increases as the distance to the target increases. For convenience, one MOA is set to equal 1" at 100 yards, although it is really 1.047 inches.

Using the scope adjustments described, align the scope reticle intersection with the center of the grid. The scope is now parallel to the axis of the bore. This adjustment will enable the first shot to be placed well within the edges of a normal-size target (for example, a 12"-18"square). You are now ready to sight-in the rifle.

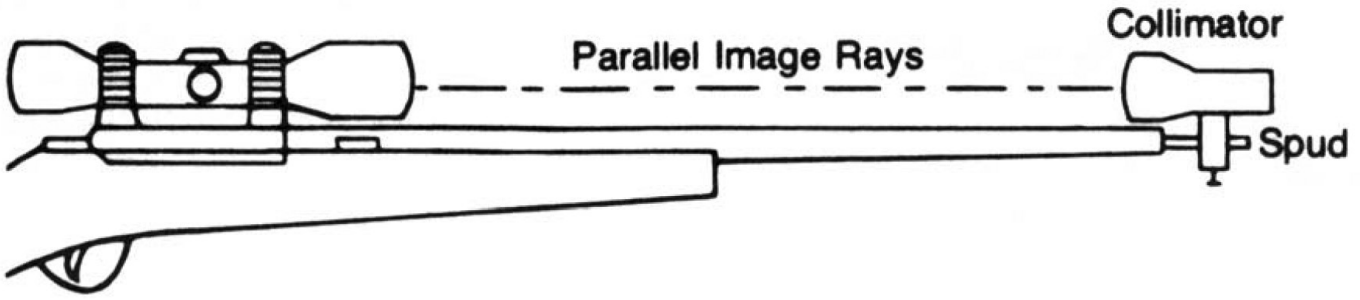


Figure 6a: Collimator in position for presighting a telescope sight.

SIGHTING-IN

When sighting-in a rifle, it is best to fire on a target within your expected average range. However, limited range facilities may prevent you from sighting-in the rifle at the desired distance. If you obtain some of the readily available ballistics charts, this handicap can be overcome easily, allowing you to sight-in your rifle at a lesser range, yet having the point of impact be almost exactly as you want it for longer ranges.

For example, let's assume that you have a .270 Weatherby Magnum rifle and you are using 130-grain factory bullets. Let's further assume that you want the rifle sighted-in at 200 yards, but your practice rifle range is only 100 yards. By referring to the Weatherby ballistics chart, you find that the midrange trajectory of the 130-grain bullet at 200 yards is 1.8 inches. Since midrange of 200 yards is 100 yards, if you sight the rifle in to shoot 1.8" high at 100 yards, you should be zeroed-in exactly at 200 yards, or at least very close.

Take this example a bit further. Let's say we want the bullet to strike the target at 300 yards. Again referring to the Weatherby chart ("Path of Bullet Above or Below Line of Sight"), we find that the 130-grain bullet, when zeroed-in at 300 yards, will strike 2.8" high at 100 yards, so that it will be "dead on" at 300 yards.

When firing, scope adjustment knobs are moved until the rifle places the bullet where it is desired.

Sighting-in should be done from a steady rest, such as a solid benchrest, tripod, or sandbags. You should also sight in your own rifle since no two people hold or fire a rifle in exactly the same way.

To zero-in the rifle, fire three shots from the desired range, using the center of the three-shot group as the hypothetical point of impact. Make the proper scope adjustments until the group is landing where you want it.

The rifle should be zeroed-in just prior to using it for target shooting or hunting.

Humidity and other changes in the weather will change the bullet impact on the target. So, from time to time recheck your rifle to see if it is holding its original point of impact. If not, adjust it accordingly.

TOP-EJECTING RIFLES

Some rifles, like the older Winchester Model 94s, eject the fired cartridge through the top of the action, making it necessary to mount the scope in an offset position in order to allow the cartridge to pass. One solution to this problem is to use a mount designed for top-ejecting rifles. Newer top-ejecting rifles require no drilling and tapping, and the mounts are installed similar to other types on which the receiver has been drilled and tapped at the factory. However, when using these scopes the shooter has to tilt his or her head slightly in order to view through the scope since it is offset from the line of the bore, as shown in Figure 8.

The offset scope mounts do have the advantage of being able to use either the scope or the open iron sights. This can be to the shooter's advantage if the scope should become fogged or if there is not enough light to adequately use the scope.

The advantage of using either the scope or iron sights has further benefits on close shots in wooded areas. In fact, many

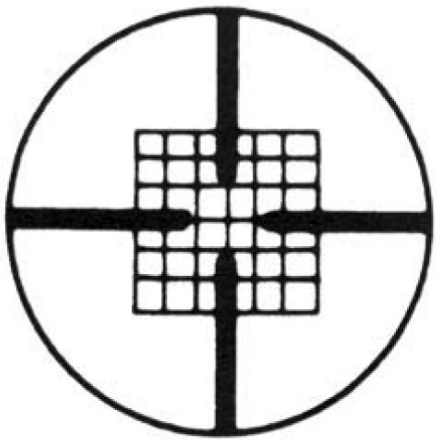


Figure 7: *When sighting-in with a bore scope, this is the image that can be seen when the collimator is in place.*



Figure 8: *To use a scope sight on some rifles, the scope must be offset to allow room for the cartridge to eject out of the top of the receiver. Photo from Lyman Products.*

hunters use see-through mounts on rifles that will handle conventional scope mounts adequately. These see-through mounts are designed with two sets of rings, with the scope mounted in the upper set. If the iron sights are to be used, the shooter aims through the lower set of rings, using the existing iron sights on the rifle. If the scope is to be used, the shooter aims through the scope.

Using offset or see-through scope mounts on rifles other than bolt-action rifles has been a problem for gunsmiths. Lever-action, slide-action, and semi-automatic rifles do not allow access to a clear view of the bore without a prism boresighter. Neither could a collimator be viewed accurately with such sights until the offset spud was introduced (Figure 9).

This collimator offset spud can be used with any boresighter to allow bore-sighting with any offset, side, see-through, or high-mounted scopes that are out of range of the conventional boresighter. The *offset spud* fastens to any boresighter spud, and any boresighter, or collimator, can be fastened to it.

DRILLING AND TAPPING FOR SCOPE MOUNTS

Most of the older rimfire and centerfire rifles, especially those designed for military use, were not supplied with drilled and tapped holes (or grooves) for mounting scope sights. Some of the older sporting rifles are well adapted to telescopic sights; but many of the military rifles and some sporting rifles require major alterations to enable a scope sight to be used satisfactorily. Mausers and Springfields, for example, require altering the bolts so they will miss, or pass by, the scope. The ears of the receiver sight on Enfield rifles must be milled or ground off to accommodate the scope mount. Other rifles may require that the scope be side-mounted, or offset, to allow functioning of the action and to eject the fired cartridge properly. Each problem will be dealt with separately.

Scope drilling jigs are used almost exclusively for drilling and tapping scope mounts. Many professionals make their own, although various types are available from gunsmith supply houses. By using these jigs, screw holes can be located and drilled in a fraction of the time it once took, so there is little reason for professional shops to use any other method. However, from time to time a professional shop may get in a rifle for which no jig is readily available, but it would not pay to make a jig for just one rifle.

The hobbyist might want to try mounting a scope, but does not want to go the expense of purchasing one of the scope jigs, which usually start out at around $100. It would be better to take it to a professional shop and have the job done for under $20. Still, there may be some who want to do the work themselves. For those who do, the following describes the procedure of mounting a scope from scratch.

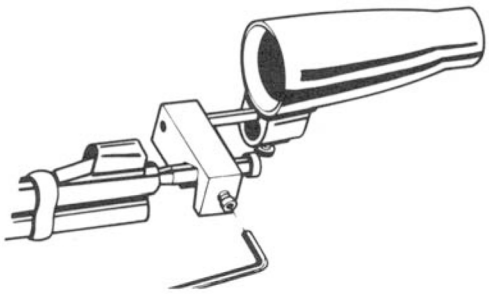


Figure 9: *B-Square offset spud for aligning offset and similar types of scope mounts.*

You will need a few tools and know how to use them before you should even begin to think about drilling and tapping a scope mount. These include an accurate level, V blocks, and tri-squares (Figure 10).

Obtain a scope base that is suited to the rifle you want to put it on. Manufacturers have bases for most rifles. If a factory base is not available, existing bases will have to be modified, or a new base will have to be made from scratch to fit the rifle exactly.

Clamp the sight base to the rifle in the exact mounting position. Use machinist's clamps for this operation. Be careful to ensure that this base is level, straight, and true before locating and spotting the correct position for the screw holes, which will have to be drilled and tapped.

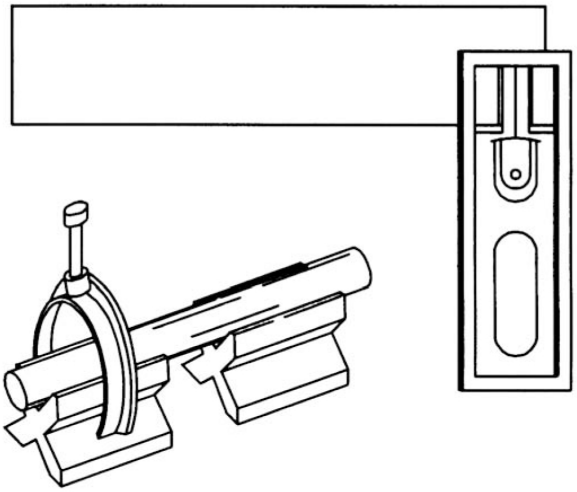


Figure 10: *V blocks and two tri-squares are essential for locating holes in receivers to be drilled. Sight jigs are better and quicker, but also more expensive.*

To locate these holes accurately, some reference point must be found on the rifle to check the work as it progresses. The rifle must also be resting on a perfectly level surface, such as a piece of plate glass, or a smooth, level table or board.

Place the barrel and receiver on this level surface, resting the barrel in V blocks, and then proceed to get the barrel and receiver absolutely vertical on this level surface. This is usually accomplished by taking some square surface on the receiver, and holding it parallel or at right-angles to the surface plate by means of small steel tri-squares. This square surface on the receiver will vary with the make of rifle, but on a typical Mauser receiver, this flat surface is located on the underside of the receiver.

On most single-shot receivers the sides of the receiver are used and the squares are placed upright on the surface plate with the vertical arm brought up so the receiver can be trued against it. With some rifles and shotguns, it is best to try to align on two square surfaces, and if there is any difference divide it equally.

Once the barrel and receiver are exactly vertical with respect to the surface plate, they must carefully be kept in this position until the sight base is securely clamped in its correct position.

Now, carefully clamp the sight base in its approximate position on the rifle receiver, using a few machinist's clamps for holding. One way to accomplish this is to place a square up against either side of the barrel. With inside calipers, carefully measure from the square to the side of the base on each side to make sure that the base is in the absolute center of the barrel (Figure 11). This should be done at both the front and rear end of the base. Then change the position of the squares to ascertain that the top surface of the base is absolutely level and parallel to the surface plate, as shown in Figure 12.

With the sight base absolutely correct, the clamps are then tightened so there is no danger of the base moving out of alignment. To ensure that this will not happen, it is a good idea to scribe a narrow line around the sides of the base so that any movement will be readily recognizable.

There are usually three or four screw holes in the base to hold the base to the receiver. Therefore, a spot must be located exactly in the center of these screw holes to mark the drilling point.

To obtain the exact center by the method described, it is best to use the sight base itself as a guide. Use a drill that is the same size as the screw hole in the sight base. This is not the same as the size used for the hole that will be tapped. Since the sight base is clamped firmly to the receiver, the barrel and receiver may now be removed from the V blocks, and the assembly clamped in a drill-press vise under the drill press, or you can leave the barrel and action where they are, and use a breast drill for the drilling.

Start the drill down straight through the hole; using the hole in the base mounts as a guide, drill a spot in the receiver that is at the exact center and correct for the receiver screw hole. At the same time, make sure the drill does not move the base(s) out of line. Mark all the holes in this manner for a two-piece mount; or just mark one front hole and one rear hole for a one-piece mount. Now you can remove the clamps and sight base for the rest of the drilling.

The most common size of a sight-base screw is a 6-48, requiring a No. 31 wire-gauge drill to drill the pilot hole prior to tapping. While a drill press is best to ensure proper straightness of the hole, a hand or breast drill will do for those who are careful. However, before drilling, examine the areas carefully to be drilled to determine the depth of each hole. Obviously,

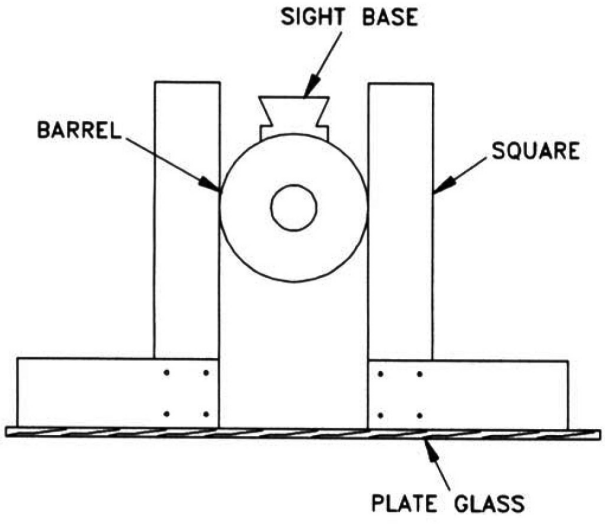


Figure 11: *One way to align scope bases on a rifle barrel.*

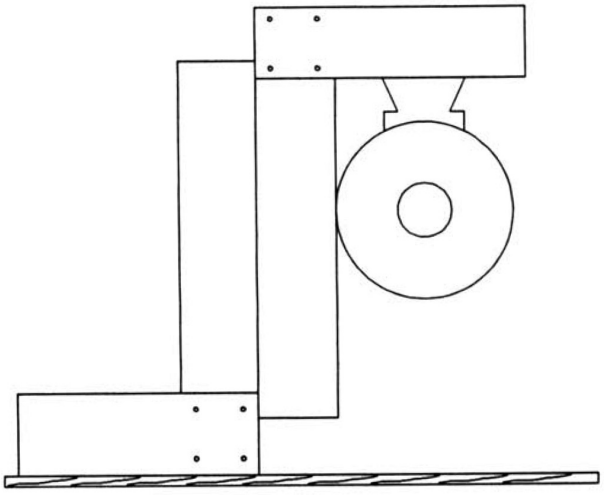


Figure 12: *Check the sight base again by changing the position of the squares, this time trying the top of the base to make sure it is level and parallel to the surface plate.*

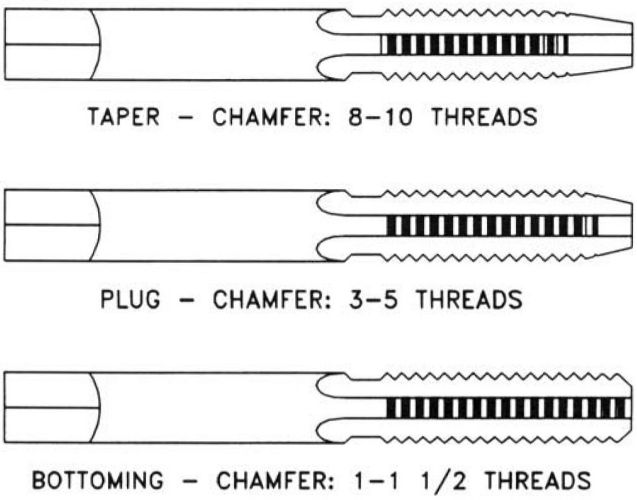


Figure 13: Three types of taps in common use: the taper, the plug, and the bottoming tap.

you must not let the drill enter the bore. This mistake has been made by both professionals and amateurs, so be extremely cautious in the barrel area.

Most drilling will take place in the receiver area, and although not as critical as the barrel area, be careful not to drill too deeply or through areas that conflict with the functioning of the action. Go slowly and use a depth gauge to show how deep you are at any given time. You must drill deep enough to get a good bite on the screw, which is usually about three threads, or about $^{1}/_{8}$ inch. If there is enough room, $^{3}/_{16}$" is better.

Figure 13 shows the three types of common taps: the taper, the plug, and the bottoming tap. For screw holes drilled completely through the receiver top, a conventional No. 2 taper tap will suffice for the entire tapping operation. For holes that go only partially through, a bottoming tap should be used, after starting the thread with the taper tap, to ensure cutting the threads squarely to the bottom of the hole. When all holes are correctly tapped, dip the screws in oil and screw the sight base onto the receiver.

Caution. When using the bottoming tap, it is quite easy to snap the tap off once it reaches bottom if too much force is applied. It is very difficult to get the broken tap out, so be extremely careful. When tightening the screws, use the proper screwdriver to avoid marring the screw heads.

With the base(s), in place, attach the scope rings and scope and inspect all items for correct alignment. If everything seems in order, remove the screws and bases, clean off all surplus oil, and apply Loctite solution to freeze the screws in place.

When mounting two-piece bases, they must be perfectly aligned with each other on top of the receiver, as shown in Figure 14. To obtain this result, many gun- smiths use a steel rule that is true and accurate. The rule is applied to the sides of the bases. Make sure it touches both bases equally for their entire length, showing them to be in line. Make any necessary adjustments to align them. Both bases should be fitted at the same time while the barrel and action are on the V block on the surface plate. Spot the holes simultaneously.

Bore-sight and zero the rifle the same way as you would for mounting factory-tapped rifles.

DRILLING HARDENED RECEIVERS

Many older military receivers have been case- hardened. With such receivers, you can dull several drill bits and not even begin to scratch the surface. Sometimes, you can take a Moto-Tool and grind the surface of the receiver exactly at the spots you intend to drill so the bit will penetrate the softer inner metal;



Figure 14: When mounting two-piece bases, they must be in absolute alignment with each other on top of the receiver



Figure 15: *To drill and tap this case-hardened Springfield 1903 receiver for a one piece scope mount, the spots on the receiver require annealing where the holes where drilled.*

but sometimes even this will not work. When a situation like this arises, the only solution is to spot-anneal the areas to be drilled, as in the rifle in Figure 15. This is accomplished by heating the area and then letting it cool slowly. Be careful to soften only the spot where the screw holes will be drilled and not the entire receiver, otherwise the receiver might be weakened so that it will not withstand the strain of the breech pressure when fired.

To spot-anneal a receiver, first locate the screw holes and then clamp the sight base in place. Now, mark the location of each hole to be drilled. Remove the sight and use a Moto-Tool to polish the spots with an emery wheel to remove the finish and leave the spots bright and smooth. There will be small bright marks on the receiver at each location of the screw holes where they are to be drilled. The tip of a soldering iron can then be held to each of these polished spots until the bare metal turns a dark blue. Then let the metal cool slowly. This will usually anneal, or soft- en, the receiver surface so the drill bit will enter without difficulty and not weaken the surrounding metal.

Some gunsmiths prefer to use a torch rather than a soldering iron because the heating is quicker. This will work, but extra precautions must be taken prior to heating. Drill holes through a piece of asbestos and then secure the sheet of asbestos around the receiver, aligning the holes in the asbestos with the polishing marks on the receiver. Now, wrap wet cloths all over the receiver and around the edges of the asbestos sheet so that the entire receiver is wrapped with the exception of the area to be spot-annealed. To anneal, use a torch whose flame blows into the holes of the asbestos so that the steel underneath becomes hot. Again, continue heating until the polished metal surfaces become a dark blue color, then allow the receiver to cool slowly.

Once annealed, the holes are relocated, marked, spotted, drilled, and tapped. Just make sure that you allow sufficient time for the metal to cool slowly before starting the drilling and tapping operation.

You can skip this annealing operation by using a solid carbide drill. Brownells offers two sizes, a number 31 for 6-48 taps and a number 28 for 8-40 taps. They will drill through the hardest receivers, or can be used to "crack the skin" of case-hardened receivers after which a regular drill bit is used to finish the job.

However, there are two problems with the carbide drills. First, the solid carbide drills are easily broken. If kept clean they are less likely to bind and break.

Second, if the inner steel is extremely hard, the taps are likely to break and getting them out can be quite difficult. But carbide drills are recommended to those who are capable of using good judgment and proper care. These drills should not be used on softer steels and should be used only after other drills have failed, or when the hardness of the steel is known.

SIGHT-MOUNTING JIGS

As mentioned previously, most professional gun- smiths use drill jigs to spot drill holes in receivers for mounting sights. The relatively high cost of these jigs is more than offset with only three or four drilling and tapping jobs.

B-Square Receiver Sight Jig. This non-marring, aluminum jig clamps to receiver bolt-lug grooves in bolt-action rifles for accurate positioning of the hardened steel drill guide-bushing. It eliminates the need for the time-consuming method of spotting holes, and is used for receiver sights and to align holes on a bore's centerline axis. The jig spaces holes to match the sight exactly. Use it on Springfields, Enfields, and Mausers.

B-Square Professional Drill Jig. This is the fastest device know for aligning, drilling, and tapping scope mount holes in the receivers of Springfields, Enfields, Mausers, Remington Model 30s, and similar bolt-action rifles.

To use, remove the bolt of the rifle and insert the drill jig. It automatically locates the holes in reference to the recoil shoulder and aligns and spaces the holes vertically on the centerline of the receiver. Holes are all drilled at one time. The hole spacing matches the mounts made by Weaver and Redfield.

Both of these jigs are recommended for professional gunsmiths if much scope work is encountered. The work involved is at least 10 times faster than setting up with squares and V blocks as discussed previously.

For gunsmiths doing much sight work on firearms other than the bolt-action rifles described above, the Foster universal sight-mounting fixture, shown in Figure 16, is almost impossible to do without. It will handle all bolt-action, lever-action, slide-action, and semi-automatic rifles as long as the barrel can be laid in the V blocks of the fixture.

The Forster fixture will locate the holes to a standard predetermined spacing built into the overarm, or to any spacing by sliding the overarm in either direction. "Walking" or "run out" of the drill is eliminated since the drill is guided through a hardened and ground drill bushing. Tapping is done through another bushing of the correct tap size, and eliminates cocking the tap— a major cause of tap breakage and sloppy screw holes. The sliding overarm has three holes with standard spacing of 0.500" and 0.860" between centers into which the interchangeable drill and tap guide- bushings fit. The overarm is keyed and slides in a T-slot, keeping it in true alignment with the center of the gun barrel.

The main body of the fixture is cast aluminum. The two V blocks are adjustable for height and are made of hardened steel accurately ground on the V as well as on the shaft. A fixture like this belongs in every professional shop.

To use, first remove the stock from the gun to be drilled and tapped. In most cases, only the fore-end needs to be removed on rifles with two-piece stocks, such as the Marlin 336 and Savage Model 99. The Remington 760 requires the removal of the slide and slide bolt, as well as the bolt mechanism. The trigger mechanism can usually be left in on most bolt-action rifles. Tubular magazine rifles must have the magazine removed before placing the barrel in the fixture for drilling. The barrel is then laid in the V blocks, and the action is laid over the end of the fixture with the clearance slot. Whenever possible, the barrel to be drilled should be positioned so that



Figure 16: *The Forester universal sight mounting fixture is invaluable for shops doing extensive scope mounting.*

the action is close to the rear V block, with the cylindrical or straight portion of the barrel supported by the V block.

Slide the overarm in place over the portion of the action to be drilled and raise the rear V block up to bring the action or receiver in contact with the correct size drill bushing. Next, measure the diameter of the barrel with a micrometer at the points of contact at the front and rear of the V blocks. Since most barrels are tapered, it will be necessary to raise the front V block. The amount is determined by subtracting the smaller diameter from the larger diameter, and then multiplying this value by 0.707. The resulting answer will be the height the front V block must be raised above the rear V block. This measuring can be done with a steel machinist's rule. If extreme accuracy is desired, use a feeler gauge between the top of the machined boss and the bottom of the V block. Many gunsmiths use out- side calipers for this operation.

Once the V blocks are adjusted to their proper height, clamp the barrel lightly in the V blocks using the aluminum pads under the clamp screws to avoid marring the barrel. On bolt-actions rifles, raise the flat top sup- port pad into firm contact with the flat bottom of the action. This squares up the action and acts as a support during the drilling operation. The clamp on top of the leveling overarm may be moved over any part of the action. Now tighten the clamps.

Some receivers will not have flat bottoms, but they still can be lined up by means of a square from the top of the overarm, or any other machined surface on the fixture. The rifle action can also be lined up by using a level; however, be sure the fixture itself is level before lining up the rifle.

One method used by many gunsmiths to locate mounts is to place the mount on the action or barrel in the desired position and mark the forward hole on the gun with a scriber or pencil. With the locator pin pointing down in the front hole of the overarm, slide it over the gun so the point lines up with the mark and lock it in place. Drill and tap this hole. Now, screw the mount onto the gun with one screw. Loosen the overarm and, with the tapered point of the locator pin, place the overarm over the second hole in the mount and lock it in place. Lock the spacer block against the overarm. The overarm then can be moved out of the way, the mount removed, and the overarm reset against the spacer block. The second hole is then drilled and tapped. Other holes in the mount can be located and drilled in the same way. Do not drill the holes with the mount in place; this may prevent you from drilling the holes on the true center of the action.

When drilling for receiver sights, line up the barrel in the V blocks in the usual way, but turn the action sideways and square it up using a small square laid on top of the overarm. Locate the first hole and proceed as already described. The same procedure is followed when mounting side mounts, but holds true only if all the holes are in line with the center of the rifle bore.

If the desired holes are not on the centerline of the barrel, the fixture can still be used to hold the gun squarely and steadily in the drill press. In this case, the over-arm is not used.

When drilling and tapping for a front sight on a barrel, the position of the gun is reversed; that is, the muzzle end is placed at the notched end of the fixture. The V blocks, in this case, are raised high enough so the drill bushings will contact the barrel. Allowance must be made for the taper in the barrel. It will be necessary to square up the gun with a level. Shotgun beads are mounted by following the same procedure.

When first using this fixture, go slowly and care- fully, double-checking all measurements and your setup to make sure you are drilling the holes exactly where you want them. Also make sure that the V blocks line up squarely by tightening the screws gently at first, so that the flat of the screw contacts the flat of the shaft squarely. A twisted V block will throw you off due to the taper in the barrel, and especially so if the barrel is supported at a point where the taper is abrupt.

Extreme care must be exercised to prevent metal chips from getting between the finished surfaces of the overarm and the body of the fixture when the overarm is moved. This is equally true of the spacer block. If chips are allowed to lodge between the two finished surfaces, they will impair the inherent accuracy of the fixture. Brush away all chips with a small, dry brush before loosening the overarm and spacer block. A blast of compressed air will also do the job quickly. Do not use force when tightening the screws holding the over-arm and spacer block.

SELF-TEST QUESTIONS

Please check your answers on page 18.

1. *True or False.* **In most cases, modern rifles are drilled and tapped for mounting telescope sights at the factory.**
2. **What is the name of the great time-saving devices for locating, drilling, and tapping screw holes for mounting sights?**
3. **What must be done to a case-hardened receiver before it can be drilled and tapped for scope mounts with conventional drills?**
4. **What type of drills are designed for drilling hardened receivers without further attention to the receiver?**

American Gunsmithing

A gunsmith, by definition, is one who builds or repairs guns. However, gunsmithing work and the manufacture of firearms today is much different from the way it was 200 years ago, or even 100 years ago.

Before the beginning of the nineteenth century, most firearms were made completely by hand, on a one-at-a-time basis. Every sizable village and cross- road had its own gunsmith who could turn out one or two finished rifles a week, and exactly to the owner's specifications, right down to the French polished black walnut stock and evenly browned metal parts.

Most of the firearms made before 1800 were flint- locks, meaning that when the hammer fell, a piece of flint struck steel and made a spark that lit the priming powder in the pan. However, around 1800, the percussion cap was perfected and eliminated the need for extra priming powder and flint; the cap fired when hit by the hammer and was more reliable than the earlier flintlock systems.

All of these early firearms were made entirely by hand, without a single power tool. For example, a bow drill was used to drill holes, similar to a conventional bow used with arrows. The bowstring is looped around a wooden spool that holds the drill, then the bow is drawn back and forth, which spins the drill bit for cutting.

The typical gunsmithing shop of the 1700s was probably a shed of about 12' x 16' with a roof made from hand-split shakes. Some floors may have been made of wooden planks, but more than likely it was plain dirt. Usually, a handmade forge stood in one corner of the shop and an anvil was certain to be nearby. In this same vicinity was a large grindstone with a hand crank. A couple of planks secured to a solid frame served as a bench. This bench normally held an iron or wooden vise.

Two or three rifling guides could be seen hanging from the ceiling along with several reamers and sever- al long rods with wood rifling heads. The long benches used for reaming and filing were also sometimes situated inside the shop building, but due to their size, these were often built outdoors.

Besides making guns from scratch, these early gunsmiths also repaired guns. However, when a spring in one of the early firearms broke, they could not obtain a replacement from the factory; one had to be made by hand, as shown in Figure 17. The gunsmith would cut off a piece of chisel steel, forge it under the hammer somewhere near to size, and then file it to shape. The spring was hardened by heating it to a bright red color, then plunging it in water and tempering it. Then it was laid on a piece of red-hot iron until it turned blue. When the color was right, beeswax was put on it. When the beeswax flashed, the spring had reached the right tem- per. With the wide assortment of scrap metals laying around the shop, there was no way of knowing exactly what the metal would do until it was used.

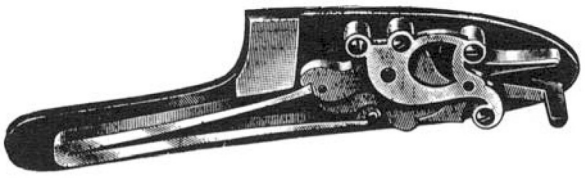


Figure 17: *All gun springs, some very complicated, were once made entirely by hand.*

A modern gunsmith either buys factory replacement springs or else purchases spring stock of a known quality from one of the suppliers.

Another common problem was a shot-out or rusted rifle barrel. The barrel was rebored and rerifled to a larger size. Then a mold was made for a round ball or bullet to match. But other problems prevailed. The cup-shaped hammer nose of a percussion rifle got worn or rusted and pieces of cap would fly around in firing. Mainsprings broke, and stocks split.

Rifling a barrel consisted of cutting spiral grooves on the inside of the barrel. The ridges left between the grooves are called lands. It is the lands that bite into the bullet and spin it as it is forced down the barrel by the exploding gases of the black powder.

All the rifling of 200 years ago was done by hand; the rifling cutter was set in a hickory head at the end of a long rod. The rifling guide was usually a cylinder of walnut with spiral grooves cut in it. The rod carrying the rifling head was fixed to one end of the guide. As the gunsmith pushed and pulled on kind of a cradle, the cutter was forced to follow the grooves of the rifling guide and thus cut grooves in the rifle barrel of the same pitch. The experienced gunsmith of the time could rifle one barrel in a day's time. Today's gunsmith production is about 1 to $1^1/_2$ gun barrels per day even using modern machines! However, broached barrels, using a hydraulic press, can be completed in less than a minute. One pass of the broach cuts all the rifling grooves at once.

The original Kentucky-style rifle stock usually ran the full length of the barrel, with the forward part housing the ramrod. Many rifles of the time were very plain, but others utilized elaborately shaped lids for the patch boxes inletted into the buttstocks; some had many metal inlays for decoration. The inlays, like the cover for the patch box, were commonly made of sheet brass, but were also made of German and coin silver.

The preferred wood was hard maple grown on hill- sides, and not from trees grown in the rich, damp soil of the bottom land. The hillside trees, getting less moisture, grew slower. Their wood was harder and they usually had more figure, such as the fiddleback, which was sought after by violin makers as well as stock makers. However, some gunsmiths used other woods: walnut, wild cherry, apple, and beech, just to name a few.

Then about 1800, young Eli Whitney obtained a contract to supply 10,000 muskets to the U.S. Government at a cost of

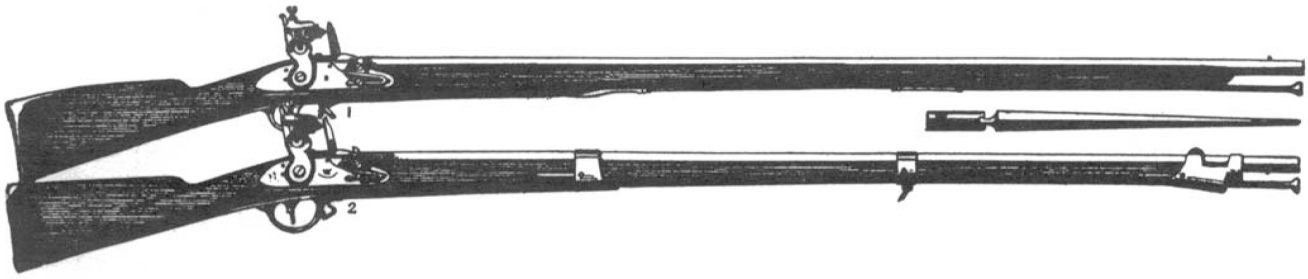


Figure 18: *The Whitney musket was the first U.S. Government firearm to use interchangeable parts.*

$13.50 each. In doing so, Whitney devised a system for manufacturing interchangeable gun parts, which eliminated the need for laboriously filing each gun part individually, as shown in Figure 18. Instead, individual parts were simply made to fit a standard gauge. If the part fit the gauge or an outline template, it would also fit the other parts without additional hand fitting. With the need for skilled fitters eliminated, Whitney could hire an untrained worker and quickly teach the simple job of musket assembly from already-manufactured parts. Eli Whitney not only fulfilled his government contract, but also went on to form the Whitney Armory—a company that manufactured arms until about 1888.

A generation after Eli Whitney filled his first musket contract, Samuel Colt organized the production line, and the manufacturing of guns truly entered the modern age. Industrial historians generally agree that Sam Colt is the father of mass production.

Before Whitney and Colt, gun parts had been shaped mainly by forging, grinding, and hand-filing. Screws, pins, and other small round parts were turned on foot-powered treadle lathes. The heavy grinding, such as the contouring of barrels, was accomplished with relative speed by water-powered grinding wheels. This is why gunmakers and other manufacturers situated their factories on the banks of running streams.

The invention of the steam engine changed all that. With steam-powered machinery, it was possible to locate a factory anywhere, and of even greater importance, the speed and power of steam energy made it possible to build and use giant lathes, drills, and milling machines. A gun part that had previously required tedious hours of grinding and hand-filing could now be shaped in brief minutes on a steam-powered milling machine. A factory of the mid-and late 1800s had an engine room where power was transferred to work areas through overhead power shafts. A system of pulleys and belts connected machinery such as lathes and drills to the power shafts, and everything hummed along nicely. The year Colt opened his Hartford factory, a modern facility such as his was the epitome of the Industrial Revolution.

With the passing of years, metal-cutting techniques became more sophisticated, and as they did, gun design became more complex. Winchester's lever-action rifles are good examples of the level of complexity of design and manufacture that firearms reached by the second half of the 1800s. The famous Model 1873 Winchester, shown in Figure 19, with its complex interlocking parts, represented the full flowering of the machine-made firearm. However, considerable hand labor was still involved in the making of the 1873

Winchester, just as there is much hand-labor in making most of today's guns. Even so, the Winchester rifle could never have existed without the lathe, the drill press, and the milling machine.

In time, the steam engine and overhead belt drives were replaced by the dynamo or electric generator and electric motors, but methods of making guns remained remarkably unchanged. In fact, if you could have visited the Colt, Remington, or Winchester factories in

1870 and then returned in 1950, you would have been astonished at how little their methods had changed.

But by the 1950s, gunmakers had to change their ways or be left in the dust. Factories that had been the last word in modern manufacturing in 1875 were critically outdated. The worst—and the best—thing about the gun industry is that it is tied to tradition. This is bad because gunmakers tend to cling to ideas long after they have become unpopular and unprofitable. It is good because it causes most gunmakers to continue making guns in what they believe to be the best way.

One of the headaches of making guns after World War II was the cost and difficulty of many machine operations. The milling machine that had been a blessing in 1850 because of its speed and labor-saving advantages by 1950 had become the curse of the industry because of its inflexibility, high installation expense, and need for a skilled operator.

You can get an idea of the problem by comparing the receivers of most firearms manufactured prior to World War II with those made in the 1950s. Each complex con- tour and angle

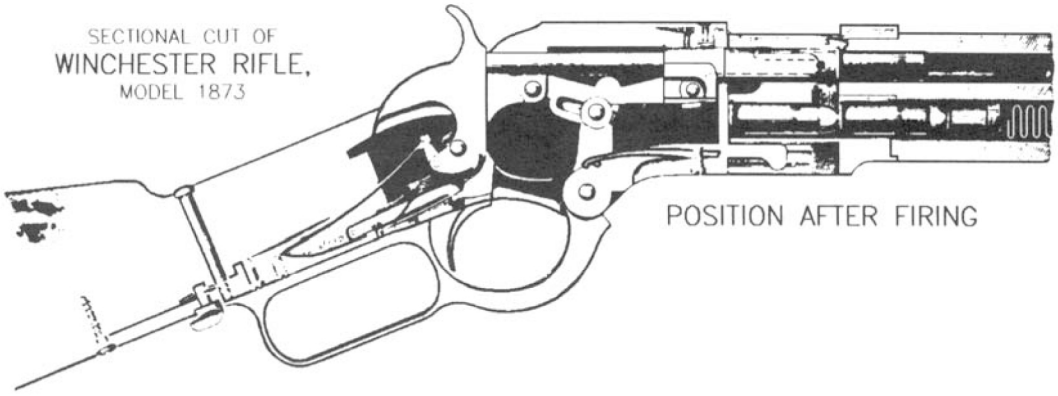


Figure 19: *The Winchester Model 1873 rifle represents the full flowering of the machine-made firearm in the 1870s.*

required a separate machining operation, with each probably done on a different machine. A half-dozen or so milling machines were involved in the production of a single part. Once the machines are set up and adjusted to perform a specific job, manufacturers do not like to change because too much time is lost in the changeover from one function to another. This is why a major manufacturer will have a separate production line for each model it makes. When you consider the hundreds of thousands of dollars represented in the machines set up for a single model of gun, it becomes clear why manufacturers are very reluctant to introduce new guns or reintroduce discontinued models. Very often, gun enthusiasts ask manufacturers to reintroduce favorite old models such as the Parker, L.C. Smith, and Winchester Model 12 shotguns. Most people believe that once a manufacturer has built a certain gun, the company could easily make a few more. It is not quite so simple. Once a production line has been broken up and the machinery put to use on other models, there is no going back. Reintroducing a discontinued model can be as costly as producing a new model, except for the initial design stages.

Since World War II, gunmakers have employed a variety of manufacturing techniques in an effort to streamline production and thereby reduce costs. Many, if not most, of these streamlining procedures have been aimed at reducing or eliminating the costs of machining operations. Remington took the first major steps in this direction in 1949 with the introduction of the Sportsman 48 auto-loading shotgun. Though this model is now history, it remains a landmark because the trigger guard and trigger assembly were later successfully adapted for use in a continuing line of Remington shotguns and rifles. These guns have been made by the million, and the cost effectiveness has been tremendous.

Another landmark of simplification was provided by Remington's Model 721 and Model 722 rifles, introduced in 1948. Abandoning the complex contours that had characterized the receivers and bolts of centerfire bolt-action rifles until that time, Remington's 721 and 722 actions conformed to the simplest shape of all. They were round in cross-section. The bolt was also round, and there was a simple extraction and ejection system.

The action was, and is, so economical to make and so strong and efficient that the design has been used virtually unchanged for a series of Remington rifles right up to today's Model 700 hunting rifles and the very accurate 40-XBR target rifles. Back in 1948, the Model 721 and Model 722 rifles were so plain-looking that most people laughed at them. Little did they know that those models would change rifle design forever. These Remington rifles are still favorites among many hunters and collectors.

INVESTMENT CASTING

Another way of escaping the costs of machining steel was pioneered by Bill Ruger. Investment casting, also known as lost-wax casting, dates back thousands of years and was commonly used in the making of jewelry and other complex design forms. Basically, the object to be produced is first molded in wax, which is then covered with a ceramic material that hardens into a heat-resistant shell. The shell is then heated, causing the wax to melt and run out through special openings. Molten metal is then poured into the empty shell, where it hardens in the form of the original wax image. Then the ceramic shell is shattered, revealing a very nearly finished product. Ruger reasoned that this ancient technique lent itself very well to the making of gun parts with complex shapes and incorporated it into the manufacturer of Ruger firearms (Figure 20).

The practicality of the investment-casting process is evident in the phenomenal growth of the Ruger Company and the worldwide acceptance of Ruger arms.

Despite Ruger's success with investment casting, nearly all gunmakers continued with traditional machining techniques and die-stamped parts. By the early 1970s, the gun industry's



Figure 20: Bill Ruger revived the investment casting process for developing his fine line of firearms.

favorite buzzword was "tape-controlled." Tape-controlled machining is an automatic process in which a perforated tape is fed through a control module in the machine or machine center. The control module "reads" the holes in the tape, and directs the machine's metal-cutting operations. As you probably suspect, these sophisticated machines are very expensive, but they offer the advantages of faster production and reduced labor costs. However, even with such fancy machinery, several fundamental problems remain and are joined by new problems.

SELF- TEST QUESTIONS

Please check your questions on page 18.

5. **Who was the inventor who first utilized interchangeable parts in firearms?**
6. ***True or False*. Before Eli Whitney and Sam Colt, most gun parts were made by forging, grinding, and hand-filing.**
7. **Which manufacturer revived the investment casting process for making certain gun parts?**
8. **What is another name for investment casting?**

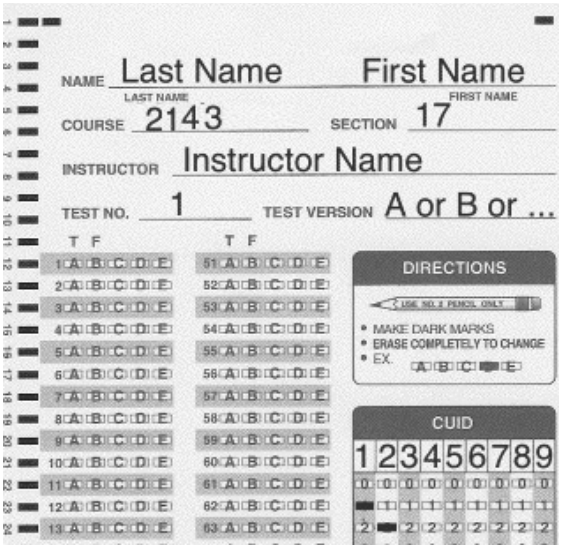
Answers to Self-Test Questions

1. True.
2. Sight-mounting jigs.
3. The small areas where the holes will be drilled must be annealed.
4. Solid carbide drills.
5. Eli Whitney.
6. True.
7. Bill Ruger of Sturm, Ruger and Company, Inc.
8. Lost-wax casting.

Lesson Questions

THIS IS LESSON NUMBER 2171.

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



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

You may also complete your exams and submit them online via the SDI Student Services page at www.sonoranlearning.com.

1. **What is the major drawback when using solid car- bide drill bits to drill hardened receivers?**
   a. They are easily broken.
   b. They seldom run true.
   c. They are only good for rimfire receivers.
   d. Solid carbide drill bits may be used only on centerfire rifle receivers.

2. **Rather than being drilled and tapped for a scope mount, how are most rimfire rifle receivers arranged for mounting scopes?**
   a. Scopes are mounted with drift pins.
   b. Clamps are used.
   c. The receivers are grooved.
   d. Scopes are riveted to the receiver.

3. **What is the average diameter of scope rings for telescopic sights used on centerfire rifles?**
   a. ½ inch.
   b. 1 inch.
   c. 2 inches.
   d. 3 inches.

4. **When a sight-mounting jig is not used, name two important tools for aligning scope bases.**
   a. Drift punch and screwdriver.
   b. V blocks and tri-squares.
   c. Depth micrometer.
   d. Mainspring vise.

5. **How would you find the correct sight base for a given make and model rifle?**
   a. Refer to any ballistic table.
   b. Use a bullet-drop table.
   c. Look at the markings on the rifle barrel.
   d. Refer to a sight base chart, find the make and model of rifle, and then obtain the catalog number of the proper sight base.

6. **What is the instrument called that allows fast, accurate bore-sighting?**
   a. Collimator.
   b. Chronographs.
   c. Pro-mount.
   d. Bore guide.

7. **When mounting telescope sights on top-ejecting rifles, what type of mounts is normally used?**
   a. One-piece mounts.
   b. Off-set mount.
   c. Low-profile mount.
   d. High-profile mount.

8. **What is the main purpose of elevation and windage knobs on scope sights?**
   a. To secure the scope to the receiver.
   b. To allow easier maintenance of the scope.
   c. To adjust the bullet's point of impact on the target.
   d. To make the front sight show up better.

9. When using a bottoming tap in a blind screw hole, what is one precaution you should always take?

a. Do not use much force as the tap reaches the bottom of the hole.

b. Use a lot of force as the tap approaches the bottom of the hole.

c. Never reverse the tap while in the screw hole.

d. Always turn the tap counterclockwise to cut.

10. If the precaution in Question 9 is not followed, what is likely to happen?

a. The tap is certain to break when it reaches bottom.

b. The tap will be dulled.

c. The threads will be out of line.

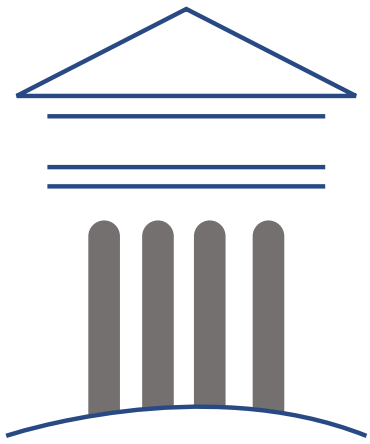
d. The threads will be oversize.

Accurizing Firearms Lesson: 2172

OBJECTIVES 3
INTRODUCTION 3
ACCURIZING THE COLT MODEL 1911 PISTOL 4
- Bushing Barrel-Entry Clearance 4
- Fit Barrel Hood To Slide 5
- Bushing Lock-Up Clearance 6
- Determine Total Lug Engagement 7
- Cutting The Bottom Barrel Lug 8
- Fitting A Match Link 12
- Barrel Bed Check 13
- Final Lock-Up Engagement Test 14
- Barrel Face Modification 14
- Barrel/Slide Final Fit 16
- Chamber Check 17
- Ejection Port Modification 18
- Fitting The Extractor 19
- Self-Test Questions 19

MISCELLANEOUS ALIGNMENT TECHNIQUES 20
- Rifles 20
- Handguns 21
- Self-Test Questions 22

ANSWERS TO SELF-TEST QUESTIONS 23
LESSON QUESTIONS 24



Objectives

In this lesson, you will learn

1. How to hood a custom barrel for a Colt Model 1911 semi-automatic pistol.
2. What the minimum shoulder dimension is for the barrel link on a Colt Model 1911 pistol.
3. What the minimum trigger pull is for a hunting rifle.
4. How to modify the ejection port on a Colt Model 1911 pistol.
5. How to understand the indications of a grouping that is below the bull's-eye if the pistol is properly sighted.



Introduction

There are some gunsmiths in the United States and abroad who do no other gunsmithing work but accurizing firearms for competition shooters. Some of these are so highly specialized that they work only on one model of firearm. For example, one gunsmith may devote his or her time entirely to accurizing Colt Model 1911 semi-automatic pistols for match shooting; another may specialize in small-bore rifles, such as the Winchester Model 52, Anschutz, and other target rifles. Still another may work only on large-bore match rifles for use at Camp Perry and other matches.

It is no secret that when gunsmiths are capable of turning out firearms that consistently win at the matches, they seldom need to advertise their services. By word of mouth, competitive shooters learn of the gunsmith's skill, resulting in steady work for the gunsmith. Furthermore, such gunsmiths demand a premium price for their work. They will not cut corners because they know that one bad rifle or handgun could hurt their reputation. Consequently, they do only the best work obtainable and charge accordingly. Once the major portion of the work is complete, they might spend another 40 hours or more just fine-tuning the weapon. But when the gunsmith is finished with the firearm, the reward is a check for a few thousand dollars.

Most gunsmiths who do only accurizing work did not start out this way. Just like most of their colleagues, they started out doing minor gun repairs, a little refinishing, and similar jobs. However, sometime in the gunsmith's career, he or she started getting good at accurizing a particular model firearm, and eventually got to be one of the best in the field. With competitive shooters from all over the country needing to have the gunsmith to work on their firearms, he or she had to give up regular gunsmithing work and concentrate solely on accurizing jobs.

Accurizing the Colt Model 1911 Pistol

There are many types of competition-style barrel bushings available, including matched or pre-fitted, under-sized and over-sized. They are produced in chrome moly and stainless steel and are available in finger- or full-skirt styles. Be selective when choosing the size and style to ensure that the bushing closely satisfies your requirements, which will reduce fitting time required to prepare the bushing.

For match-grade performance, avoid reworking standard bushings with expansion or swaging methods to obtain proper fit. This procedure is useful for the requirements of a standard gun, but does not maintain match-grade tolerances.

Determining the true dimension of the bearing surface of the muzzle end of the barrel, proceed to open the inside diameter of the bushing. This procedure is executed using an expandable reamer as shown in Figure 1. Make multiple light cuts as needed until a moderate fit between the barrel and the bushing is achieved. Complete the sizing operation by honing to a precise fit.

As previously instructed, work with compatible dimensions. When preparing the barrel, the bushing bearing surface is reduced to retain additional wall thickness in the oversized bushing. This limits the need to ream the inside diameter of the bushing and restricts this procedure to a honing operation. This saves fitting time and provides a more durable bushing that will retain match tolerances longer.

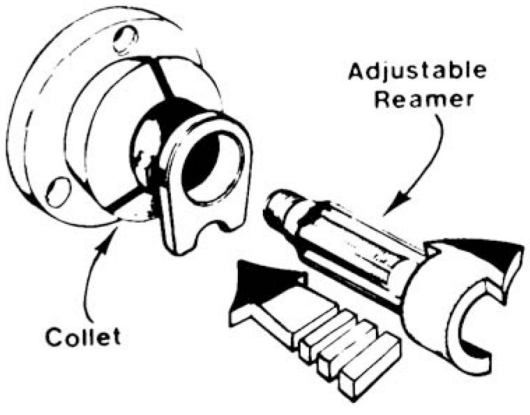


Figure 1: *Open the inside bushing diameter with an adjustable reamer.*

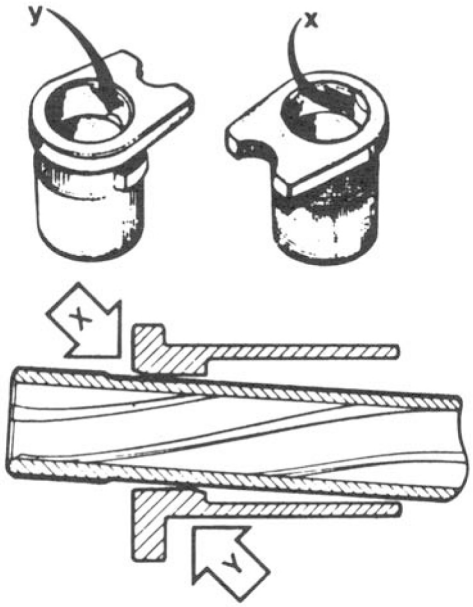


Figure 2: *Burnish the inside shoulders of the sized bushing at points X and Y.*

BUSHING BARREL-ENTRY CLEARANCE

As shown in Figure 2, hone the inside shoulders of the sized bushing at points X and Y to allow unrestricted ,but controlled, barrel movement. The light honing in conjunction with the transition taper of the barrel permits the barrel to re-enter the bushing as the feeding cycle is completed. Arrows X and Y indicate the initial contact areas to be addressed. This procedure is best accomplished by hand using a half-round India stone.

For clarity, the illustration exaggerates these areas. Proceed carefully. This operation requires very little metal removal to refine the surface.

With the sized bushing installed in the slide, insert the barrel through the bushing and draw it back toward lock-up position to check your progress.

FIT BARREL HOOD TO SLIDE

Custom barrels often provide long hoods which give proper fitting to the slide. If this is the case, the hood must be fitted, shortened, and relieved to prevent binding (Figure 3). The barrel hood consistently positions the barrel in the slide during each lock-up cycle. The fitting is initiated by stoning the side skirts, indicated by arrow A. Use layout fluid to determine the contact points. Continue the stoning operation to achieve full engagement. Face off area B to shorten the hood as required. To avoid inadvertent contact, as the extended hood enters the recessed area of the slide, slightly round the corners of the barrel hood indicated by arrow C. Area D must be polished. The relieved taper should extend into the barrel hood to ensure proper clearance with the slide when a longer link is fitted to the barrel.

During this operation, use the original bushing or an oversized equivalent to avoid front-end binding. The purpose of this fitting procedure is to achieve even contact on all surfaces, without interference. The fit can be readily checked by applying a light source beneath the slide. If a proper fit has been achieved, the only visible light will appear at the relieved corners of the hood.

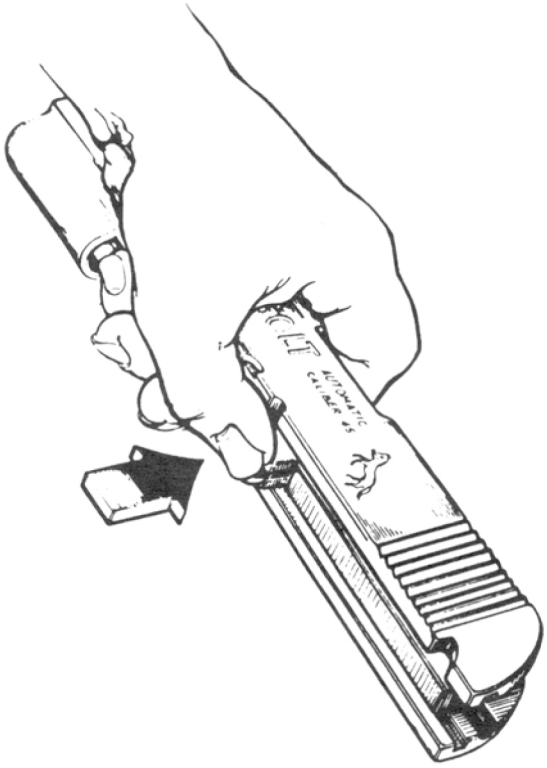


Figure 4: *Method used to stimulate barrel movement.*

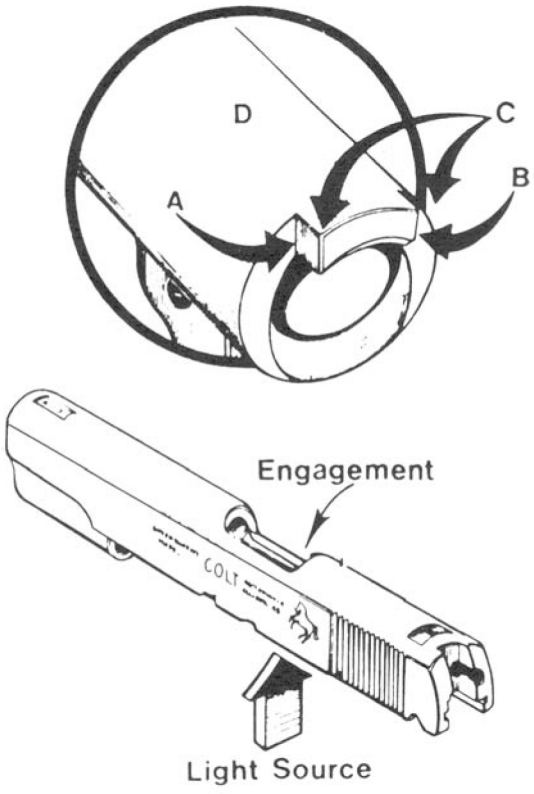


Figure 3: *Long hoods must be fitted, shortened, and relived to prevent binding.*

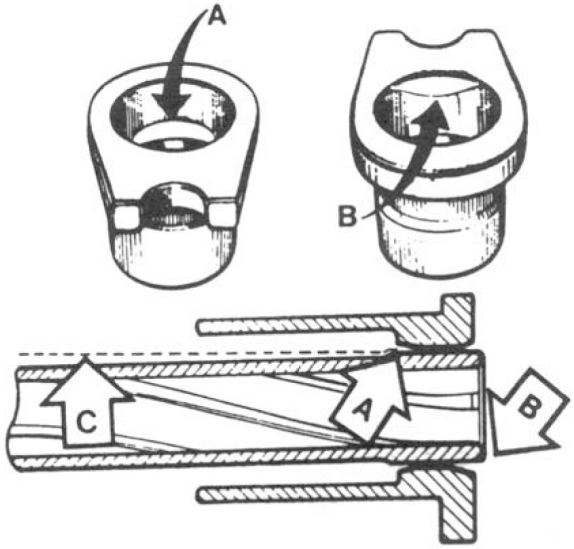


Figure 5: If spring-back exists, the bushing shoulders must be relieved to prevent binding.

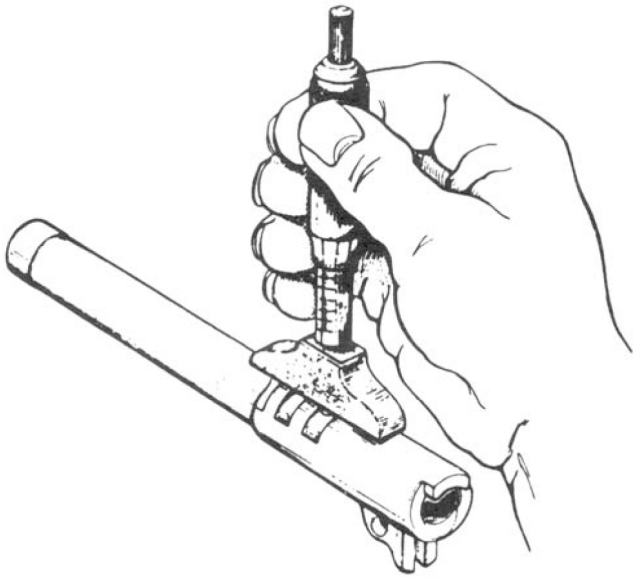


Figure 6: Apply pressure to seat lugs; then measure the engagement with a depth micrometer.

BUSHING LOCK-UP CLEARANCE

To begin this clearance procedure, insert the match barrel in the slide and install the fitted bushing. With the barrel in this position in the slide assembly, manually push the lugs into full engagement with the slide. This will simulate the movement of the barrel as it swings up into full lock-up position (Figure 4).

As you release the pressure on the barrel, check for any resistance. If spring-back exists, the bushing shoulders must be relieved to prevent binding when the barrel swings into lock-up position, as indicated by arrow C in Figure 5. This procedure requires some metal removal and can be accomplished using a half-round stone. With the stone, carefully create the profiles indicated by arrows A and B.

NOTE: For clarity, the illustration exaggerates these areas and angles. Proceed slowly, frequently checking your progress until only slight resistance occurs. At this point, continue with the India stone to achieve final fit, which provides a solid lock-up, eliminates all spring-back, and allows no additional movement.

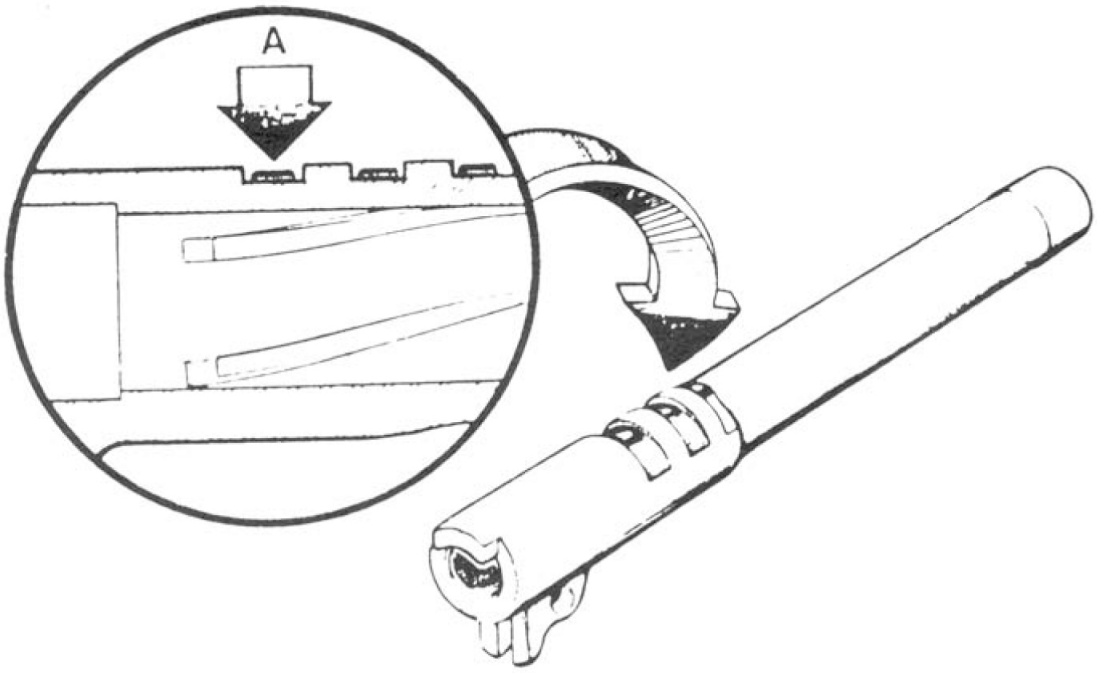


Figure 7: *Place 1/8" pads in each lug slot at the top of the radius.*

DETERMINE TOTAL LUG ENGAGEMENT

You have previously determined the lug/slot compatibility during your preliminary component survey. This procedure determines whether full engagement is available between the first slide lug and barrel slot. Because the barrel swings up into locked position, the forward lugs exhibit progressively less engagement. You can check the engagement using a light compression of Plastigauge. This compression-sensitive material is placed in each lug slot and the barrel is installed in the slide with the fitted bushing in place as in Figure 4. Apply pressure to seat the lugs before removing the barrel to measure the engagement with a depth micrometer, as in Figure 6. If full engagement does not occur, check the barrel and internal slide preparation procedures again. First, determine whether the top of the barrel above the chamber area has been properly taper-relieved. Second, when honing the interior slide, be sure that the area from the ejection port forward is properly polished.

If Plastigauge is not available, you can substitute modeling clay to check the tolerances. Press out a pad to the appropriate thickness. With an X-Acto knife, cut ¼" pads. Apply a silicon spray to the interior slide to function as a release agent for the clay, then place the pads in each lug slot at the top of the radius as shown in Figure 7. Be careful when making micrometer measurements because clay compresses more easily than Plastigauge, particularly when warm.

To confirm total engagement, there should be no measurable thickness of clay remaining in the first barrel slot, indicated by arrow A in Figure 7.

CUTTING THE BOTTOM BARREL LUG

Check the uncut lug area of the new barrel to determine that a minimum of 0.100" of shoulder exists between the link pin hole and the bottom of the barrel lug as in Figure 8.

A quick reference check can be made using the longest available link. With the long link temporarily installed, the stop pin hole should be partially restricted by the lug shoulder. This will establish that adequate lug area exists for prefit cutting.

To cut the bottom barrel lug, the frame is used as a cutting jig in conjunction with a lug-cutting tool as shown in Figure 9. As with other gunsmithing accessories, there are a number of suitable lug-cutting fixtures available. The one illustrated here was constructed in a gunshop.

Always consider what tools and parts are commercially available. If nothing is on the market that satisfies your requirements, make it. If it is commercially available at a reasonable price, buy it.

This lug-cutting equipment consists of five basic components: the lug cutter, cutter bushing, slide lever, barrel support, and the frame plates and filler. A lug cutter with a handle is shown in Figure 10. This two- stage cutter furnishes a roughing diameter of 0.195" and a finishing diameter of 0.197 inch. The cutting rotation is implemented by a knurled handle with an offset shaft. The cutter bushing, shown in Figure 11, is fabricated from drill rod and then hardened. Before the outside dimensions are turned, the round stock is faced off and center drilled to a diameter of 0.125 inch. Then, the tailstock is moved in to locate the drilled hole on a live center. The outside profile is cut to specifications and a 0.006° taper is turned on the outside of the bushing collar. With the aid of a cut-off tool, the bushing is cut to length and the pilot hole is deburred. The flange is milled for proper slide relief before heat treating, using a slide lever, shown in Figure 12. This accessory can be fabricated from a ¼" shaft screw- driver. Shorten the shaft to 5" and bend the middle 15 degrees. Profile the end of the shaft to conform to the

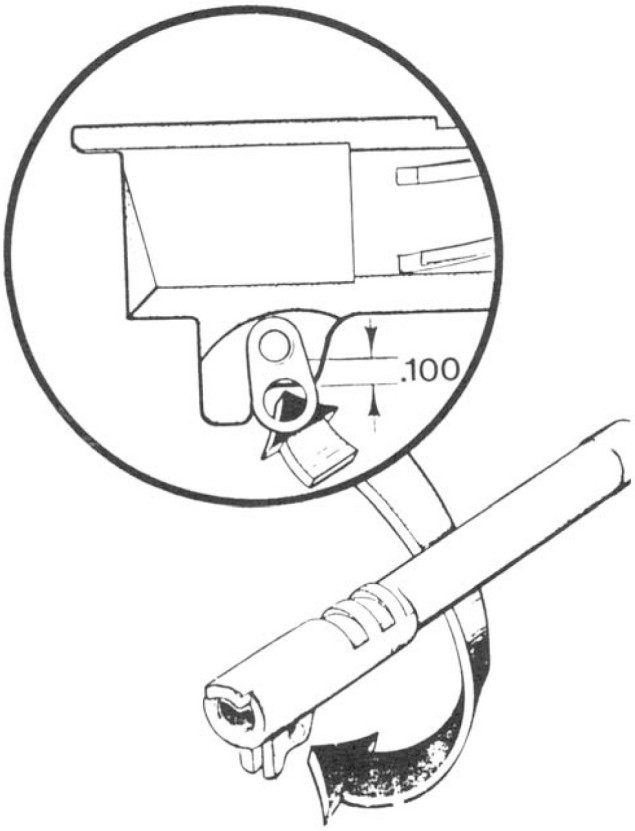


Figure 8: *Make sure that a minimum of 0.100 exists here.*

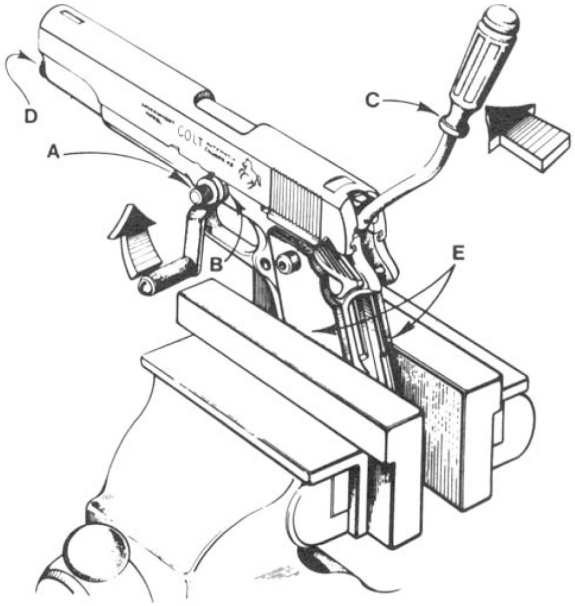


Figure 9: *To cut the bottom lug, the frame is used as a cutting jig in conjunction with a lug-cutting tool.*

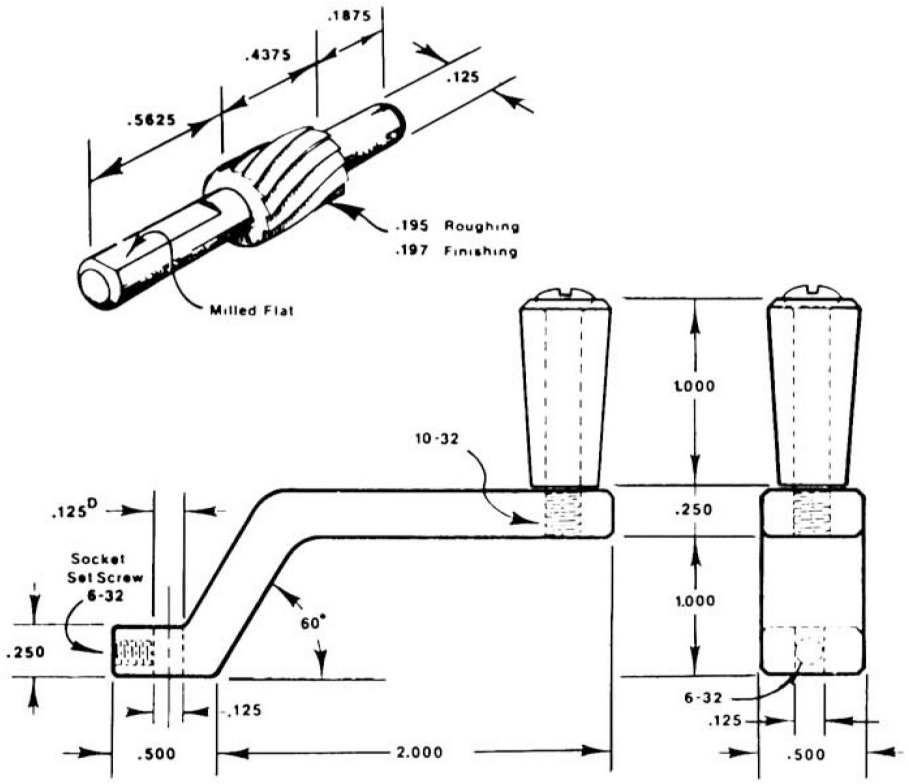


Figure 10: Dimensions of a lug-cutting tool.

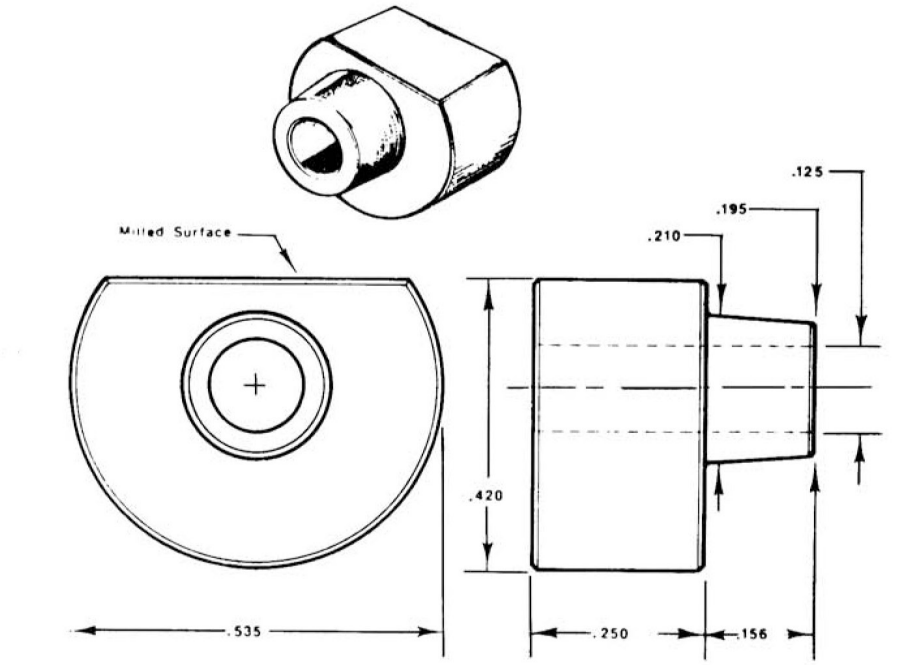


Figure 11: The cutter bushing is fabricated from the drill rod then hardened.

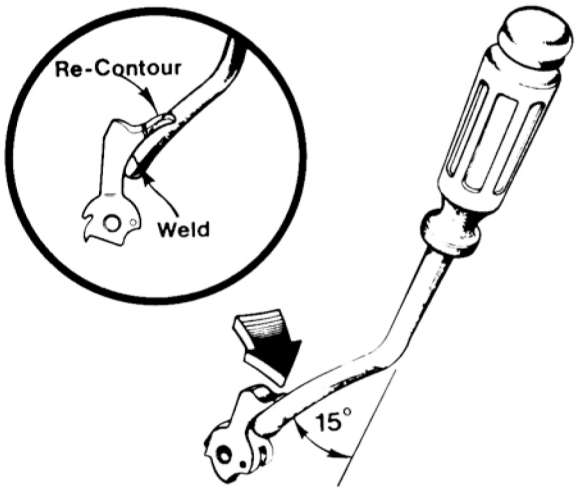


Figure 12: The slide lever can be fabricated for a 1/4" shaft screwdriver.

back side of a surplus hammer. Weld the hammer in place and dress and polish the sides for proper clearance. The barrel support, shown in Figure 13, can be turned from ½" drill rod. After counter-boring the end for a live center, relieve a 2" section to 0.442" diameter. Set measurements to 0.495" for the next section, which is 1 7/16" long. Relieve the next 3/32"-0.390" diameter to finish the end, before cutting to length. To complete the unit, drill and tap a 10-32 hole, 0.375" from the end and install an Allen screw for tension. The frame plates and filler, shown in Figure 14, are smaller plates that are useful when you need access to the various frame areas, which are restricted when using the larger units. These components can be made from ¼" flat stock. Standard grip panels offer an acceptable pattern profile and provide relieved areas for component access. The top dimension is 1 3/8", which tapers the full length of 4" to a bottom dimension of 1 3/4 inches. The right side frame plate is fitted with an extension to support the cutter bushing. Retaining holes are drilled to clear the grip screw bushings, which will retain the plates, if installed. If you are working on a stripped frame, Allen screws may be used to retain the plates. A standard 4" filler is placed in the magazine to prevent frame distortion.

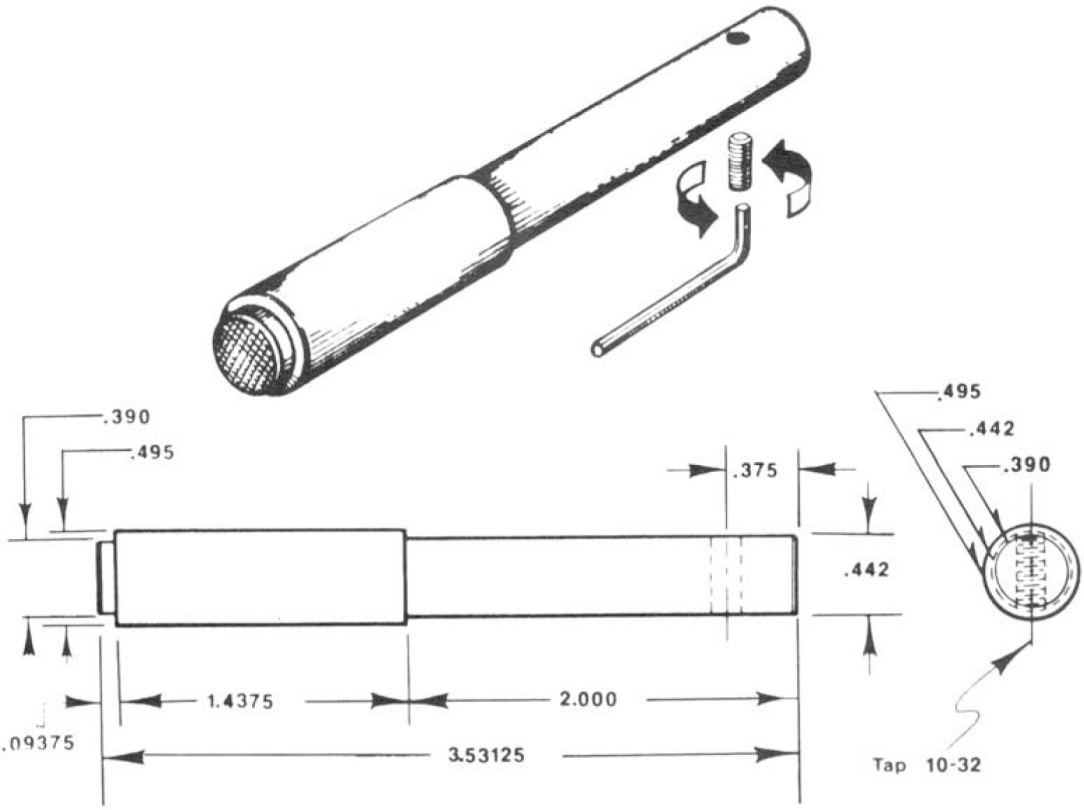


Figure 13: Dimensions of barrel support.

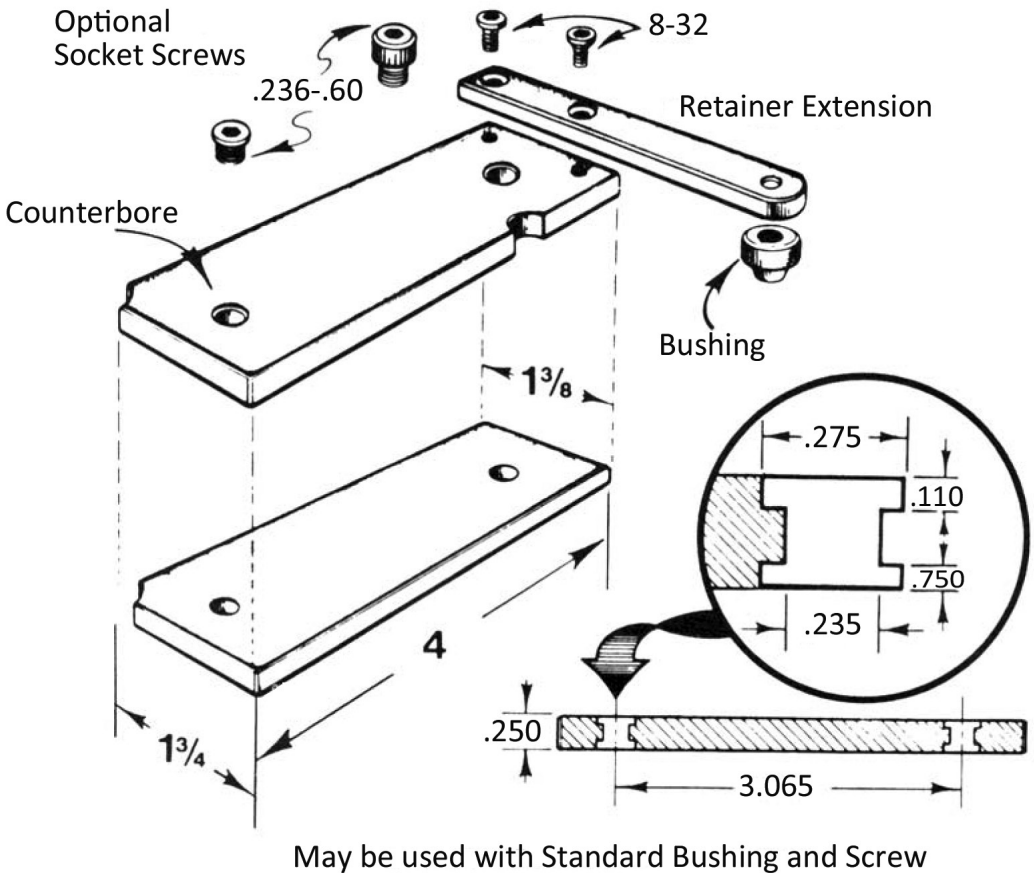


Figure 14: *Frame plates and filler.*

To complete the operation, place one cutter bushing in the left side of the frame and install the frame plates to retain it. Insert the magazine filler and secure the frame in a suitable vise. Position the barrel and bushing in the slide and insert the barrel support. Engage the barrel with the retaining screw and secure it in an elevated position, locked up against the slide face. Install the slide assembly on the frame. Place the other bushing on the long shank of the roughing cutter and secure it in place with the set screw of the rotating handle. Insert this cutter assembly through the slide stop hole to engage the off-side bushing. Insert the slide lever in position and secure it with a hammer pin. Using the lever, move the slide assembly forward to engage the cutter. Rotate the cutter handle clockwise to initiate the cutting procedure. Lubricate frequently to clear the flutes and promote a smooth cut. Continue the operation until the thumb safety engages the slide notch as shown in Figure 15.

To complete the initial lug cutting procedure, install the larger cutter and ream to the finished contour. After the final cut is made, dress the machined surfaces of the recontoured areas. This polishing process is completed by using a half-round India stone to remove any remaining cutter marks. If you do not wish to make these tools, they are available from Brownells.

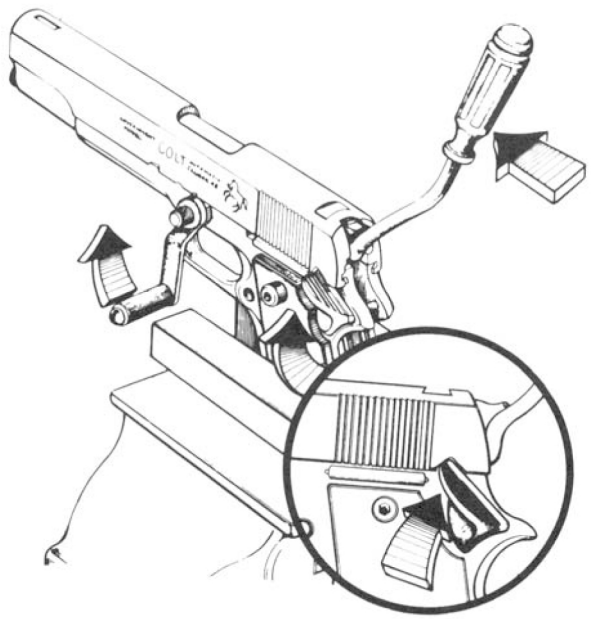


Figure 15: Rotate the cutter handle clockwise to preform the cutting operation.

FITTING A MATCH LINK

Before any further fitting can be done, the final lock- up position must be established. This entails determining the proper link length. To facilitate this procedure, have a complete assortment of links available. This selection should begin with the nominal Colt spec of a 0.278" center-to-center hole dimension and advance in standard increments to a 0.299" dimension. The proper size determination is best made using an undersized link pin. Place the appropriate link in a vertical position and secure it with the undersized fitting pin as in Figure 16. Insert the slide stop pin to determine total lug contact in its rearmost position.

NOTE: The diameter of the stop pin should be compatible with the chosen link to ensure proper fit with no excessive tolerance or binding.

The undersized fitting pin in conjunction with the tolerance of the lug cutter will provide for an adequate lug surface during the final fitting procedure. This final clearance is completed using a properly contoured India stone to relieve all remaining high spots or irregularities. Coating the lug contour with layout fluid will help determine those areas and expedite this procedure. Before the final dressing procedure begins, replace the fitting pin with a properly sized link pin to ensure precise clearance. The fit is complete when the link, with the slide stop pin installed, pivots up in an unobstructed swing, until it comes to a stop at its rearmost position. At this point, the stop pin should be supported at both the back and bottom of the lug. This contact may be checked by sliding the stop pin laterally through the link as shown in the insert in Figure 16. Proper support is indicated, if a slight resistance is required to move the pin. The lateral movement will cause the layout fluid to be displaced at all points of contact to indicate the areas of support.

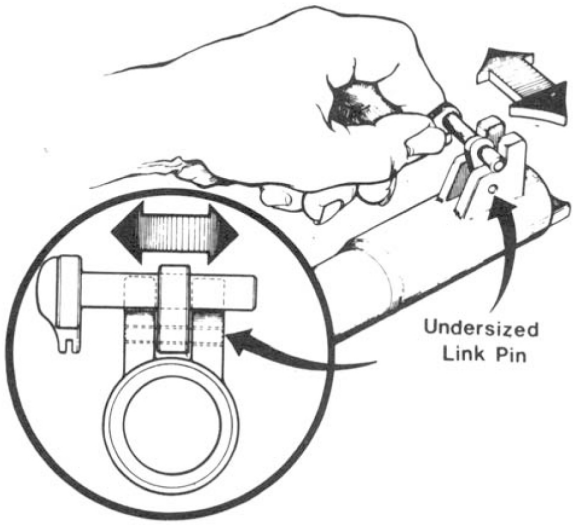


Figure 16: Place the appropriate link in a vertical position and secure it with the undersized fitting pin.

BARREL BED CHECK

Stake the fitted link pin in position and dress the side of the barrel lugs, if required. Place the linked barrel on the frame and insert the slide stop pin to retain it. Slowly move the barrel to the rear and carefully observe the action. The barrel should seat firmly into the curvature of the barrel bed. To confirm that the proper link-down relationship exists, firmly hold the barrel in this rearward position and rotate the slide stop. The pin should rotate freely as it passes through the frame and link as shown in Figure 17. If the present fit of the barrel is proved by this check to have accept- able tolerances, proceed with the lug engagement test in full link-up position.

If the test shows negative results and the barrel is not properly bedded, the barrel lugs may be engaging the frame prematurely (See insert A in Figure 17). If this is the case, coat the vertical surfaces of the barrel lugs with layout fluid and again push it to the rear to contact the frame as indicated by arrow A.

Withdraw the stop pin and remove the barrel to stone the contact areas to obtain proper clearance as indicated by arrow X. Repeat this operation as required until full bed contact is achieved.

All modifications are performed on the barrel lugs during this operation. The frame must not be altered in the barrel bed area.

If the barrel requires bottom lug modification to achieve proper bedding, check to see that the proper barrel/frame relationship exists at the ramp area (See insert B in Figure 17). If the resulting barrel set-back reduced the 0.030" step, the lower barrel face must be altered to provide the required clearance at arrow A.

This corrective procedure may be performed with a rotary motor tool fitted with a medium Cratex point. Relieve only the lower 20% of the barrel face as indicated by arrow Y of the insert.

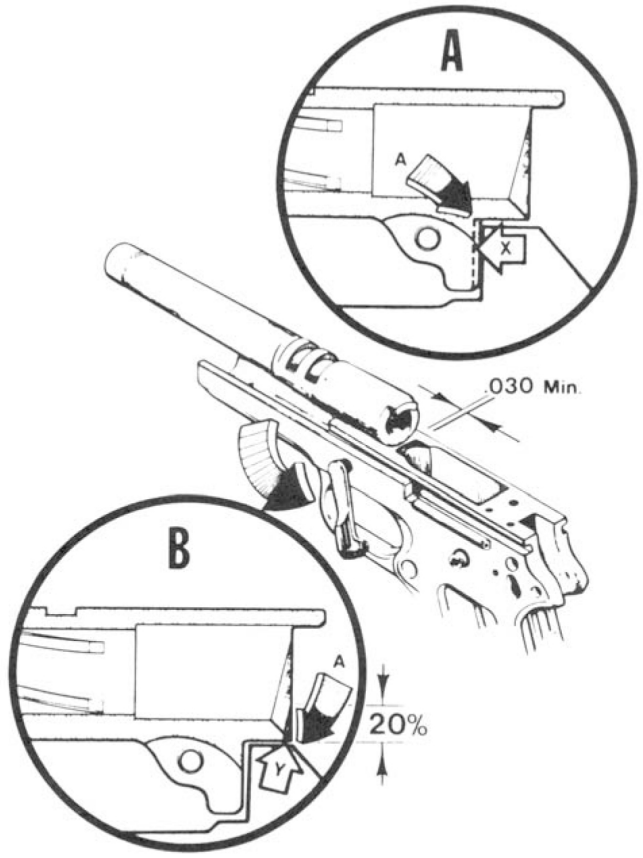


Figure 17: *The pin should rotate freely as it passes through the frame and link.*

FINAL LOCK-UP ENGAGEMENT TEST

Prepare the barrel and slide as before in the lug/slot engagement test. Insert the Plastigauge or clay in the barrel slots and spray the slide lug area with silicon. With the linked barrel installed in the slide, position the assembly on the frame. Insert the slide stop pin to locate the link and move the slide forward into a full lock-up position to compress the pressure-sensitive material. Remove the slide to recover the barrel and measure the depth of each succeeding barrel-lug slot as shown in Figure 18. This will effectively indicate the actual lug engagement.

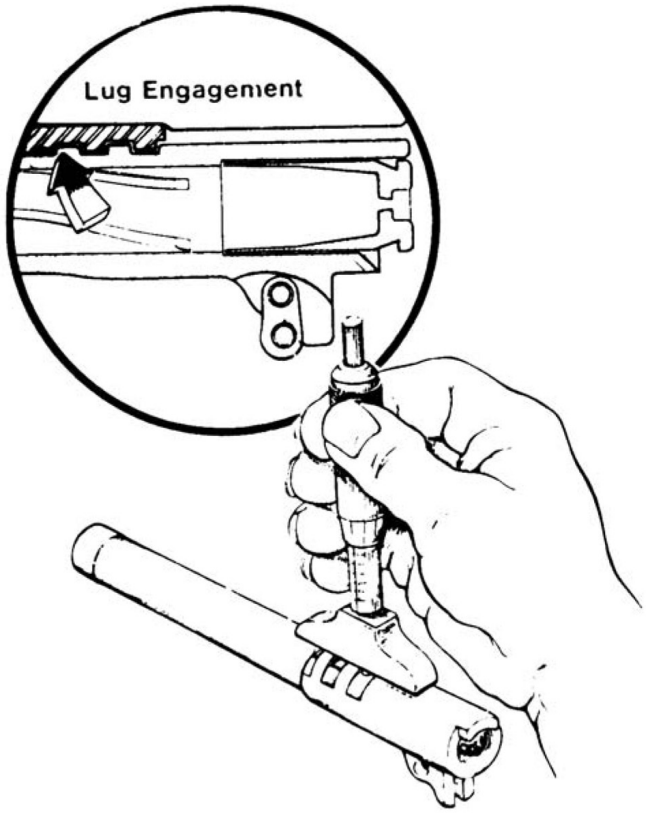


Figure 18: *Measure the depth of each succeeding barrel-lug slot*

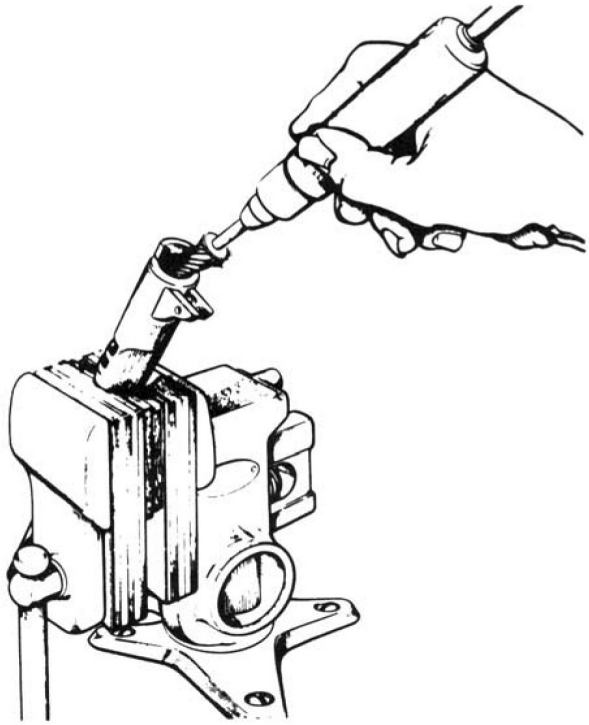


Figure 19: *The primary throating procedure is best accomplished using a hand grinder.*

BARREL FACE MODIFICATION

With the proper link fit and lock-up established, you may proceed with barrel face modifications as required. This operation will involve both throating and ramping procedures designed to improve the feeding characteristics and capabilities of the weapon. The primary throating procedure is best accomplished using a hand grinder or a variable-speed Moto-Tool fitted with a high-speed spiral cutter or carbide burr. This motorized equipment is best controlled when used in conjunction with foot-operated speed control. The barrel should be secured at an appropriate angle in a bench vise. Figure 19 shows the use of felt-lined wooden inserts to protect the barrel and to dampen vibration to prevent tool chatter.

An unaltered factory throat is illustrated in Figure 20, showing the proper relationship of the barrel and frame. Note that 0.030" of the top of the receiver is exposed between the feed ramp of the barrel and that of the frame. This step must be maintained to ensure proper function. The original chamber entry throat of a standard issue barrel is shown in Figure 20. Point A illustrates the contour of the unaltered barrel ramp.

NOTE: Colt Mark IV and later-issue barrels are factory throated and will require very little modification. Most custom and after-market barrels are already throated and will only require polishing.

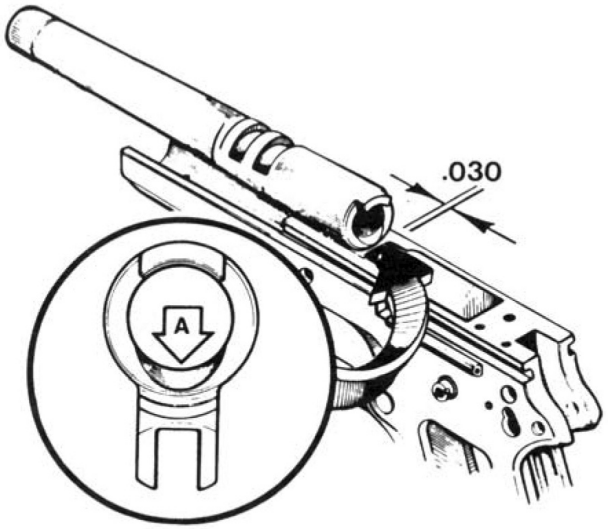


Figure 20: A distance of 0.030" of the top of the receiver is exposed between the feed ramp of the barrel and that of the frame.

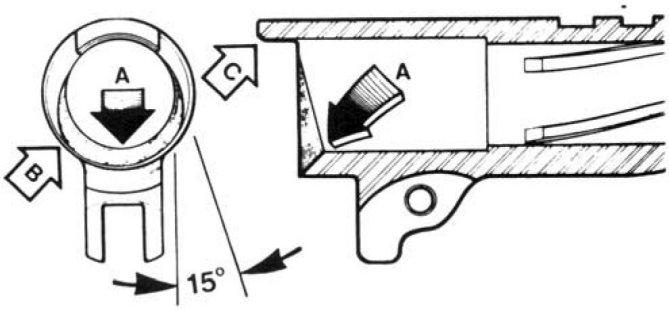


Figure 21 Point A indicates the angle of the original feed ramp. Point B shows the throated area of the widened chamber. Point C indicates the beveled barrel hood.

Both the contour and the profile of a modified barrel face are illustrated in Figure 21. Point A indicates the angle of the original feed ramp, which should remain unaltered and must not be extended into the chamber area. To lengthen this ramp would expose more unsupported case area and result in a potentially dangerous situation. Point B shows the throated area of the widened chamber mouth blending into the polished barrel ramp. Note that this area is extended at a 15° angle to encompass the lower 2.3' of the barrel face. Do not extend this recommended profile or an excessive amount of the surface of the barrel face will be removed. This would result in an inadequate engagement area for the slide in addition to affording insufficient case support. Point C indicates the area of the barrel hood that should be beveled at a 45° angle to chamber non-jacketed ammunition. Again, proceed with moderation and do not exceed the profile shown.

The cutaway in Figure 22 shows the barrel feed ramp, cut to the recommended profile, indicating the relationship between the modified barrel ramp and a chambered case that may be removed during modification. This dimension must not exceed 0.240" as measured from the face of the case.

A chambered case must be the measurement reference since the bottom of the barrel face may have been relieved to obtain the proper step clearance during earlier fitting procedures. Maintaining this tolerance limit will provide a safety margin to compensate for variations in case-wall thickness. This will limit the unsupported case area and avoid the danger of bulged or ruptured cases.

After the barrel throat has been radiused, inspect the recontoured area for any tool marks created during the initial shaping procedure (Figure 23). These irregularities can be removed with a medium or fine India stone. The final polish of the chamber throat is completed using progressively finer abrasive wheels or Cratex Points to blend the profile of both the feed ramp and barrel throat into one continuous surface.

The 0.030" step between the ramps must be maintained to ensure proper function.

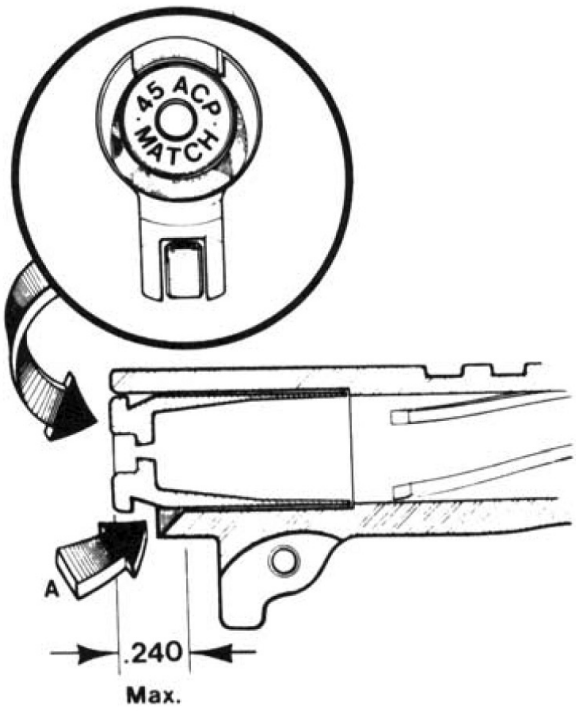


Figure 22: Barrel-fed ramp cut to the recommended profile.

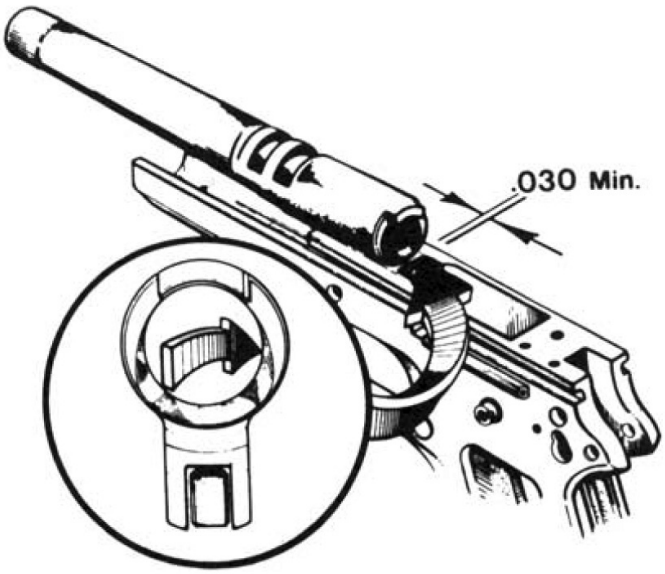


Figure 23: The 0.030" dimension between ramps must be maintained to ensure proper function.

BARREL/SLIDE FINAL FIT

The final fitting procedure follows the initial preparation of the primary slide components.

To clarify this operation, a finished barrel showing the fitted relationship to the frame and slide is shown in Figure 24. The screened areas illustrate the polished ramp and throat showing the appropriately modified configurations. Dimension A indicates 0.030", the correct tolerance step that must be maintained between the barrel face and the feed ramp. Arrow B signifies the area of the barrel hood that must be chambered to facilitate feeding various bullet configurations.

To ensure proper lock-up, the corners of the barrel hood, indicated by C, are relieved to avoid inadvertent contact with the slide. The hood has been properly fitted and relieved at point D to prevent binding. Area E, the section of the barrel above the chamber, has been polished and relieved. This relieved taper extends into the barrel hood to ensure proper clearance with the slide.

The area of the barrel face, indicated by arrows F, has been fitted to bear evenly on the breech face of the slide at point X. This creates a consistent vertical contact area, which helps ensure that the barrel is secured in exactly the same position during each lock-up cycle. This positive and precise positioning of the barrel is essential to sustain improved accuracy.

All of these areas must be checked for proper contact and clearance. The final fitting procedure is completed slowly and deliberately.

Being overzealous at this point could cause irreparable damage to previously fitted components and result in many hours of lost labor. This operation is primarily an oil-honing and hand-lapping procedure intended to relieve any light resistance. You may initiate this procedure by applying layout fluid to the surfaces of primary contact. When these suspect areas are determined, a light stoning will relieve them to prepare for the honing operation and final seating. As with all honing or grinding operations, proceed with caution.

CHAMBER CHECK

When you have achieved the proper barrel/frame/slide relationship, test the chamber length. This procedure measures the chamber accurately to determine that you have maintained the correct headspace tolerance. You may confirm this by using both Go and No-Go headspace gauges, illustrated in Figure 25.

The .45 ACP is a rimless straight case with headspaces off the case mouth. The nominal chamber length is 0.898" and you can check this by carefully chambering the Go headspace gauge. This initial test confirms that the chamber is adequate in length. To further establish that there is no excessive length, insert the No-Go gauge and ease the slide down. If this gauge prevents the barrel from locking up, the correct headspace relationship has been attained.

Usually, this procedure confirms that you have maintained proper chamber tolerances. However, if the fitting operation resulted in a tight chamber, it may be necessary for you to use a chambering reamer to return the chamber to its correct dimension. This procedure can be completed by hand-using a finishing reamer as shown in Figure 26. Work slowly using multiple, light passes to recut the chamber to the required depth. Check your progress frequently with the headspace gauges. Remove the reamer carefully and clear the chamber area each time before inserting the No-Go gauge. As you near the correct chamber depth, the barrel will move into lock-up position. To complete the operation, confirm the chamber dimension with the Go gauge.

NOTE: An excellent source for both chambering reamers and headspace gauges is Clymer Manufacturing Co., Inc. (www.clymertool.com)

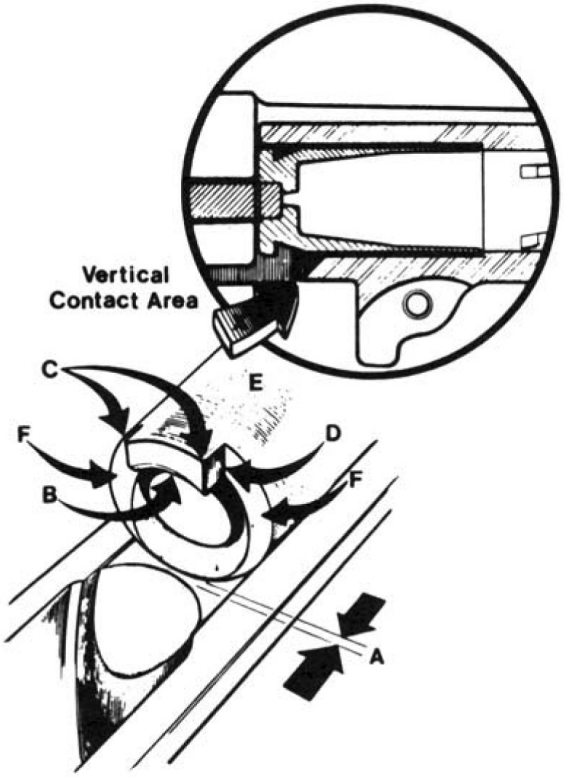


Figure 24: A finished barrel showing the fitted relationship to the frame and slide.

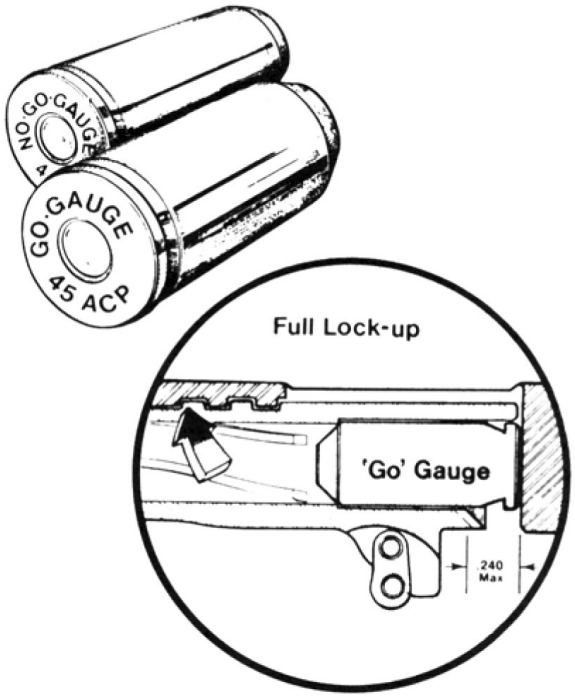


Figure 25: Once the barrel/frame/slide relationship has been obtained, check your work with headspace gauges.

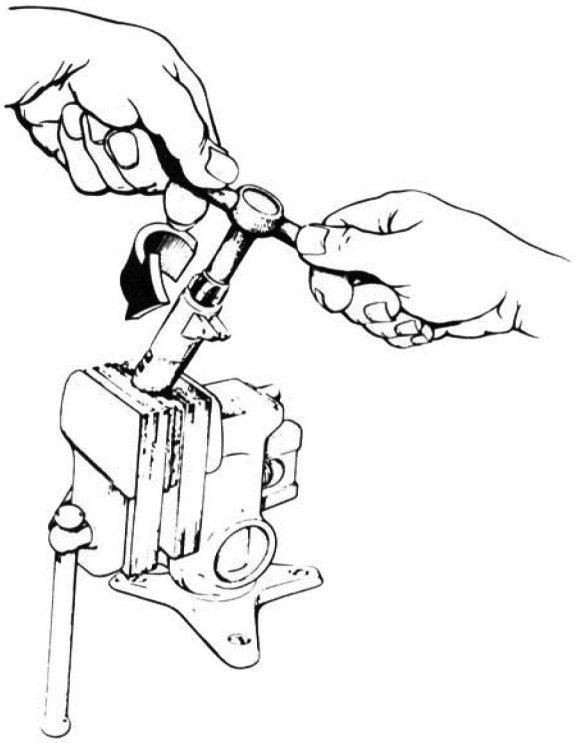


Figure 26: It might be necessary to use a chambering reamer to correct the chamber dimensions.

EJECTION PORT MODIFICATION

Lowering the ejection port is a modification performed to aid case ejection and ensure functional reliability. If you utilize the standard port profile, the fired case will contact the frame after the ejector clears it from the extractor. This contact both damages the cartridge case and invites potential malfunction. If you are working with a Gold Cup or Custom slide, this modification has already been performed and little or no additional work is required.

This slide modification is best performed using a milling machine to first lower the profile of the port opening as illustrated in Figure 27. Remove only the metal required to ensure case clearance and maintain the same vertical configuration.

Do not cut the slide wall below the indicated dimension. Following the milling operation, the rear port wall must be radiused to facilitate ejection. This procedure is best accomplished using a variable speed Moto tool fitted with a carbide cutter. The required dimension of this cut is established by the position and profile of the fired case as it is ejected from the port and pivots to the rear as shown in Figure 28. This relief cut should be made in the slide beginning 0.125" down from the barrel hood offset. The profile of the relief should extend

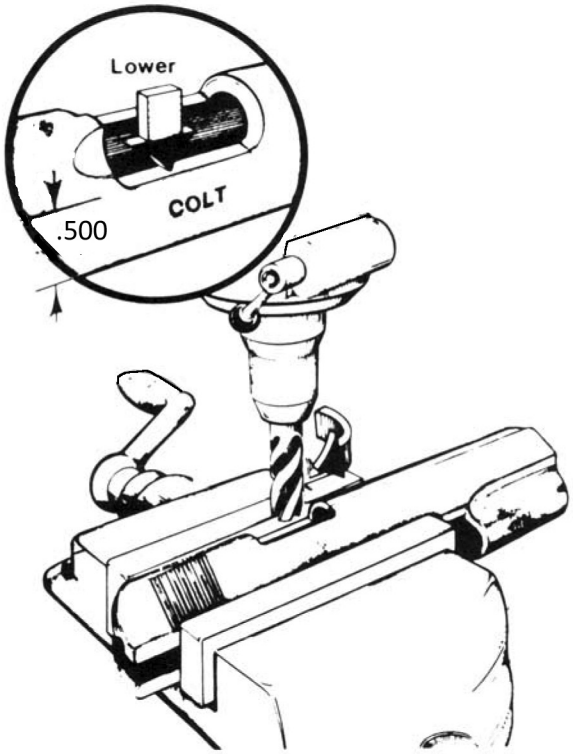


Figure 27: The slide modification is best performed using a milling machine to first lower the profile of the port opening.

0.375 " toward the rear of the slide as indicated. The depth of the cut in the face of the slide should not extend below the outer perimeter of the face of the barrel. Using a medium Cratex point, polish the relieved area to complete the port alteration.

FITTING THE EXTRACTOR

The extractor, shown in Figure 29, must be reshaped and polished to ensure positive extraction. This procedure involves relieving the front profile of the extractor to provide adequate clearance in the extractor groove of the cartridge case. First, check the claw height to make sure that the claw is not biting into the bottom of the extractor groove of the ejected case.

The dimensions in this area of the case vary with imported ammunition. The nominal extractor groove depth is 0.400 inch. The maximum recommended clearance is 0.05 inches. Modify the extractor claw height accordingly and polish. Secondly, the beveled tip of the extractor must not contact the case when seated in the groove, since it would exert rearward pressure against the rim. Relieve and polish this area of the extractor to ensure proper clearance. Next, the lower edge of the extractor slot must be modified. The standard extractor exhibits little or no camming angle in this area. This area of the extractor must be recontoured to facilitate the camming action necessary to ensure positive feeding.

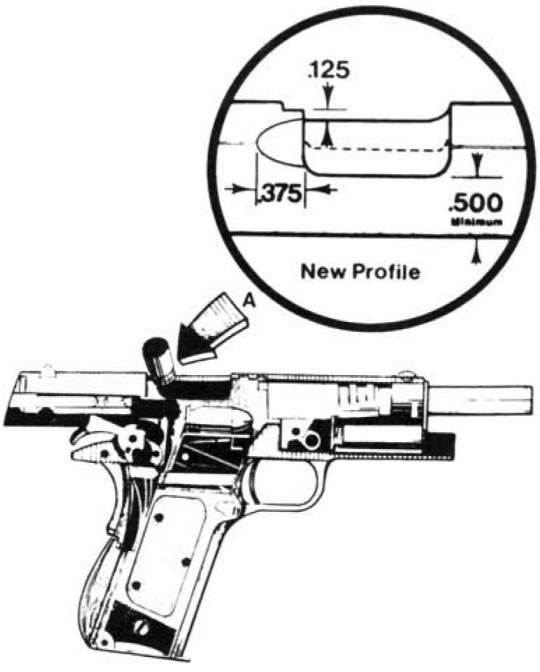


Figure 28: The required dimension of this cut is established by the position and profile of the fired case as its ejected.

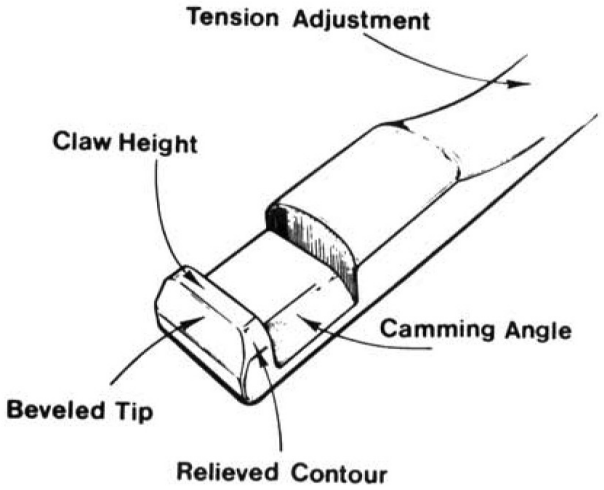


Figure 29: Detail of a modified extractor.

Finally, the tension of the extractor must be adjusted to further ensure reliability. Both feeding and ejection will be adversely affected by improper adjustment. The correct tension for a combat weapon is 4 pounds, with slightly less pressure required for target guns using a lighter projectile. To adjust the tension, bend the extractor bar in front of the center lug. This procedure is best performed with the slide removed from the frame. After obtaining the appropriate bar contour, check the tension by inserting a dummy round up under the extractor hook. The round should slide smoothly into position. The required pressure used to cam the extractor should not exceed 4 pounds. The test may be concluded by inverting and rotating the slide to confirm that the test round will remain secured by the extractor hook.

SELF-TEST QUESTIONS

Please check your answers on page 23.

1. ***True or False*. Most factory rifles are good enough for any competition or match shooting; further modification is not necessary.**
2. **When long hoods are provided on custom barrels for the Colt Model 1911 pistol, what three operations must be done to the custom barrel to be used in the Colt pistol?**
3. **When cutting the bottom barrel lug on a custom barrel for a Colt Model 1911 pistol, what part of the pistol may be used as a cutting jig in conjunction with a lug-cutting tool?**
4. **What is the purpose of the barrel face modification on the Colt Model 1911 pistol?**

Miscellaneous Alignment Techniques

The degree of accuracy required from a particular rifle or handgun depends almost entirely upon how the firearm will be used.

A brush hunting rifle for use in the Eastern United States would be quite satisfactory if it grouped into two or three inches at 100 yards. However, this same rifle, when used for Western hunting—where shots may run up to 300 or 400 yards—would be considered unsatisfactory. The same holds true for handguns. A pistol used entirely for self-defense at close range (under 25 yards) obviously does not have to be as accurate as one used for target competition or hunting. Most shooters prefer to obtain the highest degree of accuracy possible from any rifle or handgun; this chapter is designed to help you obtain these results.

RIFLES

There are many factors that can affect a rifle's accuracy: chamber, bore, stock bedding, tightness of action, and others. Consider the following example: A Savage Model 24 over/under rifle/shotgun (Figure 30) had problems with accuracy in the rifle barrel chambered for a .357 Magnum. Some test shots at a target set up at 40 yards produced a wide group of shots. Since the gun was relatively new and there was nothing visibly wrong with the bore, there was no reason for the gun to shoot so poorly.

The shooter switched from lead to jacketed bullets and tried another test firing; the groups improved. These results hinted that the rifling was not as smooth as it should be, requiring bore lapping. An hour or so later the job was completed and another string was fired. This time, with both lead and jacketed bullets, the rifle grouped as it should. In this case, a rough bore was all it took to cause poor accuracy. A lapping job is the easiest way to solve such accuracy problems.

Referring again to the Savage Model 24, the factory trigger pull was more than 9 pounds. Good rifle accuracy can never be obtained with such a heavy pull. By carefully honing the sear and hammer notch, the pull on this rifle was reduced to a little more than 4 pounds; further improvement in accuracy resulted.

Many of the better bolt-action rifles currently manufactured have adjustable triggers, and offer no major problem in this area. If the trigger pull is too heavy, a quick adjustment will usually solve the problem. However, many of the cheaper .22s leave much to be desired when it comes to trigger pull. Most can be improved by careful honing, as described earlier in this course. When trying to enhance the accuracy of any firearm, remember that trigger pull is an important factor.

Next in line, with respect to accuracy, is barrel bedding, the method of contact between metal and wood in a rifle. There has been much controversy over which method is best: free-floating or exact metal-to-wood contact. You will see good and bad results from both.

Glass bedding has been used for several decades to improve the accuracy of rifles. The old standby is Acraglas, manufactured by Brownells. Complete directions on its use come with each kit.



***Figure 30**: A Savage Model 24 over/under rifle/shotgun*

Ultimate accuracy with rifles can be attained by utilizing the following hints:

- Make sure the bore is free of pits and roughness, and that your bullets exactly fit the bore and groove diameter of the barrel.
- Obtain a clean, crisp trigger pull—not under 3 pounds for hunting rifles—with no creep.
- Make sure you have a good metal-to-wood fit.
- The barrel threads which join the barrel to the receiver must be tight.
- Make certain that pressure points do not cause poor accuracy. This is especially true with tubular magazine rifles. Check barrel bands and barrel lugs.
- Use ammunition with which your particular gun shoots well.

HANDGUNS

Pistols and revolvers are characteristically similar to rifles, in some respects. For example, smoothness and condition of the rifling play an important role in the accuracy of handguns, as does trigger pull. Both can contribute to good accuracy.

To offer a better trigger pull, spring kits are available that greatly improve the accuracy of any handgun. These kits are available for all popular models. Depending upon the type of handgun, most kits replace the factory trigger-return spring and mainspring, and greatly improve trigger pull, while reducing the hammer slam. In most cases, the trigger pull is lightened, and is also consider- ably smoother in operation.

These spring kits may be classified as high-performance tune-up kits that contain assorted springs of various strengths so you can experiment and determine which set of springs matches an individual pistol best. All are ideal for target or combat competition, or for the critical shooter who demands the ultimate from his handgun.

In accurizing handguns, first completely disassemble the gun. On semi-automatics, check the magazine for any cracks at the rear edge of the feeding lips. If any cracks are found, the best solution is to replace the entire magazine with a good one.

While the gun is disassembled, the next step is to examine each part carefully for wear and breakage. Any defective part that cannot be easily repaired should be replaced. Look for burrs, sharp edges, springs with kinks, or any other abnormalities.



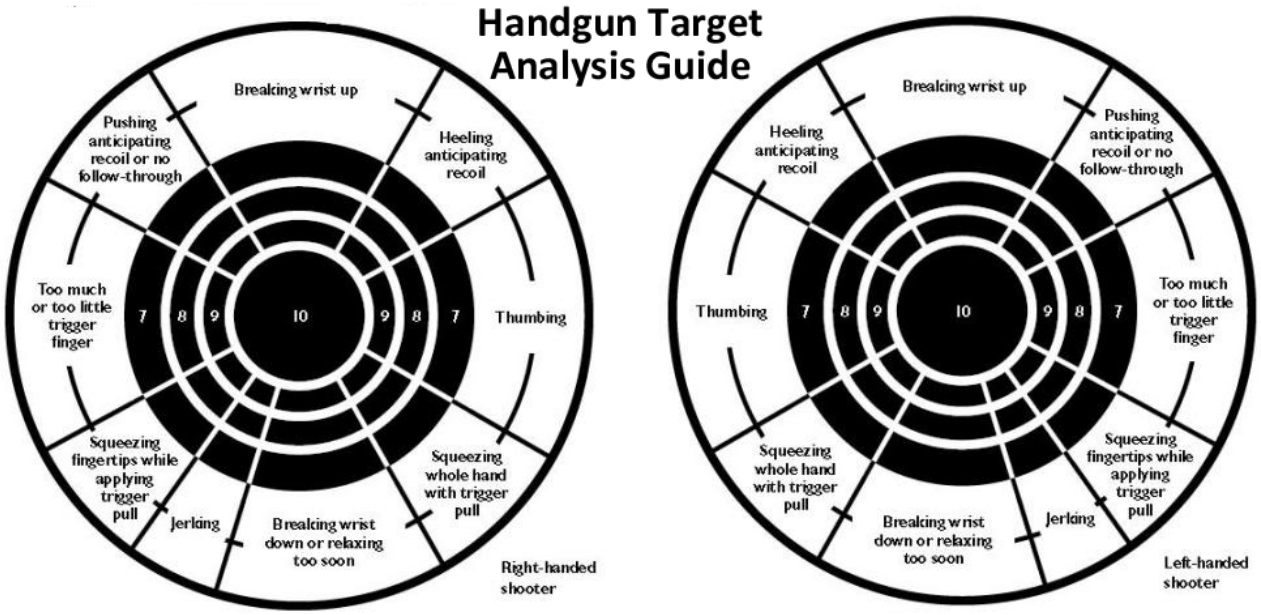


Figure 31: This chart shows probable faults when shooting a handgun.

Once the bore and trigger pull have been given consideration on any handgun, the next point of interest should be the sights. Until recently, most handguns contained fixed sights of poor design. There were some exceptions, but for the most part, commercial handguns left much to be desired in the way of sights.

Good handgun sights are currently available that will take care of practically all applications. For example, Millett offers a complete line of precision-engineered, fully adjustable, all-steel sights for pistols and revolvers. These are designed to replace the often less- than-adequate factory adjustable sights. They have many features that make them highly desirable for both target and hunting use.

Micro sights are another line of replacement sights for handguns that have been used extensively by tournament shooters. These sights require the minimum of fitting to most guns, and are never affected by recoil.

Another area in handgun accuracy often overlooked is the grips used on the handgun. A person cannot be expected to shoot well if the grips used are too large or too small. There are many custom grips on the market that will serve any shooter for any situation. For example, Fitz pistol grips are available in various styles. Their "Accu-Riser" models are designed for target shooters who want the best possible score. Most have thumb rests for better control, and also a plate that fits the palm swell of the hand perfectly. The total effect of the "Accu-Riser" is to lock your hand into a "solid, firm fist" with complete control of the gun. The result is significantly better scores.

Once handgun sights, trigger pull, and other alignment techniques have been applied to the gun, the next most valuable hint is to get in plenty of practice. However, incorrect practicing does little good. You must be able to determine what you are doing wrong, and then correct it. The chart in Figure 31 will help you analyze the situation so you can take steps to make the necessary corrections.

SELF-TEST QUESTIONS

Please check your questions on page 23.

5. **If you are firing a handgun that has been properly sighted, and your shots tend to go high in the twelve o'clock zone, what is your most probable fault?**
6. **If you determine that a rifle bore is giving poor accuracy due to a rough bore, what is the obvious solution?**
7. **How is trigger pull improved on trigger mechanisms without factory adjustment screws?**
8. ***True or False.* You must practice to become good at handgun shooting; it does not matter how you practice, just as long as you shoot.**

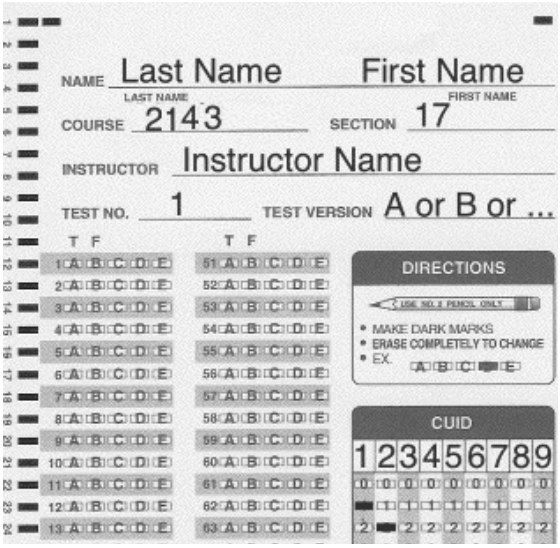
Answers to Self-Test Questions

1. False.
2. Long hoods must be fitted, shortened, and relieved to prevent binding.
3. Frame.
4. To improve feeding.
5. Breaking your wrist up.
6. Lap the bore.
7. By careful honing.
8. False. Incorrect practicing with a handgun does little good.

Lesson Questions

THIS IS LESSON NUMBER 2172.

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



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

You may also complete your exams and submit them online via the SDI Student Services page at www.sonoranlearning.com.

1. **Custom barrels for the Colt Model 1911 pistol often have long hoods to afford proper fitting to the slide. If so, what must be done to prevent the barrel from binding?**
   a. The hood must be heavily oiled.
   b. The hood must be fitted, shortened, and relieved.
   c. The hood must be removed from the barrel.
   d. Apply beeswax to contact points.

2. **How can you manually simulate the movement of the barrel on a Colt Model 1911 pistol with the barrel and bushing installed in the slide?**
   a. Push the lugs into full engagement with the slide.
   b. Remove the match bushing.
   c. Use modeling clay in the engagement lugs.
   d. Remove the barrel from the slide.

3. **When cutting the bottom barrel lug on a Colt Model 1911 pistol, what is the minimum dimension of shoulder that must exist between the link pin hole and the bottom of the barrel lug?**
   a. 0.050 inches.
   b. 0.075 inches.
   c. 0.100 inches.
   d. 0.125 inches.

4. **When cutting the bottom barrel lug, what material should the cutter bushing be made from?**
   a. Copper.
   b. Soft iron.
   c. Brass.
   d. Drill rod.

5. **The minimum trigger pull for hunting rifles is**
   a. 1 pound.
   b. 2 pounds.
   c. 3 pounds.
   d. 4 pounds.

6. **During barrel-face modification of the Colt Model 1911 pistol, how is the primary throating best accomplished?**
   a. With a rat-tailed file.
   b. With a hand grinder.
   c. With a metal turning lathe.
   d. With a vertical milling machine.

7. **What gauges are used to ensure that you have maintained correct headspace tolerance during the accurizing procedure?**
   a. Ting gauges.
   b. Headspace gauges.
   c. Thickness gauges.
   d. Screw-pitch gauges.

8. **After testing with the gauges as described previously in Question 7, and it is found that the chamber needs reworking, which of the following tools would you use?**
   a. A No-Go headspace gauge.
   b. A half-round bastard file.
   c. Twist drill bit.
   d. Chambering reamer.

9. **To ensure proper functioning, how should the ejector port be modified when accurizing the Colt Model 1911 pistol?**

   a. It should be lowered.

   b. It should be raised.

   c. It should be lengthened toward the muzzle.

   d. It should be lengthened toward the rear.

10. **When using a handgun that has been properly sighted, grouping your shots below the bull's-eye, what are the probable causes?**

   a. Too much trigger finger.

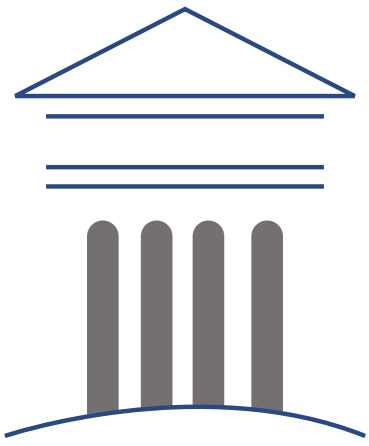
   b. Breaking wrist down or relaxing too soon.

   c. Too little trigger finger.

   d. Thumbing.

Black Powder Gunsmithing (#)
Lesson: 2173

OBJECTIVES	3
INTRODUCTION	3
THE DISCOVERY OF GUNPOWDER	4
Pyrodex	6
Self-Test Questions	7
DEVELOPMENT OF BLACK POWDER ARMS	8
Kentucky Rifles	10
Plains Rifles	10
The Zouave	11
Restoring Black Powder Arms	11
Improving Accuracy	11
Ailments Of Muzzleloaders	12
Specialized Tools And Accessories	12
Self-Test Question	12
BLACK POWDER TRADING	13
Evaluating Condition	13
Finding Black Powder Guns	16
Selling Black Powder Arms	17
Self-Test Questions	20
ANSWERS TO SELF-TEST QUESTIONS	21
LESSON QUESTIONS	22





Objectives

In this lesson, you will learn

1. The present formula for black powder.
2. How to convert black powder to Pyrodex.
3. The problems caused by dry firing a cap lock rifle.
4. The name of the first breechloader used by the U.S. government.

Introduction

The interest in black powder arms has risen tremendously over the past two decades. The reasons are many: fewer legal restrictions, the desire to relive the days of our ancestors, special muzzleloading hunting seasons, and others.

Most gunsmiths who specialize in selling black powder arms and accessories do very good business. Those who also specialize in black powder gunsmithing do even better.

In almost every part of this country, black powder shooting is on the rise, and shooters want to continue improving their arms and shooting accessories. Eventually, they will want custom work done, such as an antique reproduction telescope sight installed; the bore lapped and smoothed; or the barrel browned instead of the conventional blue.

If muzzleloading firearms interest you, plenty of work is available for any good gunsmith. Besides repairing existing black powder arms, the gunsmith's income can be supplemented by selling commercial black powder arms and accessories, and perhaps building a few custom black powder rifles for those customers who want the best. Custom-built black powder guns sell for $1,000 or more, depending on the type of gun and the amount of ornamentation on it.

A good black powder gunsmith can expect a five-figure income in the first year of business, if the shop is located in the right area. It may take a little time to get started, but if you do good work, charge fair prices, and have a good supply of parts, you will quickly develop a good reputation. Chances are, within three or four months, your business will be booming.

Of course, not everyone is cut out to be in business. Regardless of how good a gunsmith is, it takes a good knowledge of general business practices to succeed. For those who lack this business ability, a business partner might be the best answer.

The Discovery of Gunpowder

The origin of gunpowder is still uncertain, but its discovery is generally attributed to Roger Bacon, who recorded its formula in 1248.

In his later works, *Opus Tertium, De Secretis*, and *Opus Majus* (published about 1270), there is little doubt that Roger Bacon was acquainted with explosive mixtures of sulfur, charcoal, and niter (saltpeter). However, the substance was not extensively developed until the invention of firearms more than a century later.

Berthold Schwartz (Figure 1), a monk of Freiburg, Germany, studied the writings of Bacon regarding explosives, and later did extensive experimenting with black powder. He commonly is credited as its inventor, since he made the properties of gunpowder known and put it to practical use. However, the early uses of gunpowder were confined to warfare; no use was made of it for hunting or other sporting purposes until several hundred years later.

During the end of the fourteenth century, frequent references to gunpowder were made in literature, often in a way that proves the properties of gunpowder as a propellant were well known to most people. For example, Chaucer's reference in *The House of Fame*, makes it apparent that a "pillet," which was fired out of the "gonne" by the explosion of the "pouder," was a single projectile.



Figure 1: *Berthold Schwartz, a monk of Freiburg, Germany, did extensive experimenting with black powder.*

Initially, gunpowder was manufactured by the crude method of pounding the ingredients together by hand. Edge runners, which greatly facilitated the milling process, were introduced toward the end of the sixteenth century. During that century, the process of "corning," or "granulating," was introduced, assuring grains of equal size when grading the powder.

Bacon's notes on gunpowder call for several parts of saltpeter, five parts of sulfur, and five hazel twigs. This "recipe" for black powder has been modified many times to reach today's proportions of 10% sulfur, 15% charcoal, and 75% saltpeter.

Even though smokeless powder began to replace black powder in the early 1890s, there was still a great demand for black powder through the first decade of the twentieth century. Many black powder arms are still used for sporting purposes, requiring supplies and the proper ammunition (Figure 2). In many parts of the world, only black powder arms were allowed by law or were economically feasible. These markets required a constant supply of black powder.

Recently, an increased interest in black powder arms has increased the demand for black powder over the amount required a few decades ago. For a while, DuPont was the only active domestic manufacturer of black powder. The DuPont Corporation withdrew from the black powder industry after a thunderous explosion destroyed the entire plant in the early 1970s. DuPont's entire operation was sold to Gearhart-Owen, which is the only active domestic manufacturer of black powder today, although much black powder comes from Scotland and Canada.



***Figure 2**: A page from an old black powder catalog comparing the different sizes of black powder, each of which has a specific purpose.*

PYRODEX

Hodgdon Powder Company, Inc. of Kansas began experimenting some years ago with a black powder substitute. After much expense and explosions that killed some of its employees, Hodgdon now manufacturers a black powder substitute called Pyrodex that is available at gun shops and sporting goods stores.

Pyrodex, shown in Figure 3, is a pyrotechnic composition that is best described as replica black powder. It does not contain nitrocellulose, nor is it a smokeless propellant. Rather, it is a propellant designed for use in percussion and black powder cartridge arms that are in good shooting condition. Although Pyrodex is not black powder, it does smoke. It is classified by the Bureau of Explosives as a flammable solid, and can be shipped by most common carriers, including United Parcel Service (UPS). Pyrodex can be sold by all dealers selling smokeless powders, and does not require any additional licenses to sell. It is currently available in four grades: RS (Rifle and Shotgun), P (Pistol), CTG (Cartridge and Shotshell), and C (Cannon).

Pyrodex is intended to be used on a volume-to-volume basis, the same as the appropriate granulation of black powder. It will give approximately the same velocity and pressure as black powder when used in this manner. Pyrodex is slightly harder to ignite than black powder; therefore, "hot" percussion caps should be used for best ignition. Most percussion caps on the market today can properly ignite Pyrodex. The ball or projectile must be seated firmly on the powder when loading.

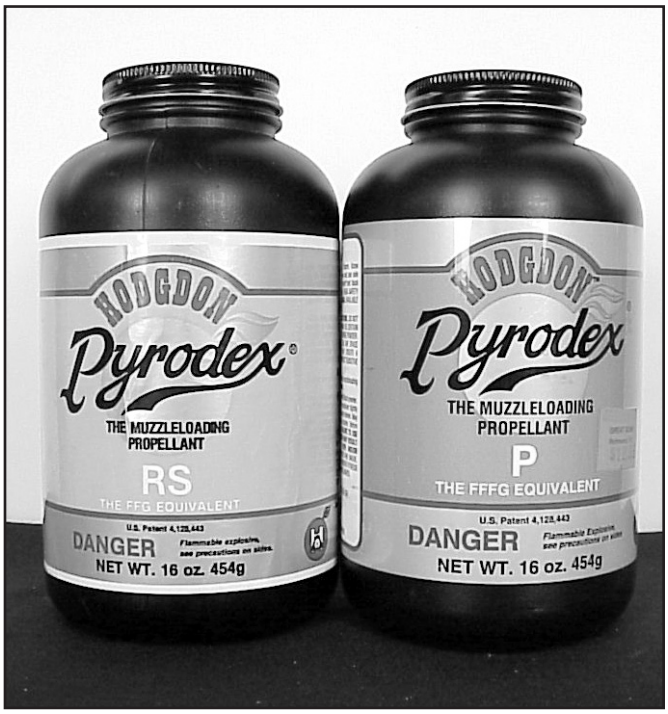


Figure 3: *Popular types of Hodgdon Pyrodex Powder — the black powder substitute.*

Pyrodex burns cleaner and produces less buildup than black powder. Although Pyrodex leaves fouling in the barrel and must be cleaned before the gun is stored, the fouling does not increase with successive shots, nor does it affect ease of loading, pressure, or velocity after the initial shot. Therefore, it is not necessary to clean the bore after each shot, as it is with black powder. Our tests show that Pyrodex gives greater accuracy if the bore is not cleaned after each shot.

Pyrodex residue is corrosive, and the gun should be cleaned with a water-based solvent, dried thoroughly, and oiled the same as with black powder. Spit Ball and Spit Patch are the lubricants designed for use when shooting Pyrodex. Spit Bath is the cleaning solvent recommended for use in cleaning a black powder gun.

Pyrodex can be used in flintlocks if you use black powder in the flash pan, and about 10 grains of black powder as a starter charge, followed by Pyrodex as the main charge.

Pyrodex produces similar ballistics pressure curves to black powder when equal volumes of each are used. Although Pyrodex is safer than black powder, it will burn violently if ignited. As with black powder, Pyrodex can be overloaded to create dangerous pressures. Follow recommended data only, and do not attempt "magnum" loadings, or use multiple ball loadings; this will create dangerous chamber pressures.

Pyrodex is not recommended for use in guns with Damascus barrels. Do not expose Pyrodex to direct sunlight, open flame, sparks, or heat. Do not allow it to become contaminated with oil, grease, or any other foreign materials. Keep the cap on the can when not in use, as moisture will ruin Pyrodex. Do not store Pyrodex in glass bottles, copper flasks, or horns for long periods of time, and stocks should be rotated, using the oldest lots first.

Pyrodex, like all smokeless propellants, has a "shelf life," or will eventually deteriorate, The shelf life of Pyrodex depends on the methods of handling and storage (cold or heat, dry or humid conditions, particular lots of powder, breakdown of powder granules, etc.). It is not possible to predict the exact shelf life, but when stored properly, Pyrodex should last for many years.

Pyrodex is intended for use in firearms only, and is not intended for blasting. Do not grind or crush Pyrodex; as with any flammable material, this practice can be dangerous. Pyrodex may be harmful if swallowed. If this happens, induce vomiting and immediately call a physician. Keep out of the reach of children.

SELF-TEST QUESTIONS

Please check your answers on page 21.

1. ***True or False*. The invention of gunpowder is generally attributed to Robert Bacon.**
2. **Name three of the many reasons that black powder arms have gained popularity in recent years.**
3. **What percentage of sulfur is used in the current formula for black powder?**
4. **How is Pyrodex best described?**

Development of Black Powder Arms

No one knows who developed the first firearm, or when. There are no records indicating which of the powder arms came first—the handgun (hand cannon) or the artillery cannon. The defenders of Seville, in 1247, reportedly used a rock-throwing cannon to defend their city. This is one of the earliest references to the cannon. A fresco painting by Paolo Neri dated 1340 pictures a person firing a hand cannon. It is relatively safe to assume that by 1350 the use of cannons and hand cannons was becoming more common. The first firearms were constructed by banding together flat iron bars, similar to the banding of oak kegs. These firearms were ignited with a "slow match," or fuse, giving the gunners time to retreat to a safe distance before the fuse burned to the priming powder.

Spain is credited with being the first country to furnish soldiers with firearms that could be carried by one person. They were crude weapons, consisting of an iron tube closed at one end and lashed to a pole that held the cannon. Most hand cannons could not be fired from the traditional offhand position. The soldier instead was forced to carry a "rest" along with the hand cannon. When the soldier was ready to fire his gun, he balanced it on the rest, steadied it by holding the scantling (handle) under his arm, and then "touched it off" with a live coal, while sighting along the barrel to take aim. What happened immediately after the coal came in contact with the powder was unpredictable, because when loading the hand cannons, the shooter poured an undetermined amount of impure powder down the barrel. Sometimes they fired, causing considerable damage at both ends. However, these guns were often overloaded and burst in the shooter's hands.

It is no wonder that the crossbow held its own for about two centuries after the invention of hand cannons. It was not until 1596 that Queen Elizabeth ordered crossbows and other types of bows used in the army to be discarded in favor of muskets.

The first rifle was made during the latter part of the fifteenth century by Gaspard Zollner of Vienna. The rifle was a simple barrel with straight grooves, which helped prevent it from becoming dirty through continual use. Spiral grooving, which gave a bullet a "twist" to better stabilize it during flight, apparently was not thought of until many years later.

The earliest known improvements in the hand cannon were to make it lighter and to give it a longer barrel. The improved firearm was called the arquebus, but even this gun was so heavy that a rest was required to fire it. The rest was a single staff with a steel point which stuck in the ground. The other end

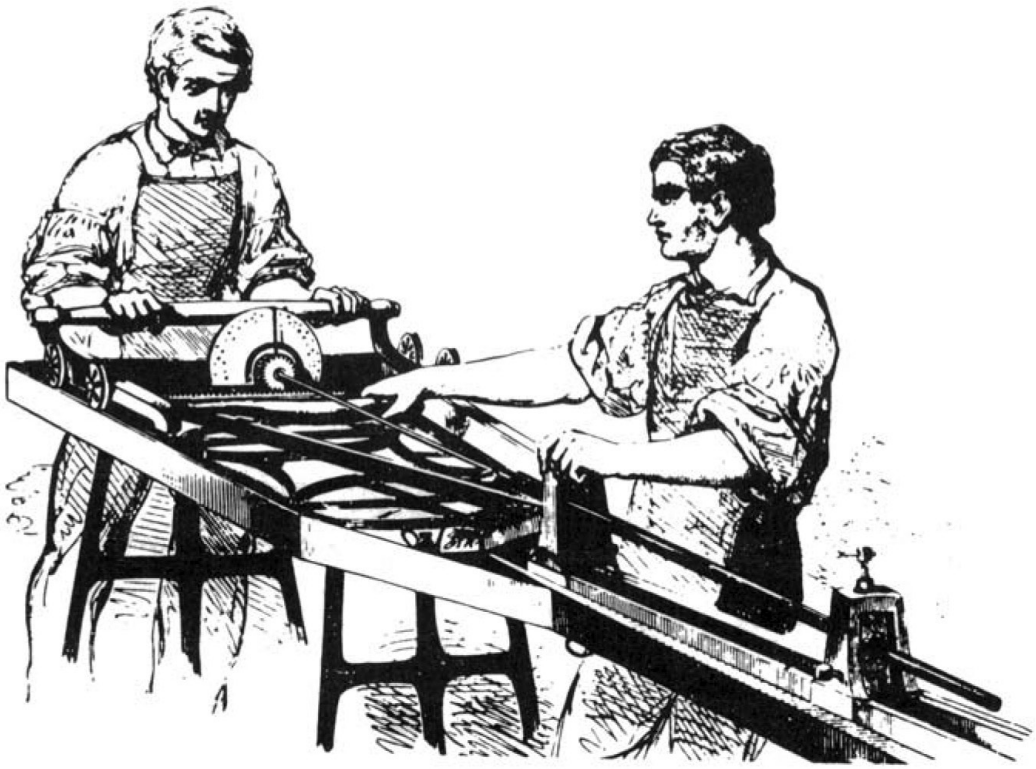


Figure 4: *Drawing showing one of the better examples of rifling machines of the 18th century.*

of the rest sometimes had a U-shaped configuration to cradle the gun barrel.

The arquebus was a regular "match-gun." It had a pan, or receptacle, at the side of the breech for the priming powder that linked to the interior of the barrel by a small perforation called the touchhole. The priming powder was lit by a match, which consisted of a coil of small rope saturated with a chemical that caused it to burn readily. The person using the arquebus carried the match and kept it burning during the entire firing period. The manner of firing the gun was similar to that of firing with the live coal; the gunner secured the gun on the rest, took aim, and then touched the priming with the lighted match.

The matchlock, which came into use about 1450, was one of the first practical locks. It consisted of a semi- circular-shaped piece of metal pivoted to the side of the gun. At the end opposite the pivot was a slow match, a device to hold a cord treated with saltpeter to make it burn slowly. The tip of this cord was gripped in the holder at one end of a C-shaped piece of metal and pushed with a finger to contact the priming powder, which fired the weapon.

Around 1500, the matchlock was greatly improved with the invention of the serpentine match holder, which consisted of a piece of metal bent to resemble an S. The bottom portion of the S initially was the trigger. A short time later a sear was added, allowing the shooter to pull back the matchlock and hold it, preventing ignition until the shooter was ready to fire. This led to the introduction of gun sights, and aim became more accurate.

Rifling emerged about the same time, along with efforts to make a multi-shot gun. Some of these efforts featured revolving cylinders similar to the revolver in use today. Others employed multi-load barrels and double, triple, and other combinations of barrels. However, all these inventions suffered from the lack of an effective ignition system (Figure 4).

The wheel lock came next, operating in much the same manner as a modern cigarette lighter. A serrated steel wheel rotated against a flint, throwing sparks into the priming pan to ignite the charge in the barrel. To fire the wheel lock, a heavy spring was wound, and the cock that held a piece of flint until it came in contact with the serrated wheel was pulled. This was the "ready" position. The arm was then aimed and the trigger pulled, which started the wheel spinning, throwing sparks into the priming pan.

In the mid-1500s, the snaphaunce came about. This ignition system consisted of a hammer that held a piece of flint, similar to flintlocks of nearly 100 years later. When the trigger released the hammer, the hammer fell forward and struck near the touchhole, causing sparks to fly and enter the priming pan, igniting the powder charge and discharging the firearm much the same as the later flintlocks. The development of the snaphaunce was the forerunner of all firearms used until the Civil War.

During the early 1600s, the flintlock system was developed. The flintlock was basically the snaphaunce with the addition of an angled steel pan, which covered the priming pan by use of a hinge at either the front or back end of the pan. As the hammer released, it struck the angled surface of this hinged pan, called a frizzen. The striking of the hammer, containing flint, against the frizzen threw back the cover and exposed the priming powder contained in the pan. It also showered sparks into the priming powder to fire the gun. The flint-lock system was used in rifles and pistols, and was the U.S. military type of lock until 1862. During this period, paper cartridges were developed, along with breechloading firearms that were put to practical, but sparing, use.

The Hall rifle, shown in Figure 5, was the first breechloader to be adopted by the U .S. government. It was a flintlock with a tip-up action. Upon releasing a lever, the front end of the breech section tipped up, loaded the gun, and then fell back down into alignment with the barrel. The U.S. army model was a .54-caliber rifle, and was used in the Seminole War in Florida.

The Jenks Rifle, invented by William Jenks in 1838, was the forerunner of the Merrill rifle and was used in Florida in 1841 by U.S. troops. The hammer, which operated horizontally, was its outstanding feature.

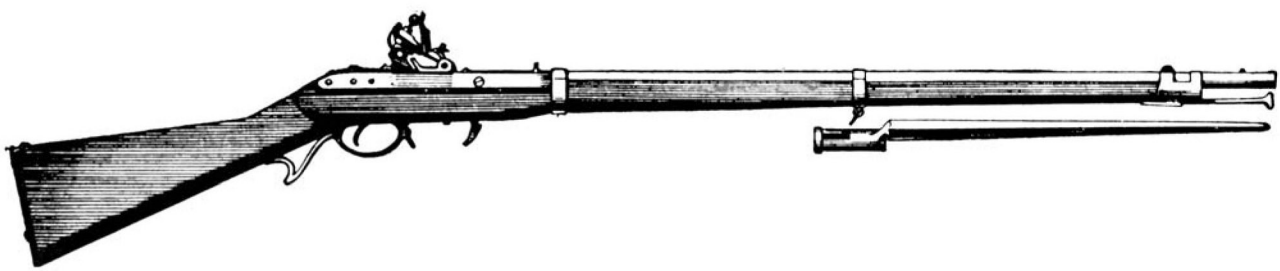


***Figure 5**. The Hall rifle was the first breechloader to be adopted by the U.S. government. It was a flintlock with a tip-up action*

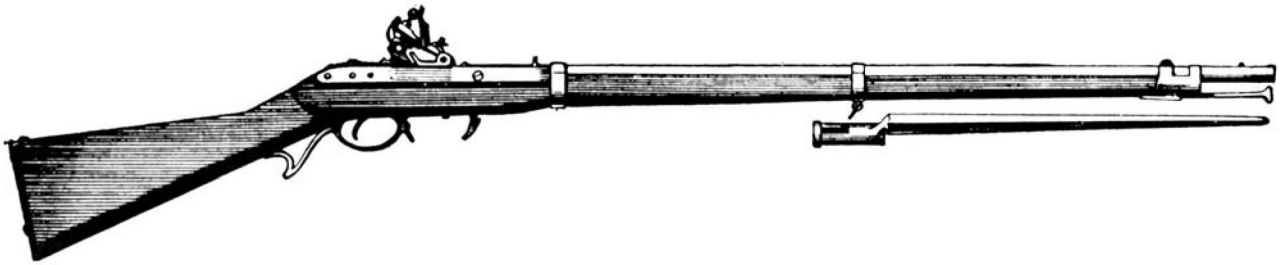


***Figure 6**. The Greene rifle was the first bolt-action gun use by U.S. troops.*

The Greene Rifle, shown in Figure 6, was the first bolt-action gun used by U.S. troops (about 1857). The bolt handle was in the rear and was released by pressing down a spring catch on the tang. It was a percussion arm and had the nipple underneath the receiver, with a ring-shaped hammer. The .535 cartridge had the bullet positioned in the rear, so that the gun always held two cartridges when loaded; the rear cartridge was intended to act as a gas check. A few of these rifles were used in the Civil War.

Breechloaders that followed consisted of the Sharps and Hankins rifle, the Ballard rifle, the Merrill alteration of the Model 1842 musket, and the Peabody alteration of the Model 1861 Springfield rifled musket. No less than a dozen other experimental breechloaders were used up to the turn of the century. The most popular were the trapdoor Springfields in .50- .70 and .45-.70 calibers. Repeating U.S. handguns followed the same general pattern as the rifle, except they were used more extensively by officers and NCOs.

The invention of shotguns was inspired by the poor accuracy of early firearms. A target was easier to hit with multi-ball loads than with a single projectile. However, small shot was not invented until about 1750, the time at which single- and double-barrel shotguns were commonplace in the United States. Most were percussion-primed muzzleloaders, sidelocks with exposed hammers. By 1860, a number of breechloading shotguns, using pinfire and centerfire cartridges, were on the market.

The black powder gunsmith will encounter three basic styles of muzzleloading rifles and two basic ignition systems of locks. The locks are the flintlock and percussion; the styles of muzzleloading rifles are the Kentucky, Plains, and Zouave.

KENTUCKY RIFLES

The first Kentucky rifles were flintlocks, as shown in Figure 7 on the next page, and eventually evolved into cap locks (percussion). This type of rifle was named more for the wilderness it tamed than for its point of origin. Most were made in Pennsylvania by the German gunsmiths of the area.

The European guns of the era were ponderous and heavy with large bores, and were burdensome to pioneers who traveled mostly on foot. The Kentucky rifle evolved through a gradual slenderizing and shortening of the European rifles, including the reduction of the bore—most were between .32 and .45 caliber.

The main advantage of this bore reduction was to provide more shots per pound of lead. For example, a pound of lead provided only 16 shots from a. 70-bore rifle. A .45-caliber rifle could fire 48 shots from a pound of lead. Less powder per shot was required with these small-bore rifles. Since the pioneer of that day had to carry every necessity in a pack, it is easy to see how the Kentucky rifle emerged on the American scene and quickly became popular.

PLAINS RIFLES

The Plains rifle that followed the Kentucky rifle was shorter, usually of bigger bore diameter, and thicker through the wrist of the stock for added strength. Although plain in design, this rifle was highly efficient. The most popular Plains rifle was produced in the St. Louis shop of two brothers, Jake and Sam Hawken. The Hawken rifle averaged 10-12 pounds, with a bore diameter of between .45 and .54 caliber. Most were half-stocked, straight, sturdy at the wrist, and featured a percussion cap lock design.

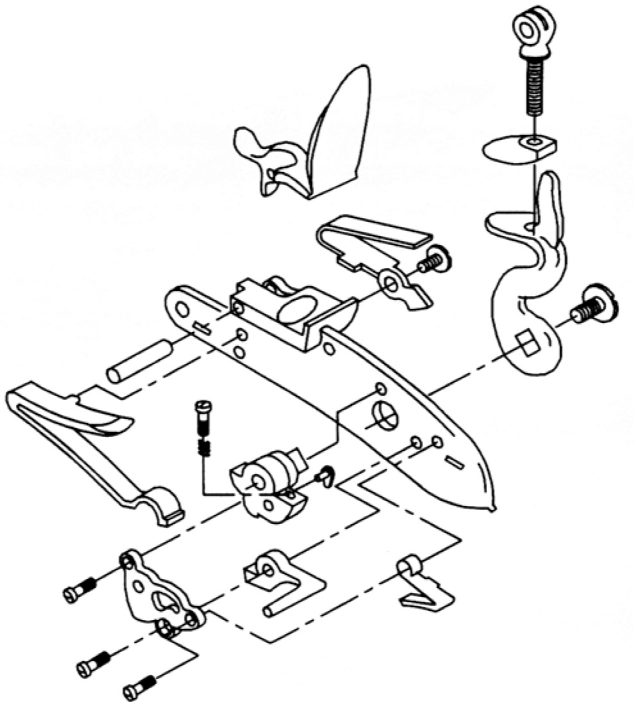


***Figure 7**: The first Kentucky rifles used the flintlock ignition system used by the U.S. military until about 1862, when they converted to the percussion ignition system.*

THE ZOUAVE

The .58-caliber Remington Zouave was designed to take advantage of the bullet developed by French Army Captain Minié. It was a huge picket ball, with a hollow base that expanded to fill the rifle grooves, thus eliminating the need for a patch to seal the bore. The Minié ball had a number of circular grooves that scraped black powder fouling from the bore with each shot. They also contained lubricant to help prevent leading.

RESTORING BLACK POWDER ARMS

It is best not to restore old antique muzzleloaders. Any deviation from the original will lower the value as a collector's piece. It is not a matter of returning these arms to shooting condition; few people shoot a rare collector's item.

There are cases where the restoration of a muzzle- loader is warranted. Collectors prefer to have their firearms complete, so if a particular rare model is missing a hammer, for example, it would be in order to find an original hammer—not a modern-made duplicate— and replace it. If the buyer does not like this, the replacement is easily removed without any damage to the original gun.

A tumbler with badly worn or missing notches can be welded and reshaped. If the tumbler hole in the lock plate is worn or oversized, it can be welded and redrilled. Old springs that are not broken but have lost their strength can be heated to a dull red and opened slightly, then reheated for the proper temper.

IMPROVING ACCURACY

Authentic replica black powder arms echo the assets and faults of the originals. Most disturbing to serious shooters is the lack of accuracy, caused mainly by inadequate sights. Muzzleloading rifles and single- shot pistols have better factory sights than do the cap and ball revolvers, although some can be improved.

The Lyman Gun Sight Company—long noted for its fine gun sights and reloading equipment — now makes a No.57 SML that is designed to fit the tang of most muzzleloading rifles by drilling and tapping two holes in the tang. This sight, a peep type, features audible 14-minute click adjustments for both windage and elevation. A quick-release button allows instant on-and-off, and an elevation stop screw assures quick return to original zero. When the peep sight is used, Lyman recommends its No.17 AMI globe front sight, which can be used with a variety of interchangeable post and aperture inserts for target shooting. For hunting, use a Lyman No.37 front sight, with a large ivory or brass bead.

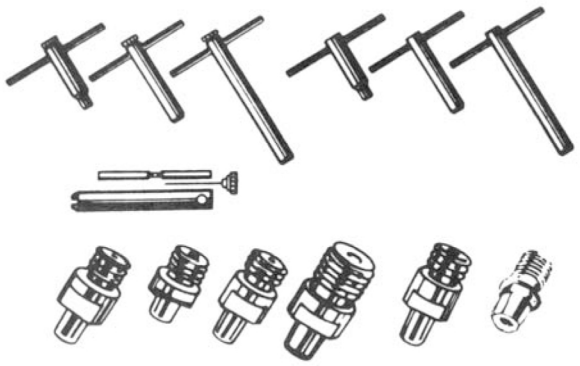


Figure 8: The black powder gunsmith should have a wide assortment of nipples and nipple wrenches on hand.

AILMENTS OF MUZZLELOADERS

With sustained use, old muzzleloaders—as well as the newer reproduction models—can develop a number of ailments that will need attention if the gun is to continue to fire safely. Most common among these ailments is misfiring after the nipples become worn or battered, due to dry firing with no percussion cap to cushion the blow of the hammer. The inevitable result is a peening of the nipples (on cap lock models), which eventually leads to poor ignition.

Even if a muzzleloader is never dry fired, erosion takes place inside the nipple, and this eventually enlarges the hole to a point where the nipple must be replaced. This ailment is relatively simple to correct. With a nipple wrench like the ones shown in Figure 8, replace the nipple with a new one in which the hole is smaller. Use replacement nipples of stainless steel or beryllium copper. Make sure they are long enough to provide a firm cushioning action by the hammer, yet not so long that they will be prone to peening. Ideally the hammer will rest against the frame, with the nose just touching the face of the nipple. This requires a near-perfect fit, achieved after careful filing.

You probably will encounter a few black powder "bargains" that have been offered on the market in recent years, which will need minor adjustments to satisfy the shooter. The worst offenders are cap and ball revolvers that were not timed and fitted properly at the factory. In many cases, you will find that parts such as the bolt, hand, hammer, and trigger guard are filed too small to function properly. With problems like this, it is usually best to order new parts from the factory. However, they can be built up by welding metal on the improperly formed part and reshaping it to correct the configuration. This welding should be done with an oil-hardening, steel welding rod.

A set of honing stones will solve most problems with cap and ball revolvers. For example, if the cylinder rotates with difficulty and sounds like a miniature jackhammer, the cylinder ratchet and hand need honing, and perhaps the handspring should be lightened. Most flat mainsprings can be ground thinner to improve the cocking action.

SPECIALIZED TOOLS AND ACCESSORIES

There are certain maintenance and repair jobs unique to black powder arms which will require special tools.

Let's illustrate one such problem. When a modern cartridge rifle misfires, the shooter can open the breech and remove the cartridge before attempting to find out what caused the trouble. However, muzzleloaders require a different unloading procedure. The charge (powder) in a muzzleloader rests tightly in place between the breech plug and the patched ball. To remove the charge without firing, either the breech plug must be removed so the charge can be pushed out the rear of the barrel, or the ball must be pulled out through the muzzle of the barrel. To do this, attach a screw to a rod and insert both in the bore from the muzzle end, pushing down the bore until the screw tip comes in contact with the lead ball. Then twist the screw into the lead ball until you have a firm grip. Then you can pull the ball and patch out of the bore and dump out the powder.

SELF-TEST QUESTION

Please check your questions on page 21.

5. ***True or False*. The first Kentucky rifles utilized the cap lock, or percussion, ignition system.**
6. **What was the most popular Plains rifle that originated out of St. Louis?**
7. **The flintlock ignition system was the type used by the U.S. military until approximately what year?**
8. **What is the name of the bullet type, developed by a French army captain that utilized a number of circular grooves that were intended to scrape black powder fouling from the bore with each shot?**

Black Powder Trading

Since the Gun Control Act of 1968 limited the sale of firearms through the mail, black powder arms sales have rapidly increased because muzzleloading arms can be mailed without any special permit or license. Also, compared to modern cartridge firearms, most black powder arms are reasonably priced. Add to this the fact that many states offer special hunting seasons for black powder firearms, and it is easy to understand why black powder guns are experiencing a new popularity.

While black powder antiques are selling well, the real sales are in the form of reproduction black powder arms, either in finished or kit form. Few used guns are available. Owners tend to be reluctant to part with them, after spending so much time assembling and carefully attending to every detail of inletting and finishing. Usually you will find a used muzzleloader for sale only when the owner graduates to a different model, and even then the gun is usually sold to a friend or to someone in the seller's black powder club who has been waiting in line.

Original antique black powder arms are traded daily, and many styles, in various conditions, are available at good prices. Dixie Gun Works, one of the largest dealers in the United States, probably has the biggest supply of antique black powder arms in the nation, if not the world. At any time, they carry 1,000 or more original and collector guns in stock. They have a tremendous turnover in antique arms, and publish an updated antique arms catalog every six months. The catalog pictures each gun and thoroughly describes it, including historical information. Generally, a nicely styled Kentucky rifle of high quality will command $600-$1,000. Occasionally, the catalog features rifles built by some of the well-known black powder arms makers, and these will bring a premium of $2,000 or more. The catalog is an excellent reference and a fine price guide to antique arms. For more information, visit their website at dixiegunworks.com or write to Dixie Gun Works, Inc., 1412 West Reelfoot Avenue Union City, TN 38281.

EVALUATING CONDITION

The grading system used for antique arms differs from the system used to evaluate modern arms. The official condition standard for antique firearms are as follows:

Factory new: All original parts; 100% original finish and in perfect condition.

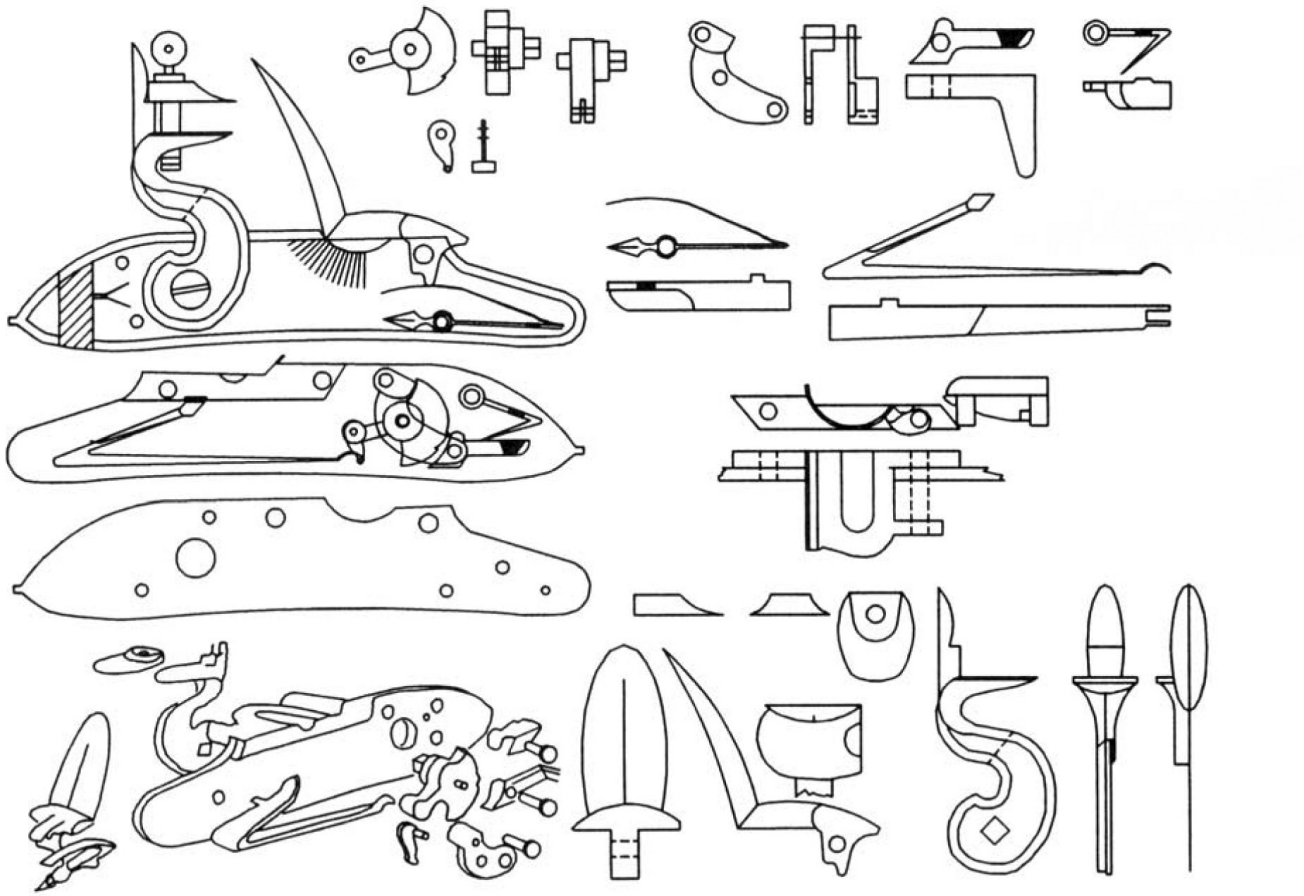


***Figure 9**: Diagram of the stirrup-type lock mechanism used in many Kentucky rifles.*

Excellent: All original parts; over 40% original finish; sharp lettering, numerals, and design on metal and wood; unmarred wood; fine bore.

Fine: All original parts; over 30% original finish; sharp lettering, numerals, and design on metal and wood; minor marks in wood; good bore.

Very good: All original parts; 0%-30% original finish; original metal surfaces smooth with all edges sharp; clear lettering, numerals, and design on metal; wood slightly scratched or bruised; bore disregarded for col- lectors' firearms.

Good: Some minor replacement parts; metal smoothly rusted or lightly pitted in places, cleaned or reblued; principal lettering, numerals, and design on metal legible; wood refinished, scratched, bruised, or minor cracks repaired; in good working order. Except for the plate, hammer, and striker, all of the parts shown in Figure 9 are considered minor.

Fair: Some major parts replaced; minor replacement parts may be required; metal rusted, may be lightly pitted all over, vigorously cleaned or reblued; rounded edges or metal partly obliterated; wood scratched, bruised, cracked, or repaired where broken; in fair working order or can be easily repaired and put in working order.

Poor: Major and minor parts replaced; major replacement parts required and extensive restoration needed; metal deeply pitted; principal lettering, numerals, and design obliterated; wood badly scratched, bruised, cracked, or broken; mechanically inoperative; generally undesirable as a collector's firearm.

The appearance of an antique weapon is easy to evaluate even by the beginner, but detecting worn or broken parts can be difficult. First, it is difficult to disassemble many antique firearms without damaging them, since many have rusted screws and parts. Sometimes the arms are so rusted that the parts look as if they have been welded together. However, in all but the worst cases, most of these can be disassembled with the proper tools and a good working knowledge of their use (Figure 10).

There are many guides available that will help you determine the prices for antique firearms. Various ones are available on-line. The site iguide.net is the "Internet Enclyclopedia of Antiques and Collectibles", this is just one source for pricing. It can pay off to do your research.

Attending antique gun shows, talking to the experts, and noting the prices asked are probably the best ways to determine the current market value of an antique firearm. However, just because a firearm carries a certain price tag does not mean that it will bring this amount. Watch the sales to determine the actual price at which the guns are bought. If several guns of the same model and condition bring similar prices at a gun show, you can be relatively sure this is the going market price.

If you have an antique arm that you think is valuable, but you are unable to find pricing information, Dixie Gun Works offers an appraising service. Note the following particulars:

- **Certification:** Dixie Gun Works is a member of the Appraisers Association of America. There is no national or state organization of gun dealers to pass on or certify that an individual is a certified appraiser of antique firearms.

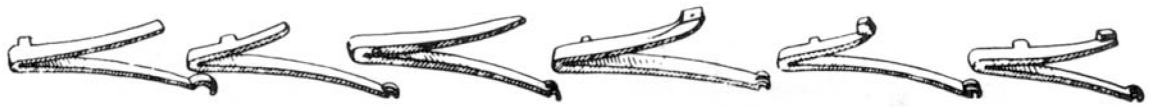
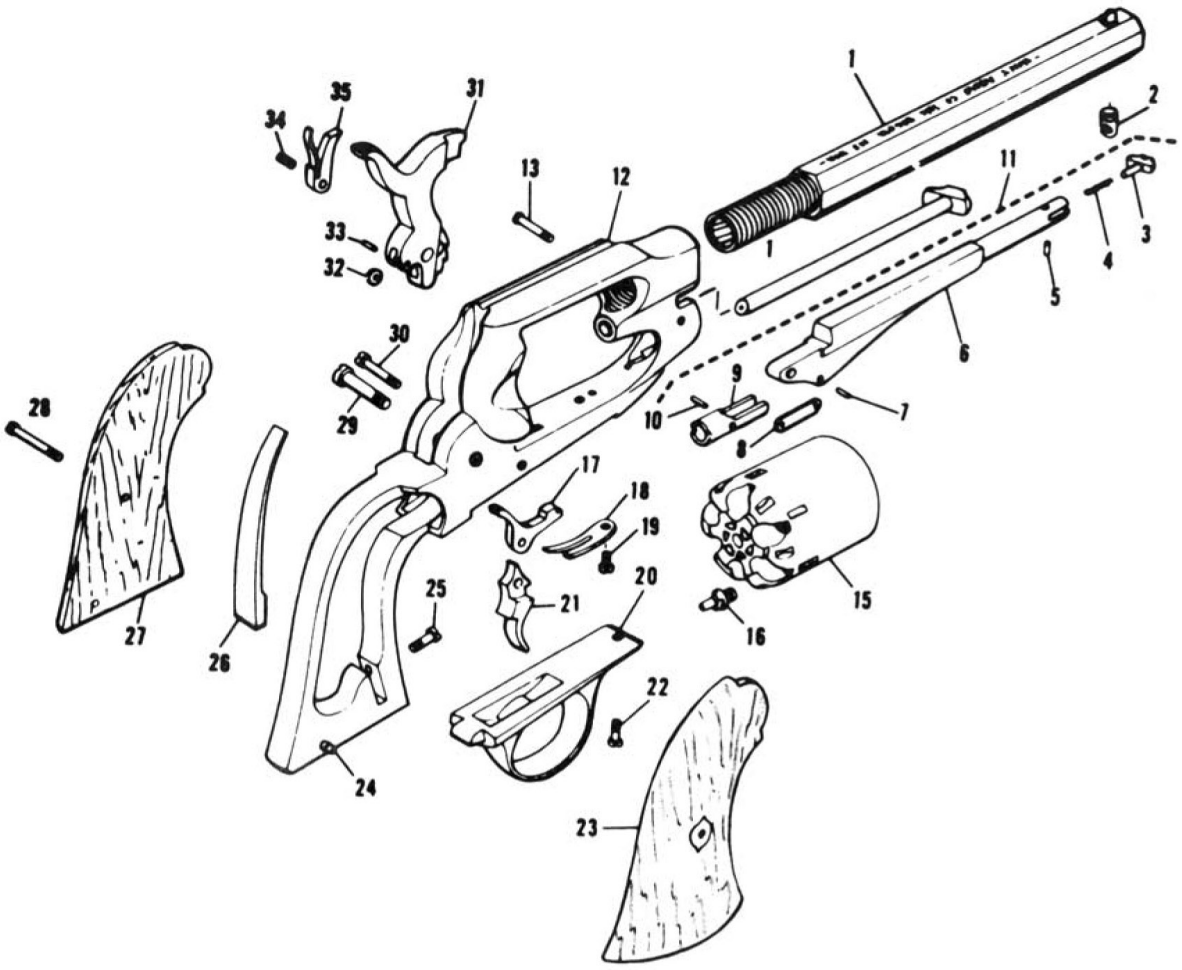


Figure 10: *The mainspring is one part that often requires replacing to make a block powder arm shootable; above is a sampling of different types of mainsprings of which you should become familiar.*



1. BARREL
2. LOADING LEVER RETAINER
3. LOADING LEVER CATCH
4. CATCH SPRING
5. CATCH PIN
6. LOADING LEVER
7. LINK PIN
8. LINK
9. BULLET RAMMER
10. REAR RAMMER PIN
11. LOADING LEVER ASSEMBLY
12. FRAME
13. LOADING LEVER SCREW
14. CYLINDER PIN
15. CYLINDER
16. NIPPLE
17. CYLINDER STOP
18. TRIGGER & CYLINDER STOP SPRING
19. SPRING RETAINER SCREW
20. TRIGGER GUARD
21. TRIGGER
22. TRIGGER GUARD SCREW
23. RIGHT GRIP
24. GRIP PIN
25. MAIN SPRING SCREW
26. MAIN SPRING
27. LEFT GRIP
28. GRIP SCREW
29. HAMMER SCREW
30. TRIGGER & CYLINDER STOP SCREW
31. HAMMER
32. ROLLER
33. ROLLER PIN
34. HAND SCREW
35. HAND

Figure 11: *Exploded views and parts list of old block powder guns are invaluable for use in disassembling arms as well as checking for missing parts.*

- **Fees:** They charge a flat fee per hour or any fraction of an hour. You will be billed for the time it takes to process the necessary documents. If an appraisal is made outside the store, necessary telephone calls and overnight accommodations will be added to a flat fee. Compared to doing an appraisal out of town, the cost is minimal at the store in Union City.

- **Documentation:** The appraisal document you receive from Dixie is good for any legal debate in court or for insurance purposes. The company describes antique firearms and their accoutrements in language that an average person can understand. The evaluation is at the retail level, which means that an item is evaluated at its average retail value. Dixie will not purposely appraise a gun higher than its real value in the case of an insurance claim.

As a general rule, antique black powder arms of collector status should not be fired. Their present condition should be preserved as much as possible. However, there may be times when an owner may desire to fire an arm of questionable condition. Before doing so, the arm should be disassembled completely, including the removal of the breech plug, and checked as discussed previously (Figure 11). If there are no signs of cracks in the metal or serious metal deterioration, and if the gun seems tight and sound, the next step is to "proof" the arm.

Proofing is done by firing heavier-than-normal charges in the gun from a rest and with the trigger pulled by an attached cord, with all persons at a safe distance, preferably behind protective cover. The arm may be secured to an old auto tire with a string run from the trigger to a safe location away from the gun. If after firing an overload several times the gun holds together, it is relatively safe to fire with reduced loads. For example, assume you have calculated that your black powder arms should hold a load of 60 grains of FFFg powder behind a round ball of the correct size. Five or six loads shot with 100 grains of FFFg black powder behind the ball is sufficient. Another option is to test the rifle with two balls in front of the powder charge to obtain extra pressure.

This test, of course, does not guarantee that the gun is safe for future firings. The last proof load could have caused a crack in the barrel that might not have been noticed. Then, on the first firing by hand, the barrel could let go. Therefore, after each proof load—especially after the last one—carefully examine the gun for hairline cracks or other telltale signs.

FINDING BLACK POWDER GUNS

The various antique gun shows held monthly through- out the country are the best places for trading of antique firearms. A large variety of weapons from which to choose are available. Also, you will be able to see the price for which the arms are selling, enabling you to determine a fair price for one you might want to buy. Each issue of Shotgun News lists dozens of such arms.

Flea markets and yard sales are other good sources of antique arms. Check your local newspapers for notices of auction sales. Often, antique arms can be found at public estate auctions. A Spencer Carbine in excellent condition was recently found in a box of odds and ends at an auction. See Figure 13, for illustrations of some antique firearms.

Since black powder arms are exempt from the Gun Control Act of 1968, they are traded extensively through the mail. In advertisements, the condition usually will be listed as "good," which will vary from poor to just a little less than excellent. Therefore, it is always recommended that you have the privilege of returning the gun for a full refund if it is not what you expect.

SELLING BLACK POWDER ARMS

A person who wants to sell one or two antique arms (Figure 12), but who is not very knowledgeable about the subject, would do well to let a reputable dealer sell the guns for him or her. This way, there is a better chance of getting a fair price and a quicker sale. The usual fee for this service is 15%-25% of the gun's value. If the gun sells for $200, the dealer would withhold $30-$50 commission and give the balance to the former owner.

Many gun owners balk at this practice, because they think that by selling a gun or two themselves, they will save the commission and, consequently, will receive more for their firearms. However, when consideration is given to advertising fees, inquiries from people who have no intentions of buying, and possible liability associated with gun misuse, the commission paid to a dealer might be a good investment.

If several firearms are available, it might be worth-while to consider taking them to a gun show or advertising in publications that cater to gun collectors and then sending a list to those who reply. The list should include detailed descriptions of every gun offered for sale, with careful evaluations and listings of the exact condition of each gun.

When an order is received, guns should be shipped only upon receipt of payment or C.O.D. (cash on delivery). UPS is an excellent way to send black powder arms. Simply package the firearm according to postal requirements and take it to the nearest UPS office. If you want to send the gun COD, specify if you will accept a check or want cash only. The UPS personnel will comply and send you payment within a short time after the package is delivered. However, each state has its own laws, for shipping questions, always check with the closest ATF Field Division Office in your state or contact:

Bureau of Alcohol, Tobacco, Firearms and Explosives
Federal Firearms Licensing Center
244 Needy Road
Martinsburg, West Virginia25405USA
Voice (866) 662-2750 (Toll Free)w
NLC@atf.gov

If the gun has been carefully described and the condition is exactly as stated, the buyer will seldom complain. However, if the buyer does complain, never argue. Ask the buyer to return the gun and promptly refund his or her money when the gun is returned in the condition it was sent out. By doing so, you will maintain a good reputation as a gun dealer, which will pay off in dividends later.

Once a person becomes successful in disposing of a few unwanted firearms, he or she may decide to deal in guns as a part-time occupation, especially if he or she wants to try to find good specimens for a private collection. If so, the owner must



***Figure 12:** . This Bounty Percussion or Flintlock Pistol was available for sale on-line broker for over $400.*
This pistol, because of its long barrel that could assure better accuracy of firing at long distance, was the favorite one of the Bounty Hunters.

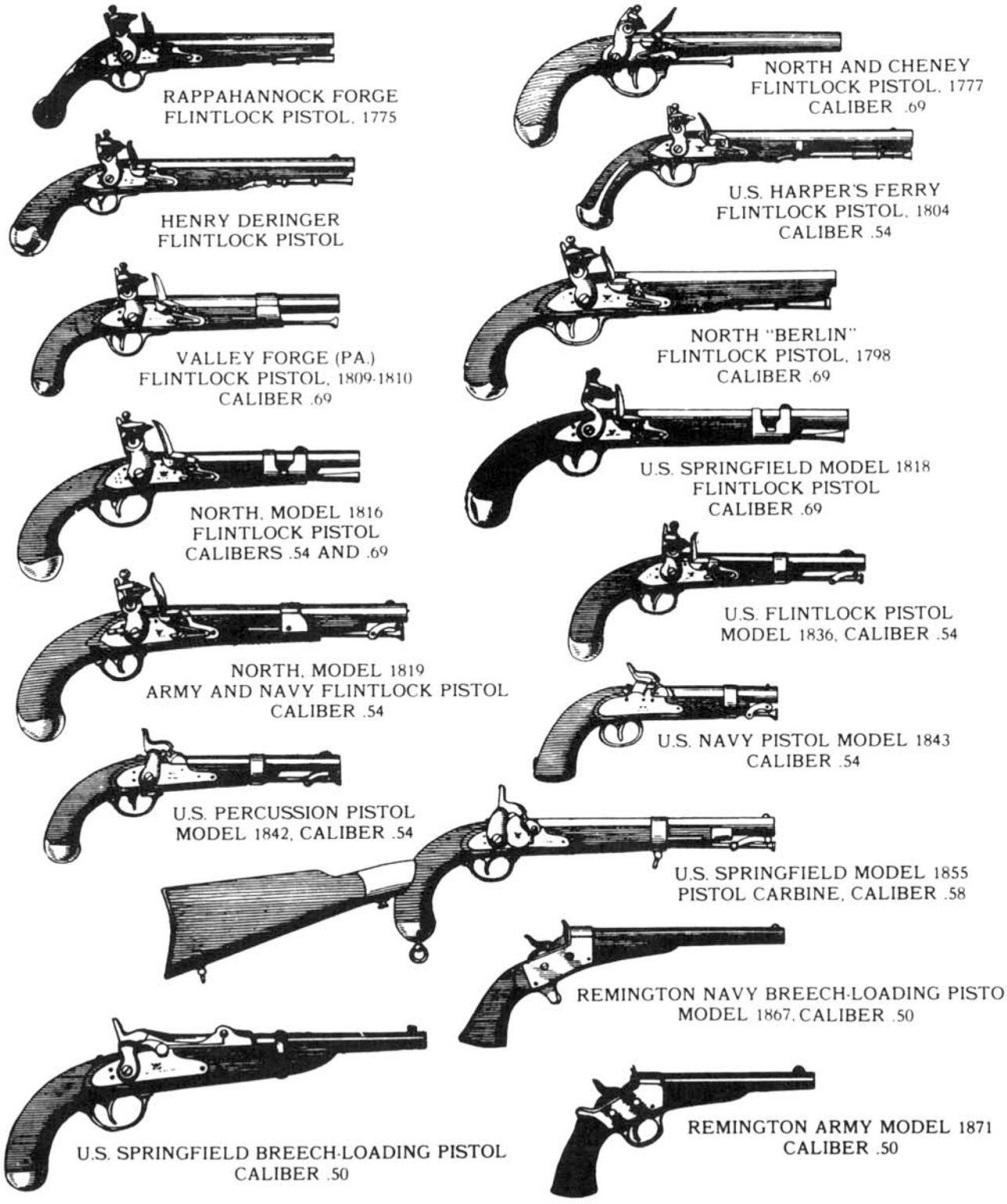


Figure 12: U.S. Pistols of flintlock, percussion, and cartridge types.

decide what profit is necessary to make the effort worthwhile. This decision must be based on several factors, and all should be considered thoroughly before reaching a conclusion.

While firearms can be resold quickly, the profit may be small on each gun; however, the overall profit at the end of the year may be substantial. Consider the following example: A dealer operates from a garage in back of his house—keeping his overhead to the barest minimum—and usually marks up his arms only 10% above cost. He is usually able to resell his guns within 30 days or less after purchase, and therefore makes his 10% profit in that period of time. By turning over his capital investment 12 times during the year, the total gross profit on his working capital is 120 percent.

Another dealer, who converted part of her supermarket into a gun shop, looks at the situation differently. The space allotted for her guns occupies about 30% of the total area in the building. Therefore, this space must be charged against her overhead, which includes the amount she spends for rent, utilities, insurance, etc. This dealer lists her guns so that 30% profit can be made on each one. However, her turnover is not as fast as the previous dealer's, and many of her guns are kept for 90 days or more before they are sold; many have occupied the gun rack for a year or more. From this, it's easy to see that this dealer is turning her capital over not more than four times each year, yet she still makes 120% on her capital investment (4 x 30 percent).

Therefore, your profit depends on the number of guns you want to handle during the period of a year. A good recommendation would be to start out with a relatively high profit and then adjust it to suit your own personal needs. It's much easier to come down on a price than go up if you want to continue to attract customers.

Another factor to consider when dealing in guns is the cost of operation. Obviously, a large store in a high-rent district with all kinds of operating expenses will have to have a much bigger volume of sales, or charge a larger profit, than if the business were located in a home or garage. The larger the business, the more employees will have to be hired, the higher the rent will be on the building, the higher the utilities will be, etc. Most successful gun businesses started out on a very small scale and enlarged as the sales dictated.

For example, Francis Bannerman & Sons—at one time the largest dealer in antiques and military goods in the world—was started in the 1860s by Francis Bannerman who, by capitalizing on post-Civil War opportunities, became the first seller of surplus war materials. By using sound business practices, he expanded the business to legendary proportions that lasted nearly a century. Dixie Gun Works was started on a small scale in Turner Kirkland's backyard and is presently one of the largest dealers of black powder guns and parts in the United States.

Many dealers are engaged in other businesses besides dealing in guns. Some may be running a service station, general store, a hardware store, automotive shop, etc. When one type of retail business is being operated, the addition of a firearms business usually increases the revenue without adding too much to the overhead.

In selecting stock, the condition should be emphasized. It is best not to concentrate on low-quality arms. Inevitably you will get a few, but try to have a good stock of the better collector items also. The only time a firearm in poor condition should be purchased is when the gun can be salvaged for parts or can be repaired and restored to good condition. Dealers who sell only junk soon earn a reputation for selling only poor-quality firearms. Although these firearms will eventually sell, the turnover is usually slow, and the danger of having defective firearms on your shelf is ever-present.

The most successful dealers have worked diligently over the years to establish a reputation of fair dealing. The gun dealer who consistently provides fair values and is astute enough to buy merchandise at competitive prices is the dealer who is going to stay in business and enjoy nice profits.

As a dealer, service should be an important aspect of your business. As a consumer, do not be lured into buying a product from one retailer simply because the price tag is a few dollars cheaper than another retailer's product — you will only regret it if a problem occurs and the service is poor or nonexistent.

Buyer and seller alike need to take three major considerations into account when making a firearm transaction: product knowledge, value, and service.

SELF-TEST QUESTIONS

Please check your questions on page 21.

9. **What is the name of the company in Tennessee that probably has the largest selection of black powder firearms in the United States?**
10. **What is the condition of an antique firearm that has all original parts and over 30% original finish and a fine bore?**
11. **Where are some good places to find antique arms for sale?**
12. ***True or False*. You will encounter many old drawings and catalogs of antique gun parts; throw away all those except for those you need immediately.**

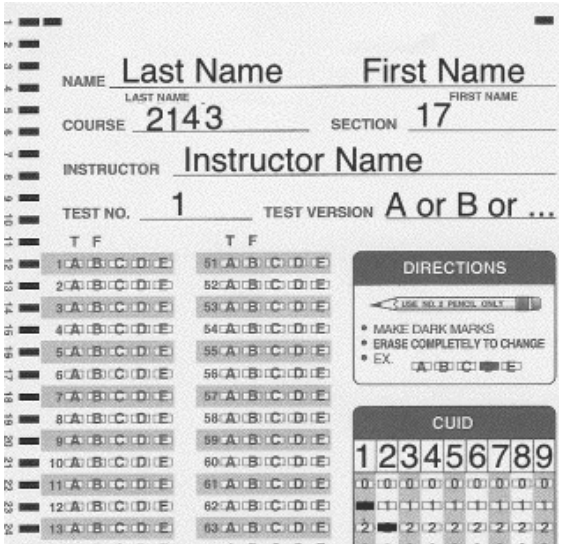
Answers to Self-Test Questions

1. True.
2. Fewer legal restrictions, special muzzleloading hunting seasons, and the desire to relive the days of our ancestors.
3. 10 percent.
4. Pyrodex is replica black powder.
5. False. The first Kentucky rifles used the flintlock system.
6. The Hawken rifle.
7. 1862.
8. Minié ball. It's named after its inventor, Captain Minié of France.
9. Dixie Gun Works
10. Fine.
11. Gun shows.
12. False. File every bit of information that you encounter.

Lesson Questions

THIS IS LESSON NUMBER 2173.

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



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

You may also complete your exams and submit them online via the SDI Student Services page at www.sonoranlearning.com.

1. **Black powder arms are less popular than they were several years ago.**
   a. True.
   b. False.

2. **What year did Roger Bacon record the formula for black powder?**
   a. 152.
   b. 47 B.C.
   c. 1270.
   d. 1248.

3. **The present formula for black powder is**
   a. 10% saltpeter, 15% sulfur, and 75% charcoal.
   b. 10% sulfur, 15% charcoal, and 75% saltpeter.
   c. 10% charcoal, 10% sulfur, and 80% saltpeter.
   d. 15% sulfur, 10% charcoal, and 75% saltpeter.

4. **How is Pyrodex measured in comparison to genuine black powder?**
   a. Volume-to-volume.
   b. Pound for pound.
   c. Ounce for ounce.
   d. Grain for grain.

5. **In approximately what year did cannons and hand cannons begin to be used?**
   a. 750.
   b. 1050.
   c. 1250.
   d. 1350.

6. **In approximately what year was the matchlock ignition system improved with the serpentine match holder?**
   a. 1400.
   b. 1500.
   c. 1600.
   d. 1700.

7. **What is the name of the first breechloader used by the U. S. government?**
   a. Jenks rifle.
   b. Springfield.
   c. Hall rifle.
   d. Remington rifle.

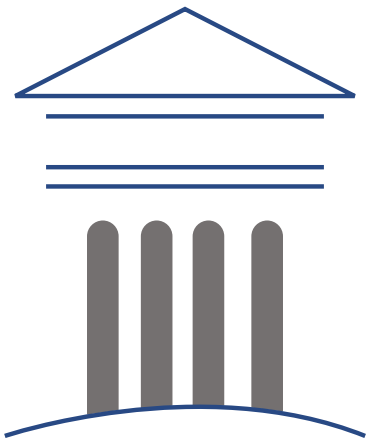
8. **What is the name of the rifle that was made in Pennsylvania by German gunsmiths and was a favorite of those taming the wilderness in the late 1700s and early 1800s?**
   a. Pennsylvania rifle.
   b. Plains rifle.
   c. Kentucky rifle.
   d. Zouave rifle.

9. **When cap lock rifles are dry fired, what problem occurs?**
   a. The barrel double-fires.
   b. Peening over of the nipples.
   c. The nipples corrode.
   d. Trigger pull increases.

10. **As a general rule, which of the following statements is true about antique black powder firearms of collector status?**
   a. They should not be fired.
   b. They should be fired frequently.
   c. They should be fired only with smokeless powder.
   d. They should be fired only about once a week.

Cleaning Firearms Lab (#)
Lab: 2484

INTRODUCTION	3
TRAINING UNIT CONTENTS	4
PREPARATION	4
Cleaning A Bolt-Action Rifle	6
Cleaning A Semi-Automatic Firearm	7
Cleaning Revolvers	7
SUMMARY	7
EXAMINATION QUESTIONS	8



Introduction

Simply stated, a clean gun shoots better. A firearm with a clean bore and a clean action is more accurate and less likely to jam or misfire. Cleaning the firearm keeps rust and other corrosion from ruining it. Remember, a firearm can be a major investment, and with proper care can last many lifetimes.

The external appearance of the firearm is just as important as the internal condition and should not be neglected. Keeping the external parts of the firearm clean and rust-free increases the resale value of the gun.

Your primary concern when handling any gun is safety, especially during the cleaning process. Many accidents that occur during gun cleaning could be prevented with some common sense and attention to the rules of safe firearms handling. Whenever you are handling a firearm, remember that it is better to be safe than sorry. If necessary, review the safety procedures discussed in your first lesson.

Ideally, the firearm should be cleaned after every shooting session. If you cannot clean the gun on the same day it is used, clean it as soon as possible. The longer the powder residue sits, the harder it is to remove. Also, some of the military ammunition on the market is made with corrosive primers that have an acid base. This compound must be removed quickly or it will cause deterioration of the bore.



Figure 1: Lab kit

** Please note that from time-to-time kits may be unavailable. Should this occur, we will substitute an appropriate kit that will meet the objective of this lesson.*

Training Unit Contents

The materials you received in this training unit are shown in Figure 1 with the part number and description. If any of the parts are missing, complete an Ask Your Instructor form and return it to the Sonoran Desert Institute. The missing part will be sent to you. If you find that any of the parts are damaged, return the part to us for replacement.

The materials included in this training unit allow you to clean all rifles and handguns from .22 to .50 caliber and shotguns up to 12 gauge. In addition to the training unit equipment, you will need an old tooth- brush or some other type of soft nylon brush.

Preparation

You will need a quiet and secluded place to work while you clean the firearms. The ideal place to work is at a bench in a workshop.

However, any table will do if you take a few precautions. Cover the table with a thick towel or other protective material to protect both the table and the gunstock.

The gun conditioner in this kit contains petroleum distillates.

Be sure to keep this product as well as your firearms and ammunition out of the reach of children. The gun conditioner will make spots on furniture finishes, so be careful with it.

There is a time-tested procedure that works well for cleaning all firearms. This procedure applies to the bores of rifles, shotguns, and handguns. There may be other steps to take, but the basic procedure is always the same. We will discuss the basic procedure here and some of the additional steps later in this manual.

The first step is probably the most important: **Make absolutely sure that the gun is not loaded!** Open the action of the firearm and check the chamber. Leave the action open. Remove the magazine if possible. If not, make certain there are no cartridges left in the magazine.

Next, with your bore light, check the bore to be sure there are no obstructions. Take a moment to check the overall condition of the bore. If you are working on a customer's firearm and you find a pitted bore, advise the customer of the situation before you do any more work. It shows the customer that you intend to do a thorough job and prevents the customer from returning and saying that your work damaged the bore.

While you are disassembling a firearm for cleaning, check the parts for wear or damage. If it is a customer's gun and a problem is found, stop and inform the customer of the problem and give the approximate cost of repair.

Disassemble the firearm only as much as necessary. Refer to the owner's manual for specific disassembly instructions.

RIFLES. For bolt-action rifles, remove the bolt and open the magazine floor plate, as shown in Figure 2, if possible. If not, clean the rifle with the floor plate pointed up to prevent the bore cleaner from dripping into the magazine.

For pump-and lever-action semi-automatics, refer to the manual and follow the disassembly instructions. As you become familiar with different firearms, you will find that you will not always need to refer to the manual. Many rifles use the same type of action and are disassembled in the same way (the military MI Garand and the Ruger Mini-14, for example).

SHOTGUNS. Most pump-action shotguns, as well as a large percentage of semi-automatics, have removable barrels. Usually, the barrel can be removed by unscrewing the large thumb-nut at the end of the magazine tube.

HANDGUNS. For double-action revolvers, merely open the cylinder by operating the cylinder release. For single-action revolvers, remove the cylinder, if possible.

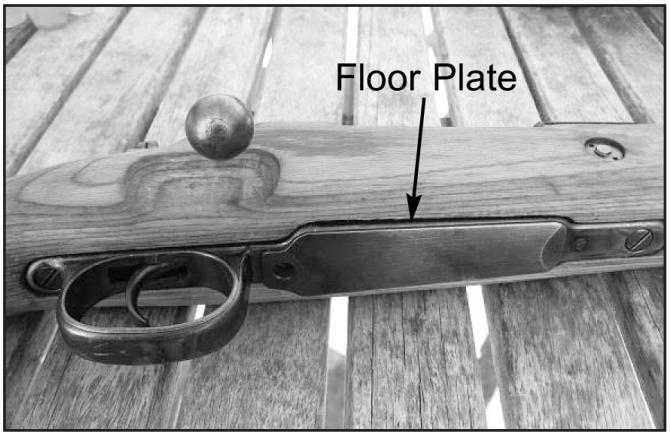


Figure 2. *The floor plate of a rifle.*



Figure 3. *A Sig Sauer P-220. The lever above the trigger will release the slide when it aligns with the release notch.*

For semi-automatic handguns, remove the slide from the frame. Many semi-automatics are based on the Colt 1911 action and are disassembled in the same manner.

Many of the new-style semi-automatics have a slide release lever like the one on the Sig Sauer P-226 shown in Figure 3.

After disassembling the firearm, put the cleaning rod together so it is the correct length for the firearm being cleaned. Attach the accessory adapter to the end of the cleaning rod and then attach the correct size jag to the end of the adapter (Figure 4). Jags are considered to be the most effective cleaning method.

The next step is to get the correct-size patch for cleaning the bore of the firearm. The best material for cleaning patches is cotton flannel. This material is more absorbent than the synthetic material that is used for some of the cleaning patches on the market.

The patch material included in your cleaning training unit is cotton flannel. In this training unit there are two 3' strips of material. Each strip is 2" wide. When cut, this material will allow you to clean any firearm up to .50 caliber. The dimensions of the patches are as follows:

.22-.270	1½" square
7mm-.357	2" square
.35-.40 and 20-gauge	2½" x 2"
.45-.50 16 and 12-gauge	3" x 2"

Determine the correct patch size and cut several patches from one of the strips.

When you have used all of the patch material that you received in this training unit, you will probably want to purchase the precut patches that are available. Again, be sure to buy the cotton patches rather than the synthetic patches.

The bore should be cleaned from the breech when- ever possible. Even if the cleaning rod cannot be inserted into the barrel at the breech, keep the muzzle lower than the breech. This prevents bore cleaner, powder residue, dirt, and gun oil from dripping into the magazine or the action. These are the basic cleaning steps:

1. Saturate a patch with the cleaning solvent (Formula 3) and place the patch on the cleaning jag. Be sure that the jag is centered on the patch. Push the first patch completely through the bore. Since this patch removes most of the powder residue, the patch should be pushed in only one direction. If you pull the patch back, it tends to smear dissolved powder residue along the length of the barrel, most of which can be pushed out with the first stroke. Be careful not to scrape the cleaning rod on the surface of the barrel, especially if you are cleaning from the muzzle.

   To start the rod in the bore, grip a section of the rod near the cleaning end. Slowly feed the rod into the bore. After feeding in the first 3"- 4", grasp the handle and push the rod straight in. You will notice that the handle rotates on the shaft of the cleaning rod. This allows the patch to turn in the riflings of the firearm.



Figure 4. *The cleaning rod and brushes, pre-assembly.*

On bores that are extremely dirty or lightly fouled, you should use a phosphor bronze brush. Use the brush after the first patch has been run through the bore. The brush should be saturated with solvent and worked through the bore. Do not reverse the direction of the brush in the bore because it can kink the bristles, cause binding, and damage the bore. Instead, push the brush completely out of the bore before you change directions. Work the brush through the bore 5-10 times. Then, continue with Step 2.

2. Saturate a second patch with cleaning solvent. Place the patch on the jag as before and insert it into the barrel. Push the patch through the barrel, but do not push it completely out the other end. If you are cleaning from the breech, you will be able to see the patch at the muzzle. When the patch reaches the muzzle and sticks out about ¼", pull it back into the bore. Work this patch back and forth through the bore 5–10 times.

3. Place a clean dry patch on the jag and repeat the procedure in Step 2. Continue this step until the patch comes out completely clean.

4. Once the bore is completely clean, lightly oil a patch with Formula 3 and run it through the bore to apply a light coat of oil to protect it from rust during storage.

5. Clean the remaining parts with solvent and the soft nylon brush. Apply a light coat of oil and reassemble the firearm.

6. Use the silicone cloth to wipe clean the external parts of the firearm, including the stock, before storing the firearm. Perspiration from your hands has an acid content, so wiping the gun clean pre-vents minor acid-etching, as well as reduces the possibility of rust. Remember this whenever you handle any firearm, and keep your hands on the stock and off the metal as much as possible.



***Figure 5**. The extractor of a rifle bolt.*

A light coat of oil is all that is ever needed. Over-lubrication will cause problems. The oil will collect dust and dirt, which act like a grinding compound and accelerate the effect of normal wear and tear on the gun.

Before a stored firearm is fired, a clean patch should be run through the barrel to remove any excess oil. Also, before you fire a new gun, it should be thoroughly cleaned and the action lightly oiled.

CLEANING A BOLT-ACTION RIFLE

In addition to the steps covered above, it will be necessary to clean the bolt and the chamber opening of a bolt-action rifle. An old toothbrush works very well for this. When cleaning the bolt, be sure to clean under the extractor, shown in Figure 5. A dirt build-up in this area can cause cartridge cases to stick in the chamber when the bolt is opened.

Put a few drops of solvent on the toothbrush and scrub the bolt and chamber. Wipe off the dirty solvent and apply a light coat of oil. Clean the magazine well; if necessary, use a clean, dry brush. Lubricate the areas of the bolt that come in contact with the grooves in the receiver.

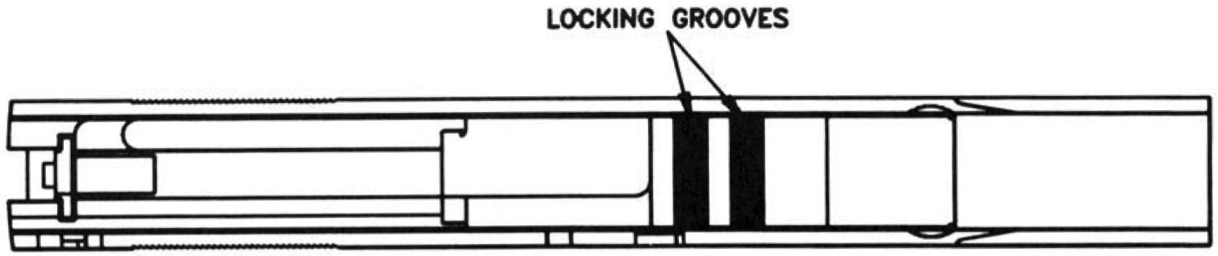


Figure 6. Be sure to clean the locking grooves of the slide.

CLEANING A SEMI-AUTOMATIC FIREARM

Cleaning semi-automatic firearms is different from cleaning other guns because of the steps necessary to disassemble the gun. Generally speaking, any part removed during disassembly should be cleaned and lightly oiled. Springs only need to be wiped with a cloth. Other parts may need solvent and a brush.

If you are cleaning a 1911-style automatic pistol, be sure to clean the locking grooves in the slide, shown in Figure 6. This is the area of the slide where the breech locks during firing. If the grooves are not clean, the barrel will not lock and will not cycle. Also, be sure to lubricate the grooves of the slide and the frame rails.

Be sure to oil lightly all moving parts when you are reassembling the firearm.

CLEANING REVOLVERS

In addition to cleaning the bore of a revolver, it is necessary to clean each of the chambers. This can be accomplished in the same fashion as cleaning the bore.

Also, you will need to clean the area under the extraction star. This is done by pushing out the extractor rod and scrubbing the exposed area with a tooth- brush treated with a few drops of solvent. Next, clean the recoil shield and the forcing cone, shown in Figure 7. Pay particular attention to the area between the forcing cone and the top strap of the frame.

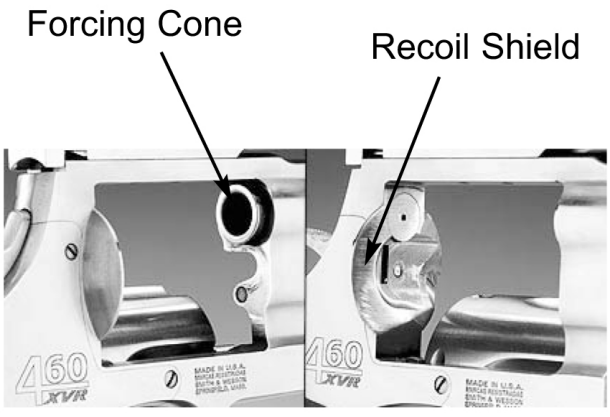


Figure 7. Clean the recoil shield and forcing cone of revolvers.

With revolvers, *leading* (lead deposits in the bore, pronounced *"ledding"*) is more of a problem than with other types of firearms. If leading is not excessive, you may be able to remove all of it by applying a coat of Formula 3 solvent, allowing it to sit over night, and using the bore brush the following day to remove all of the leading. For extreme leading conditions, you will need either a different solvent or a special lead-removing tool as discussed in your lessons.

Summary

Cleaning a firearm is not a difficult operation. However, many gun owners rarely, if ever, clean their guns, because they do not know how, do not have the proper equipment, or do not want to take the time. In servicing firearms, you may find that operating difficulties are more frequently caused by dirt than by mechanical malfunction. A simple cleaning often returns the firearm to working condition.

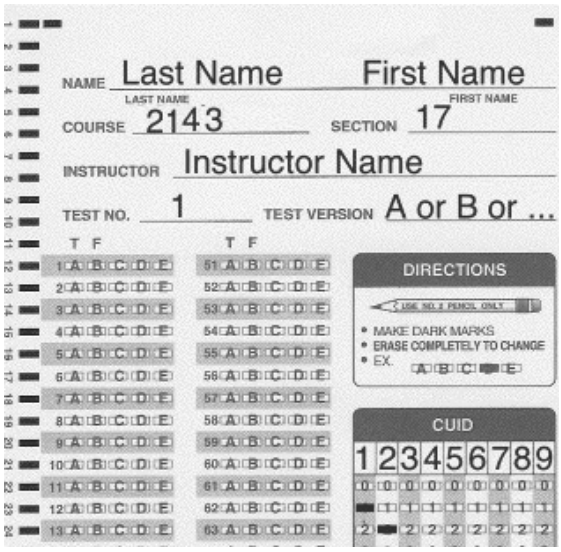
When cleaning a firearm, remember: ***safety first***. Always check to be sure that the gun is not loaded. Also, wear eye protection when using chemicals, and store them out of the reach of children.

Finally, remember that you are just starting in the profession. You may, from time to time, encounter a firearm that you do not know how disassemble. Refer to the owner's manual or the firearm's service information for instructions on how to properly disassemble the gun. When it is clean, you will have no problem reassembling it.

Examination Questions

This is Examination Number 2484.

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



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

You may also complete your exams and submit them online via the SDI Student Services page at www.sonoranlearning.com.

1. **The first step in cleaning a firearm is to run a saturated patch through the bore.**
   a. True.
   b. False.

2. **The first patch that is run through the bore should be worked through the bore**
   a. 1 time.
   b. 3 times.
   c. 5-10 times.
   d. 20-30 times.

3. **The correct size patch to use to clean a .45-caliber handgun is**
   a. 1½" square.
   b. 2" square.
   c. 2½"x 2".
   d. 3"x 2".

4. **Only the bore of a firearm needs to be cleaned.**
   a. True.
   b. False.

5. **How often should a firearm be cleaned?**
   a. Every year.
   b. Every six months.
   c. After ever shooting session.
   d. Never.

6. **To remove light fouling from the barrel, you should use**
   a. A dry patch.
   b. A bore brush.
   c. No patch at all.
   d. A screwdriver.

7. **The best way to hold the patch in contact with the surface of the bore is to use**
   a. A bore brush.
   b. A slotted tip.
   c. A cleaning jag.
   d. A screwdriver.

8. **The best cleaning patch is made of**
   a. Nylon.
   b. Plastic.
   c. Cotton.
   d. Polyester.

9. **To clean the bolt of a rifle, you should use**
   a. A bore brush.
   b. An old toothbrush.
   c. A wire brush.
   d. Nothing, the bolt should not be cleaned.

10. When cleaning a firearm, you should

a. Disassemble it to the last screw and drift pin.

b. Disassemble it only as far as necessary.

c. Open the action and clean the bore without removing any parts.

d. Just wipe the outside of the gun with solvent.