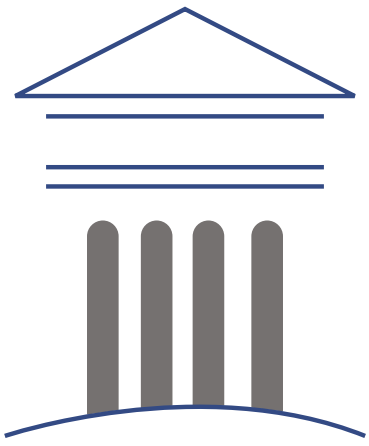
Restoring Metal Finishes
Lesson: 2196

OBJECTIVES 3
INTRODUCTION 4
EVALUATING FIREARMS 4
- Restoration Techniques 5
- Customizing 5

METALS USED IN FIREARM PRODUCTION 6
- Winchester Barrel Steel 9
- Restoring Gun Metal 10
- Self-Test Questions 11

OBTAINING ORIGINAL METAL FINISHES 12
- Chemical Use Safety 12
- Browning Formulas 12
- Slow Rust Bluing Formulas 13
- Summary 15
- Self-Test Questions 15

ANSWERS TO SELF-TEST QUESTIONS 16
LESSON QUESTIONS 17





Objectives

After completing this lesson, you should

1. Be familiar with the type of finish that case-hardening metal will provide.
2. Understand how the old finish is removed from antique firearms.
3. Know what carbonia blue is.
4. Know which alloy is used as a deoxidizer and will offset the effects of sulphur.

Introduction

Restoring the metal finish on antique or obsolete guns is a controversial subject, especially among collectors. Many valuable firearms have been completely ruined by hobbyists who were not aware of the gun's value and tried to "fix it up." A good rule of thumb for restoring antique firearms is to try to stop deterioration, preserve the current appearance, and, if possible, not rework any parts. Restoring modern firearms can also be a mistake. For example, many firearms manufactured before 1964 have recently gained some collector value. If 80% of the original finish is present on any of these guns, they should be restored only to the extent of avoiding further deterioration.

On the other hand, there are models that are definitely in the collectors' class, but have been seriously neglected through the years. Perhaps the wood has been cracked or gouged, certain parts have rusted badly, and pits have formed in the metal. Such a gun will normally have little collector value, unless it is a rarity. If the gun can be restored to a good appearance and working order, restoration is certainly legitimate and should be encouraged.

The main objective in restoring an old firearm is to maintain the gun's original form. For example, if the metal finish is to be restored, the original finishing process should be implemented, if it is known. If the original finishing process is not known, one of the processes of the period in which the firearm was originally produced should be applied. The original process of assembly should be applied to all parts of the gun. For wood, any missing parts should be replaced with original parts, if available. If not available, try to obtain reproduction parts that are as authentic as possible.

The main objective of this lesson is to discuss some of the metal finishes that are used on antique and obsolete firearms, and when and how to restore these finishes.

Evaluating Firearms

Firearms are brought to gun shops in various conditions. It is up to the gunsmith to assess its condition and find out what the customer wants to do with the firearm once restored. An owner might want to put a badly abused gun back into service. Other firearms might have a sentimental value to the owner who wants the gun restored. Some owners who are collectors might want to restore a gun for a collection. However, in all cases of gun restoration, the gun should be in poor condition before restoration is attempted.

The first step is to inspect the entire gun carefully with a magnifying lens, making notes during the process. Look for hairline cracks in the metal and wood parts. Note any rust and any pits, both inside and out, without disassembling the firearm. Check the action for proper functioning using blank ammo or snap caps for testing.

After evaluating the gun's exact condition, clean it thoroughly from muzzle to butt. Try to remove all foreign matter, but not the original finish. During cleaning, more defects will probably surface.

If the gun functions well, it is usually best that you not restore it. On the other hand, if the gun is not functional in its present condition, and if it is not a rare firearm, further restoration might be called for.

The extent of restoration can range from replacing a small, defective part to overhauling the gun completely, removing all pits, rejuvenating engraving, rebluing, and replacing or refinishing the stock and fore-end. It depends entirely on the value of the firearm and what the customer wants. Keep in mind that usually a collectible firearm, like the one shown in Figure 1, will lose some value (unless it is in very poor condition) when it is restored. This is why most restored guns are working guns, rather than collector or valuable firearms.



***Figure 1**: This Remington Beals Army Percussion revolver is a rare find, especially in good condition. No attempt whatsoever should be made to restore such firearms beyond stopping any further deterioration.*



***Figure 2**: Restoring the finish on the receiver of this W.W. Greener double-barrel shotgun calls for intricate and timely work.*

RESTORATION TECHNIQUES

In general, modern gunsmithing methods cannot be used on old gun parts, like the one shown in Figure 2, because the results are usually unsatisfactory. For example, power metal polishing cuts too much metal and closes the pores in the metal. As a result, the fine blue-black finish does not appear. The popular hot caustic bluing method is another forbidden practice on most antique firearms. The glossy black appearance of this finish does not look authentic on the older guns.

The hot caustic method also attacks soft soldering, the type used to secure barrel ribs and to join the barrels on the older double-barrel shotguns.

There are several alternative methods to restore old guns. For example, a gunsmith can use a power buffer to remove some pits in the metal and then polish by hand. The slow rust method or the hot water method can be used for restoring many high-quality guns instead of the hot caustic method. It is important to discover methods that are less harsh on the old firearm, and yet can restore the gun to a greater value.

A technique that adds to the value and authenticity of many older firearms is color case-hardening. Color case-hardening involves hardening metals that result in hues of mottled blues, browns, grays, and blacks. Few gun shops offer this service, mainly because most formulas require the addition of cyanide to the hardening compound, which is lethal. Color case-hardening can be performed without the use of cyanide but the process takes longer.

One of the most difficult items to restore on a firearm is the engraving. The majority of fine metal engravers had their own style and technique, and you can well imagine the difficulty a good modern-day engraver experiences duplicating the work. Fortunately, most gun engravings do not have to be completely re-etched. Many times, the engravings only need to have lines deepened. For example, the trigger guards on some double-barreled shotguns have a simple border engraving on them. These same trigger guards are subject to rust and pits and, in many cases, removing the pits means removing the engraving, too. An expert restorer makes an exact pattern of the original border engraving and also takes close-up photos before any polishing begins. The pits are removed, taking off as little metal as possible. The restorer or the engraver recuts the engraved border following the original pattern prior to bluing, which maintains the original appearance of the firearm.

Obviously, a firearm restorer must be a highly dedicated individual, know firearm history, and know the techniques of the period and how to apply them. Mostly, a restorer must have an appreciation of high craftsmanship.

CUSTOMIZING

Occasionally, it is best to customize an old rifle, rather than restore it. For example, let's assume that a customer takes to a restorer a pre-64 Winchester Model 70 with a shot-out barrel, a broken stock, and a badly scratched receiver. An original barrel and stock for this model, if available, will run over $500. Add the labor involved in replacing and refinishing these parts, the final sum would be approximately $1,500. And unfortunately, after all of the restoration work, the customer will not have an original Model 70.

A good Model 70 can be purchased, at this writing, for about $1,000, but can go as high as $3,000. Why bother restoring it? A customer would be better off trading it in or selling the action to a gunsmith to be made into a custom rifle, then buying a good used Model 70 from a dealer.

On the other hand, a customer might want a custom-built rifle. A competent gunsmith needs to be able to assess what the customer wants as well as what is the most practical solution. Sometimes, it might be better to customize rather than restore. Again, it depends upon the rarity of the gun in question, what the customer wants, the time involved in restoration, and the expense.

You will probably want to do some work yourself and then "farm out" any parts of the restoration that you would prefer not to handle. However, be sure to check the restorer's credentials thoroughly. If there is any doubt as to whether or not you should have a particular gun restored, wait until you are absolutely sure you want the work done.

When deciding to restore a firearm, first consider the function of the gun. The firearm should first be repaired to function safely and properly.

The wood of a particular firearm should be the next consideration. A careful examination will reveal if the stock should be replaced entirely or if it only needs to be repaired and refinished. If repairing or restoring the gun, any existing checkering should be cleaned out first, the area masked off, and the remaining surfaces sanded or the finish chemically removed.

Metals Used in Firearm Production

Metals used in the production of firearms consist of iron, steel, copper, bronze, brass, aluminum, and nickel alloys. The materials for the metal are selected based on tensile strength and hardness.

The metal specifications regarding the properties of tensile strength and hardness are often furnished by the raw material supplier. For example, specifications are available for steel that is suitable for case-hardening, stainless steels that resist corrosion, brass suitable for screw machine work, or for drawing operations, and so forth.

Restricting Impurities. The specifications of the metals might restrict the content of elements considered to be impurities, such as phosphorus and sulphur in iron. These restrictions specify the carbon content of iron and steel, and indicate the content of nickel, chromium, or copper in the various alloy irons and steels; the copper, tin, zinc, and nickel content of bronzes; and the silicon and copper content of aluminum. There are, of course, general rules and specifications for any material used.

Choosing Material. The material from which a gun part is made must be carefully selected based on the function of the part. A steel casting, for example, might be used for a part because it is tougher than cast iron and can stand shock better. Aluminum castings are sometimes used for trigger guards, for frames in low-pressure, rimfire rifles, and other areas where lightness, strength, and resistance to corrosion are important.

The Colt revolvers shown in Figure 3 and also in Figure 4, on next page, use different types of steel.

Among the principal specifications of any material are the tensile strength and the hardness.

Tensile Strength. Tensile strength is the maximum amount of the stress that the material can withstand without breaking. It is usually measured in pounds per square inch (psi). While most cast metals fracture easily when tested for tensile strength, wrought materials, especially steel, stretch before breaking.

Hardness. Hardness is the material's resistance to scratches, cuts, and dents by other materials.

Metals can be given fairly definite values of tensile strength and hardness by alloying, by heat treatment, or by both. The nature of the necessary heat treatment that increases any particular property usually forms part of the specification.

Alloys. An alloy consists of two or more metals mixed together by melting, usually with a larger proportion of one metal to the other metals. Steel can be alloyed with nickel, manganese, chromium, tungsten, molybdenum, vanadium, or cobalt. Copper can be alloyed with zinc to form brass or with tin to make bronze. Aluminum and a small amount of copper makes duraluminum, which has the strength of steel but the lightness of aluminum. Small amounts of other metals added to cast iron give the alloy valuable properties.

Most moving gun parts are made of steel because of its high strength, which in the case of certain alloy steels may reach 200,000 per square inch. Also, most steels can be machined by average equipment in the annealed or normalized condition, and then hardened by various methods. Some moving parts in firearms, such as a breechblock, have a high stress when working because of the pressures developed when a cartridge is fired. These are almost always made of alloy steel.



Figure 3: *The metal used in the Colt percussion revolver is much different than the modern steel used in the Colt Python in Figure 4. In fact, the steel in Colt revolvers has changed hundreds of times of the past century.*



***Figure 4**: The steel in the cylinder of this Colt Python revolver is of a special high-tensile strength to withstand the 40,000 psi pressure of the .357 Magnum cartridges. The use of a lesser strength material would surely result in a ruptured cylinder.*

Carbon and manganese were the chief alloys used in gun metal during the early part of this century. However, too much of either made the steel too brittle. Nickel was used to toughen steel. Adding chromium to steel increases its strength without much decrease in ductility. Chromium is one of the alloys used in stainless steel. Molybdenum increases the ability of steel to withstand shock and fatigue.

Steel. Cast steel is usually low in carbon compared to cast iron, sometimes as low as 0.10% carbon. Cast steel is always given at least one type of heat treatment. It can also be alloyed with chromium, nickel, vanadium, molybdenum, copper, or a combination of these elements, in addition to the manganese and silicon which are generally present.

After normalizing or annealing, hardening, and tempering, cast steel develops a tensile strength of at least 60,000 psi and with some alloys as high as 120,000 pounds per square inch.

Steel is described in various terms, some of which relate to the process of manufacture and others to the carbon or alloy content. What is collectively referred to as mild steel is generally a cheap material used for structural work and general purposes. Sometimes it is designated as *Bessemer steel* because it can be made by burning out the carbon from the pig iron in a Bessemer converter.

Open-hearth steel is made in a furnace by a boiling process. Unlike Bessemer steel, which is always made from molten pig iron, open-hearth steel can be made from steel scrap as well as pig iron. Both these processes produce steel from iron by removing carbon.

Crucible steel, which is sometimes called cast steel, was the most common type for producing tool steels and other high quality steels for many years. Today these steels are almost always produced in electric furnaces. The crucible method consists of placing the iron, carbon, and other alloys in specific proportions in a small pot or crucible, which is heated as a unit in a large, flat, gas-fired furnace. When melted, the hot crucible is lifted, the seal broken, and the molten metal poured into ingot molds. Each crucible usually holds about 100 pounds of steel.

Steel Drill Rod. Drill rods come in various lengths, but 36" is the most common length. Drill rods range in size from #1 to #80 in drill-gauge dimensions. They are also made in letter and fractional sizes, in squares, and in flats. Drill rods are always useful for making drift pins, screws, screwdriver tips, firing pins, cleaning rods, and many other necessities.

Spring Steel. Spring stock is available in several types and sizes, including coils, spring wire, round oil-tempered spring stock, and flat spring stock. All of these are available from Brownells, Inc., as well as other manufacturers.

Steel Tubing. Steel tubing is available in all required weights and diameters and has many uses. Barrel bands, magazine tubes, and bushings can easily be made from steel tubing. A special tubing is also used for the oil tubes of barrel drills, barrel reamers and rifling heads. Another type of tubing is used for relining rifle barrels.

Furnaces. The basic electric furnace is constructed in sizes that are able to produce 1,100 tons at each heat. In a typical furnace with a cold charge of scrap and alloying materials, all of the

known chemical and physical properties are melted by passing heavy currents of electricity through the steel. When melted, burned lime and fluorspar or sand is added, which forms a basic slag in combination with the oxides from the molten metal. Chemical analysis is made several times during melting to check the elements. The entire furnace is tilted to pour the molten metal into a ladle then into ingot molds.

Tool Steels. Tool steels are produced in a wide variety under many trade names. They can be classified into a few general types of steel.

The most common and oldest type of steel is *carbon* or *water-hardening tool steel*. It usually hardens into a very hard outside or chill case with a comparatively tough and softer core, providing the strength necessary for high-impact jobs such as punches. It is also used for hand tools. Small additions of vanadium or chromium produce steels of similar general characteristics, but of a finer grain and a deeper hardening.

Low carbon and low alloyed tool steels are used for jobs requiring high strength and medium hardness such as dies for metal die castings, tough chisels, punches, etc.

Highly alloyed, high-carbon, high-chrome steels are used for very long-wearing operations. They are, in general, difficult to machine and grind.



***Figure 5**: Most hand tools used in gunsmithing work are made from tool steel.*

High-speed steels are generally used as cutting tools, tool bits, drills, milling cutters, and so forth. They are characterized by their ability to maintain hardness and a sharp cutting edge even at dull red temperatures. Tungsten and molybdenum are required elements with chromium, vanadium, and cobalt. They are also used at times for hot working dyes and sometimes for regular cold working tools, dyes, and the like.

The majority of gunsmithing tools, like the ones shown in Figure 5, other than those made from alloy steels, are made from tool steel with a carbon content of 0.85%-1.35%, according to the final hardness wanted.

These high-carbon steels, however, are not often used for machine parts. Softer steels are cheaper and easier to mold. The necessary hardness is attained by causing the surface to absorb carbon in the case-hardening process.

The main difference in steels is the carbon content, and the percentage of nickel, chromium, vanadium, molybdenum, tungsten included, which gives definite strength and hardness values to the resulting mixture. The substance made from cast iron, by the Bessemer process, the open-hearth furnace, or in an electric furnace, is carbon-free iron. Certain amounts of carbon and other elements are added to this.

Grain of Steel. Grain size of steel is important to users. In most applications, the fine-grain steels are deeper hardening, tougher, less apt to develop quenching cracks, less susceptible to grinding cracks, have less distortion in hardening, and have lower internal stresses. This same material is more difficult to machine, but gives better machining in fine-cut finishes. The opposite is true of the coarse-grained steels, which have a grain size of less than five.

Alloying Elements in Steel. Aluminum is used as a deoxidizer. It is also present in steels made specially for nitriding.

Chromium increases the ability of a steel to harden, increases the abrasion resistance (especially in compositions with high carbon), and contributes to strength at high temperatures.

Cobalt resists softening at high temperatures and decreases the ability of steel to harden.

Manganese is required as a deoxidizer, offsets the harmful effects of sulphur, and produces a moderate increase in hardenability. At 12%, it produces a hard material. This material will not harden under regular, quenching heat treatment, but from cold working.

Molybdenum considerably increases hardenability, increases strength at high temperatures, and corrosion resistance in stainless steels. It also increases strength and can replace tungsten in high-speed steels.

Nickel promotes high toughness in composition with other elements and develops good hardenability. In stainless steels (combined with chromium), nickel produces good corrosion resistance and is not hardenable by quenching treatment, but by cold working. Very high nickel alloys have special thermal and magnetic properties.

Phosphorus improves machinability in high-sulphur steels, but must be limited to less than 0.05% to obtain plasticity. It contributes to hardenability, strengthens low-carbon steels, and adds some corrosion resistance.

Silicon is a general-purpose deoxidizer and increases strength, especially in combination with manganese. It is universally used in magnetic sheet steels to aid in crystallization and increase electrical resistance.

Titanium is a good deoxidizer, prevents grain growth at high temperatures in stainless steels, and reduces hardenability in medium-grade chromium steels.

Tungsten resists softening at high temperatures, increases hardenability, and forms hard, abrasive-resistant carbide particles. It is almost always present in high-speed cutting tools.

Vanadium produces fine-grain steel and increases hardenability.

Case-Hardening. All but a few of the mildest steels can be case-hardened, and steels having a low carbon content are generally used for parts like the receiver shown in Figure 6, which have to be case-hardened — 0.2% carbon is usually the maximum amount allowable.

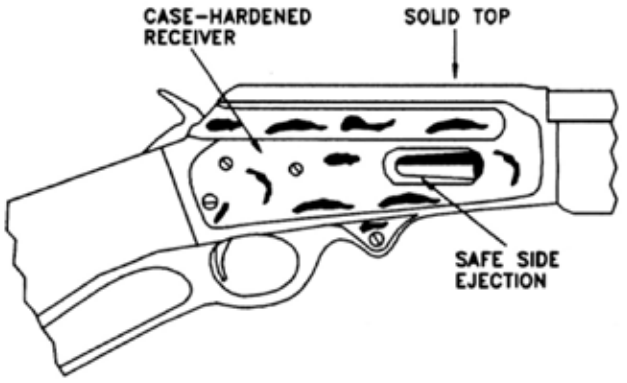


***Figure 6**: Some gun parts, especially some rifle receivers and revolver frames, are case hardened with mottled colors.*

The soft, low-carbon steels are easy to machine, and are often used for parts which do not need to be case-hardened. This softening, however, might increase the difficulty of obtaining the fine finish needed for certain parts, especially when final grinding to exact size is difficult because of the shape or design of the part.

The nickel steels, without sacrificing any of the toughness, give a slight increase in hardness and fineness of structure, which provides the smooth surface essential for parts intended for case-hardening.

Alloy Steels. Good quality alloy steels contrast favorably with the plain carbon type. Great care is taken in manufacture resulting in lower impurities and greater tensile strength and ductility. However, alloy steels cost more to buy and machine than the plain carbon steels. The only practical drawback to the use of these steels in machines is that the surface is never thoroughly hard.

The more common alloys, such as manganese, chromium, and molybdenum, in addition to nickel, are all very effective in facilitating hardening. They reduce the critical cooling velocity necessary for complete hardening. If sufficiently alloyed, hardening can be obtained even with slow rates of cooling, such as are associated with the normal cooling of large masses in air. Many gun parts are made from alloy steel, as shown in Figure 7, on next page.

WINCHESTER BARREL STEEL

A rifle barrel is simply a piece of steel with a hole in it, and with spiral rifling (or grooves) cut so that the bullet will spin fast enough to fly point-on. Winchester used barrels of plain carbon steel in their earlier firearms, which was composed of 0.14% manganese, 0.040% phosphorus, and 0.08%-0.13% sulphur. These metal barrels are sufficient for lead bullets at low pressures, or for rimfire cartridges with lead bullets. However, when using jacketed bullets at high velocities, problems develop.

When smokeless powder, high velocities, and higher pressures came into play in the 1890s, Winchester used nickel steel for some of their barrels, but still produced the plain carbon barrels well into the twentieth century, since lead bullets were still quite popular. Nickel steel was used until the mid-1930s, when Winchester changed to heat-treated chromium-molybdenum steel, which was called "Winchester Proof Steel." For a while, Winchester also used stainless steel barrels on some models, which were so stainless that they could not be blued. To color these barrels, they were first copper-plated. The copper was then turned black by another chemical process.



Figure 7: *Many modern semi-automatic and slide-action shotguns use a light alloy steel for receivers and other parts on the guns. Alloy steels combine strength with lighter weight.*

So, what will happen when you shoot jacketed bullets, like those shown in Figure 8, in early black-powder barrels at relatively high velocities, yet within safe working pressure? They will probably not blow up, but the barrel will be completely shot out in a few hundred rounds or less. In some cases, pieces of the soft steel rifling have emerged with the bullet to be lost forever downrange.

Therefore, those who shoot their antique rifles should heed the recommended velocities and use only lubricated lead bullets. If you want to shoot at high velocities with jacketed bullets, have the rifle rebarreled if the gun is not in the collector class.



Figure 8*: The type of bullet and the velocity at which it leaves the muzzle has a lot to do with how long a rifle barrel will last.*

RESTORING GUN METAL

Before any firearm can be refinished (blued, browned, Parkerized, etc.), the metal must first be prepared to accept the new finish. All of the old finish is removed and the metal is polished and degreased. However, in some cases the metal is in poor condition for conventional polishing. Pits, dings, broken parts, and the like all account for additional work.

Where the metal is in really poor condition, it is usually best to leave the gun as is. Most attempts to put on a new finish will look worse than the old. If you have the time, a complete restoration of almost any firearm is possible. Dings or gouges in the metal, for example, appear in the form of raised craters on the steel. You can take a ball-peen hammer and lightly tap to peen every bit of the metal back into its original place. Once this is done, a light polishing will make the metal look like new with no trace of the crater. As you peen the metal this way, you are actually forging the metal and causing it to flow. In doing so, the flowing metal will take the course of least resistance which is to move back to its original location. Most nicks and dings can be peened back in place in less than 15 minutes.

If the metal is gone, as in pits and holes in the metal, the metal be must replaced. The location and the depth of the pits will determine which method to use. If the pits are shallow, the surrounding metal can be polished to the level of the pit bottoms, thus removing them. However, if they are very deep, the pits must be filled in with a welder. Some gunsmiths have good results with spray welding. Both methods are complicated and beyond the scope of this course. Until you gain the necessary experience to do this type of work, it is recommended that you "farm out" all such work to those who specialize in replacing metal.

Pits on round barrels can be removed with a belt sander which places the barrel in a spinning fixture. Pits on octagonal barrels, with flats running the length of the barrel, can be removed by draw-filing or by using a flat-bench honing stone. Many gun shops that can afford a power grinder use it for this operation.

Consequently, restoring the metal of firearms to its original condition takes a combination of techniques, including the following:

- Using a rust-penetrating oil to loosen screws, pins, and other parts to allow complete disassembly of the firearm with damaging any parts.
- Removing the old finish with a blue/rust remover.
- Peening any gouges or nicks to make the raised metal flow to its original position.
- Filling any large pits or holes by welding.
- Repairing or replacing any broken parts.
- Polishing and cleaning the metal surface so that it is ready for the new finish.
- Refinishing the metal with a type of finish compatible with the era in which the gun was built.

Obviously, there is much detail to each of the above operations, and every gun will present a different set of problems. Therefore, you must evaluate each gun on its condition, its value, and the methods needed to restore it.

SELF-TEST QUESTIONS

Please check your answers on page 16.

1. ***True or False.*** **All pits, gouges, and holes in gun metal can be restored by peening alone.**
2. **What type of metal is used for tools requiring high-strength and medium hardness, such as chisels, punches, and the like?**
3. **What is the oldest type of tool steels?**
4. **Phosphorus improves machinability in high-sulphur steels, but must be limited to what percent for the steel to maintain plasticity?**

Obtaining Original Metal Finishes

The previously described methods of finishing gun metal should suffice for virtually all gun refinishing that a gunsmith will encounter. However, there are a few other recognized methods and formulas that have been used in the past that might benefit certain gunsmiths who want to specialize in restoring antique firearms, experiment with different methods, or know how certain guns of the past were refinished.

When an ordinary firearm is to be refinished, a gunsmith normally uses the hot caustic method unless the firearm is a double-barrel shotgun with soft soldered barrels or with a soft-soldered barrel rib or sight ramp. If this is the case, use the hot water process or the slow rusting process. Certain classic guns of the past, however, can be treated differently. For example, Parker shotguns have become a prized possession among gun collectors. Some models are valued at $100,000 so these guns should be left as they are because any type of refinishing at all will lower their value considerably.

On the other hand, the finish of the gun might be so poor that it would have little value to a collector, but could be restored as a hunting arm. In this case, the reconditioning of an old gun, provided it is not completely beyond repair, is perfectly legitimate. When repairing a gun for hunting, make an effort to follow the original finishing process, if this is known, or at least one of the processes used during the period in which the gun was constructed.

Modern hot caustic bluing salts are so similar to the old finish that it doesn't make much difference which brand to use to restore a modern gun. However, if you want the new finish to look like the original finish, use the bluing chemicals used by the gun manufacturer. For example, Colt, Savage, and other arms have been using bluing salts manufactured by Heathbath Corp. To find this information, contact the manufacturer of the firearm.

CHEMICAL USE SAFETY

All chemicals carry varying degrees of hazardous exposure. It is essential that you undertake basic safety precautions when dealing with dangerous compounds.

- First and foremost, know what you are dealing with! There are different types of chemicals which come in various forms: liquid, gas, vapor, dust, fume, or mist. Before handling any chemical, understand its properties, how it is used, and how it must be handled to avoid harmful exposure.
- Know what to do in case of emergency! Using safe practices when cleaning up leaks or spills and knowing when to call emergency help will minimize harmful effects.
- Always wear protective gear when dealing with any chemical. A rubber shop apron, gloves, and boots , as well as a face shield and hat should be worn at all times.
- Mix all chemicals in well-ventilated areas, preferably outdoors.
- In case of contamination, wash all skin thoroughly, and , if necessary, dispose of clothing. If clothing can be safely laundered, wash separately after rinsing items outdoors using a hose or washtub.
- Never bring food into an area where chemicals are being used or stored. Wash hands, or shower and change clothes before eating.
- Keep the work area free from contamination by properly cleaning up spills immediately, and appropriately disposing of hazardous material.
- Know the proper way to store or dispose of any leftover chemicals.
- Make sure at least one other person is available to undertake emergency measures should you become incapacitated from harmful exposure.

BROWNING FORMULAS

The browning formulas listed have been tried and used by many gunsmiths. If you decide to use them, remember that most bluing or browning solutions contain poisonous chemicals and it is recommended that you have a druggist or chemist mix the solutions. Furthermore, you should seek a chemist's advice regarding further use and safety concerns. Follow safety procedures as you would for any other product in the home that contains poisons or caustic chemicals.

Browning Solution No. 1. This solution has been around for more than 60 years and has been used by hundreds of gunsmiths with excellent results. Mix the following:

1 oz. tincture ferric chloride

1 oz. alcohol (95% by volume)

¼ oz. bichloride of mercury

¼ oz. nitric acid (specific gravity 1.40)

1/8 oz. copper sulphate

1 quart distilled water

Do not store this mixture for longer than a few days. Mix the amount you need a few days prior to using and store in a brown glass bottle with acid-proof stopper or cap. Apply the solution as recommended.

Browning Solution No. 2. Here is a relatively old formula that was used around the turn of the twentieth century to brown Damascus barrels that were common on many side-by-side double-barrel shotguns.

½ oz. of sweet spirits of nitre

¼ oz. of tincture of steel

½ oz. corrosive sublimate

4 grains of nitrate of silver

¼ teaspoon of chalk

1 pint of distilled water

60 drops of aqua fortis

Handle the above chemicals with caution. This solution is poisonous and highly corrosive. Mix the chemicals outdoors and do not breathe the fumes emitted during mixing.

Browning Solution No. 3. A similar formula to the one mentioned above, it works better on some steels than the other solution. However, it has a tendency to etch the steel more.

1 oz. of sweet spirits of nitre

¼ oz. of tincture of steel

¼ oz. of blue vitriol

6 drops of nitric acid

14 grains of corrosive sublimate

1 pint of distilled water

SLOW RUST BLUING FORMULAS

Slow Rust Bluing Formula No. 1. This solution will give a light blue-black color to metal. It is somewhat slower than solutions used in the hot water bluing process, but faster than most slow rusting methods. Mix the chemicals outdoors. Do not breathe the fumes. Store the solution in a dark brown bottle with an acid-resistance cap or stopper. Label this and other bottles **Poison**.

4 oz. of hydrochloric acid

½ oz. of nitric acid

1 pound of ferric chloride

½ oz. of copper sulphate

1 gallon of distilled water

Avoid getting this and all other formulas on your skin since they are highly caustic.

Slow Rust Bluing Formula No. 2. This is the basic slow rust formula used for rifles such as the one in Figure 9. The first two ingredients are mixed outdoors and poured into a glass container. A considerable amount of heat and fumes will be generated so be careful. Then carefully drop in the nails. Be careful not to let any of the solution splash on you during the process. Wear safety goggles and rubber gloves as well as other protective clothing. Stir the mixture gently with a glass rod and let the mixture sit for an hour or until the nails have been dissolved by the acids. Pour the distilled water into an empty milk carton made of plastic or a glass jug. Note that we said pour the water into an empty container. *Never pour water into an acid solution.*

Slowly pour the acid solution into the jug with the water. Do this very slowly to avoid splattering. Let the solution "cure" for a couple of weeks and then pour the clear liquid into a dark glass jar. Leave the residue on the bottom of the milk carton



***Figure 9**: The Winchester Model 94 carbine has gone through many bluing methods since its introduction 1894, beginning with the slow-rust and nitre methods through the hot-caustic method, which began about 1939.*

in the carton. Do not pour this into the dark bottle with the clear liquid. Use as described for slow rust bluing as previously described. You will need:

4 oz. of nitric acid

3 oz. of hydrochloric acid

½ pound of small clean iron nails

1 quart of distilled water

Again, label the container Poison and handle this as you would any other dangerous chemical. By this time, you might think that safety is over-emphasized, but you cannot get careless with chemicals without having dangerous and possibly lethal results. As long as you are careful, it is a safe operation.

Slow Rust Formula No. 3. The following formula has been standard at the Savage Arms plant around the early part of the twentieth century for browning certain firearms. Currently, they use the hot caustic solution supplied by Heatbath Corp. of Springfield, Massachusetts, except for certain soft soldered guns that are refinished. The solution is applied to the metal parts as described previously, but a steam cabinet is used to hasten and improve the job. Mix the following chemicals outdoors:

1½ oz. of mercuric chloride

1 oz. of copper sulphate

1 quart of distilled water

Dissolve the solids in the distilled water and then add

4½ oz. of spirits of wine

1½ oz. of tincture of ferric chloride

1½ oz. of ethyl nitrate

¾ oz. of nitric acid

Store the solution in a dark brown bottle with an acid-proof stopper. Use as described previously.

Steam for about three hours between carding. This formula will give a durable, slow rust bluing job in approximately 24 hours that will surpass most factory jobs today.

Hot Water Bluing Formula No. 1. This formula has been used by many gunsmiths throughout the country with excellent results on most steel barrels. The formula is over 60 years old and has been tested to produce the desired results when using the hot water method of bluing. Mix the following powders in a clean, glass jar:

¼ oz. of sodium nitrate

¼ oz. of potassium nitrate

½ oz. of mercuric chloride

½ oz. of potassium chlorate

Heat 10 oz. of distilled water (warm but not boiling) and pour slowly into the container holding the mixed powders. Stir continuously with a glass rod until the solution cools. Add ½ oz. of ethyl nitrate. Pour the solution immediately into a brown glass or plastic bottle (use an acid-proof cap) and keep in a dark place until ready for use. Label the bottle Poison and Shake Well Before Using.

Hot Water Bluing Formula No. 2. Stainless steel barrels are very difficult to color by any conventional method because bluing or browning is merely a rusting process. These steels are highly rust-resistant. The late Clyde Baker, in his book *Modern Gunsmithing*, suggests the addition of ½ oz. tincture of ferric chloride, ¼ oz. nitric acid, and ¼ oz. hydrochloric acid to the Hot Water Bluing Formula No. 1 (above) for coloring stainless steel. Use the methods previously described. However, two or three dozen applications might be required to do the job because the coloring is very slow. Mr. Baker's book was first published in 1928 and is now available from online book retailers.

Hot Caustic Formula No. 1. This formula is easy to mix and use. Your biggest problem will be finding the chemicals in small enough quantities to make the mixing worthwhile.

15 pounds of sodium hydroxide (flakes)

7½ pounds of ammonium nitrate

3 gallons of pure water

Mix the first two ingredients dry. Place the three gallons of water in your bluing tank and slowly add the mixed powders. Mix well. Add only a little at a time because heat will be produced as they are dissolved in the water.

Wear protective clothing, eye protection, and rubber gloves. When the chemicals are completely dissolved, heat the solution slowly until it boils at about 285° F. If the solution boils before this temperature is reached, add a little more of the dry chemicals (mixed in the same proportion: one part ammonium nitrate to two parts sodium hydroxide) or let the water evaporate until the solution boils between 285-290° F.

When using this formula, a considerable amount of ammonia gas is given off and must not be inhaled. Use plenty of ventilation and be especially careful when you have to get near the tanks since a good "shot" of the ammonia gases can almost knock a person down.

As with most hot caustic methods, this formula will eat soft soldered joints. Do not blue double-barreled shotgun barrels that are joined this way. Also, rifle barrels with soft soldered ramps should not be blued in this solution. Use one of the hot water methods for these types.

SUMMARY

Although you might not realize it, this lesson is not meant to discourage you from restoring the metal finish on old firearms. This lesson was meant as a guide. *Be very careful before you start restoring the finish of any gun.* It would be a shame to begin a project only to find out that you have just ruined a valuable collector's piece. You should have a great deal of experience before you attempt a restoration job for a customer.

One way to gain experience is to buy some older guns to restore. There are many old shotguns (black powder) on the market. Many can be purchased at gun shows for less than $200.00. This will not only give you the experience, but will also provide you with a way of demonstrating the type of work that you can perform.

Finally, be sure that you know the type of material that you will be working with. Different types of metals react in different ways to the same procedures. Do not be surprised if the metal of one firearm reacts different to the same bluing operation. Most likely, the metals have a different alloy.

SELF-TEST QUESTIONS

Please check your answers on page 16.

5. **When mixing chemicals for bluing or browning formulas, should the acid be poured into the water or the water poured into the acid?**
6. ***True or False*. If the exact bluing method of an old firearm is not known, a method known to have been used during the era in which the gun was built should be used.**
7. **Should a highly-prized collector firearm be refinished if 30% of the gun's original finish remains?**
8. **Should the hot caustic bluing method be used to blue soft soldered, double-barrel shotguns?**

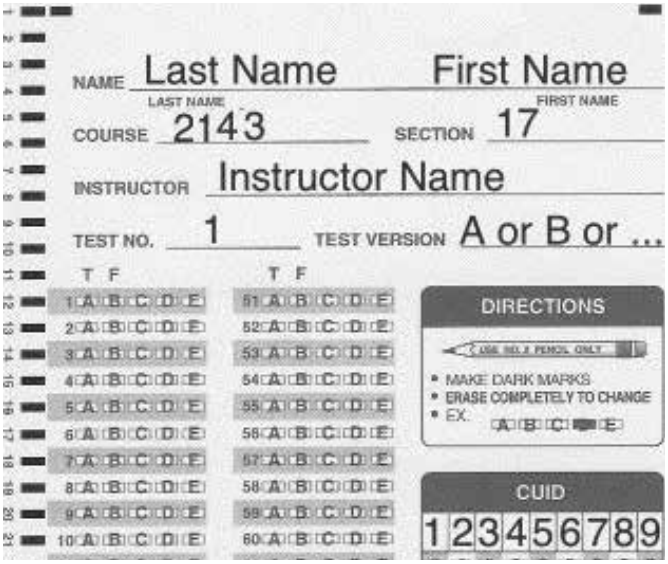
Answers to Self-Test Questions

1. False.
2. Low-carbon and low-alloyed tool steels.
3. Carbon or water-hardening tool steel.
4. 0.05 percent.
5. Always pour acid very slowly into water; not vice versa.
6. True.
7. No. Refinishing collector guns in good condition will lower their collector value.
8. No. Use either the slow rust or hot water bluing methods.

Lesson Questions

THIS IS LESSON NUMBER 2196.

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



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

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

1. **A good rule for restoring antique firearms is**
   a. Completely remove all the old finish.
   b. Buff the guns with a wire brush.
   c. Try to stop deterioration and preserve the original condition, leaving all existing parts intact.
   d. Use as many new replacement parts as possible.

2. **What term refers to how much stress a metal can withstand without breaking?**
   a. Tensile Strength.
   b. Hardness.
   c. Alloy.
   d. Duraluminum.

3. **When removing the old finish from a worn antique firearm, which of the following is the preferred method?**
   a. Power polishing.
   b. Hand-polishing.
   c. Surface grinding.
   d. A combination of power polishing and surface grinding.

4. **The bluing method used before World War II, in which gun parts to be blued were suspended on rods inside a large rotating metal container, partially filled with a special chemical is**
   a. Parkerizing.
   b. Hot rust bluing.
   c. Slow rust bluing.
   d. Carbonia bluing.

5. **When a gunsmith restores a modern working gun, what should be his or her first consideration?**
   a. Correct functioning of the firearm.
   b. The appearance of the firearm.
   c. The sights.
   d. The rifle sling.

6. **What is the bluing method used in practically all modern gun shops for bluing gun metal on modern firearms?**
   a. Hot water bluing.
   b. Slow rust bluing.
   c. Hot caustic bluing.
   d. Instant bluing.

7. **What type of steel is used for practically all tools used in gunsmithing work?**
   a. Cold rolled steel.
   b. Tool steel.
   c. Bronze.
   d. Brass.

8. **What is Bessemer steel always made from?**
   a. Copper and tin.
   b. Brass and tin.
   c. Steel scraps.
   d. Molten pig iron.

9. **Which of the following alloys acts as a deoxidizer, offsets the harmful effects of sulphur, and gives moderate increase in hardenability.**

   a. Chromium.

   b. Manganese.

   c. Cobalt.

   d. Tin.

10. **What of the following types of steel is used for cutting tools, tool bits, and the like?**

   a. Low-alloyed steel.

   b. Low-carbon steel.

   c. Low-speed steel.

   d. High-speed steel.