BROWNELLS® COLOR CASE HARDENING

READ & FOLLOW THESE

INSTRUCTIONS

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SAVE THESE INSTRUCTIONS IN YOUR BROWNELLS GUNSMITHS DATA RING BINDER

The process of adding carbon to the surface of mild steel or iron as a means of making it harder has been with us for a very long time, at least for a thousand years. Apparently the process was first used for edged weapons, but was eventually found to be useful in the fabrication of other tools and mechanical devices, including firearm locks. Just exactly when in history it was discovered that the process could also produce an attractive, colorful finish that found favor for use on the *outside* of the firearm is also not known. Suffice it to say, it was at least a couple hundred years ago, and since then, firearms of all kinds; rifles, handguns, and shotguns, high grade and low, have featured color case hardened components. Some of these components were so finished for purposes of surface hardening and wear resistance, some for purposes of cosmetics, and some for both.

The exact derivation of the term "case" seems also to have been lost to history. Some folks seem to think that it has something to do with the hard surface which "encases" the softer, inner core. Others think that the term refers to the canister, or crucible, that holds the parts during the hardening process. Regardless of the meaning of the terms, the tools and techniques to safely achieve the color are what concerns us here.

Progress in the field of metallurgy has resulted in steel alloys which are far stronger, tougher, and harder than any low carbon steel typically treated by case hardening. However, the distinctive pattern of colors produced by CCH continues to interest and intrigue firearms aficionados.

NOTES ON PROCESS/ART

Prior to issuing these "instructions", Brownells made every effort to determine a process which, when followed, would safely produce truly case hardened parts with an acceptable mottled colored appearance. Our objective was to keep it as simple as possible and attempt to weed out the "eye of newt, wing of bat" shroud of mystery that so often accompanies the myths and secrets of firearms work.

We have found that, other than the sequence of steps, which follows shortly, there is very little agreement on certain, what-would-seem-to-be-critical, aspects. For example, from our search, we have found reference of oven/furnace temperatures from 1250° to 1500° F., and heating times of from 1 to 5 hours; recommendations to highly polish all parts, and recommendations to not exceed 240 grit; bone/wood charcoal ratios from 1/1 to 1/20; quench temperatures from 45° F. to 100° F.; quenches requiring clean, soft water, and quenches containing used charcoal, potassium nitrate and whatever moss seems to grow best. In other words, you can't tell an artist how to paint, and you can't tell the artist how to color case harden. These different variations in specifications and techniques are what provide for the subtle differences and nuances of color and pattern that differentiate one person's work from another's. You can describe the motions, but the end result is left up to the "artist" and his interpretation.

The instructions that follow have worked well for the Brownells crew. We do not claim that our specifications are the latest or the best, but they have worked well for us. We believe that if you follow the same sequence and specs, you will also have success. The changes are up to you.

What Parts Can Be Color Case Hardened?

As mentioned before, the process was developed to change the outermost layer of low carbon steel to a carbon-rich, very hard, wear resistant skin. This allows the manufacturer of firearms and components to fabricate parts with easy to machine, but tough, alloys and then case harden them which provides a hard, wear-resistant surface with the softer, shock resistant inner core remaining.

Single-shot rifles, lever-action rifles, side-by-side shotguns, and single-action revolvers typically had color case hardened receivers, levers, and other high-stress fire control parts like hammers, sears, and triggers. These sort of parts make ideal candidates for re-case hardening. Newly manufactured parts made from low-carbon steels like 1018, 1020, 1022, 1117, or "no-carbon" wrought iron can also be effectively color case hardened.

DO NOT attempt to CCH "modern" receivers or other firearm components manufactured with chrome moly or any tool steel. Most tool steels are "air hardening". The "quench", or cooling step in their heat treatment involves careful regulation of surrounding air temperatures, and then a tempering or draw stage of controlled reheating to a specific temperature and another cooling. Subjecting alloys of this type to the drastic, liquid quench involved in CCH will result in making them extremely brittle and likely to fail if subjected to the pressures of firing.

WARPAGE

There is no question that parts finished by CCH are usually dimensionally different after the process than they were before. There is no way to avoid it. In fact, many of the old makers of fine shotguns utilized two separate groups of employees to fit and assemble their firearms. One group worked as "soft fitters", the other as "hard fitters". The first group fit parts and components while the parts were still in the soft state. The second used different tools and techniques to accommodate the changes that occurred after the hardening operation.

While the warpage/change is inevitable, you can minimize its effect by fabricating and installing "bracing blocks" to maintain dimension and straightness. We recommend that all receivers utilize, at a minimum, a threaded plug to fill the barrel shank hole, to keep that portion of the receiver straight and round. Regardless of the design of the particular receiver you are processing, whether lever action, falling block, pump, side by side, or single-action revolver, all breech block ways, hammer and trigger slots, cylinder windows, tangs and base pin holes, must be braced with closely fitting blocks to minimize dimensional changes. Side-plates can be attached to a thicker, more rigid, but similarly-shaped piece of steel to help maintain straightness. Spacers between the plate and the block will cause it to stand off and allow for quench circulation.

Once fabricated for a particular action, these blocks can be used over and over. Their fabrication requires reasonably sophisticated machining capability. The barrel shank plug will require a lathe in order to turn it to diameter and produce the proper thread pitch. "Dummy" breech blocks and cylinders and tang braces will require a milling machine, and close attention to matching the gun's dimensions. Dummy breech bolts need to be fabricated to fit the width of the bolt and must also vertically support any alignment slots and grooves to preclude any collapse. We recommend the larger blocks be fairly well “honeycombed” to reduce their mass and allow for faster temperature exchange, both in heating up and cooling down.

EQUIPMENT LIST

1. Oven - must be large enough to contain the crucible being used, plus provide adequate clearance for air circulation to avoid overheating of elements. Even though the recommended operating temperature is 1400° F. for CCH, it is recommended the oven have a heating capacity approaching 2000° F. to avoid overly long heatup periods. The SWEST® Extra Large Heat Treat Furnace is ideal for this sort of work.

2. Canister - can be fabricated in a variety of shapes to accommodate the oven in which they are used, or the parts to be hardened. They are typically fabricated of light steel sheets, ideally stainless steel, from 16 gauge up to 1/8" thick, either tubular, square, or rectangular, with welded bottoms and handling hardware. The height can be as short as 3" for small parts or as tall as 12". Diameters can vary from 2" to 5". The bottom should be approximately 3/16" to 1/4" thicker, and one to two inches larger in diameter than the body to make the canister steadier, and less likely to tip over. The lid should be fabricated of the same, heavier steel as the base so its weight helps hold it in place on the canister, and makes it less likely to bend or deform when it is quickly removed prior to quench. It should have a flange to fit either inside or outside of the canister to keep it from sliding off.

WARNING

The extreme heat to which the canister is subjected, along with its repeated removal from the oven, the movement to the quench sequence all contribute to its wear and tear. When steel is red hot, it is easily deformed and welds tend to separate. Canisters may have a limited life, however, straightening and repairing welds can extend that life considerably. Pay very careful attention to the condition of your canisters. If your canisters are made of regular steel, rather than stainless steel, decarburization will occur with every use, causing the metal to become thinner and thinner. At some point the thin walls will no longer be able to support the stress of normal use. The results could be catastrophic if the canister should fail when packed and heated to red hot.

3. Canister Handling Equipment - Because of the extreme heat involved, attention must be paid to the means of placing the canister into the oven and also removing it. A filled and packed canister is relatively heavy. The “handle” must be sturdy enough to support the canister and maintain it in the upright position, and long enough to avoid potential injury to the operator. It must allow the operator the means to release the canister when placing it into the oven, and also a way to attach to the canister to secure it when removing it from the oven. The system needs to be relatively simple and straightforward, because when the canister is red hot, it is very difficult to identify any flanges, hooks, or attachment devices thereon.

4. Protective Equipment and Clothing - Handling hot items requires personal protection. During the quench process, a significant amount of burning charcoal particles will erupt and may land on the operator, causing burns to skin or clothing. Keep the operator completely covered. Brownells recommends using a full face shield, a welder’s cap or similar headgear, insulated coveralls, and temperature resistant gloves. Sturdy, hard-toed shoes are also recommended in the event a canister is dropped during handling.

5. Quench Barrel and Aeration System - Use a steel or heavy plastic barrel of 30 or 55 gallon capacity. Plastic barrels have several advantages. They are light, do not rust, and their flexibility is a desirable feature when “dumping” the canister and the handling equipment makes contact with the edge of the barrel.

The quench water needs to be aerated, however, it need not be bubbling at the time of the quench. We have found that an excessive, violent bubbling quench causes scaling and a general lack of colors. You must keep air from making contact with the heated parts. Aerate the quench water vigorously for approximately one hour prior to the quench, but turn the air supply down to a point where there is only enough air entering the water to cause minor swirling, immediately before the actual quench.

The aeration system need not be very sophisticated. We have had excellent results with 1/2" copper tubing bent into a spiral pattern similar to an electric range burner element, drilled with 1/8" holes, and connected to an air compressor. The spiral portion sits on the bottom of the quench barrel while the upright portion extends along the side of the barrel, extending above the surface of the water several inches. A quick-disconnect soldered on the end completes the system.

Fabricate a “catch basket” out of coarse wire screen, chicken wire, or light, expanded, metal sheeting. Suspend it approximately 6" above the aerator so air can pass through, but the parts will be caught before they get all the way to the bottom. Rig some light wire, or chain so the basket can be retrieved with the parts in it.

6. Charcoal - The “old-timers” used charcoal from any number of sources, including leather which was salvaged from old shoes, boots, saddles, and harness. A customer of ours, who offers color case hardening in his shop, advises that he adds peach-pit charcoal which he processes himself. However, bone charcoal is readily available and seems to provide the color variations most desired in CCH finishes. Brownells has determined that combining wood charcoal with bone charcoal in ratios from “1 bone to 1 wood” to 1 bone to 5 wood” usually gives us the kind of look we consider satisfactory. PLEASE NOTE - There is absolutely no way to guarantee any particular pattern or combination of colors as a result of this process. The operator is advised to experiment with scrap and practice plates using a variety of combinations until the desired goal is achieved.

SEQUENCE OF OPERATIONS TO COLOR CASE HARDEN LOW CARBON IRON OR STEEL COMPONENTS

1. Properly prepare the surface of the parts.
2. Clean/rinse the polished parts.
3. Block or brace parts to minimize warpage.
4. Mix charcoal.
5. Pack the parts with charcoal in a canister.
6. Place the canister in a pre-heated oven.
7. Remove the canister from the oven and quench in aerated water.
8. Remove parts from quench, temper, oil, or apply protective coating.

Using these steps as our guide, we will discuss each one in order.

1. SURFACE PREPARATION - Component parts should be polished the same as any parts being prepared for refinishing.

NOTE - If the parts to be CCH were previously case hardened, it is sometimes advantageous to anneal them first. This is especially true if engraving or stamping is to be performed or refreshed, or if the hardening that remains interferes with doing a good polish job. Annealing may also somewhat lessen the tendency for flat or thin components to warp. The proper technique for annealing is as follows:

a. Pack the parts to be annealed in the case hardening canister, using only <u>wood</u> charcoal, and cover with the lid. (The wood charcoal used in the annealing process can be saved and used for color case hardening.)
b. Place in the heat treat oven, and bring to 1500° F.
c. Hold at that temperature for one hour, then turn off the heat.
d. Leave the canister in the oven until it returns to room temperature.
e. Remove the annealed parts and continue with the surface preparation.

Remove all corrosion, pits and tooling marks. Treat parts that have heavy rust first with Brownells Rust & Blue Remover or Steel White™. Polish to remove all imperfections, pitting, scratches, or tool marks. Case hardening will not cover up any imperfections. Any marks present on the surface before hardening will still be there after hardening. The degree of polish is up to the operator. Case colors will appear even on parts that are coarsely sand-blasted, however, the result is not very attractive. For firearms, a higher polish is more appropriate, but because of the nature of the high heat process to which the parts are subjected, there is a point of diminishing returns, and the operator will see little difference between 600 grit and mirror bright. A recommended level of polish is in the range of 400 to 600 grit. This is where experience and personal preference comes in. Some 'smiths polish to 400 grit, coat the part with mineral oil, and lightly brush, using a fine, .003” diameter wire wheel. It is highly recommended that the operator experiment with scrap or non-critical parts until a preferred “look” is found.

2. CLEAN - All parts to be color case hardened must be thoroughly cleaned prior to packing in the canister. Any dirt, oil, grease or polishing compound remaining on the parts will contaminate the effects of the charcoal, and will result in discoloration. We recommend that all parts be pre-cleaned, using Brownells TCE to remove all traces of lube, preservatives, and buffing compound. Then, scrub parts using Brownells d’Solve™, mixed with water in the ratio of 1 to 5, to remove all traces of contaminants.

WARNING

Do not allow polished parts to remain in d’Solve longer than a few minutes. An extended soak can result in the d’Solve attacking the bare metal resulting in a darkening and roughening of the part. Rinse with clean water. Quickly and thoroughly dry the parts or blow off water with clean, oil-free compressed air to avoid rusting. Wear cotton or surgical gloves to avoid leaving finger prints.

3. BRACING - Refer to Warpage on Page 1.

4. MIX CHARCOAL - Using a plastic measuring cup and a plastic bucket, measure bone and wood charcoal in the desired ratio, (1 part bone to 4 parts wood is a good place to begin your experimentation) and mix together using a plastic or wooden spoon. The bone charcoal offered by Brownells is significantly finer than the wood charcoal, you must mix thoroughly to avoid “pockets” of either one type or the other.

WARNING

Mixing powdered charcoals will release dust into the air. To protect against dust inhalation, always wear an OSHA approved dust mask.

5. PACK - Arrange the parts within the canister, and pack with the mixed charcoal. Allow a minimum of ½" between parts within the canister and the same distance between the parts and the bottom, and sides of the canister. Allow a minimum of 1" thickness of charcoal at the top. (The charcoal always settles to some extent during the heating, and you don't want parts exposed to the air prior to quench). Tap the sides of the canister with a small hammer as you pack in the parts in order to settle the charcoal, eliminating all air spaces and gaps. Arrange flat-shaped items so they will exit the canister and enter the quench "edge-on". If flat items hit the quench broad-side they will definitely warp. A rule of thumb is to arrange parts so the thinnest portion of the part is pointed "up", and thus is the first portion to hit the quench water. It is not necessary to compress or pound the charcoal in any way. Fill the canister to the top. Make every effort to completely fill the canister, leaving no air space. It is recommended that you choose a canister properly sized for the work you plan to put into it. If a significant amount of excess space exists above the packed in parts, use the less expensive wood charcoal to occupy that space. Place the canister lid on the canister and press it firmly into place. There is no need to seal the canister with furnace cement or clay. The parts must be packed solidly in place with no tendency to shift. Packing should be done wearing cotton gloves or dry surgical gloves so no contaminants or fingerprints are left to spot your results.

6. HEAT - Turn the oven on and set the temperature controls to the highest position. Many 'smiths will turn the oven on to preheat while the cleaning and packing steps are being performed. When the oven reaches 1400° F., place the packed canister quickly and carefully inside it. Center the canister in the available space to allow for the most consistent heating, and close and latch the door. Work quickly to limit the amount of heat escaping from the oven. Take note of the temperature. The thermometer will show a drop of several hundred degrees during this step. With the heat adjustment controls still in the "high" position, allow the temperature to rise until it again reaches 1400° F. If you are using the SWEST Extra-large Heat Treat Oven, this typically takes 15 to 30 minutes, depending on the size of the crucible, its relative temperature when it was placed inside, and what it contains. At this time, adjust the controls to "medium" setting and continue to observe the temperature registered on the thermometer. The objective is to maintain the oven as close to 1400° F. as possible. It may be necessary to make several small adjustments before the temperature steadies. Keep the changes small and do not open the door to "see how things are going". Allow the packed canister to remain in the oven for an additional 1 to 1¾ hours after it has regained 1400° F.

7. QUENCH - At the end of the heating period, carefully open the oven's door, secure the canister using appropriate handling equipment, remove the canister from the oven, remove its lid, and quickly dump the contents into the quench tank. Move as quickly as possible without sacrificing safety. Quench water temperature is another of those variables that needs to be worked out by the operator. We have successfully processed parts with water heated to 100° F., water cooled to 45° F., and water at outdoor ambient temperature. Most of our customers who do this kind of work have advised us they fill their barrel with little concern about temperature. From our experience we have concluded that a "used" water quench bath produces better colors than a fresh one that has had no parts quenched in it. Maintenance of the quench bath involves removing the bulk of the "used" charcoal that settles to the bottom of the barrel after about every two or three quenches, and topping off the water prior to starting the aeration.

WARNING

To help avoid injury always wear proper protective clothing when working with any high temperature heat source such as a heat treating furnace. Always wear high temperature protective gloves, a full-coverage leather or heavy denim apron, a long sleeve cotton or wool shirt, pull on, high top leather boots, and a full face shield along with appropriate safety glasses or goggles. Remove all flammable material from your work area and keep a fully charged fire extinguisher within reach. With regard to this process, the advice of Brownells Incorporated is general. If there is any question as to a specific application it would be best to seek out specific advice from other sources and not rely solely on the general advice and warnings given here.

7. REMOVE PARTS FROM QUENCH; TEMPER, OIL, OR ADD PROTECTIVE COATING - Remove parts from quench tank, rinse them in clean water, dry them off, and oil (Brownells Rust Preventive No. 2™ is an excellent choice for this.) If a protective finish such as clear Baking Lacquer, or Aluma-Hyde II™ is desired, do not oil, but clean with solvent like TCE and proceed with the application. We believe that critical parts, such as receivers, or other parts subject to stress, should be "drawn", or tempered, to reduce brittleness and internal stresses immediately after the quench. Many gunsmiths draw all the parts they CCH simply as a matter of course. Recommended draw temperature for low carbon steels is 300° - 350° F. for one hour. It is not recommended that you attempt to utilize your main heat treat oven for tempering. A small "toaster oven" capable of reaching 400° F. is entirely adequate; and for that matter, the kitchen range will also do the job.