All you ever wanted to know about Rifle Stock Finishing

Thanks to Roger Linger, he makes a good knife and a great friend.
A. Long
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Introduction

Making a fine rifle stock is very rewarding in many ways. I have gained a great appreciation for woods and have been able to enhance my level of patience from all the mistakes made in some previous hurried and failed attempts to bring out the beauty of their grain and figure.

The information I intend to provide is for wood stocks only however, some discussions (bedding, floating, etc.) may be applied to stocks of other material. I, though, only have experience with those of wood.

If done correctly building, finishing, refinishing a stock requires great patience. Before spending money on an expensive piece of walnut, sanding papers, tools, oils, etc., or removing that old finish please be sure you really want to do this. Those of us who have done this before know that more time and care than expected is often required to achieve the desired result. It is my belief any person with an admirable amount of patience and a real desire to turn out a beautiful stock can do so. Keep in mind though, a hurried job will show. Shortcuts tend to be the outstanding feature of such stocks. One can see some by visiting a few pawn shops.

Picture is compliments of Kevin Quinn who customized this Thompson Center in caliber .221 Remington Fireball. The wood is from Bullberry Barrel Works and Kevin did the shaping and finishing himself following the instructions found on this web site.

For me, the wood of a firearm should stand on it’s on. I place firearm craftsmanship equal to that of fine furniture and refuse to purposely compromise the natural color tones of their woods. Even sap wood found on some extra fancy specimens are part of the individuality of the piece and best displayed unaltered. I do not even like minor color changes finishing oils cause. This is an opinion of mine and why staining stocks, except for below, is not further mentioned within.

If you wish to stain, do it before the stock is sealed or after the stock is sealed deeply with only one very thin sealing coat. Do not stain after the stock is heavily sealed or the grain
has been filled. Doing so can cause inconsistency in color tone since absorptions of the
stain will be limited by the sealing/filling oil. Apply stain evenly with a lightly stain
soaked cloth. Do not paint or dab it on the wood as some parts of the wood may absorb
more than others, thereby causing inconsistency in tone. The object is too keep the stain
as shallow as possible and consistent in spread. Because wood stains are often very thin,
much wood has to be removed in order to return the stock to its natural colors. Many
stains are water based. Be sure to allow the stock to dissipate moisture before sealing and
filling its grain, otherwise the moisture will be trapped within the stock and later cause
grain to open under warm conditions.
Refinishing an Existing Stock

Refinishing an old firearm stock enables one to remove or repair damages and enhance its appearance. There is also that 'I did it' factor that makes it fun. Some firearms though just are not meant to be tampered with. I have a model 89 Marlin in .38-.40 that would be greatly devalued if I changed it. Beside that it was handed down to me and I have no desire to erase any of its history. If I really wanted to I could restock it and keep the old (unchanged) stock in a safe place.

Before I ever built my first rifle stock I had tried refinishing one first. In fact I refinshed that stock more than once. Not because it saw that much use between times but because it took that long (for me) to get it right. I think it good that I had achieved an idea of how much work would be involved before tackling a semi-inletted blank. If asked, I would advise learning on a lower value firearm before building or refinishing that prize family treasure.

Sand Paper or Chemical

All stocks I have stripped have been done the old fashioned way. Lots of sand paper, time and care in retaining the stocks' original lines and general shape. Today there are chemicals available to ease your efforts and help preserve the stocks original form. Currently, I have no experience with these for removing old gun stock finish.

I will proceed as if we are sanding to the bare wood.

Removing Stock Components

Before stripping the wood remove all action components (barrel band, barreled action, floor plate, etc.).

A grip cap, forend tip, butt plate, recoil pad, and sling studs may be part of the stock to be stripped. Remove sling studs. The pistol grip cap and recoil pad may be permanent attachments (bonded to the stock), in which case they must remain. However, most recoil pads that appear to be bonded actually are not. The recoil pad may have two tiny slots hiding screw holes. You must pull on the edges of the recoil pad to see them. Unless your stock is Mannlicher in style or has a barrel band, the forend tip, if one, is probably permanent.

Sling studs should always be removed since they prevent proper sanding where they are attached. If not made of metal or if not thinly coated, I prefer leaving the grip cap, forend tip and butt plate, including recoil pad, on the stock. This is the best way of keeping the stock lines level with the parts. If removed rounding of edges is possible. Also, the wood may end up lower than the part it mates to. I do not worry about sanding on these parts
but am careful to retain their original form and only use fine grit paper around and on them. Upon completion the stock is masked with tape where it mates with these parts. You can then carefully buff layers of oil finish off and sanding marks out with fine grit sand paper and steel wool. If these parts are of blued, anodized or plated metal or if coated plastic take them off. If they can not be removed, mask them with tape. I use masking tape, taking care to replace it as it wears. In such instances work carefully with fine grit paper around such areas so not to remove too much wood. You do not want the parts higher than the wood they mate to. Parts of solid brass such as a muzzle loader patch box can be left on and sanded as if part of the wood. This keeps the parts level with the wood. Polishing deep scratches out of metal requires a lot of elbow grease so use the finest grit paper as practical for the job.

**Removing the Old Finish**

**Using a Sanding Block**

It is most important to retain the specific shape of the wood; the lines, curves, sharp edges, etc. Except for some difficult areas such as tang area a sanding block must be used. I like rectangular gum erasers for this. I cut the paper into about 1 1/2 inch X 2 inch pieces and place it to bottom and both sides of the eraser (sanding block). The paper is held to the block by finger pressure. The use of a sanding block helps ensure unwanted dips or valleys are not cut into the wood and that sharp edges such as those found on cheek piece, butt end, top of barrel channel, etc. are not rounded. Except on small curved areas such as pistol grip and cheek piece drop using fingers alone as a sanding block will cause ripples and rounded edges on your otherwise beautiful work and the higher the finish the more it will show. For small curved areas a pliable material, such as a flat piece of rubber or a spongy material, can be used as a backing for the paper. Always, wherever permissible, use a sanding block. The choice of material and size depends on your preference and area of stock being worked.

Just a few possible sanding blocks. Wood, gum or plastic eraser, ink pen cap and even a cigarette filter can be used were applicable.
Sand Papers

I like to have on hand about 2 sheets of 120 grit, 3 of 180 grit, 4 of 220 grit, 4 of 320 grit, 6 of 400 grit and 6 of 600 grit paper for stripping and smoothing a stock. You may not need much or any of the coarser grits depending on the type of finish and damage to be removed. For shaping and finishing a semi-inletted blank you will probably need a bit more of all these grits. The grits mentioned above should be found at a local hardware store. On occasion a finer grit may be wanted. Woods of complex grain patterns usually have open and close grain. Not all of the close grain may completely fill after wet sanding. These can be filled in a different manner but still require sanding. In such cases grits of 1000 or even 1500 may be desired. I have been able to easily find these and finer grits at auto parts stores. However, I do not recommend purchasing a super fine grit unless you later decide it is needed.

The 320, 400 and 600 grit papers should be of wet-or-dry type since they will also be used to fill the wood grain during wet sanding.

I do not like to use steel wool of any grade on the wood or its finish. The fibers of steel wool find their way into open grain. It has caused me extra work more than once. Finally I have sworn off its use for all but buffing up plastic butt plates and such and then only after the final coat of finish has been applied and the stock is masked off.

Removing the Old Finish

Start out with a relatively fine grit paper - say 220 grit and use a sanding block wherever permissible. Go to the next courser size if needed. The object is to remove the finish without cutting too much wood. The finest grit that works well for you is the one you want. Work carefully around checkering borders so not to flatten the points of the diamonds. If some become damaged they can later be pointed up with an inexpensive checkering tool that can be purchased from such places as Brownells. It is important though to damage the diamonds as little as possible since pointing them also deepens them. This causes the diamonds that you point to be lower than the diamonds in the rest of the pattern. You could point up the entire pattern, and you may want to, but cutting the pattern too deep will cause it to be lower than the wood bordering it. Also, go slowly with the checkering tool. Just about the time you think it's really working well is about when it slips outside the pattern and scars the stock. I would not point any diamonds until all sanding is complete and the stock grain has been filled.

Once all finish is removed nicks, scratches and dings can be attended to. All these can be sanded out if they are not so deep as to alter the shape of the stock and if they are not in places that mate with another component (floor plate, grip cap, butt plate, etc.). Such damage can be filled with epoxy. I do not like using the fast drying ones that are bought at the local department store. I use glass bedding epoxy sold by Brownells, specifically their original Acraglas. It comes with a packet of brown dye that can be used to help match it to the stock. Just a tiny amount will make it deep brown, so experiment first. A perfect match is highly unlikely since you won't know the exact shade of wood until the
finish is applied. Another way to match the color is to mix wood dust from the stock with the epoxy. Once any exterior finish has been removed, save dust from sanding the area to be filled. Mix generously with the epoxy but do not include any dye. The flock (fiber glass) that comes with the kit is for added strength and is not used for surface repairs. I like to sand the stock smooth, removing all unwanted shallow marks, before filling deep problems with epoxy. It's really just a matter of choice I suppose and since the epoxy is so much harder than wood it may be better to apply it before sanding much wood off first. Regardless, remove the old finish before repairing the damage. Since the epoxy will soak into the grain keep it off other areas of the stock, otherwise it will have to be sanded out or these areas will be discolored. Allow the epoxy to cure before sanding. With Acraglas this will take at least 24 hours. If upon sanding the repaired area air holes appear in the epoxy two things can be done. If the hole is not too small it can be filled with more epoxy. Or, if not too large it can be filled during the wet sanding procedures to follow.

Mashed wood can be raised with a hot iron. Soak only that area with hot water and apply a hot iron. Buffer the iron from the wood with some paper. This does not work well on gauges.

After the old finish has been removed and deep damage filled it is time to smooth the stock with fine grit paper. This will remove shallow marks, scratches, etc. and prepare the stock for wet sanding. A 220 grit paper is as coarse as I would start with moving down to 320 or 400 grit for the final smoothing. Grits of 400 will be used during wet sanding, to follow. Always sand in the direction of the grain. If not, sanding marks and whiskers will show after applying finish. Sheen enhances imperfections. Watch to see how the grain runs. Highly figured woods can have grain running in various directions. It often runs one way and curls to another in different areas of the wood. This makes your job more time consuming but well worth the extra work.

Painting the stock with mineral spirits will highlight the stock by temporarily bringing out color and figure and help locate areas that need additional work. Mineral spirits will evaporate without leaving additional moisture behind. Do not allow water or water based liquids to contact the bare wood prior to sealing.

Sealing the Stock

This is what will give the wooden stock longevity and enhance reliability.

The object is to seal moisture out of the stock. We will stabilize the wood by sealing it. The more moisture in the wood the more the wood will react to temperature change causing stress on the barreled action, thereby causing precision to suffer. Of coarse sealing the wood also helps protects it from the deteriorating effects of weather. There are other sealers but tung oil or modified tung oil is the usual choice for sealing a gun stock and filling its grain. The last rifle I finished I used a product called Waterlox Original Sealer/Finish. It is a tung oil product that was recommended to me and I do like it. I was
not able to find it locally but the fine people at Waterlox quickly sent me a quart C.O.D. at my request. Brownells and Great American Gunstocks offer some other good tung oil products specifically for us.

It is important to realize that upon sealing the stock any moisture currently in it becomes locked into the wood. For this reason, I advise not applying a sealer while the ambient atmosphere is or has recently been high in humidity. Rainy days are not good here and, in fact, I would place the bare stock in a warm low humidity area for some time before applying a sealer. If too much moisture is allowed to be trapped inside the wood it could cause grain to open and disfigure the finish during periods the firearm is subjected to hot dry weather.

For me, sealing the wood is the easiest and one of the most enjoyable parts of finishing a stock. Now finally the basic color(s) and figure of the grain will be exposed. We do not have to worry about getting the sealer on smoothly or, except for non-wood parts permanently attached, wiping it off. We do want the sealer to be very thin and to apply it to all areas of exposed wood. This means that we will dilute the sealer so that it will penetrate deep into the wood and that we will apply sealer to all the stock including (if possible) areas that grip cap, butt plate, etc. attach to, barrel channel and action area and inside holes that sling studs reside. The entire stock must be sealed. Areas of glass bedding and factory bonded parts such as grip cap and forend tip are already sealed by the bonding.

Before sealing the wood you may know whether the stock is to be (glass) bedded. Although not essential because areas to be bedded are roughed before bedding, if the stock had not yet been sealed, I might elect to bed the rifle before sealing the barrel channel and action area, thereby allowing the bedding compound to soak into the grain. The rest of the stock should be sealed and filled before bedding. This keeps the excess epoxy that pushes out during the bedding process from soaking into unwanted parts of the stock thereby discoloring it. Even though it is wiped off as it is exposed it will still penetrate into the wood if no protective barrier is present. The epoxy bedding will seal the wood and no sealer should be applied to the surface of the finished bedding. Sealer contacting bedding should be wiped away. Do seal all inletting joining the bedding.

The stock should be clean of dust or whatever before applying the sealer. If you used steel wool on the stock, be sure no fibers were left behind. Those little buggers get in everything they can find. If you miss any now you'll find them after the final coat of finish has been applied.

To seal the wooden stock you will need mineral spirits, tung oil, a small container to mix the two and a small clean brush or lint free cloth. This part is easy and fun. Mix 4 parts mineral spirits to 1 part tung oil. A little more mineral spirits is not bad but more tung oil is. Seems too thin? You want it to be. Get that oil deep. You can apply another after this one dries. Replace the cap to the tung oil container soon as it thickens quickly and you will need it several times again for filling the grain. Saturate all the stock you can but only once. Do not put more on a little later but do check to see if any spots were missed.
Periodically turn the stock for gravity to help deepen penetration on all sides. Let the stock cure at ambient room temperature in a dry ventilated place for at least one full day. Two days is better. Do not allow the fresh stock to be subjected to direct sun light or try to hurry the drying process by heating it. Enjoy the beauty of the wood that the oil has begun to bring out and inspect for areas that need more work (a missed sanding mark, whatever) and correct them before applying more sealer or finish. If, after the sealer has dried, you decide to do another coat keep it diluted as described above. The wet sanding procedures that follow will also help to seal the stock; however, the deep sealer coat is essential to stabilizing the wood.

You can extend the life of your oil by putting small clean gravel into its container in order to evacuate excess air.

**Pictures and Descriptions of Sealing a Stock**

The stock was lightly sanded using sanding blocks and 400 grit paper then all dust removed. For the sealer four parts mineral spirits was mixed with one part tung oil. The tung oil used here is a product of Waterlox by the name of Waterlox Original Sealer/Finish.

First all screw holes and other small holes were saturated with the sealer. You can use a tooth pick for small areas like screw holes.

Then all inletting (patch box inlet, lock inlet, fore-tip, butt, and barrel channel) was painted well using a small brush. The sealer was allowed to soak into the wood for a couple minutes before turning the stock to seal other areas.
The stock, one side at a time, was then saturated with the sealing mixture.

The sealer is allowed to soak into wood for a couple minutes before applying sealer to other sides.

The ram rod is also painted with sealer. The ram rod came from the vendor assembled with the well polished brass ends attached with pins. Being careful not to scratch the brass ends the ram rod wood was polished smooth to 320 grit with sand paper before applying sealer.

The sealer coat helps to highlight errors. After sealer has been applied to all parts of stock and stock is no longer tacky to the touch the stock is inspected for over looked errors in shaping. Errors are noted and corrected after sealer has cured, at least 24 hours. A second sealer coat, mixed three parts mineral spirits to one part tung oil, is then applied to the entire stock and ram rod. The stock is then allowed to dry at ambient room temperature for no less than two days before wet sanding.

**Filling the Grain (Wet Sanding Method)**

Filling the grain will smooth the stock to a slippery surface. It enhances appearance and helps to weather proof. This is the step that will allow the finishing oil(s) to bring out the full beauty of the grain and its figure.

The stock will be sanded with fine grit wet-or-dry paper wetted with oil. Modified tung oil is a classic choice for gun stocks and I will proceed as if that is the oil being used, although the procedure should apply to other popular gunstock oils prescribed for filling grain. It is pretty simple to do but requires a soft touch. The object is to sand wood dust into the oil. When the oil becomes thick with wood dust sanding stops and the oily sludge is gently wiped across the grain causing the grain to be filled with its own oily dust.
We will thin the oil so it will not too much impede the sanding effect of the paper. Mix 2 parts mineral spirits with 1 part oil for use with the finest grit paper that will add sanding dust to the oil before the oil gets too tacky. It will not take much per session. About 3 tablespoons total mixture should do it but start out with more at first until you get the feel for it. It won't hurt to mix a little more mineral spirits either. Cut the paper into small squares or rectangles. One inch by two inch or two by two should do it. Have several of them ready, say about 10 or 12. Start with 400 grit wet-or-dry paper moving up to 320 grit if needed. If starting with wet-or-dry 320 grit paper go down to 400 grit after the wood is mostly filled. Be sure to have about two squares of lint free cloth on hand to wipe the sludge into the grain. I sometimes use toilet paper if nothing preferable is handy.

Wet the paper with the oil/mineral spirits mixture and sand with the grain (in the direction of grain flow) and always us a sanding block wherever possible. Be aware of how the grain flows at all parts of the stock so you never sand against it. Sand a small area at a time until the oil becomes thick with dust. With a little experience you will feel and see when the mixture is prime for wiping into the grain. Gently wipe the sludge across the grain diagonal to its direction of flow (close to opposite the direction you were sanding). To do this, I use not much more than the weight of the cloth. Done with the right touch, this will force the dust thickened oil into the grain. Do not try to wipe the oil off the stock. That will pull oil out of the grain. Continue wet sanding and filling relatively small adjacent areas until all the stock has been done. The stock will be thinly smeared with the dull oil. Let the stock cure at ambient room temperature in a dry ventilated place for at least one full day. Two days is better. Do not allow the fresh stock to be subjected to direct sun light or try to hurry the drying process by heating it. Depending on the wood, it will take several wet sanding sessions to complete the filling process and it is essential that you allow the oil to dry before wet sanding again. Otherwise uncured oil will be lifted out of the grain. Some walnut may take 6 or more attempts to get all grain level. Sanding too forcefully can open new grain making it more difficult to fill the stock.

After each wet sanding and the stock is fairly dry inspect it under various light conditions to see how well the grain is filling. Check it from different angles in both dim and bright light. You will notice that the grain appears more filled before the oil dries and that the oil seems to collapse onto itself as it dries. This will lesson with each successive wet sanding.

Some grain, especially on highly figured wood, may not fill completely. If some grain just won't completely close you can try something else. Use a sharp pointed tooth pick, or something else that is not harder than the wood, tipped with a very small amount of undiluted tung oil to fill tiny openings in the grain. Let dry then polish smooth with a rubbing compound or 600 grit to 1200 grit paper. If a cluster of grain won't fill you can wet sand it separately but sometimes this opens some grain at the outskirts of were you sand. Another way that has worked for me is to wet sand another piece of the same type wood (walnut, whatever); wipe up the sludge and transfer it to the area to be filled.
Keep the stock out of direct sun light and heat above ambient room temperature between coats and after the final coat until the stock has completely cured (several weeks).

When the stock is filled and completely dry (no less than two full days to dry and longer is better) it should be polished smooth to the surface of the wood using a medium to fine grade polish such as Brownells Original or Triple "F" Stock Rubbing Compound. After the stock has been polished smooth and to the wood inspect it for defects. If no defects are found rub the stock down well with a finer polish such as Five "F" Stock Rubbing Compound to enhance sheen. Clean out any checkering patterns with a checkering tool. Brush them clean of dust and lightly coat the patterns only with diluted tung oil. At this point you have a 'classic' hand rubbed tung oil finish with all the oil inside the wood and none on top of the wood.

Unless you want an exterior finish above the wood, your stock is finished and ready for assembly or glass bedding.

**Pictures and Descriptions of Wet Sanding a Rifle Stock**

Although not pictured below, the ram rod is also wet sanded in the same manner as the stock.

**Dipping wet-or-dry paper into tung oil.**

**Wet sanding with 320 grit wet-or-dry paper and sanding block**
Wet sanding area of flute with 320 grit wet-or-dry paper but without sanding block.

After wet sanding a small portion of stock. Notice the sludge made by tung oil mixed with wood dust.

The dust laden oil is gently wiped into the grain by very lightly dragging a soft cloth diagonal to grain flow.
After the complete stock has been wet sanded sludge is cleaned from areas inside inletting.

The stock is set aside and allowed to dry at ambient room temperature for no less than two full days before wet sanding it again.

**Finishes**

**Surface Finish**

Applying finish to the outside of the wood is not necessary but can increase sheen, depth and add some extra protection to the wood surface. It is much easier to remove future damage without a surface finish since all such finish will have to be removed in order to sand out scratches and dings. With only a classic 'in the wood' finish (the kind you have now if you've gotten this far) all you have to do is refill the grain where the repair was made. If you want a surface finish the stock should be sealed and the grain filled before proceeding. Do not apply surface finish to the barrel channel, action area or places other components attach to.

There are different oils, and finishes other than oil, to choose from. The most commonly used on gun stocks seem to be modified linseed oil (lin-speed), tru-oil (has some linseed
in it), tung oil and products containing oils and polyurethane. Some are sprayed on, others are hand rubbed.

If you are one of those that can spray paint without causing even the tiniest run a spray on finish should turn out great for you. You can build the coats up pretty thick giving a deep polyurethane finish. The usual method for non-factory and custom stock makers is hand rubbing the finish on. Regardless of the method chosen, first check closely for any overlooked sanding marks or unfilled grain before applying finish on top of the wood. The wood will not be accessible once you begin and all surface finish will have to be removed in order to correct any missed imperfections.

If you spray the finish on be careful not to allow dust or lint to contact the stock during or after applying finish. You will not be able to remove them wet without leaving a mark behind. The stock must be completely clean of anything foreign that will be trapped inside the finish. The higher the gloss the more fibers, dust, whatever will stand out. The only way I know of to get them out is to take the stock down to the wood surface and start over. You should already know how to properly spray a finish if this is what you want to do. Other than to remind you that the last coat should be dry before the next is applied and the number of coats is whatever your heart desires, I will move on to hand rubbed finishing.

**Hand Rubbed Oil Finish**

*Hand rubbed modified tung oil finish. No surface finish applied*

Here you will not have to concern yourself about dust embedding into the finish. Each coat will be applied so thin that anything foreign will be wiped off. However, start with a clean stock and be just as sure as before to allow at least one full day (two days is better) for drying before applying a proceeding coat. You will begin to notice a visible increase in gloss after about the third coat. The number of coats is up to you and how long your wife (mine is good for about seven coats) will tolerate having your nose stuck in that piece of wood.

You can continue with tung oil here if you like. Tru-oil and lin-speed (brand names) will give higher sheen and is more commonly used for surface finishing and accessible at about any gun store. As before, the oil will be diluted with mineral spirits and you will need a couple large lint free squares of clean soft cloth. Very little oil/mineral spirits mixture is needed per coat. About 2 tablespoons total mixture should be more than enough to work with. Since the oil that gets into the cloth stiffens when dry, they will
eventually need to be replaced. If you can find them, cotton baby diapers are great for this kind of work or sneak out some soft cotton hand towels. Stay with the same oil you choose to surface finish with. If you start with tru-oil or whatever stay with tru-oil or whatever. It is okay that our sealer and filler coats are of tung oil.

Wipe the stock clean of dust. Mix 1 part or a bit more mineral spirits to 1 part oil. You do not want the oil thick. If thick it will get tacky too quickly and not spread evenly. With fingers I apply a small amount to a starting point on the stock. I start at the forend tip on one side of the stock and smear the oil down toward the pistol grip area. When the oil will not not spread any further I wipe it with the cloth in the direction of grain flow . I act as though I am wiping all the oil off but a very thin coat of oil is left behind. Do not be afraid to wipe well and you need to. You want no high spots in the finish and you want all finish to blend together. That is why we want each coat to be very thin. It takes me about four dips worth of the fingers to coat one side from fore-tip to pistol grip. While the oil can be rubbed on in any direction, even circular, it is imperative that the stock be wiped with the grain . Keep working at a comfortable but uninterrupted and steady pace. Do not jump from one part of the stock to another. Rather, keep the work connected. Do not stop until all the stock is coated and wiped down. If spots are missed they can be wetted and wiped dry if not much time has elapsed. After you have finished wipe the stock down again and always in the direction of grain flow. It takes me about a half hour each time I do this, not counting cleanup time. Be sure this time will not be interrupted.

Put no less than four coats on the stock. Keep it out of direct sun light and heat above ambient room temperature between coats and after the final coat until the stock has completely cured (several weeks). On the next to last coat you may want to polish the finish with a super fine polish such as Brownells Five "F" Stock Rubbing Compound. This will smooth the finish. If you have applied quite a few coats, say seven or more, you may lightly polish with Three "F" compound followed by Five "F". Do not polish the final coat as that will dull its gloss. If there are any checkering patterns clean them out with a checkering tool. Brush them clean of dust and apply diluted tung oil to the patterns only. Let dry then apply one diluted coat of finishing oil to the patterns only.

After the final coat has dried the stock is ready for assembly or glass bedding.

**Detailed Pictures and Descriptions of a Hand Rubbed Finish**

Before applying any surface finish all inletting was scraped to remove polishing residue and dried tung oil that was used during wet sanding. The brass parts were then checked for proper fit. The inletting will be scraped again after all surface coats have been applied and dry.
Using a file and sand paper, a scraper was fashioned from a beer can tab.

Permalyn purchased from Brownells was chosen as the finish to use on the surface of the stock and ram rod.
About one teaspoon of Permalyn was mixed with an equal amount of mineral spirits. This thinned the oil so it would not dry too quickly while applying it and rubbing it on stock.

Applying finish/mineral spirits mixture to a section of stock.

Wiping excess off with soft cotton cloth. All rubbing is done in the direction of grain flow.

One side of the butt section was lightly smeared with the Permalyn mixture and wiped dry with a clean soft cloth and then the other side. The procedure was likewise repeated up the stock until all the stock had been done. Then finish was likewise applied to the ram rod. All wiping of the finish was done in the direction of grain flow and before the finish was allowed to become tacky. Although some finish gets into inletting, no finish was purposely applied to areas of inletting and any that remains will be scraped away before completion of rifle.

The stock and ram rod was softly wiped and rubbed with the cloth in such a manner as to remove the finishing oil. Left behind was an even and microscopic film of finishing oil on the surface of the stock. Addition coats will be applied until the desired depth and sheen is achieved. The end result will be a stronger, more resistant finish and more evenly applied finish than a few heavy coats of finish.

Before setting the stock aside to dry it was inspected for missed areas such as tiny spots that excess finish could hide and cause runs or build up, such as where the cheek piece tapers to the face of stock. All inletting was also checked for pools of finishing oil that could run out onto the stock while the stock was set to dry.

Each coat of finish is allowed to dry for one full day at ambient room temperature before applying the next coat.
A total of eleven surface coats of Permalyn mixed 1 to 1 with mineral spirits were applied to the stock and ram rod. After the final coat had dried the stock and ram rod were lightly polished using a small square of cotton cloth and Brownells Five F stock rubbing compound. The stock and ram rod were polished in the direction of grain flow. Polishing was done to remove any microscopic ripples caused by applying by hand the numerous coats of finish. Sheen rose substantially as a result of polishing. Polishing the stock with Five F compound took about 1 hour 15 minutes. Shown above are the results.

A final, twelfth, coat of surface finish was then applied to the stock and ram rod but not polished.

One full day after applying the final coat of surface finish excess finish that had gotten into the inletting was carefully scraped away. Any bare wood left from scraping was lightly coated with one part tung oil mixed with three parts mineral spirits. One day later the rifle was assembled.
Making a Custom Stock

This section presumes you will be finishing a semi-inletted stock. These stocks come in various degrees of completion, usually advertised as 80% or 90% shaped. They are very rough compared to what you want the finished stock to be. There will probably be a lot of excess wood to remove on most of the stock and perhaps not very much in some areas. The stock will be inletted to accept the barreled action you requested it for. The inletting will be good at the action area but will require wood removal to fit the action and then more removal to relieve stress on the action. There is a good chance that you will have to fashion the bolt drop, as some come with very little wood cut for that. Inletting of the barrel channel will probably be quite undersized with you having to cut most all of it. However, the channel will be centered with the action making it not difficult to fit the barrel properly leaving equal wood on both sides of forearm. The butt end of the stock will almost always not have to be shortened. The forearm tip may well have to be shortened. If their is a bonded tip cap (rosewood, etc.) it may need to be shortened. It is best not to shorten stock until barrel channel is fully fashioned since over widening can occur at tip during channel enlargement.

Because the stock will be shuffled around a lot during the inletting process, likely causing it to hit something while it is moved side to side, up and down and all around, I suggest inletting the barreled action first. If you want to float the barrel I suggest doing so before removing much wood from the forearm You may need extra wood there because of the widened channel. Floating the action can wait since that does not require the degree of removal as does the barrel.

Glass bedding and Pillar bedding can be performed at any stage after the stock is completely inletted.

Inletting a Rifle Stock

Here is described inletting of a semi-inletted stock for an average bolt action design. Some rifles require additional inletting not described below. Following these procedures should equip you for other inletting tasks.
You will need sand papers, sanding block(s), a small assortment of files, perhaps a small wood chisel, the barreled action and the semi-inleted stock. Having some inleting black may help. It can be found at such outlets as Brownells. A dremel tool may be helpful at certain spots if used with great care and at slow speed. Remove the bolt, trigger guard and magazine. Along with action bolts, set these parts aside. They will not be needed for some time.

The first objective is to get the action to fit far enough into the inletting for the barrel to contact and lay centered upon the barrel channel. At that point the barrel and action inletting can slowly be worked alternating between the two until the action appears that it would fully seat if the barrel could drop far enough into its channel. There can be some friction but do not force action into inletting as that may crack the thin walls of the side wood. Later all friction must be removed for the rifle to shoot with precision. If the barrel is not centered on the channel use inleting black to locate and remove wood stress points at the action. Do not fashion barrel channel until action is true with channel, otherwise barrel will run off center of stock.

**Action**

Study the current extent of inletting at the action area well before removing any wood. Chances are you will have to remove at least a little from all sides and a bit more in some areas. Remove small amounts of wood at a time equally from all sides and check fit until the bottom of action begins to fit into the stock. Once you get this far inleting black can help identify wood that needs removal. Use the black very sparingly applying it only to parts of action that, so far, will fit into the stock.

Use a sanding block on the side walls of action inletting and keep it flat against them. Do likewise with any filing you may have to do. This will prevent the top of the walls from becoming too thin or rounded. It is important to keep it crisp because at this area of stock very little wood can be removed for correction and if rounded or too thin it will show as a sloppy fit.

Bed wood may well have to be lowered in order for action to seat far enough into inlet. Judge this by how far the barrel is allowed to drop into barrel channel. The barrel should be allowed to drop to or close to its diameter (half way). Though, it is equally important that the barrel not be allowed to drop past its diameter (more than half way). You will not know if bed wood will have to be shaved from action inletting until barrel channel inletting is far enough along. If it becomes necessary a small wood chisel should be used, removing very little wood before checking fit.
Keep flat of stock top sharp where it drops into barrel and action inletting.

**Barrel Channel**

If a forend tip is to be installed it is best to do it before inletting the barrel channel.

Once the action is inletted to the extent that when installed the barrel rests centered on the groove of barrel channel, the channel can be enlarged. Find something cylindrical to use as a sanding form (I hesitate to call it a sanding block since it is round). I have used ink pens. A short piece of steel rod found at hardware stores is great. What ever it is it must be smaller in diameter, including sand paper, than the barrel is at fore-end tip. If it is, with paper attached, as large in diameter as barrel you will get rounded edges that can not be corrected because of the large gap that would be left between barrel and top of stock.

As explained above, fashion your channel such that the barrel will seat halfway, and no more, into stock when rifle is assembled. Slightly less is permissible. More than half will cause a large gap between wood and metal since the stock will be above barrel axis. Also, glass bedding will wrap around barrel diameter and seize it to stock. To a small extent, and it depends upon the amount of wood your stock can sacrifice, such problem can be resolved by working excess wood down to midpoint of barrel and action. In such case watch that forearm remains functionally massive enough for comfortable shooting control and that tang is not dropped so far as to cause thinning in wrist area of stock.
Start out with about a 120 grit paper, courser if needed. Cut a square to wrap around the sanding form. Sand the groove with the cylindrical sanding form laying upon it. Periodically fit the barrel to check your work. If the barrel has a taper, such as sporter rifles do and bench rifles may not, you will have to widen the groove to match the contour. Applying downward side pressure as you sand will do that. Take care to match the contour of the barrel as you sand. To help prevent unwanted rounding of edges, cut the channel deep enough to allow side pressure without cutting too high on the channel. When deep enough that a sanding block, such as a gum eraser, can be used do so to finish the contour without rounding its edge. Be careful not to cut too deeply at for-end tip as that will show as a nonuniform gap.

Inletting for the recoil lug will probably already be deep enough. With inletting black applied to bottom of recoil lug, check to see if lug bottoms out. If so, careful use of a dremel tool set to slow speed can be used to remove very little wood at a time until lug clears the bottom of inletting. If you know you will not be glass bedding the stock, care should be taken not to remove wood from back of recoil lug inletting. This is the flat closest to butt end of stock, the surface which transfers recoil to the shoulder and helps to keep rifle consistent in position relative to its anchor points at the stock.

When finished inletting, the barreled action should drop into the stock with no wood causing it stress and no high spots in barrel channel, recoil lug recess, or action area.

**Floor Plate/Trigger Guard**

Trigger guard inletting will most likely also be undersized. The lines will be correct, or close, so that all that is needed is to enlarge the inletting. This is done with sand paper. The original inletting will be centered with stock bottom and action inletting so take care to remove equal amounts of wood from opposite sides. Wood can be removed at front of receiver bolt hole and at rear of tang bolt hole with a slow speed dremel and sanding wheel. Remove minute amounts and check for a glove fit. As always, keep edges sharp.

If there is no floor plate, the wood bedding of the trigger guard can be shallowed with a small wood chisel until action and trigger guard can be properly assembled. If there is a floor plate the assembly may not seat fully into inletting until the outside is shaped. This is because the hinged plate may be wider than the magazine inletting. Keeping the plate opened or removed will allow you to complete inletting before shaping the stock.

Deepen wood bedding enough to allow full threading of guard bolts when rifle is assembled. Do not allow threads of bolt to extend into receiver or through the tang. Doing so can cause bolt damage and danger. If too much bed wood is removed the guard will have to be raised with glass bedding before shaping the stock. Often check for proper assembly as you deepen the bedding.

**Bolt Handle Recess**

When finished, inletting will follow contour of bolt handle in width and depth. It will be deep at top and converge with stock face as dropped bolt handle extends out of the wood.
If the machined stock came with any inletting at bolt recess, widen it a little at a time until handle begins to snugly drop into it. If there is no inletting use a sharp pencil to mark were handle contacts top of stock and start the cut inside the marks, keeping the initial groove narrow. Deepen and widen very small amounts of inletting at a time, slowly working down the stock face with small flat files for sides, which will be flat and sharp, and sanding block for bottom. Often check fit with rifle assembled (guard bolts installed). Keep the fit snug until bolt will lock into the closed position. If the bolt handle is round (most are) at the point it exits the inletting, terminate the inletting with a curve (inletted area closest to bolt knob).

The lines of inletting should follow the lines of the bolt handle. Once bolt will close, remove small amounts of wood until bolt handle no longer touches wood on sides or bottom when dropped into closed position. This will prevent stress on the bolt handle which could stress the bolt, bolt face, cartridge and action, causing precision to suffer. It takes very little clearance to achieve this with reliability, so leave no obvious and unsightly gaps as you relieve the bolt handle. Finish sand to 400 grit.

**Ejection Port**

This step can be performed anytime after inletting is complete but does not have to wait until glass or pillar bedding has been performed. The stock should be fully inletted and completely assembled, guard bolts installed but minus the bolt. With a sharp pencil outline the ejection cut out onto the receiver side of the wood. The stock came cut for this but no doubt undersized.

Disassemble rifle. Use small files, round for corners if corners are round and flat for the bottom and sides. Uniformly cut to inside of pencil marks. Reassemble rifle minus the bolt. Mask all metal close to work with tape so as not to scar. Cut sides of port 90 degrees, perpendicular with receiver. Cut the bottom to match the angle of receiver rail. An example is the model 700 slopes slightly downward, as shown above. The slope at bottom should taper through the two corners, not before corners, and become 90 degrees of stock face for the two sides. When not much wood is needed to remove, disassemble rifle and remove masking tape from receiver. Remove only small amounts of wood with sanding block only, periodically reassembling to check. The dimension and angles of port should match that of the receiver. Finish sand to 400 grit.
Floating the Barrel

Unless the rifle is used for short range shooting, as hunting deer in the woods of West Virginia where shots over 50 yards are unusual, I suggest floating the barrel and relieving the action. This is especially true for wooden rifle stocks but can also be justified for synthetics, as neither are completely stable under varying conditions.

The barrel channel and action area should be sufficiently larger than the running diameter of the barrel and action to not allow stock moisture or resident chemicals to cause the stock to warp enough to stress the barreled action under any shooting condition.

The following procedure specifies the absolute minimum clearance between barrel and channel. You can increase the specified barrel channel clearance to about 0.07 inch, just slightly greater than 1/16 th inch, if you like.
Floating and properly bedding a rifle pays off when needed. I held high on this turkey aiming at center of neck expecting bullet to drop into heart/lung area. I misjudged distance and hit the turkey where I aimed - 63 yards. Don't ask me to do it again.

Floating the barreled action involves relieving all stress points and potential stress points to all metal parts of the firearm. The barrel will have no less than 0.05 inch clearance of stock and greater, up to about 0.07 inch, is better. The action, bolt handle and trigger assembly will have approximately 0.02 inch clearance. The magazine should have a bit more, say 0.03 inch but can be greater, since it is capable of movement non-relative to action. At a minimum a short section from front of magazine box to just past recoil lug will be glass bedded. Pillar bedding is recommended for all wooden stock rifles subject to anything more than short range shooting.

If you are working with a semi-inletted stock complete action and trigger guard inletting before floating the barrel. It may also be wise to not fashion the exterior of forearm until barrel channel has been widened. This will ensure plenty of wood for forearm is left.

Find something cylindrical to use as a sanding form. Including sand paper, it must be less in diameter than the barrel is at forend tip. If too large it may cut the top of barrel channel back too far leaving an unsightly gap. You will also need a small sanding block. A gum eraser should work well. Use the finest grit paper practical working down to finer grits as the work progresses.

Find some good plastic adhesive tape. Electrical or plumbers tape will do. If you do not know the thickness of the tape, cut small lengths. Stack a few together and measure thickness with a caliper or micrometer until you find the number of layers needed to achieve 0.05 inch thickness. Cut one short piece of tape. Wrap it around barrel about one inch forward of forend tip. Remove barreled action from rifle stock. Set magazine, bolt, guard bolts and trigger guard aside. They will not be needed for some time. We will tape the bottom half of the barrel circumference to increase its horizontal diameter by 0.05 inch. On the bottom of barrel run one piece of tape from front of recoil lug to the tape band you applied just forward of forend tip. If the tape is not wide enough to cover half the circumference of the barrel another strip or two will have to be run adjacent to it. Uniformly add layers of tape until 0.05 inch has been added to barrel from front of recoil lug to forend tip. The tape should conform to the contour of the barrel. The barrel channel will be expanded to allow taped barrel to seat in stock, at which time the channel will be 0.05 inch deeper at all points than before.

Using the cylindrical sanding form deepen the barrel channel bottom and sides without allowing sand paper to touch the tops of channel. Use the small sanding block for expanding the tops of channel and take care to retain its original contour. Angle the sanding block slightly into the channel as you run it the length of channel. This will help keep the drop into channel sharp and crisp. Periodically check fit with barreled action. Check fit more often as more wood is removed. Wood lose seems to occur more easily at forend tip so take it slow at that area or an unsightly gap will occur. The gaps can be greater than 0.05 inch in areas of the channel that will not be seen and it may help
precision. Do not allow gaps that will be seen to be non-uniform in width. When barreled action will seat without friction remove tape. With rifle assembled check appearance. Disassemble and touch up wood that does not conform to contour.

Using the sanding block sand action inlet until you can slip a paper business card between stock and action from front of receiver to tang. Do not remove wood from bedding of action (where guard bolts attach). That should be done during the glass bedding procedure. Likewise remove wood around areas of magazine and trigger assembly. Remove just enough wood around trigger guard/floor plate inlet so that with one piece of electrical tape wrapped tightly around trigger guard the guard will fit snugly into inlet. Do not remove wood from trigger guard bedding (that which it fastens against when assembled). With rifle assembled apply a very thin even coat of inletting black to bolt handle. Close bolt to check for handle touching wood. If so remove high spots until handle touches no wood when dropped into closed position.

When finished seal the sanded areas or glass bed the stock before sealing. It is advisable to glass a short area from front of receiver to just past recoil lug. This will relieve the action from supporting the barrel.

**Bedding the Stock**

**Glass Bedding**

There are two goals to strive for through bedding a rifle. They are to eliminate possible stress to barrel, bolt and action and to ensure movement relative to its anchor points on stock is minimized during ignition. If the action does not return to the same position on the bedding after ignition it can not be relied upon to shot with consistent precision or accuracy.

The barreled action part of the stock can be glassed in one step. After that bedding has cured the trigger guard should be glassed.

When finished only metal from the front of magazine inlet to a short distance forward of recoil lug, the back of recoil lug, the tang, and the trigger guard where guard bolts pass through will contact the glass bedding. The rest of the rifle should hang in air.

*Top View of Stock*
With course sand paper, rough the inletting from front of magazine inlet to about 2 1/2 inches forward of recoil lug. With rifle assembled lightly trace the outside of tang. Disassemble and carefully rough where the rifle tang only rests on the stock. Use a finer grit paper here since this area is small. Do not rough the wood bedding of trigger guard yet.

Here are suggestions as to how far to glass bed the barrel channel. Regardless of what is written be sure the bedding covers the center of gravity of the complete barreled action. Take the barreled action and balance it. The point of balance is the minimum extent of bedding: If your barrel is a feather weight (lighter than the normal sporter weight) you can stop the bedding about 1 to 1 1/4 inch forward of the recoil lug. If a sporter barrel make it 1 1/4 to 1 1/2 inch. If a bench rest barrel (commonly called bull barrel) make it 2 1/4 to 2 1/2 inches. If a lot larger than that forget this section entirely and learn how to install a barrel bedding block. The goal in bedding this area is to relieve the action of stress caused by barrel leverage at the breech threads. When finished the rest of barrel should touch nothing.

Recoil lug inletting will be glass bedded. Glass bedding the area between the recoil lug and wood bedding will help eliminate longitudinal travel of the barrel from the effects of ignition. Check that the recoil lug is not wider at the bottom than top. If lug is thinner at top than bottom or if lug slants back toward receiver epoxy bedding will lock it into place making it impossible to disassemble rifle without causing damage.

The back of recoil lug (the flat surface of lug closest to the receiver) should fit flush against the glass bedding. The sides, bottom and front should have clearance between it and bedding. Find some good plastic adhesive tape. Electrical tape will do. If you do not know the thickness of the tape, cut a couple small lengths. Stack two together and measure thickness with a micrometer until you find the number of layers needed to achieve 0.01 inch thickness. Tape the sides, front and bottom of recoil lug to 0.01 inch clearance. Do not tape the back of recoil lug.

Modeling clay may be found locally. If not it can be purchased from such places as Brownells. Use a small amount of modeling clay to make a dam where the epoxy bedding is to stop in the barrel channel. Dam the front and sides of magazine inletting to keep epoxy from squeezing into it. Do the same at inletting adjoining the area of tang. Slowly place barreled action in stock pressing it into place. Remove and check modeling clay. Refashion the clay as needed and repeat until satisfied. Be sure that the barrel still recedes half way into barrel channel. Keep the edges of dam face flat so that you will have a neat looking job when done.

Remove all protective oils from the barreled action, trigger guard, guard bolts, magazine, and trigger assembly. Set the bolt aside. It will not be needed for at least 15 days.

Release agent should have come with the bedding kit. I use Brownells Original Glass Bedding kits. Coat the entire action, the inside of receiver, entire trigger assembly, tang,
trigger guard, guard bolts, the back of recoil lug, the tape that was applied to recoil lug, magazine, and twice the length of barrel that is subject to bedding with release agent. If there is a magazine box attach it to the action and lightly coat where it attaches with release agent. Set parts aside to cure at ambient room temperature for a couple hours. After which a second coats needs to be applied. Let second coat cure for at least three more hours before proceeding. You can wait longer if you like but do not shortcut the release agent drying time. Take care that the film left by the cured release agent does not get mashed or scared. Epoxy will find its way into even a pin hole.

Tape exterior sides of stock from top to bottom where excess epoxy could contact when barreled action is fitted. Do not tape the top ridge of barrel channel. Place stock right side up in padded vise. Check with level to make it horizontal to ground. Cover table, floor, etc. to catch excess epoxy that may drop onto it. Have a rag soaked in vinegar handy to clean epoxy off your hands and stock. Keep vinegar bottle close by and some extra rags or some paper towels. If using paper towels have about 20 or so separated and close by. In wiping stock do not allow vinegar to touch any metal parts. It will corrode the metal. It will also destroy the release agent and compromise the epoxy. So keep vinegar away from the top of stock while cleaning off excess epoxy that has squeezed out. Otherwise it will seep into barrel channel and destroy release agent causing epoxy to bond to steel and also cause corrosion to develop.

In mixing the epoxy bedding compound add aggregates that may have been supplied with the kit (floc, steel or aluminum dust, etc). Add them according to the vendor's instructions. This will increase strength and stiffness of the bedding, much like gravel does for concrete.

Mix bedding compound according to the vendor's instructions. Apply enough compound to recoil lug inlet to fill it completely when lug is fitted. Apply compound from dam at front of magazine to dam forward of recoil lug. Apply a small amount to area of tang. Fit barreled action into stock. Without turning stock, fit trigger guard into place and assemble rifle with guard bolts snug but not as tight as you normally would. Quickly and carefully wipe excess epoxy off of stock without getting it on clean areas of stock or metal. It is almost impossible not to get it smeared somewhere else as you do this but it will all wipe clean if you work without interruption. Make sure barrel is fully seated (approximately half in channel but no more and consistent in depth its full length). Remove tape applied to stock and clean off any epoxy from stock it may have hidden. In good light check stock carefully to be sure no epoxy remains. Check all of stock including areas you thought not touched. If epoxy has found its way into checkering use Q-TIPS soaked with vinegar to wash it clean. Vinegar will cut uncured epoxy. It will also, as mentioned above, destroy cured release agent if it is allowed to contact it.

Wait 2 hours. Back guard bolts off 1/2 turn only. This will prevent them from seizing. Do not re-tighten guard bolts.
Twenty four hours after bedding remove from padded vise. Do not yet remove barreled action from stock or fire rifle. Store assembled rifle at ambient room temperature for 4 more days at which time, with some careful labor, rifle can be disassembled.

After bedding has cured disassemble rifle. It may well be necessary to tap barrel just forward of forend with a rubber mullet to break barrel and action loose. Do not tap high on barrel (close to muzzle). Remove all modeling clay and wipe clean. Remove plastic film of release agent from bedding and metal. Remove epoxy that may have found its way into the magazine or trigger assembly inletting with small files and sand paper. Take care not to score surface of bedding while cleaning the job up.

Remove 1/8 inch wood from trigger guard bedding (the points the guard bolts pass through). Use modeling clay to dam the magazine and trigger assembly inletting. As described above, protect trigger guard, guard bolts, action, inside of receiver, a generous portion of the barrel, and trigger assembly with release agent and apply bedding compound to trigger guard bedding points and assemble rifle. NOTE: Remember that 1/8 inch wood was removed decreasing the spacing between guard and action. So, do not thread guard bolts deeper than before. This will push bedding compound away from bed points and cause threads to enter receiver interior and to exit tang. The goal is to replace the 1/8 inch removed with 1/8 inch of glass bedding. If the rifle has a magazine box (such as the model 700 does) assemble rifle with magazine box installed. This will keep spacing between guard and action proper. Be sure the magazine was protected with release agent.

This time the rifle will be right side down and do not back guard bolts off after two hours. Observe the same curing period, 5 days total before disassembly.

After bedding has cured disassemble rifle. Remove all modeling clay and wipe clean. Remove plastic film of release agent from all bedding and metal. With fine grit paper, remove any film left on wood by modeling clay and seal those areas of wood left open to weather. Seal all exposed wood but do not get any sealer on bedding. Allow sealer to dry 2 days before assembling rifle.

**Do not fire rifle until at least 10 days have elapsed from final bedding.**
Pillar Bedding

This section has not yet been fully developed. In the mean time Pillar bedding by Darrel Holland and Installing Bedding Pillars by Mark Hendricks are excellent.

Barrel Bedding Block Method

Barrel bedding blocks come in shapes that suit the builder. They can be rectangular, cylindrical, polygon and combinations. The intent is to surround the barrel with a metal (normally steel but can be aluminum) of a certain length and stiffness depending on the rifle to be used on. They are normally clamped or bonded to the barrel. Regardless of shape they are referred to as 'barrel bedding blocks'.

The barrel bedding block allows all the rifle to float; the action, magazine, trigger assembly and barrel hang in air. The only contact the rifle has with the stock is the block that surrounds part of the barrel. This method of bedding is normally found on rifles used for very long range shooting. Aside from the advantage just described it enhances rifle precision by increasing barrel stiffness by effectively increasing part of the barrel diameter and by relieving the barrel of supporting much of its own weight, though that part of barrel rear of block does support the weight of the receiver, magazine, bolt and trigger assembly.

Here will be described the procedure used to bed a Ruger 10/22 LR using the barrel bedding block method. Hopefully, the end result will be very tight groups to at least 100 yards. The theory used is the same as for custom large bolt action rifles (those this method is, so far, usually found on) but a lighter, shorter block can be used than otherwise suggested because of the relative lightness of the Ruger 10/22. In fact, I intend to offer these 10/22 blocks through this web site.
To do this a semi-inletted stock with wide forend wood was obtained to accommodate the extra width of the steel block that will surround the Green Mountain 0.92 inch diameter barrel chosen for the project. The stock, a wild cat design in walnut laminate, was purchased from Elk Ridge Unfinished Stocks and the extra forend wood was specified upon order. Also specified was that the normal retainer screw hole not be drilled.

For the block a piece of stainless steel rod 1 1/4 inch diameter by 5 inches long was drilled 15/16 inch for the 0.92 inch rifle barrel to pass thru. The block was then drilled and taped for the two 1/4 by 28 retainer screws that will be used to attach the rifle to the stock. Then the block was polished on a lathe to 320 grit. A fine 28 pitch thread was chosen because of the rather thin (5/32 inch) block wall. The large 1/4 inch diameter retainer screw was chosen because the block supports the entire barreled action. The block will be epoxied to the barrel using glass bedding compound mixed with steel dust. Metal pillars will be epoxied to the wooden walls of the retainer screw holes and the block will rest on a bed of epoxy mixed with steel dust and the top of the metal pillars. No part of the rifle shall contact stock wood.

Left- 1 1/4 inch by 5 inch stainless steel

Right - after hollowing to 15/16 inch, drilled and taped for 1/4 by 28 retainer screws and polished to 320 grit. After squaring the faces the block is 4 15/16 inches long. The screw holes are 5/8 inch center from block face.
The back end of block was positioned as close to receiver as would still allow removal of barrel retainer screws. The position of the front and back of block was then marked on the barrel with a pencil so that the stock could be inletted to properly accept the block.

The spacing from front face of receiver to back face of block is 2 3/8 inch. In this position the 4 15/16 inch block more than covers the barreled action center of gravity with or without the scope attached.

Wood scrapers and sanding block with 80 grit paper were used to fashion barrel channel, action inlet and channel for barrel bedding block.

The block channel is deepened enough that the block does not touch its bottom or sides and 1/16th to 1/8th inch clearance is wanted at the bottom. The vacant area will later be filled with glass bedding compound. Enough wood is left at the barrel channel tip and receiver areas for the barreled action to rest on. After bedding the stock these areas will be scraped down so that all the rifle rests on is the glass bedding in the block channel.

Fitted and ready for bonding the barrel bedding block to the barrel.

Screw holes were packed with modeling clay to protect them from the epoxy.

Mineral spirits was used to degrease the inside of block.
Left- The back and front face of block positions were marked with felt pen.

Right - A mark was made short of the front and rear faces of block are application of epoxy is to begin and stop. This will minimize excess epoxy from being shoved out while sliding block into position.

Because the barrel bedding block will be screwed rearward over the epoxy, tape was applied to protect barrel from being scared.

Brownells glass bedding compound was mixed with a generous amount of steel dust and applied to a couple inches of barrel at a time. The barrel was generously coated its entire circumference.

The block is slowly screwed over epoxy and stopped to apply more epoxy.
Application of epoxy ceases at the epoxy line marked with felt pen (described above).

The face of block is cleaned with cotton swabs.

The block is slowly screwed into final position and barrel and block are cleaned of excess epoxy using many dry cotton swabs.

The barrel is carefully turned upside down to properly align retainer screw holes. The barrel is returned to the upright position to check horizontal alignment and check for excess epoxy. This is done several times until epoxy begins to set and one time the barreled action was briefly set in the stock to be sure horizontal alignment would be correct.

Rifle shown curing on the rifle rest that was used while attaching the barrel bedding block.
After the epoxy cured work was begun on glass bedding the stock.

Before glass bedding inletting black was applied to block to make a final check for high spots on the wood bedding.

Placing the barreled action in the stock shows a high spot marked by the inletting black at the upper-left-of-center in the block channel. The high spot was removed using wood scrapers.

Modeling clay was used to fashion dams at the front and rear where epoxy glass bedding is to cease. The dams were fashioned by installing and removing the barreled action in the stock several times until the desired position and shape was achieved. Initially the barrel was only allowed to sink a small amount into the clay. Depth was gradually increased as shaping progressed and at no time was more than the weight of the barreled action allowed to rest on the clay dams.
Five layers of masking tape was applied to the lower half of the front face of the block. This will permit easy removal and installation of rifle and stock by leaving a small gap between glass bedding and front of block. The rear of block is not masked and will fit flush against bedding so as to serve as a recoil surface.

Five strips of masking tape were stacked together and cut to the curve of the block face. A 35 millimeter film canister turned out to be the same diameter as the block (1 1/4 inch) and was used as a template to mark the tape for cutting.

Here the barreled block is ready to be set in the glass bedding compound. Note the masking tape (described above) on the lower front face of block. The flutes and screw holes were packed with modeling clay to keep bedding compound from entering them and seeping into spaces between block and barrel. Three coats of release agent (that came with the bedding kit) was applied to all metal parts, tape and clay packing that might come in contact with the epoxy bedding compound. One coat of release agent was applied to the face of the clay dams in the stock. The release agent was allowed to cure 1 1/2 hour between coats and a bit more for the final coat.

As always before setting a rifle in bedding compound, an abundance of paper towels and cotton swabs were at the ready for a quick response to emergency clean up.
One part steel dust was mixed with 2 1/2 parts Brownells glass bedding compound. Enough mixture was carefully poured into the bottom of the block channel to cover only part of the stock walls when block is set. The goal is to provide a strong bed with minimum contact with stock walls to keep barrel from twisting sideways but minimize the effects of stock warpage.

Note the release agent (blue in color) that was applied to the face of clay dams. The wood close to these faces was lightly scraped to remove any release agent that had gotten on it.

The barreled action is set in stock and left to cure. The rifle is attached to the stock by its own weight only. Note the small bubble level used to level the rifle so that the bedding compound disperses evenly as it cures. No bedding compound squeezed out between block and stock. Using a flash light to look between block and stock shows compound may have come about half way up walls. That is what is wanted.

Shortly after removing rifle from stock after bedding cured. Notice the marks left by the retainer screw holes making it easy to center the bit for drilling.
The epoxy over runs and modeling clay were removed. The retainer screw holes were drilled with a 7/16 inch bit for the 3/8 inch O.D. pillars to reside within.

Two 1/4 inch I.D - 3/8 inch O.D by 1 inch long steel pillars, purchased from a hardware store, were cut to the desired lengths and roughed for bedding into the retainer screw holes. For this particular stock the rear pillar was cut to 11/16 inch and the front pillar to 7/16 inch. Hex head retainer screws are 1/4 with 28 pitch threads. To keep the screws from stressing the barrel, it is important the screws do not touch the barrel or epoxy bonded to the barrel when the screws are tightened onto the pillars. The rear is 7/8 inch long and the front screw is 3/4 inch long. The screw heads were turned to the approximate outside diameter of the pillars.

The barrel bedding block, barrel bedding block screw holes, retainer screws, inside of pillars and top and bottom of pillars were coated with release agent and allowed to cure 1 1/2 hours. Then a second coat was applied and allowed to cure 1 1/2 hours. The outside of pillars were not coated with release agent since that part of pillars will be epoxied into the stock. After the second coat of release agent had cured the rifle was set in the stock.
Masking tape was tightly wrapped around barrel bedding block and stock to hold rifle in place while bedding the pillars.

Bedding was mixed one part steel dust to two parts epoxy bedding compound. The walls of the rear retainer screw hole and the outside of the rear pillar were liberally coated with bedding compound. The pillar was then slide into place and tightened against the barrel bedding block with the rear hex retainer screw. The front pillar was then bedded in the same manner.

Placing the rifle upside down keeps the epoxy from running out of the retainer screw holes. The rifle is checked for level and left to cure. In order to keep the screws from ceasing, after about 45 minutes the retainer screws are backed off a full turn and re-tightened. This is repeated again a half hour later and again a half hour after that.

After pillars cured. High spots in the wood bedding can now be scraped away in order that all the rifle except the barrel bedding block floats in air
The stock is not fully fashioned but this gives a reasonable idea of what the rifle will look like with the barrel bedding block.

**Inlays, Tips and Caps**

**Inlays**

Inlays can be used to cover cross bolt holes drilled for large caliber magnum rifles, a bad spot on the stock, or for just having something fancy. They can be of exotic woods, ivory, metals or whatever. They can be of all the same type material or a mixture that only the imagination could compose. Once I saw a pool cue stick with diamond inlays.

Before cutting the stock, practice inletting the inlay on another piece of wood. This may prevent a disaster and increase confidence.

Lay inlay on stock and trace the outline with a sharp tool. Inlet the inlay to approximately 1/8 inch deep. Do not pry the walls of the inlet with the cutting tool. Doing so will leave a dent and the wood may split or splinter outside the pattern. The inlay should be slightly
angled so that pressing it in causes it to tighten against the outline of the inlet, giving it a seamless appearance.

Using glass bedding epoxy, epoxy the inlay into place and let cure. Do not mix floc or metal aggregates that may have come with the bedding kit and let epoxy cure at least two days before sanding. Sand inlay to stock surface. Remember to sand with the grain of the stock.

You can put inlays in inlays and inlays appearing to overlap inlays (see picture below). To do this inlet as described above but wait until base inlay(s) has cured and been sanded to stock surface before cutting into it. To have inlays appear to overlap, as shown in the bottom most example below, the outside inlays would be installed first. In the top two examples shown the center inlay would be installed first.

Some inlays and pieces for grip and tip caps.

Some inletting and barrel channeling tools.
Pictures are compliments of Wright's Gunstock Blanks who also sells this stuff. Tools are also available through Brownells and others.
Forend Tip and Pistol Grip Cap

Although a tip piece can be installed at any stage before applying finish, it is best to install it before inletting the barrel channel.

A thin maple wafer is often used as a spacer for tip pieces and grip caps.

Forend tips are installed 90 degrees or 45 degrees to the forend of the stock. For a 45 degree cut the longest part of forend (not tip) is at the top of barrel channel. The end of the tip being attached can be cut to angle or not regardless of whether the forend of stock is cut 90 degrees or 45 degrees. The picture above shows three blocks cut 45 degrees suitable for use as forend tip pieces. The face of block would be bonded to the face of a 45 degree cut on forend of stock. The block would then be shaped to lines matching that of stock. Notice that one of the blocks shown is long enough to have an angled cut at the end. The angle can be up to 45 degrees but must angle opposite to that of the other (the stock will be longer at underside, not at top of barrel channel). An angle less than 45 degrees is normal and causes the rifle to act less like a brush hook as it is being carried through the woods. I like to keep it around 22 to 30 degrees. Though, the stock cut should be only a 45 or 90 degree cut.

Rough the face of tip piece and forend, however be sure the face of both are smooth at their extremities so that once tip piece is bonded and shaped no marks will be seen at the bond. To bond, apply only a small amount of glass bedding epoxy to entire face surfaces. Do not mix any aggregates that may have come with the glass bedding kit. Use something to keep pressure on tip piece so that no large bonding line will be seen when cured and shaped. Let cure for at least two days. With flat files rough shape tip piece to that of stock lines, finishing with a sanding block to 320 or 400 grit. Inlet for barrel. Cut tip end 90 degrees or angle. With flat files evenly round tip and finish with a sanding block.

A 90 degree and three 45 degree forend tip caps.
Bottom pictures were scanned from Richards Micro-Fit Stocks catalog. Top left is from a stock I built.
A wooden piece for use as a pistol grip cap can be bonded before or after the grip is fashioned. A pre-fashioned cap, such as those made of metal, can be attached and fashioned by filing and polishing to match the wood contour or by matching the wood to its contour. Metal caps should be attached with hardware. Wooden caps can be bonded or attached with hardware. It is usual for wooden caps to be bonded.

Picture of metal grip caps are compliments of Wright's Gunstock Blanks Metal caps are also available through Brownells.

**Minute of Angle**

Most firearm sighting scopes incorporate windage and elevation adjustments referenced to MOA (minute of angle). Each click of the scope turret is usually 1/4 MOA change and on some scopes 1/8 MOA. Normally, shooters refer to these adjustments as a change of a fraction of an inch at 100 yards rather than the true value of MOA for which they are supposedly calibrated to. The value of inch is a nice easy number to work with and most of us can easily visualize its length and its multiples without the aid of a calculator. Actually the comparison is close enough to not be of practical concern, especially at distances up to a few hundred yards, and the real difference is a mere 0.47 inch at 1000 yards. For serious target shooting and as shooting distances increase the attention to MOA value relative to sight adjustment becomes more essential.

**Calculating Minute of Angle**

The angle of an arc is expressed in number of degrees. There are 360 degrees of arc to a full circle. Each degree consists of 60 minutes of arc. The distance covered by the measure of arc is relative to the circumference (total distance around the circle) it is contained within. Knowing the radius (distance to center of circle) circumference is easily calculated by using the constant pi. The ratio (represented by pi) of circumference is constant to diameter (radius x 2) regardless of circle size. The precise value of pi is so far unknown to man but is normally resolved to 3.1416 or 3.141 for our purposes.

Suppose a circle with a 6 inch radius. Circumference can be calculated as:

\[
\text{circumference} = (\text{radius} \times 2) \times \pi
\]
circumference = (6 x 2) x 3.1416
circumference = 12 x 3.1416
circumference = 37.6992 inches

The distance covered by 1 degree of angle (37.6992 / 360 or, circumference divided by 360 degrees) is 0.1047 inch at 6 inches from center of circle.

And, 1 minute of angle represents (0.1047 / 60 or, 1 degree divided by 60 minutes) 0.001745 inch at 6 inches from center of circle.

Knowing what MOA represents allows us to calculate its value to any distance.

Six inches (the radius of the above example) is 1/600th of 100 yards: (100 yards x 36 inches) / 6 inches = 600

Therefore, the value of MOA at 100 yards is 1.047 inches (0.001745 x 600 = 1.047)
At 50 yards 1/2 the 100 yard value; 70% @ 70 yards; twice @ 200 yards; 6 times @ 600 yards; and so on.

So, the difference between thinking in inches as opposed to MOA is 0.47 inch @ 1000 yards.

Four (4) clicks of the scope adjustment equals 1.047 inch change @ 100 yards for scopes of 1/4MOA per click.

Where group size is expressed in inches the word 'inch' should be spelled. Writing the symbol commonly used to represent the measure of inch (”) is not accurate here, and in fact misleading since that symbol also represents 'second of angle' (1/60 of a minute of
angle. Therefore, a group of 1 inch would properly be written as '1 inch' not 1". It could also be written as 1' since that symbol (') is used to represent minute of angle but that might be misleading to those thinking in feet.

**Why Use MOA**

As shown above, the value of a measure of angle can easily be calculated to any distance from its source of origin - center of circle or muzzle of barrel. Such measures as MOA (minute of angle) are also part of our only universal language - mathematics. While knowing a rifle has a precision of a certain value of the inch at a particular distance also makes it simple to calculate its precision at other distances, one would have to know both the distance and the measure in inch (example: 1 inch @ 100 yards) before calculating it to other distances. In contrast, knowing only the measure of angle is needed to do the same. An example of the contrast is expressing 0.73 inch @ 100 yards verses 0.7 MOA (0.73 / 1.0472 = 0.697). The two equate practically the same (1 MOA = 1.047 inch @ 100 yards) but the expression using MOA is more concise since no distances are included in the expression.

Two informative sites for further discussion of MOA relative to firearm use: What Is MOA and Is It Really an Inch At 100 Yards? and Mil-dots and Minutes-of-angle, From a Technical Perspective

**Calculating Scope Click**

For long ranges where shooting distances may vary considerably it is wise to know the actual value of each scope adjustment. This is especially true if scope settings are changed in the field as shooting distances change. Not all scopes are precisely calibrated to MOA (minute of angle) or to the inch. Below is a procedure learned from Varmint Al's Shooting Page for better determining the value of each click of the scope turret.

Shooting from a solid bench rest, determine the center of group using the Average Group Radius method. Without reaching the adjustment limit of the scope, make and record as many scope elevation clicks as will still keep the group on the target while shooting at the same aiming point as before. Again determine center of group using the Average Group Radius method. Return the scope elevation to its previous setting. Determine the distance between the center of the two groups. Divide that distance by the number of elevation clicks used to achieve group two. That is the calculated value of change for that distance for each click.

For high power rifles it is recommended the target be no less than 100 yards distance as some projectiles may not completely stabilize at shorter distances, thereby giving a false indication of true performance.
Calculating Rifle Precision

First, precision and accuracy are not the same. A rifle grouping 1/4 MOA is very precise for a firearm. If that 1/4 MOA rifle puts groups off the aiming point it is not accurate. Rifle precision is a measure of how close it will hit to the same point it had before. Rifle accuracy is hitting the aiming point. Equally though, it is true that if you are shooting for groups and do not wish to destroy the aiming point but rather have the shots hit somewhere else on the target the rifle is accurate if it does what you wish. All of the above assumes, of course, that no blame can be proven on the operator of said rifle.

For the purpose of determining rifle precision I will discuss only two methods. The 'extreme' or 'maximum spread' method is the usual and quickest method used by most of us while in the field. It is not accurate in fairly determining the performance of a rifle but becomes a less inaccurate method as group size decreases. For very tight groups it is a good method of measure because the distinction between it and the 'average group radius' diminishes. The 'average group radius' method is the best and most difficult I know of in determining rifle precision. Determining average group radius involves time consuming measurements and calculations in order to determine center of group and then average shot placement relative to that center. It is a highly accurate means of calculating rifle precision.

MAXIMUM SPREAD

77 Yard Target

Calculations are compliments of RSI Shooting Lab Software

Using the Maximum Spread Method the above 3 shot grouping measures 0.70 MOA; the Average Group Radius is 0.33 MOA.

Average Group Radius tells us how far from center of group we can expect the shot to be. Maximum Spread emphasizes the worse shot.
Maximum Spread
Sometimes referred to as 'extreme spread' maximum spread is a measure of the distance between the centers of the two furthest shots within a group. It is often thought to be a measure of the smallest circle the group will fit into. This is misleading because the method does not distinguish between a tight group that has a dissimilar shot and a not so tight group that is evenly dispersed. The maximum spread method is acceptable for measuring tight groups that do not have so called flyers and a reasonable measure for groups with all its shots evenly dispersed. While in the field, I will usually rely on this method for a quick idea of what the group is. If the group is interesting enough or important enough I will later take the time to calculate the average group radius.

Average Group Radius
First find the group center. Measure distance from center of group to center of each shot. Average the distances. The result is the average group radius. Double that would be the average diameter of the group but this figure is not normally expressed. The average group radius is the average distance of the center of shot to center of group.

To manually find the center of group draw a horizontal line through the center of the lowest shot. Draw a vertical line through the center of the leftmost shot. Measure and add the distances from the center of each shot to the horizontal line. Average the sum of these distances by dividing it by the number of shots. This gives the distance from the horizontal line to the vertical center. Measure this distance from the horizontal line and mark that location on the target. Measure and add the distances from the center of each shot to the vertical line. Average the sum of these distances by dividing it by the number of shots. This gives the distance from the vertical line to the horizontal center. Place rule across vertical line and mark made at vertical center. Measure the distance of the horizontal center from the vertical line and mark it on the target. This last mark is the statistical center of the group.

There is a ballistics program available that includes the unique feature of entering a target grouping into the program. It will analyze the group and give statistical data on it. Included in the analysis is the average group radius. It is easy to enter. You press the target to the video screen and click on each bullet hole with the mouse. You can also scan the target in. There is a feature the software includes to calibrate the aspect ratio of the video input so that the distances in both horizontal and vertical directions are correct. The software can be found at Recreational Software Inc. and is the software used to analyze the above target.

A further discussion on measuring rifle precision is provided by selecting 'Measuring Targets Tech. Article' at Tech. Articles.

Target Crowning a Muzzle
The primary purpose of a firearm muzzle crown is to provide propellant gases a resistance free path away from all parts of the projectile as it exits the bore of the barrel. The secondary purpose is to protect the bore from damage caused by misuse. The third
purpose is for good looks which is always achieved when the primary purpose is satisfied.

There are two basic types of target crown - the 'step' and the '11 degree'. The muzzle of the step crown is first cut 90 degrees of barrel (square) then about half the muzzle radius is counter sunk with the wall of the counter sink usually at an angle of about 45 degrees. The muzzle of the 11 degree crown is sunk at an angle of 11 degrees from square (79 degrees of barrel). The 11 degree angle extends either the full muzzle radius or the greater part of muzzle radius. The exact angle sometimes varies a degree or two from eleven and is still referred to as being a target crown but through experimentation and time eleven degrees is normally accepted as the optimum universal angle for this type of target crown.

**Step Type Target Crown**

![Step Type Target Crown](image)

Picture shows a 'step' type target crown on a Green Mountain .22 caliber barrel.

Below is a description and procedure for making a step type target crown taught me by Ray Dixon, who cuts target crowns on target and varmint rifle barrels as part of his profession.

![A Step Type Target Crown](image)

Using a lathe with steady rest and cutting tool to turn and cut the work piece, the muzzle is squared then stepped in a few hundredths of an inch. The sharp edge of the muzzle is
turned off at a non-critical angle to help protect it from dings. Leaving metal above the circumference of the step (the crown) protects the crown from dings.

The step is angled down at about 45 degrees to help direct gas turbulence away from the exiting bullet.

Because gases should escape with equal resistance across the entire area of the crown, it is important that all crown surfaces be smooth and similar throughout its area. Attention to this becomes more critical as the crown approaches the bore.

Using a 60 degree piloted bit attached to the tail stock of the lathe, the sharp 90 degree edge of the bore exit is turned off at a 60 degree angle. The importance of this is to protect the bore edge from gas erosion and thereby ensure the bore exit remain smooth with no irregularities along its circumference. Great care is taken to make this cut very smooth so that it be alike along its entire surface. To aid in this the barrel is turned only by hand while making very slow advances of the tail stock, which contains the piloted bit. To help ensure the 60 degree edge be consistent in depth and bit chatter minimized this cut is kept very shallow, only about 0.020 to 0.025 inch in depth. The pilot of the bit is a diameter which matches that of the bore closely enough to keep the axis of the bit aligned with that of the bore, keeping bit chatter down and depth consistent.

Should the bore exit not be consistent about its perimeter gases escaping unevenly around the bullet base will cause bullet yaw and loss of precision.

**11 Degree Target Crown**

Below is detailed the tool and procedure recently used to apply an 11 degree target crown to the muzzle of a Ruger model Number 1B, caliber Springfield 30-06.

![Tool and procedure](image)

Left - .308 caliber brass pilot, 79 degree muzzle crowning cutter, cutter handle and allen wrench for tightening pilot to cutter.
Center - the assembled tool used for cutting the 11 degree target crown.
Right - the business end of the tool.

All parts of tool were purchased from Brownells. The hex wrench did not come with the tool.
The 79 degree cutter is found through their web site index under ‘CROWNING/BARREL’ or ‘CHAMFERING/BARREL’.
The handle for cutter and the pilot are both found under 'CHAMFERING/MUZZLE'.

Pilots are advertised for most calibers and are available in steel or brass. Brass was chosen because it is softer than the rifling lands.

Two sizes of cutter are advertised: 1/2 inch diameter and 3/4 inch diameter for small and larger barrel diameters. The cutter used here is the 3/4 inch version which works for small and larger diameter barrels. Note that using this cutter, crowning a 1 inch diameter barrel would leave a minimum of 1/8 inch radius uncut but none-the-less would yield a proper functioning 11 degree target crown.

The original factory crown just before cutting it to an 11 degree target crown.

Honing oil is applied to cutter and muzzle before any cutting is performed. It is also wise to apply oil to pilot to reduce possible friction to rifling lands. Periodically cutting stops to clean metal shavings from muzzle, bore and tool. Honing oil is re-applied before cutting continues. The oil used here is honing oil sold for knife sharpening.

Left - crowning cutter with pilot inside bore, ready to start cutting.

Center - beginning of target crown after only 10 or 12 light 1/2 rotations of cutter. Care is taken to keep light and consistent downward hand pressure centered on bore so pilot does not wobble. Cutting is performed slowly and can be stopped and resumed at will but it is important to keep cutting surfaces coated with the oil and to clean metal shavings from bore, muzzle and cutter before re-inserting pilot.
Right - to keep shavings from getting between cutter face and muzzle care is taken cutter never leaves the surface of muzzle while cutting is being performed. Cutting is often stopped to clean shavings from muzzle, bore and tool and to check depth of cut.

As cutting goes deeper into muzzle cutting slows because more muzzle face is contacting cutter surface. Cutting is often stopped to check for depth and to clean away shavings. The muzzle becomes very sharp where it enters the bore and ruff cutting is stopped just short of maximum barrel radius. Shown above the ruff muzzle is ready for finish cutting after about eight careful cutting sessions.

Left - finish cutting is performed with increasingly lighter pressure as cutting progresses until almost only the weight of tool is applied to the muzzle.

Center - crown after finish cutting.

Right - a thin and even amount of 00 steel wool is placed on cutter face and used to lightly burnish any microscopic burrs off muzzle crown. Care is taken to flatten the wool against the cutter face before inserting pilot into bore and it is important not to over burnish using this method because any steel fibers accidentally allowed into bore could score rifling lands.
Left - after using alcohol to degrease the muzzle OXPHO-BLUE from Brownells is used to cold blue the muzzle.

Right - Three coats of blueing agent was applied to muzzle. After each application the muzzle was wiped with dry towel and lightly polished using 0000 steel wool.
Building a Muzzle Loader from Kit

Below are pictures and descriptions of the procedures I recently used in building a .50 caliber Hawken style percussion muzzle loader from a CVA kit. The wood supplied was almost completely inletted. The barrel channel and lock inletting was all that had to be enlarged. The stock came with very little wood to be removed except around the cheek piece where, though, there was not as much wood left from the machining as I wanted in some areas.

Fitting Butt Piece, Patch Box and Forend Tip

It is normal for the brass furniture to come with foundry and machine marks and they need a lot of filing, sanding and polishing to make them fit correctly and look proper.
After draw filing butt piece close to level with wood; sanding with 80 and 100 grit paper to match height of brass parts to that of wood. The entire length of stock section being worked is sanded equally so as not to remove too much wood from small areas which would cause unsightly low spots that would be magnified after applying the finish. In the depictions above the complete butt section of stock was carefully sanded from front to back, not just around the areas of brass fittings.

Patch box and butt piece after filing brass and sanding wood and brass level with each other. Note that foundry marks left from the mold have been removed in the process. Also note that much work is still needed to make the brass glassy smooth, which will be done after fashioning the stock but prior to sealing the stock.

The holes drilled for the forend tip were not properly centered. The picture on the left shows one of the holes filled with a piece of a round tooth pick and epoxy. It was cut flush and sanded smooth after curing. The new hole could then be drilled without the small bit drifting into the original hole.

The picture on the left shows excess wood must be removed to mate properly with brass tip. The other side shows excess brass must be filed and sanded smooth with wood.
Draw filing brass tip level with wood.

Sanding forearm and brass tip with 80 and 100 grit paper. Note that entire length of forearm is sanded using a sanding block so as not to cause dips and other low spots in wood.
Fitting the Barrel

Measuring barrel width with caliper. The yellow tape was used to protect blueing from being scratched.

The barrel channel (upper-most flats only) is widened equally on both sides using a sanding block with 80 and 100 grit paper.

Channel is enlarged until caliper set to barrel width will equally fit inside channel its full length.
Barrel thinly painted with inletting black shows where high spots are in the barrel channel. High spots are removed with the use of a sanding block and the barrel re-seated with inletting black until all high spots are found and removed from the entire length of channel. The barrel channel side flats only (upper-most flat) are then widened to 1/32 inch clearance of barrel.

Using 100 grit paper and a sanding block laying on top of both channel rails, the rails are sanded even with top of brass forend tip. Care is taken to ensure the rails come half way up the barrel side flats when barrel is fully seated, and that the rails are the same height the entire length of channel. Laying the block on top both rails helps keep them flat and alike.

While enlarging barrel channel a section between the lock inletting and channel opened leaving a weak spot in the stock. A strip of tape was applied to channel side against cut out. Then a piece of tissue was stuffed inside channel to keep tape tight against cut out. Glass bedding epoxy mixed with brass filings (saved from filing the brass fittings) was used to fill the void and strengthen that area. The brass filings act as an aggregate giving added strength and stiffness to the epoxy. After curing the tape was easily removed.
**Fashioning the Tang**

Unlike brass fittings, because the tang is blued it was removed before sanding the wood flush with it. Inletting black was applied to mark the depth to remove wood to. Once most of the wood was removed, using a sanding block with 100 grit paper, the tang was often re-fitted to check that too much wood not be removed. The sanding followed the natural contour of the drop to sides of stock ensuring no dips or other low spots were cut into wood.

On left side of stock the channel rail slopes up to meet face of tang. To fashion slope gracefully and to keep its top flat and matched to that of the rest of rails, a large wooden sanding block is used. Note that only the bare wood of the block touches areas of stock not to be sanded. A pencil mark is made to indicate tang face where sanding ceases.

**Fashioning the Cheek Plate (Piece)**

This is the cheek piece before working it. There is plenty of wood rear and below the piece but is shallow at top and front. I studied along time on how I wanted to fashion it. Finally deciding on a shadow line on what I will call a 3/4 cheek piece.
The shadow line is started by cutting it with a sanding block. Following the outside of a pencil mark, the block is used to cut into the wood that slopes away from the cheek face. The cut is made perpendicular to what will become the flat face of the butt of the stock. 100 and 120 grit paper is used.

Working forward the slope becomes too steep to control the cut well enough with the wooden sanding block. Here a steel measuring scale is used with 100 or 120 grit paper to start the cut. After a small ledge has been cut using the scale the block is used to deepen the cut.

At the extreme front and rear, where the shadow line will taper to the face of the stock, a small pointed file is used to cut the line.
After the shadow line is cut almost as deep as it will be the scale, file and sanding block are used to square up the face of the shadow line and properly curve the line around the face of the cheek piece.

Once the shadow line is about finished high spots are sanded out of the rear of butt section. The wood is leveled from brass butt piece to shadow line. All sanding is done in the direction of grain flow. Note that sanding block is angled so as to run flush into shadow line as sanding is performed.

A sanding block with 80 and 100 grit paper is used to contour the bottom of butt section and mate it with the bottom of shadow line.
Here the shadow line is close to completion.

The curved slope from face of cheek piece to shadow line drop off is fashioned using a cigarette filter as a sanding form (block). The filter is easily shaped with finger pressure and, with some difficulty, can even be used at the extreme front and rear tapers.

Using a sanding block with 80, 100 and 120 grit paper the face of the cheek piece is dropped and contoured to preference. This also helps to sharpen the edges of the face. Great care is taken to keep the sanding block flat against face so that the edges of face do not become rounded from sanding.

Except for final sanding and final inspection the cheek piece is complete and ready to have the flute cut into it.
Fashioning the Flutes

Like the shadow line above, flutes are not essential on the Hawken. I will add them because it enhances the rifle and because it offers an opportunity to show how I do it.

Right and left sides of front comb before cutting flutes. It may help to have a model to reference. The picture on the right shows a factory flute on a Remington model 700BDL. There are probably about as many past and present Hawken designs as there are flies to trout fish with however, in keeping with what I believe a Hawken flute might look and fit like I will attempt to point the apex of flute more toward the bottom of stock than that of the above model which, as can be seen, runs rather horizontal to center of stock.

Hawken flute might look and fit like I will attempt to point the apex of flute more toward the bottom of stock than that of the above model which, as can be seen, runs rather horizontal to center of stock.

After reviewing some pictures of Hawken percussion rifles I decided to mark with pencil approximately how the flute will lay. The actual flute may deviate some depending on how I feel it looks and fits as it is being shaped. I will use the penciled outline as a perimeter not to, at first, exceed.

Right - measuring outline to help duplicate on other side of stock.
Starting flute with 100 and 80 grit paper. Notice the handy cigarette filter as a sanding form for cutting small curves. The deepest cutting is made at the front comb drop.

The beginning of a flute.

Smoothing the contour and curving wrist area into flute. One of the few places no sanding block is used.

Mineral spirits was sometimes applied to highlight errors. Right - Finished after 8 coats of surface finish.
Left - Here the flute is almost fashioned. The rear curve needs to be made greater and begin closer to tip of front comb.

Right - Finished flute and cheekpiece after 8 coats of surface finish.

**Fashioning the Bottom of Butt Section and Area of Trigger Guard**

Regrettably I had already worked on the bottom of the butt section before it occurred to me that I should document the project. Therefore, I have no pictures of this part of the stock as it arrived to me from the vendor. The stock was not wide enough, for my taste, from toe to comb to flatten the bottom all the way to brass butt piece. It had been cut flat at trigger guard inlet, forward of inlet and just rearward of inlet by the vendor's machine (which is proper for a Hawken). Using a sanding block I continued the flat up the butt section in line with guard inlet and ending in a slow tapper.

I elected to bring the lines closer to the inlet at trigger guard, giving this section a more curved appearance. The picture on the left shows this section of stock as it arrived from the vendor. As always, the sanding was performed in direction of grain flow while using a sanding block.
**Lock Inletting**

From the vendor the lock fit too tight in its inletting. It needed to be relieved a little to prevent future problems caused by stock swelling.

Using a small brush handle as a sanding form and 100 grit paper to enlarge curved ends of lock inlet.

Here a sliver cut from a plastic eraser and 100 grit paper is used as a sanding block to remove wood from the straight runs of lock inlet. Only small amounts are uniformly removed before checking for fit.

After fitting the lock wood was sanded level with face of lock in the same manner the tang area was fashioned. One exception is that no inletting black was used here. Instead only small amounts of wood was removed before fitting lock to check.

**Polishing the Brass Fittings**

The stock is shaped and ready to be sealed. Before sealing the stock the brass fixtures will be polished to a mirror finish, after which they will be reassembled to the stock to make sure brass and wood are still level with each other.

All foundry and machine marks must be removed and brass polished to a mirror surface. Left - Brass fixtures before polishing. Right - 180 grit sand paper highlights foundry marks that must be removed.
Left - Draw filing foundry marks out of brass. Right - Filed and ready for sanding.

Left to right - After sanding to 180 grit, 320 grit, 600 grit, 0000 steel wool
All sanding was done by hand. The part was sanded in a circular motion.

The trigger guard does not have to be polished before sealing the stock. It will be worked while the sealer is curing.

The patch box and butt plate do not need further draw filing because the butt plate was filed before shaping the stock and the patch box was sanded while shaping the stock. Those pieces will be sanded and buffed in the same manner as the tip cap above. The stock will then be reassembled and checked for wood removal. Later the brass fixtures will be further polished using stock rubbing compounds.
Bottom view of CVA Hawken style patch box
Not all areas of patch box lid are accessible for polishing while assembled.

Left - Polishing patch box with Brownells Three F Stock Rubbing Compound. 
Right - Trigger guard after polishing with Brownells Original, then Three F, then Five F stock rubbing compound. Notice the reflection of me taking the picture.

**Sealing the Stock**

See instructions given on page 8.
The Finished Rifle

Photographs below show the fit, finish and shape of the completed rifle.

Differences in color tones are due to varying light conditions
The lock embellishment and barrel lettering was inlayed with 23 karat jewelers gold using an inexpensive kit purchased from Brownells. Only time and usage will prove how well it will wear.
Sixteen days after the last coat of finish was applied the rifle was open sighted.
Group measures 1 13/16 inch maximum spread.

The .50 caliber CVA turned out to be a shooter. Eighty (80) grains (by volume measure) of FFg GOEX Black Powder behind 0.490 inch 175 grain Hornady round ball on 0.015 inch thick pre-lubed patch and CCI No. 11 Magnum Cap were used to produce the above 54 yard grouping. Ninety (90) grains of powder produced a slightly greater spread and 80 grains will be the recommended charge for this particular rifle for use with round ball projectiles.

After sighting the rifle a few coats of Birchwood Casey Gun Stock Wax was applied to all exterior parts of the assembled rifle. The wax was applied following the directions supplied on the container.

The rifle is ready for delivery.

Work on the rifle began on March 3. Including sight in, work on the rifle was complete May 5. Nine weeks total.
Completing the Rifle

Eliminate Trigger Over-Travel

Here is a simple but very effective way of eliminating that nasty trigger over-travel. This great little tip was given me by David Lake of Composite Gunsmithing and Custom CARBON FIBER and KEVLAR stocks and pistol grips; http://compositeguns.com. I have found David to be both knowledgeable and eager to help with advice based on experience.

Although this can be done to any trigger that has no over-travel adjustment, below is detailed the procedure used for making an adjustable over-travel on a Ruger 10/22 rifle.

The trigger was removed from its assembly and a hole was simply drilled and tapped through the trigger so that a 6 X 32 set screw could be screwed through it. The hole was drilled so that the screw resides just above the trigger spring and at a like angle as the spring. This position places the screw as far out of sight as possible and drives the screw directly onto the inside face of trigger guard when the trigger is depressed.

The set screw was fashioned by cutting the head off a 1/2 inch 6 X 32 hex screw and cutting a screw driver slot in its place. It was then shortened so that it would not protrude from the trigger face when adjusted. The screw was then re-blued using a good cold blue solution.

After field testing to determine the optimum adjustment (zero over-travel without interfering with trigger pull) the screw will be locked in place with a thread lock; a drop of super glue, finger nail polish or the like on the back side of trigger.
Remove 10/22 Trigger

Ruger part numbers are designated in parentheses.

Left - The hammer strut and spring assembly (B18, B44, B45) is pulled out after un-cocking the hammer.

Center - The hammer pivot pin (B19) is pushed out.

Right - The hammer (B17), hammer bushings 2 (B43), and bolt lock spring (B42) are removed.

Left - The trigger pivot pin (B21) is pushed out.

Right - The trigger/disconnector/disconnector pivot pin assembly (B20, B25, KE-28), sear (B23) and sear spring (B24) are removed by pushing trigger through the top of trigger guard (B2).
Assemble 10/22 Trigger and Hammer
Ruger part numbers are designated in parentheses.

Left - The disconnector (B25) is pivoted so that the sear (B23) (sear spring hole facing up) lays below disconnector. The sear spring (B24) is then inserted in the spring holes on disconnector and sear.

Right - To keep the assembly together while installing into trigger guard (B2), a round toothpick is inserted through trigger pivot pin hole and cut flush with trigger. The assembly is then put in place through the top of trigger guard. The trigger pivot pin (B21) is pushed through trigger guard and trigger with the temporary toothpick pin being pushed out the other side of trigger guard by the pivot pin.

Left - The bottom arm of bolt lock spring (B42) (forward of bend in spring) lays in a small dimple on the top of bolt lock (B41).

Center and Right - The four hammer components (hammer, hammer bushings 2, and bolt lock spring (B17, B43, B42)) are held in place and inserted into trigger guard (B2). The bolt lock spring is first placed on bolt lock (B41) as shown (above left). Then the assembly is slowly pulled backward until there is enough clearance to slip upper arm of
spring under the magazine latch pivot & ejector pin (B35) as shown (above right). The hammer pivot pin (B19) is inserted through the trigger guard and hammer assembly.

**Attaching the Recoil Pad**

Below is described a procedure used to attach a recoil pad to a rifle stock. The recoil pad used is a Pachmayr model. Although the pad already has a white spacer built into it, a maple spacer was included in the procedure both because it was wanted and so as to describe its inclusion.

Even though epoxy is used as a bonding agent, retainer screws are employed to help secure the recoil pad to the stock. This is because epoxy does not actually bond with plastics or rubber. However, the epoxy will provide a very strong adhesion and can be defeated with determination if the screws are removed.

Round tooth picks are punched through the pad to show where the screw holes are. Holes come molded into the pad from Pachmayr but are only visible from the back. For the spacer, an outline of the stock butt was penciled onto a 1/16 th inch thick sheet of maple and cut out using a jig saw. The spacer was cut out following the outside of the scribe marks so that the spacer would be slightly over sized.

The small holes made by pushing the toothpicks through the pad's face were marked with a pen and a utility knife was used to cut very short slits into the pad where the retainer screw heads can push through and vanish into the pad's interior. The two screws came with the pad from the vendor. Pads should first be inspected to assure these slits were not already made by the manufacturer.

Brownells original glass bedding epoxy compound was used to attach the recoil pad to the stock. Within that kit came packs of both black and brown dye. For attaching the maple spacer to the recoil pad, black dye was mixed with epoxy compound to match the
color of the recoil pad just in case the spacer did not rest perfectly flat on the pad surface after adhering. The epoxy should not be thickened so no other aggregate, such as the floc that also comes with the kit, was mixed with the compound.

Left - Epoxy compound was mixed and spread liberally onto one side of the maple spacer. All the surface was covered.

Right - Excess epoxy was then scrapped off the spacer until only a very thin and even layer remained. The remaining epoxy is so thin as to not allow it to ooze out when attached to the pad.

The recoil pad, where the spacer will attach to, is likewise treated to a very thin and even coat of the epoxy.

Left - The spacer is centered onto the pad and pad and spacer are sandwiched between two flat pieces of wood for clamping. The spacer is squeezed tight to the pad to prevent gaps between the two. The clamp is left in place for a couple days to allow the epoxy to cure.
Right - After curing the clamp is removed and the spacer is adhered, gap free, to the pad with no epoxy lines showing.

Top - To mark where the maple spacer is to be drilled for the retainer screws, a pointed pick is run, centered, through the screw holes and carefully driven through the spacer.

Bottom Left - The maple spacer is drilled through the pin holes so the retainer screws can pass through into the stock butt. Drilling ceases as soon as the bit passes through the maple spacer.

Bottom Right - Burrs caused by the drill bit are lightly knocked off with a medium grit sand paper.

Left - A Q-tip was cut in half. Each half was run through a retainer screw hole. The tips were then lightly coated with inletting black. The tips were then pulled back just inside the maple spacer so they would not protrude. The pad was then aligned onto the stock butt and the Q-tip halves, held perpendicular, were slowly screwed onto the stock butt.

Right - Inletting black left by the tips of the Q-tip halves mark were the retainer screw holes are to be drilled.

The stock is drilled to accept the two retainer screws before bonding the recoil pad to the stock.
For the same reason mentioned at the top of this procedure, some brown dye supplied with the bedding kit is used to match the epoxy to the color of the stock wood.

Left - Epoxy compound was mixed and spread liberally onto the maple spacer. All the surface was covered.

Right - Excess epoxy was then scrapped off the spacer until only a very thin and even layer remained. The remaining epoxy is so thin as to not allow it to ooze out when attached to the stock.

The stock butt, where the spacer will attach to, is likewise treated to a very thin and even coat of the epoxy.

The pad is aligned onto the stock. The retainer screws are tightened into the stock and the pad is tightly clamped to the stock. The clamp is allowed to remain in place for a couple days while the epoxy cures.

The pad is bonded to the stock with no gaps or epoxy lines showing. The pad will be generally shaped using a belt sander. Final shaping will occur as the stock is hand shaped using sanding papers backed with sanding blocks. The plastic factory spacer can be seen in the picture below. It will become fully visible as shaping is performed.