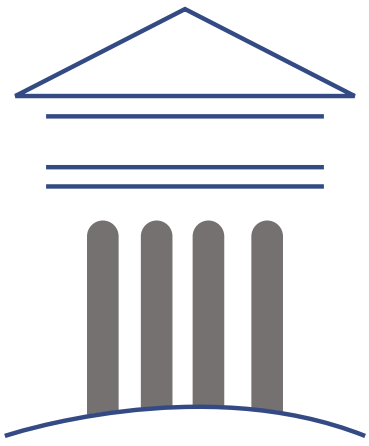
Chambering, Free Boring, and Trigger Work Lesson: 2180

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Objectives

After completing this lesson, you should

1. Be familiar with the components of the trigger mechanism.
2. Know what tools to use to adjust the trigger pull.
3. Be able to identify the three types of chamber reamers.
4. Know what free bore is.

Introduction

When the trigger on a firearm is pulled, it releases the firing pin to ignite the cartridge primer. This part was originally called "the tricker," because, when pulled, it "did the trick."

When a trigger is pulled, increasing pressure is applied until the sear is disengaged, allowing the firing pin to fall against the cartridge primer, which in turn ignites the powder to push the bullet out of the muzzle. Effective trigger squeeze requires proper follow-through. By avoiding the natural inclination to jerk or flinch at the moment the sear is released, the shooter reduces gun disturbance (and improves the aim). For this reason, proper trigger squeeze is very important for obtaining the best accuracy. Just as important is , the distance and pressure required to move the trigger enough to release the sear.

The adjustment of trigger pull is a job that many gunsmiths frequently encounter and one which every potential professional should learn as soon as possible.

Practically every rifle needs some smoothing or adjusting to meet the demands of the more serious shooter, since good accuracy depends a great deal upon perfect trigger control. It stands to reason that a trigger cannot be perfectly controlled if it drags, jumps, creeps, or varies in the amount of pull required to release the hammer or plunger.

Experience has shown that the best trigger pull for general use requires a pressure on the trigger ranging from 2½ to 4 pounds to discharge the rifle. Some shooters prefer a lighter pull, but a lighter pull can be dangerous unless the rifle is designed strictly for target and benchrest shooting. A clean, crisp trigger pull is most important; the trigger should not move at all until it releases the firing pin or plunger. Then it should give way suddenly without any preliminary movement. This is the type of trigger pull that the gunsmith should seek when making adjustments.

Triggers

Trigger mechanisms usually consist of three essential parts, not including springs and pins:

- Hammer (cocking piece, plunger, or striker)
- Sear
- Trigger

In all cases, the hammer is held in a cocked position by the sear engaging in a notch. The sear may be a separate part or it may be the upper end of the trigger itself. The quality of any trigger pull is determined by the bearing surface smoothness of these three interacting components.

In mechanisms in which the sear functions as an integral part of the trigger, the trigger is pivoted by means of a pin or screw between the upper end, which forms the sear, and the lower end, to which the pressure is applied. This type of trigger operates on the primary-lever principle with the trigger becoming a lever, the sear forming the weight, and the pin or screw acting as the pivot point, or fulcrum. The finger supplies the power at the lower end.

When a separate sear is interposed between the trigger and hammer or striker as shown in Figure 1, a dual-leverage system is formed, and the trigger is usually a secondary lever. As shown in Figure 1, the weight (W) is located between the fulcrum (F) and the power (P) and is transmitted to the trigger through the sear. The sear may be either a primary or secondary lever, according to the design of the mechanism.

Figure 2 shows various classes of lever principles. In all three examples, the closer the fulcrum is to the weight, the less pressure is required for movement. When applying these principles to trigger mechanisms, the closer the pivot point of the trigger is to the cocking piece, the less trigger pull is required. However, the lighter the trigger pull (in a two-stage trigger mechanism), the longer the trigger travel and the greater the creep. *Creep* is the first stage of the trigger's travel to the rear, usually requiring a pull weight of 1-3 pounds. Then to release the sear for firing, a separate 3-6 pounds of pull weight is required.

There are several types of triggers used today, all operating on a similar but slightly different principle. For example, triggers used on military rifles like the Krag, Springfield, Enfield, and Mauser are always two-stage designs and are noted for creep and hard pull.

The main advantage of this two-stage trigger is safety. Two-stage triggers are difficult to discharge if jolted or bumped, or if handled clumsily by new, untrained recruits.

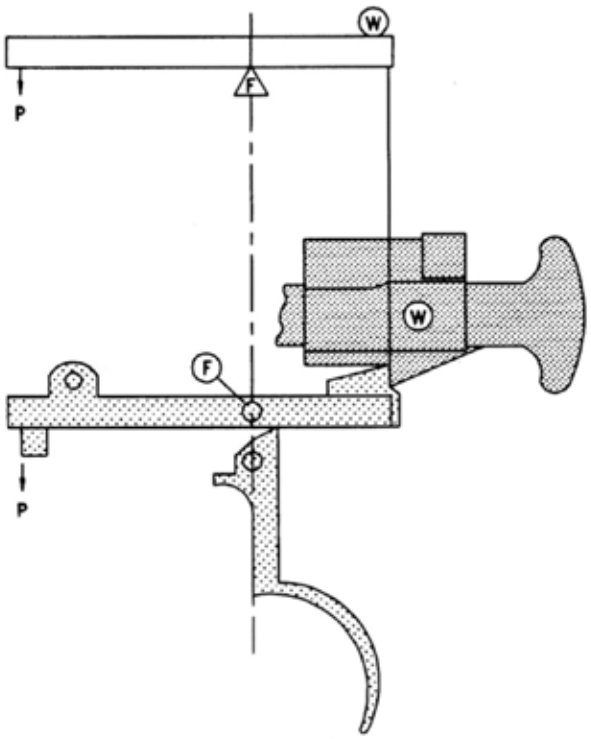


***Figure 1**: Operating principles of a two-stage trigger mechanism.*

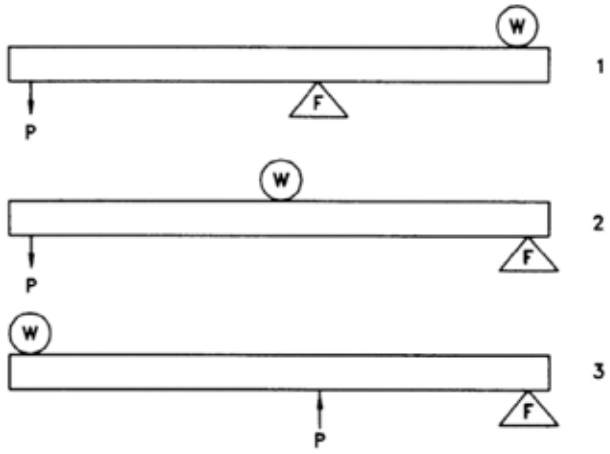


***Figure 2**: Various classes of lever principles.*

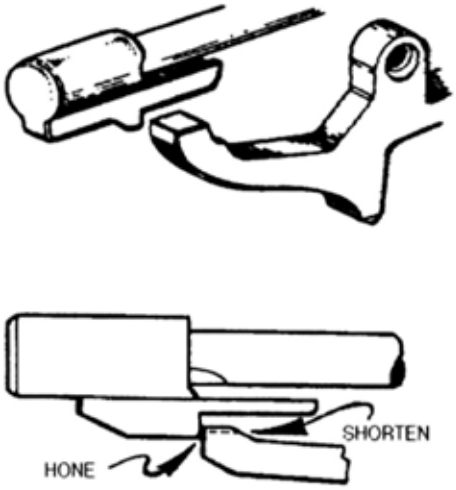


***Figure 3**: Areas of a simple trigger mechanism (sear and cocking piece) to adjust for smooth trigger pull.*

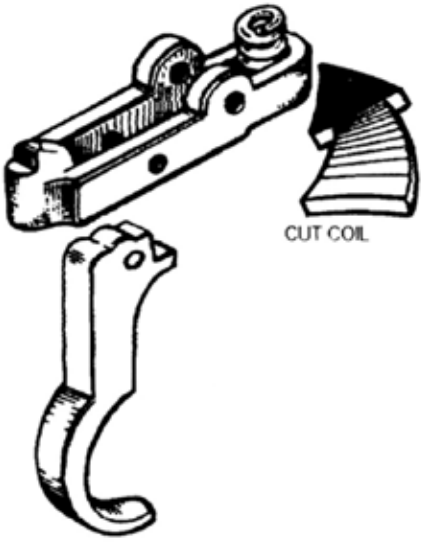


***Figure 4**: Most sear springs on older military rifles may be lightened by merely cutting off a coil or two.*

Bolt-action rifle trigger mechanisms are controlled by the bearing surface smoothness of three interacting components: the cocking piece, the trigger sear, and the trigger. When the bolt of such a rifle is forced forward and shot, the cocking piece pushes hard against the sear. The contact surfaces of the cocking piece and the sear must be large and strong to stand the wear and to prevent the cocking piece from slipping and causing an accidental discharge of the rifle when closing the breech. The trigger is arranged to have two distinct motions. During the first motion, the trigger moves to the rear quite easily when about 1½ pounds of pressure is applied. This is the creep we mentioned previously. During this creep, the sear is lowered in its contact with the cocking piece until it rests against the nose of the cocking piece very slightly, just like a conventional trigger sear resting in a hammer notch.

To lighten a bolt-action rifle trigger pull, and also to eliminate creep and drag, you should first polish the contact surfaces of the sear and cocking piece where they come in contact with each other. This is best done with honing stones, but be careful not to take off too much metal at one time. Until you have several hours of experience, this polishing should be done very sparingly, trying the trigger for "feel" every few strokes of the stone. Do not attempt to change the angle too much at this stage. Simply polish the contact points so that they will slide evenly over each other without any grate.

The next step is to make this slide shorter, which is done by grinding the top of the sear as shown in Figure 3. Again, go slowly, reassembling and trying the parts frequently. You can always take off more metal, but it is hard to put it back on. It is also necessary, in some cases, to lighten the tension slightly of the sear spring, which is usually a coil spring. To lighten, merely cut off one coil at a time until the right tension is felt, as shown in Figure 4. In some rare cases, this spring will be too light and will have to be strengthened. To do so, use a pair of pliers and a vise to stretch or lengthen the spring.

When any trigger repair is done, the entire trigger and safety mechanism must be tested several times to make certain that the rifle will not fire accidentally if you hit the butt against the floor. Do not pound the rifle butt against a hard object—just a few light taps should do it. Of course, the gun should not be loaded. Never load a gun with live ammunition while it is being repaired or tested in this manner.

Another type of military trigger utilizes two fulcrums (also called humps) at the top of the trigger. The forward hump is responsible for the first-stage creep as it pivots against the underside of the receiver, creating a drag or creep. Its main purpose is to slow down the cocking piece let-off and let the shooter know that firing is just a hump away. Creep on this type of trigger can be eliminated by grinding off this forward hump.

In doing so, the trigger sear will rise slightly higher against the cocking piece sear and provide a little more bearing surface. This will usually correct the problem of a rifle accidentally firing when the bolt is closed. Once the forward hump has been removed, the creep will disappear, but the trigger pull will be harder since the bearing weight has been increased. This problem can be corrected by slightly rounding the rear hump with a soft Arkansas stone. Again, this operation should be done gradually with many trials during the process. If too much metal is removed at this point, the rifle may fire on closing the bolt. With this slight alteration, plus a final polishing of all bearing surfaces, the trigger should have a medium-light crisp pull.

Again, when you complete the alteration, thoroughly test the gun (unloaded) to ensure that it will not accidentally discharge.

One of the easiest ways to improve the pull on a military trigger is by using a Viggo Miller military trigger attachment, which is designed to eliminate creep and enable the depth of the trigger sear engagement to be adjusted.

For example, to attach one of these devices to the trigger mechanism of a .30-40 Krag rifle, remove the stock from the metal parts to allow complete access to the action and trigger mechanism (Refer to Figure 5). Hook adjusting bracket E into the slot at the base of the trigger. Back-screw B out from the clamp piece until it is flush with the inside of the clamp (D). Next remove screw A from the clamp so that the clamp can be slipped over bracket E. Afterward, replace screw A. The trigger of the .30-40 Krag is tapered, and if the clamp is at the upper part of the taper, it will be easier to insert screw A. Then push the clamp down towards the lower end on the taper, being sure that the lip on the bracket remains tight against the base of the trigger. Tighten screw B first; then tighten screw A.

To adjust the trigger, turn adjusting screw C in or out as needed to obtain the desired trigger pull; lock adjusting screw C with the locknut.

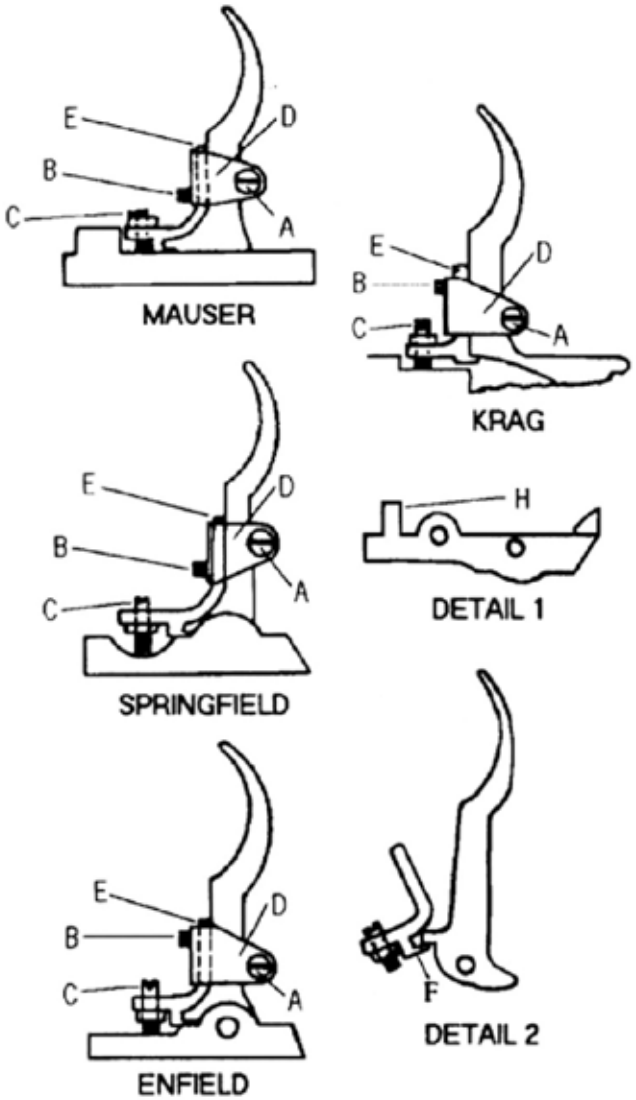


***Figure 5**: Viggo Miller's simple trigger attachment to improve trigger pulls on military rifles.*

If there is not enough clearance around the trigger well of the gunstock to accommodate the attachment, remove some of the wood in this area with a stock-maker's chisel.

Since trigger mechanisms on other types of military rifles vary slightly, the procedure for installing the trigger attachment also will vary. However, complete installation instructions accompany each individual attachment.

TRIGGER REPLACEMENT

For ultimate speed, safety, and accuracy in a converted military weapon, many gunsmiths prefer to replace the issue trigger with a new, easily adjustable trigger mechanism. These mechanisms are available from gunsmith suppliers. In most cases, only minor alterations are required to replace the issue trigger with the more modern one.

Dayton-Traister Company manufactures an all-steel trigger mechanism with case-hardened operating parts, expertly honed to deliver crisp, uniform trigger pulls every time. These are available from Brownells, Inc. The tempered, treated, and blued springs resist corrosion and fatigue, and the grooved finger area helps provide a nonslip finger grip. Trigger mechanisms are commonly available for most military weapons and sporting arms.

Custom trigger mechanisms normally are adjustable from 2 to 6 pounds to give a converted military rifle a faster lock-time and to increase the accuracy with a uniform, crisp trigger pull.

SINGLE-STATE TRIGGERS

Next comes the plain single-stage trigger found on many single-shot shotguns and hammer rifles such as the Winchester Model 94 or the Marlin Model 336. This type of trigger is either entirely loose in its guard or entirely stationary. When squeezed, the trigger remains stationary until it releases the hammer or firing pin; then it gives way suddenly, discharging the rifle. Many of these triggers come with a very hard pull of up to 8 pounds, which is too much for any rifle. Some of these triggers also have a drag or creep, giving way slightly after a pound or two of pressure is applied. The perfect trigger squeeze is one that does not move at all until it releases the hammer or cocking piece.

To lighten and smooth this type of trigger, you will need a set of Arkansas stones of different shapes, a sheet or two of fine emery paper and crocus cloth, and a small trigger scale to measure the weight of pull. You will also need disassembly tools and a magnifying glass.

Figure 6 shows the trigger, the hammer, and the half-cock and full-cock notches in the hammer of a plain trigger. In this case, the trigger and sear are combined, but in some guns the trigger and sear are separate pieces.

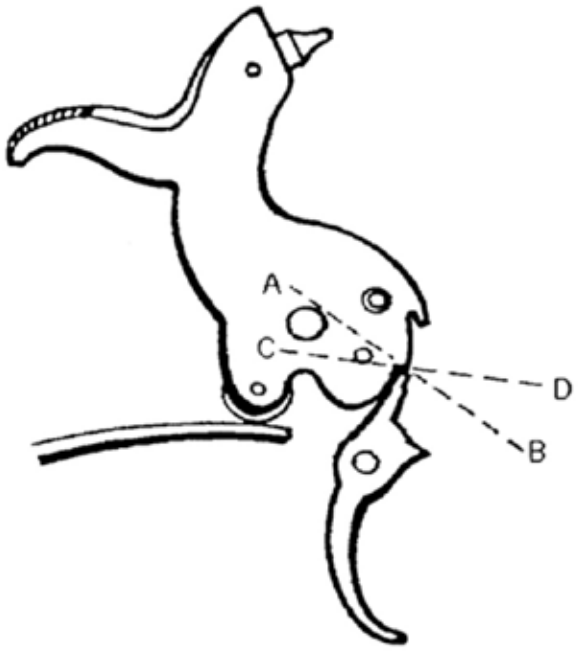


***Figure 6**: Changing the angle of contact from A-B to C-D will usually lighten trigger pulls on simple trigger mechanisms.*

First examine the surfaces of the sear and hammer notches to determine the angle at which they meet each other. If the pull is heavy, the surfaces will probably come into contact like the dotted line A-B in Figure 6, showing that the sear, in order to release itself from the hammer notch, must act strongly against the tension of the hammer mainspring. This causes the heavy trigger pull. Also, the sear may be too deep in the notch, requiring much lifting before it disengages itself.

Remove the hammer and sear from the action and use the Arkansas stones to hone the two contact surfaces so the angle of contact will be changed to that shown by the line C-D in the illustration. During the honing, check the fit frequently to ensure that the surfaces will fit exactly when reassembled. The honing must also be done straight; that is, you should hone no more on either side than in the middle.

Go very slowly, assembling the parts often to test the weight of the trigger pull by the trigger scale. Watch the scale as the pull is applied, and notice the maximum figure on the trigger pull gauge just before the trigger gives way. As you get down to within a pound or so of the desired pull, be extremely careful, since frequently three or four more strokes of the honing stone will be all that is required.

In most cases, the above operation is all that is required to get a good trigger pull from this type of trigger mechanism, but in some cases the sear may take too deep a bite in the hammer notch. When this occurs, work only on the sear — not the hammer notch. If the hammer notches are not perfect, there is a good chance that, upon releasing the sear, the hammer will catch in the half-cock as it falls, preventing the gun from firing consistently. One way to prevent the sear from entering into the notch too deeply is to use a small center punch to raise a small crater just in the rear of the notch, as shown in Figure 7. The sear will then strike against the raised portions of the metal around the crater and will not settle down as deeply in the notch.

If the raised portions of the crater are too high, the situation is easily corrected with a few strokes of the honing stone over them. This cratering will also eliminate the majority of trigger creep, since this is usually due to the sear entering the notch too deeply. If it does not eliminate creep, then it is because the contact surfaces of the sear and notch are not smooth enough; this can be corrected by honing both surfaces smooth.

Set triggers have been used on both sporting and target rifles for quite some time. The first ones used on modern sporting arms were on the Mannlicher rifles manufactured around the turn of the century, although the Winchester Repeating Arms Company first offered set triggers on their Model 1873 lever-action rifles. There are many kinds of set triggers, but the most common contain two triggers within the trigger guard, as shown in Figure 8. The front trigger, when pulled alone, operates like a normal trigger. But when the rear trigger is pulled first (until it clicks), the front trigger is then set, and upon touching the front trigger with only an ounce or so of pressure, releases the hammer or cocking piece. This is truly a "hair trigger," and the trigger should never be set until the gun is ready to be fired. Another type of set trigger contains only one trigger. When this is pulled rearward, ordinary pressure is required to release the hammer. However, when the trigger is first pushed forward until it clicks, this sets the rearward movement, which will release on a very minute amount of pressure.

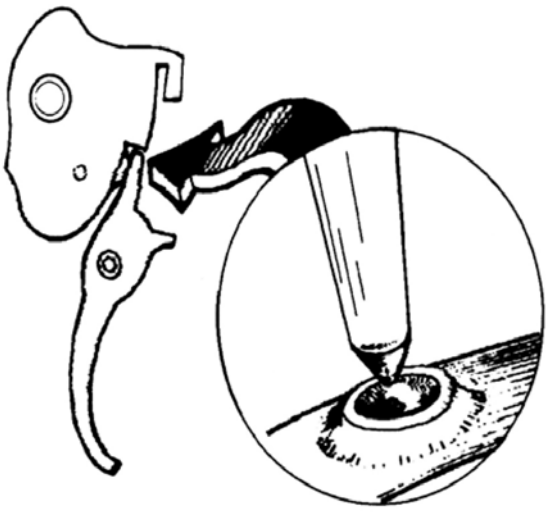


***Figure 7** : Cratering the contact area on the hammer notch of simple trigger mechanisms will prevent the sear from entering the hammer notch too deeply.*

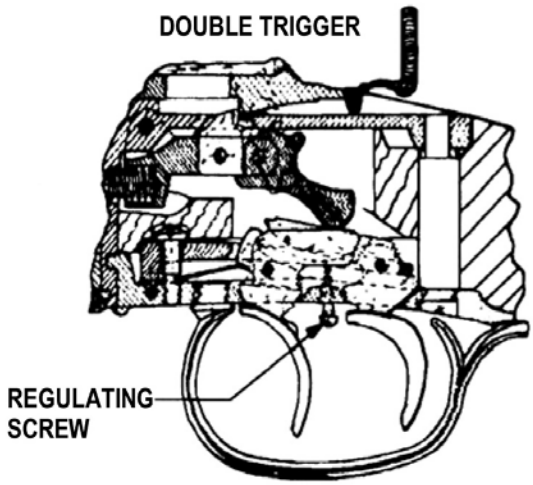


***Figure 8**: The double-set trigger mechanism found on European-type bolt-action rifles.*

Many of the muzzleloading rifles of the past century utilized a set trigger, and this practice has been carried over on the modern reproductions of these rifles. Nearly all are adjustable by means of two adjusting screws, either in the lock or on the outside of the rifle near the triggers.

The mechanical actions of all set triggers are very similar in that the action of setting compresses and locks back a strong lever or hammer. The sear of this hammer is attached to the front trigger and is very delicate. On touching the front trigger, this sear releases the hammer or lever, which then flies up and, with a blow, drives the true sear away from the true hammer or cocking piece, causing the firearm to discharge.

HANDGUN TRIGGERS

Early handgun triggers were nearly all similar to the plain trigger used on most shotguns and hammer-type rifles, and the instructions given for these also apply to the handgun triggers. This, of course, applies only to single-action revolvers like the Colt Peacemaker and others. Double-action revolvers, when used in the double-action mode, depend a great deal on the strength of the mainspring and its tension on the hammer as to the amount of trigger pull required. Brownells, Inc. offers several spring kits for various handguns, and any of them will greatly improve trigger pull and hammer slap. For example, the Bullseye Kit No. 2 is designed for the Colt MK III series revolvers and consists of a new hammer and trigger spring which are designed to lighten both the double- and single-action functions without any other work or adjustments to the revolver. Since the double-action trigger pull on these revolvers is almost legendary in the industry, this modification kit will do wonders for the revolver's trigger pull, improving accuracy and eliminating jerking. Kits are also available for other models such as Ruger, S&W, Browning, Dan Wesson, etc. Figure 9 shows a typical single-action revolver trigger assembly.

Some of the older handguns, especially double-action revolvers, had their trigger pull lightened by grinding the mainspring to make it thinner and easier to operate. However, this practice also made the mainspring weaker, and misfires were frequent. Other types of revolvers have a small screw on the front of the grip-frame near the bottom of the handle. This is a strain screw that is used for applying tension to the mainspring. Some people have tried to lighten the trigger pull by loosening this screw, but this almost always causes trouble. This screw needs to be tight to cause the mainspring to lie with the proper curve; otherwise, the action of the revolver will be impaired.

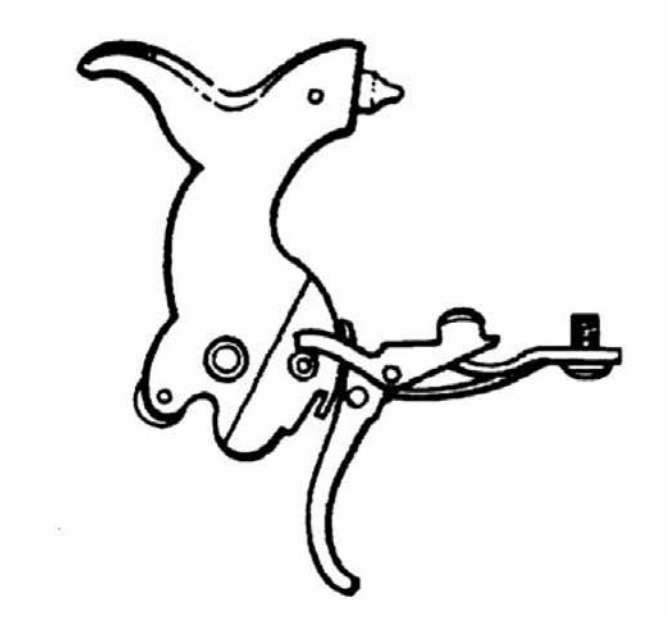


***Figure 9**: Typical single-action revolver trigger assembly. This is the style used on the Colt, Ruger, and other brands of single-action revolvers.*

Semi-automatic pistols such as the Colt .45, Browning, Star, Savage, and others can have their trigger pull improved, but care must be taken in this area when altering the trigger. If a very delicate trigger pull is obtained, a jar of the action may cause the hammer to follow the slide, resulting in an automatic-firing weapon which is both dangerous and illegal.

Trigger sears and hammers on automatic pistols are honed in much the same way as the firing mechanism on shotguns and exposed hammer rifles. But after the adjustment has been made, the pistol should be tested by cocking the hammer and, with the finger off the trigger and the grip safety compressed, drawing back the slide and allowing it to slam forward several times as violently as possible. If the hammer follows the slide (fails to stay cocked), the pull is obviously too light.

A light pull can sometimes be corrected by increasing the tension on the sear spring by bending it, but in most cases it is best to order a new hammer and sear and start over. Take great care in honing these parts of the automatic pistol to avoid making this mistake.

Semi-automatic pistols with no hammer exposed usually have a sear which engages a shoulder or notch in the plunger or firing pin. Most of these weapons have a heavy, dragging pull, which in some constructions cannot be overcome, due to the leverage employed in the design. In other types, it can be somewhat improved by carefully honing the contact surfaces so that they will slide evenly and smoothly. In general, the depth of contact or the angle of the surfaces should not be changed, since in many semi-automatic pistols — especially of foreign make — the safety only prevents the trigger from being pulled, but does not prevent the sear from jarring out of engagement with the firing pin if the gun is dropped. When these pistols are loaded they are always cocked, and to alter the sear or firing pin might render the pistol extremely dangerous to carry loaded. For this and other reasons, it is good practice never to load a round into the chamber of a semi-automatic pistol until the gun is ready to be fired. Just slide the magazine into its place in the grip, but do not chamber a round. When firing is completed, unload the pistol and make sure the chamber is empty.

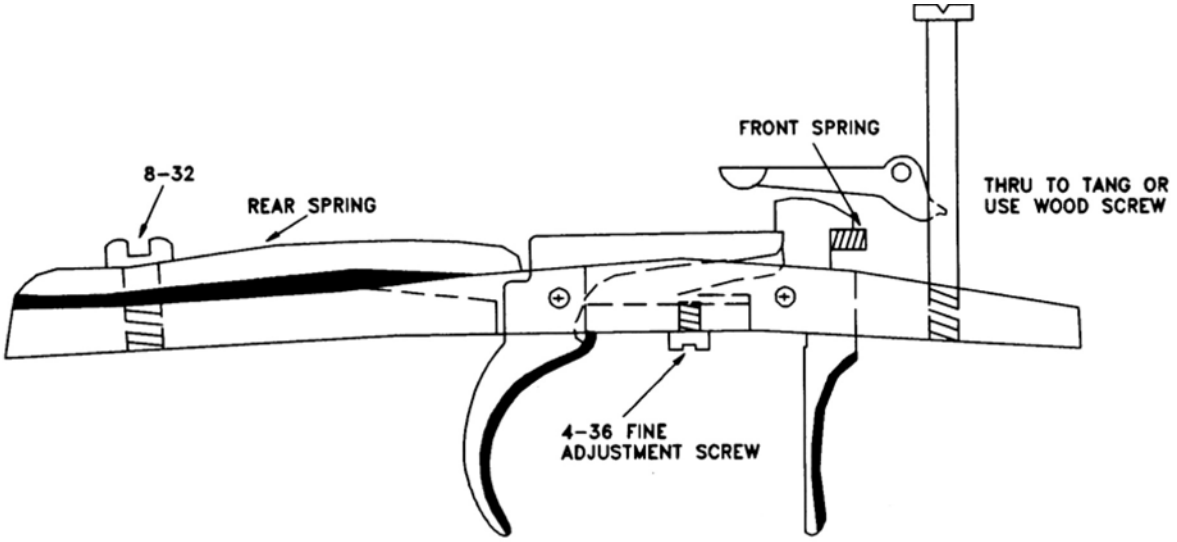


***Figure 10**: Typical black-powder double-set trigger mechanism. Note the trigger-adjustment screw between the front and rear trigger. The screw adjusts the pressure required to release the true sear when the front trigger is touched.*

TRIGGERS FOR MUZZLELOADERS

Those who have cleaned up and restored an old muzzleloader to firing condition can tell you that the trigger pull on these weapons leaves a lot to be desired. Even the modern reproduction models often have an extremely hard and rough trigger pull so that good accuracy is almost impossible. However, nearly all of these trigger mechanisms can be improved relatively easily — provided you have patience.

To smooth up the trigger pull on one of these guns, disassemble the lock from the stock to gain access to the mechanism. Use only screwdrivers that fit the screw slots exactly, and on older models (which will probably be rusted) use plenty of penetrating oil to help loosen the screws. Using a spring vise, remove the mainspring from the lock and then release the sear. Cycle the action a number of times until you are thoroughly familiar with the interaction of each part. You may now wish to make a sketch or take a close-up photo of the lock parts intact to ensure that it can be assembled correctly at a later date. At this time, examine each part very carefully, looking for any burrs or drag marks indicating which areas should be honed for a smoother action. Make a note of your findings and then disassemble the parts that need to be worked on. Again, older locks may require soaking in a penetrating oil or kerosene to enable the screws or pins to be removed without damage.

Once the lock has been disassembled, clean all oil and debris from the back side of the lock plate and then examine it carefully. Chances are you will find a rough surface, left just as it was when cast. First use a No .2 cut mill file to smooth the worst of this roughness down, ending up with various grits of wet-or-dry abrasive paper for the final polishing. Also polish the side of the tumbler and sear at this time. You will also want to check the space between the bridle and the lock plate to see if it is too wide. If it is, file the shoulder of the bridle at the point it makes contact with the lock plate, until just enough room remains for the tumbler to rotate without binding.

In many muzzleloading rifles, the sear is somewhat narrower than the tumbler, causing excessive side play even when the bridle is snugged up tight on the tumbler. This problem can be corrected by inserting a thin washer next to the lock plate to shim the sear.

Next examine the hammer. Sometimes it will be canted and dragging against the lock plate, or there may be excessive play between the hammer and lock plate. If this is the case, file the square hole (or peen, whatever the case may be) to make the hammer stand parallel to the lock plate without too wide a gap.

Hone the sear and sear notch in the tumbler with a three-cornered Arkansas stone. In doing so, keep the sear surfaces square and parallel to retain full contact across their entire width. After establishing the correct sear angles, polish the sear as discussed previously, but be careful not to deepen the sear notch on the tumbler during the process. To remove any creep, drill a very small hole in the tumbler, just below the sear notch and press-fit a small pin that will fit snugly into the drilled hole. Then file the pin back just enough to allow a safe sear engagement. Never file down the top of the sear notch on the tumbler to reduce creep. This will usually cause the sear to catch on the half-cock notch as the tumbler rotates in firing.

The strong springs in the older muzzleloaders were the chief cause of a heavy trigger pull. This was the main reason for set triggers. In most cases it is best to replace the old spring with a new, lighter one. However, if the old spring is in good condition, it can be lightened considerably by using a small grinding wheel in one of the rotary tools, carefully grinding the spring lengthwise until the desired tension is attained. You do not want to grind the spring to the point where it might break or be so weak that misfires may result.

Once all of the surfaces have been polished, they will wear much longer if hardened by first heating the part to cherry red and then dipping the part into commercial hardening compound such as Kasenit, and then reheating it. Use a wire brush to clean the scale off the part and then lightly polish it before reassembling it. Of course, a spring cannot be hardened further once the proper temper has been reached. Only mating surfaces such as sears should be hardened. Then use your notes and sketches to reassemble the lock. Test and adjust accordingly. Figure 10 shows a typical black powder double-set trigger mechanism.

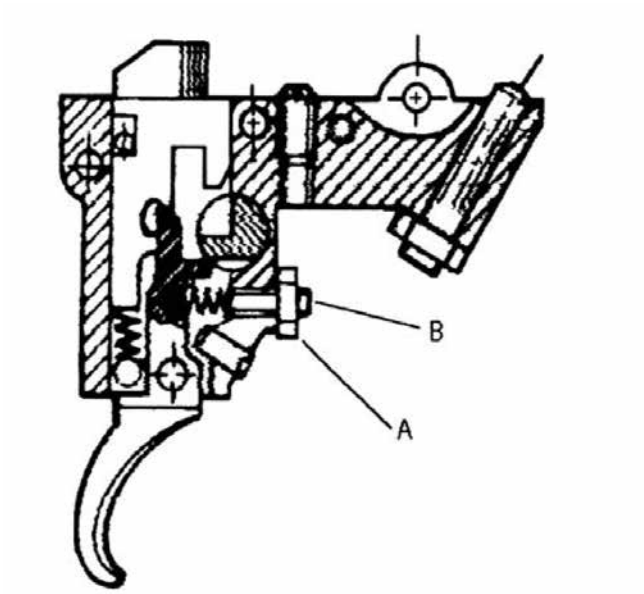


***Figure 11**: Trigger assembly for Sako bolt-action rifle showing points of adjustment.*

ADJUSTING FACTORY TRIGGERS

Most of the better centerfire rifles manufactured today come with adjustable trigger mechanisms. The Sako trigger assembly, for example, is factory set for perfect sear engagement. The weight of pull and backlash can be adjusted simply and positively without too much trouble. Look at the illustration in Figure 11 and then make the following adjustments:

- To lessen the weight of pull, loosen locknut A and turn screw B until the desired weight of trigger pull is reached. Then again tighten locknut A.
- To increase the weight of pull, reverse the above procedure.
- Backlash may be reduced by turning the end screw.

Make sure that all remaining screws are tight before attempting any of the adjustments just described. Other makes of trigger assemblies may be adjusted in a similar way; adjustment instructions normally accompany the firearm.

INSTALLING NEW ADJUSTABLE TRIGGERS

Custom rifles built on military rifle actions, such as Mauser, Springfield, Enfield, etc., normally have their trigger mechanisms replaced with adjustable, single- stage replacement triggers. Some of the more popular brands are those manufactured by Dayton-Traister, Timney, and N.O.C. All of these usually require some fitting, with honing stones and small files. Also, wood must be removed from the trigger recess in the rifle stock. Some of these, especially set trigger assemblies, also require modification of the trigger guard and floor plate. There are really no set instructions that can be given to install these trigger assemblies perfectly each time. It is a matter of trial-and-error: the trigger is tried in position on the receiver; tight areas are noted; these areas are honed down; and then the trigger is retried. Once the trigger assembly operates perfectly with the rifle's action, the barreled action and trigger assembly are lowered into the stock. When an obstacle or tight resistance is met, a portion of the wood is removed in much the same way as when inletting a stock for a barreled action.

The importance of a good, crisp trigger pull cannot be stressed too much if the best possible accuracy is desired. Trigger work is often thought of as a highly specialized field suitable only for the professional gunsmith. While this statement is partially true, there is no reason why a seasoned hobbyist cannot obtain good results, provided the work is taken slowly, that every move is carefully analyzed first, and that care is taken to obtain the best workmanship possible. It is suggested that the beginner's first project be done on a cheap military trigger mechanism before attempting any such adjustment on a more valuable firearm. When you have sufficient experience, you may then progress to more complex trigger adjustments on more expensive weapons.

SELF-TEST QUESTIONS

Please check your answers on page 18.

1. ***True or False.*** **Although a good trigger pull makes a rifle more enjoyable to fire, it never affects accuracy.**
2. **To lighten the trigger pull of the average bolt-action rifle, what are the two areas that should be polished first?**
3. **What type of rifle utilizes a trigger mechanism with two fulcrums at the top of the trigger?**
4. **When any trigger mechanism has been worked on, what should be done before using live ammunition in the gun?**
5. **How may the trigger pull be lightened on some military rifles that use a coil spring for the sear spring?**
6. **When the sear enters the hammer notch too deeply, what is one simple way to correct this condition?**
7. **What is one way to lighten the trigger pull on a simple trigger mechanism like the ones found on single-shot shotguns?**
8. **If you try raising a crater on a simple trigger mechanism with a center punch and you find the crater too deep, how can you correct the problem?**

Chambering

CHAMBERING REAMERS

In general, there are three types of chambering reamers: the rougher, the finish reamer, and the burnishing reamer. The rougher is designed to cut out a lot of steel fast, and gives only approximate chamber dimensions. If all three types of reamers are used, this is the one that will be used first. Next comes the finishing reamer, which cuts the roughed-out hole in the barrel (made with the rougher) to exact chamber dimensions. The burnishing reamer exerts only a scraping and polishing action. It is used as a final step to give a glass-smooth finish to very fine barrels. It will remove no appreciable amount of steel.

Chambering reamers are not cheap. They cost anywhere from $50 to $100 each, depending on the type. Therefore, the average gunsmith will try to get by with just the finishing reamer. This practice is okay in some cases, but it is a waste of time and money in others. If you are chambering a .45-caliber barrel, for example, to .45-70, there is not much metal that has to be removed, since the .45-70 cartridge is almost a straight case with very little taper. In this case, the finishing reamer will do very nicely for the entire job, and will remain sharp (if correctly oiled) for several chambering jobs. At the other extreme would be chambering a .25-caliber barrel to accept the .257 Weatherby cartridge. In this case, there is a lot of metal that needs to be taken away to accept this big magnum case in comparison to the small .25-caliber bore, and if the job is done only with a finishing reamer, the reamer would probably get too dull to cut before the full chamber dimensions were reached. In this latter case, you definitely want to use a rougher first (Figure 12).

However, to save the expense of purchasing a rougher, some experienced gunsmiths use an undersized twist drill to remove excess metal from the chamber area before using the finishing reamer to cut the chamber to exact dimensions. This is fine if you know what you are doing, but it is also a good way to get the chamber off center to the bore, and possibly ruin the job completely.

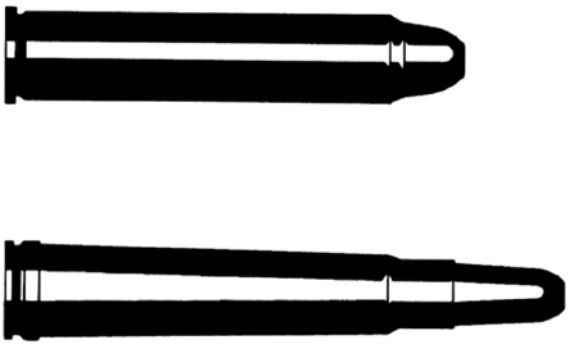


Figure 12: *It stands to reason that the straight cartridge case (top) requires less cutting than the bottleneck cartridge case (bottom).*

Look at the cross-sectional view of a rifle barrel shown in Figure 13. Notice that the chamber section (cartridge chamber) begins at the breech end of the barrel (the left-hand end with the barrel threads) and extends toward the muzzle through the bullet seat area. This area is what a chambering reamer cuts. With these facts in mind, let us see how the chamber of a rifle barrel is cut.

To chamber the barrel, chuck the muzzle end of the barrel in the lathe's three-jaw chuck, using a lathe center in the tailstock at the chamber end to align the barrel perfectly between centers. Then use a steady rest on the lathe bed to secure the barrel in this position once the tailstock is removed for actual chambering. A dial indicator must be used here to ensure perfect alignment. Once the steady rest and barrel have been secured, remove the tailstock center from the chamber end and insert a drill chuck, with the chambering reamer in the tailstock where the center had been.

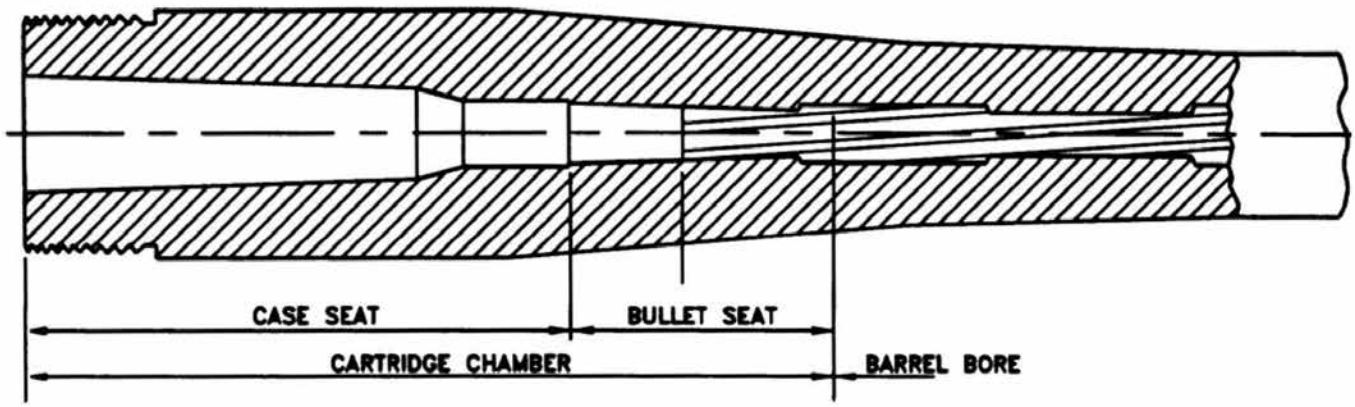


Figure 13: *Cross-section of a rifle barrel, showing case seat, bullet seat, and barrel bore.*

Adjust the lathe to run on its lowest speed and start the barrel rotating. Carefully oil the reamer with clean cutting oil and slowly start the reamer into the chamber area. Depending upon the size of cut, let the reamer cut to a depth of about ½" before removing it from the chamber to be cleaned and re-oiled. In doing so, never reverse the reamer in the chamber; always keep it turning in a clockwise direction. Since the reamer remains stationary, this means the barrel must turn in a counter-clockwise direction. To allow otherwise will damage the chamber. Use a clean rag to wipe the reamer clean of any metal chips; also, blowout the chamber with compressed air before taking another cut. This procedure is repeated until the reamer is nearly "home" by about 0.02 inch. Leave this much space until the receiver is fitted, to allow for headspace correction.

If the barrel has not been threaded prior to chambering, leave the barrel in its present position and thread as discussed earlier in this course. The thread of the barrel should fit the receiver without any loss of motion, and the barrel should screw up by hand to within about ¼" on the circumference of its position when fully home.

Remove the barrel from the lathe bed and tighten the barrel onto the rifle receiver with one of the several types of barrel vises available on the market. Or, if you have a bench vise of sufficient size, merely bore out a set of oak blocks to grasp the barrel. Then, coat the barrel with powdered rosin and tightly clamp it between the two wood blocks in the bench vise. A suitable wrench is then used on the receiver to tighten it onto the barrel; the type will vary, depending upon what type of receiver is used.

HEADSPACE

Next comes *headspace*: the correct distance between the head of the cartridge in the chamber and the face of the bolt, or breechblock. The headspace should be such that when a cartridge of maximum dimensions is positioned into the chamber, the bolt will close without effort, and have almost a friction contact with the head of the cartridge case. Figure 14 shows the dimensions of a rifle chamber for the .30-06 cartridge.

Headspace gauges are available to determine the proper dimensions, and are designated "Go," "No-Go," and "Field." In most cases, you should have both Go and No-Go gauges.

Secure the barreled receiver into a padded bench vise, with the muzzle pointing toward the floor. Clean the chamber thoroughly of all oil and metal chips, and then place the Go gauge into the chamber. Insert the action bolt and try closing it. It will probably not close completely because the chamber was

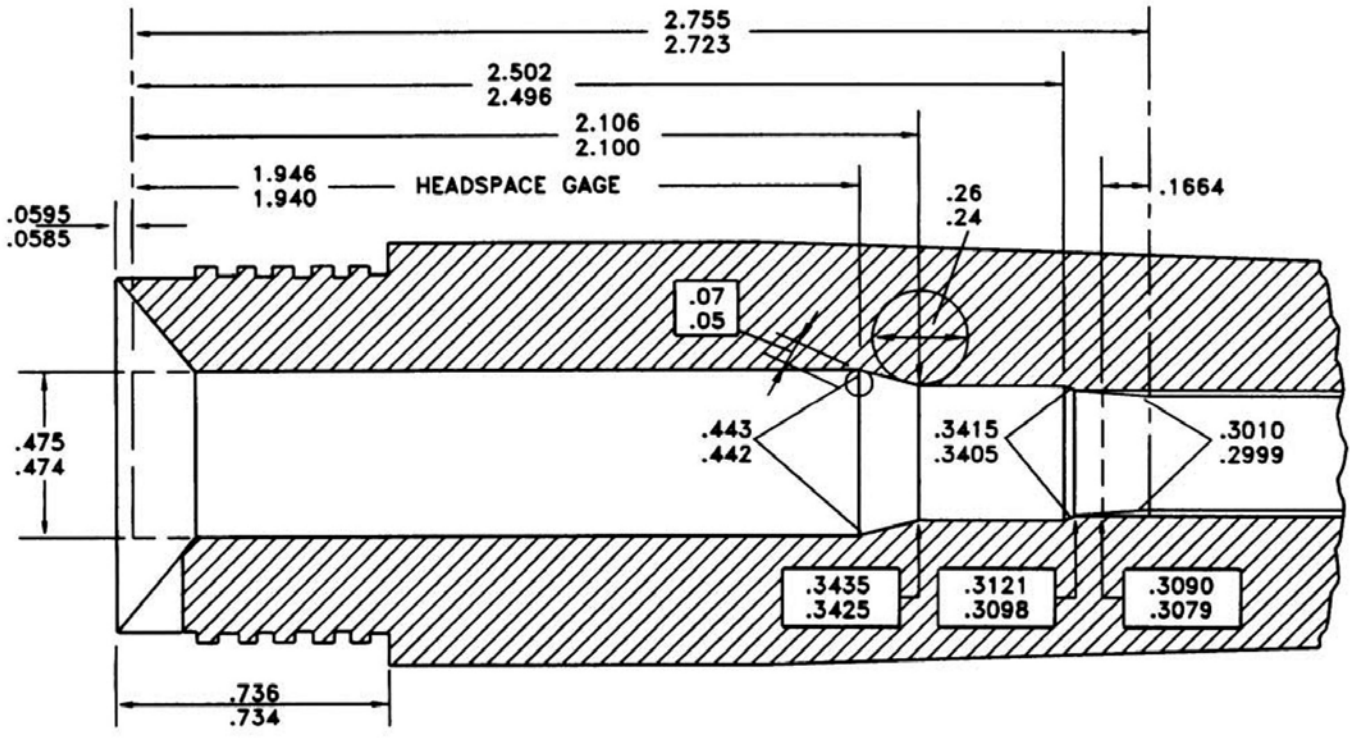


Figure 14: *Dimensions in inches of a rifle chamber for the .30-06 cartridge.*

purposely left about 0.02" too short when the finishing reamer was removed. If this is the case, use an extension handle on the chambering reamer (to get through the receiver and into the chamber area of the barrel), and gently insert the reamer into the chamber. Next, use a tap wrench on the chambering reamer extension handle, use cutting oil on the reamer, and take one light cut (one revolution). Remove the entire chambering assembly, wipe both the chamber and reamer clean, and again try the Go gauge. Continue this operation of taking one light cut and trying the Go gauge until finally the bolt will close tightly on the Go gauge.

Now, use a polishing cloth, such as 500-grit abrasive paper, positioned into a split end of a wooden dowel which, in turn, is chucked into a fast electric drill (or lathe). This is used to polish the chamber just enough to be bright and free of all tool marks.

Try the Go gauge once more. The bolt should close snugly, without much effort. If you think too much effort is required, go back to the reamer. Take one more light cut, then polish. To be sure the job has been correctly done, use the No-Go gauge as a check. The bolt should not close on this gauge; if it does, great force should have to be applied to do so.

Once you get some practice and are confident about taking accurate measurements, the time involved can be cut considerably by taking measurements prior to chambering the barrel. A good machinist or gunsmith can leave out this trial-and-error method just described and usually produce an accurate cut right on the lathe.

To complete the chambering while the barrel is still chucked in the lathe, first use a depth micrometer. Holding the micrometer flush across the front ring of the receiver, measure down to the inside of the front shoulder, where the end of the barrel will terminate. Take another measurement, with the stripped bolt in place (locked in its closed position), from the front right of the receiver to the bolt face. The second measurement, minus the first measurement, minus about 0.002" for a crush factor is the distance the headspace gauge must protrude from the chamber breech to rest against the bolt face. With these measurements, many gunsmiths are able to obtain a perfect chambering job on the first time around, but it takes a little practice to perfect.

SELF-TEST QUESTIONS

Please check your answers on page 18.

9. **The beginner should not try for final dimensions when chambering a barrel in the lathe. To what distance should the chamber be cut?**
10. **When much metal is to be cut from the chamber area, what type of chambering reamer should be used prior to using the finishing reamer?**
11. ***True or False*. During final chambering, the No-Go gauge should be used for the trial-and-error cuts.**
12. **What is the distance between the head of the cartridge in the chamber and the face of the breechbolt called?**

Free Boring

A rifle with excessive headspace of between 0.035" and 0.040" gains from 75 to 100 feet per second velocity, depending on the cartridge. The reason for this increase in velocity is that this increased headspace gives the bullet a little space to travel before it strikes the lands and grooves (rifling) of the barrel. A bullet will enter into the rifling faster with this slight running start, so to speak, than from a standing start with the bullet already touching the rifling at the time of firing. But excessive headspace can also be dangerous.

Knowing the above facts, the late Roy Weatherby started experimenting with his now-famous line of Weatherby Magnum cartridges during the 1940s. Rather than allowing excessive headspace to give the bullets a running start, he cut out the lands and grooves of the rifling just ahead of the bullet seat for about ¾ inch. This practice is called *free boring*. Theoretically, free boring gives the powder gas more area to expand before the bullet encounters resistance; this reduces chamber pressure and allows for more powder in the charge, which supposedly increases the bullet's velocity.

A cross-section of the Weatherby Mark V action and attached barrel is shown in Figure 15. In reviewing this illustration, note the distance from the nose of the bullet to the beginning of the rifling in the bore. This is the *throat*, or *free bore*.

Actually, the amount of free bore in Weatherby rifles has varied over the years. The original length of free bore used in Weatherby rifles for their magnum cartridges was approximately ¾ inch. Then between 1967 and 1968, Weatherby shortened this length to $^{7}/_{16}$ inch. Therefore, those who use reloading data must be aware that the shorter the free bore, the higher the resulting pressures when the cartridge is fired. In other words, the loads must be reduced accordingly.

Experts still argue about which is best — free bore or non-free bore. Some shooters will have nothing else but free bore, while others claim that free boring a rifle is a waste of time and money. Regardless of who might be right, gunsmiths get lots of calls for free boring, and you should know how to do it if you are called upon.

If you are chambering a barrel blank for a cartridge which the customer wants free bored, you can purchase reamers so that the free boring takes place at the same time the chamber is cut. Clymer Manufacturing Co., Inc. (1645 West Hamlin Road, Rochester Hills, Michigan 48309-3368, www.clymertool.com) furnishes chambering reamers with long throats. If your customer specifies a non- standard length of free bore, Clymer will even make a custom reamer for you. The chart in Figure 16 shows a typical bottleneck cartridge with boxes for filling in the dimensions you desire. Note the box designated "Free bore length." If you want a free bore reamer for a standard cartridge, all you have to do is fill in the amount of free bore, and specify "standard dimensions" for the remaining boxes.

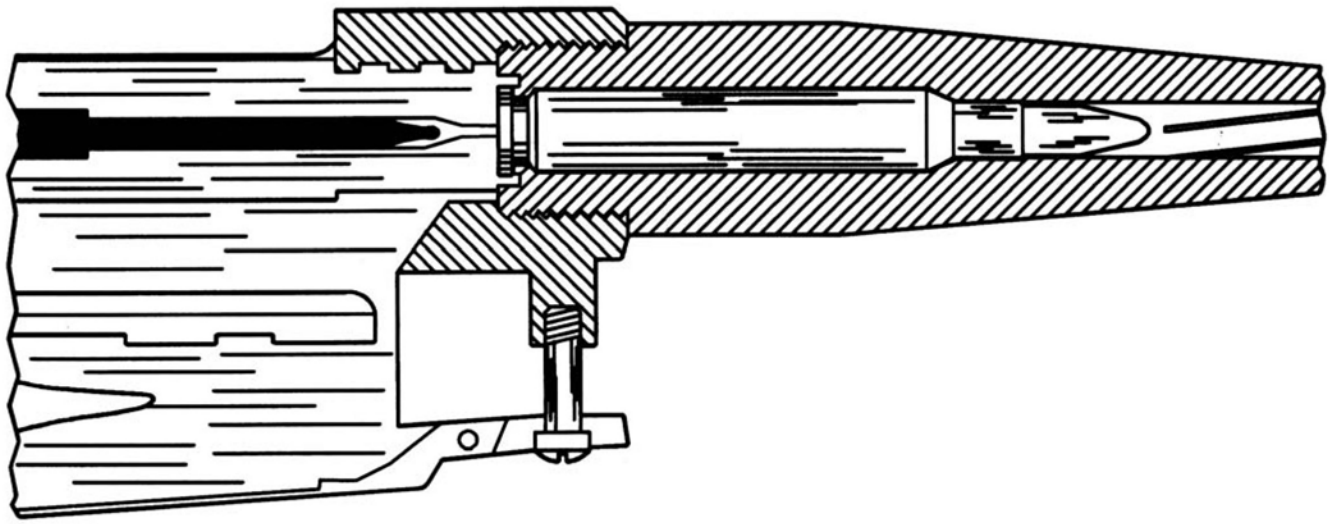


Figure 15: *Cross-section of a Weatherby Mark V rifle action. Weatherby barrels chambered for their magnum cartridges were originally free-bored for about $^{3}/_{4}$", but changed to $^{7}/_{16}$" between 1967 and 1968.*

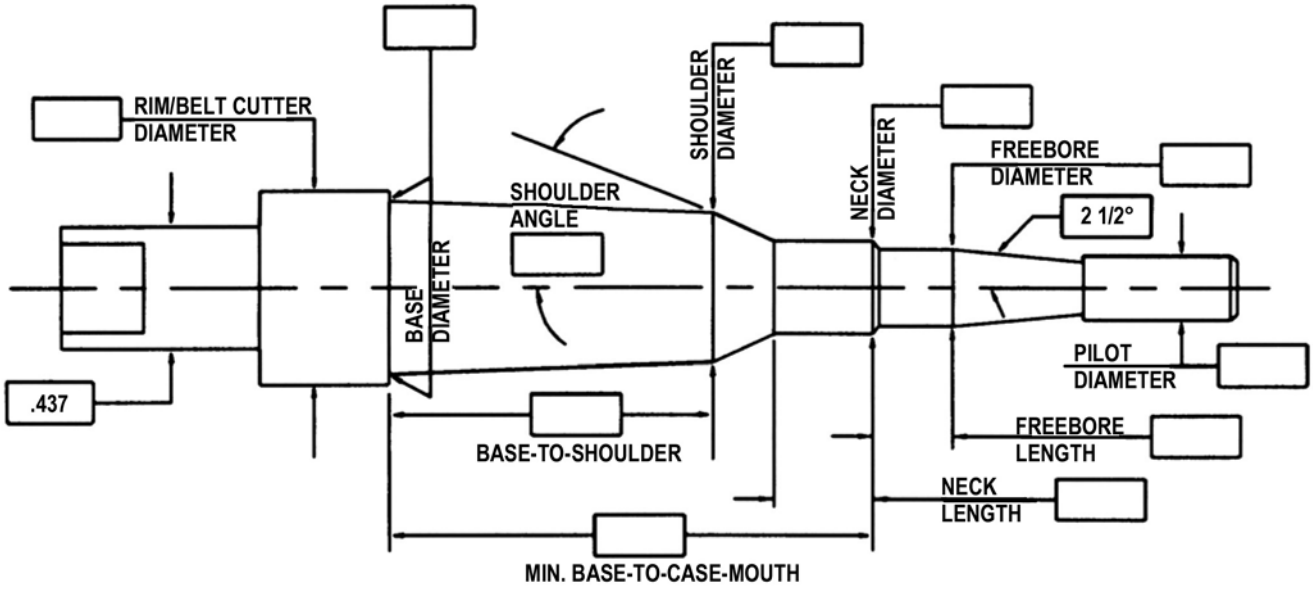


Figure 16: *Clymer chart for custom designing chambering reamers.*

Clymer also furnishes reamers for barrels that are already chambered for a certain cartridge. *Throaters*, sometimes called *free bore reamers,* are used to extend the throat of a chamber in order to give more clearance around the bullet. Some gunsmiths will also order chambering reamers with a throat section and will then use a separate throater to cut the throat of the chamber to match a specific bullet.

The standard throaters supplied by Clymer are generally 0.002" larger than the actual bullet diameter. Therefore, if 0.308" diameter bullets are used, the throat will be 0.310 inch. Two throat angles are also available as standard: 1°30' and 2½°.

All Clymer throaters have five left-hand spiral flutes to prevent the flutes from dropping into the rifling and to give a superior surface finish. The tool is 4" long with a ¼" shank diameter to fit their throater T-handles.

Free-boring is done almost exactly the same as described earlier in this lesson in the section titled Chambering. If the barrel has already been chambered, you can lengthen the throat of the chamber without any power tools. Merely purchase the proper throater, attach a throater T-handle to reach through the receiver to the chamber, and cut the throat by hand. A pilot on the end of the throater helps to align the tool with the bore.

SELF-TEST QUESTIONS

Please check your answers on page 18.

13. **What is another name for free bore reamers?**
14. **What type of handle is used on reamers to reach through a rifle action to the chamber area of the bore?**
15. ***True or False*. Free-boring a chamber is very similar to chambering.**
16. **What length of free bore did Weatherby rifles utilize prior to 1967?**

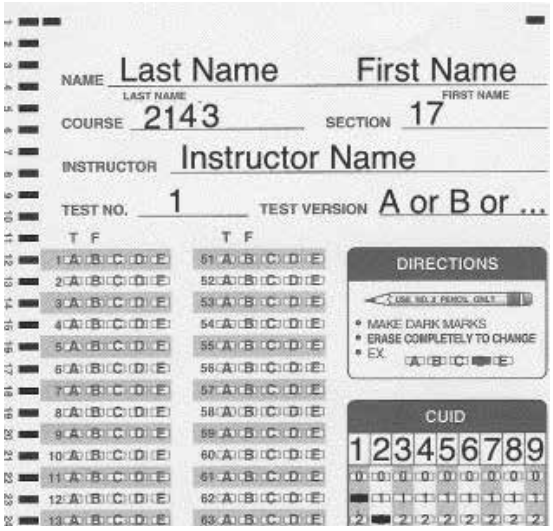
Answers to Self-Test Questions

1. False.
2. The sear and the cocking piece.
3. Older military rifles.
4. The trigger should be tested to make sure that it holds and that the safety operates correctly.
5. Cut off one of the coils.
6. Peen a crater in the hammer notch.
7. Change the angle of contact.
8. A few strokes of a honing stone will lower the crater.
9. 0.02 inch.
10. Roughing reamer.
11. False.
12. Headspace.
13. Throaters.
14. A T-handle extension.
15. True.
16. ¾ inch.

Lesson Questions

THIS IS LESSON NUMBER 2180.

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



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

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

1. **What was a trigger originally called?**
   a. Releaser.
   b. Striker.
   c. Cocking piece.
   d. Tricker.

2. **What are the three main parts of a trigger mechanism?**
   a. Hammer, sear, and trigger.
   b. Trigger, trigger guard, and floor plate.
   c. Mainspring, pivot pin, and trigger.
   d. Side plate, side plate screws, and mainspring.

3. **What is the best trigger pull for general use?**
   a. 1-2 pounds.
   b. 2-4 pounds.
   c. 3-6 pounds.
   d. 8-10 pounds.

4. **What is the best tool to use when polishing the sear and cocking piece on a trigger assembly to make the trigger pull smoother?**
   a. Honing stones.
   b. Bastard file.
   c. 240-grit abrasive paper.
   d. 600-grit abrasive paper.

5. **Who manufactured a trigger attachment that may be used on military trigger assemblies to improve trigger pull?**
   a. Glenn Miller.
   b. P. O. Ackley.
   c. Viggo Miller.
   d. Ray Riling.

6. **What type of factory trigger is used on the Winchester Model 94 and Marlin Model 336 rifles?**
   a. Single-stage.
   b. Two-stage.
   c. Three-stage.
   d. Set.

7. **What gunsmithing operation may be used on a simple single-stage trigger to prevent the sear from entering the hammer notch too deeply?**
   a. The sear is narrowed with honing stones.
   b. A metal file is used to deepen the hammer notch.
   c. A center punch may be used to raise a crater on the hammer notch.
   d. The angle of the hammer notch is changed.

8. **The three types of chambering reamers include:**
   a. Fluted, piped, and spiral.
   b. Throater, free bore, and spiral.
   c. Rougher, finish, and burnishing.
   d. Single-stage, two-stage, and three-stage.

9. **What is the name of the chamber area from the cartridge case mouth to the beginning of the barrel rifling?**

   a. Case seat.

   b. Bullet seat.

   c. Lands and grooves.

   d. Barrel bore.

10. **What is the name given to boring out the throat of the chamber from $^{7}/_{16}$" to ¾" ahead of the bullet?**

   a. Burnishing.

   b. Rough chambering.

   c. Free-boring.

   d. Counterboring.