Fastener Repair Lab

SONORAN DESERT INSTITUTE

SCHOOL OF FIREARMS TECHNOLOGY

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Introduction

In this lab, we will be discussing screw-type fasteners, their uses, and how to troubleshoot them. We will look at the different types of fasteners and how they are applied to firearms. This lab will also endeavor to relay pitfalls to be aware of when you come across these repairs either in your own business or over the course of your career.

This lab will take the form of several discussions, with procedures throughout to give practical experience on this topic. Procedures will be clearly noted and may be completed as they come up, or the student may read the entire lab prior to taking them on.

HOW TO DISCUSS THE JOB WITH A CUSTOMER

When you are presented with a problem on a firearm by a customer, you are sometimes put in a difficult position. Because so many different guns can have so many different types of problems, no one can expect to have the answers. This is not always apparent to every customer, however.

Each situation can present its own challenges, and most of the time you will not know exactly what you are up against until you have attempted the job. Experience will tell you either which jobs you should immediately turn down or which ones you should brace the customer for needing major repair. We will provide some techniques you can use to handle each situation.

First, always admit when you do not know something. Again, no one will ever know everything there is to know about any subject, so this is no admission of deficiency. On the contrary, you gain both a chance to show your humility (a trait some gunsmiths hardly value) and an opportunity to learn something. Always use tools such as the internet to aid in your research.

Second, always be up front with your customer about how much or how long a job will take. Let them know you will contact them if you get into the project and find it will be a bigger repair than you estimated. This will put your honesty on display and avoid most disagreements on price once the job is complete.

Lastly, do not attempt a repair in front of the customer. This will save you any embarrassment if you accidentally damage something or get stuck and have to research further. Also, maintaining your workspace apart from customers is more professional.

Why the discourse on professionalism when this is supposed to be a lab about screw repair? Because oftentimes the culprit to a long repair job or damaged firearm is caused by difficult or broken screws.

THINK THE JOB THROUGH BEFORE APPLYING TOO MUCH FORCE

A gunsmith must think and act intentionally and deliberately. Getting in a hurry will get you in a hurry for trouble. We will go over the symptoms and reasons for stuck screws in the course of this lab, but one thing you should always remember: **DON'T FORCE IT!**

Before putting excessive pressure on any screw, be sure you have examined the situation to determine what is causing the screw to be stuck. "Boogered" screw heads (an industry term) and broken screws are sometimes easily avoided if you take your time and avoid applying excessive force until it is absolutely necessary.

Tools

PROPER SCREWDRIVERS

As firearms technology progresses, the types of screws and other fasteners used in them continually diversify. What used to only consist of fillister (also called flat-head or slotted) and sometimes Philips-head screws now includes hex, Torx, square, dual-head and even some proprietary screw types. Each type uses its own screwdriver and each screwdriver must meet certain standards to be worthy of gracing the gunsmith's bench.

Fillister screw heads require a screwdriver with parallel sides that will not try to wedge themselves out of the slot when pressure is applied. Equally important is that the blade of the screwdriver is almost as thick and wide as the slot in the screw, with only minimal space left for clearance. Also, always be sure that a screwdriver is not too big or too wide to fit in a screw or you may end up with a damaged screw or gun.

Many authors have devoted page space to the importance of the fit of fillister-head screwdrivers, but the other types of screws need the same consideration.

Phillips-head screws are mostly used in hidden areas or on less expensive guns. It is important to use a screwdriver or bit that properly fits down into the recesses on the screw head. Using too big or small of a driver can cause damage to the tool or the screw, not to mention robbing the tool of much-needed torque.

Hex-head, more commonly called by the brand name Allen, can be a real pain if the proper driver or wrench isn't used. Not only do hex screws have a lower tolerance for torque, there are some guns that use metric and some that use English heads. Sometimes, an English bit will somewhat fit in a metric head or the opposite and the screw can be damaged if the wrong bit is used. Be sure to check the fit of your bits well before applying any force, and use common sense when deciding which tool to pick up. A Remington® Model 700® made in South Carolina is likely to have an English hex screw, while a Finnish Sako rifle will have metric screws.

Figure 1: Properly ground fillister-head screwdrivers are essential for removing or installing gun screws.

Figure 2: It is just as important to use the correct size Phillips-head screwdriver.

Figure 3: Hex-head or Allen wrenches come in several varieties.

Torx screws are star-shaped and have largely replaced hex-head screws in things like scope rings. Torx screws can take much more torque than Allen screws. The biggest thing to look out for with a Torx screwdriver is using a bit that is too small for the screw you are trying to turn. A too-small head can both strip the bit and the inner points of the star on the screw.

Figure 4: Torx-head drivers are capable of putting tremendous torque on a screw without damaging it.

Square, dual-head (hex-head screws that have star points like a Torx-head) and proprietary screws each present their own challenges and each must be approached individually. Remember, fit is important and the tighter the fit, the more torque that can safely be applied.

DRILL BITS

There are only two main types of drill bits that are of concern to the gunsmith: the twist drill and the center drill. Twist drills are very commonly encountered and most people have some in their garage. Center drills are shorter drills with the specific purpose of starting a hole and finding its center for the twist drill.

Twist drill bits are measured in a few different ways, and it is important to know each in order to be able to select the correct drill for the job. The four ways a drill bit is measured are:

- **Fractional**: $\frac{1}{4}$ in., $\frac{5}{16}$ in., $\frac{11}{64}$ in., $1\frac{1}{32}$ in., etc.
- **Numeric**: Sizes #80-1, with the smaller number indicating the larger bit.
- **Letter**: After a #1 drill, the next size up is the A drill and the drill size increases through the Z drill.

Figure 5: Pictured here are the three most common lengths of twist drill. From the top: Stub, jobber, and aircraft length.

- **Metric**: Drill sizes that increase by 0.1mm, rarely encountered in the American gunsmith's shop.

The tip of a twist drill bit is usually 118°, as this has been found to be the best for centering the drill in a hole without it binding. A smaller or larger angle can sometimes help drilling through different types of material, and you most likely find that out through trial and error. For further information on drill angles, see Machinery's Handbook.

There are three lengths that drill bits come in. The shortest is the stub length, also called screw machine length. This is used when rigidity is paramount and the conditions allow the use of a shorter drill.

Figure 6: A center drill is too rigid to wander, making it ideal for starting a hole.

The next and most common size is the jobber length drill. Jobber drills have flutes that are between 9 and 14 times longer than the diameter of the drill. This is the drill bit that gets the most use in most gunsmithing shops.

The last and least encountered bit length is the aircraft length or extended-reach drills. These drills are not often used, but can sometimes be lifesavers when a screw is broken in a hard-to-reach area.

Drill bits are commonly made of either high-speed steel or carbide. High-speed steel (HSS) is sometimes coated with titanium nitride or other substances to enhance its wear characteristics. Carbide is more brittle but holds a very sharp edge.

TAPS AND DIES

Taps are used to make female threads, and dies are used to make male threads. Taps are used far more often in gunsmithing than dies are, as most male threads are turned on a lathe. However, dies do still play a role.

Because dies cut on male threads, dies can also be used to repair screws that have damaged threads, but care must be taken to thread the die on straight.

Figure 7: A variety of tap wrenches.

Whether repairing a screw or threading a piece of drill rod, you must remember that one side of a die is slightly tapered as to make it easier to start on the work. When threading to a shoulder, the die is turned as far as the tapered side will go and then unthreaded and turned around to cut the threads all the way to the shoulder.

Dies must be used in a wrench. One or two wrenches are usually sufficient to handle all the dies a gunsmith may need.

Like drill bits, taps are usually made of either high-speed steel or carbide. High-speed steel is most commonly used and will cut through most materials the gunsmith will encounter if proper procedures are used. Carbide taps may be needed when tapping especially hard material, but care must be taken to not break the more brittle material.

Taps also come in three common types:

- Taper tap – This tap has a long taper before the threads start, allowing the tap to ease and center itself in the hole. This type of tap should always be used first, when possible.
- Plug tap – Plug taps have a much shorter taper leading to the threads and will cut threads deeper into a blind hole. This tap should be used to start the threads in a blind hole that is too shallow for a taper tap to bite.
- Bottoming tap – This tap has no taper and is used to cut threads all the way to the bottom of a blind hole after starting with a taper or plug tap.
- Taps and dies are both sized according to the threads they will cut, such as ¼ x 20, and we will look at those sizes a little further on.

Figure 8: Three different taps. From left: Taper, plug, and bottoming taps.

Figure 9: Screw extractors: square and EZ-Out types.

SCREW EXTRACTORS

Screw extractors are used to remove broken or stuck screws. They are designed to be put in a predrilled hole in the broken screw and turned to remove the screw. If removing a right-handed screw, the flutes on the extractor will bite when turned to the left.

There are two types of screw extractors: spiral-fluted and straight-fluted.

- Spiral-fluted screw extractors, sometimes referred to by their trade name, EZ-Outs, are basically very coarsely threaded screws.
- Square-fluted screw extractors have a tapered square shaft with a flute on each corner.

Screw extractors are made of very hard steel that can break, and too much pressure can actually push a screw outward, farther sticking it in the threads of the hole you are trying to get it out of. Be careful not to torque too hard on your screw extractors.

Figure 10: Die wrenches for holding round or hexagonal dies.

TAP EXTRACTORS

This tool has several claws that go in between the flutes on a broken tap that allow you to apply pressure to remove it. You can get different extractors to remove broken taps with three or four flutes. In practice, they are used like screw extractors — inserted into the broken tap and used to unscrew it.

DRILLING FIXTURES

Drilling fixtures are used to position the work in a precise position to accurately locate a hole to be drilled. These fixtures may also include bushings for the drill and tap to pass through to maintain straightness.

When a shop has a mill or a very accurate drill press, drill fixtures are unnecessary, but can be helpful in saving set up time.

TORQUE WRENCH

This is a wrench with a spring in it that, when compressed, allows the wrench to only apply a certain amount of rotational force to the screw or bolt being turned. Once reaching this amount, measured in inch-pounds, the wrench will click or snap and you will not be able to apply any more force.

Torque wrenches come in either the traditional wrench form or as something similar to an interchangeable bladed screwdriver. Each has its uses in the gunsmith's shop, but the screwdriver type is used more frequently.

Figure 12: From left: A screwdriver-shaped torque wrench and an impact driver.

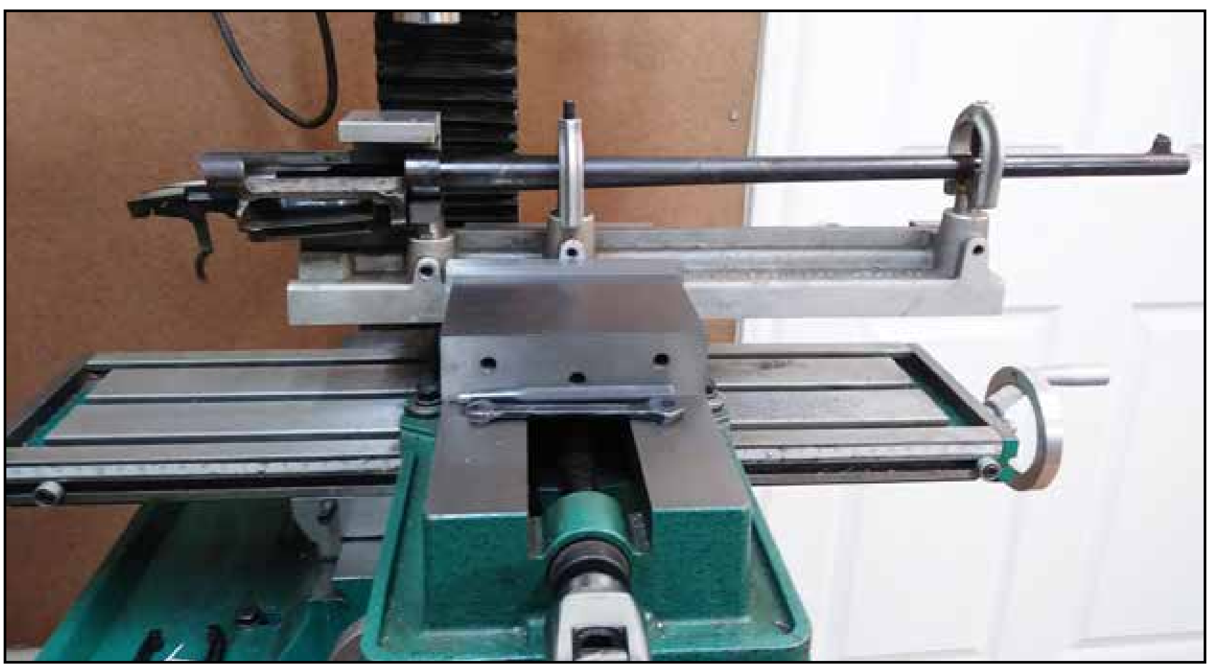

Figure 11: A drilling fixture set up in the mill.

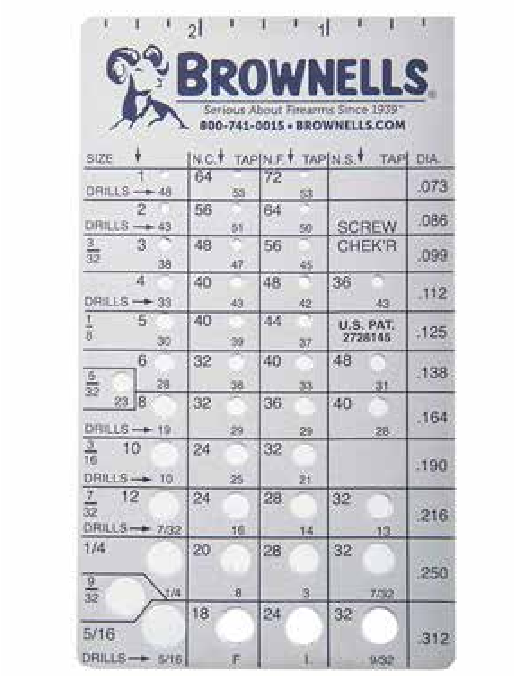

Figure 13: A screw checker.

THREAD GAUGE

A thread gauge indicates the threads per inch (tpi) of a screw, along with the screw's pitch. Thread gauges are available for English and metric threads.

SCREW CHECKER

When you need to verify what size a common gun screw is, a screw checker is a very valuable tool. Screw checkers are pieces of flat steel that have several holes threaded or drilled into them. The screw checker is sold by Brownells and includes the tap drill size, several thread sizes for each bolt size, and the diameter of the screw.

PIN GAUGES

Pin gauges, sometimes also called plug gauges, are somewhat of a luxury, though once you have them, you will wonder how you ever worked without them. They come in different sets that range between sizes. The two most useful are the .062 – .250 in. and the .251 – .500 in. sets. The gauges can be used to accurately tell the size of an existing hole, as well as to help align the work in machines.

Pin gauges are 2 in. in length and are graded by a letter and plus/minus designation. Typically, the best gauges for a gunsmith shop are a minus Class ZZ set. That means that the gauge will have a tolerance of -.0002 in. from the stated dimension.

Figure 15: The two most useful sets of pin gauges.

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Types of Screws and How They Are Designated

METAL VS WOOD

There are several types of metal screws, but the one used almost exclusively in gunsmithing is the machine screw. Machine screws have a finer thread and are more precisely sized than wood screws.

Wood screws have very coarse threads for tapping themselves into wood when turned in the first time, as well as having more surface area to grip the wood. Wood screw sizes, while standardized in areas like carpentry, are usually proprietary to each individual gun manufacturer.

MACHINE SCREW SIZES

There are a couple of definitions one should know about threads before we proceed:

- **Major diameter**: The largest diameter on any thread; the outside diameter on a male thread.

Figure 16: The difference can clearly be seen between a machine and wood screw.

- **Minor diameter**: The diameter at the root of the thread; the inside diameter on a female thread.
- **Pitch**: The distance between the crests of two threads.

Machine screws, like most threads, come in two common types: English and metric.

An English screw designation will look like this:

¼ in. x 20 tpi

In this case, this means that the major diameter of the thread is ¼ in. and there are 20 threads per inch.

Sometimes you will see threads like this:

10 x 32 tpi

This means a #10 bolt with 32 threads per inch. Bolt sizes can be found at various websites, as well as in Machinery's Handbook.

Or this:

.578 in. x 28 tpi

Again, this thread has a major diameter of .578 in. and 28 threads per inch.

Metric threads are measured by major diameter and pitch. Thus, you may see a thread like this:

3 mm x 0.5

This means that the outer diameter is 3 mm and the pitch is 0.5 mm.

Thread nomenclature can be confusing sometimes, especially when you don't know whether you're looking at a metric or English thread. So many types of threads have been used in the gun world for almost 200 years that learning how to identify the correct threads is essential both for removal of damaged screws and installation of good ones.

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Drilling and Tapping

Taps are not designed to make threaded holes on their own. A drill must first be used to remove the majority of material before the tap is turned through. This procedure is relatively simple with the right equipment.

TAP AND DRILL SIZE

Taps have two drills associated with them: tap drills and clearance drills. Tap drills should be 85 percent of the major diameter for coarse threads and 95 percent of the diameter for fine threads. Clearance drills are slightly larger than the major diameter of the screw. They are used when you need a hole for a screw to freely fit through, such as attaching two parts together.

FEEDS AND SPEEDS

The rate at which the tap drill turns as well as the speed at which it is pushed through the work is important to know when drilling and tapping. Specific feeds and speeds for different drills/material can be found online or in reference material. The general rule of thumb is higher speeds, lower feed rate for small drill bits, and a lower speed, faster feed for larger bits.

Figure 17: A tap with the correct tap drill on the left, and the clearance drill on the right.

DRILLING IN DIFFERENT MATERIAL

What type of material you will be drilling into also plays a role in both your feeds/speeds as well as what kind of drill to use. For instance, a jobber length, high-speed steel bit will drill just fine through aluminum or mild steel. When drilling through a notoriously hard case-hardened military action, a carbide stub drill might be called for.

When drilling through tough material, there are a couple of tricks to try if you either don't have a carbide drill, or it too has failed.

First, try sharpening your bit with a less acute (sharp) angle. The wider angle can sometimes provide enough of a cutting edge to start through the tough outer case.

Also, if you have an oxy-acetylene torch available, you can spot heat the place where the hole is to be drilled and let it cool at room temperature. This will anneal that particular spot and make drilling easier. One word of caution, though: DO NOT overheat the front receiver ring on any bolt-action rifle. This could ruin the heat treat and make the gun unsafe.

BLIND VS THROUGH-HOLES

When drilling, consideration must be given to whether a hole can go straight through or if it will be blind. A blind hole is one that must stop at a predetermined depth and is more difficult to drill and tap.

Blind holes are most common in gunsmithing when a rifle needs to be drilled and tapped for scope mounts. Invariably, at least one hole needs to be where it would go into the tenon of the barrel if drilled too deep. Either the barrel needs to be removed before drilling (not often feasible), or a mill or drill press with a quill stop must be used to control the depth of the hole.

ALIGNMENT AND FIXTURES

Alignment of tapped holes is particularly important in gunsmithing, as precision is key to professional work and accuracy. Toward that end, a mill or drill press should always be used to drill and tap.

If you are going up in thread size, you can use a pin gauge to locate the existing hole in the work. Find which gauge fits the hole the best and put it in the chuck or collet. Lower the quill onto the work and adjust the position until the gauge will move in and out of the hole freely. Then you can drill and tap as normal, trusting that you are aligned with the existing hole you are enlarging.

There are some fixtures commercially available for precisely locating holes for scope mounts, shotgun rib beads, etc. Also, the gunsmith will become equipped to make any specific fixture needed should enough jobs of one type come in.

FEEL

Feel is a very important part of tapping. As you gain experience, you will be able to feel how much pressure to put on a tap, when the tap has bottomed out, or when the tap isn't cutting properly. Being able to feel these things will prevent broken taps and cross-threaded holes.

Procedure: Drilling And Tapping A Piece Of Aluminum

Tools needed:

- Drill press/mill (strongly recommended)
- Calipers/scribe
- Center punch/center drill
- Tap drill
- Tap
- Countersink

May be needed:

- Compressed air

LOCATING THE HOLE

To begin, measure a set distance from each corner and mark the spot to be drilled. Calipers can be used as a scribe, or layout fluid and a height gauge with a scribe tip can be used. For the purposes of this exercise, the hole location can be estimated.

Figure 19: It's easy to find the intersection of two scribed lines with a sharp center punch.

PUNCHING/CENTER DRILLING

Put your center punch over the hole and give it a good rap with a hammer. Hit with authority, but not hard enough to damage or slip off the material. If you are using a mill, punching is not always necessary. If you have a center drill, you may start the hole with it. Position the center drill directly over the spot for the hole and drill just until the shoulder starts cutting.

Figure 18: Calipers can be used as a scribe when marking the hole location on material.

TAP DRILLING

Chuck the tap drill in the machine and lower the quill to be sure it is in line with either the punch mark or center drilled hole. Raise the quill and start the machine. Using plenty of cutting fluid, begin to drill into the material, raising the drill up periodically to clear the chips. Drill until you are through the work or the depth has been reached. Remove the drill bit.

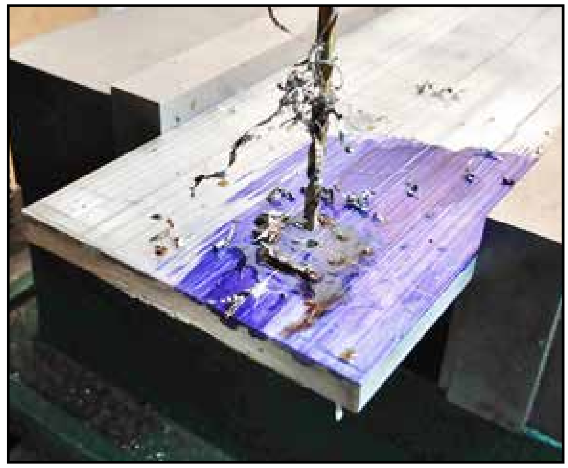

Figure 20: Drilling through aluminum is not difficult, but cutting fluid is still recommended.

TAPPING

DO NOT TURN ON THE MACHINE FOR THIS STEP!

Chuck the tap into the machine and lower it until it just touches the hole. Begin turning the tap by hand, until it has cut a few threads. This ensures the tap has started cutting parallel to the hole.

Lock the quill in place and loosen the chuck. Raise the chuck high enough to allow a wrench to be placed on the tap.

Place the wrench on the tap and begin to turn the tap in farther. If you are cutting small, fine threads, back the tap out a bit after each turn or turn-and-a-half. If you are cutting large threads (¾ in. or bigger), turn the tap all the way without backing it out. Larger taps have more clearance in the flutes for chips and backing them out can damage the cutting edge on certain materials.

When the hole is either bottomed out or through the hole, back it out all the way and remove the tap from the wrench.

Figure 21: After being started into the hole with the powered-down machine chuck, the tap is turned most of the way by hand.

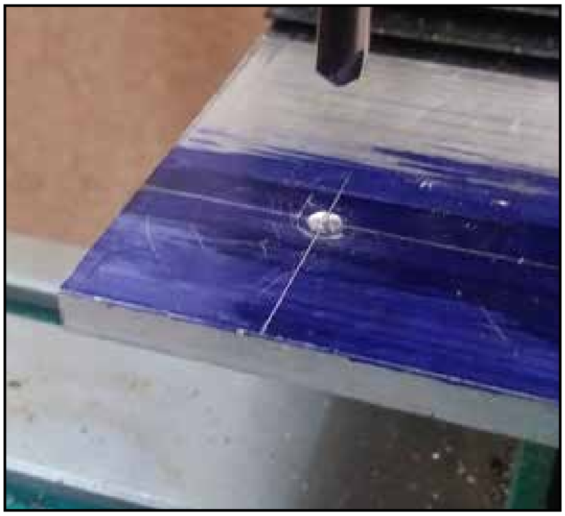

Figure 22: Spotting the hole to remove burrs after tapping.

Figure 23: Two examples of countersinks used to deburr holes and to countersink for screw heads.

SPOTTING THE HOLE

Tapping raises burrs on both sides of the hole and these burrs must be removed by “spotting” or chamfering.

To spot your hole, install a countersink in the chuck, turn on the machine and run it into the threaded hole just deep enough to clear all the burrs off. Countersinks can also be used by hand, especially on softer materials.

CLEANING AND TESTING

Once your hole is drilled, tapped, and countersunk, clean the hole out with compressed air. If compressed air is not available, a pressurized cleaner, such as Gun Scrubber® can be used.

Take the screw for which you just tapped the hole and be sure it fits without binding.

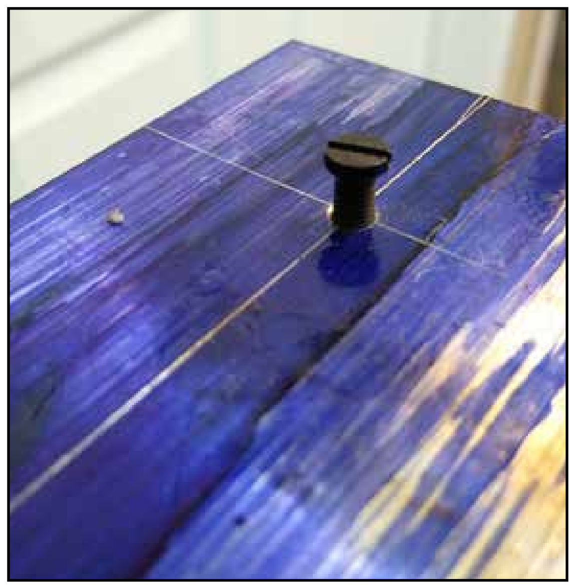

Figure 24: Check to make sure the screw fits properly before removing the work from the machine.

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Why Screws Get Stuck in Metal

CROSS-THREADED

Screws that have been threaded into a hole at an angle are cross-threaded. When this happens, either the threads in the hole or the threads on the screw itself are damaged. If you notice the screw cross-threading quickly enough when screwing it in, you can usually back the screw out and the female threads will still be alright. Other than the screw being stuck, cross-threading can cause damage from slightly bent starting threads to completely wrecked parts.

RUSTED IN PLACE

If a gun is neglected long enough or is exposed to particularly harsh conditions without cleaning, rust can form. Rust can seriously seize parts to the point where they seem to be welded in place. This is particularly insidious when it comes to rusted-in screws, as the part may look rust-free from the outside. This is one reason it is important to suggest to your customers that they have their weapons regularly serviced. At the very least, a complete teardown and clean is needed after a wet-weather event, such as a hunt or competition.

THREADLOCKED IN PLACE

In very few instances is a threadlocking compound called for on firearms, although that never seems to deter gun manufacturers or over-zealous gunsmiths from using it. The major problem with threadlocker is, like rust, it is difficult to tell from the outside whether or not someone has used it.

Threadlocker comes in different strengths and is commonly referred to by its trade name, Loctite®. Blue threadlocker is generally considered medium strength, whereas red is maximum strength.

BOOGERED HEADS

Yes, "boogered" is how many gunsmiths refer to a damaged screw head. Boogered screw heads are almost universally caused by an ill-fitting screwdriver. If the screwdriver slips while in use, it will almost certainly damage the screw head, not to mention surrounding areas of the gun.

Often, a screw is stuck for a reason other than a damaged head and the head is boogered trying to get it out, exacerbating the problem.

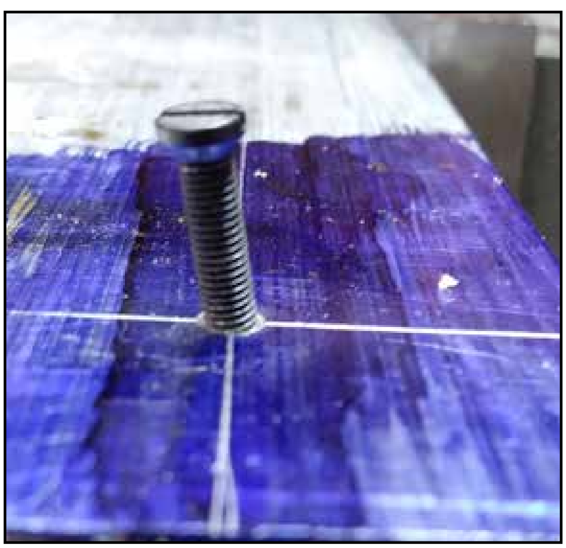

Figure 25: A cross-threaded screw is clearly canted.

Figure 26: Examples of boogered screw heads.

MECHANICALLY LOCKED (BY ANOTHER PART)

Some guns have pins, parts, or other screws holding a screw in place. Be aware of the disassembly procedure for the firearm you are working on. This will help avoid putting excess pressure on a screw that you believe to be stuck but is really being held in place by another part. Turning a screw held in place will likely damage the threads on the screw, the other part holding it in place, and the head.

OVER-TORQUED

Sometimes, a screw has simply been screwed in too tight. This is not very common, with the exception of barrel tenons, and is hard to diagnose. Never over-torque any threaded part.

WRONG SCREW

In some instances, an incorrect screw can be installed in a threaded hole. Though the screw will feel tight going in, there are some who charge forward anyway. Commonly, these screws are of the same major diameter with different thread pitches, such as putting a 6-40 screw into a 6-48 hole. As with the other ways of getting a screw stuck, this can cause serious damage to the screw or threaded hole.

PROCEDURE: CROSS-THREADING A SCREW

Tools needed:

- Well-fitting screwdriver

This is the Wrong Way To Do This

This procedure is intended to intentionally damage and stick a screw into a threaded hole. The purpose is to get a screw stuck in a threaded hole in order to learn how to get it out.

How To Tell When You Are Cross-Threading A Screw

Since you have already checked the fit of the screw in the hole you drilled and tapped in the last procedure, you should know how it feels when a screw thread is unimpeded. However, in order to avoid it, it is important to know how it feels when a screw begins to cross-thread.

As stated above, a screw is cross-threaded if it is threaded in at an angle. This angle may not

Figure 27: Be careful not to accidentally try to install a screw with the wrong pitch. The 6-40 on the left can be indistinguishable from the 6-48 in the middle unless you have a screw checker.

always be apparent, and it may feel like it's threading in normally for a half turn or so. After that, it becomes much more difficult to turn and you know something's wrong.

How to Cross-Thread

To cross-thread a screw, hold it at a slight angle and attempt to thread it in. If it goes in easily, it is not cross-threaded. Do not make the angle at which you are trying to thread in the screw too severe or it will not go in the hole very far.

After the screw is cross-threaded into the hole, put a slight amount of pressure on the screw as if you were unscrewing it to be sure it is good and stuck.

METHODS OF SCREW REMOVAL IF THE SCREW IS STILL INTACT

Application of Heat

Heat can help remove stuck screws in two ways. First, if a screw is locked in place with a thread-locking compound, heat will soften the compound and allow the screw to be removed. Second, since different sized parts heat up at different rates, heat can loosen over-torqued or rusted-in screws.

When applying heat to a firearm, caution must be exercised. Take into account any bluing or other finishes that may be damaged by excessive heat. Traditional hot bluing, rust bluing, Parkerizing, anodizing, and bead blasting can take heat directly from a torch, although you must be careful not to overheat or you will ruin the finish. A torch should not directly be used on any painted surfaces or surfaces coated with products like DuraCoat® or Cerakote™, as they can melt or bubble and crack.

Next Size Screwdriver

In cases where a screw head has been buggered by using the wrong screwdriver, the next larger size screwdriver or wrench can be tapped into the slot or hole with a hammer. This will make sure that the bit fits tightly and, remember, the tighter the bit, the more torque that can be put on it.

With a fillister screw, be sure to use a driver or bit that is the next size up in width, but not in length. You do not ever want to use a screwdriver with a bit so long it overhangs the side of

Figure 28: This small oxy-fuel torch is perfect for heating gun parts to loosen stuck screws.

Figure 29: You can sometimes get stuck screws out by using a larger bit. Here is a selection of bits with different thicknesses, but the same width.

the screws, as that is a surefire way to scratch the gun surrounding the screw hole.

When a hex-head screw has been stripped, the next fractional size can be driven into the hole to allow the wrench to regain its grip on the screw. A metric wrench can sometimes be a better solution if it is bigger, but not so much so that it is difficult to drive it into the slot. This is why it's advantageous to keep a large selection of hex wrenches around.

Torx-head screws rarely strip, but if they do, the same procedure as the hex-head screw can be followed. Also, sometimes a Torx driver can be driven into a boogered hex-head screw to help get it out.

Using a bit that is fractionally larger may help get a screw out, but the screw head will always be damaged — sometimes beyond repair. Be sure to have a replacement screw on hand before using this method.

Wrench/Lever/Pliers

Sometimes, a screw or its head is proud enough of the surface to be able to grab it with pliers. In these cases, care must be taken to not damage the surrounding surfaces. Masking or painter's tape placed on the gun will help prevent scratches. Be sure to not use smooth jaw pliers and to grip as tightly as possible. This is not a recommended method if you have to save the screw.

It is advisable to also keep a screwdriver in your tool kit that can accept different bits and also has a square or flat-sided shaft. In cases where you have a very tight-fitting screw, you can put an adjustable wrench on the shaft to apply extra torque while you apply downward pressure on the screw.

Lastly, on screwdrivers with plastic or hardwood handles, you can drill a hole in the handle to be able to insert a punch or piece of drill rod to act as a lever to apply extra torque. This technique is especially helpful when using a screwdriver with a long shaft, such as one used to remove buttstocks with through bolts.

Impact Driver

An impact driver (not to be confused with the air-tool used in the auto industry) is a tool that

Figure 30: A wrench can be used to add torque to some screwdrivers.

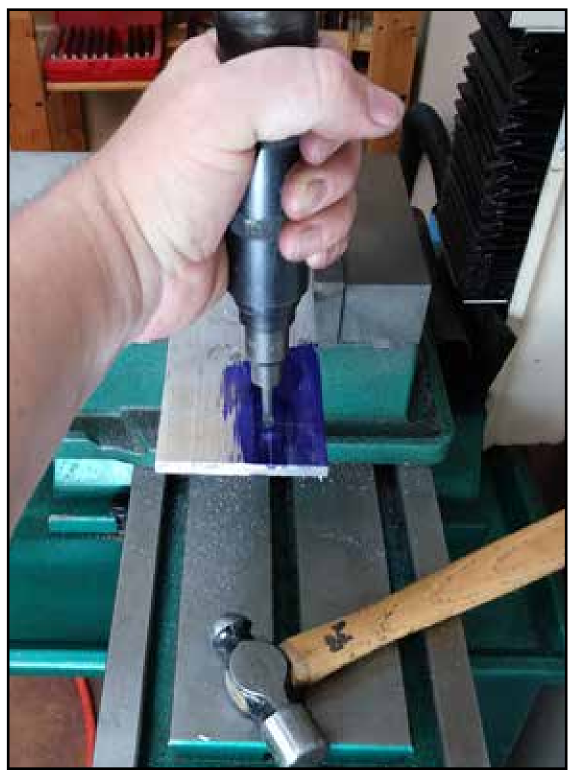

Figure 31: An impact driver is held in one hand, while the other swings the hammer.

converts a downward force into a rotational force. It has the ability to accept common screwdriver bits for varied uses.

In practice, the correct size bit is inserted into the driver and is placed on the screw. The driver is preloaded by turning it in the direction you want the screw to turn, usually counterclockwise. Holding the driver in your hand, take a medium weight hammer in your other hand and strike the end of the wrench. This will force the bit to rotate fractionally to loosen the screw. This tool is only for breaking the torque on a screw. After the screw starts moving, use a regular gunsmith's screwdriver to get it out. Ending this process with an intact screw is a hit or miss proposition.

Penetrating Oil

When a screw is locked in place by over-torquing or rust, a good penetrating oil can be used. Penetrating oil is a thin oil that wicks its way into the minute space between the parts by capillary action. In this fashion, it penetrates the parts, helping to lubricate and separate so the screw will come loose.

Penetrating oil is best used in conjunction with heat. Obviously, heat that is too high will just burn off the oil and make a mess. You only want to get the part hot enough to be just barely too hot to touch with your bare hand. Be sure to heat both the part you are trying to remove and the part it's being removed from. This heat will help the oil penetrate farther.

Punch on Edge of Standard Slot

An old method of removing screws and one that will always damage, if not ruin, the screw is to use a punch on one end of the slot. This method will only work for fillister-head screws.

Place a sharp punch at the end of the slot, pointing in the direction you want the screw to turn. Hit the end of the punch in such a way that it applies rotational force in the correct direction. This will help loosen some screws.

Figure 32: A punch being used on the edge of a screw to remove it.

More than any other method of screw removal, punching the edge of a slotted screw correctly takes practice and experience to make the most of it, but can be done very expediently.

Using a Mill/Drill Press for Pressure

If you have machinery available to you, you can use it as a sort of brace to apply downward pressure to remove some seized screws.

Place the gun in a vise attached to either a mill or drill press table and insert a drill bit into the chuck. Line-up the bit with the screw and place downward pressure on the quill through the handle (Figure 33). Turn the chuck either with a spanner wrench on the chuck or quill. This will provide extra pressure on the screw and hold the work tighter so as to apply more torque.

Figure 33: A machine can add downward pressure to a screwdriver bit when removing a stubborn screw.

Figure 34: If you can reach the head, or any portion of the screw, you can sometimes use pliers to remove it.

PROCEDURE: CROSS-THREADED SCREW REMOVAL AND THREAD REPAIR

Tools needed:

- Well-fitting screwdriver
- Tap/die

May be needed:

- Compressed air
- Adjustable wrench
- Drill press/mill

Figure 35: These threads were damaged from cross-threading.

Remove Screw

How well you were able to get the screw stuck into the threaded hole will determine the method you will need to use to remove the screw. Examine the screw and determine how you will remove it using one of the above methods. Because the screw is stuck in a softer metal (aluminum), you will likely be able to get it out either using the wrench/lever method or using a drill press/mill.

Check All Threads for Damage

Once you have removed the stuck screw, now is the time to inspect it and the hole for damage. It is likely in most cross-threaded situations that there will be some damage to at least the first few threads on both the screw and in the hole. What you need to determine is if there are enough good threads left to continue using the same screw and if you need (or can) re-drill and tap the hole one size bigger.

A word of caution: Be careful with re-drilling and tapping screw holes. If you do this in certain parts, they will be non-factory and their replacement could be difficult in the future.

Use Dies/Taps To Repair Hole

In most cases of cross-threading, cleaning out the hole and the screw with the appropriate tap or die is a good idea. This will straighten the existing threads and help make sure the screw doesn't try and follow the wrong threads left by cross-threading.

When tapping, it is best to either use a mill or drill press that can guarantee straightness. Also, if you can, you may come from the opposite side of a through-hole to clean out the threads.

Verify Threads Are Repaired Enough for Continued Use

After you have removed the screw, inspected it and the hole, and cleaned up the threads, you must verify that the parts can still fit tightly together. Thread the screw in the hole until it either bottoms out or the head stops it from going in any farther. Apply torque to the screw to make sure the threads are not going to strip, and then you can reassemble as normal.

OPTIONAL PROCEDURE: REPAIR OF BOOGERED SCREW HEAD

Tools needed:

- File
- Vise
- Sandpaper
- Wood block
- Drill/drill press

If the head on a fillister screw has become damaged, and it is not too severe, repair is possible. The idea here is to remove any burrs that were raised and to polish and reblue the screw head. This will not make the screw head perfect, but it can reasonably repair a screw head that isn't easily replaced.

First, remove the screw from the gun and inspect the slot. If the burrs raised are very minor, you may skip the next step.

Figure 36: This is the boogered screw before the repair.

Next, place the screw in a secure old device; a bench vise is best. Be sure to not crush the threads in the vise. Take a smooth file and remove the burrs around the slot. Be careful to not materially alter the shape of the screw head; we're only trying to remove any metal that was raised when the screw was damaged.

After the burrs are removed, place the screw in the drill chuck with the head facing away from the drill. If you are using a drill press, take the

Figure 37: A file is used to remove the larger burr on the edge of the slot.

Figure 38: The block of wood conforms to the shape of the screw head under the sandpaper.

Figure 39: The screw is brought down on the sandpaper several times until it is completely polished.

Figure 40: The screw after polishing.

block of wood, place it on the table under the chuck, and cover it with a strip of sandpaper. Turn on the drill and lower the quill, pressing the screw head onto the sandpaper-covered block. As the screw turns on the sandpaper, it will conform to the screw shape due to the softer wood underneath it. This will polish the screw very well and you can work through successive grits of sandpaper, depending on how deep the scratches/burrs are.

If you do not have access to a drill press, a hand drill can be used almost as effectively with the block of wood held in a vise.

PROCEDURE: COLD BLUING A SCREW HEAD

Materials needed:

- Cold blue
- Cotton-tipped applicators
- Steel wool or wire brush with wires .003 in. or less

After a screw has been repaired, cold blue may be applied to recolor the steel to match the gun. There are many formulas for cold blue, as well as pastes vs liquids, and each comes with its own quirks and instructions. Different formulas will work better for different types of steel. Follow the procedures given by the manufacturer of each type, but here is the basic method.

- Make sure the steel to be blued is clean of all oils, including fingerprints. Acetone or brake cleaner is a good product to use for this. Any oil left on the steel will result in a discoloration of the final product.
- Apply the cold blue with a cotton-tipped applicator and allow it to work for one minute. Use one applicator per coat. Do not re-dip the applicator in the bottle of cold blue to avoid contamination.
- After a minute has passed, run the part under cold water to neutralize the solution.

Figure 41: Some supplies for cold bluing.

Figure 42: Cold blue begins to work instantly.

Figure 43: After rinsing, the screw is brushed with a fine wire wheel.

- Rub the part with steel wool or with the wire wheel turned at around 500 rpm.
- Repeat the above steps until the desired color is reached, and then oil the part.

Figure 44: After several applications of blue, rinse, brush. Not perfect, but much better!

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Taps/Screws Broken Off in Metal

WAYS SCREWS BREAK IN METAL

Over-Torqued During Installation

When installing a screw in a firearm, you must be careful not to over-torque it. The most common place for a screw to break when over-torqued is right where the head meets the threads. This is because the head is usually stopped by the counterbore or surface of the gun, while the threads continue to try and pull it farther into the threaded hole.

Improper Disassembly Procedure

Some gun assemblies can be complicated or not what they seem on the surface. Many times, a screw is holding another part in place or is itself held in place by something — usually a pin or another screw. Obviously, trying to turn out the screw that's got something in the way is going to damage something. Unfortunately, it usually means that not only is the screw going to be damaged, the part holding it in will also be damaged and it will make it more difficult to remove either.

This is a good time to make note that you should never be ashamed to seek information you do not have. With the thousands of gun models out there, it is impossible to know them all. This writer keeps a large library of disassembly books in the shop and refers to the internet frequently. It will save time and money if you learn (or relearn) how to take a gun apart the right way.

Removal Attempted When the Screw Is Rusted

Surprisingly, screws do not break as often because they are held in place by rust. This is due to the fact that if a screw is rusted, the whole thing, including the head, will be firmly locked in place and nothing will be able to be turned to break. That's not to say that it cannot happen. If you find a screw is rusted (or threadlocked) in place, try the penetrating oil and heat method before attempting to remove it.

Screw Shears Off With Attached Part

When a screw threads through another part attached to the gun, it is possible that the part will break sometimes with, sometimes without breaking the screw, as well. This situation can be particularly insidious because, not only will you still have a stuck or broken screw, but you will have another often small and hard-to-grip part to get it out of.

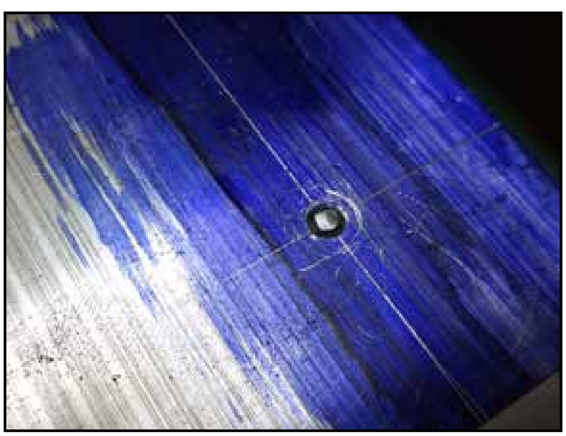

Figure 45: The "broken" screw installed in the threaded hole.

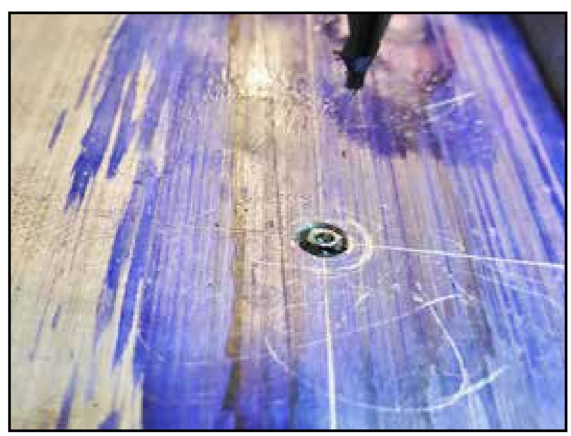

Figure 46: Center drilling the screw shaft.

Standard screw removal techniques apply to getting the screw out in this situation, although you may have to be creative in how you hold the part you are removing the screw from. A drill press, mill, or bench vise is almost required for this situation.

Ways That Taps Break In Metal

Taps break more often than screws almost exclusively because they are made to be sharper, harder, and therefore brittle. Unlike broken screws, broken taps are always caused by human error. They will also almost always be stuck in the hole as well as broken.

Not Using Cutting Oil

If cutting oil is not used, especially in harder materials, it can cause the tap to gall instead of cut. Galling is when two surfaces slide against each other with such friction that they start to stick together. Obviously, galling will place a much larger strain on the tap, and trying to work through the galling can break it.

Not Clearing Chips

Taps have flutes so that the chips created by tapping will have someplace to go as they're cut away. The smaller the tap, the shallower the flute and, therefore, the easier it is to bind. If a tap binds in the hole, it can easily break.

When tapping, especially smaller holes, always back the tap out a half turn counterclockwise for every full turn clockwise. If you are tapping a particularly deep hole, back the tap out all the way to clear the chips every ½ in. or so for the smaller, fine-thread gun screws.

Going Too Fast

Taps must be turned slowly, and, if you try and go too fast, the tap will break. Again this is especially true with smaller, fine thread screws.

What happens when you go too fast is the torque you are putting on the tool overruns the cutting action of the edge. This means that the rotational force is put into the shaft of the tool rather than the cutting edge, overloading and breaking the tool.

Continuing To Turn at the Bottom of a Hole

When tapping a blind hole, feel is particularly important. You must be able to tell when you've reached the bottom of a hole. Until you develop this feel, don't be ashamed to take the tap all the way out of the hole to inspect whether or not the threads go to the bottom.

Using a Machine

Unfortunately, many machinists recommend the use of a machine to tap a hole, especially when the work is already set up to drill. They say to loosen the quill, put the machine in back gear, and use the slowest speed of the machine to pull the tap into the work and create the threads. You are strongly cautioned against using a machine to tap.

There are several problems with using a machine to tap. First, and most important, you lose all feel of the tool. If the tool is binding, bottoming, or otherwise not cutting properly, you will not be able to tell until it is too late.

Second, the machine will put a constant, often high-torque, amount of pressure on the tool, increasing the likelihood of the tap breaking.

Next, once you've started to tap in with a machine, it will only stop when you hit the off switch. This means that the tap is either going to plow right though the material or will hit the bottom of a blind hole and break. It is almost impossible to stop a machine in time for a tap to not bind at the bottom of a blind hole.

Fourth, because the machine has to overcome the spring tension in the quill to pull itself through the work, there it a good chance that the threads in the finished hole will be stretched. In this instance, the requisite screw will not be able to be turned in as tightly and will come loose easier.

Lastly, almost all of the taps used in the gunsmithing business are small, fine thread taps that are more fragile than taps used in, say, the automotive industry. Obviously, this means that the amount of rotational force that can be put on them by a machine can easily break them.

The one caveat to the above is in the use of Computer Numerical Controlled, or CNC, machinery. CNC machines have the finesse and precision ability to machine tap even the smallest of holes, although their presence in a gunsmithing shop is exceedingly rare.

Not Using Correct Tap for Material

As we discussed earlier, taps are made of two common materials. High-speed steel taps are fine for softer materials and should give no trouble when used with the correct procedures. Carbide taps are very hard and easy to break.

If you determine that the material you need to tap is particularly hard, whether all the way through or with just a tough, outer case-hardened shell, you must be careful to not apply too much pressure to the tap. Not only do you need to go easy because of the type of material, but all of the other pitfalls of tapping must be avoided.

REMOVING A BROKEN SCREW

How Much Screw Can You Get To?

How difficult removing a broken screw is largely depends on where the screw breaks. If the head of the screw shears off and leaves some of the screw shaft proud of the surface, removal may be as easy as grabbing it with a pair of pliers and twisting it out. If, however, the screw is broken below the surface, other methods must be employed.

Punching Out the Screw

Sometimes, if the screw is broken in a manner that leaves one side of the screw higher than the other, you may be able to use a punch to remove the screw. This procedure is similar to using a punch to rotate a stuck screw, but you must be more careful. When using this method to remove a broken screw, you must be very careful to not let your tool strike the internal threads of the hole the screw is broken off into. If you do damage the threads, not only will you get the screw stuck, you will make it difficult for the rest of it to unscrew past the damaged threads.

Drilling/Milling It Out

The best and most sure way to remove a broken screw is with a mill or drill press. The idea when using one of these machines for this purpose is to drill a hole as straight through the broken screw as possible so it can either be picked out or a screw extractor can be used. If the screw is broken far enough below the surface, you can set it up using a pin gauge to locate the hole.

The major hurdle when using this method is that screws almost never break off square or perpendicular to their threads. This means that a flat surface must be created by either milling or grinding the top of the broken screw before you try and drill through the broken piece of screw. If you do not create this space, the drill will wander all over the screw as it tries to get started. The flat space does not have to be big at all — just big enough for you to be able to center punch a spot to start the drill.

Figure 47: In the case of a through-hole, drill completely through the screw to ease removal.

Figure 48: Using an EZ-Out to remove the broken screw.

Once you have a center-punched hole and the piece is set up in the machine, use a center drill to start the hole. Center drills are much stiffer and will not wander as easily.

After you have the hole started, choose a drill that is small enough to not damage the internal threads. Drill either all the way through or just far enough not to bottom-out on a blind hole.

If the screw is small enough, you may be able to pick or break out what's left after drilling through it. This is much easier in a through-hole. If this isn't an option, you should use a screw extractor.

Sometimes, a screw will not come out either by screw extractor or any other method you try. In this case, the only option is to attempt to remove as much of the broken screw as possible and use the correct size tap to remove it. Turn the tap in slowly, going only a turn or so before completely removing it to clear the chips. If the threads of the hole are damaged during this, the hole will have to be drilled and tapped for the next screw size up.

Screw Extractor

Screw extractors are wonderful tools for getting out stuck screws, but they require a hole through which to place them to turn a screw out. Once you have a screw (broken or not) with a hole down its center, place the extractor, held in a t-handle, in the hole and turn in the direction to remove the screw. You may need to grind the tip off of an extractor to get it to properly fit in whichever hole size you had to use. It is recommended to keep several extractors on hand for custom fitting.

REMOVING A BROKEN TAP

How Much Tap Can You Reach?

As with a broken screw where the tap has broken, it is important to know the method of removal. Also, even if a broken piece of the tap is proud of the surface, taps are so much more brittle than screws that there is a chance you may break it trying to remove it with pliers.

Tap Extractor

A tap extractor is used just like a screw extractor, except you do not need to drill a hole to use it.

Place the tap extractor in a t-handled wrench, insert the fingers of the tool in between the flutes of the tap and turn it to remove. Sometimes, on a through-hole, it may be better to continue through the hole rather than trying to back the tool out.

Punching It Out

Punching a tap out is not recommended as broken taps are almost always stuck, and stuck taps will usually break before they move if a punch is used on them. On some larger taps, like those rarely used in gunsmithing, you may be able to get a broken tap to start unscrewing using the punch method.

Breaking the Tap

The brittleness of taps can be used as an advantage when removing broken ones. This works best for small taps, but you may be able to break the tap with a punch and hammer and then remove the pieces. This method also has some things to look out for, though.

First, you will be putting serious force on the broken tap, which could damage the threads.

Also, when attempting this in a blind hole, you may drive the broken tap pieces into whatever is at the bottom of the hole. Maintain awareness of what is below the tap piece you are trying to break out.

You must be careful when using this method, as it does sometimes damage a hole to the point it needs to be re-drilled and tapped to the next size bolt. However, this can be a highly effective method for removing broken taps that are used in gunsmithing, such as for drilling and tapping for scopes.

Milling/Drilling

Again, due to the hardness of taps, it is very difficult to get conventional tooling to mill or drill through them. Couple this with the fact that, due to its deep flutes, a tap has a very small surface into which you can drill, and you can see that using a machine is not the recommended method to remove taps.

PROCEDURE: REMOVING A BROKEN SCREW

Improper Procedure: Break the Screw

Before we proceed, we need to cut or shear the head off of a screw to practice removal of it. It is not necessary to break the screw while it is installed, as you can use pliers to turn it in the hole to drill and remove. Use a hacksaw or cutoff wheel in a rotary tool to remove the screw head.

Is the Screw Broken Above or Below the Top of the Hole?

As with every job, take a minute to assess before proceeding. If the screw is broken above the surface, you may be able to easily remove it with pliers. For the purposes of this exercise, however, we will continue as if the screw needs to be drilled and extracted.

Square-Up/Center Punch Screw

First, we want to square-up the top of the broken screw in order to give us a flat surface upon which to center punch to locate the hole. If the screw is proud of the surface, you can just use a file to do this.

If the screw is broken too low to get with a file, either put it in a mill and use an end mill to make a flat surface on the top, or carefully use a Dremel® or other rotary tool with a burr to make a spot to center punch.

Take a very sharp center punch with a tip that is narrow enough to not damage the surrounding material and tap a locating spot on the top of the broken screw. Remove the punch and verify the spot is in the correct location, then use the punch to make a deeper location spot.

Drill Screw

Using the center punched mark, locate the screw directly under the quill of your mill or drill press and center drill a shallow hole in the screw.

Remove the center drill from the chuck and insert the correct size twist drill without moving the work.

Even though we are drilling a screw in a through-hole, we will pretend it is a blind hole as to practice the more difficult procedure.

Drill into the screw using the twist drill, raising the quill every few thousandths to clear the chips. Drill until you are .050 in. or so from the bottom of the screw.

Use Screw Extractor

Remove the work from the machine and put it in a vise or clamp.

Test fit the screw extractor in the hole you just drilled in order to determine the fit.

Place the extractor in a t-handle or other wrench and insert it into the hole.

While applying downward pressure, turn the extractor in a counterclockwise direction until you feel it start to bite into the metal.

Continue turning the extractor until the screw piece is completely removed.

Inspect for Damage

Inspect the threaded hole in the work for any damage. Test the hole with another screw of the same size to determine whether it may be used again, or whether it needs to be drilled and tapped to a larger size.

Screws in Wood

CONSIDERATION OF WOOD WHERE SCREWS FIT

As wood is much softer than metal, not nearly as much torque can be applied to wood screws as machine screws. Wood screws are almost never used to hold parts that are under stress together, such as attaching a receiver to a stock.

Screws Stuck In Wood (Rare)

Wood screws almost never become stuck. On very rare occasions, a screw may have rusted so badly in the wood that it gets stuck or breaks. In these cases, normal screw removal procedures can be used, though you may need to get creative with how you hold the work in the machine.

Wood Stripped-Out Around Screws

Much more common with wood screws is that the hole the screw goes into gets stripped-out. There are two causes for this.

First, excessive torque may have been applied to the screw, tearing out the wood around it.

Second, and this is more common with older guns, oil or moisture may have seeped into the wood surrounding the screw. This weakens the hole in the wood and makes it easy to tear or chip out around the screw.

In either case, the repair is the same. Mill or chisel around the screw hole until all the damaged or oil-soaked wood is removed. In extreme cases, the stock may need to be soaked in acetone for several days to remove deeply soaked-in oil.

After the offending section of wood is removed, another piece of wood must be shaped and glued in the section left from the removal. After the glue sets, re-drill, reinstall, and refinish as needed.

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Proper Application of Screws On Gun

WHAT JOB DOES THIS SCREW DO?/WHAT FORCE WILL BE PUT UPON IT?

Time saved is money earned, so it makes sense to approach every application of a screw by asking the two questions above. Many times, when a screw needs to be replaced, a new one can be ordered from one of the major parts houses. Other times, when a screw must be made or customized, what the screw does must be taken into consideration.

Holds Two Non-Moving Parts Together

Screws that hold non-moving parts together can be divided into two categories: screws that have force put on them and those that don't.

Screws that have force put upon them must be made of tough steel that is not too soft and not too hard so as not to shear or break, respectively. Screws such as those that hold an action into the stock or hold scope mounts to a receiver are among this type.

Screws that do not have force put upon them can be made of a wider range of steel. Almost all wood screws fall into this category.

Holds Parts That Rotate/Slide Upon Screw

Some screws have unthreaded tips that act as pins for other parts to rotate or slide upon. A good example of the former is the trigger and bolt screws that fit in a Colt® Single-Action Army. The portion of the screw near the head is threaded, while the rest of the screw is a straight shaft that the parts rotate on.

Holds Other Parts/Screws/Pins in Place

There are some screws that are used to secure other parts in place. Sometimes, these screws fit into a recess cut in another screw and keep it from rotating. A good example of this is the action screws on military Mausers and almost every screw in the Browning® Auto-5.

Other screws hold pins in place, such as the screw that holds the lever pin in place on a Winchester® High Wall. Do not attempt to remove said parts without removing the screw first, especially if the screw is perpendicular to the part it holds in.

Figure 49: Some gun parts are essentially screws. Clockwise from top left: Rifle barrel, sling swivel stud, shotgun magazine tube, rimfire magazine tube.

Figure 50: This screw secures the crosspin on this High Wall.

Hold Springs

Screws that hold leaf-type springs in place, such as the hammer, carrier lifter, and lever spring screws on a Winchester '73 are under particularly constant tension. These screws can strip easily, especially on old, original guns. When disassembling these guns, do your best to remove the tension from the spring before attempting to remove the screw.

Screws that hold in coil springs should be removed carefully as well, as the spring will have a tendency to shoot out of its space and get lost on the shop floor.

Dual Purpose Parts That Are Screws

When considering screws, it must be remembered that many gun parts are essentially screws, even if called by a different name. Most barrels are screws, as they thread into the receiver. Magazine tubes on shotguns are often screws. Become aware of what parts are threaded and treat them like screws when installing, disassembling, or troubleshooting.

Proper Torque

Proper torque is a nebulous concept, and there is no real standard for many screws encountered in the gunsmithing trade. Some screws do have recommended torque, such as scope mount and ring screws as well as action screws (and even barrels) on precision rifles. These screws should be installed with a torque wrench to the manufacturer's specs.

Other screws will normally be torqued by feel. You should know how much torque was on a screw based on how hard it was to remove. Experience will tell you how to find the sweet-spot for tightening a screw enough for it not to get stuck or break, but also not to come loose.

CONCLUSION

Screws have a very wide scope in the firearms world and there will always be something new cropping up, no matter how much experience you have. You are encouraged to collect and keep as many reference materials around as possible. Older books may contain information not easily found on the internet.

Always take your time and approach your work intentionally.

Never stop learning, and never be afraid to admit when you need to learn something. Good gunsmithing!

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