



DEC 2015

DIGITAL ARCHIVE
EDITION

PRECISION ARMS WORKSHOP

AND THE AMERICAN GUNSMITH ARCHIVE

A TECHNICAL JOURNAL OF CRAFT, REPAIR & RESTORATION

12

ARCHIVE ISSUE NUMBER

INSIDE THE ARCHIVE

THE BASICS OF CUT RIFLING A RIFLE BARREL

GUNS OF OUTLAWS • RUGER SCOUT RIFLE • MAGAZINE CHECKS • HYDROGRAPHICS

ORIGINAL METHODS. MODERN ACCESS.

ARCHIVE EDITION 144

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AMERICAN GUNSMITH

DIGITAL ARCHIVE EDITION • DECEMBER 2015

ISSUE RECORD

ORIGINAL DATE	December 2015
VOLUME	Archive volume not stated
ISSUE NUMBER	12
SOURCE ID	ag-713e266be6ceac3e034ca159

DIGITAL EDITION

PUBLICATION	American Gunsmith
EDITION	Digital Archive Edition
ARCHIVE STEWARD	Innovation Network LLC
CONTACT	editor@gunsmithmag.com

Editorial fidelity. Article titles, author attribution, issue relationships, source-page references, and article text remain bound to the archive corpus. Layout, covers, navigation, and conversion notes are newly produced for this edition. Historical statements remain part of the original editorial record.

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HISTORY

Guns Of Outlaws

BY AMERICAN GUNSMITH EDITORS DECEMBER 2015

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From colonial-era rifles carried on the “Owlhoot Trail” to John Dillinger’s Colt pistols, the history of the American outlaw is told in guns—weapons that became each man’s personal signature. Authors Gerry and Janet Souter peer into these criminal’s choices of derringers, revolvers, shotguns, rifles, machine guns, and curious hybrids, giving us a glimpse into the minds behind the trigger fingers.

With over 200 illustrations, *Guns of Outlaws* gives a unique look at the lives and the hardware of the most infamous outlaws in American history, and of the law enforcement officers who hunted them. *Guns Of Outlaws* As settlers moved further west, away from authority and soft city life into the Great Plains, the push for survival through the endless prairies and jagged isolating mountain ranges bred ruthless men.

Most outlaws were technology freaks who seized upon the latest weapon innovations developed in the industrious East to provide an edge in the life-and-death cosmos of the Wild West. Outlaws tinkered with their guns, creating unique hardware that became their call-

ing cards. Attempts by lawmen to take control sparked a weapons race, pitting gunmen and bandit gangs against home-grown lawmen and vigilante “posses.” By the late 1930s and early 1940s, outlaws on horseback had given way to marauding bank robbers.

Using fast cars and faster guns, they became folk heroes of the Great Depression, even as the law was hard on their tails. The book’s 22 chapters begin in the eighteenth century and works forward covering nearly two centuries of history of infamous criminal use and misuse. Even being on the wrong side of the law, outlaws were quick to adapt the newest technology.

Where the outlaws of the Natchez Trace used flintlocks, post-Mexican War castaways had percussion caps, everyone was quick to grab up cartridge breechloaders, and then self-loaders when they became available. Gerry and Janet Souter formed Avril 1 Group (avril1.com) and have published 50 books, notably *American Shooter*. Like that book, *Guns of Outlaws* is a thorough history taken from the perspective of the American bad man.

PEOPLE & COMPANIES

Ruger Scout Rifle

Ruger's Scout Rifle is built exactly like a Ruger Model 77. Almost.

BY CHICK BLOOD DECEMBER 2015

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It's pretty much understood that Jeff Cooper was first to formally define a Scout rifle. It has to weigh less than seven pounds; sight options should be forward mounted optical or open iron; magazine capacity of ten rounds; be factory prepped for mounting a center bore Picatinny rail; include a threaded barrel for adding on a flash hider/muzzle brake; and have an adjustable length of pull. So it is with the Ruger. There are some differences that could trip you up in servicing this popular hunting gun.

True, it is built on the trusted and proven Model 77 platform and retains the reliable LP6 trigger. Like the Model 77 in .357 we covered in the November 2012 issue and most other Ruger 77 rifles, its firing pin assembly is restricted. Once it has been removed from the bolt body it has to remain as removed until reassembly. Powerful springs combined with a need for unavailable and proprietary tooling make any parts replacement outside the factory off limits if not impossible. Please consider yourself advised.

Unlike other Model 77 versions the Scout Rifle has switched from a two-piece to a single piece bolt body configuration. More on how the switch alters an approach to the ejector will come later. One headache of no small proportions remains present with the Scout Rifle and common to all other Model 77-based rifles. The forward mounting screw (47) and mounting lug (29) remain unchanged. You'll note the lug is angled.

This serves to secure the magazine and torque down the receiver into solid contact with the stock via tightening the mounting screw. The action cannot be removed from the stock as long as the mounting screw and lug remain in place. It is also available with a laminated wooden stock and meets the definitions of the concept. Current calibers are .308 Winchester and .223 Remington/5.56mm NATO.

Are you familiar with a running back wearing #24 for the Seattle Seahawks called "The Beast." When functioning in Beast Mode the entire Seahawk offense feeds on his intensity at plowing through or over all opposition. Similarly, as with all other Model 77 platforms, the forward mounting screw is installed in beast mode. About 80 to 90 inch-pounds of it. I made, or rather chose to make, a tooling investment to avoid multiple broken driver bits, loused up mounting screw heads, and badly bruised self respect.

The tool purchased appears in Brownells catalog identified as a California Torque Wrench, having a twelve-inch handle and adjusts from 30 to 200 inch-pounds. Along with the wrench I ordered in a 1/4" square-to-hex converter that snaps into the wrench to accept all 1/4" hex bits. My Magna-Tip #430-5 fit perfectly. Uncharacteristically compared to its Seattle namesake, the Beast backed off. The rear mounting screw (#46) presented no similar problem. Neither did the cross bolt nut (#7) or the cross bolt (#30).

The action is lifted straight up a little at a time to assure the barrel and receiver remain level. The magazine well (#53) is pushed straight downward along with the trigger guard. Stock and action are now separated. To remove the bolt, rotate its handle (#14) upward and pull the bolt to the rear while simultaneously swinging the bolt stop (#15) outward. The stop is located on the left side of the receiver for right handed models and on the right side of the receiver for left hand models.

Rarely will you need to go any further to provide a routine cleaning of the rifle. I'm going to consider this is one of those rare occasions. After you have cocked and opened the bolt, locate what I'll call "the further disassembly hole" in the striker/cocking piece. Insert a close-fitting length of drill rod or punch least two inches long through the hole. The drill rod or punch will act as a T-handle when backing out or replacing the firing pin assembly.

Do not remove the rod or punch until after the assembly has been reinstalled in the bolt. The means of extraction differs significantly between a Scout Rifle and others riding the Model 77 platform. I'll refer you back once again to coverage in our November 2012 issue. There, the extractor was part of, meaning built in to, the bolt head. With the Scout, the extractor (#23) rides in a track milled into the bolt body and

RUGER SCOUT RIFLE CONTINUED

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retained by an extractor band (#16). There are similar track-mounted extractors in the world of rifles. There are special extractor pliers made for them from Brownells. They are gentle and kind when used to raise the main body of the extractor in order to rotate it out of its track, or slot as some prefer to call it. Once that is accomplished, the retainer is easily removed from the body of the extractor. Staying on the main subject of Ruger's Scout Rifle obliges me to point to another significant difference.

Its ejector (#28) is part of the receiver, not the bolt, and retained by a pivot pin (#21). The procedure of removal/ replacement therefore bears no similarity to most other 77 Models. More precisely then, once the bolt is out of the rifle hold it with the ejector facing upward. Press inward on the ejector. Simultaneously, tap lightly but repeatedly on the front end of the receiver. The pivot pin should react to the tapping by starting to escape its Both can be indispensable when dealing with super tight screws.

The action cannot be separated from the stock with the screw in place. pivot hole. When you can help it along with tweezers or a set of smooth jaw long nose pliers please

do so. Access to the pin or ejector for repair/replacement is a reality. In the "offer praise when praise is due" department, there are owner's manuals and other manufacturer manuals not worth owning in the firearms business.

I have often huffed mightily in protest and all too frequently wasted my huffing in efforts to convince manufacturers, importers, and assorted representatives well positioned in their respective organizations of a fact I believe is absolute truth: The more information the majority of individuals serving the shooting public who purchase the products made or marketed by an organization can acquire and put into practice (meaning us) the lower the cost and risk of litigation to that organization will be.

It is with no small satisfaction I have learned the higher the head wearing the ears doing the listening, the higher may be the interest in any suggestion made. Please do not misunderstand. I take and deserve no credit for specific content of Ruger's instruction manual.

Outside of the now out-of-print field manuals previously published to support off Apremises warranty service, such as those

once published for Winchester, Browning, and Remington factory service centers, the Ruger Scout Rifle owner's manual comes the closest I've been exposed to in meeting my pleas for information. Maybe, just maybe, somebody upstairs agrees with me. The manual adds nothing more than hasn't been said here about the forbidden firing pin assembly.

Included between its pages are disassembly/reassembly of the trigger, sear, safety assembly, and reinstallation of the firing pin assembly according to factory methods. Aside from the oft-mentioned restricted nature of the ignition assembly, the only item not mentioned is the use of a plastic bag within which you can perform disassembly without risk of losing, thereby having to replace at your own expense, a fairly sizable number of little springs and other equally small parts.

Keeping that potential loss of profit in mind, I advise with no small urgency you place a call to Ruger Customer Service for a free copy of the Scout Rifle Instruction Manual. Of course, you can also download a copy of it at ruger.com. The instruction manual for this Ruger sets a much higher standard for providing more meaningful gun-

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smithing information than the majority of owner's manuals. Having one on hand in your tech file is recommended as a sound, advanced planning step to take. It will contain the complete parts list.

Have the serial number of the rifle involved at hand
Ruger Scout Rifle (Specifications subject to change without notice) 1 Barrel 2 Receiver 3 Front Sight Cross Pin 4 Front Sight 5 Butt Pad Holder 6 Butt Plate Screw 7 Stock Cross Bolt Nut 8 Rear Sling Swivel Stud 9 Sling Swivel Front Screw 10 Recoil Pad Screws, 2 Req'd 11 Butt Pad Spacer 12 Recoil Pad 13 Stock 14 Bolt and use the sometimes lengthy part number when placing the order.

They have been dictated by technicians of 15 Bolt Stop 16 Extractor 17 Safety 18 Safety Selector Retainer 19 Magazine Latch 20 Flash Suppressor 21 Ejector Pivot Pin 22 Sear 23 Extractor Band 24 Safety Selector Detent

Spring 25 Safety Selector Detent 26 Rear Sight Base 27 Sear Pivot Pin 28 Ejector 29 Front Mounting Lug 30 Stock Cross Bolt 31 Bolt Stop Plunger Spring Retaining 32 Bolt Stop Plunger 33 Bolt Stop Stud Bushing 34 Bolt Stop Screw Stud 35 Flash Suppressor Washer 36 Dovetail Slide (Rear Sight) 37 Rear Sight Windage Screw 38 Rear Sight Aperture 39 Trigger 40 Ejector Spring 41 Trigger/Sear Spring 42 Magazine the manufacturer of the firearm featured and must not be revealed to non-AGA members/American Gunsmith readers.

AG 43 Rear Sight Screw 44 Picatinny Rail Screw, 4 Req'd 45 Picatinny Rail 46 Rear Mounting Screw 47 Front Mounting Screw 48 Magazine Latch Pin 49 Magazine Latch Spring 50 Trigger Pivot Pin 51 Firing Pin Spring 52 Firing Pin 53 Trigger Guard/Magazine Well 54 Bolt Stop Plunger Spring 55 Scope Ring, High 56 Scope Ring, Medium

RIFLES

The Basics Of Cut Rifling A Rifle Barrel

Using modern machines and tools to create those important grooves.

BY CHARLES J. MOORE DECEMBER 2015

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Because gun barrels have been rifled for so long in so many different regions of the world, the device that is used to guide and support the hook cutter during a rifling operation is known by several different names. These names include, but probably are not limited to, rifling cutter box, rifling cutter head, rifling head, rifling box, rifling bar, and cutter box. As far as I know, there is no one correct name for the tool; all of the preceding names seem to be equally valid.

I use the term rifling cutter box simply because that is the first name for the thing with which I became acquainted. Early rifling cutter boxes were made of hardwood or brass. They were hand fitted to the bore size of the gun barrels to be rifled and were tapered on each end to permit easy entry into the bore. A small slot was cut into them and a hand-made cutter was inserted into the slot. The cutters were made of hardened iron and usually had multiple cutting edges, somewhat like a saw blade.

The cutting edges were formed with a triangular file. Because the angles of the file's corners were 60°, the cutting edges formed in this fashion usually had a negative rake of 30°. With a such a steep negative rake angle, these cutters were incapable of actually cutting material away from the barrel. The cutters could only scrape away fine shavings from the wrought iron barrels.

As with the other early tools used to make rifle barrels, these early ri- The rigidly-fixed shoe indexes into the groove and causes the cylinder to rotate as the rapid traverse system moves the carriages back and forth along the bed bars. Below center: This is the basic concept of using a twisted rod to index the rifling twist rate. As the twisted square rod moves through the square hole in the fixture, it is forced to spin. Moving the rod to the left will cause the side flat to twist up.

Moving the rod to the right will cause the side flat to twist down. In the interest of illustrative clarity, the rack has been abbreviated and the carriage has been eliminated completely. Also for visual clarity, the axle be-

tween the spur gear and its associated miter gear has been included, as has an abbreviated section of the rifling cutter box pull-rod in the second miter gear. The rack is rigidly mounted to the side of the machine bed.

As the carriage moves away from the spindle for the cutting stroke, it takes the gears along with it, causing them to rotate in the directions indicated. fling tools required quite a bit of time and labor to accomplish the task of rifling a barrel. And the cutter boxes had to be replaced after rifling a few barrels, although the ones made of brass tended to fare better than those made of hardwood.

In order to deepen the grooves in the bore with successive passes of the rifling cutter box, paper shims were placed under the cutters when enough material had been scraped away from the groove bottoms to cause the cutter to become loose. In the pre-industrial days, barrel makers had no pillow-block bearings with which to hold a rotating spindle precisely on the centerline of the rifling bench. The

THE BASICS OF CUT RIFLING A RIFLE BARREL CONTINUED

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The rifling cutter box pull-rod also had to go. The shoe is fixed to the bottom of the rack and the sine bar is mounted to the machine bed at the appropriate angle. As the carriage moves away from the spindle, the shoe grips the sine bar and causes the rack to slide laterally across the carriage. This, in turn, causes the spur gear to rotate in the direction indicated. barrel blank was simply clamped into position on the bench with a pair of hardwood clamping blocks.

The barrel had to remain absolutely fixed in this position until the rifling operation was complete. If the barrel was allowed to slip either longitudinally or radially during the cutting process, it would be extremely difficult to get the grooves to once again align with the path of the cutter and the barrel would likely have to be reamed to a larger caliber so that the rifling process could be started anew.

The rifling cutter box had to be rotated as it was drawn through the barrel's bore in order to cause the grooves to spiral around the circumference. At the time, there were two primary methods to index the twist rate of the helical grooves. One method was to layout the desired rate of twist onto a hardwood cylinder and then cut grooves into the cylinder. One groove was cut into the cylinder for each groove that would be cut into the barrel.

The cylinder was placed into a fixture that could be slid back and forth on the rifling bench and the cutter box's pull-rod was attached to the cylinder. A shoe, or pin, was affixed to the bench and engaged a groove in the cylinder. The shoe caused the cylinder and the attached cutter box to rotate as the fixture was slid along on the bench. The second common method to rotate the cutter box involved using a square iron rod as the pull-rod for the cutter box.

The square rod was twisted to the desired rate of rifling pitch and the cutter box was affixed to its end. The pull-rod would then have a handle attached to the other end which would allow the pull-rod to rotate while the handle did not. As with the rifling cylinder method, a fixture on the bench would engage the pull-rod to impart rotation to the assembly.

In this case, a square hole through the fixture interfaced with the square profile of the pull-rod and caused the assembly to rotate as it was slid back and forth atop the rifling bench. As before, this caused the cutter box to rotate as it traversed the barrel's bore. position on the early rifling benches, the entire tooling assembly had to be capable of being positioned in discreet radial increments in order to cut multiple grooves into the barrel.

With the rifling cylinder method, the shoe or pin would be disengaged from the groove in the cylinder after drawing the cutter box through the bore. The cylinder and cutter box assembly would then be rotated to the next groove in the cylinder and the shoe would be replaced into the fixture to engage the newly aligned groove.

When the twisted pull-rod method of indexing twist was used, the squareholed fixture and cutter box assembly would be rotated slightly and a pin or screw would hold the fixture in the new position to cut the next groove in the barrel. This process of indexing the cutter box assembly with consecutive grooves in the barrel, while adding paper shims under the cutter on each trip around, would continue until the barrel's grooves had all finally been scraped to full depth.

The entire duration of the rifling operation was measured in days, not hours. Rifling Cutter Box Geometry The basic design of the rifling cutter box has changed little over the centuries. Contemporary cutter boxes are still simple cylinders about five or six inches in length and they still hold a centrally mounted cutter. However, cutter boxes are now made of hardened tool steel instead of hardwood. Since the barrel had to be firmly clamped into

THE BASICS OF CUT RIFLING A RIFLE BARREL CONTINUED

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Every time the spindle comes back around to the white line, the cutter is raised for the next cut. or brass and the mechanism used to raise the cutter for successive passes through the bore has become quite a bit more sophisticated than paper shims. There are several styles of mechanisms used in modern rifling cutter boxes to raise the cutter but most use a screw to precisely control the amount of the cutter's rise.

Some mechanisms use a screw that impinges directly on the cutter itself and the interplay between the cutter's geometry and the geometry of the cutter box slot determine the amount of cutter rise for each full turn of the screw. Other mechanisms use an adjustable ramp under the cutter to control the cutter's rise. Advancing the screw, or a nut on the screw, will change the ramp's depth of penetration under the cutter, thereby raising the cutter as it incrementally climbs the slope of the ramp.

The most basic design of rifling cutter box to employ an adjustable ramp to raise the cutter does not use any type of screw to precisely control the amount of cutter rise for successive passes through the bore. This type of cutter box uses a section of ordinary drill rod with the ramp milled onto one end. To adjust the cutter, the cutter box is drawn into the barrel just far enough for the cutting edge to touch the leading edge of the bore.

The end of the drill rod is then rapped lightly with a small hammer, or other appropriate tool. This forces the ramp tight under the cutter and simultaneously forces the cutting edge into firm contact with the bore so that steel will be cut away as the cutter box is drawn through the barrel. When the cutter becomes loose in the bore, the drill rod is tapped again to bring it back into firm, cutting contact.

This mechanism is obviously not very precise as the exact amount of cutter rise cannot be accurately controlled. However, this simple system is used to make first-class barrels by those who employ it. The barrel maker must use a light touch in advancing the ramp during the final cuts to bring the rifling to full depth, but no deeper. A heavy-handed approach with this system during the finishing cuts can lead to a slightly over-sized groove/circle diameter.

There are two different types of cutter boxes that use a screw to control the depth of ramp penetration under the cutter. The first type employs a ramp with an integral threaded stem. In this system, a retaining nut is fabricated to slide onto the ramp stem, without engaging the threads of the stem, and screw into the cutter box. As its name implies, the retaining nut has an inside diameter smaller than

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0001" deep cut. Also note the pull-rod guide bushing centered in the steady rest, the ramp diameter and it retains the ramp within the rifling cutter box. An adjusting nut is screwed onto the stem. The position of this nut on the stem determines the depth of ramp penetration. The ramp can slide under the cutter until the adjusting nut butts against the retaining nut. The adjusting nut is normally graduated with ten index marks.

When the adjusting nut is turned one-tenth of a turn to the next indexing mark, the cutter will be raised 0.0001" over the previous adjustment when the ramp is slid into position under the cutter. Because the rise of the cutter at each adjustment can be precisely predicted, this system allows the barrel maker to maintain tight control over groove depth without the need for constant measurements between cuts during the final passes through the bore.

However, this system is not suitable to automation of the cutter-raising adjustments. This system requires that the barrel maker manually adjust the depth of cut after one pass has been made through each groove at a particular depth setting. The other type of mechanism that employs a screw and ramp to control the depth of cut does allow the adjustment to be automated. This system employs a screw and a separate ramp as individual components.

The screw threads directly into the rifling cutter box and impinges upon the rear of the ramp. When it is time to raise the cutter, the screw is turned by the increment required to raise the cutter by the desired amount. As the screw is turned, it penetrates more deeply into the cutter box and forces the ramp to drive deeper under the

cutter ahead of it. This mechanism can be automated by incorporating a radiused slot in the end of the screw.

This slot is engaged by an indexing driver that looks somewhat like the tip of a hollow-ground screwdriver. When the cutter box has made a cutting pass through each groove, the driver turns by the amount required to advance the screw and raise the cutter for the next series of passes. As the cutter box exits the bore on the return stroke after cutting the last groove in the series, the radiused slot in the screw engages the driver in its new position and the screw is forced to turn.

This automatic indexing feature is quite useful on machines that cycle automatically under hydraulic power because it allows the rifling operation to flow seamlessly with no stops required to raise the hook cutter. The final type of rifling cutter box employs a screw which directly impinges on the cutter itself. As with the preceding example, the screw threads directly into the cutter box and the adjustments can be automated.

However, the screw used by this system must be screwed out of the cutter box as the rifling operation proceeds, rather than being screwed deeper. As the screw is retracted from the cutter box, it allows the cutter to be driven back by a spring. Both the rear surface of the hook cutter and the interfacing surface of the cutter box must be ground to just the right angle in order for this system to work properly.

As the cutter is forced backwards by the spring to the limit allowed by the screw, the interaction of the sloped surfaces on the cutter and cutter box cause the cutter to rise

incrementally out of its slot to cut the grooves deeper. Because the geometry of both the cutter box slot and the cutter itself must be just right, this type of rifling cutter box is generally employed only by large manufacturers who have the necessary tool room equipment required to accurately machine these components.

Barrel makers who fabricate their own tooling and do not have a well-equipped tool room usually choose one of the other mechanisms simply because the components and the cutters are easier to fabricate. Rifling Machines The machines used for rifling gun barrels are very specialized pieces of equipment. These machines are of no use whatsoever for any task other than cutting grooves into rifle barrels.

As with the older style of rifling bench, modern rifling machines move the rifling cutter box back and forth on the longitudinal axis of the machine to accomplish the cut. However, unlike the antique rifling cutters, the hook cutters used to cut rifling on modern machines are ground with a positive rake, usually 5°, and actually cut the barrel steel rather than simply scraping it.

This change in cutter geometry, along with several changes made to the machines themselves, have made the act of cut rifling a barrel with a modern rifling machine a much less time-consuming proposition than it used to be. One major difference between the old rifling benches and modern rifling machines is the use of pillow-block bearings to mount a rotating spindle to the bed of the machine. On many older machines, the spindle is rotated in discreet increments after each groove has been cut at a particular cutter

THE BASICS OF CUT RIFLING A RIFLE BARREL CONTINUED

ORIGINAL PAGE 10

depth setting. An indexing fixture is used to lock the spindle in position for each cut. Some fixtures are designed to engage a series of holes drilled into the spindle, or a collar around the spindle. Others are designed to employ a ratcheting action to engage cut-outs on a spindle-mounted collar. Either of these options locks the spindle by mechanical means and they require that the rifling cutter box be spun as it is drawn through the bore.

Modern, CNC-controlled machines typically do things the other way around. The rifling cutter box does not rotate on these machines. Instead, a servo motor is used to rotate the barrel spindle at a rate which matches the desired twist as the cutter box is drawn through the bore. Rifling machines can be made to use either hydraulic or mechanical systems to impart longitudinal movement to the rifling cutter box.

On most modern machines designed for mass production, hydraulics power the linear movement of the tool carriage. As mentioned before, these machines will typically employ an automated system to raise the hook cutter after a series of cuts has been completed. The hydraulics used to power the carriage will also cycle automatically once the rifling process has begun. It is important to realize that the hydraulics are not used to allow a deeper cut to be taken, nor are they used to increase the speed of the cut.

In order to keep the hook cutter sharp for as long as possible, the rifling cuts must be made at a relatively slow speed. Because of this, the hydraulically powered machines are usually setup so that the stroke of the piston which drives the cut is slower than the return stroke. Since no steel is being cut away during the cutter box's return, it is beneficial to accomplish the return stroke with all due haste.

The rifling machines that use mechanical power to move the rifling cutter box typically use one of three options. The options for driving the cutter box are chains and sprockets, rack and pinion gearing, and leadscrews. The machines which use

chains and sprockets to power the carriage are usually built from scratch. A hand crank is placed on the sprocket axle which lies closest to the barrel spindle and this allows the barrel maker to remain in one position as the carriage moves.

The machines which use either rack and pinion or leadscrew systems are typically built on the bed of an old long-bed lathe that has been reconditioned for use as a rifling machine. The lathes original gearing and/or leadscrew setup is used to power the carriage. And if the original lathe had powered feed, the rifling machine can also be made to have power feed.

However, advancing the carriage by use of the hand wheel on the apron will prove to be a far faster way to accomplish the cuts on most machines due to the powerfeed rates typically employed in lathe work. This option will require that the barrel maker follow the carriage as it moves back and forth. There are several different types of twist indexing systems employed on modern rifling machines. One of the most common and well known is the sine bar system.

With this system, a steel bar is set at an angle to the centerline of the machine. A sliding rack is made to engage the sine bar. The sliding rack is mounted on the carriage of the machine perpendicular to the longitudinal axis of the machine. As the carriage moves back and forth, the rack's engagement with the sine bar causes it to slide along a path at right angles to the motion of the carriage. A pinion gear at the rear of the rifling cutter box's pull-rod engages the rack.

As the rack slides, the pinion gear rotates and this causes the cutter box to rotate along with it. The twist rate cut into the barrel is determined by the circumference of the pinion gear in conjunction with the angle of the sine bar. The smaller the pinion gear and the greater the angle of the sine bar, the faster the twist rate of the rifling will be. These sine bar systems are adjustable to cut all standard twist rates, and any twist rate in between.

The second common twist indexing system seen on modern machines is the rack and pinion system. These machines employ a fixed rack that is mounted to the machine bed parallel to the longitudinal axis. A pinion gear engages the rack and rotates an axle which is mounted on the carriage perpendicular to the machine's axis. A miter gear on the axle interfaces with a miter gear mounted to the rear of the rifling cutter box's pull-rod. As the gears spin, the cutter box is forced to rotate as well.

In this case, the twist rate of the rifling is determined by the circumference of the pinion gear alone. In order to change the twist rate of the rifling, the rack must be adjusted higher or lower to accommodate a pinion gear of a different size. Because of this, these systems are not infinitely adjustable for twist rate. Only the twist rates that can be cut with the available, discrete gear sizes are available to the barrel maker. One additional feature of the automated rifling machines is a cutting oil system.

Since these machines cycle automatically, they must be capable of clearing chips with no intervention by the barrel maker. As with the machines used to drill and ream rifle barrels, these machines pump oil through the shank of the rifling cutter box. The oil will typically exit the cutter box at the hook cutter slot to flush the chips away from the cutting edge. The oil then carries the chips away through the barrel to be deposited in the chip tray upon exit.

The machines that are operated under manual power and/or with manual cutter feed settings do not usually have an oil pumping system. The chips are cleared away from the cutting edge at the end of each stroke by the barrel maker before proceeding with the return stroke. Troubleshooting Rifling The rifling operation is the make-or-break moment in the process of fabricating a rifle barrel. If this delicate job is botched the barrel will have to be scrapped, or at least reamed to a larg-

THE BASICS OF CUT RIFLING A RIFLE BARREL CONTINUED

ORIGINAL PAGE 11

er caliber to try the rifling operation again. The most troublesome problem that can arise during the rifling operation is rough groove bottoms. A second issue that can occur is incorrect groove depth. The grooves must be cut to within specified tolerances of depth in order for the rifle barrel to be safe and accurate. One of the most common causes of rough groove bottoms is a too-aggressive cutter feed.

Rifling grooves are typically cut a mere 0.0001" deeper on each successive pass of the cutter box through the bore. If the cut is any more aggressive than this, the groove bottoms tend to be very rough. Lapping is mandatory for these rough barrels because they will foul quickly and lose accuracy if the grooves are not lapped smooth. When using a cutter box with the capability for precisely controlling the cutter feed, excessively heavy feed and rough grooves should not be an issue.

However, if using the simpler cutter box design in which the ramp is simply tapped to advance it, rather than being positively controlled by a screw, then a too-heavy feed is certainly possible. The condition of the groove bottoms should be monitored to check for this condition when using one of these cutter boxes. An easily correctable, but sometimes frustrating, problem that will definitely occur at some point in every barrel makers life is a dull hook cutter that refuses to cut.

Since the rifling cuts are so very shallow, any slight imperfection of the cutting edge can cause the cutter to skip and scrape rather than cutting the way it should. This condition is easily detectable when using a manually operated machine. The barrel maker will be able to feel and hear the hook cutter sliding through the bore rather than cutting.

When using an automated machine, a dull hook cutter can be a little harder to detect simply because the barrel maker is not intricately involved in every step of the process. If the barrel maker has a grinding fixture that can be used to accurately sharpen the cutter, the rifling cutter box can be removed from the machine to sharpen the cutter.

However, if there is a barrel in place in the spindle that is not yet completely rifled, the barrel maker had better be very certain that the rifling cutter box can be re-installed on the machine in the exact same orientation after the cutter is sharp. If the cutter box is misaligned with the incomplete grooves by even a tiny amount, the finished results will likely be less than satisfactory. The other option is to sharpen the cutter by hand while leaving the rifling cutter box in position on the machine.

This technique requires a bit more manual dexterity, but it does avoid the possibility of misaligning the rifling cutter box during

re-installation. The final issue that must be dealt with is accurately measuring the groove-circle diameter. The time-honored method used to accomplish this is by pushing a slightly oversized, soft lead slug through the bore. The slug emerges with raised ridges that correspond to the grooves in the barrel.

The measurement across the ridges on the slug is the same as the measurement of the groove-circle. The cutter is fed out of the cutter box and the rifling operation continues until the desired groove depth is reached. Another alternative for measuring the groove-circle is to fabricate a simple tee-gage that is dimensioned to represent the lower limit of groove-circle diameter. When this gage can be slid into opposing grooves, the barrel is finished.

Please do note that either of these procedures will be far easier to employ if an even number of grooves is cut into the barrel because each groove will have another groove directly across the bore from it. If an odd number of grooves is cut into the barrel, each groove will be mated to a land on the opposite side of the barrel. This configuration makes measuring the groove-circle diameter a little more problematic. More detailed information on rifling barrels is provided in Steel Helix (steelhelixrifle.com).

MACHINING

Magazine Checks

Dusting off a few proven techniques for improving accuracy.

BY JOE CARLOS DECEMBER 2015

ORIGINAL PP. 12-15

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When I came on as Armorer for the Army Reserve Marksmanship Program I machine rest tested 135 National Match uppers and only 39 shot MOA. The Reserves didn't previously have an in-house maintenance program and lacked parts so I substituted sweat (mine!) and eventually cut group sizes in half. When I left the Team a decade later all 135 of those uppers shot sub-minute groups with some type of ammo if tested properly.

This article is not so much about shrinking groups as getting all of your groups (rifle or pistol) to hit to the same point of impact (POI.) Magazines, integral or detachable, work by using a spring to push a fresh round up in front of a bolt or slide. That cartridge is then pushed into the chamber either manually or by a compressed spring. The magazine under the bolt is exerting upward pressure on it.

If one magazine exerts a different pressure on the underside of a bolt or slide it can result in POI changes as compared to other maga-

zines. Most magazines have feed lips, followers, and springs which influence feeding and hence the orientation of the cartridge in the chamber and the pressures that the bolt or breech face, extractors, and ejectors exert on the rims of casings. Those differences can also influence down range bullet impacts.

High capacity double stack magazines feeding rounds alternately from right to left at an angle, such as the M1A and AR-15 rifles, likely have the potential to exacerbate differences in orientation and pressures on case heads. There have been firearms that fed from the side. Most of these were military guns that ultimately fell out of favor. I have never heard of this design causing POI problems but many of them have been submachine guns used in relatively close quarters.

I said that magazines work to change down range bullet impact The M9 magazine on the right feeds all rounds straight in. Below center: True match bolt carriers (from top) from Les Baer, JP Rifles, and Young Manufacturing. 22LR single round Bob Sled magazine from

Compass Lake Engineering for use with their very good dedicated .22LR uppers. in part by varying upward pressures that all of them exert on the bottom of the bolt carrier.

Locking a charged magazine in an AR-15 with the bolt forward demonstrates this, as you'll notice the carrier move upwards just as the magazine locks in place, compressing the top round downward. When the top round is positioned on the left the carrier will also want to rotate clockwise a bit but it's unlikely you'll be able to see it. When the top round is on the right the rotation will be opposite. You can also perform this test with pistols and see the back of the barrel or the entire slide react.

There will be more movement in rack grade pistols as match pistols usually have most visible slop removed by the builder. That doesn't mean that upward pressures can't influence in POI in accurized pistols, however.

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Above center: When shooting single shot slow fire events remember to always push the round up into the chamber with your index finger. This will insure more consistent round positioning and enhanced grouping. I dealt with match bolt carriers in "AR-15 Upper Quick Fixes: Match Bolt Carriers" (May 2014) and mentioned three match carriers I have used that increase bearing surfaces and give fatter front dimensions.

When going through guns currently in my shop and watching for magazine-induced bolt carrier movement, I noticed uppers equipped with match carriers had less upward movement. Since more carrier movement yields greater potential change in POI I would suspect that match carriers may lessen this effect. Unfortunately, when designing my study of match bolt carriers I was short sighted.

All I was thinking about at the time was the reduction in group size (8.8% average) and not any positive influence in changes in POI caused by magazines. My bad and what's done is done. Or is it? I mentioned at the end of that article that until we can solve the accuracy-robbing problem of bolt carrier in the Stoner platform we'll never realize full accuracy potential.

I've been researching potential solutions to this and by observing magazine-induced upward carrier movement I noticed match carriers with anti-tilt pads exhibited much less movement. Experimental antitilt pads are already showing 14% average accuracy increas-

es and I'll begin watching to see if they help with the POI problems as well. Applying Theories The magazine test scan (page 15) was a check performed machine rest testing a rack grade Combat Team rifle and three magazines.

Note the distance from group one fired with the first magazine and the other groups each fired with different mags is 2- 1/4" at 100 yards. Many competitive events include reloads and different magazines are needed. To exacerbate matters even further, sighter rounds are offered in some events and some shooters elect to different magazines for that. I recommend taking sighters with a magazine you'll use when shooting for record.

Other stages single feed rounds and many shooters use a "sled" magazine with no spring and follower and exerts no upward pressures on the bolt carrier. I recommend using such a magazine where appropriate because no pressure is always most consistent. When single feeding for slow fire always push the round up into the chamber a consistent distance, then close the bolt. Doing so will give you a net average reduction in group size of 13.8% because rounds will be positioned more uniformly in the chamber.

Never use a single shot sled mag for sighters if record shots are fired employing regular magazines with springs. The target on page 14 illustrates why. The 300-yard SR-3 target has a seven-inch 10 ring. If our unfortunate shooter chooses that second magazine for

sighters, mag three for the first two for record, and mag one for the remaining eight rounds, the POI difference is 2.25 MOA and those eight rounds will be centered on the left edge of the 8 ring.

Given the average hold of a Master class shooter I'd expect 12 points to be lost, resulting in an 88. This can really confuse and demoralize any shooter. 3 Gun events involving various pistol, shotgun and rifle stages require rapid reloads with multiple magazines. The more magazines involved the greater the chance for changes in POI caused by one of them. After Viet Nam I was a drill sergeant for many years before moving on as a small arms instructor, shooting team member, and armorer.

During range qualifications troops are issued several magazines for the day's training only to turn them all in at the end. Soldiers may zero and then qualify with different magazines. Compound possible POI error with M855 "green tip" ball (some of the least accurate ammo I've used) and it doesn't help getting hits at distance. I also spent 28 years in law enforcement and was a firearms instructor during all of it.

My department qualification course went back to 50 yards and any POI error could certainly have an effect. The first group I know performing magazine checks was the bullseye pistol crowd. National Match Course

MAGAZINE CHECKS CONTINUED

ORIGINAL PAGE 14

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Above center: Ransom Rest used to conduct magazine checks for pistols like the M9. Magazines with newer green plastic replacement followers should not be mixed with older issued magazines. pistol competitors began testing with the Ransom Rest in the 1970s when the 1911 in .45 ACP was king. While it was somewhat affordable for individuals, gun clubs often bought one and shared it among their members. Most all of the big military and police teams also had them.

Machine rest testing verified that different magazines would change the POI. Shooters began numbering their mags and checked them on the machine rest. When the M9 was adopted by the military I used my Ransom Rest to document this with those guns. When I came to the Army Reserve Service Rifle Team in the 1980s as a shooter I heard rumors that other big military shooting teams used their rifle machine rests to perform magazine checks on M14 National Match Course rifles.

The Reserves didn't have a rifle machine rest then and contracted maintenance by paying another competing team to do the work. I questioned that particular bit of logic, wondering how many race car drivers would let a mechanic from a competing team tune their engines. As a Team competitor I tested a

number of our M14s and never found one that I felt was capable of anything much better than 2 MOA. I had my own M1As, all double lugged and built by the best civilian gunsmiths in the country.

My personal rifles shot rings around our Team guns. Team policy, however, mandated shooting government guns in competition and my scores declined during my time there. I found this very discouraging and ended up switching to the Combat Team, which used rack grade M16s. The effect of magazines on POI remained nebulous during the M14 era.

The one good thing that came of my negative experience with military Team guns was that it fueled my passion to never subject shooters under my care to substandard firearms when I became the Armorer. During my time with the Combat Team the finicky, high maintenance M14s were dropped (yay!) and replaced by the AR-15. The Reserves were still contracting with a competing team for weapons maintenance, however, and many shooters were still unhappy.

I had my own commercially-made rifle machine rest and spent the previous decade working on Combat Team M16s and civilian AR-15s, learning the Stoner platform front to back. I had been performing magazine checks on Combat and civilian AR-15s, M9s, and .45s and was confident this would help the

Service Rifle Team. Performing Magazine Checks Before we describe the process we need to lay down a few simple ground rules.

First, exert only those pressures on the magazine that will be in effect when the gun is actually being fired for record. In general, NRA competitions disallow placing the floor plate of a rifle magazine on the ground for support so it would be inappropriate to do so when testing. Other shooting disciplines do permit using the magazine for support and good shooters take advantage of the extra stability.

Many matches and almost all battlefield applications require shooters to fire from multiple positions and may exert no pressure on the magazine in some positions while placing a great deal in others. You will need to test those magazines both ways. I like to use machine rests as much as possible. They speed results and I have faith that I am not committing any errors in application of shooting fundamentals that could corrupt my results.

Machine rests do not exert pressures on magazines so in testing a weapon that will be fired both with and without pressures on the magazines requires additional testing from position. Those of you without rifle machine rests would likely test the gun supported by sand bags and then repeat with the magazine resting on the ground.

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25" distance between group centers. The results that you get are specific to that gun and magazines only! Magazines tested in one firearm can not be relied upon to be free of inducing changes in POI when employed in a different gun. Test magazines in the firearm(s) they will be used with. The AR-15 can throw a monkey wrench in this as it is quite common for shooters to swap uppers around on different lowers.

If you perform a check with a given upper/lower combination and then swap them, repeat the magazine evaluation with the different combination. Pre-sorting magazines can be helpful but isn't a substitute for firing. Only test magazines that have proven to be 100% reliable in feeding, then sort by brand. Charge the magazines and cull any that present the rounds with a cant different than other magazines.

Also, insert charged mags into the firearm with the bolt or slide forward and watch for any noticeable change in feel when they seat in place or observe the bolt, bolt carrier, or slide reacts. I would also question magazines whose feed lips look different than the rest of the litter. Many shooters keep a few magazines charged for unexpected "go to war" situations. It is said that doing so can cause compressed magazine springs to "take a set" or be weak and are cautioned to rotate periodically.

I would also avoid magazines that have remained charged for over a year in competition. I have AR mags dating back to Viet Nam that still feed perfectly. Some folks succumb to advertising and want to "fix" unbroken things. Older mags with original

springs and followers and others with replaced parts can be identified by different spring resistance if they weren't already marked. I would want my competition magazines to be either 100% with original springs and followers or with all new ones.

Put careful effort into getting the gas tube alignment proper with the bolt carrier key. See "Gas Tube Alignment" (March 2014) on how to do this. These two parts will be locked up during firing and the final stages of chambering. There is room for variation in testing and my way is not necessarily the only right way to perform it. Start with a clean, lubricated firearm and don't hesitate to add oil to slides, bolts, and bolt carriers frequently during testing. Magazines need to be clean as well.

Use some type of permanent marker to number mags to keep track. I like to test this using three shot groups but that's mostly due to my military background. Always chamber the first round by the same method you'll use at a match or elsewhere. This is also a key piece of advice when shooting sighters. Decades ago pistol shooters discovered the first shot out of the magazine chambered manually is different from self-loaded rounds. This holds equally for rifles as well.

If your particular discipline calls for you to insert the magazine with the bolt or slide forward and then rack the first round into the chamber that is the way you should be testing. Conversely, if you will be locking the magazine in place with the slide or bolt locked to the rear then do likewise when

testing. Always pay particular attention to where that manually chambered first round goes out of each magazine.

Sometimes it helps to fire a fourth shot, triangulating magazine-fed shots two through four and if it differs from the first manually-fed round. The distance for testing will be determined by a number of variables. For method of observation I use a spotting scope and can see .22 holes reliably at 100 yards but am less confident seeing them at 200 under certain lighting conditions. .30 caliber holes can be seen at 200 yards with good optics. Since the AR-15 is my bread and butter gun I test at 100 yards.

It is easy to see .22 and up at either 25 or 50 yards in most spotting scopes so either distance is acceptable for testing. I think that electronic targets like Sius-Ascor units (sometimes called "bullet sensors") would be the ticket for performing magazine checks and would really increase throughput as you can isolate specific shots or groups and the software will locate group centers. Alas, most of the units I've seen price out at five figures so you'll likely have to resort to "old school" methods.

Wind is another factor and also why I test rifles at yards. For those of you testing pistols you might want to consider 25 yards on days when wind drift at the 50 could be contaminating your data. Bookkeeping There are three ways of keeping track of your test groups that I can think of. If you fail to diligently employ one of them all your hard work will surely turn to chaos. (Continued on page 21)

MAGAZINE CHECKS CONTINUED

ORIGINAL PAGE 21

Mental tracking is what I use. I keep track of the bullet locations and from which magazines they were fired in my head. I can only keep that straight for about three groups before clearing the gun and going down range to sketch in the triangles and label. This takes practice and demands no distractions. The sketch pad method requires marking each shot on a sketch pad or graph paper as it is fired, then marking each three shot group, triangulating and labeling with the magazine it corresponds to.

This calls for periodic cease fires when you go down range and label the actual test target using your sketch as a memory enhancer. The third is to go down range and label each group as they're fired. This has the dual benefit of giving you the most exercise while affording the least opportunity of error, however, it is slow and you'll spend more time walking than actual test firing. Eventually you are going to have to tack up anew target. I do it every time I go down range after nine shots.

I pencil a dot in the middle of the new target paper and then overlay that dot in the center of my previous test groups, not considering any groups fired from rejected mags. You should test and have faith in the absolute maximum number of magazines you will ever be called upon to fire in a match or the number you intend to carry as your load plan for tactical applications plus a few spares. Once a magazine is checked and found OK it will seldom change your POI of its own volition.

This assumes that it is not subjected to some type of abuse. If you suspect that a magazine may have been damaged, furlough it temporarily, rotate in a tested

spare, and retest later. To avoid both function and POI shifts in magazines, keep them clean. For some shooting disciplines this will only mean an annual cleaning. Others will require it more often. Be religious about re-assembling magazines during cleaning sessions to ensure that the parts go back together the same as they started.

Use whatever bookkeeping method you prefer in order to ensure that springs and followers go back in the magazine bodies they came out of. The number one cause of POI shifts following a quick magazine change is shooter error. This usually relates to adopting a slightly altered position after the reload which compromises the natural point of aim. The second most likely cause is probably a change in condition. The wind is blowing harder or the sun comes out from behind a cloud, changing the lighting.

Magazines run a distant third but they can't be ignored. If a shooter is only encountering a group shift occasionally it's probably shooter error or conditions changes. If it is happening frequently, test magazines. If you don't have the proper machine rest I recommend shifting responsibility for testing to the shooter as trying to test using sand bags or other support is too time consuming for most gunsmiths.

At least now you can provide proper advice to shooters on how to perform magazine checks to determine if they are causing shifts in point of impact. AG

SHOTGUNS

Hydrographics

Now you see it, now you don't. Like a magician's trick, hydrographics is a simple method to add realistic camouflage to make any firearm virtually disappear.

BY ROY SEIFERT DECEMBER 2015

ORIGINAL PP. 16-18

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When my mother turned 90 the entire family got together to celebrate this happy occasion. Everyone in the family knows that I am a “gun guy” so it was only natural that my 22-year old nephew, Nathan, came to me with a gun question. He wanted to go duck hunting with some of his friends in the fall and asked me what shotgun to buy. My somewhat glib response was to get something that would go bang and kill a duck! After a brief moment of confusion he then asked me what brand of shotgun I would recommend.

I told him Remington, Mossberg, Browning, Winchester—just to name a few—all made fine shotguns; it would really depend on what he could afford. I made it clear to him, however, that it's The forearm has been painted with the primer and base coat and is ready to be dipped. The dowel in the forearm helped me hold it for dipping without having to touch the part. not

the gun that's important; it's the man behind the gun that counts. At the time, I owned three 12 gauge Winchester Model 1300 shotguns.

One was a Defender model that I use for 3 Gun competition and the other two were field grade. I decided to gift one of these field-grade guns to Nathan (how many of us received our first gun as a gift from a father, uncle, or mentor?) but I wanted to prepare it for him for duck hunting by adding camouflage. There are a number of methods to camouflage a gun; some good and others not so good. The easiest method is to paint a camouflage pattern onto the gun.

Watch the movie Shooter with Mark Wahlberg and notice how he uses camouflage paint with natural leaves and sticks as stencils to apply a camouflage pattern to a sniper rifle. Pre-cut stencils make the patterns look more realistic but painting can be messy. Unless you use a stencil, the pat-

tern is not very realistic. Paint can also build up, changing tolerances of close-fit parts.

Slip-on covers, tape, and heatshrink wrap are more realistic and temporary but they can get in the way of moving parts, sights, and the ejection port. Hydrographics A very popular method for adding camouflage to a gun is using hydrographics, sometimes called liquid printing, water printing, or water transfer imaging. Many firearms manufacturers are using this method to enhance their factory guns.

A piece of film is produced by printing a camouflage pattern onto a watersoluble backing, cut to the desired size, and placed into a tank of water. This causes the backing to dissolve, leaving the pattern floating on top of the water. A chemical activator is sprayed onto the pattern which causes the ink to turn to liquid. The prepared part is then dipped into the liquefied pattern, causing it to wrap

HYDROGRAPHICS CONTINUED

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The masking tape frame prevents the film from curling when it is laid in the water. The masking tape floating on top of the water prevents the wet film from expanding too far and destroying the pattern. itself around the part. After the nowcamouflaged part is dried it is coated with a clear coat to protect the finish. This camouflage method is permanent, the patterns are very realistic, and the clear coat protects the gun so you never have to keep the outside oiled or worry about rust.

I did some research on the Internet and found a company that sells a do- No water should be allowed to sit on top of the film or it will not adhere to the part. Notice how the

slits are separated. The film is ready for apart to be dipped. it-yourself hydrographics kit called My Dip Kit (mydipkit.com). They have many different patterns to choose from including 58 camouflage patterns.

The complete kit comes with four spray cans (primer, base coat color, activator, and clear coat finish), latex gloves, a brown coarse scrub pad, mask, and a sheet of the pattern film. They have three different kits to choose from. I chose the "designer" kit which comes with 2.5 square meters of film. This provided plenty of film to cover the gun and enough to practice, learn, and make mistakes.

For duck hunting in a marsh environment I chose the Vzion Outdoors Boggy Vision pattern because duck hunting usually takes place in a marshland environment. This particular pattern had a rightside-up, which meant I couldn't cover both sides of apart with one dip as one side would have the pattern upside down. Would ducks notice the difference? Of course not, but I would. This meant I would do half of each part at a time. Preparation I completely disassembled the gun into the major components I planned to dip.

I USED 120-GRIT SAND PAPER TO

HYDROGRAPHICS CONTINUED

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Although the kit came with one pair of latex gloves I purchased a box of vinyl gloves because I was doing multiple dips. Without the gloves my hands would have become “camouflaged” by the liquid ink. roughen all of the areas to be covered. Any rust needs to be completely removed as rust will continue to corrode the metal even under the paint. Before masking the parts I made sure the inside of all parts to be dipped in water were well coated with oil.

I didn’t want any rust to appear inside the gun where I wouldn’t be able to reach it. I used masking tape to mask off any areas I didn’t want to get covered, such as the magazine tube. Because I planned to dip only half of the receiver, butt stock, and barrel at a time I masked off the half not being covered. I added Each part to be covered needs to be painted first with the gray etch primer, then with the base coat color. Painting should be done in a well-ventilated area.

The kit comes with a mask to prevent breathing in paint fumes. I used multiple light coats to cover each part and allowed the paint to dry for one hour before applying a second coat. Multiple light coats of paint are better than one heavy coat which could run. The

base coat color provided was labeled tan, but it was really light beige. Much of the pattern film is clear which allows the base coat color to come through. By changing the base coat color you can change the overall color of the result.

I cut out the sheets I needed to cover each part of the gun. There needed to be enough film to cover The butt stock and receiver I dipped one side at a time. The forearm I dipped and rolled to get the pattern to cover the top. Happy birthday, Nathan! wooden dowels used as handles for dipping, and used modeling clay to plug any holes to prevent paint spray or ink from penetrating inside the part. the piece with some leftover. More is better.

Following the instructions, I laid masking tape on the film to create a frame, and then cut out around the frame. The film was not wide enough to cover the entire barrel so I laid the barrel onto the film at an angle so I could cut one long piece. I put apiece of white poster board behind the film when laying it out for cutting to make it easier to see. My cutting table is brown which made the film very difficult to see. It is camouflage after all!

The Process Any container that will hold water can serve as a dipping tank. It has to be long and wide enough to allow about one inch of clearance around the film to allow it to expand and deep enough to be able to submerge the entire part at a 30-degree angle. I borrowed one of my wife’s plastic storage bins and filled it with 80-degree water, checked with a cooking thermometer to ensure the water coming out of the tap was at proper temperature.

If the tank is too large the instructions advised laying a masking tape frame on top of the water to prevent the film from expanding too far. I was careful not to fill the tank too much to prevent spills when dipping the part and possibly ruining the film. The next step is to cut slits through the masking tape border around the sheet of film to be used. I cut the slits completely through the masking tape. These slits allow the film to expand once sprayed with the activator.

Holding two opposite corners of the film together like a sling, I carefully laid the film on top of the water. I was careful not to get any water onto the top of the film or it would not adhere to the part. I left the film (Continued on page 21)

on top of the water for exactly 60 seconds. This softens the backing and turns it into a jelly-like liquid. Now it's time to turn the ink into liquid. I sprayed a thin, even layer of the activator onto the film and it immediately started to expand. The tank and/or masking-tape border prevents the film from expanding too far. If the film expands too much, the pattern will become distorted or completely dissolve. After about 20 seconds the film became shiny indicating it was ready for dipping.

With the part properly prepared and painted, I held it at a 30-degree angle and slowly dipped it into the liquid ink. This prevents air bubbles from forming. Where air bubbles form the ink will not stick to the part and will wash off during the rinse process, leaving base-color dots throughout the pattern. With the part completely submerged I gave it a gentle shake to separate it from any unused film. I had to be careful not to touch the newly covered part or to allow the part to touch the bottom of the tank.

The ink is still liquid at this point and can be rubbed off. After removing the part from the tank I rinsed it off with warm running water until the part was no longer shiny. This indicates that all of the jellied backing was removed. I allowed the part to air dry, then sprayed it with two coats of the provided matte clear coat. I performed the same process to the other half of the parts after masking the newly camouflaged half.

I removed all masking and plugs, made sure all the parts were properly lubricated, and reassembled the gun. I presented the completed shotgun to Nathan for his birthday and everyone was amazed at the camouflage. I warned him not to set it down and walk away or he might not be able to find it again! Pretty good considering I performed all of the dipping in my bathroom. The process doesn't require much space, just a source of running water.

One major advantage of hydrographics is that you are not limited to camouflage patterns. I've seen guns finished with skulls, flames, carbon fiber, wood grain, or pretty much any pattern you can think of. This provides a great alternative to paint for aluminum receivers that may need an original finish or refinishing. There are many professional companies providing hydrographics services but even the small shop owner can add this to his repertoire of services. AG

ORIGINAL SOURCE PAGE

21

FROM THE ARCHIVE

Gunsmithing Correspondence Schools

Not everyone can attend resident courses. Universities offer distance learning for complete college degrees. Gunsmithing is no different.

BY JERRY SPADORCIO DECEMBER 2015

ORIGINAL PP. 19-21

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I have been a full-time, professional gunsmith for about 11 years working from a shop I built on my property. When I retired from law enforcement after 30 years, I wanted to do something fulfilling with my retirement. Since I had a love for guns, gunsmith school was the natural choice. I wanted nothing more than to have my own shop and hang my shingle.

While I did consider attending a full resident course and investigated those options, I ultimately chose taking a correspondence school instead of attending a trade school. As with most major life choices needing careful consideration, education was based on time limit, money, location, and what I could get out of the training. A resident gunsmith trade school can cost \$20,000 to \$40,000 or more for tuition alone, not including the cost of living expense for a two year school or longer.

Instead, I went with distance education courses offered from the American Gunsmithing Institute (American Gunsmithing Institute. net) out of Napa, California. They are a private proprietary institution approved to operate by the California Bureau for the private Postsecondary Education Act of 2009 (as amended) and division 7.5 of Title 5 of the California Code. This course put me in the right direction and fulfilled all of the requirements I needed to become a qualified gunsmith.

All of the subjects are taught by master gunsmiths. For example, Bob Dunlap taught gunsmithing at a college for 30 years. Each subject is taught in segments, such as pistols and revolvers, rimfire guns,

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Hands-on work is required to complete the AGI correspondence course and samples showing off things like your machine work are sent in for evaluation. shotguns, and rifles. I was taught the theory of gunsmithing and how each gun works with a demonstrated understanding before working on guns. Other topics included heat treating, case hardening, spring making, stock work and refinishing, trigger jobs, glass bedding, rebarreling, and finishing work such as bluing, slow rust, and nitro bluing.

Each subject is taught as a series of segments on DVDs. What's very helpful about this approach is the convenience of reviewing any segment as often as needed to better understand what is being said or shown. Instructors lecture on each topic, telling the story of each gun, how they work, and what can cause them to not operate, just like in a classroom environment. Demonstrations are given with full-size cutouts showing how things work internally along with black board drawings and other illustrations.

The close-ups on each gun part and the repairs shown are fantastic. It's as if you were sitting in a classroom listening to your instructor as they show every intricate part of the gun. Just like sitting in a classroom, you must take notes while listening to help you

learn. The important theories of gunsmithing are covered by learning how each part of a gun works. You learn quite a bit on fire control systems. Math is also involved, especially in firing pin protrusion.

You are taught trigger jobs and how to do it right along with what parts are hardened or case hardened. Other courses cover machine shop work (lathe and milling), welding such as TIG, MIG and gas, and the like. Beyond shop work are also lessons on business concerns, such as managing your shop, advertising, tax records, product liability and other insurance, and obtaining your FFL. Written tests follow each segment which are taken on your computer and must be passed before going on.

In addition to written tests, various projects must be completed and submitted for grade. For example, test bars on the lathe and milling machines to evaluate your shop work. The instructors send a metal test bar or block with instructions and blue prints of measurements of what is needed to turn and cut them. When done, send them back for final testing. The total tuition is not cheap at \$15,000 but the course is very thorough.

Even though it is distance learning, it is formal learning with the same sort of lecture, demonstration, hands-on work, and

testing you'd take in any good class. Since completing the course I opened my own gunsmithing shop named Jerry's Gunsmithing in Dallas, Oregon where I do general gun repair. In addition to individual area gun owners, there are four gun shop dealers in my vicinity and I am their gunsmith. I have been told that I do a very good job for them.

I have made firing pins, hammers, springs, small sights, and pins. I also have reconstructed parts that were broken, TIG welded parts together, and use heat treating to harden parts. I was able to do this because of what I have learned through the American Gunsmith Institute. I do not know what the best gunsmith school out there is. Each one is a little different and some are not as good as others. Distance education is now offered for full Bachelor's Degrees and higher.

In away, American Gunsmith publishes good articles and takes reader questions so this is also a form of distance education as well. If you learned something useful and it helped you as a gunsmith, then distance education can be good. I completed my AGI course and am now a professional gunsmith. Yes, I was taught by a correspondence gunsmith school, but I chose the right one for me and business is good. AG

MAINTENANCE & REPAIR

Reader Forum

BY AMERICAN GUNSMITH EDITORS DECEMBER 2015

ORIGINAL PP. 23-24

AMT Automag III I inherited an AMT Automag III and found the September 2015 article about it interesting. In cleaning the pistol I found a stainless steel pin inside (0.125" diameter, 0.750" length). I cannot find where this pin goes in the gun. Do you know where this pin might fit or where I can find a diagram? Would it be safe to try to shoot this gun or do I need to wait? Author Dave Strom responds. I would not fire this gun until you are 100% sure that things are safe.

The AMT I worked on has been returned to the owner so I don't have it here to measure the existing pins. There is an exploded view for download on the Numrich Gun Parts Corporation's website (gunpartscorp.com) that lists the part. Search You Tube for disassembly videos as well. Rebarreling and Recoil Pads Some comments from the October 2015 Reader Forum. First, rebarreling a 760 Remington is done just like any other Remington.

The barrel lug is sandwiched between the barrel extension and must be properly indexed after fitting the extension with a special wrench. I use one I designed and made myself. Concerning recoil pads for synthetic stocks, most of these need to be cut off. The hole spacing likely won't match but the process is the same.

I rasp pieces of wood to match the inside contour of the stock top and bottom, then rough up the inside of the stock with a small steel cutter in a Dremel tool with under cut gouges to lock the wood pieces. Bond with epoxy as nothing else sticks to plastic. The pad is attached and fit as normal and can be removed or replaced. Norman Weaver Weaver's Gun Shop Thanks for sharing these tips with our

readers. H&K Problem I have a Heckler & Koch Model 4 .380 (serial number 06XXX) that I bought new in the early 1970s.

On the left side of the slide it says "Harrington & Richardson Inc.—Worcester, Mass. USA—Made In Germany" and a circular symbol with what looks like a lion in it with the dates 1871 and 1971 on either side of it. The gun has about 200-300 rounds through it. Robert After shooting a few rounds the slide locked back like it was welded in place. A gunsmith freed it and told me that the plastic recoil buffer had disintegrated with age. The buffer plate was OK. I found a new buffer and put the gun back together.

Four rounds into the next range trip the pistol locked up again and has been that way since. I have no desire to take a screw driver or pry bar to it and I do not know what that gunsmith did to unlock it. Do you have any idea how to solve this problem? Can you recommend anyone that works on these pistols? The pistol is based on the Mauser HSC and was discontinued in 1984.

The Model 4 probably predates anyone currently with H&K in Georgia but it's worth a try. That failing, get a copy of Gun Digest's pistol assembly book, examine the HSC instructions, and you might find a solution. Air Guns Do you have knowledge of any place where I can learn to work on BB guns and other air guns? I work on firearms and receive requests to work on them, the latest being a Model 25 Daisy pump. Any advice on exploded views?

Mel Kline Mel's Leather Bloomfield, MO Airgun manufacturers are tighter than producers of firearms when it comes to handing out technical information. It took us over a year to pry enough loose from Air Force Airguns to do an article on their top

of the line, 1000 fps, reservoir-powered model. Benjamin requires prior attendance at their school in order to secure any parts needed to repair their products. Daisy has no such school we've heard of but can provide an owner's manual for the Model 25.

As you know, 99.9% of all owners manuals contain a schematic. Whether or not they'll send you repair parts depends on the part(s) requested. Check out Daisy Manufacturing (daisy.com) for contacts and information on their airgun propulsion systems. Winchester Model 50 A customer keeps returning an almost-new Winchester Model 50 20 gauge (serial number 61XXX.) As with the previous times, his complaint is he loads one to three shotshells, cycles the action, but the hammer isn't cocked.

After recocking, he says it will shoot it from one to over a dozen times before doing it again and doesn't seem to matter if the gun cycles itself or if it's done manually. The gun is better than factory cleaned and well lubricated. I previously deepened the hammer and sear engagement. C. Frustratingly, I have shot over a box of shotshells through the gun, shooting fast and slow, and can not replicate the problem despite his demonstrating exactly what he's doing.

I called Winchester and they said this gun is too old and they have no info on it. My copy of the NRA's Firearms Assembly is the only reference I can find with a note about any kind of problem, saying that due to over engineering a misfire can be caused by a light trigger pull and that to prevent doubling, a second sear was ground in the hammer. A light trigger pull could allow a sear to re-engage the hammer. Winchester issued a Model 50 blue book to show how to fix the problem. Mike Leonard Tamarack

READER FORUM CONTINUED

ORIGINAL PAGE 24

We didn't see anything specific to your customer's problem but we have our suspicion that he is not holding the shotgun firmly to his shoulder. A gas operated shotgun needs something to work against. It's a recoil friendly gun. Years ago, Brownells published The Encyclopedia of Modern Firearms. Within it you will find a drawing-for-drawing, word-for-word guide on how the factory disassembled/reassembled the Model 50.

If a study of that doesn't turn up an answer, contact Nu Line Guns, a former Winchester Authorized Service Center and ask for Jerry Stevens at Extension #5. Stevens 22-410 I have a Stevens 22-410 that wouldn't fire .410 shotshells. Discovering the selector wouldn't go fully into position, I filed the selector so that it would. The gun then fired Federal 3 inch shotshells every time, however, my customer found that Remington ammunition would only fire intermittently and Winchester not at all.

My plan is to work the selector some more but I would appreciate some advice. We wouldn't advise further work on the selector. Though chamber size and length is specified by SAMMI in this country, all ammo may not be exactly alike. For example, the rim thickness of .22LR cartridges can vary from brand to brand as can the internal case volumes of centerfire brass. The general rule followed by most is to check out several brands of factory fodder to discover which one the gun likes and performs with best.

Then provide a steady diet of it. High Standard What is the proper procedure to remove a rear sight from a High Standard Supermatic Citation having a U-shaped bracket attached to frame? We assume you refer to the 107 series. Well, it ain't easy. First, remove all parts from the action. Then focus on pins. The roll pin at the bottom of the bracket retains the large, twopiece stud beside it. That roll pin is drifted into the frame to free up the stud which is drifted all the way out.

The two pins at the top of the bracket do not appear to be roll pins in our Larry reference photo. They must be drifted completely out. Caution: The larger pin retains some very small rear sight components and are easily lost. With all retainers out of its way, the rear sight is removed to the rear. Winchester 1894 A friend brought me a Winchester 94 carbine that needs a barrel, a post-64 model made in 1965.

I received a good used barrel that still has the front half of the receiver attached, preventing me from seeing the threads on the barrel. I am an amateur gunsmith and have no experience replacing a barrel. Can you tell me how to remove the barrels without any damage? I assume that I need a special vise or block to place the barrel in. Are the threads right or left hand? How much force is required to break it loose? Should I apply steady pressure or impact?

Charles You didn't mention how much of the receiver remains. We hope there's enough to allow a Model 1894 receiver wrench to get a hold on. In addition, you will need a barrel wrench with jaw inserts that clamp firmly to the barrel. Check Brownells for needed tooling. The finish of the barrel should be protected with duct tape prior to securing the barrel between the jaws. Winchester barrels were not turned in as tightly as, say, an '03 Springfield and some present day Ruger barrels.

Regardless, you may have to add an extension to the receiver wrench handle for additional leverage. A length of galvanized pipe that slips over the handle works. Francis X. Votta Catonsville, There's an old chestnut regarding screws in general still heard in gunmaking and gunsmithing: Lefty loosey, righty tightey. So, the receiver is backed off counter clockwise. Concentrate your efforts on applying a steady force, though you might need a tap or two on the receiver wrench to get it started.

Also, the barrel vise must be anchored solidly along with the bench to which it is anchored. AG

SEARCHABLE ISSUE RECORD

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