Introduction

At the initial onset of this section, I had no idea it would grow to this size. There is a lot of information here to digest, and quite frankly it's more than what most readers are looking for.

If you are going to skip around, I ask that you read this first section below, and then skip around as you desire. There is a lot of bad information on the internet, espoused by shooters who may have good intentions, but very little technical knowledge, actual experience, or advanced tools to support their ideas. What is discussed here is my view on the topic, backed up with photos and examples of fouling and how to remove it.

Feel free to quote it (thank you!), disagree with it, or even go out and try to prove me wrong (good luck with that), but don't stick your head back in the proverbial sand and pretend this topic is not important to rimfires. That is unless we are competing against each other at a match, then by all means stop reading now. Don't worry about cleaning, I'm sure your barrel is just fine.

HTG Silencer I-7 core after 1200 rounds of 17 HMR

Why Clean a Rimfire?

When I first sat down to write this section, I had it in mind to layout the most convincing argument as to why a shooter should clean their rimfire rifle or pistol.

When I talk about cleaning, what I am really focusing on is cleaning the barrel and chamber of the firearm. The rest of the firearm, such as trigger, action, receiver, sights, and such are so widely varied that it is not practical to address every combination.

More than likely common sense will prevail and keeping the other parts clean will sort of be obvious, but cleaning the barrel seems to be where most of the fuss centers on.

Initially I had the idea of conducting numerous tests to show accuracy changes as the barrel collects fouling, from a number of test rifles and barrels. The more I looked into it, the more I realized just how many things I would need to test to prove my point, and

after considering it further, I realized that in many ways it was really not my goal to convince shooters they *need to clean*, but rather show them *how to clean*, if they were already so inclined.

I'm comfortable in the notion that clean barrels are more accurate, especially since it is common practice in every major rimfire event I have competed in and also attended as an observer. From Benchrest to Olympic position shooters, everyone (meaning those shooters who consistently perform well) clean their barrels, *frequently*. I see no real need to argue the merits, but rather time better spent on breaking down the process and equipment.

The goal of this section is to discuss all the types of equipment that are useful in cleaning a rimfire, as well as some advanced inspection equipment, techniques, and some tips on frequency and such. Even if your rifle only needs to be minute-of-beer can accurate, you may still decide to clean it once a year. The information here will help you.

This will also be one of the few articles I write where I explicitly state a company or product endorsement, so here it is. Everything you could ever want or need for this task can be found in two catalogs: Brownells and Sinclair International. I will often times mention specific products in this article, such as cleaning rod brands and such, but there are many choices to pick from. All of these choices are found between these two company catalogs, which is actually owned by one company; Brownells. With that said, let's continue.

Cleaning can be a simple or very technical topic, depending on how much you actually want to know. I have tried to break this topic up into sections, allowing the reader to skim until they find what they are looking for. Or if you so choose, you can start from the beginning and plow your way through the mass of information and commentary. I have tried to lay out the information in a logical sequence, starting with the problem and then getting to the solution. So, let's begin with "Fouling."

Lapua Center-X .22lr Target Ammunition

What is Fouling?

When looking at a basic lubricated-lead 22lr rimfire round, there are four major components to the cartridge. You have a lubricated lead bullet, brass alloy case, smokeless powder, and primer material. Of those elements, all but the brass case play a role as to what eventually ends up in the barrel of your rimfire.

Starting with the bullet, most lead alloys have trace amounts of tin and antimony to help develop hardness in the lead, but still make it soft enough to seal the bore of the barrel when launched from the brass case. Of course a bare lead bullet would smear some lead off onto the barrel's interior (known as "leading") so the manufacturer adds a wax coating to act as a lubrication between the lead bullet and the barrel.

As a side note, the lubrication also protects the lead bullet from oxidizing when stored for long periods of time.

The terminology for these coatings varies with references such as; waxed, lubricated, and lubricated lead. There are various trade names also associated with this wax lubrication, but the basic point is that nearly every lead bullet has a coating of some type.

Surprisingly, in many instances the lubrication is a simple form of wax with a few basic additives. How it is applied is a trade secret, as well as the exact formula, and each company performs this process a little differently. Some bullets have lubrication which is almost clear and slippery, while others are yellowish, heavy, and a bit sticky. Even the copper plated bullets have a wax coating.

Not only does the wax coating help prevent the lead from smearing off into the barrel, but it also forms a lubricated surface which reduces friction, slightly fills the pores of the metal, and ultimately makes the bullet's path down the barrel more uniform in velocity. Thus, there is an accuracy gain from the lubrication.

Digging in deeper, a general rule of thumb I have seen is that it takes on average one bullet for every inch of barrel length to properly fill all the barrels pores and lay an even layer of lubrication from the chamber to the muzzle. For premium hand-lapped match

barrels like a Lilja, it takes fewer rounds, maybe about half. For rough or hastily made barrels, it can be much more. There will be more discussion about barrel quality later on.

This is where you start to see the rationale behind shooters not wanting to clean their barrels. It's because they remove all the wax lubrication and the next series of groups are not very good. That's the result of the bullets "squeaking" down the bore without the aid of a fully lubricated path. This is where the phrase "Fouling the Bore" comes from. It's the process of shooting enough rounds down the barrel to reapply the desired amount of lubrication.

But keep in mind, lubrication is only one part of this equation. There is a lot more that is going on, but the basic idea of lubrication is creating a smooth and slippery surface for the bullet to travel upon.

Thin copper plating found on most high-velocity 22lr.

Copper Plating

For some sporting ammunition, there is the additional component of a very thin copper plating or wash, which is applied either though electro-chemical plating or shot-peening, depending on the manufacturer.

You will commonly find this copper plating on high-velocity ammunition. Without this plating, it is believed that high-velocity ammunition tends to leave more lead deposits in the barrel.

After researching this topic, I have found a few conflicting schools of thought about the purpose of the plating, so I decided to split them apart and let you form your own conclusions.

Some shooters see the copper plating as an additional layer of lubrication at higher velocities. You will commonly find this copper plating on high-velocity ammunition. Without this plating, high-velocity ammunition tends to create more lead deposits in the barrel; at least that is the generally assumed idea.

When the first High-Speed rimfire rounds were released, they featured this new copper plating. It was assumed and possibly shared through company advertising that the copper plating does indeed help with fouling and reduced friction.

While this is claimed, it may not be the case. In fact you recover a copper washed / plated bullet, you will still see that the plating is still on the bullet. This is because the lubrication on the outside of the bullet, the wax, protected the copper plating from rubbing off onto the barrel. So, if the wax is indeed providing a layer of protection, what is the copper doing?

Remove the wax lubrication and just run plain copper washed bullets down your barrel, and chances are you will have a ugly mess on your hands. It will not act as a lubricant, and if anything it will increase fouling.

Black Fingers..?

Another thought is that the copper plating is added to help keep a shooter's hands clean when handing the ammunition.

In reality the black color on your hands and fingers from handling the basic lubricated lead bullet is a mixture of the wax lubrication and colorant added to the lead to make the lead look uniform in composition.

L to R: Kroil on a cotton patch, subsequent rubbings on a target bullet.

In this photo you can see that with the help of some Kroil, the lubrication was easily removed from the bullet onto a soft cotton cloth.

Initially the color was very black, but as I continued to rub the bullet, it became much lighter and then nothing was coming off at all. Yet, the bare lead bullet still has all the faint marks on the surface. The lead had not been polished or removed, but only the wax lubrication and surface coloring in the lead.

The lead itself leaves very little color marking on the cloth. While I am not saying that you can skip washing your hands after handling ammunition, the black color on your fingertips is not lead. There may be some lead present in the black sticky mess, but it's not all lead.

Wax Lubrication

As an example of a basic wax coating, this CCI Green Tag target round has a wax coating on the surface of the bullet to act as lubrication.

You can see just a slight bit of the wax coating on the side of the case. In the bright light of the photograph, it appears to be shiny, but as you notice the rest of the bullet, the surface is slightly dull.

On some rounds of Green Tag the wax is thicker, but for the most part it is thin and uniform on the bullet. When there is buildup, it is found on the tip of the nose, cause by the drying position of the bullet (nose down) when lubricated in their machines.

CCI Green Tag .22lr

CCI Velocitor .22lr

Copper Plated and Wax Lubricated

In this next photo, a single round of CCI Velocitor is used to demonstrate the copper plating and thin wax lubrication applied over the copper plating. I was able to peel some of the wax off the bullet, and this is what appears to be a white spot on the bullet in the photograph.

To further delve into the lubrication and plating issue, at times ammunition surfaces which is copper plated yet has no wax lubrication. This may bring into question how and if this is a error or a test run of ammunition, or even a mistake.

In most circumstances, and with most manufacturers, wax lubrication of ammunition is an industry standard, but there are examples of non-lubricated ammunition in existence.

Some of this could be the result of a manufacturing error, or a test batch of ammunition that mistakenly left the factory. It's unknown as to the reasons for every circumstance. It is also not possible to say that every manufacturer of ammunition always intends to apply some kind of lubrication to all of their ammunition, but you really have to dig around to find examples, and these

tend to be offerings from smaller companies in the past, not a modern trend.

CCI lubricates their entire line of .22lr ammunition that is lead based, but their Short Range Green ammunition (a .22lr round), not containing lead, has no wax lubrication. This is mentioned because not all .22lr ammunition that is copper in appearance is lubricated, and under casual inspection, it looks to be a darker copper plated bullet when in fact it is a copper blended bullet created in a mold, not a die. There is no plating of copper on the outside.

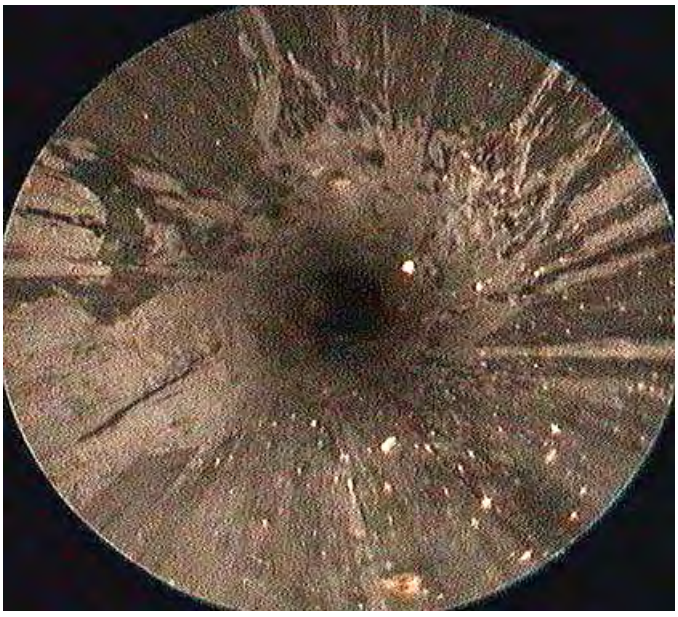
In this final photo, a 30 year old 22lr round from Canuck, a Canadian ammunition manufacturer, shows how once soft wax lubrication can dry out and oxidized on the surface of the bullet.

For all intents, this bullet no longer has adequate lubrication and will most definitely leave trace amounts of lead in your barrel. When fired at a high rate of speed in a hot barrel, you will have a serious mess on your hands.

During some testing in a scrap barrel, I also found the case to be failing to the point that every third round would rupture in the case rim and send a blast of hot gas down through the bolt body.

There may be some lead oxide on the bullet as well, but I can't determine that for sure.

Canuck Target



Everything gray is lead in a rimfire barrel.

Lead in the Barrel

We spoke of lead earlier on as one source of fouling, and it does collect in the barrel. The following photos show extreme examples of lead fouling. In many cases, firearms with just casual use have minimal amounts of lead present in the barrel.

Oddly, it tends to be more present near the end of the barrel at the muzzle rather than the beginning near the chamber, but I have seen it randomly distributed throughout the entire length.

In the worst instance of leading, I found the highest concentration in the last two inches of a test barrel.

The barrel in these photos was run at very high temperatures during a project, and it is my assumption that as the lead cooled down during its travel through the barrel, it began to stick to the lands and grooves.

Typically the throat has the highest temperatures and the muzzle the lowest, but I have a few small projects in the work dealing with barrel temperature and will post the data later on. There may be a few more dynamics to the cause of lead to build up more at the muzzle than the chamber.

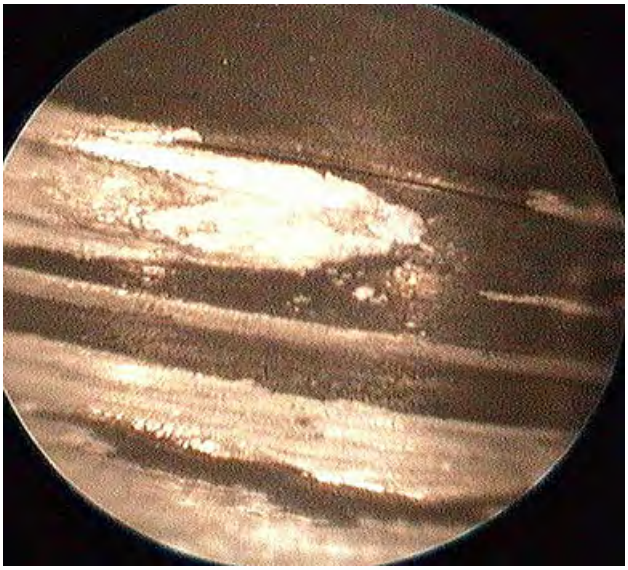
In this image, everything that is gray is lead that's stuck to the inside of the barrel. Buildup this deep is very difficult to remove, requiring a lot of time and care in order to not damage the rifling yet completely remove the lead. It took nearly all day to remove the lead from this test barrel.

This is the same barrel, and you can see the streaks of gray lead stuck to the interior of the bore. If you look close, you can see where the lead is so thick that it fills in the transition between the groove and land of the barrel.

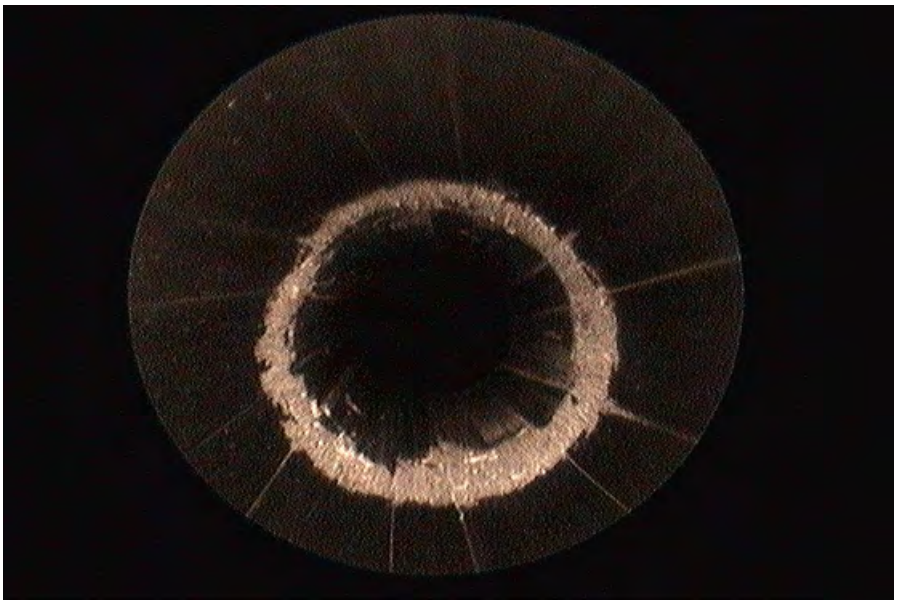
The inside color of the barrel has been darkened to highlight the gray lead streaks inside the bore. Also, this barrel is very dirty with carbon fouling.

I feel it's worth stating again, this is an extreme example of lead fouling in a rimfire barrel. Almost never do barrel become this fouling with regular use. I'm sure there are shooters out there who push their firearms to the absolute limit in terms of volume and speed, and chances are their bores look similar to this.

For the casual shooter, lead will collect in a barrel, but very slowly and not at this level.



Gray / silver colored lead deposits in a .22lr rimfire barrel.



Lead ring in the barrel.

In this image, I was able to capture a photo of a lead ring; an uncommon sight during inspections.

The story is that this shooter was out with his semi-auto Ruger 10/22, heavily modified for precision target shooting.

He had adjusted the recoil spring and other parts to reduce the amount of bolt bounce during cycling, with the idea that it would help accuracy.

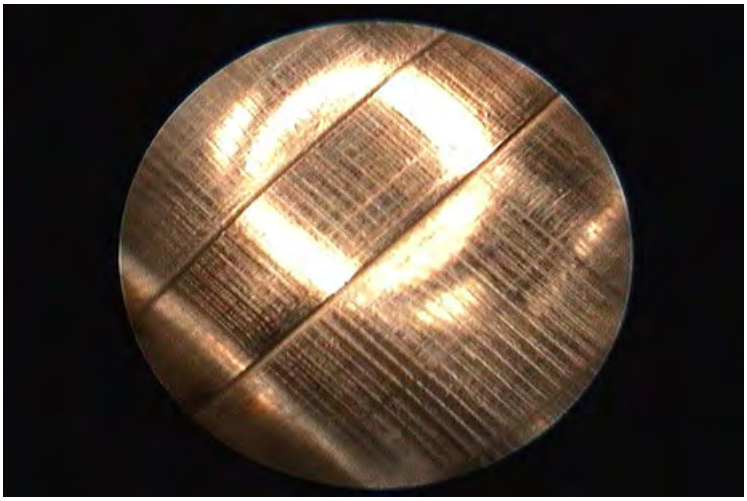
During one session, he complained that a certain batch of target ammunition, pulled from a stash long forgotten about from decades ago, was giving him some low strikes on the target.

The ammunition appeared to be degrading due to time or storage conditions, and there were enough “duds” and low strikes that it was obvious there was something wrong with the ammo.

Of course he continued to use it and noticed that at times the bullets never made it to the target, or maybe they passed through a preexisting hole in the paper. As he continued to shoot, the accuracy of the rifle really fell off and started to send shots wildly on the target.

He asked me to take a look at this rifle to see what was wrong with it, and sure enough I found a lead ring, and as I looked at it, I knew exactly what happened. He got a bullet stuck in the barrel from a light round - we call it a “BIB” or bullet stuck in the barrel. More than likely he thought the bullet just struck low or passed through a group, so he fired another round. The following lead bullet plowed into the stuck bullet, slightly bulging the aluminum tension-sleeved barrel, and then continued on.

This bulge, while not apparent from the outside by visual inspection (you can feel it with your fingers though), acted as a dip in the road, and stared to collect lead fouling. As more rounds were fired, the lead built up in this bulge and ultimately began to pinch down on the following bullets as they would pass though. Of course this wrecked his accuracy. The only solution is a new barrel. An interesting photo so I thought I would share.



Tooling marks inside the bore from manufacturing

If there are tooling marks present in the barrel, lead will collect there in short order. When is does collect in a barrel, it looks like a skid-mark from a tire.

It's a streak of lead, almost like a wax crayon on paper. As subsequent rounds pass over these lead streaks, more lead stick to the streak. They become longer and thicker, building up a considerable height in the bore.

The lead can completely fill the grooves in some instances.

At some point the lead will dislodge and cause the bullet to fly wildly off from the point of aim, sometimes three to four inches at 25 yards, and even more at further distances. It may be the cause behind some shooter's fliers.

The marks in this barrel are from the gun-drilling and reaming process used to create the hole in the barrel for rifling. You can see that even after button rifling (this barrel is not lapped), it remains littered with deep tooling marks. These will quickly collect fouling and cause some problems with accuracy. A button will not remove these marks.

From the outside, the barrel looks to have a smooth bore when looking down either the muzzle or breech end. Anybody who claims to be able to look down a barrel and see these drilling marks is trying to fool or impress you. It's not possible to see the marks with the naked eye.

In fact, it's complete nonsense. You need a borescope fitted with a 90 degree mirror to look directly at the bore. These images were taken with a Gradient Lens digital video borescope; a specialized tool considered to be the industry standard for barrel inspection.

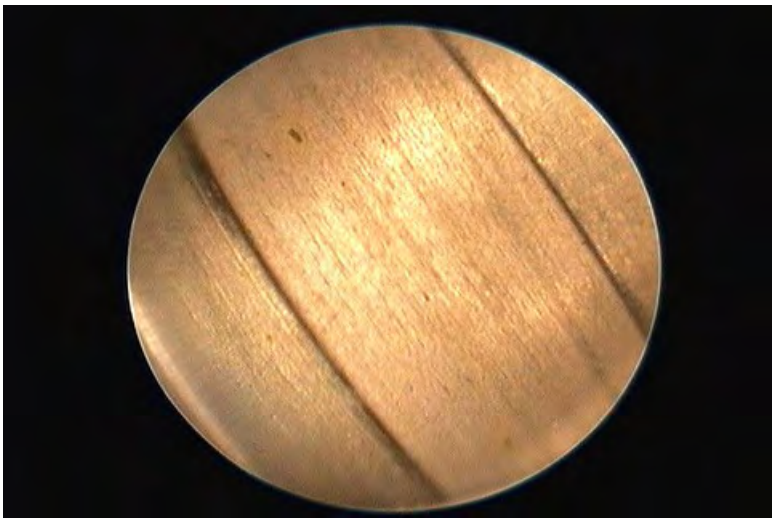
This barrel is from an aftermarket barrel maker for the Ruger 10/22 platforms. This heavy, custom stainless-steel "match" barrel fetches a considerable price and is very well finished on the outside. It fouls terribly and is a major pain to clean after a day of shooting.

Don't judge a barrel's quality by how it looks on the outside.

Custom, hand-lapped barrels from manufacturers like Lilja, Shilen, and others fetch such a price because of the time and care in manufacturing and finishing.

Hand-lapping a barrel takes time and skill, and there are no shortcuts in this process. At Lilja's shop in particular, each rimfire barrel, both 0.17" and 0.22" caliber barrels, are lapped by hand.

The technician pours a lead lap and embeds their special lapping compound into the lead, and uses that to create a perfect finish inside the barrel.



Factory Anschutz barrel free from tool marks

The lead lap rotates with the rifling, keeping the cutting surface working in parallel with the lands and grooves. Each barrel gets its own lap, custom fitted to that exact dimension. For this expertise and finish, you pay a higher fee, but once you shoot a true custom barrel, you will know where the money went.

High-end target rifles with match barrels also receive special attention, but typically they are not hand lapped. Rifle manufacturer's such as Anschutz, Feinwerkbau, and a few others spend a lot of time finishing their barrels for optimal performance. Their actual

process is kept a trade secret, but with some reason one could assume there is a finishing process to remove all the tooling marks from the gun drilling process.

The smoother the barrel, the less they foul with lead. This is why some target rifles are able to shoot so long between cleanings and still maintain a decent level of accuracy. In reality, it's not the lead buildup in these barrels causing problems, but rather the build up of fouling in the throat of the rifle. We will get to that shortly.

CCI powder burning from .22lr loading.

Powder Fouling

Besides a wax lubrication coating the barrel and possible lead fouling, there is also powder residue (both burnt and un-burnt powder) spread throughout the length of the barrel.

Some of this powder fouling sits loose in the barrel and is usually pushed out by the following round, but a small portion of it is mixed with the soft wax lubrication and remains inside the barrel.

It tends to collect more so near the chamber, and lurks most commonly in the edges of the grooves of the barrel. The powder itself in a rimfire round is very fast, needing only a few grains to launch the lead bullet at supersonic velocities. It burns quickly and with considerable intensity.

When fired under pressure, the flame burns hotter and leaves a slightly different residue. We will get into that later on.

Inside the case you may find all types of powers in terms of structure and quality. Manufacturers use all types including flattened ball, flake, ball, short-cut extruded, and even blended powders (often called double-base).

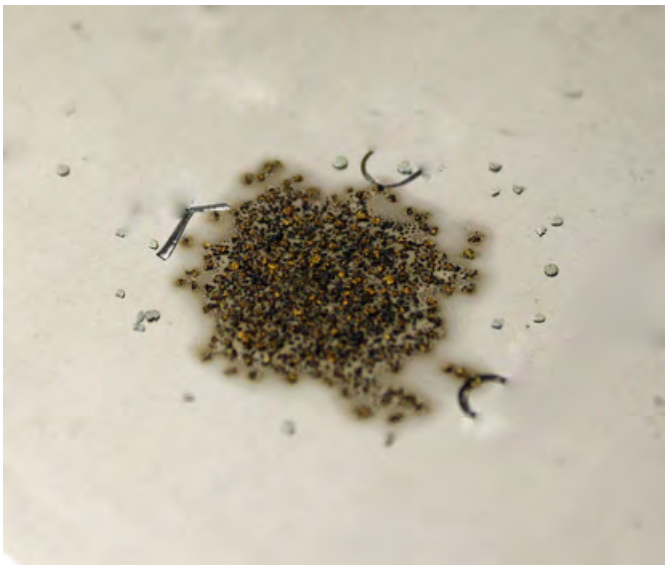
Not all rimfire ammunition uses the same powder, even if everything else about the round is the same. Depending on the manufacturer's need for velocity and pressure, they will select a specific powder for an application. The burn rate of powder will vary as well as the powder charge weight. Typically, sporting and high velocity ammunition will have a larger charge weight than subsonic and target ammunition.

Powder Continued....

In this photograph, you can see the clean flake powder used by CCI for this particular loading. It is free from debris and broken pieces, and exhibits a surprising level of uniformity.

This powder kernel shape also lends itself to easy metering, making the loading process more uniform and reliable.

CCI powder from three .22lr rounds.



CCI powder after combustion.

And Continued..

Interesting, the byproduct left when the powder burns is slightly sticky and will clump together when scraped with a tool.

This is one of the reasons why dirty barrels are hard to get the first few tight fitting patches down the bore.

You are working against this sticky powder and wax mixture. This is one reason why you do not want a tight fitting patch on the cleaning rod for the first couple passes.

The lower quality ammunition tends to produce more of this sticky mess than premium ammunition, causing barrels to foul as a faster rate.

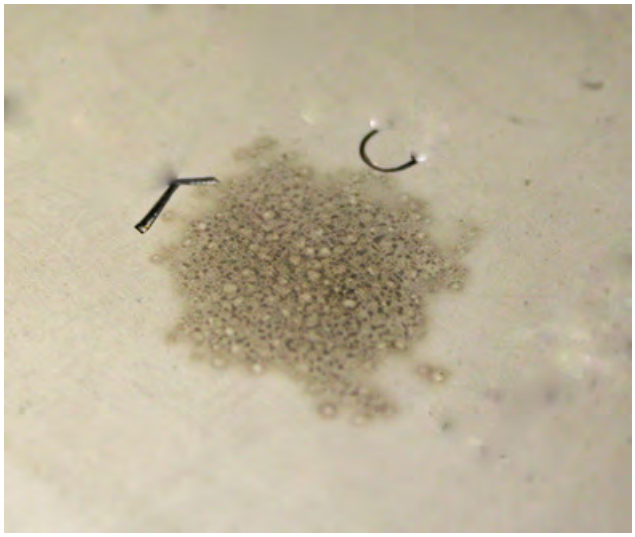
Inside of a barrel, this combustion process is more complete.

Powder Residue

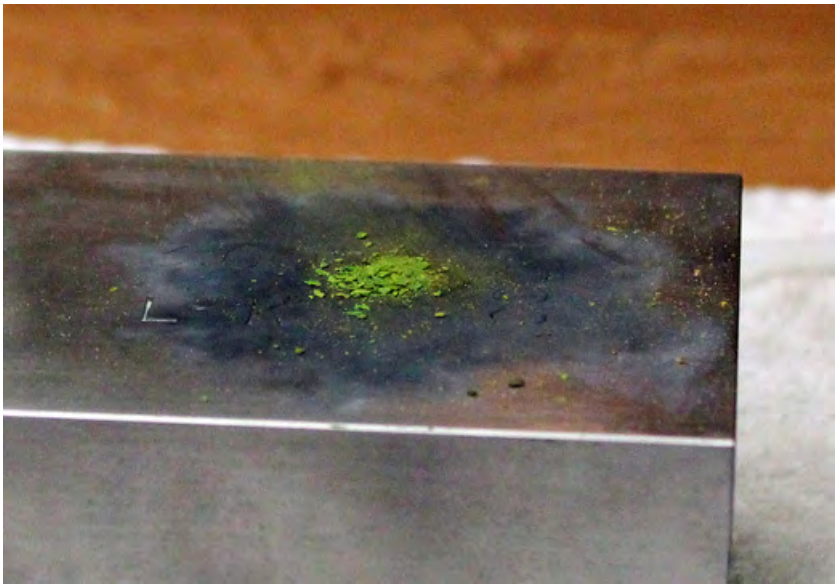
After wiping the powder away with a soft cloth and using a business card to scrape away the residue, you can still see the stain from the powder burning on the steel.

I was able to remove this with a simple metal polish in previous tests, but for this test the photograph does a fair job in demonstrating that powder combustion does not simply result in dry ash.

After numerous rounds in a firearm, this fouling will begin to build up in the bore.



After the burnt powder was removed with solvent.



CCI primer material from two rounds.

Primer Material and Fouling

Rimfire rifles also have the unique fouling of the burned priming compound. Primer material gets some of the most attention when discussing parts of rimfire ammunition, and that is mostly due to the complexity of preparing and placing the compound inside the case.

That process is considered to be one of the most guarded secrets in the ammunition industry, and the internet is so full of wild speculation passed off as fact about this process that the industry joke is Bigfoot works inside the building where it is made.

Being there myself, I was able to see the Loch Ness monster outside the lunchroom window at the facility.

Unless you are part of the company or there for some pressing reason, you will never see how this is done or be accurately told about it. Sharing information about the actual process of priming a rimfire case on the internet can be seen as a "very career limiting" mistake.

In all honesty, it is a complex process that requires a lot of technology, skill, and great care due to the explosive nature of the material. Keep in mind that primer material does not burn; it explodes, violently.

Skipping past the manufacturing process of priming (for legal reasons), the part that concerns shooters in terms of cleaning is the byproduct of primer material which contains one of its key ingredients; silica. Besides this silica, there are other chemicals in this priming compound including barium nitrate, antimony sulfide, lead styphnate (nasty stuff), and the aforementioned silica - often times just finely ground glass.

This mineral, silica, is added to create friction within the primer material to cause it to explode when struck by the firing pin. It also makes the material very dangerous to handle when completely dry. Any type of sharp impact to the material can cause it to explode, which is one reason why there is no commercial source for purchasing primed rimfire cases for reloading.

Inside the case is an even coating of primer material up around the case rim which explodes upon impact, starting the combustion process of the smokeless powder.

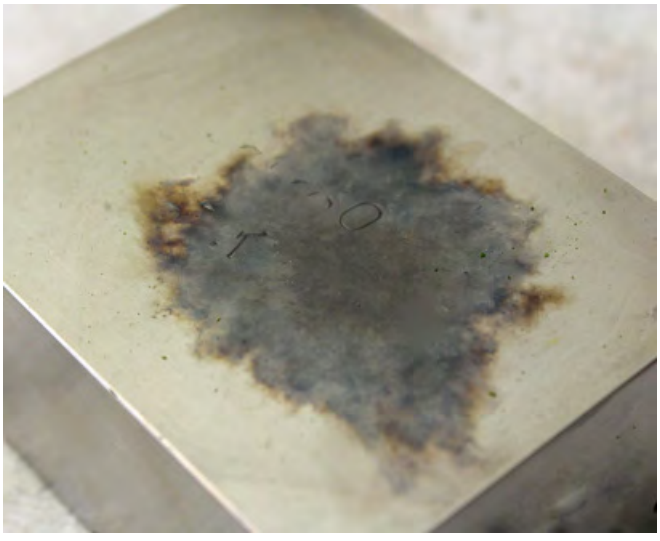
During this combustion process, the primer material follows the bullet down the bore, but not all of the residue completely exits the barrel. A fair amount of the fouling stays in the barrel, and some of the primer material's components, such as this silica, becomes intermixed with the powder and lubrication fouling.

Because the silica is abrasive, some care needs to be taken when removing fouling from the bore. It's not hard to do and I will discuss that step later on.

While primer material may start out in various colors; CCI tends to favor a light green where as Lapua's primer material is bright pink; it all works the same.

In this photo, two CCI Green Tag cases were taken apart and the primer material carefully removed. I placed it on a steel block to demonstrate how violent and bright the explosion is.

Primer combusting / exploding



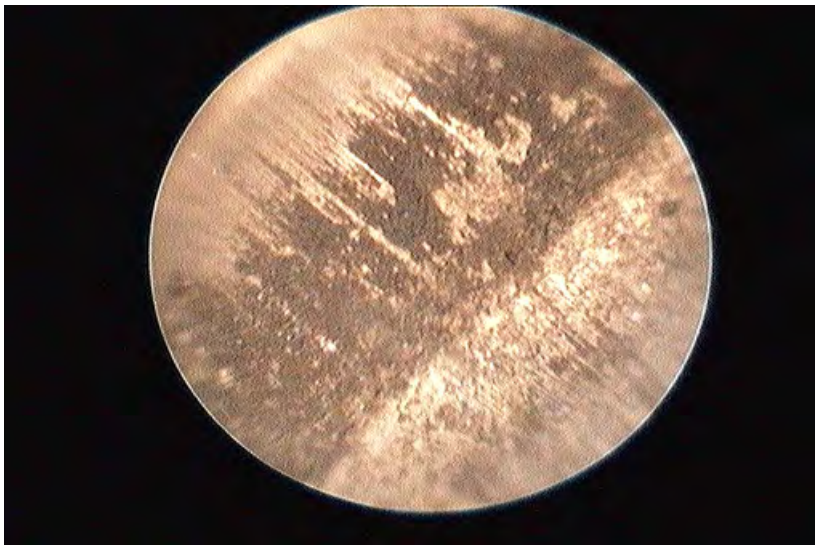
Primer Residue

The end result is a scorched block, which is not terribly surprising and not overly representative of what happens inside the barrel.

Because of the open environment, the primer fouling was blown completely off the steel block.

In the next photo, I was able to capture some powder fouling which does contain some primer material.

The Dreaded "Black Ring"



The Dreaded "Black Ring"

The next area of fouling accumulation is in the front part of the chamber, known as the Throat and Leade Angle. Some shooters ask me what the difference is between the two terms, and the best way I can explain it is that the leade angle is the slope which starts at the flat wall of the chamber and angles up into the lands and grooves.

This angle varies by reamer specifications, and at what depth this transition begins. When measured from the breech face, will impact how tight of a feel the shooter will notice on the bolt handle as they close the bolt on a live round.

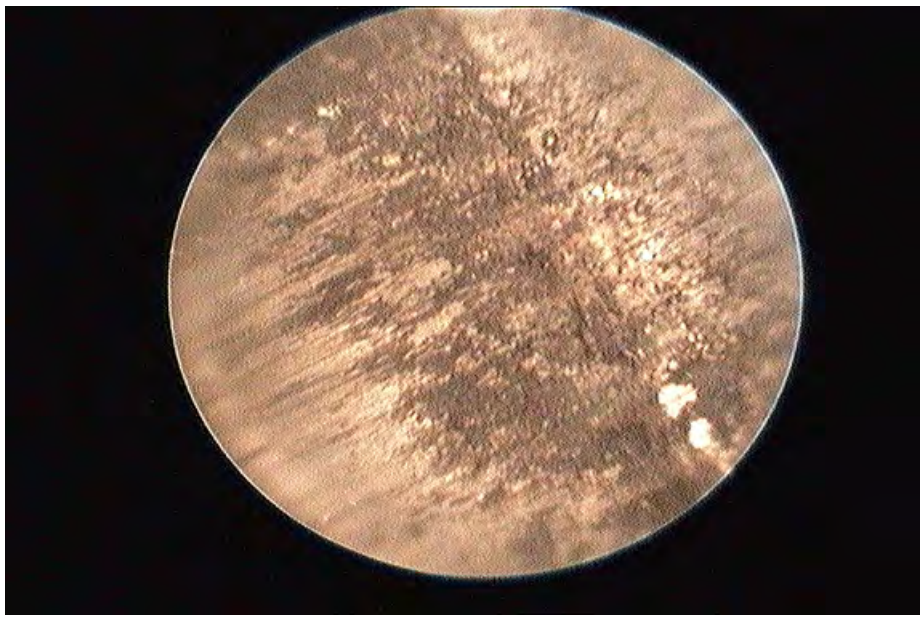
This leade angle is found in the area of the chamber called the “throat.” The throat can be seen as the part of the chamber where the leade angle is located.

Knowing what the terms mean will help a shooter understand where this nasty little bit of fouling likes to collect; the dreaded Black Ring.

During the initial combustion of the round, burning gasses loaded with various bit of fouling blast out from the case mouth right when the bullet leaves the case. At the point where the bullet has just separated from the case mouth, hot gases consisting of burning powder (carbon), a tiny amount of vaporized lead from the base of the bullet, and burnt primer material blast into the chamber’s throat.

At this point, the gases are at their peak temperature and reaching their max pressure. As this mixture is blasted into the chamber’s throat, it quickly cools and some of this fouling begins to stick.

In the photo above, the bullet's direction of travel is from the lower right part of the photo to the upper left part of the photo. You will also notice a distinct black line. The darker side is where the bullet sits, and the lighter side is what is covered up by the brass case. This photo is from a semi-auto which uses the gas pressure to cycle the bolt. As you can see, fouling also builds up in the chamber, but to a lesser extent.



Fouling build up in the throat and leade angle.

Since the bullet is actually traveling in front of this hot mess of gasses (it has already started down the barrel) the fouling continues to build up in this area faster than anywhere else in the barrel.

The lead bullet is not pushing out the fouling in this area.

Subsequent firings continue to build until this ring begins to actually touch the bullet itself, which can either push the bullet off-center in the chamber or act as a giant speed bump for the bullet to squeeze past before it starts down the barrel.

This is why so many shooters in rimfire Benchrest competition focus on the chamber and first few inches of the barrel when they

scrub.

They are trying to remove this black ring because it causes a gradual fade in accuracy, resulting in larger groups and bullets to drift out from the desired point of impact.

You may have heard shooting term referred to as the “window” of accuracy. This window represents a range of fouling in the barrel where the rifle shoots the best. Typically at the end of this range, the black ring is starting to impinge on the bullet by pressing into the bullet’s side, or the fouling has grown into a long sticky mess which grabs at the bullet when it passes by.

In sporting rifles with large chambers, it can take a long time for this fouling ring to built to the point where it begins to contact the bullet when chambered. In target rifles, it can be noticed within a single shooting session.

In a semi-auto rifle, this black ring builds even faster because the dirty gasses linger longer due to the blow-back aspect of the action. As the glasses blast the case and bolt rewards, they further cool in the chamber leaving deposits on the chamber walls and throat.

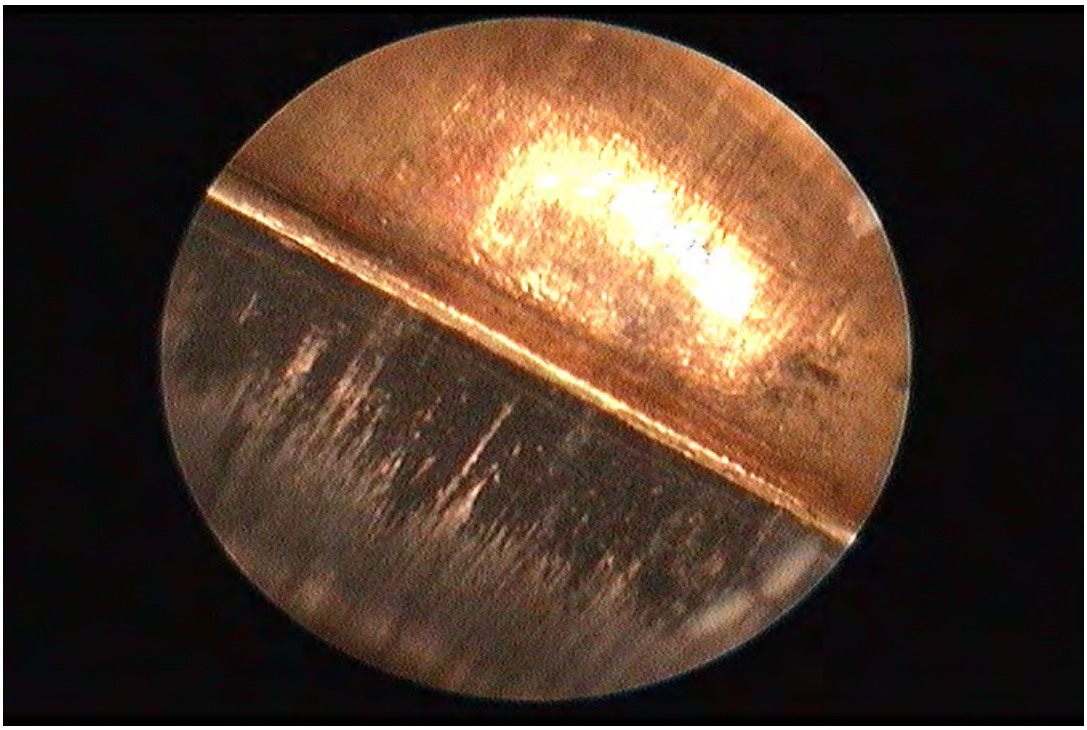
As this ring builds up, it can prevent the next round from fully seating in the chamber. This then leads to more problems such as; failure to fire, failure to chamber fully, and the worst; out-of-battery firings.

When a round is fired out-of-battery, this means that the bolt is not fully closed, leaving small part of the case unsupported on the bottom near the rim. In this situation the brass case often bulges, or even ruptures, sending hot gasses through the action. This can damage magazines and give the shooter quite a scare as these hot gases blast out the rifle, either through the bottom, or the ejection port, or even out the rear of the action.

In this photo, I was able to slide the borescope into a pistol barrel through the muzzle and capture an image of an empty case inside the chamber.

You can see how the black ring of fouling is formed around the case mouth, and would be in contact with the sides of the bullet.

Keeping this area clean is paramount for accuracy, and later on I will describe exactly how to remove it.



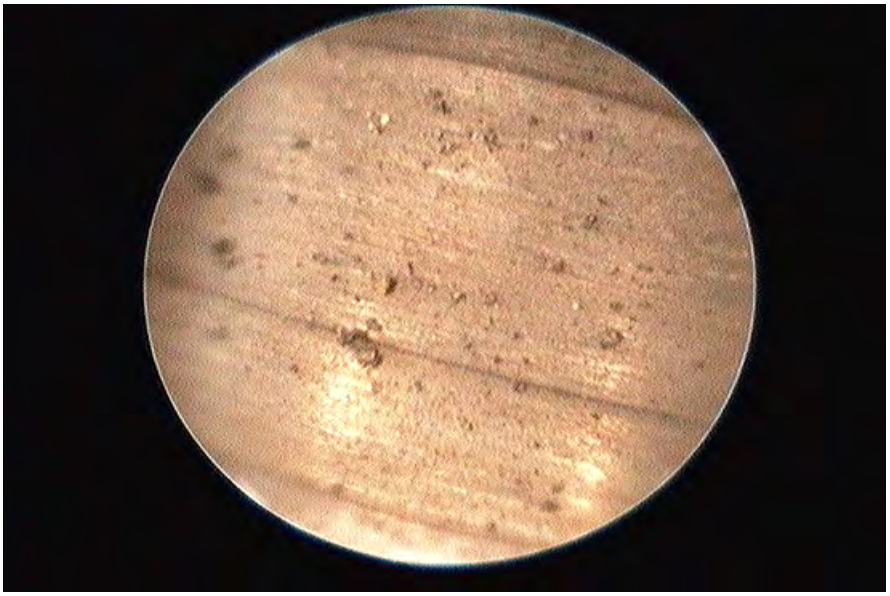
Unfired brass case next to the Black Ring.

The bullet's direction of travel in this photo is from the top right to the bottom left. I know for some who are not accustom to looking at borescope images, that this can be a bit confusing as to what exactly the photo is showing.

Not only will the black ring of fouling grow thicker, it also grows longer, working it's way down the barrel. Even with slow-fire shooting, this area of fouling will develop.

Fouling Location, Gravity, and Barrel Wear

In this part of the cleaning section, we are going to veer off in a bit of a different direction that



Loose fouling present in the bore.

what most shooters are accustomed to reading.

It's a bit of a side discussion, but it directly relates to what is happening inside the barrel, and it is focused on the actual location of fouling.

For years I have studied the fouling process in a rimfire rifle looking to fully understand exactly what is happening inside the barrel, and ultimately how
it relates to possibly to the cause of barrel wear.

Like many shooters, for years I thought that barrel wear was a friction-based process where the abrasive components of the primer material act as a lapping agent when coupled with the lead slug of the 22 bullet. It's easy to think that these two components, that being the abrasive material and the lead bullet acted in the exact same fashion as a lead lap used by a custom barrel manufacturer.

Every time around is fired, the lead bullet is embedded with some of this abrasive silica, and as it travels down the bore under pressure, it very slightly abrades away some of the bore's surface. When this is done tens of thousands of times, it's easy to see or to conclude that this is what makes a barrel wear out.

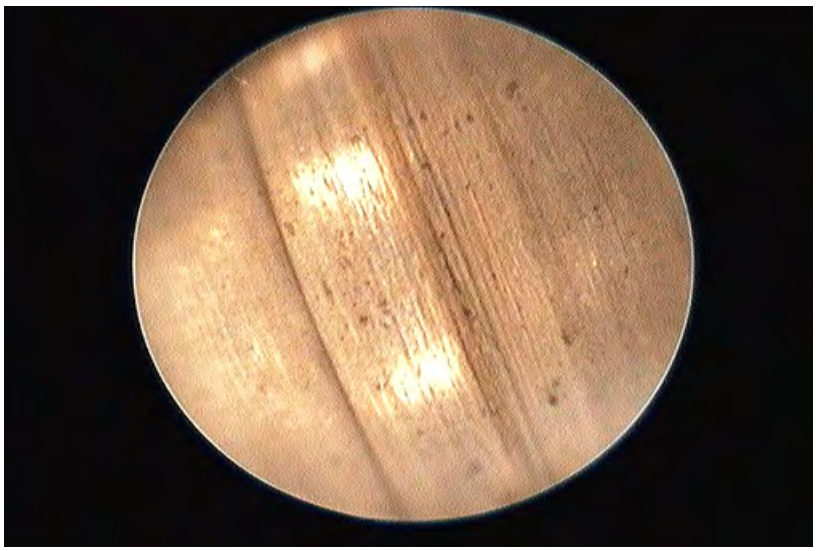
Now some will chime in and say that cleaning is what wears a barrel out; this is nonsense. Not knowing how to use the tools properly may damage a barrel, but that is the human element messing up the process, not the process itself.

Going back to the abrasion idea of wearing out a barrel, I'm not going to say that this is incorrect, it is indeed a major part of what wears out a barrel, but I'm convinced that it's not the only thing that's going on inside the bore.

But before we get into any other factors that could affect a barrel's lifespan, we need to review exactly where the fouling ends up in the barrel after the round has been fired.

Something that may appear logical, but not for obvious reasons, is where fouling accumulates in the main length of the barrel.

Besides the black ring formation in the throat, the rest of the barrel also picks up a general amount of fouling from the combustion process taking place.



Looking up at the 12 o'clock position, 4 inches deep from the chamber.

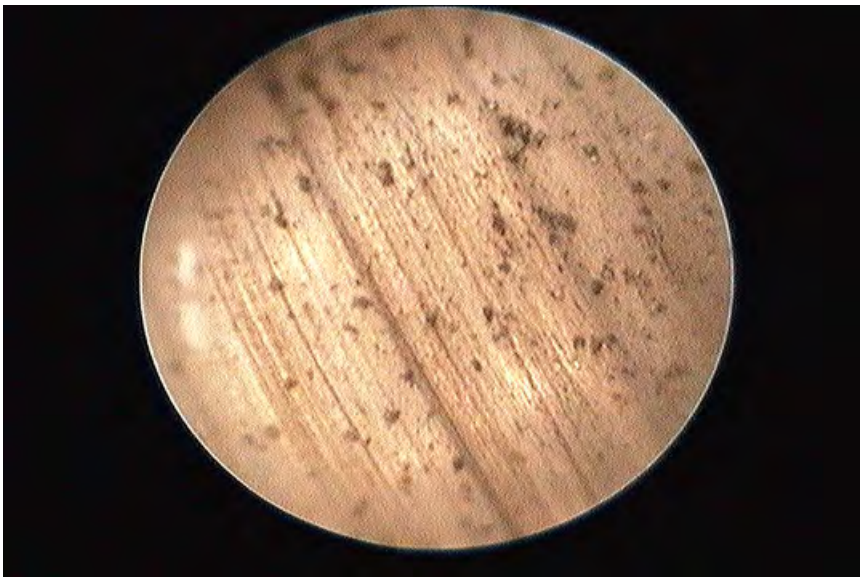
As many of you have noticed when looking down a fouled barrel, all the loose material seems to collect in the bottom of the barrel. This loose material, mostly consisting of larger chunks of powder fouling and primer residue, sits in what is often referred to as the 6 o'clock position of the barrel.

I bring this observation up for a few reasons, but first let's address why this fouling is collecting in the bottom or the bore. In the most basic sense, the reason is gravity. This is rather easy to observe, and also fairly simple to photograph.

I started by taking one of my prone rifles and firing a few hundred rounds during a practice session. The rifle remained level the

entire time and I did not clean out the bore.

At the end of the session I carefully placed the rifle in a cradle and leveled out the bottom of the stock. Setting up the video borescope, I carefully inserted the steel tube and rotated it until it was taking an image of the inside top of the barrel, referred to as the 12 o'clock position.



Same depth, but looking at the 6 o'clock position.

After snapping those photos, I rotated the mirror around 180 degrees and took some photos of the 6 o'clock position.

It was not much of a surprise that the bulk of the fouling sat in the 6 o'clock position. I did not change the depth of the borescope, but just where it was focused.

Now you may ask why doesn't all the loose fouling follow the bullet out of the barrel, considering how much muzzle blast is associated even a standard velocity 22lr round, and my answer is that some of it does in fact follow the bullet out of the barrel, but not all of it.

There is still some fouling that slows down and remains in the bore. We can see that easily. It looks to be the heavier bits of solid material rather than the light-weight high-velocity gasses.

I believe the sticky nature of the wax lubrication and other fouling agents present in the barrel is enough to grab hold of some of the fouling still traveling in the cloud of combustion gases and effectively slow this mixture down before has time to reach the muzzle.

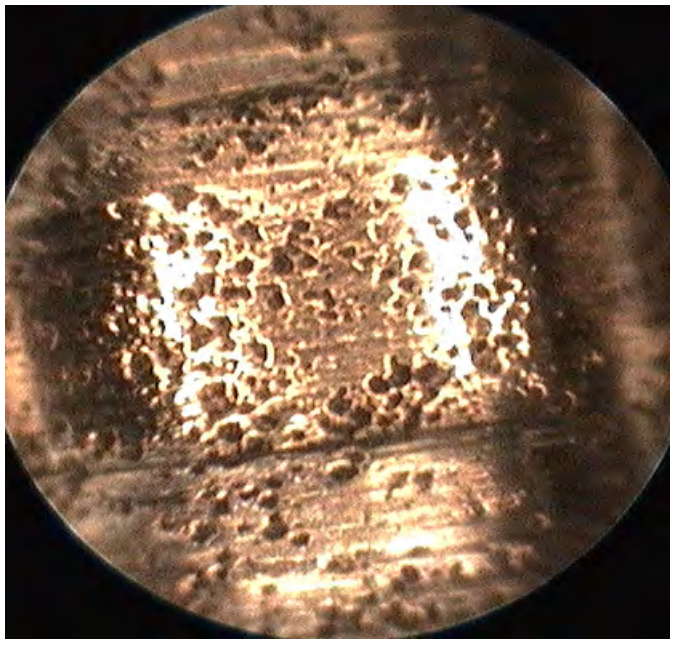
The Big Leap

I feel this is the best point for adding in some different thoughts about the cause of barrel wear.

We have reviewed the process of primer material as one agent responsible for barrel wear, but there is another aspect which I believe is also part of the equation, and that is *oxidation*.

Something I've noticed over the years on many rimfire barrels, either when replacing them or simply a tune up, was various stages of pitting in the first few inches of the bore.

These pits did not look to be caused by primer material; they seemed too round and deep, almost like a pothole in an asphalt street. On the older barrels, the pits were much deeper, and on the newer barrel they seemed to fewer but still I could see them starting to form at the 6 o'clock position within the "frosted" or "hazed" area of the barrel.



Tha Pits...

If you are not familiar with the two terms "frosting" or "hazing", they refer to the appearance of the bore where is has lost the smooth reflective finish and now looks like frosted glass when observed through a borescope. Interestingly, this looks to be directly caused by the primer material, given that the frosting looks like many little scratches and divots. Typically you can see this in the first few inches of a barrel within 1,000 rounds.

Going back to the pits, I feel that there is a chemical reaction taking place in these little divots in the bore, which is separate from the

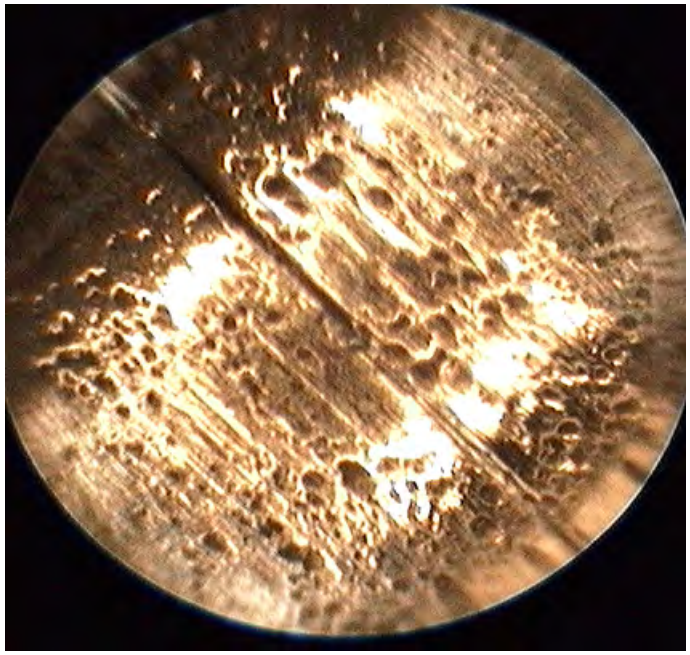
abrasive effect of the primer material. Further, I feel it's the hazed area which allows various chemicals to take hold, much like a cavity in a tooth.

The question is; was the culprit cleaning chemicals left in the bore that are slowly eating away at the bore and causing these pits, or was it moisture?

If it were just cleaning chemicals and moisture alone, then the entire barrel should be evenly pitted, but they are most definitely not. In fact that in a 24" target barrel, I have never seen pits past ten inches deep down the bore, so there must be some connection to the heating of the metal as well as the chemical process which is at play here.

Some would argue that the pits in the bore are just specific spots where the primer material is digging into the surface of the steel the most, but that seems too random. It's not that the bullet is mashing down on the silica and driving it in a 90° angle into the barrel. That's not what's happening at all, rather when a bullet travels down the barrel, it initially expands to seal the bore and it pushes along its path until it exits the barrel.

The more substantial fouling such as lead buildup in the bore is adhered so tightly to the lands and grooves that the bullet squeezes past this deposit, but all the loose stuff in the barrel is pushed out for the most part by the bullet. There is a continual buildup of wax lubrication but the bullet rides on top of that surface, so in general, loose fouling can only build to a certain point.



Pits at the 6 o'clock position.

So again where are these pits coming from? I puzzled over this for a while, making note of the pits during inspection and noticing further that they seemed to be focused in the 6 o'clock position on newer barrels, but eventually encircled the bore on the older barrels I inspected. And still all of this was taking place within the first few inches of the barrel.

At one point I happen to be talking to Ed Shilen, founder of Shilen Rifle Barrels Inc., and we were discussing various topics, and this observed pitting in the bore came up.

Ed had commented the he believes the pitting is actually a combination of two factors. The first factor being that of impurities in the barrel steel itself. As we know both stainless and chromoly is really an alloy; it's not a pure metal. Various elements are added, such as sulfur, to make the metal more machine friendly and workable.

Sometimes during the manufacturing process of the steel, this mixture is not perfectly homogenous and there can be little bits of these substances, such as sulfur, which are exposed on the surface after the barrel has been gun drilled, reamed, and then rifled.

Initially the bore still has the appearance of a smooth surface when new, but the imperfections that Ed is referring to are microscopic, virtually invisible to the human eye, even with the borescope.

During the firing process, as the heat from the burning gases cause the surface of the metal to expand slightly, these exposed impurities begin to break down and erode much faster than the surrounding metal. That's the first part of the concept; heat and exposed impurities in the metal.

The second part which is been mentioned before but not discussed in great detail is moisture. Moisture finds its way into a barrel by two general methods. The first is through the environment, such as humid conditions on a coastal region, or rainy regions have a higher moisture level in the ambient air.

Another path for moisture is the actual combustion process itself. A byproduct of combustion is water. Nearly every combustion process result in some amount of water, and this can be seen when you fire a rimfire round from a rifle and remove the bolt; you can't see down the bore.

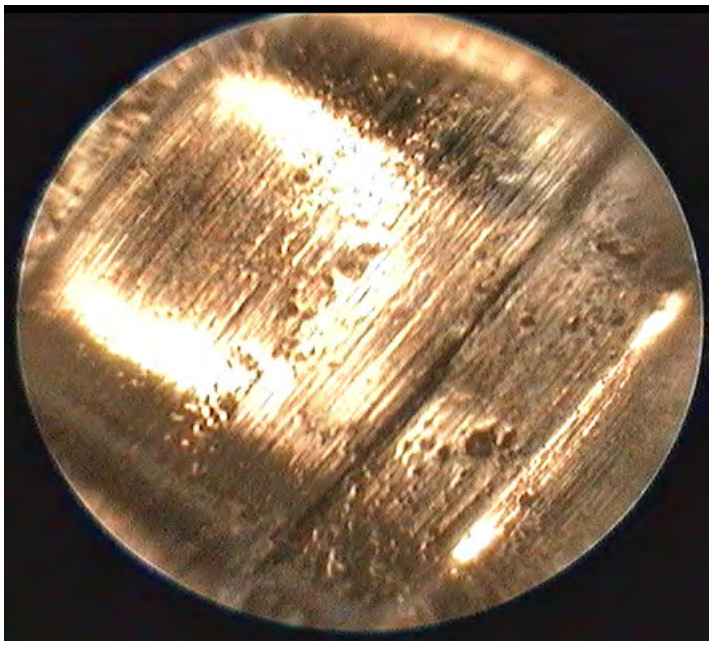
It's full of smoke from the combustion gases with a small amount of water vapor, and if you sit there and let it cool long enough, the smoke it will eventually disperse, but as the temperature drops, guess what comes back out of vapor? Liquid water.

When the water comes back out of vapor it wants to stick to something, and a small amount of it collects on the surface of the cooling metal. It stands to reason that as the metal contracts, some of the water works its way into the metal pores and come into contact with impurities in the metal surface.

These impurities, when heated and combined with moisture begin to oxidize. The impurity breaks down and is dissolved away leaving a small void, which when repeated thousands of times, results in a pit.

Back to Gravity

We have reviewed the essence of fouling, and that gravity causes it to collect at the bottom of the bore. Fouling is the stuff that we've described as primarily unburned powder, carbon, some melted wax lubrication, a small amount of lead. This mixture is hygroscopic, meaning it absorbs water.



Pits at the 12 o'clock position

So this slightly moist fouling is sitting at the bottom of the barrel, and that also happens to be where the majority of pits are found.

I feel there is a connection between the location of the fouling and the higher concentration of pits.

When the metal surface is hot and the pores are open, the fouling provides a source of moisture for the formation of pits in the barrel.

This is why I feel that barrel wear is a blend of many issues, and not just linked to a single culprit. The abrasive wear from the primer material, impurities in the metal alloy failing faster than the surrounding material, and the addition of moisture in the barrel to further accelerate the oxidation of the impurities all contribute to the eventual death of the barrel in terms of accuracy.

So what is to be done about this?

Well, unless you want to clean the barrel after every shot, which I do not suggest, we are going to have to deal with the primer material slowly abrading away the metal. There is not much to be done about that.

But given the choice to either clean the bore after a shooting session, or just leave the barrel to sit in the gun safe, loaded with this moisture-collecting fouling, the choice for me is easy; I'm gonna clean the barrel and try to slow down the pitting process. I see it the same as brushing your teeth; it seems pretty logical when you think about it, and I like to have minty fresh breath.

Tools, Solvents, and Accessories

In this part of the article, we will discuss all the tools and equipment needed for proper cleaning. Being prepared to clean a rifle barrel is really half the battle.

By using the right equipment, you will greatly reduce the risk of damaging your rifle in the process.

There is a wide range of products out there, and many of them do the exact same task. Choosing which one is right for you can be as simple as color or style, or even just brand recognition.

Throughout this section I will identify some brands more frequently than others, and this is just because I use these the most, and they happen to be handy on my work bench. It does not mean that they are the very best made, but I also have a fondness for nice equipment, so more often than not I try to get the best that I can afford.

For me, cleaning is half art and half science, with just as much importance placed on what you do as well as how you do it. Cleaning a rimfire rifle requires a bit of finesse and some attention to detail. If you are careless with your equipment, or if you yank on the cleaning rod like you're trying to start an old lawn mower, chances are you will indeed cause more harm than good. Take your time, use the right equipment, and everything will work to improve your overall performance out at the range or in the field.

Below is a list of items that I consider essential to any kind of rifle cleaning, not just rimfire rifles. I have broken then down into general categories for simplicity.

Cleaning Rods

The most important tool in your cleaning kit is the cleaning rod. The quality of this tool will make the biggest difference to the overall health of your rifle.

There are specific features found on many high-quality cleaning rods, such as: rotating grips fitted with ball bearings, one-piece shafts made from hardened spring steel or carbon fiber, protective coatings or highly polished surfaces, and well machined thread forms for implement attachment.

Ball bearings in the handle allow the rod to rotate along the twist of the bore, pushing the fouling out of the grooves, rather than having the patch or brush skip across the top of the lands.

From the top: Bore Tech, Pro Shot, Ivy, and Dewey.

The cleaning rod's shaft must be perfectly straight, free from kinks or bows, and it also must be flexible enough to bend slightly and then snap back straight.

It should also be a one-piece construction; sectional rods tend to scrape the bore at the joints and collect fouling between the sections. There is no reason to ever use a sectioned cleaning rod unless absolutely necessary, such as if you are stuck in the jungle and just dropped your rifle into a patch of quicksand, and a sectioned leaning rod it's the only tool you have handy. Maybe then it's reasonable, but if you have the opportunity to use a one-piece rod, please do so.

The hard rubber coating on some cleaning rods, such as Dewey, will protect the sharp edges of the barrel's lands when the rod comes into contact with the bore. Over time, this coating will begin to wear away, and that's not a bad thing, it just means it's time for a new rod. Some of the wear is from contacting the bore, and other times it's from the harsh solvents used for cleaning. But what I have noticed is that a common culprit to cleaning rod damage in rimfire firearms is the ejector!

The ejector is the small tab of metal that is often part of the feeding ramp of floor plate of a firearm which sticks up to the near center-line of the bore. Its job is to knock out the spent casing from the grip of the extractor and send it flying out the ejection port. Some rifles, like the Ruger 10/22 have this part attached to the trigger group, so it's not in the way once the trigger group housing is removed, but other firearms, such as the Ruger MK series of pistols have it installed into the receiver.

That little tab of metal is often squared at the end and will peel the coating off a cleaning rod just a carrot peeler. One off-center forward pass can ruin a rod if you run it against the ejector. Pulling back the rod at any downward angle will also leave a nasty scratch on a steel or coated rod. On some rifles, this ejector is beveled in the rear, which is prevent most of the damage, but on many

factory rifles, it is sharp on both sides.

The trick here is to file a bevel on the rear and just gently break the edge on the front side. If you remove too much metal from the front, your rifle won't eject the shells. Most of the damage is actually done when you run the rod into the barrel because there is no support behind the bore guide, so the rear of the ejector is most important.

Various rod in the rack.

For a long time I used the coated Dewey rods, and they did serve me quite well. As I needed to replace them, I switched to Pro Shot and Ivy stainless steel one-piece rods.

Both of these brands are very well made and I like the hardened and highly polished surfaces. They are easy to wipe down and are nearly impervious to solvents or primer abrasive.

Being that they are highly polished and very hard, the fouling does not dig into the rod and become bedded. This is one concern with some low-quality coated rods.

The feedback on the carbon fiber and graphite rods has been minimal but good, but I have only used them on a limited basis and don't have any in my personal collection. At this time I think they are far behind the stainless steel rods in terms of popularity.

A key aspect when using cleaning rods is that you should wipe the rod off after each pass down the bore, no matter if it is coated or polished. This prevents accumulation of any debris on the rod and rubbing it against the inside of the bore. This debris can act as a lapping compound and result in fine scratches or wear spots in the bore.

Also, by rubbing down the rod after each pass, it will give you the change to feel any burs or damage that has happened to a rod before you make another pass down the bore and possibly ruin your barrel.

Cleaning rods are offered in various lengths, and determining the required length is fairly simple. To do this, take the rifle, install the rod guide (we discuss this piece of equipment in a minute), and measure from the back of the rod guide to the end of the muzzle. Add on about four inches, and that's your minimum length for a cleaning rod.

You can purchase a longer rod, but the longer a rod is, the more prone it is to bending. If your rifle has a high comb, purchase a cleaning rod that is no shorter than the entire length of the rifle, from the butt plate to the muzzle. The high comb can interfere with the handle of the rod and force you to bend the rod slightly upwards to make a complete pass.

Stainless Steel Ivy Rod

Cleaning rods are either male or female threaded at the end, depending on the manufacturer and caliber, but the most common type is a female-threaded rod with male attachments. There are a few variations on the thread pattern, so make sure your rods and attachments are of the same pattern. Also, the thinner 0.17"caliber rods are most often fitted with a male end and the attachments are female.

Another aspect to the cleaning rod is using the right size. Since we are focusing on rimfire, the best rod to use for the 0.22" caliber rifles is a rod specified for the .22lr rimfire bores. Of course, the 0.17" caliber rods will work best in the .17 HMR and .17 Mach 2.

Don't be tempted to save money by purchasing a 0.17" caliber rod and using it for both the 0.17" and 0.22" caliber bores. There is a good chance that you will bend a 0.17" caliber rod in the 0.22" caliber bore when using a stiff brush. If the rod is too small in diameter, it will have more room to flex and press against a side of the barrel, known as "bellying." A properly sized rod will greatly reduce this.

Bore Tech rods have precision ball bearings inside the handles.

Now, not to turn right around and counter this suggestion, but some very successful shooters use a 0.20" caliber rod to clean a 22lr rimfire rifle.

It's a way to split the difference and allow for a bit more patch to be used in the bore. Using a 1" square patch on a 0.20" caliber jag and rod, the shooter gets more patch surface area against the barrel per pass than with a 0.22" caliber rod and ¾" patch.

This technique works well for experienced shooters who have a feel for the proper amount of pressure to exert against the patch and rod.

I also use a 0.20" caliber rod for running patches down the bore, but when I use a nylon brush, I use a 0.22" caliber rod. The brush requires more force to push down the bore, making the rod prone to flexing and bending.

When you damage a rod by bending it, or when the coating begins to chip and wear off, it's time to throw it out and replace it with a new one. Keeping a spare rod around is a wise investment. When I'm out on a weeklong varmint-hunting trip, I usually have two to three rods with me just in case.

A trick that will save you time is using two rods to clean your barrel, and I don't mean running two rods down the bore at the same time. Have one rod threaded with a pierce jag, and had the other rod threaded with a nylon brush. This way you don't need to spend the time switching back and forth.

Storing and transporting your cleaning rods is another issue worth discussing.

First, store them tip down or tip up, just make sure they are vertical. Do not store them lying down; they can develop a warp and are real easy to step on that way.

Some shooters store them in large cardboard tubes next to their workbench while others keep them in nifty PVC tubes with end caps.

There are cleaning rod carriers which can be purchased, but try to avoid the thin aluminum ones, they bend easily. In my shop, I hang the rods off the side of the rifle stock rack with a Brownells cleaning rod rack.

It keeps them handy and out of the way. Take the time and find a good spot for the rods in your working area.

Peeling of the plastic coating and a scratch from the ejector.

Cleaning Rod Attachments (Jags)

Various Attachments

Rod attachment, also known as "Jags," are threaded pieces of brass, or sometimes aluminum, which thread into the end of the rod.

The function of a jag is to secure a cleaning patch to the rod and maintain its position while the patch is pushed through the bore.

Some of the different types of implements are; pierce jags, loops, wraps, and mops.

Over the years I have seen various jags offered, using a range of materials from brass, aluminum, and plastic. What has impressed me is the continual improvement of the manufacturing process and design of modern jags. Features like beveled edges, clearance reliefs on the sides, and sharp points have made cleaning a bit easier on both the shooter and the barrel.

In the following sections, we will touch on each general type of attachment, as well as some of their merits and deficiencies.

Pierce Style Jags

A pierce jag has a sharp point on the end that pokes through the cleaning patch to secure it; hence the name "Pierce."

They vary in style with some having a series of rings to press the patch against the bore, while others have a knurled surface. Some have long, pointy spears at the end while others are short and stubby.

Pierce Jags

For the most part they are machined out of solid brass, but there are a few types out there which are made from aluminum, with the idea that if you are using a strong copper solvent, they will not give you a false reading on the patch. I can see the idea behind this, but prefer the standard brass jags.

What is important on a pierce style jag is a very sharp point and a relief cut on the side. The sharp point allows the patch to be easily penetrated without pulling some of the cotton fibers out of place. On a dull jag, it can really make a mess of a patch.

The relief cut on the side of a jag is a narrower diameter portion, which allows the excess patch material to fold behind the head of the jag. This keeps from creating too much friction-induced pressure on the rod when trying to push a patch down the bore. Since most patches are square, they need this clearance to fold the excess material around the jag.

Since the bronze or aluminum material is relatively soft, I often touch up the point of my jags with just a few passes over a file. I also take a moment from time to time and make sure there are no dings or defects on the sides or head of the jag.

Loops

Loops have, well, a loop at the end and allow the patch to pass through, much like thread through the eye of a needle. It's a pretty straight-forward idea in the design.

Loop Jag

These were popular many years ago, but you rarely see them now for use in rimfire applications.

I think it's a mixture of changing ideas about rimfire cleaning and the fact that they require a small patch to fit down the barrel.

I have this one in my collection just for photographs now. Some of the pull-though cleaning systems like Otis use a loop, but they are much smaller in size and necessary for that type of system to work.

Wrap Jags (Parker Hale)

Wraps, often referred to as Parker Hale jags, are similar to pierce jags, but instead of a sharp point, the wrap has teeth encircling the shaft which are used to hold a cleaning patch that has been wrapped around the jag.

Some shooters use these in combination with bore paste, like JB's, to scrub the bore. On larger calibers they work well, but most shooters now use a worn-out brush to wrap a patch around for this kind of scrubbing in a rimfire.

Parker Hale Style Wrap Jag

If you want to use a wrap type of jag, it's best to use a pistol brush for this process. The shorter length of the pistol brush, when compared to a rifle brush, reduces the amount of force needed to work the patch back and forth in the barrel.

Bore Mops

Bore Mops

Another kind of attachment encountered from time to time is a bore mop. These function as their description states, in that the dense fibers absorb the oils from the bore. Some shooters soak them in solvent and mop back and forth, but it really is not ideal.

First off you use a lot of solvent to soak a mop to the point where will place a significant amount of solvent into the bore and not just hold it in the fibers.

Also, once you get it dirty, they are a pain and not really worth the effort to clean.

Mops are also great collectors of primer fouling, which is something you want to avoid running back and forth down your barrel. My advice is to completely skip the bore mops.

VFG Cleaning Pellets

A newer kind of cleaning device is the felt pellet.

While they have been in various forms over the years, a company called VFG has a very nifty system which I use frequently.

They offer a threaded attachment for your cleaning rod, which then uses a thread form to hold their various types of cleaning pellets.

You can soak them in solvent or coat them in a paste, and these do an excellent job in removing stubborn carbon fouling in the chamber.

VFG Cleaning Pellets

The more "Super Intensive" pellets have bronze fibers woven into the felt pellets, and these are idea for removing lead from a barrel without causing unnecessary wear to the bore.

When it comes to removing the carbon ring from a chamber, this is one of the best tools. I use a short Pro-Shot pistol rod and an aggressive VFG pellet rolled in JB bore paste and short stroke the chamber about ten times.

This, along with some solvent down the bore, will quickly remove the dreaded black ring. I will get more into the detailed process later on, but the VFG line can be found in Brownells' catalog.

Various Nylon Brushes

Brushes

When it comes to brushes, I only use nylon. I like the nylon brushes, and I use Bore Tech and Dewey brand brushes for my cleaning. They have good thick bristles and last quite a while.

Nylon brushes also carry solvent well and can be used to work the solvent into the barrel's pores for soaking. Unlike brushes made from bronze, the nylon bristles do not react to the copper solvents.

Some shooters like to use bronze brushes, thinking that the extra stiffness and abrasiveness of a bronze brush is helpful.

I don't think the shooter gains much from the mechanical forces of running a bronze brush, but if you feel the need, by all means do so.

I will say that for my competition rifles with premium quality barrel, I have never found a need to run a bronze brush down the bore. They clean up easily with a nylon brush, and I find the nylon brush does not need as much force to push down a barrel. Remember, when you have to push really hard to get a new bronze brush down your bore, chances are you are bending the rod inside the barrel and possibly touching the lands with the rod, even with a rod guide.

What has surprised me about bronze brushes is all the emotional turmoil these basic devices cause on various internet sites. There is one group who states bronze brushes will destroy your barrel in short order, and the other who claims that bronze is softer than steel so it could never possibly hurt the barrel.

Well, there are a few things to consider first. One is that yes, bronze is much softer than barrel steel and chances are you will not remove enough metal inside the bore to ever make it larger. But, to think that working the brush back and forth will never blunt the sharp edge of the lands is assuming a bit too much. On some barrels, the delicate top edge of a land is very narrow, and working that brush back and forth will slowly dull that sharp edge of the land. Will this harm accuracy? That is an untested question, and I am unaware of a long-term test which focuses on this topic.

A better question would have to do with a particular rifle setup and shooter skill being able to resolve the difference. Some shooters do, while most do not. I know of some very good shooters who use a bronze brush after every shooting session, and I know just as many who do not. It really comes down to personal preference. I don't use them, and after spending so much time with a borescope, I have yet to see a need to do so. Proper maintenance will more than likely alleviate any need to use the mechanical force of a bronze brush.

Rod Guides

Various Rod Guides

A rod guide is a cylindrical piece of plastic or aluminum, with a hole running length-wise down the center.

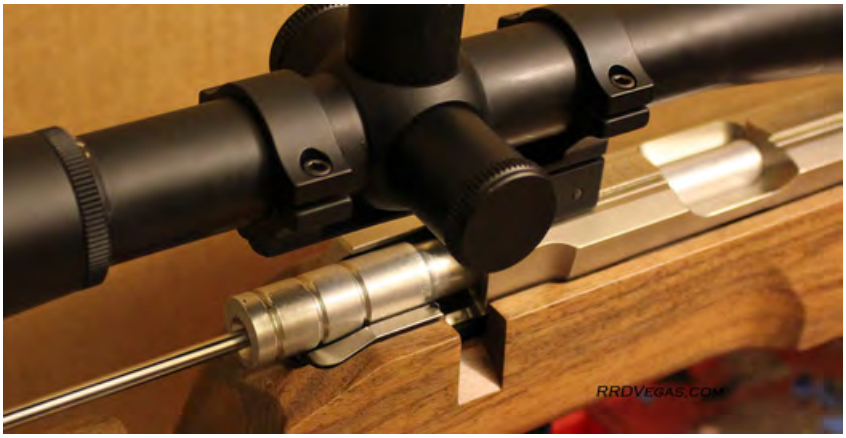
For years I, like many others, have mistakenly used the term "bore guide" for this piece of equipment.

It's really a rod guide, because that is what it does; it guides the rod, not the bore.

Does it matter? Probably not, but still from here out I will refer to this piece of equipment as a rod guide.

Installed where the bolt resides, a rod guide sits in alignment with the bore of the barrel. Looking from the rear, you should be able to see a perfectly straight path through the rod guide down the bore.

The rod guide provides a guided path for the cleaning rod to follow, keeping it in alignment with the bore of the barrel, helping you to keep the rod from bumping into the inside of the receiver or breech face while working it back and forth.



Rod guide in place

A good rod guide will also extend the life of your rod by preventing it from rubbing on the breech opening of the chamber or exposed lands in the throat of the barrel.

These hard steel edges can quickly peel off any plastic coating on a rod or scratch a polished steel surface.

Many centerfire rod guides extend into the chamber and have rubber o-ring seals located in the front to prevent solvent from dripping back into the action and trigger group.

Rimfire rod guides stop right at the breech face and do not have any o-ring seals. Special care must be taken when working with rimfire rod guides to prevent excessive cleaning solvent from creeping back into the action, trigger group, or bedding.

Keeping the rifle pointed slightly down during cleaning will help. It's also handy to stuff a small piece of cloth into the magazine well

if the rifle is a repeater; this will help catch any drips that run into the magazine well.

Also check to see that the rod guide extends out far enough to cover the exposed trigger group. If it does not cover the trigger group, look for another one - do not compromise on this. Dumping solvent into your trigger group will result in unimaginable horror.

A quality rod guide will cost about $30.00, depending on what it's made from and the quality of construction. Companies like Sinclair International have a wide selection of rod guides, matched to specific actions, and crafted from solvent resistant polymers or aluminum.

As one of the most important tools for cleaning, it's wise to invest the money and purchase a high quality and action specific rod guide for each rimfire rifle. Quality rod guides last for years and may never need replacement. Since most are made from plastic or aluminum, they can be wiped down and do not require any oil for protection.

Before you insert the rod guide in the action, make sure that it's clean on the outside and does not have any grit stuck to it.

Solvents and Cleaners

With so many different cleaners on the market, it can be difficult to pick the right one. Kroil, Butch's Bore Shine, Montana Extreme, Break Free, Bore Tech, and JB Bore paste all work well, with Kroil, Bore Tech, and JB being standards in my cleaning kit.

Cleaning solvents is an area where you will have to experiment and see what works best in your rifle.

Various solvents and cleaning agents

I generally will try something new if I feel my current solvents are not doing a good job, and over the past few years, the only product line I have added to my inventory has been from Bore Tech. Their stuff works pretty darn well.

I still use my standard products, like Kroil, but a change from time to time keeps things interesting. I'm spending a bit more time with the classis Hoppe's #9 solvent. It seems to work just as well as the other solvents.

Don't buy huge quantities of chemical, unless you really need them. 16 ounces of Montana Extreme (a strong copper solvent) will last me over a year, but I go through Kroil pretty quick because it's great for a lot of stuff.

I also use the JB product line of cleaning pastes. Like many of you, I have read various stories about the JB bore paste wearing out a barrel, and that how it will grind away at the lands and grooves in the barrel.

This is complete nonsense. Typically it is not the paste that is the problem, but the heavy-handed person ramming their cleaning rod back and forth down the barrel like they're sawing lumber.

I have used JB for years, and I have never attributed a loss of accuracy in any of my rifles to its use. A VFG pellet rolled in some JB bore paste is excellent for removing the carbon ring in a chamber, and does an excellent job in gently removing lead from a barrel.

I have also found a lot of "snake oil" on the market in recent years.

Kroil

Most of the new products are just slight changes to what already exists, and some of their advertisements are flat-out lies. If it sounds too good to be true, it generally is.

As with all cleaning products, store these chemicals in a safe place and do your best to keep these off of your hands while cleaning the rifle. In recent times, I have seen a trend where shooters are mixing cleaning chemicals to develop one "super" solvent. Don't do this. Unless you are a chemist by trade, you stand a better chance of making a solvent that can etch the steel in your barrel or create a vapor which will lay you out on the floor of your reloading room. Leave chemical mixing to the professionals.

Cleaning Cradles

It's best to clean a gun in a proper cleaning cradle. It prevents the rifle from jumping around and gives you much more control over the cleaning rod.

I use the MTM cradle for my gun cleaning because it's light, has places to hold jags and parts, and the rubberized feet and cradle arms hold the rifle in place.

There are quite a few different cradles on the market, so take the time and find one that fits your needs.

One thing I do change about the cradle is that I add weight to the bottom of the unit. Since I don't use the main storage trays underneath, I filled it with small bags of lead shot. This helps put some downward pressure on the tray and increase the traction of the rubber feet.

MTM Cleaning Cradle

Brownell's and Sinclair International both sell nice cleaning cradles that fit a variety of rifles and are worth a look.

Cleaning Patches

Cleaning patches are pretty much the same, no matter what brand you purchase, just make sure you purchase enough.

Cutting them out by hand is a waste of time and rarely do you find a material better than the standard cotton patch.

There are a few options in shape, but I mostly use either round or square patches. For most rimfire applications, I keep 0.75" patches

Cleaning Patches

on hand for my 0.17" barrels and 1.0" to 1.25" for the 0.22" caliber barrels.

Because each manufacturer varies slightly in size, I keep my smaller patches separate from the rest. This is because getting a patch stuck in a 0.17" caliber barrel is pretty easy and a real pain to remove.

Pull-Through Cleaners

Cable styled pull-through cleaner

Over the years I have looked at these various devices, often referred to as "Bore Snakes," with some skepticism, yet they seem to be popular with enough shooters to keep them in production.

There are two basic types in use today; one being a thick fabric cord or rope which is pulled through the barrel from the muzzle, and the other a much thinner plastic coated steel cable or plastic line used in a similar fashion.

The thicker version which features a fiber cord or rope, is larger in diameter than the bore, and uses its size to press against the insides of the barrel, wiping away the fouling. The softer cord material compresses as it is pulled though the barrel.

The manufacturers of the fabric cord design state that one pass with this kind of bore snake is like making hundreds of passes with a conventional patch and rod. In a sense, they are correct when looking at the volume of fabric material between the two, but it does not mean that it is hundreds of times better.

These fabric cords also are found with some bronze bristles woven into the cord's body at various intervals to help remove lead and other stubborn fouling residue.

Feed the cable through the ejection port.

The only down-side to this pull-though system is that the more you use it, the dirtier it becomes, and over time you end up pulling debris back into the barrel. The cord becomes embedded with the very same material you are trying to remove.

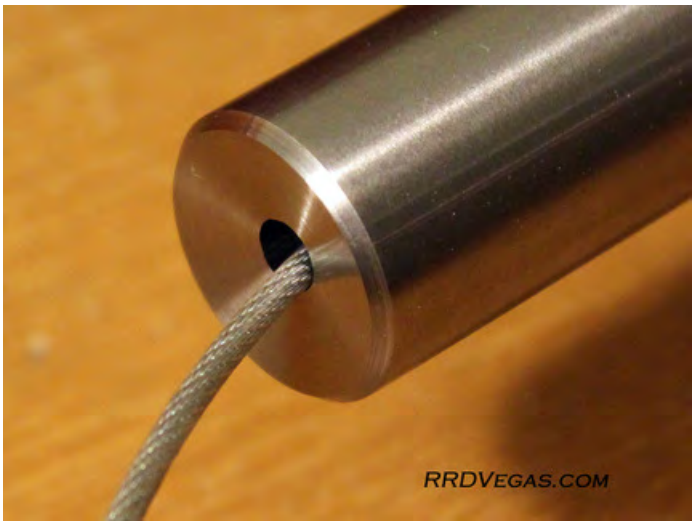
If you do use one of these systems, take the time to scrub it down with a brush and soapy water. This should help remove the larger particles of powder fouling and primer material.

The other type is based on a thin cable or plastic line, which pulls a patch or brush down the barrel. These are often made from plastic coated steel cables, or even just simple thick plastic line, such as a weed trimming cord. These systems are much easier to clean than the fabric rope.

Pull-through cleaners became popular with the Ruger 10/22 semi-auto or other auto-loaders where you cannot easily access the rear

of the receiver to run rod down through the barrel. The pull-through cleaner allows the user to feed the front of the cable through the ejection port and into the breech, and the pull it out from the muzzle of the barrel.

This is a far better option than running rod backwards through the barrel, starting from the muzzling of the rifle.



The cable can damage a crown if pulled through at an angle.

After running a number of passes with a pull-through cleaner on a dirty barrel, I checked the inside of the barrel with a borescope to see how well the chamber and bore was being cleaned.

As I expected, it wasn't doing a very good job. While it removed most of the fouling from a barrel, both systems did very little in removing the black ring from the chamber.

I continued on with additional passes, and after a while the chamber started to look somewhat decent. I feel that if you are willing to make enough passes with the system, it will get about 80% of the fouling out that a cleaning rod would remove.

I find that using a pull-though system that much is actually more work than just using a rod and patch, but it does have a place in your cleaning gear if you have a semi-auto that won't allow the use of a rod.

When using one of these systems, it's very important to make sure you are pulling the cable out perfectly straight from the muzzle. If you allow it to rub against the side of the crown, it can act as an abrading agent and quickly cut into the delicate angle of the muzzle.

In a field setting, I think they work fine for instances where you may have gotten dirt, water, or something in the bore. But compared to a cleaning rod and patches, they do not do as good of a job. I keep the Otis cleaner in my field kit for such instances, and a few times I found a need to use it.

Borescopes

To truly know what's going on inside of a barrel, it's essential to have a borescope.

Simply looking down the bore of a rifle with the unaided eye tells you very little about the level fouling and the presence of machining marks, damage, or even a burned-out throat.

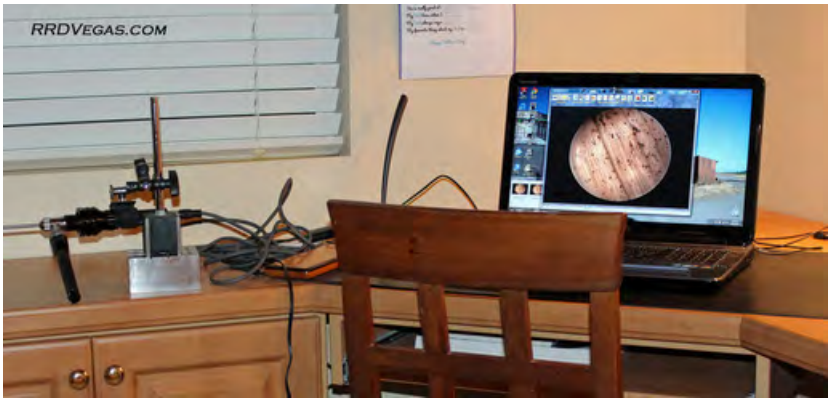
The unit I use is made by Gradient Lens Corporation, called the Hawkeye Pro Borescope.

Borescope, Sony camera, and angled eye piece.

This particular borescope is a precision made optical instrument that allows the shooter to inspect the inside of a bore and see tooling marks, erosion, and fouling at a 90 degree angle. Rather than looking down the bore, parallel to the direction of the lands and grooves, the borescope lets you look directly at the bore itself.

The borescope's major component is a stainless steel tube with a series of special glass rods mounted at specific intervals inside the tube.

These glass rods are precisely shaped with their ends ground and polished, much like the lens in your



Inspecting the barrel on the computer with the attached Sony video camera.

reading glasses, and designed to carry light images down the tube.

At the far end of the borescope, there is the subject objective lens and a reflective mirror.

The reflective mirror is mounted at a 45-degree angle, allowing the shooter to have a perpendicular view of the bore. At the user end is the eye piece, which contains an adjustable lens for the user to focus.

Just in front of the Eyepiece, a light source is located, comprised of a small flashlight and connective aluminum housing, and also acts as a handle to the borescope. Light emitted from the flashlight is carried down the steel tube through a small sleeve of fiber optic
filaments that surround the glass rods, and projecting light out the subject objective lens and against the reflective mirror.

As the light strikes the reflective mirror, it is projected against the inside of the bore. When the light strikes the bore, it is reflected back into the mirror, which angles it back 90 degrees into the subject objective lens, and back towards the eyepiece via the glass tubes. This image is what the user sees when looking through the borescope.

With a borescope, you will be able to see detail inside the barrel that you never imagined. A barrel which looks clean when casually inspected with the naked eye can reveal all kinds of fouling when scrutinized with a borescope.

The trick is to not use the borescope as a single source of information, but rather to use the data collected from it as validation of other ideas.

When I think a rifle is shooting erratically, borescoping will help trouble shoot the problem, but may not give a definitive answer. It will certainly show such accuracy robbing attributes such as black chamber rings and copper fouling.

The cost of a borescope may prohibit some shooters from purchasing one, but often times your local gunsmith will have one that you may be able to use at their shop.


Sony camera hooked up to the borescope.

Borescopes take much of the guesswork out of cleaning and of barrel condition and quality. They are also very helpful in bore inspection when shopping for a used rifle.

Current borescope packages from Gradient Lens also have the option of hooking up a digital video camera to the unit and specialized software for your computer. This is what I use to capture the images you see on the website. As you add features to the borescope package, the price climbs quickly. That said, a base model will run about $800.00.

The standard borescope will allow you to look down a 0.22" caliber barrel and larger with no trouble. They have a new, slimmer borescope which allows you to inspect 0.17" barrels, but it's a very delicate instrument and about double the price.

The Process

Rather than trying to lump all the different rimfire calibers and types into a specific processes, I have decided to break the process of cleaning apart by bullet type, then by caliber, and

Getting Started

even by rifle type in some instances.

I feel that there are enough differences between these that they merit their own discussion.

I will also address some particular areas of cleaning such as removing the black ring from the chamber and cleaning various muzzle attachments.

But before we begin, I have added in a few more comments that I feel are important to cover before we start running patches down the barrel.

Cleaning Rod Setup

I added this section in the beginning so I didn't have to repeat it under every topic heading. I know that some readers may skip to a section that applies to their particular needs and may not catch this information.

Below is the process I use to set up all of my cleaning rods, no matter which manufacturer they're from or what caliber they are specific to.

I don't rotate between jags and brushes on a cleaning rod, rather I just use multiple rods. I find it far better to have two rods, one fitted with the jag and the other fitted with a brush, versus swapping jags and brushes between a single cleaning rod.

Jag fitted to rod

I have seen brushes unscrew themselves on rods even when the rods are allowed to rotate, and often times this is because solvent has soaked in-between the threads of the jag and the rod, allowing them to work loose.

When fitting a new jag to a rod, I carefully thread in the jag to make sure it will reach its full depth and have the shoulder stop on the end of the rod. Once I know the jag fits properly, I remove it and clean the jag's threads in the inside threads of the rod. Then I add a drop of blue Loctite to the threads of the jag and thread back into the rod. Once seated on the shoulder, I give the jag a good firm twist and then let it dry.

After about 15 minutes, I inspect the seam between the jag and the rod. If there is any part of the jag sticking out above the rod due to a slight misalignment or sizing issue, I polish it off using a rotary tool and rubber wheel. Taking 5 minutes to fix this is well worth the effort.

On my second rod I installed a nylon brush, depending on which caliber I'll be using. Unlike jags and rods which can be used slightly undersized, I always use the correct size of nylon brush for the bore that I'm working with.

When it's a 0.22" caliber bore, I use the proper 0.22" caliber nylon brush. You're basically wasting time by using a nylon brush that is undersized. Some people prefer slightly worn out bronze brush, but I rarely use them so I leave that choice up to the reader.

Once I have the correct brush selected, I repeat the same process I did

Fitted brush

before, checking the fit first, then cleaning both thread forms and applying a small amount of Loctite and reassembling.

On just about every rod I have worked with there had to be some slight buffing between the junction of the jag or brush and the cleaning rod. At this point the rods are ready to use.

Removing the Brush Before the Backstroke

Leave the brush on the rod.

I have seen this little detail of cleaning discussed far too many times to let it go without comment, and I plan to ruffle some feathers with this following diatribe.

I have watched a few shooters do this; that is after running their brush through the barrel, they stop everything, let the brush hang out the muzzle, then walk around and remove the brush. After unscrewing the brush, they pull the cleaning rod back through the barrel, and then reattach the brush. The process is then repeated.

The idea is that this prevents the brush core from slamming into the edge of the muzzle, and dragging back across before the brush centers itself back in the bore.

This process is an absolute, utter, and complete waste of time. You may as well have a wad of Spanish moss tucked into your left pocket to help improve your accuracy and protect the crown. If you can't reverse the direction of your cleaning rod without looking like you are trying to start a neglected Briggs and Stratton lawn mower from 1983, the brush bouncing up against the muzzle is the least of your worries.

First off, all crowns should have some break in the edge, however small, between the flat of the crown and the lands and grooves. Some of these chamfers are very small, but most factory barrels have a very generous transition. This transition is plenty wide enough to allow the rod to be gently pulled up against the angle and not damage the muzzle by raising a burr.

I mean that is the problem, right, raising a burr by the rearward motion of knocking the brush core against the muzzle? If you are yanking hard enough back to cause a wound bronze wire core to dent and lift a burr on either stainless steel or chromoly barrel, you have to really stop and reassess what you're doing.

Second, by removing the brush, the end of the rod will skip across the tops of the lands as you remove the rod because there is nothing causing it to rotate in the same direction as the twist of the rifling. Something has to be sitting in the bottom of the barrel as the rod is removed, and that's the end of the rod. It's not suspended in mid-air for most of its travel back out the barrel, even with a rod guide. It just bounces along across the tops of the lands. This already happens when you use a bronze jag (much softer material than the end of a steel rod), so why do it more when you can avoid it.

It seems pretty logical to me that just a gentle reversal of the rod, easing it up into the muzzle and back down the barrel is the best approach. If you handle the equipment with care, some basic caution, and maybe even a touch of grace, you can skip this nonsense.

Depth of Stroke

The term, "Depth of Stroke," is something that I use to indicate just how far your rod should be pushed out past the end of the barrel.

I don't know if there's a conventional wisdom approach to this, but for me I let it exit the absolute minimum distance possible. There is no point in jamming a jag 10" past the exit of the muzzle, letting the side of the rod run along the edge of the crown.

Stop Here..! Pushing any further is a waste.

The same thing goes for brushes; you don't have to push until the base of your handle bumps up against the receiver or rod guide.

Now some will wonder how they going to know when to stop, or that they push with so much force that once the brush or patch exit the muzzle, the rod jumps forward some distance or until something stops it (receiver, rod guide, knuckles ramming against the scope's eye piece).

Well there's a few ways to reduce the amount of over-travel of your cleaning rod, the first is that you need to stop pushing so hard.

When you put so much force on the rod that once the jag or brush clears the muzzle, it pops out like a cork, you are more than likely bowing the rod inside the bore, causing it to rub up against the lands of the barrel.

Try using a smaller brush, smaller patch, or more solvent on the patch.

Is this necessary?

Cleaning Rod Stop Collar

The second option is to use a cleaning rod stop-collar. These are pretty nifty devices that can be found in Sinclair International's catalog, and fit around the shaft of a cleaning rod to indicate where you can stop pushing.

I actually don't use these for a brush or jag often, but I do use these when I'm short-stroking the chamber with some JB cleaning compound.

The stop collars are made from plastic with a nylon screw in the side. You can set how deep you want the rod to go, whether it's just for short stroking the chamber, or if you want the patch to just clear the muzzle.

Simply place the stop up against the rod guide and once you reach the desired depth with the cleaning rod, tighten down the nylon screw and you'll know exactly where to stop.

The nylon screw holds the collar in place on the rod without marking the surface, but it's not going to give it enough grip on the shaft to stop you from ramming the rod in the deeper. With pressure, the collar will simply slide along the rod. It's more of a little visual reminder to show you when to stop pushing. I have a number of these devices on various rods and use them from time to time.

Bolt Action Sporting Rifle – .22lr

Starting with the bolt-action sporting rifle, the cleaning process

begins with unloading the firearm to make sure it's in a safe condition to work on.

From there the bolt is set aside on a cloth and the rifle is placed in a cleaning cradle.

To begin, I take a short cleaning rod fitted with a large 0.40" caliber nylon brush, wrapped with a small cotton cloth. Working from the rear of the receiver towards the breach, I gently insert the short rod and rotate it, collecting as much of the loose fouling in the receiver as possible.

Squirrel Relocation Rifle

When there is a considerable amount of loose fouling, a few drops of oil such as Break Free will help the fouling stick to the cloth. Do not over saturate the cloth because the pressure of squeezing the cloth into the receiver can cause some of the oil to drip down into the trigger group.

By working from the rear of the receiver towards the breech, you are keeping any loose fouling out of the trigger group. Some internal workings, such as fixed ejectors, may require a smaller diameter brush or even using a toothbrush wrapped in a cotton patch.

Cleaning the receiver

Once I have all the loose fouling removed, I take a couple of Q-tips soaked in a general solvent and wipe down the feed ramp and a flat surface of the breech face.

If you don't clean the breech face before you start running patches down the bore, the patch will collect the fouling off of the breech face and drag it through the barrel.

Often times the breech face on a rimfire has a thick layer of fouling, so this process may take a little bit of time. Resist the temptation to scrape off fouling with a hard tool because it's easy to scratch the breech face or mouth to the chamber.

When necessary, use a plastic-tipped tool or a toothpick to dislodge heavier deposits. For stubborn layers of fouling, a Q-tip rolled in some JB bore paste will speed up the process. By alternating between JB bore paste and a solvent like Kroil, you will eventually get down to the bare metal.

Once that is complete, run a dry cloth through the receiver again up to the breech face, making sure there is no loose fouling or solvents from the cleaning process. I skip cleaning out the extractor slots at this point, saving that for near the end of the process. The reason why is that when you use bore paste or some other thick chemical agent to clean your barrel, some of it will inevitably end up packed into the extractor slot. Save the effort until the end of the cleaning session.

With the receiver clean, it's time to insert the rod guide and get down to business.

For the first pass, I use a loose fitting patch which has been soaked in cleaning solvent. The wet patch grabs the loose fouling inside without pressing it against the sides of the bore with excessive force.

The idea is that you want to gently lift and remove the coarse primer material and any loose fouling. I repeat the process a few times to further coat the bore with cleaning solvent.

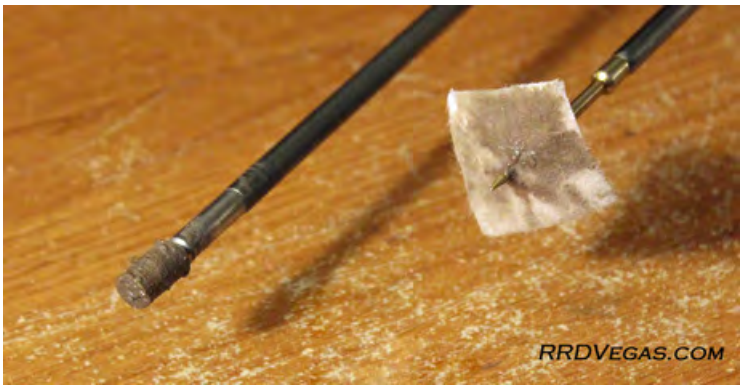
A leather cover to protect the stock's finish.

As the solvent is worked down the entire length of the bore, it will begin to loosen the fouling from the lands and grooves.

The next step is to run a nylon brush, soaked in solvent, down the bore a number of times. I tend to make at least ten passes; sometimes more if I feel the rod sticking in some areas. You can feel the brush grab over areas where there is lead accumulation or heavy fouling. I keep scrubbing in long, smooth strokes and add more solvent when the bore feels like it needs it. It's a good idea to wipe down the rod after every pass, making sure that no loose fouling has stuck to the cleaning rod.

Once the solvent and scrubbing action of the brush has loosened up much of the fouling, it's time to run a few patches down the barrel. Rather than starting with a dry patch, you should run a few solvent soaked patches down the bore first. This will help make for a smooth pass through the bore, but it will also continue the cleaning action of the solvent.

After about three of wet patches, I switch to a dry patch and run those until they come out dry. Chances are they will not be clean, but they need to be dry. This will help ensure any loose fouling and dirty solvent has been removed from the bore.



JB Bore Paste on a patch and felt pellet.

As this point, I run two more wet patches down the bore and then change my focus to the chamber and lead angle. As with many sporting rifle shooters, I tend to shoot a considerable number of rounds (hundreds) every time I head out to the field.

This will leave some level of fouling in the chamber, and I don't like to have any accumulation build up over time in that area, creating the dreaded "Black Ring." I also don't put rifles away that are dirty.

You can remove this with either a VFG pellet rolled in some JB bore paste, or a small patch coated in the similar cleaning agent.

With the rod stop set to limit the travel to only an inch deep into the rifling, I make a few short passes back and forth. In some instances I don't use a rod guide and just let my hands guide the rod. Since you are only traveling a few inches inside the bore, you can eyeball this part.

If you are uncomfortable with that, then use a rod guide. Just know that most of your cleaning paste is going to end up on the inside of the rod guide and not make it to the barrel. You will just have to make more passes with coated patches to eventually get the paste to the bore.

It seems that no matter how clean you think your rifle is, the first few strokes of bore paste in a chamber is going to turn the patch black. Don't work about this and keep scrubbing gently back and forth. After a few passes, I get a new patch and apply more bore paste and continue on, leaving the old paste in the chamber. This process should only take a few minutes of scrubbing and you will be done.

Once you think you have scrubbed enough, wipe away the paste on the surface of the breech face and clean the rod guide if you used it.

Then run a few wet patches down the bore to collect the paste and fouling that you loosened. It may surprise you how black the patches are, so keep running more solvent soaked patches until they are clean.

You don't want to leave any bore paste in the barrel. These can be followed by a number of dry patches. Finish up with about

five dry patches.

It's at this point when I take a small screwdriver and remove any bore paste from the extractor slots. A Q-tip or tooth pick will also work. Make sure you don't get any in the chamber.

At this point, your rifle will either be done, or may need a bit more work with the brush and patches. It just depends on how your last few cleaning patches looked. If they are still streaked with black, then continue to rotate between the brush and the patches. Some barrels just take more cleaning than others. If it was a heavily fouled rifle, I tend to spend a little more time working on the chamber. Of course if you have a borescope handy, you can visually inspect your progress.

If you feel that you are done, then run a few more dry patches down the bore and follow it up with one wet patch, not soaked, of light-weight oil. This is just to get a protective layer in the barrel. I follow that with a few dry patches to remove the excess oil and call the rifle's barrel done.

On Anschutz rifles, it is easy to break down the bolt and clean the internals, so I do that as well. For more complicated bolt, you can judge when the bolt seems to really need a cleaning. Just be sure to wipe down the outside of the bolt, brush off the bolt face and clean out the extractors. Then apply new grease to the lugs.

I also wipe down the outside of the rifle and apply a light bit of oil to any exposed metal surfaces. Optics are checked for dust or water spots on the lenses, and magazines are wiped down and inspected.

Anschutz 2013 Unlimited Rifle

Bolt Action Target Rifles - .22lr

For this section, I'm going to lump a few different types of target rifles together because they all fit into a similar role when it comes to cleaning.

This section will include two parts: Benchrest and Position Shooters (Prone, 3-Position, Silhouette), and this discussion will also cover any other bolt-action platform designed for precise, slow fire. It's a bit of a grab, but I think once you read through this section it will make sense.

Unlike the general sporting rifles, target rifles tend to feature smooth, well-made barrels which are free from tooling marks. Most custom barrels are hand-lapped for an even greater bore uniformity and internal finish.

These attributes tend to cause the barrels to foul much less than a regular sporting barrel, and make them much easier to clean. This does not mean they don't need to be cleaned, even thought that was the conventional wisdom from years past.

Often times the target shooter will clean the rifle based on any perceived change in accuracy. We often refer to this as exceeding the "accuracy window," which is an approximate number of rounds where a barrel is most accurate. The accuracy window starts after the barrel has been properly fouled with a minimum number of rounds needed to reach its accuracy potential. Some barrels only need a few rounds after cleaning while others may need a few dozen.

In a target rifle, fouling is a combination of the wax lubrication evenly spread out through the entire length of the bore, mixed with some carbon residue. In these barrels, lead does not seem to collect on the smooth surface, so it does not play a part in this type of

beneficial fouling.

Once an optimal level of accuracy is reached, the shooter will be able to fire subsequent rounds with a high confidence in the rifle's ability to place the bullets in the desired location on the target. For some rifles, this window of accuracy is narrow, consisting of just a few hundred rounds before a loss of accuracy is noticed, while other rifles have a surprisingly large window consisting of hundreds of rounds before there's a change.

The trick here is to take the time and test your rifle to learn how many rounds dictate its accuracy window and then clean the barrel at the correct intervals to stay within this accuracy window during competition.

Benchrest

When it comes to cleaning, the Benchrest crowd has to be the most vexing group of the bunch. With countless methods and formulas to pick from, each method has been attributed to some match victory, *somewhere*, so surely they must all work.

More likely that is not the case, but cleaning a benchrest rifle properly is critical for success in this sport.

One thing for sure is that at every major rimfire benchrest event I've competed in, I noticed every shooter cleaning their rifle at some point during the match. Some more frequently than others, but just about everybody cleans their barrel at some point.

Hall Unlimited BR

There is the odd shooter who will wait until the end of a match to clean their barrel, but they number in the few and often times the rifle is on a "hot streak" racking up good scores, so they're reluctant to change anything. These people also get burned from time to time by the random "flier" which knocks them well back into the pack. Then the question arises as to if they should have pushed their accuracy window as far as they did. Was the flier caused by the excessive buildup of fouling in the bore, or was it a bad round? It's a tough question to answer.

That situation aside, I'll clean my rifle a few times during a match, often on a break after I have shot two cards, which is approximately 75 to 100 rounds fired on two 25-Bulls-eye scoring targets (I call them cards) like RBA or ARA. A relay in a match will consist of a single card, and most matches are scored based on multiple cards. Some events are short with only a few cards being shot in total, while other events can be as many as eight cards.

As a side note, when Joe Friedrich shot is 2,462 agg for 4 ARA cards, he was cleaning his rifle ever other card. When we discussed this further, he stated that cleaning every other card has been his standard practice for years, and with multiple 9,850/10,000 scores back to back, it's worth taking note.

I find that after I foul a barrel with 10 rounds (sometimes as many as 20 depending on the barrel) I'm at the front part of the accuracy window. As I shoot more rounds on target, I will start to notice a slight drop in accuracy between 100 and 150 rounds down the barrel. With most benchrest events based on multiple targets, I don't like to gamble and have my accuracy start to drop off in the middle of a card. So by the completion of the second card, I know it's a good time to clean.

This slight change in accuracy is noticeable in a benchrest rifle, but most other disciplines where the rifle is being held or influenced by other variables, this slight initial loss of accuracy will go unnoticed. But don't fool yourself into thinking that just because you can't see your accuracy fading that it's not; you are more than likely in a situation where your rifle or the conditions can't resolve it.

When I attend a major event like the ARA Nationals, and I see all 100+ competitors cleaning their rifles throughout the day; it's not because they're fools. It's because clean rifles are accurate rifles. Here is another side note; no one is using a bore snake of any kind.

ARA will punish you for having a dirty barrel.

At the start of a match, I typically foul the barrel with 10 to 20 rounds using the sighter targets during my first relay to establish the correct level of fouling in the bore.

During these sighters, I make any adjustments for the wind condition as well. Once I start getting small groups and predicable shot placement, I move over to the scoring targets and get to work. In mild conditions, I usually shoot just under 50 shots to complete the 25 scoring targets.

If the wind is tricky or for some reason I feel the need to shoot additional sighters, the round count can reach 75 before I am done with the card.

When it's time to clean, I don't scrub the bore in the same fashion as a sporting rifle. What I do is follow the same process of cleaning the receiver and installing the bore guide, but then I run a few wet patches of solvent down the bore followed by a few dry patches, and that is all.

The key here is not to remove all of the wax lubrication from the barrel; just the heavy buildup in the first few inches of the barrel and any other loose debris throughout the length of the bore. With some fouling left in the bore, I only need to take 5 to 10 fouling shots on the next card and be right back into my accuracy window. As the day progresses and I shoot multiple cards, I repeat this process.

If the rifle seems to be acting up by throwing shots, especially when they do not relate to the wind conditions, I will take a moment a short stroke the chamber with a nylon brush and soaked in solvent. I will then make one or two passes down the entire length of the bore with the nylon brush. Then I run a series of wet and dry patches down the bore and go back to the sighter targets and re-foul the barrel. The last thing you want to do is clean the barrel and then take a shot for score. Typically the shot will be about an inch off at 50 yards.

At the end of that match, I clean the barrel completely with patches and a nylon brush, and use a little bit of the JB bore paste in the chamber just to make sure that a black ring does not have a chance to develop. It's very critical for accuracy to never allow that black ring to start in the first place.

This process has worked well for most of my benchrest rifles, and it is still what I follow today when competing. Some barrels seem to have a larger accuracy window than others, but I tend to stick to the same cleaning routine just to be on the safe side.

Position Shooters

(Prone, 3-Position, & Silhouette)

Position shooters have a bit of a tricky situation to deal with. In some events, the competitor is shooting hundreds of rounds before they have a chance to clean their barrel, and like other old habits which die hard, many traditional prone shooters are reluctant to ever clean their barrel.

Eric Uptagrafft, 2x Olympian, cleans after every practice session.

This may have been a trend in years past, but just about every top prone shooter cleans their rifle. At the AMU, it's about 100% who clean their prone rifle often. What is interesting is that while Olympian Eric Uptagrafft cleans his rifle with bronze brushes, cleaning rods, and solvent, and it seems to not keep him from shooting a 628.1 and 632.2 (new final qualification record). I asked Eric if there are any shooters at his level who don't clean, and his answer was simply; *"No." "Well, those who place top three and win with any consistency clean their rifles. I don't know what last place does, and for*

obvious reasons I don't particularly care."

Now cleaning in the middle of an event does have problems, and this is because of a concern that on the next relay, cleaning their barrel will have changed the accuracy and initial point of impact of the rifle enough to ruin their score with a single shot, and running 10 or 20 rounds down the barrel to re-foul may not be possible or allowed by rules.

This is where knowing just how large your accuracy window is plays a critical role. From testing and practice, you should have nailed this accuracy range down pretty well, and if your event does not span that range in terms of round count, then my best advice is to not clean the barrel during the event. The risk of landing a poor shot on a target or completely missing a Silhouette animal is not worth the slight gain in accuracy. A one-inch error in shot placement at 50 yards is not worth the risk.

If there is a chance to clean and re-foul the barrel at one of these events, then follow the process described in the Benchrest section of the essay. Do not completely clean the bore down to bare metal. I have shot in some prone events which allowed for shots on a sighter target at the start of each relay, and these make cleaning the barrel and re-fouling possible.

Same goes for 3-Position shooters. If there is an opportunity to clean your barrel between positions, if you expect your round count to push past your accuracy window, and if you have a chance to take a few fouling shots on a sighter target, then you should do so. The top prone shooters are skilled enough to shoot the difference in accuracy between clean and dirty barrels, and it seems that first place is decided by a very slim margin. Don't leave things like accuracy to chance if you have the opportunity to maintain it.

As for the shooters who never clean their position rifles, unless you are nailing down the Olympic quota slots along with World Cup wins, you may want to reconsider that.

Smallbore Silhouette

For my silhouette rifles, I tend to not clean until the end of the day, regardless of how many rounds are fired in an event. Consider that you only have 40 to 80 rounds for score during a match (well within most accuracy windows), and there is no opportunity to establish a new layer of fouling down the bore, why bother with it? Again, there are no sighters once the match begins.

With the size of the targets in silhouette, a slight gain in accuracy of a clean barrel when compared to a dirty barrel with 80 rounds down the bore will more than likely never be difference as to if I miss a target or don't. Pointing the gun in the wrong spot when I pull the trigger is what causes me to miss a target in silhouette.

If you follow the same process as I do, where you don't put dirty guns away at the end of the day and you don't let a black ring to develop the chamber, you'll more than likely be able to shoot a few hundred rounds before you start to suffer from accuracy problems in a position rifle.

Semi-Automatic .22lr Rifles

Unlike bolt-action rifles, the semi-automatic rifle requires attention to both the barrel and the action for proper function and accuracy.

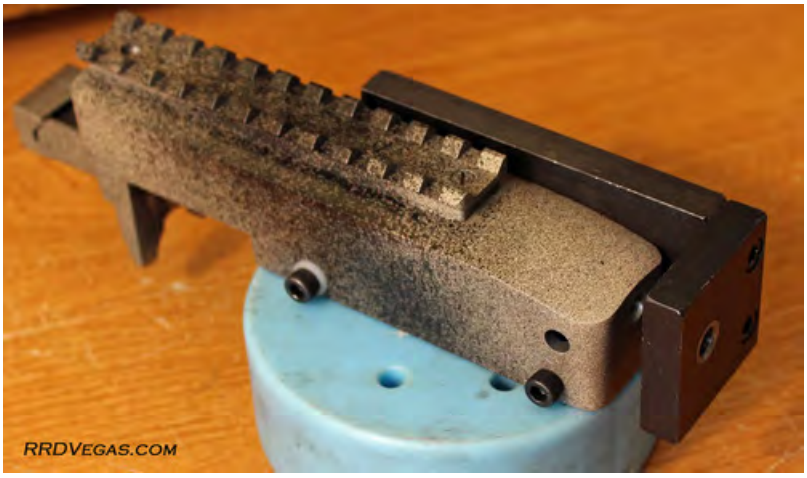
As a quick review, the functioning process semi-auto rimfire rifles use a cycling system known as: "blow-back." This is where a small amount of energy from

the combustion process of burning powder, which launches the bullet, to push the bolt rearwards and eject the spent casing and then load a new one.

There is a balance between the weight of the bolt, the strength of the recoil spring, and the energy of the expanding gases in the chamber and barrel. When everything is nice and clean, the system works great. Once fouling begins to build up in the barrel and action, problems surface.

Tactical Solutions X-Ring

These accuracy problems can be buildup of fouling in the chamber and barrel, as we have already discussed, as well as fouling building up in the action and bolt. We will first start by addressing the barrel and receiver cleaning process and then turn our attention to the bolt assembly.



Receiver Drilling Jig

What I find frustrating with many semi-auto platforms is that there is no easy way to access the barrel from the rear of the action. Rifles like the Ruger 10/22 and others use a large bolt that requires the rifle to be taken apart to remove.

Further, the rear of the receiver is solid without any way to access the barrel even when the bolt and trigger group is removed. This is why the bore snake is so popular for these rifles.

For those of you who want to use a cleaning rod on your semi-auto, you have to drill a hole into the rear of the receiver to gain access.

There are a few ways to do this, but the best is to use the receiver drilling jig from Brownells. It's a simple tool to use, and screws into the action through the existing trigger group holes and lines up your drill in the right spot to create an access hole.

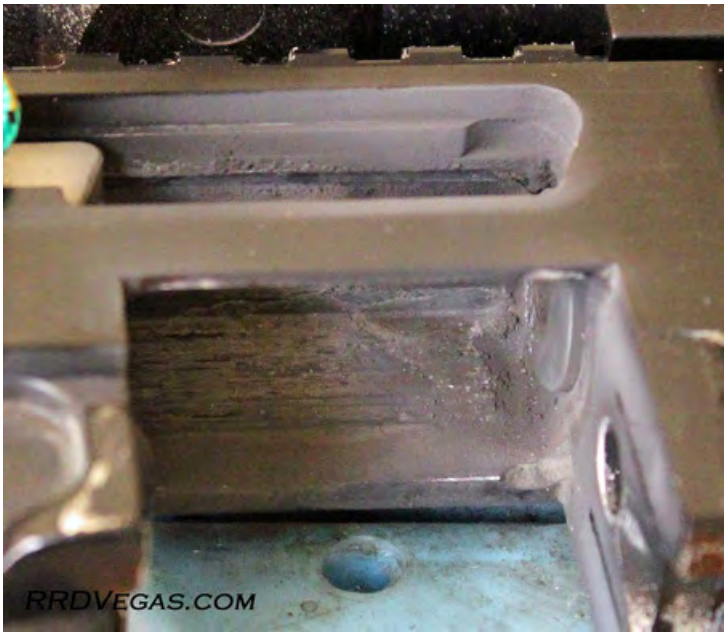
Once the access hole is drilled, you can now leave the barrel attached to the receiver and clean the action from the rear as you would a traditional rifle.

Some custom actions like the Tactical Solutions X-Ring actually come with this hole already machined as a standard feature. They use a decorative plug to keep dirt and dust from getting into the receiver, and to give the action a more finished look.

Like the original Ruger design, these custom actions still incorporate a recoil buffer pin of some kind which prevents the bolt from impacting the rear of the action. Most modern buffers are made from a softer polymer rather than the steel pin that Ruger uses.

This not only protects the receiver from the pointing forced of the bolt striking the steel cross buffer pin, but also makes the rifle noticeably quieter.

X-Ring Rear Access Port



X-Ring Receiver After 2000 Rounds

The cleaning procedure for the semi-auto barrel is actually similar to the sporting rifle, with a bit more work needed to clean the action. Actually, it takes a lot more work to clean the action.

Rimfire ammunitions foul terribly in semi-autos, and this is due to the hot combustion gasses following the empty cases out of the chamber when the rifle cycles.

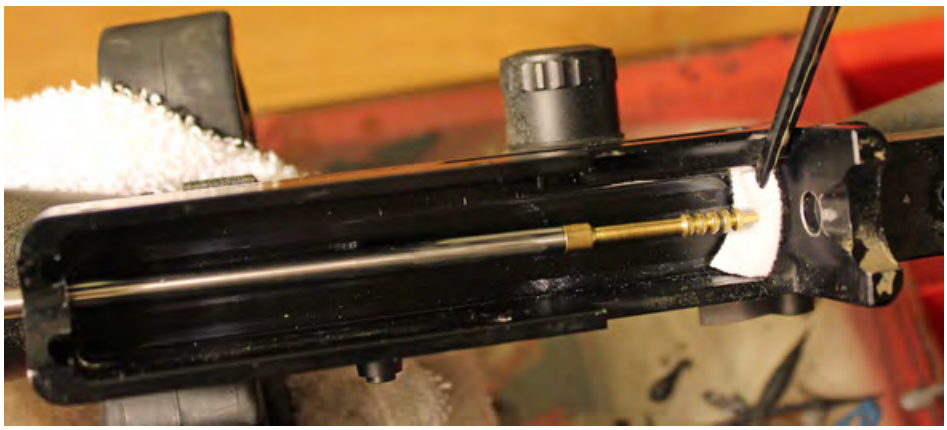
These hot gases are loaded with carbon, wax lubrication, and small bits of lead, and do an excellent job of coating the inside of the action with a sticky, gritty kind of fouling which builds up surprisingly fast.

Once you have the bolt removed, the first thing you need to do is clean all of this receiver fouling away, or you will just end up dragging it into the barrel when you run patches down the bore.

I use a large set of tweezers with some soaked patches in solvent and mop out the bottom and sides of the receiver. This take a number of patches and some scrubbing from a tooth brush.

Don't forget to completely clean off the breech face as well. The bolt has pounded the fouling against the face and it will take some time to remove this. I also use a small flat-head screws driver to dig out any heavy fouling from the extractor groove. The fouling get packed in there and it may take a bit of prying to loosen all the debris.

Because you're running a rod from the rear of the receiver through a small hole, and then spanning the gap between the end of the receiver and breech face, it would be nice to have a rod guide to help keep things running straight.



Unfortunately, since there really is no rod guide available at this point, you have to be careful and not press the cleaning rod hard against the rear access hole in the receiver. This can scratch the coating on the rod.

The access hole does a fair job in keeping the cleaning rod in alignment with the bore, it not to the same effect as a proper rod guide.

Unlike the bolt-action rifle where you place the patch on the jag and then soak the patch with solvent, you actually want to run the cleaning rod through the access port and then apply the patch and solvent. The reason why is that when you jam the soaked patch through the small access hole in the rear receiver, you squeeze off most of the solvent or cleaning paste as you pass through that hole.

I use a set of self-closing tweezers to hold the patch in place near the breech face and I guide the rod through the hole, pierce the patch, and remove the tweezers. Then I carefully run the rod for the length of the barrel. It's a bit of a chore, but it keeps the work bench from becoming a complete mess.

I also follow the same process when using a nylon brush. I apply the solvent to the brush once the brush is inside the receiver past the access hole. If you apply solvent to your brush first and then run it through the access hole, most of your solvent will end up splattered across the rear receiver and not much will be left of the brush.

To deal with the pool of solvent that will begin to grow inside the receiver, I keep a small piece of cloth or a few patches tucked up underneath the breech face where it pokes into the receiver. If you don't keep this pool of solvent from sitting in the receiver, it can creep in the screw holes for your scope base or even work around the barrel shank loosening the fit to the action.

Because semi-autos tend to consume more ammo per range session than a manually operated rifle, it also grows the black ring in the chamber at a much quicker rate. Without question I short stroke all the chambers on my semi-auto rifles with JB bore paste. As described in the Sporting Rifle section, JB bore paste is a great way to clean the chamber and remove any buildup in the chamber or leade angle.

Once the chamber is cleaned, I finish the rifle with more wet and dry patches. With the receiver and barrel ready to go, I take some time and clean out the bolt of the rifle, including the firing pin and channel, as well as the bolt face and extractor slot. The rifle can then be reassembled with a few drops of light weight oil where needed, depending on the action design.

The 17's

Bolt-Action .17 Caliber Rifles

If there is a rimfire that requires a delicate touch when cleaning, it would be the 0.17" caliber rifles. More people have bent cleaning rods and gotten jags stuck in a barrel with this caliber than any other caliber I know of.

The smaller bore diameter can be trick for some shooters to deal with, but with a little more attention to detail, it should be no more difficult to clean and maintain than any other rimfire caliber.

When it comes to 0.17" caliber barrels, I have spent quite a bit of time shooting them in the field over the past few years. Currently I have five rifles and maybe an additional three barrels chambered between the 17 HMR and 17 Mach 2, and when I head out into the field on a varmint hunting trip, I always have at least one with me.

This past year I shot a little more than 3,000 rounds of 17 HMR and nearly 7,000 rounds of 17 Mach 2, and after every trip to the range or out in the rifle, I cleaned the rifle.

The following discussion is based upon my experience cleaning these barrels, not only from a precision and accuracy point of view, but from a high-volume shooter's point of view as well.

While I'm not an advocate of pull-though bore cleaners, this may be one application where a heavy-handed shooter would better off using a pull-through system versus a rod.

Since we have already discussed the different types of pull-through cleaning systems and how they work, I won't go into the detail about the pro's and con's, so if you're more comfortable with one of those in this situation, then by all means use it.

Just know there are shooters who have broken off various pull-though cleaners inside the barrel of a 0.17" caliber rifle and ended up with a real serious problem on their hands. Even with a bore snake or cable system, you still need to use a bit more care with the 0.17" caliber bores.

17 HMR Casings

Patch size is a critical detail with these guns, and generally speaking, oversized patches are the most common cause of

Proper patch size (Left) for cleaning the 0.17" bore.

bent rods and patches becoming stuck in the bore.

It's important to not use the same patches to clean your 0.22" caliber rifle with; these are too large. You should use the 0.75" to 1.0" patches and nothing larger. I find the 0.75" patches to be the best.

A patch any larger will cause the cleaning rod to bow and rub against the lands as you push it down the bore. This will happen even with a rod guide in place, so the correct patch size is a must.

Because of the thinner cross section of the rod, it is much more prone to flexing than a thicker rod of the same length.

Like before, I start by cleaning the receiver and making sure that I'm not dragging more grit from the receiver into the barrel. Once that's done, I install the bore guide and take my properly sized 0.17" caliber rod and matched jag, completely soak a ¾" inch cleaning patch and carefully run it through the bore.

You may even want to slightly stab this patch off center if your barrel is extremely dirty. This will help ease it down the bore. For guns that I've been hunting with all day, I actually run a little bit of solvent down the barrel itself. I do this by holding the rifle pointed down with the muzzle sitting on a soft cotton cloth and with a little oil dripper I drop a bit of Kroil into the chamber, letting it run down the inside of the barrel. This will help lubricate the wet patch is it passes through the barrel.

With that first wet patch, it will tend to grab a lot as it passes through the barrel. There is not much room for the patch to squeak by. If you find the patch grabbing to the point where it feels as if it will get stuck, or if you have to use more force to push the rod though than you are used to, stop what you're doing leave everything in place.

Carefully tip the rifle muzzle-up towards the roof and drop a bit of solvent down from the muzzle into the barrel. This may help loosen up any fouling around the patch and add additional lubrication. Be liberal with the amount of solvent that you put in the bore because some of it will be absorbed from the fouling in the barrel. The goal is to help loosen the fouling around the patch and let you continue on.

No matter what, do not pound on the cleaning rod to get it down the barrel. I have seen this done at the range and it makes me crazy. Take your time and really soak the patch; it will come loose at some point. Taking time to do that is both cheaper and faster than replacing the barrel.

At this point you should be able to continue pushing the patch out the barrel. Once the first patch is through, the rest are much easier; it's the first patch that tends give you the most trouble. I follow that first patch with about ten more soaked patches, working at getting the barrel completely coated with solvent and removing as much loose fouling out of the bore as possible.

Once I feel the barrel is well soaked in solvent and the patches are starting come out clean, I switch to a different rod fitted with a 0.17" caliber nylon brush.

I dip the brush into a jar solvent, soaking all of the bristles, and I gently run it through the rod guide and into the bore. I feel that most nylon brushes for rifles are a bit too long; I prefer the shorter pistol-length brushes. That said, I still use the longer rifle brushes from time to time. It just seems that the rifles brushes are more prone to bending.

With the brush loaded with solvent, I work it back and forth a number of times, adding more solvent on each pass. The bristles are short and there's not much area to hold solvent, so to keep the cleaning process going I keep reapplying solvent.

0.17" Caliber Nylon Brush

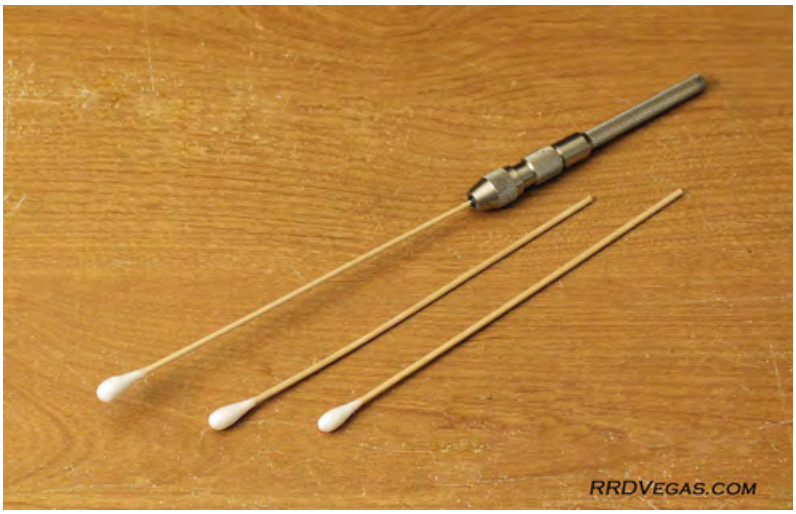
After ten passes, I switch back to the first rod and run a number of soaked patches down the bore. Once those patches start coming out clean, I carefully run a few dry patches down the bore. If they start to stick on any remaining fouling in the bore, I switch back to the nylon bush and give it an additional ten passes. You should build a run a dry patch down a clean 0.17" caliber barrel without it getting stuck or grabbing on the sides of the bore.

From time to time I hear a question about whether 0.17" caliber rimfire loadings foul the barrel with copper like a centerfire. I have checked this on a few different barrels, and every now and then I have a little blue coloration on a patch when patching the bore with a strong copper solvent. It is nothing like the amount of coloring when cleaning a centerfire, so don't expect to

I test out all new 0.17" caliber barrels when I first get them, and about one out of five will have this characteristic. If I do find one that has a bit of copper fouling, I follow a basic process to remove the copper.

To do this, I take a few patches and I soak them in a strong copper solvent and I run those down the board and let it sit for about 10 minutes. I follow that with a few more wet patches of the same copper solvent, looking to see if I get any traces on the patch (these are blue stains on the patch).

If I do find copper, it tends to be very light and a few more solvent patches seem to get rid of most of it. If I'm still getting blue coloring on the patch after a number of passes, I switch over to nylon brush soaked in copper solvent and make about ten passes. Then I repeat the process with more wet patches of the copper solvent followed by the dry patches looking to see where you're at by now you should have no blue streaks on your patches. As the barrel ages and breaks in, these traces of copper should no longer accumulate.



6" Cotton Swabs

Now what to do about the chamber..?

Because the 0.17" caliber rimfire rounds all use copper-jacketed bullets, you don't get a lead ring around the chamber, but you still get a carbon ring built up in the throat.

The upside is that it's not a sticky mess like the Black Ring is, and it's much easier to remove.

Because we are still dealing with the small 0.17" caliber bore, it's not really easy to short stroke lead angle and there are no VFG pellets that small.

You can try to wrap a patch around a worn-out brush or an undersized jag, but the problem is that unless you wrap the patch very tight, you won't be able to fit it into past the shoulder in the chamber.

I have given this problem a lot of thought and found a very simple and low-tech solution to get this knocked out perfectly. I found

these cotton swabs amongst the pages of Brownell's in the cleaning section, and they are fitted with a six-inch long wooden handle.

They sort of a pain to hold onto with the end of your fingertips, so I insert the end of the wooden handle into a Starrett 240-C pin vice. This provides a good grip on the little wooden handle and gives me the reach to go through the receiver and all into the chamber. You could use any kind of small pin or needle holding device, but I'm a tool-nut so I use a Starrett pin vice.

With the cotton swab held firmly in the pin vice, I roll the soft cotton head in JB bore paste and use these to clean my chamber, throat, and lead angle of the barrel.

You can easily reach into the receiver and have plenty of room to short-stroke the chamber and lead angle with the JB bore paste. This does a great job of removing the carbon fouling in the throat and first inch of the barrel. It takes about two or three of these long cotton swabs to remove the carbon fouling, and then I follow that up with a final cotton swab soaked in solvent. At this point I install the rod guide and run a couple of wet patches followed by couple of dry patches down the bore. I keep working until the patches come out clean.

There's a lot involved in cleaning the 0.17" caliber, well at least if you want to do it the right way, and it takes a bit more patience, but I don't consider it worthwhile to shortcut this process considering all the time spent driving out to our hunting spots and the cost of ammunition.

Once I feel the barrel is clean, I finish cleaning up by running a few lightly oiled patches down the bore followed by a few dry patches. It's very important to not leave anything but a very, very light coating of oil in the bore. Error on the side of too little oil versus too much.

Copper Jacket (l), Copper Plated (r)

Bolt-Action .22 WMR and 5mm Remington

When it comes to cleaning these two rifle calibers, you can use nearly the same approach as you do with the 0.17" caliber rimfires.

There are some subtle differences, most of them being in the shooter's favor in that the bore is larger in diameter and you're much less prone to bending a cleaning rod.

You do not need any equipment different for these two calibers than you already have for the .22lr, but you still need to use a rod guide and it doesn't hurt to check the barrel for copper fouling on occasion.

Typically it is uncommon with these rounds but from time to time you'll find a barrel that just seems to develop a little bit of copper fouling. I think in all my time with these two calibers, I've seen two barrels chambered in .22 WMR that develop any kind of copper fouling.

One thing that is important to consider is that unlike the 0.17" caliber rimfires, not all .22 WMR bullets are copper jacketed. Some of the lower priced .22 WMR ammunition is actually copper-plated lead bullets like the .22lr. To clean for this type of ammunition, you can follow the identical process that you would use for the .22lr, discussed in the Sporting Rifle section.

The 5 mm is just the same but you need use a slightly smaller jag and cleaning rod. I suggest using 0.17" caliber equipment to clean a 5 mm, especially if you already have a 0.17" caliber rifle in your collection.

Sight Extension Tubes & Tuners

Sight extension tubes and tuners need to be cleaned on occasion as well. While they do collect a lot of carbon fouling, there is very little if any lead present on the inside of these devices.

That does not mean they are any easier to clean, but rather they take a strong carbon solvent to dissolve the baked-on layers of fouling.

For obvious reasons, if you wipe down the inside of the tube after every range session, they're pretty easy to keep clean. But most of us, including myself, rarely take the time to clean them on a regular basis.

Since the bullet (ideally) never makes contact with the tube, there really is no change in accuracy of the rifle between a dirty and clean tube.

Now if the inside diameter of the tube is narrow, the fouling can actually collect to the point where the bullet will strike the fouling in the tube as it passes though. I have actually seen this years ago on an old Time Precision tuner. The owner had never cleaned the inside of the tuner since he purchased the rifle, and all of a sudden the accuracy really dropped off. Upon inspection I found the tuner almost completely full of fouling. I had never seen anything like that before or since.

There is also the possibility that if enough fouling builds in the tuner, it can begin to add weight to the unit and change the harmonic tune of the barrel. It would take a long time for this to happen, but I guess it could.

One of the challenges in cleaning some of these devices is that they are surprisingly long, with a few measuring 14" in total length. For longer tuners and tubes, you need some kind of device to help you reach down inside with some solvent and a patch.

You can use a short cleaning rod with a large pistol brush and a small cloth wrapped around it, or a specialized device like this aluminum rod in the photo. The knurled ends hold the patch surprisingly well.

Whichever tool you choose to use, the key is to get enough solvent on the patch to really soak into the carbon fouling in the tube. The fouling will absorb quite a bit of solvent before it can penetrate down to the bottom and loosen it from the tube walls. My advice it is clean these tubes as often as you can remember, and it will save you time in the long run.

As a side note to this, Eric Uptagrafft uses a 12 gauge shotgun boresnake to clean his sight extension / tuner. He uses after every event and it keeps the tuner from building up and debris. I am going to give this a try myself this season.

Closing Thoughts...

At this point, I think I have pretty well beaten this topic to death. There are a few small items that may get added from time to time, but at this point I'm not sure there is much more to say about cleaning.

I appreciate everyone who took the time to read through all the information. Many thanks. Now I'm off to go clean a barrel.

s.

10 months of rimfire casings saved...

Legal Stuff

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