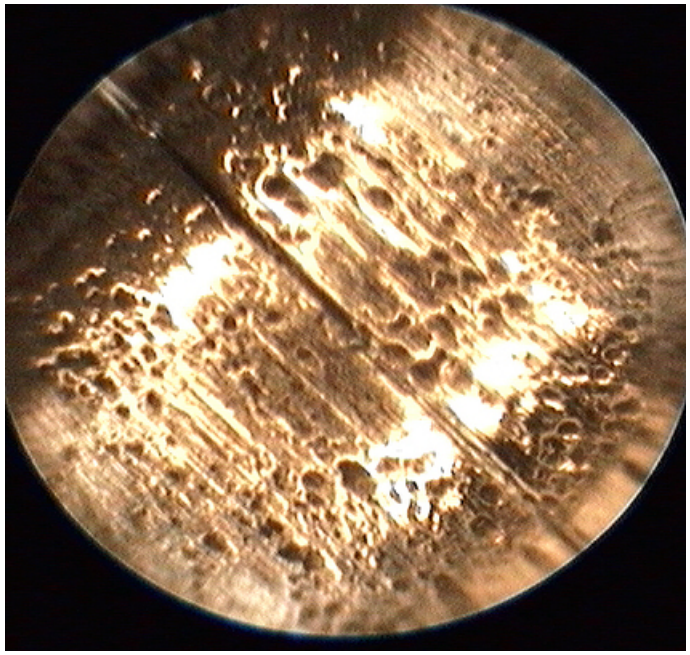
abrasive effect of the primer material. Further, I feel it's the hazed area which allows various chemicals to take hold, much like a cavity in a tooth.

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.

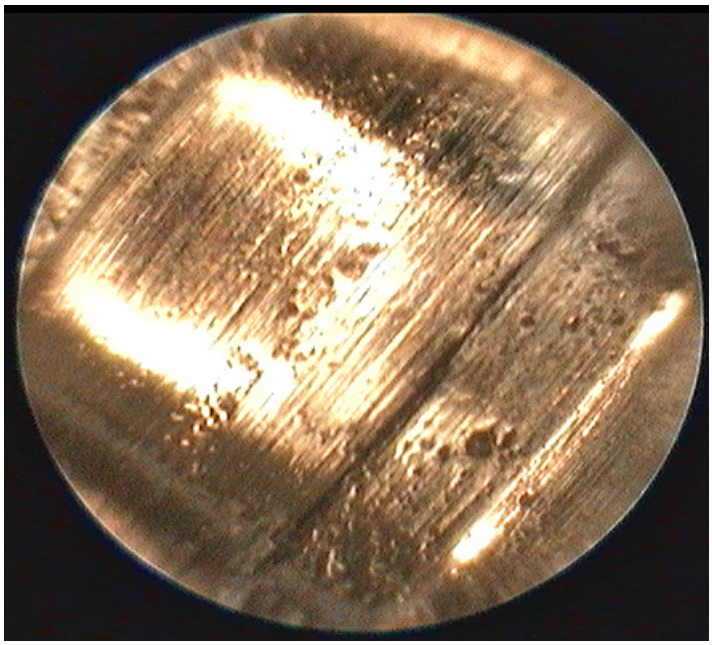
It's full of smoke from the combustion gases with a small amount of water vapor, and if you sit there and let it cool long enough, the smoke it will eventually disperse, but as the temperature drops, guess what comes back out of vapor? Liquid water.

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.

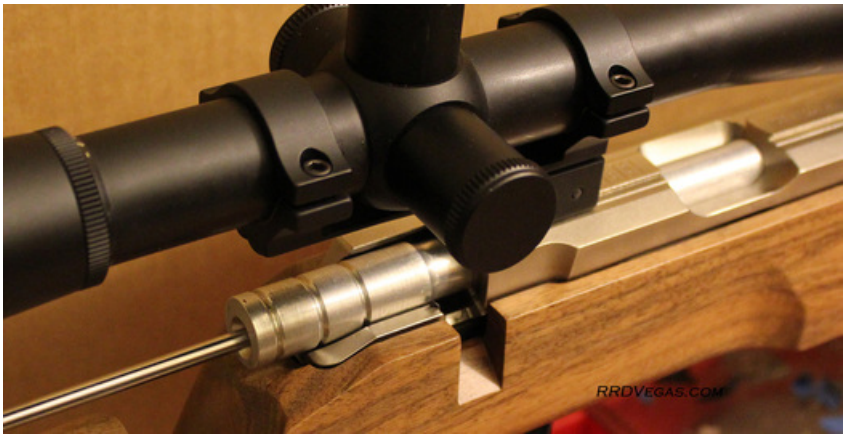
For years I, like many others, have mistakenly used the term "bore guide" for this piece of equipment.

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.