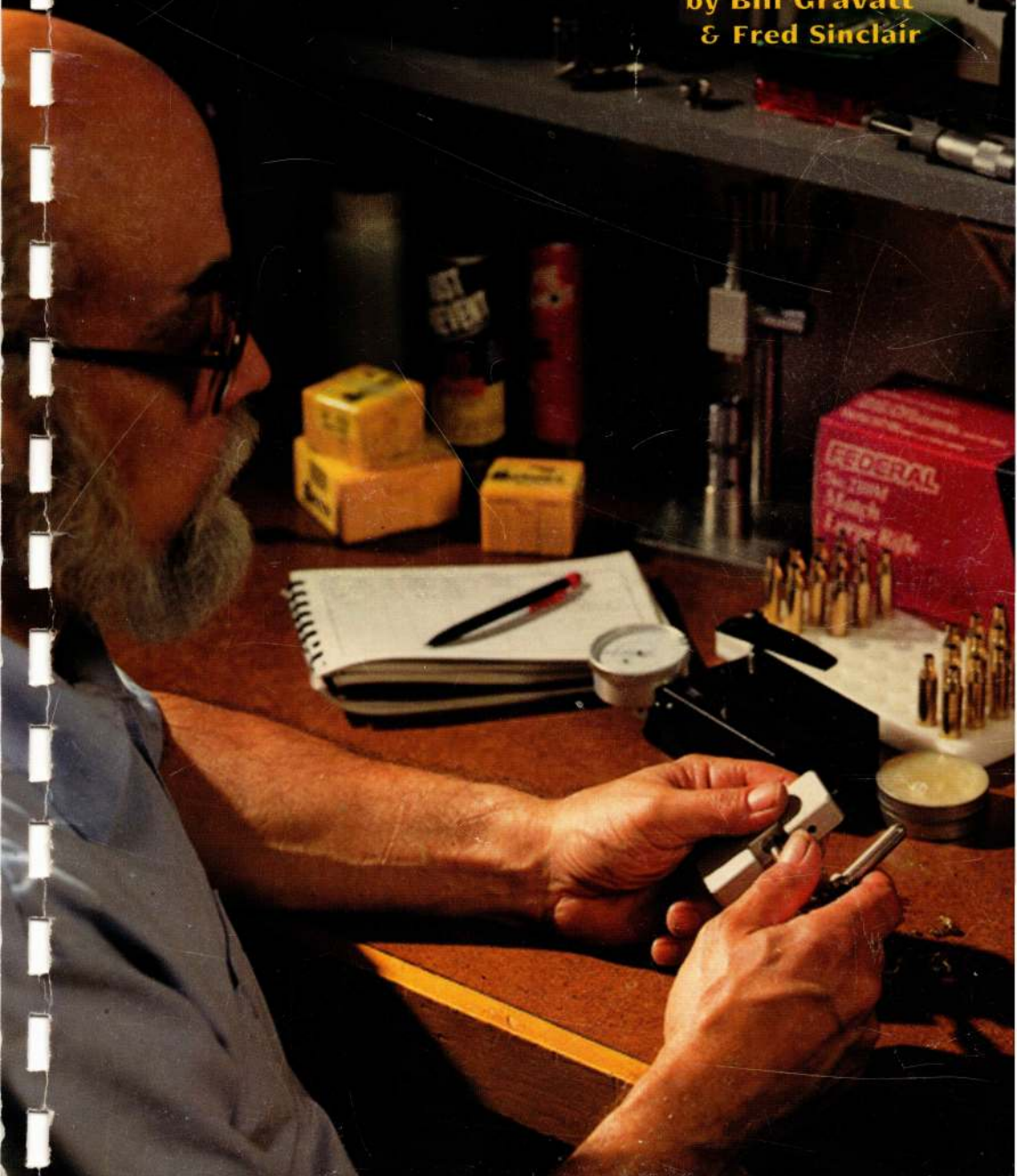
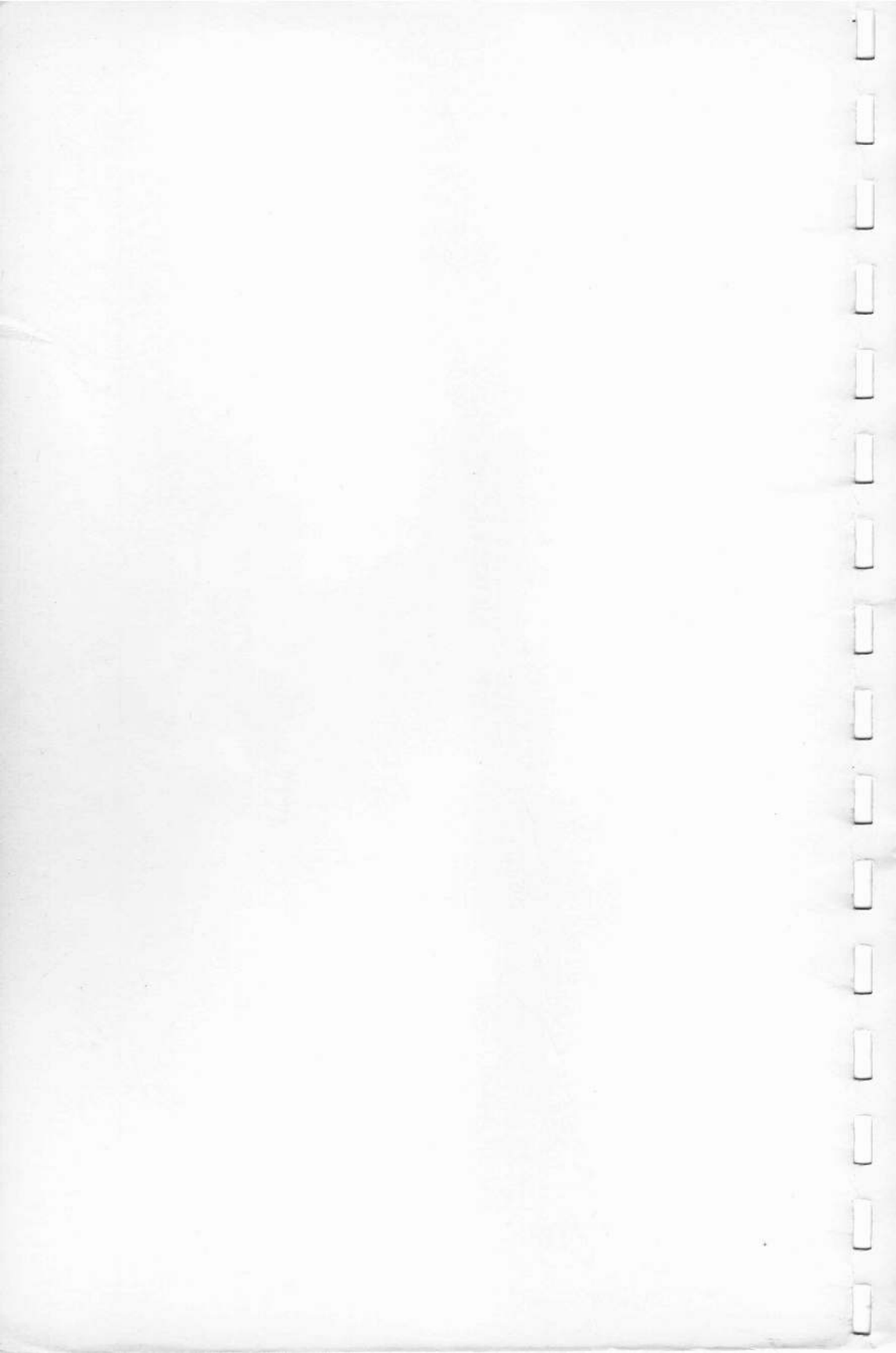


Sinclair International's **Precision Reloading & Shooting Handbook**

- 10th Edition -

by Bill Gravatt
& Fred Sinclair





Sinclair International's
Precision Reloading & Shooting Handbook

A handbook on how to develop extremely accurate
reloads for your rifle and how to shoot them.

By

**William D. Gravatt
and
Fred R. Sinclair**

10TH EDITION

REVISED AND ENHANCED

Acknowledgements

Special thanks to Cindy Gravatt, Steve Theye, and Geoff Esterline for their hard work in editing this manuscript. We are not professional writers, so believe us when we say that plenty of editing occurred.

Special thanks also to Laura Choka who coordinated the layout, design and data entry of this project.

Front Cover Photography: Jeff Bell Photography, Inc.

Back Cover: Fred Sinclair photo by Jeff Bell Photography, Inc.

Bill Gravatt photo by Don Ballasch (fellow benchrest/highpower shooter)

All other photographs were taken by the authors and fellow Sinclair International employees unless otherwise indicated.

Cover Design: Laura Choka - Sinclair International, Inc

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10th Edition
Published by Sinclair International, Inc. 1999

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Introduction

As we rapidly approach the close of the twentieth century, I am amazed at what changes there have been in handloading over the last hundred years or so. But I also ask myself how great have the changes been? In my own gun safe sits a 96 Model Swedish Mauser built in 1898, according to the date stamped into the receiver. I can go down to the local gun shop or call my distributor and still order ready made ammunition. The components are basically the same: the same powder container (brass cartridge), the same ignition system (boxer primer), the same type of propellant (smokeless powder), and the same projectile (a copper jacketed bullet). What has changed?

Well, let's start with the components. No where else in time has there been the widespread selection of components that today's handloader (you) can choose from for your firearm. There are more bullets to choose from ranging from custom bullets to mass produced bullets. There are more powders available; single based, double based, "high energy", ball, extruded, etc. The case selection is greater also. You can select match cases from Norma, Lapua, IMI, Federal, Hirtenberger, etc., or select standard cases from manufacturers such as Remington or Winchester. Primers are available in match grades, standard grades, magnums, benchrest etc. The selection is greater, and for the most part, the manufacturing process has improved so the products are better. There are a wider variety of reloading tools available. Precise machining methods have resulted in a plethora of accuracy-minded reloading tools. But the requirements are still basically the same as they were at the end of the 19th century. Accurate reloading requires extensive and methodical case preparation along with careful testing of reloads to find out what works best for your firearm. What this book attempts to do is to break down the steps involved in precise handloading, and to outline some of the accuracy enhancing procedures you can use in your handloading.

We've based this book on our own reloading experiences. But since we are in the business of precision reloading, we have the luxury of being exposed to thousands of customers who have shared with us their reloading experiences.

Our handbook is not "just for benchrest shooters". Basically all levels of handloading for accuracy are covered in this book, and you can apply it to what best fits your shooting needs. Fred and I have written in our own words, so if you notice some "bad English" now and then, please excuse us. Now let's get to it.

Bill Gravatt
New Haven, Indiana

Safety

Stop and think for a minute and try to remember if you have ever read a good book about reloading or shooting and not seen a word about safety. There is good reason for this and we are not going to start a new tradition by ignoring it.

Everyone reads about safety and always think the writers are preaching to the other guy they have seen at the range or in the field. The writers are preaching to all of us. If anyone out there has not done something a little unsafe at one time or the other, whether by accident, fatigue, forgetfulness, or by design, then we would like to meet them.

We feel every book on shooting or reloading should be required to print the Ten Commandments of Firearms Safety as we have done below. Please re-read them once in awhile, make sure you are following all of them, and try to educate someone else about them during the course of your lifetime.

The Ten Commandments of Firearm Safety

- 1) Treat every gun as if it was a loaded gun.
- 2) Always be sure of your target before you pull the trigger.
- 3) Always be sure the barrel and action are clear of obstructions.
- 4) Never point your gun at anything that you do not want to shoot.
- 5) Never leave your gun unattended unless you unload it first.
- 6) Avoid alcoholic beverages both before and during shooting.
- 7) Never climb a tree or cross a fence with a loaded gun.
- 8) Never shoot at a hard, flat surface or the surface of water. Always make sure you have a safe backstop.
- 9) Carry only empty guns, taken down or with the action open, into your camp, car, or home.
- 10) Store guns and ammunition separately under lock and key.

We have come up with some commandments of our own, but designed for reloading:

Sinclair Rules for Reloading Safety

- 1) Store your reloading supplies in safe places away from children and away from sources of ignition.
- 2) Use reloading manuals when beginning to reload for a new cartridge. **START LOW WITH POWDER LOADS AND WORK YOUR WAY UP SLOWLY WHILE WATCHING FOR WARNING SIGNS OF PRESSURE OR CASE FATIGUE.** Refer back to these manuals from time to time.
- 3) Try to locate your reloading activity in a place where you will be undisturbed. If you get interrupted, put your loads away and come back later when you can continue, uninterrupted. Reloading is a safe sport when a person keeps their mind on the task at hand.
- 4) Do not mix powders.
- 5) Do not mix cartridges from one rifle with another, even if they are the same cartridge. Learn about headspace.
- 6) Check cases frequently. Look for signs of metal fatigue, split necks, case head separation, etc.
- 7) If reloading military brass, be aware that case capacity is usually lower and initial loads should be at least 10-15% lower than published data.

Chapter 1

Getting Set Up To Load

It's hard to prepare accurate reloads without the right equipment and the right surroundings. In this chapter, we intend to focus on your loading location, whether it is at home or in the field. Most reloading activities take place in the home at a workbench, in the garage, basement, attic or even at the kitchen table. We will discuss reloading in the field later, so for now, let's primarily focus on reloading at home.

Loading at home

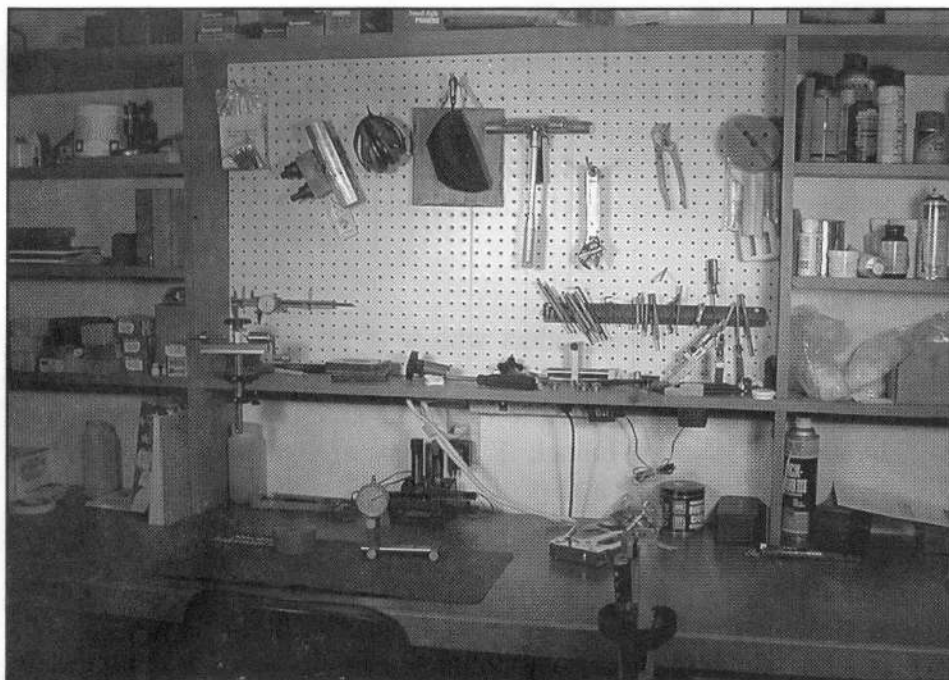
We have talked to handloaders who load in very tight surroundings where they are limited in space. We also have a customer who has a 600 square foot laboratory dedicated to reloading and gun maintenance along with an attached shooting tunnel. Regardless of your own situation, let's talk about some basics for a reloading area and some "nice to have" features.

The number one priority on your list should be to choose a location for your reloading where you can work undisturbed. Reloading, especially precision reloading, requires your complete and undivided attention to the task at hand. It's fine to sit in front of the TV and do some case preparation chores, but when you are actually loading (handling powder or primers) try to give it your utmost attention. This is why a corner of your basement or garage is a pretty good location.

The second basic priority is to have as much lighting as possible. A swing arm lamp with a fluorescent bulb is a fairly inexpensive investment and can provide a good secondary source of lighting. Make sure you also have access to an outlet. A lot of case preparations can be done under power and still be performed accurately. This is important to some of the high volume shooters such as high power shooters, varmint hunters and silhouette shooters.

Your next priority is a solid reloading bench. The general rule of thumb is to make it as thick and as sturdy as possible. It doesn't have to be a big work area, but you need to fasten it to the floor if possible or, at a mini-

mum, secure it to the walls. By eliminating bench movement we have eliminated another variable in our reloading equation. Make your bench as comfortable as you can. If you are serious about your hobby you will end up spending countless hours loading and trying new things. If you can make your bench at least 5 feet wide you will have plenty of room. Make sure it is at a comfortable height for you. One of our benches is 38" high which enables us to use it standing or sitting on a standard 24" stool.



One of our loading benches

Pre-built work benches are available almost anywhere, including home centers, hardware stores, etc. Be careful of these ready made benches, as some of them can be quite shaky and would not be suitable for reloading unless they are beefed up considerably.

When you have located your reloading bench in the right spot, surround yourself with as much pegboard and sturdy shelving as you can. Prior to bolting any equipment in place, you may want to clamp your big tools down for a short time until you can get a feel of where to put everything.

Loading in the Field

We probably do at least 50% of our reloading in the field. If you are loading in the field, try different loads to see what works best. If something shows promise, you can pursue it right then and there instead of going back home and returning at a later date.

To start with, you need to build up a kit for reloading in the field. Get a good 2 or 3 drawer tool chest for a very basic but functional box to store your tools and dies in. If you are handy with tools, you may want to build one that fits your needs perfectly. We have seen a lot of interesting boxes over the years. Also, consider having a separate box to transport your cases, primers, bullets and powder. Some people store their dies in their component box so they can have one box for common tools and one box for specific items for a certain gun.

Your tool selection will vary depending on how in-depth your reloading will get. Some shooters take prepared and primed cases to the field so all they need are tools for dispensing powder and bullet seating. Try to keep your gear to a minimum, as it can become heavy. Some items to consider besides the tools



Reloading Tool Chests

you use in your normal reloading routine would be: spare decapping pins, replacement punches, extra bushings, calipers, allen wrench set, screwdriver, logbook and a pen.

We suggest prepping your cases at home, including the primer, so you are ready to go when you get to the range. Then all you have to do is drop powder and seat the bullets. Make sure you have a solid powder stand for your measure and a way to mount the press.

We use a lot of the MTM small utility boxes to hold tools in. Drop in a piece of foam to keep things from rattling around. One last suggestion - keep a small checklist on or in your gear box to make sure you take every-

thing to the range that you will need. We would always forget something until we started doing this.

Checklist

- | | |
|-------------------------------------|---|
| <input type="checkbox"/> Targets | <input type="checkbox"/> Cleaning gear |
| <input type="checkbox"/> staple gun | <input type="checkbox"/> rods |
| <input type="checkbox"/> Brass | <input type="checkbox"/> patches |
| <input type="checkbox"/> primers | <input type="checkbox"/> solvents |
| <input type="checkbox"/> bullets | <input type="checkbox"/> brushes |
| <input type="checkbox"/> powder | <input type="checkbox"/> rod guides |
| <input type="checkbox"/> Rifle rest | <input type="checkbox"/> Reloading gear |
| <input type="checkbox"/> bags | <input type="checkbox"/> Rifle |
| <input type="checkbox"/> powder | <input type="checkbox"/> Bolt |
| | <input type="checkbox"/> Range Flags |

Chapter 2

Tools and Equipment

This chapter will cover the different tools that you may need for accuracy reloading. Not every tool or every brand of tool is covered since this is not a catalog or a reloading buyers guide. We will discuss tools that we are experienced in using and are quality built. If a tool is not mentioned, it does not mean it is necessarily a poor quality tool but, it might be one we don't have any experience with. We will sometimes emphasize the attributes that you should look for in a tool.

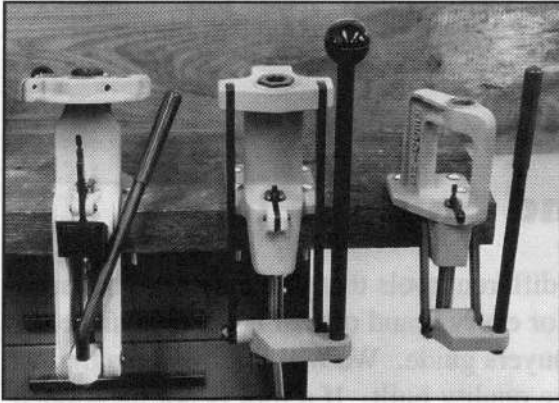
Make your tool selections carefully. Our biggest concern when helping people get started in reloading is that they buy good tools. We don't want them to buy a poorly designed tool or a cheaply made one. We have heard a lot of customers tell us how they bought a low quality tool when they started, and after actually using it a few times realized it wasn't what they wanted. The point is that you are making an investment in tools that hopefully will last you a lifetime. It doesn't matter if you buy Sinclair tools or someone else's - just buy good tools. Ask friends who reload to show you what they use, and what they like and don't like about their tools.

Reloading Presses (7/8" - 14)

The reloading press can be considered the foundation of your reloading activities. Everyone, even benchrest shooters, must own a good quality 7/8" - 14 reloading press. Carefully consider your current and future needs when selecting a press. Although we will primarily talk about single stage presses because they are the best for precision handloading, there are some high quality progressive presses out there that can produce some great ammunition (Dillon, Hornady, etc.).

Consider the size of the rounds that you are loading since the available throat opening in some presses cannot handle some of the bigger/longer cartridges particularly when you are seating bullets.

The Redding UltraMag, Forster Co-Ax, and RCBS Rockchucker are three good representatives of quality built reloading presses designed for home bench use. For medium weight to lightweight presses look at the



Redding Reloading Presses

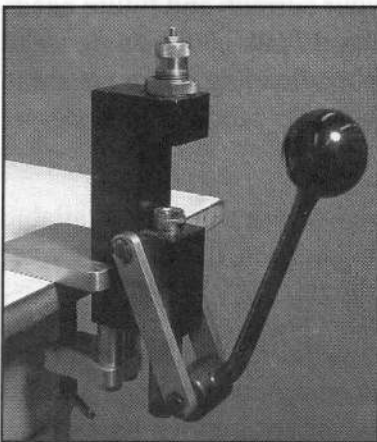
Redding Boss press and RCBS Partner press. These are presses that are light enough to carry to the field. The Partner press is one you will see most frequently at benchrest/varmint matches, but you are usually only dealing with short length PPC cases and BR cases.

The next category of presses would be the small custom presses such as a Harrell press or Ross press. These are small compact presses that usually have a very short throat and are used primarily for neck sizing or shoulder bumping. They have a built-in c-clamp for fastening to the benchtop. The throat on these presses usually limits their use on shorter cartridges (around 1.5" case length).

Choose a 7/8" - 14 press that is comfortable and easy to use as you will be pulling that lever arm a lot. A comfortable handle is great. The large round ball on the Redding UltraMag is extremely comfortable to operate. Definitely choose a press that has an insert in the casting for the dies to thread into.



Photo from Dillon Precision

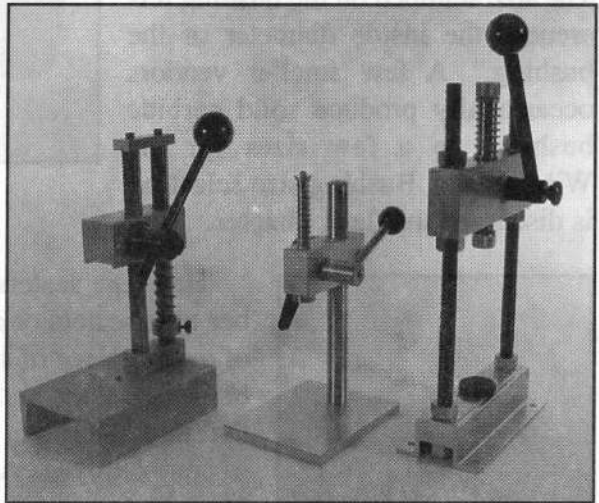


Harrell Press

Some lower quality presses have the threads cut right into the casting, so when the threads get damaged the actual press casting is damaged. The Forster Co-Ax press is one of the more interesting presses available because it uses a jaw system instead of shellholders to hold the cases, and the dies snap in place as opposed to threading in place. This press will not accept some of the larger micrometer seaters (Redding) since the handle will not clear the top of the die.

Arbor Presses

Arbor presses are used in reloading by reloaders using hand dies such as L. E. Wilson neck dies, seaters, and full length dies. If you are going to use hand dies we would strongly recommend that you do your full length resizing on your 7/8" - 14 press. Typical hand style full length dies can really overwork your brass and full length sizing is extremely hard work on an arbor press. These dies can only be adjusted by using shims and are not very practical. If you decide to use hand full length dies, you need to select a very strong arbor press such as a B-Square or Custom Products press. These presses will not handle the full length sizing of large cases. These are good presses but not very convenient for transporting and using in the field. Both of these also need to be c-clamped down. The arbor presses like the Sinclair, Bald Eagle and a host of similar presses are lightweight and more than strong enough to do neck sizing and bullet seating. These presses fit in your gear box easily and are very comfortable to use. Arbor presses have relatively very few moving parts and usually rely on a rack and gear to apply pressure on a case or seater plug. Purchase an arbor press that is easily adjustable in height for the different size dies you will use.



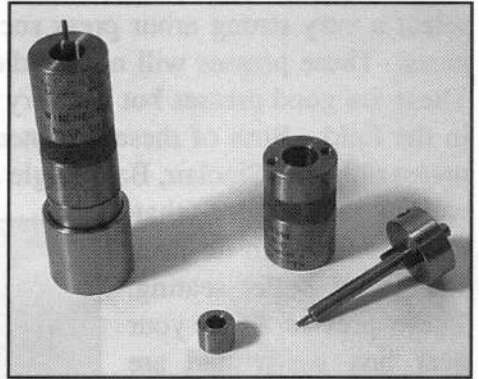
Arbor presses (left to right) Custom Products, Sinclair International, B-Square

Reloading Dies

There are two (2) basic types of reloading dies that we will discuss. There are hand dies which are used with an arbor press or leather mallet, (we don't recommend this method) and there are 7/8" - 14 threaded dies for use in single stage or progressive reloading presses.

Let's discuss hand dies first. Manufacturers of hand dies include L. E. Wilson, Custom Products, and a few small custom shops. Hand neck dies almost always use a removable bushing or insert that is selected based on the user's desired outside neck diameter. These neck dies size the case neck only and do not change the shoulder position at all. So, when your

rounds begin to feel tight in your rifle you will have to full length size the cases or shoulder bump them. Hand neck dies have a decapping rod/punch that is essentially the only moving part so they are an extremely accurate way to neck size. L. E. Wilson makes dies for most common cartridges. Their bushings measure 0.500" O.D. and are interchangeable with steel or titanium nitrite coated bushings made by Redding. Custom Products makes custom hand dies for almost any cartridge they have a reamer for. Custom Products makes slightly larger bushings than Redding or L.E. Wilson, and they are available in half thousandth increments. Redding and Wilson bushings are available in increments of 0.001". The size stamped on the bushing references the inside diameter of the bushing. A few smaller vendors occasionally produce solid carbide bushings in a few sizes for the Wilson dies. Bushing size selection is discussed in a later chapter.



*Wilson Neck Die, Die base,
(Neck die disassembled), Bushing*



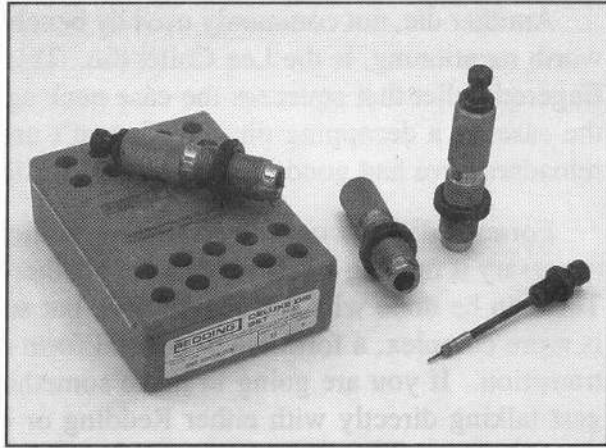
*Wilson Seater with Sinclair
Micrometer Top on left*

Hand die seaters are considered to be chamber type seaters or in line seaters. They consist of a solid piece of steel that is cut to near chamber dimensions and have a cap and seater plug that moves straight up and down while the case is completely captured in the die. The seater plug is machined to close tolerances and is adjustable in length for changing seating depth. A micrometer top made by Sinclair International can be added to Wilson dies as an aid in changing seating depths.

Hand style full length dies are not something we recommend for many reloaders because they are difficult to use and generally resize the brass too much. We suggest performing full length sizing on a threaded press. Full length sizing with hand dies requires an extremely strong arbor press or vise.

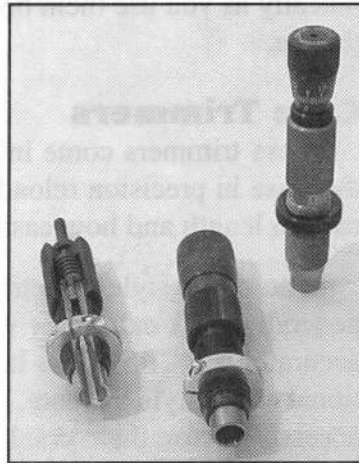
The 7/8" - 14 style dies are available through many manufacturers so we won't list them all here. There are traditional neck sizing dies, full length sizing dies, and basic seaters that are very simple to use. Most of

the sizing dies consist of the die body, a lock ring, and a decapping assembly with an expander button. The standard seaters consist of a die body, a lock ring, and a seating stem/plug. Some seaters have a built-in crimp ring, but benchrest type seaters usually do not. Almost every major die manufacturer has standard dies for the most popular cartridges.



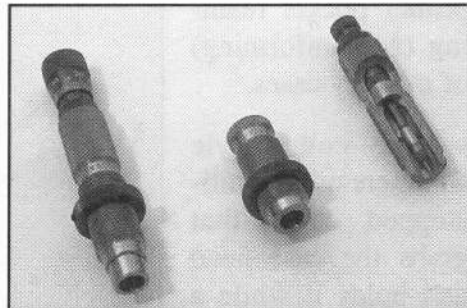
Standard 7/8" - 14 dies

Some die manufacturers have enhanced their seaters and sizers by incorporating a spring loaded sleeve in them that is machined slightly larger than chamber dimensions. These spring loaded sleeves capture the cartridge completely as it is raised on the press ram. At the top of the press stroke, the die completes the sizing operation or, more commonly, the seating operation. Forster (Bonanza) has been making seaters like this for years. Redding, RCBS, and a few others now make them. We consider the finest example of this type of die to be Redding's Competition seaters, which include a micrometer adjustable seating plug for adjusting seating depth.



*Competition Seaters (sliding sleeves)
Redding and Forster*

Redding, Hornady, and Custom Products all make bushing style neck sizing dies and full length dies. These are similar to the L. E. Wilson dies, only they are made to work in the 7/8" - 14 press. The full length sizing die that accepts bushings will neck size, bump the shoulder, and size the body.



*Redding Competition Neck Die, Body Die, and
Type S Neck Die (cutaway)*

Another die, not commonly used by benchrest shooters but unique and worth mentioning, is the Lee Collet die. This die sizes by using a multi-fingered collet that squeezes the case neck against a mandrel centered in the case by a decapping pin. We haven't used these in years, but some reloaders have had good luck with them while others have not.

Forming dies are made by a number of die manufacturers and are only necessary if making a cartridge out of another cartridge (parent cartridge). This can be done with full length dies, but sometimes when the forming is more complex, a form die or several form dies are needed to make the transition. If you are going to make something complex we would suggest talking directly with either Redding or RCBS to see what is really needed. Form dies can get expensive.

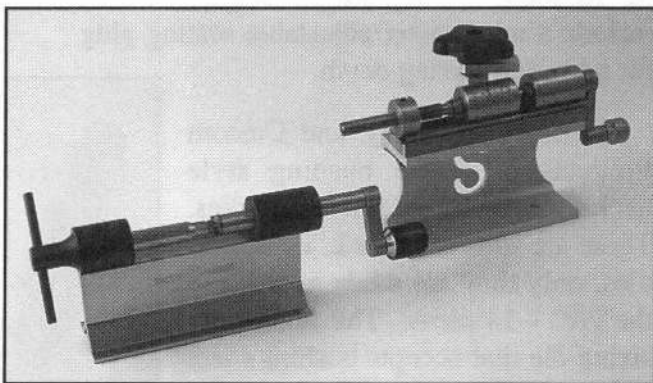
Choose well made dies that will last you a long time. It is imperative that you clean the dies when you first receive them, and clean them periodically as you use them because the cases carry a lot of grit and dirt into the die.

Case Trimmers

Case trimmers come in all flavors and colors. The basic true test of their use in precision reloading is how accurately can they squarely cut a case to length and how easily they can do the job.

The collet style case trimmers such as Forster, RCBS, Redding, etc. generally work extremely well and, if you are careful, they will cut fairly accurately. RCBS offers both a powered case trimmer and a more traditional crank style trimmer. Forster is the most versatile. They offer more accessories for their crank style trimmer than any other manufacturer including outside neck turning tool attachments, case trimming, inside neck reaming, case mouth deburring, and primer pocket reaming (not uniforming) of military cases.

The collet style trimmers use a multi-stepped collet that grabs the case head and holds it while a caliber specific pilot



Case Trimmers (left to right) - Forster case trimmer and Wilson case trimmer on a Sinclair Stand

keeps the case mouth supported and square to the cutter. You need to make sure the case is fully against the appropriate step in the collet to insure that the cases are cut to a consistent length.

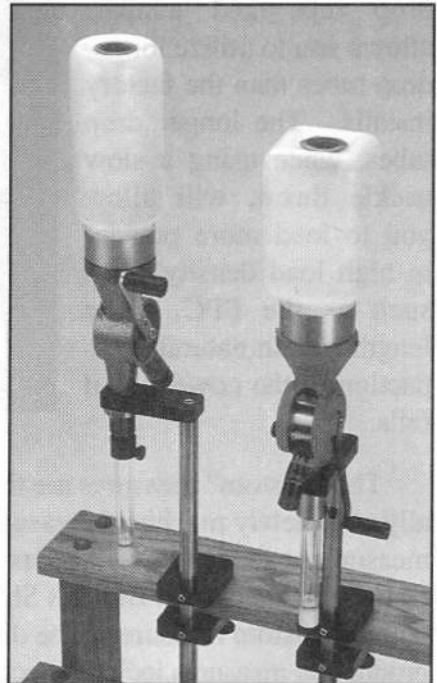
Case trimmers, like the Wilson trimmer, hold the case in a tapered case holder. This in turn holds the case on the body taper so it is square to the cutter when sitting in the alignment rails. The case head is held up against an adjustable stop and the cutter is a crank style. The caseholder can either be held down with your hand or with a clamping arm positioned over the holder. This type of trimmer cuts extremely accurately since there is no collet to push the case forward as it is tightened. The rails and holder body keep the case squarely aligned with the cutter face.

Other trimmers are the powered trimmers such as the Gracey Trimmer and the Forster Trimmer. These types of trimmers can go through the cases extremely fast. The mini-trimmers, made by EJS, Inc., index off the shoulder of the fired cases, insuring consistent trim length. They can be used by hand or under power.

Powder Measures

There are so many powder measure choices for today's reloader that it makes your head spin. Many are production measures, which we will define as powder measures made by manufacturers in assembly line fashion. These would include measures made by Lee, Hornady, Forster, Lyman, Redding, C&H, Dillon, RCBS etc. Among all of these, we feel it is noteworthy to discuss the measures produced by Redding and RCBS.

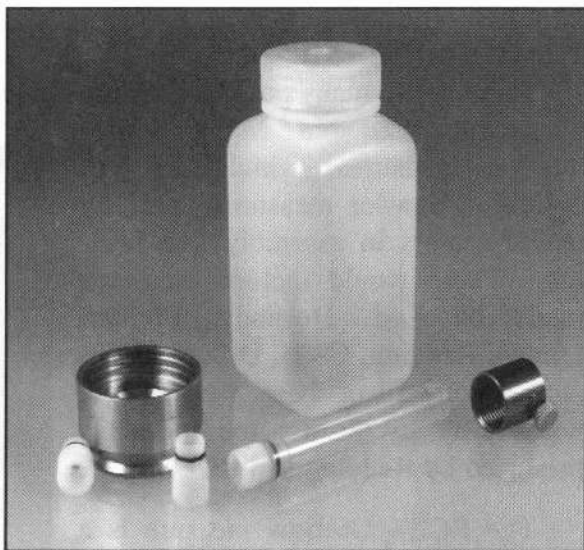
The RCBS Uniflow measure is a standard drum style measure that is fairly repeatable as it comes from the factory, but can be further improved by adding a micrometer insert (made by RCBS). This insert not only increases the measures' repeatability from throw to throw, but also allows you to accurately return later to the same micrometer setting and thus the same load.



RCBS Uniflow and Redding BR-30 measure with Sinclair accessories

Redding has two (2) extremely good powder measures in their line up. These are considered by many to be the equal of the custom measures. The Redding 3BR is a good measure that is accurate, repeatable and can throw from 5 grains to 100 grains of powder using the universal insert. You can change micrometer inserts from the universal insert to the pistol insert and throw charges from 1/2 grain to 10 grains. The 3BR measure is one of the most versatile measures available, and a great one to have on your bench. The Redding BR-30 is the true benchrest measure. It's smaller drum and match insert throws charges as accurately as anything available among the production measures. It does have a limited throw range which will cover cases needing 10 to 50 grains of powder. You wouldn't go wrong with either of these two measures.

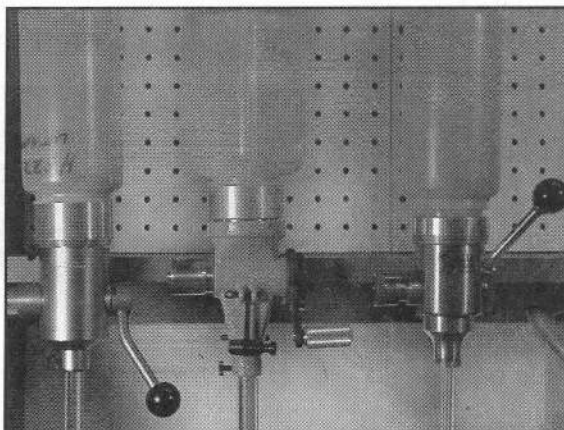
The Redding and RCBS measures can be accessorized with Sinclair aftermarket upgrades such as bottle adapters and longer drop tubes. The bottle adapters allow you to screw on common 1 lb. Hodgdon type powder bottles or 500 ml Nalgene™ bottles. This is a great way to transport your powder to and from the range. Most of the custom measures use a bottle adapter such as this. The drop tube and adapter allows you to utilize longer drop tubes than the factory installs. The longer drop tubes, when using a slow trickle throw, will allow you to load more powder in high load density cases such as the PPC. The length aids in natural compaction of the powder as it falls.



Bottle adapter, drop tube and powder bottle

The “custom” measures are those produced by small shops and are usually completely machined measures, unlike the castings that the production measures start from. Neill Jones of Custom Products, Lynwood Harrell of Harrell Precision and Bruno's Shooters Supply make three (3) of the more popular custom measures. The differences between these measures and the production measures include machined bodies, hand lapped drums, precision cut click adjustments, and built-in powder bottle adapters. These measures

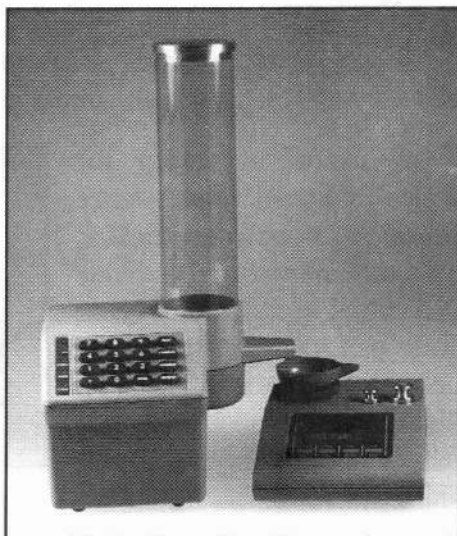
are more expensive but are considered by many to be the finest measures available. The Jones (Custom Products) and Bruno measures were in the \$250 to \$300 range at the time of printing. The Lynwood Harrell measures ran from \$150 to \$200 at the time of printing. You may want to talk with other reloaders prior to purchasing a powder measure and see what their personal experience has been.



custom powder measures

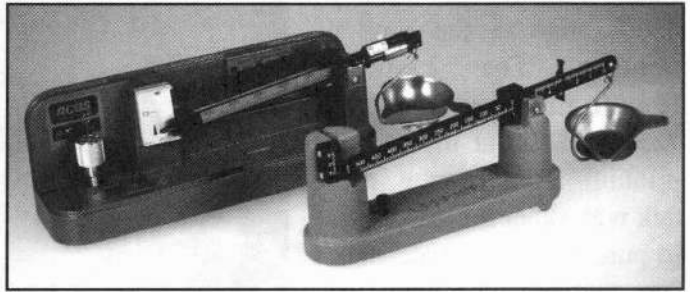
Scales

The latest generation of electronic scales has gained more than just a foothold in the reloading scale market. The accuracy, repeatability, and ease of use of these scales has made them a favorite among reloaders. Lyman, RCBS, Dillon, and PACT have brought out new models, and the price has dropped substantially. Rather than provide a sales catalog describing each model, we suggest you research all the options available if you decide to go “electronic”. From our viewpoint, PACT seems to lead the field and also makes electronic scales for RCBS. PACT introduced an electronic powder dispenser which will trickle charge your powder to the correct weight by using an infrared link with the scale. It works quite well for those interested in weighing each charge but it is quite a bit slower than throwing charges with a powder measure. The electronic scales are definitely worth considering, especially for those interested in checking case weights, bullet weights, or any highly repetitive tasks. If you plan on weighing all of your charges, you may want to consider an electronic scale and possibly the electronic dispenser system. We believe the best way to check charges is to use a balance beam scale.



PACT Electronic Powder Trickler and scale

The balance beam scales are still around, and are generally a few dollars less than the electronic scales. RCBS makes some good ones as does Redding, Hornady, and a host of others. If you buy a balance beam scale, look for an over/under scale at the indicator point, a steel knife edge on the beam, and high quality bearings for the beam to ride on.



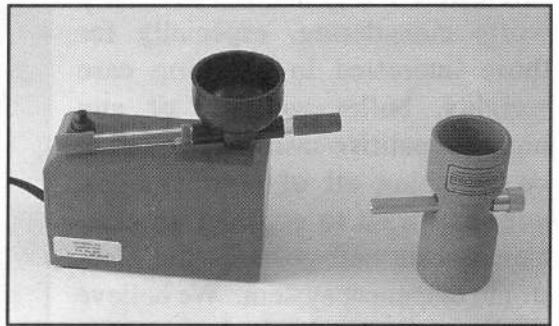
RCBS and Redding balance beam scales

Regardless of which scale you purchase, make sure you check it from time to time for accuracy. If the scale doesn't come with a scale weight check kit, get one! Make sure to use your scale on a known level surface to insure accuracy and repeatability. Also, keep your electronic or balance beam scales protected at all times since they can be damaged very easily. A bent beam or a damaged platen can be expensive to fix or replace and can give you inconsistent and inaccurate readings.

Be aware of air movement when using your scale since it will affect the reading greatly. We had a customer who thought he had a problem with an electronic scale because he was getting erroneous readings, but by questioning him about his reloading room environment we soon discovered there was a ceiling fan that was causing the inconsistent readings. Keep your scale away from air vents or air returns.

A scale is an important piece of equipment that needs to be quality built and accurate. A good scale should give you years of reliable service.

A useful accessory for scales (electronic and balance beam) is a powder trickler. This tool allows you to trickle individual grains onto your scale pan to bring the weight up to an exact charge. Tricklers are available in manual or electric operated versions.



Electric powder trickler

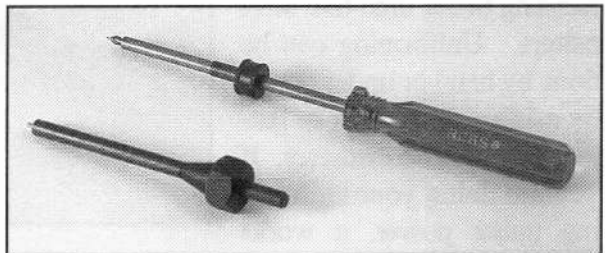
Case Preparation Tools

Since a significant portion of this book covers the steps involved in case preparation, we will try not to repeat ourselves too much.

There is an incredible variety of case preparation tools available for the reloader to use. Keep in mind the quantity of reloading that you will be doing as well as the level of precision that you will be trying to achieve when selecting case prep tools. Select tools that can be power driven if you are preparing a large amount of cases. Choose quality tools that are well made, comfortable to use, and long lasting.

One tool, not normally considered a reloading tool, that everyone should have is an eye loupe. This item can generally be found for \$10-\$20, and is extremely valuable for examining case heads, case necks, bullets, dies etc. Select either a pocket loupe or a jeweler's loupe, keep it in your reloading box. There are times in the field when it comes in handy. We use this tool almost every day.

The flash hole deburring tool is extremely valuable for improving the accuracy of your handloads. This tool is used inside the case to remove any burrs left on the inside edge of the flash hole. The burrs are formed when the flash hole is drilled or punched during the manufacturing process. The burrs cause uneven primer ignition, and their removal has been proven to improve group consistency in handloads. The deburring process is a one time operation on the case, and is easily done with the right tool. It is extremely important for precision rifle accuracy that you perform this operation, so don't skimp on your tool purchases by skipping this one.



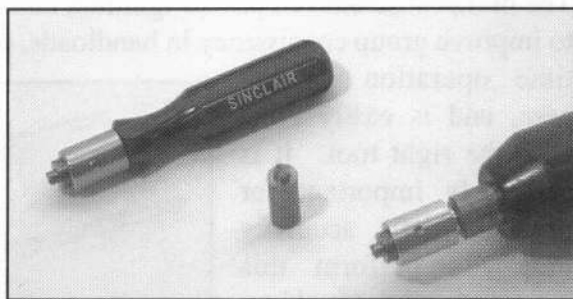
Flash hole deburring tools

EJS (Sinclair design), RCBS and others make flash hole deburring tools. The RCBS tool is a good one that utilizes case length to control the depth of the cut. Pilot stops in .22 caliber through .45 caliber enable the shooter to set the cutting depth easily. The Sinclair designed tool (made by EJS) has a built-in depth stop which keeps the cutter from cutting too deep. The tool bottoms out internally against the web of the case. The Sinclair designed tool works on cases .22 caliber through .45 caliber. There is also a Sinclair designed tool for PPC's and .17 calibers.

The RCBS flash hole tool would be our choice when performing this activity under power since the Sinclair design requires you to clear the chips that build up. If deburring by hand, we would suggest either model.

The next case prep tool to think about is the primer pocket uniformer. Primer pocket uniformers are standard tools that have been used in benchrest reloading for years. They are used to uniform primer pockets to the correct depth, and to clean the primer pockets after firing. This tool allows the shooter to cut the primer pockets squarely, cleanly, and to the correct depth so the primers will be seated squarely. The uniforming process insures that the primer anvil rests against the bottom of the primer pocket. We will cover this subject thoroughly in the loading section.

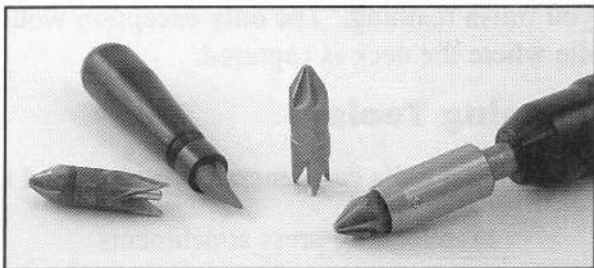
There are several tools available to uniform primer pockets. Make sure you select one with carbide cutters and, of course, select the correct one for the cases you will be uniforming. Uniformers are different for large rifle, large pistol, and small rifle primer pockets. You may notice that a uniformer for small pistol wasn't mentioned. That is because it is exactly the same size as small rifle. Large pistol and large rifle primer pockets are the same diameter, but are of different depth. See primer pocket depth and diameters in Table I on page 44. Again, make sure to select uniformers that have solid carbide cutters because they will hold up to the repetitive task of uniforming better than tool steel cutters. Uniforming can be done by hand or under power by using a drill motor or battery powered screwdriver. If you are doing your uniforming under power, it works best if you keep your motor to 1100 RPM or less.



Sinclair primer pocket uniformers

A case mouth deburring tool is another tool every reloader should have. It is used every time cutting activity has occurred in the neck region including neck reaming, neck turning, and especially case trimming. A sharp edge is formed on the mouth of the case, and it must be removed by chamfering and deburring the inside and outside of the case mouth. This is a must for providing a smooth transition of the bullet into the case mouth during the seating operation. It is especially important when loading flat base bullets. These standard deburring tools are available from most major

reloading tool manufacturers. There are some special case mouth deburring tools available for .17 caliber cases and also some special chamfering tools that have a sharper angle and create a longer bevel in the case mouth.



Case mouth deburring tools (Wilson, Holland, Redding and Sinclair power holder)

Neck reamers are not utilized by all reloaders, but there may be a time when you will need one. Some of the case trimmers can be set up to utilize neck reamers, and this is generally the preferred method. Neck reamers are usually used when forming a cartridge from a parent case where the body of the case is squeezed down so far that the body actually becomes the neck. This “new” neck wall is much too thick, and the neck reamer is used to remove the “extra” thickness. Neck reamers are also used to remove the taper that can form in the case neck as cases are fired and the brass flows unevenly into the neck area. Normally, the neck thickness in the base of the neck will become thicker and in some cartridges may need to be “reamed”.

Reamers are also used in some forming operations when an internal shoulder is formed - sometimes called a “doughnut”. The “doughnut” is created at the neck/shoulder junction and is formed during case forming due to changes in case geometry. It can also be a result of incomplete neck turning in tight neck chambers. The doughnut, after repeated firings, can lead to case neck separation. Some reloaders, ourselves included, will sometimes use a specially sized neck reamer to lightly clean up the inside surface of the neck so there is a smooth surface for the bullet to mate with when it is seated.

Inside case neck reamers are available as accessories for most case trimmers. Check with the manufacturer if you are uncertain whether or not they supply reamers. Ream dies that capture the case neck while a reamer is inserted into the neck are available through RCBS, but they can be expensive. Most reamers are slightly oversized, so be sure of the size you will need. Unless you are trying to remove large amounts of brass after case forming, you will need a neck reamer that measures 0.001” larger (at most) than the case mouth opening. Remember, inside neck reamers follow the existing hole and will not uniform the wall thickness. If the brass is thicker on one side to begin with, it will still be thicker on one side when

you finish reaming. The only exception would be if you are using a ream die where the neck is captured.

Priming Tools

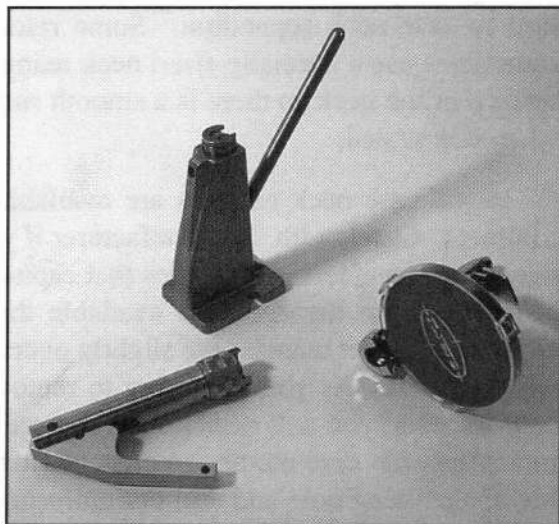
Priming tools can generally be classified into three categories:

- 1) reloading press attachments
- 2) bench style priming tools
- 3) hand held priming tools

Within these categories the tools can be available with automatic feed or set up as single feed tools.

When deciding which priming tool to purchase, keep a few things in mind. You get what you pay for. The lower priced priming tools work, but may only last a few seasons. Make sure the tool you choose works smoothly so you can feel the primer seat to the bottom of the pocket. We don't advise using a press mounted tool because there is so much mechanical advantage in the press that it is easy to over seat and crush the primer. Be careful with the automatic tray type priming tools such as the RCBS, Lee, and Hornady. Reloaders have had some accidents where primers have jammed in the feed portion of the tray and exploded when two primers were crushed together. The reloaders, in all of the accidents we know about, were using Federal primers. Lee specifically warns users of their priming tool that some Federal primers are unsafe to use in their tool. Just be careful when using this type of tool, and use care when storing and transporting primers.

The bench style priming tools such as the RCBS are nice tools to use. They have decent feel and hold up well. The single load hand tools like ours are designed specifically for the accuracy market and are generally made in small custom shops where they are machined from billet material instead of being



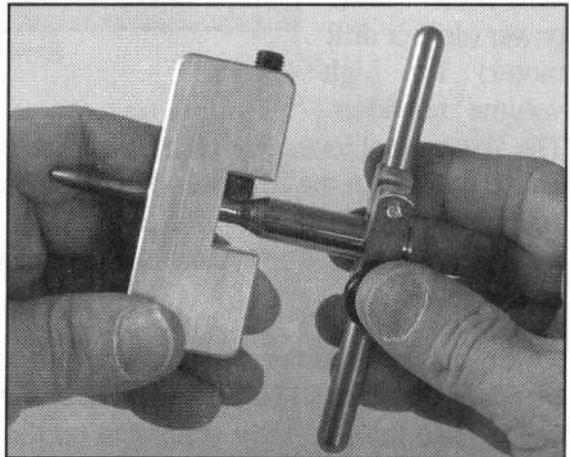
Sinclair, RCBS and Lee Priming Tools

stamped or molded from plastic. Tools like this will usually provide a lifetime of use and provide the best feel of any of the priming tools. If you are planning on doing some reloading in the field you should consider a hand tool. You won't have to bring along a c-clamp to hold down a bench type tool. If you are going to be loading a lot of cases at one sitting, such as a varmint hunter in getting prepared for a trip, you may want to consider one of the tools with automatic feed.

Outside Neck Turning Tools

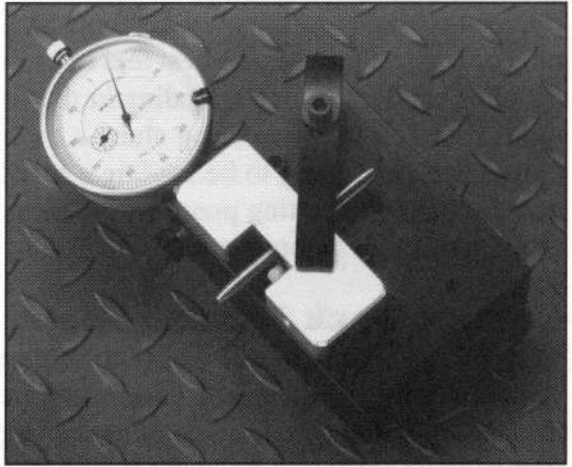
Neck turning is a task that both reduces the neck wall thickness and uniforms the wall thickness. Not every reloader needs an outside neck turning tool. Reloaders having guns with tight necked chambers must neck turn so their cases will fit in the chamber. These same shooters also neck turn so their brass has uniform neck wall thickness. Reloaders loading for standard factory chambers also neck turn to insure uniform wall thickness, but they should take care to not remove too much brass from the neck so the case won't have to expand too much to seal the chamber. For those reloaders not familiar with neck turning, a brief description of the operation is in order. A cartridge is fed onto a mandrel/pilot that is sized approximately 0.0005" to 0.001" smaller than the inside diameter of the cartridge case neck. This "fit" is crucial to the success of the neck turning operation. A good relationship between the mandrel used in sizing the case neck and the mandrel used in neck turning must be achieved. In all neck turning tools a cutter is suspended alongside the mandrel, and can be moved towards or away from the mandrel depending on the amount of material to be removed. As the case is fed onto the mandrel either the cutter or case is rotated (depending on the tool design). This allows the cutter to begin removing material from the case neck. The case is fed past the cutter until the cutter reaches the neck/shoulder junction. The cutter should not be allowed to cut deeply into the shoulder, but the neck should be turned all the way down to the neck/shoulder junction.

When selecting a neck turning tool you need to look at your particular needs. Are



Neck Turning with hand tool (Sinclair)

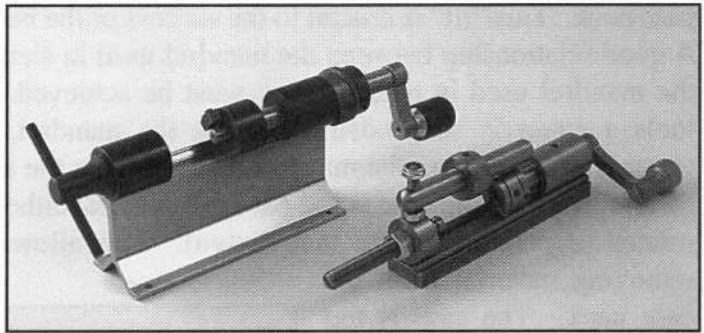
you doing a lot of cases? If so, you may wish to power this operation since neck turning is a laborious chore. Hand tools such as the Sinclair, Hart, and Marquart are extremely accurate tools, and they will give you great results. Some of these tools have provisions for dial indicators and micrometers to make setting the cutters easier. We incorporated dial indicator provision with



Sinclair adjustment fixture

some of our earlier designs, but have since changed to using a separate adjustment fixture that you mount your tool on for cutter setting. With this setup you remove your neck turning tool from the fixture and don't subject your dial indicator or micrometer to the stress of the entire neck turning operation.

Crank style tools, which are usually neck turning tools mounted on case trimmers such as the Forster or Wilson, work quite well, and can be used under power (drill or drill motor) for high volume reloaders.

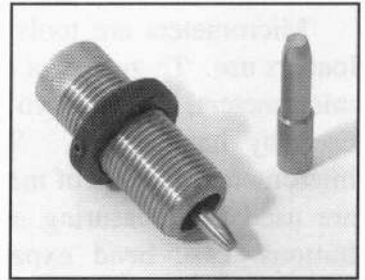


Forster and Wilson crank style neck turning tools

The Wilson tool looks like their case trimmer, but utilizes slightly different shellholders than the trimmer. This tool can be converted to a trimmer by adding a trimmer cutter and the correct trimmer shellholders but the reverse is not true. The Wilson case trimmer cannot be converted to a neck turning tool.

Several neck turner manufacturers also make specially sized expander mandrels and dies to hold them. These dies are used in a 7/8" - 14 press and do two things. They straighten up the case neck, which can have all

kinds of bumps and dimples when cases are new. This straightening process also displaces these bumps to the outside surface where they can be turned off. This process can also be accomplished using a full length sizing die. The second task the expander die performs is to correctly establish the fit between the case neck and the neck turning tool mandrel. Specially sized expanding mandrels are used and are normally machined approximately 0.001" larger than the manufacturer's neck turning mandrel.



Sinclair Expander Body/mandrel

Neck turning is basically like turning metal on a lathe. Some lubrication must be used on the mandrel to keep the metal from galling. We have seen reloaders use products such as Lock-Ease™, sizing wax/lube, STP, spray lubes, molybdenum disulfide, graphite, motor mica, etc. We generally use two products ourselves. One is Imperial Sizing die wax which comes in a can about the size of a small shoe polish can and seems to last forever. It is probably the best sizing lube around and everyone should have a can of it. The other product we use is a high performance engine assembly lube called Pro-Blend which works extremely well for neck turning.

Another product for use in case neck turning is a special holder that holds the case by the case head so you can neck turn using a drill or power screwdriver. This makes neck turning a fairly easy task.

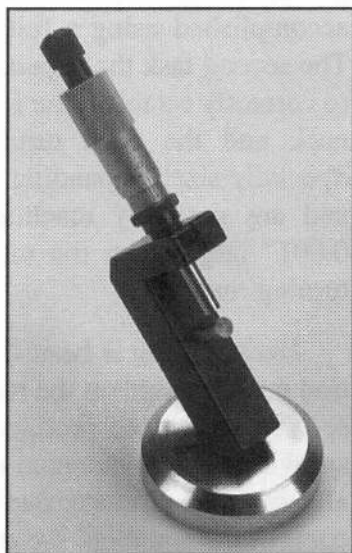
Measuring Tools

Handloaders should look seriously at available measuring tools before spending lots of money on the first ones they see. You can tie up a large amount of money in these tools very quickly.

The first and foremost measuring tool that every reloader should have is a good 6" stainless steel caliper. There are plastic ones that are cheaper, but don't buy them. Almost any quality reloading establishment has a selection. You can get a decent set of import calipers for under \$30. You can also spend over \$150 on an electronic digital caliper made by Starrett. Get what works best for your budget. Quite honestly, we each use a set of \$30 stainless steel calipers that we have had for years. This is a tool you need to keep in your range box if you plan on reloading in the field. You will use your calipers for measuring all kinds of things; your cases, check-

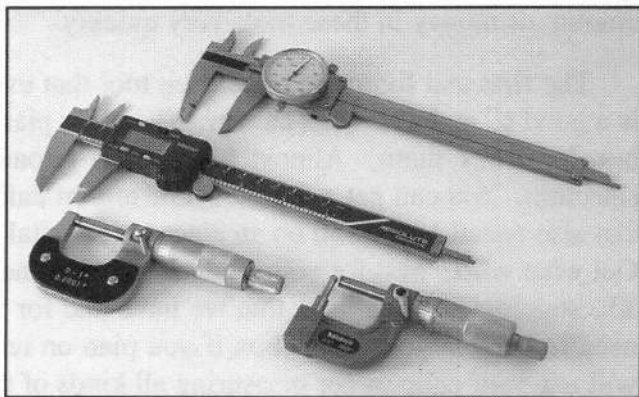
ing mandrels, checking seating depth positions, measuring material diameters, and a host of other tasks.

Micrometers are tools that not all handloaders use. There are, of course, all kinds of micrometers; but only two types are normally used by handloaders. Standard 1" throat micrometers capable of measuring to 0.0001" are used for measuring mandrels, expander buttons, case head expansion, etc. Ball micrometers are used primarily to measure neck wall thickness. Better quality micrometers will have carbide faces on the flats (anvil and stem). The ball micrometers will only have carbide on the stem. A variation of the tubing or ball micrometer is one manufactured by Sinclair International. This tool utilizes a Starrett 1" micrometer head mounted on a stand with an offset ball anvil. This offset allows the handloader to measure wall thickness right up to the neck/shoulder junction. The stand allows two handed operation so you can use your hands on the case and micrometer thimble at the same time.



Sinclair Case Neck Micrometer

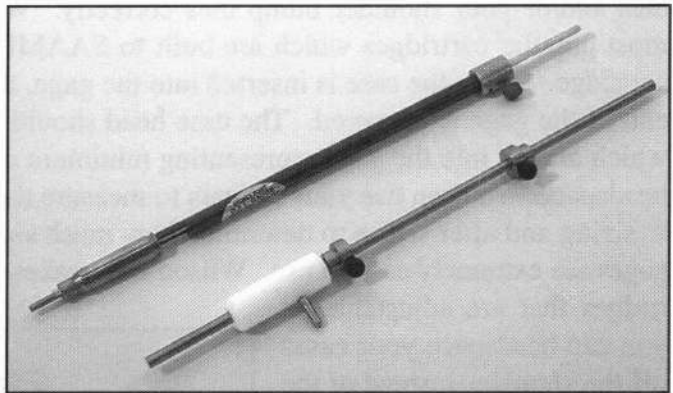
Features to look for on all micrometers include carbide faces as previously mentioned, a locking feature to lock your measurement down, and a ratcheting device which slips when you make contact with the item you are measuring. The ratchet keeps you from over tightening the micrometer, and damaging the micrometer and/or getting a false reading. Some people, especially experienced machinists, prefer to use the non-ratcheting micrometers since they develop a consistent "feel" when using the micrometer. These tools should be considered investments, and if you purchase good tools such as those from Mitutoyo, Starrett, Browne & Sharpe, etc. they should last a lifetime.



Micrometers/calipers

A seating depth tool and a bullet comparator are two tools that are extremely valuable and frequently used by the serious handloader. These tools make short work of establishing the distance between the bolt face and the contact point on the rifling for a specific bullet. There are several ways to do this which we will discuss later on.

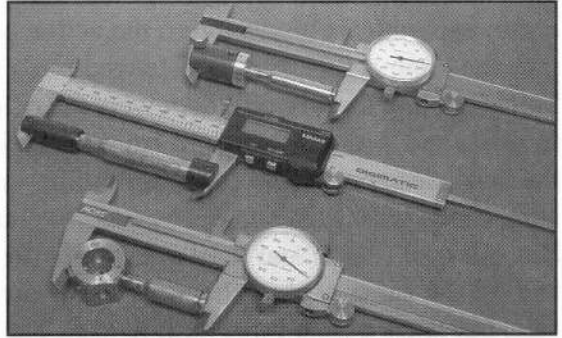
Stoney Point Products makes one of the easiest tools to use for determining seating depth on both bolt guns and semi-auto rifles. The tool consists of a sleeved rod that utilizes actual cartridges which are threaded so they can screw onto the rod. A bullet is inserted into the case, and the entire apparatus is inserted into the action so the cartridge is all of the way into the chamber. Using the sleeved push rod, the handloader pushes the bullet into the throat until it contacts the rifling. Then you just lock the rod in place and withdraw the unit from the rifle for measurement. It is one of the best designed tools for determining seating depth. The version for semi-autos works the same way only the push rod is a flexible cable. The Sinclair tool uses actual fired cases from the gun and a gage rod that is used to find the same measurement as the Stoney Point Tool. It is more accurate, but takes a little more skill to use. The RCBS Precision Mic tools can also determine seating depth to the rifling, but we have found these tools more useful as headspace gages. With the Precision Mics, you have to buy one expensive tool for each cartridge. With the Stoney Point you have to purchase a \$5.00 or less cartridge for each rifle. The Sinclair tool will work on most bolt guns from .22 caliber to 45 caliber without any add-ons unless the bolt diameter changes.



Seating Depth Tools (Stoney Point, Sinclair)

Comparators are used to take measurements from seating depth tools and to transfer those measurements to bullet seaters. Bullet comparators measure overall length from approximately the ogive of the bullet to the base of the cartridge. This is the preferred way to take OAL (overall length) measurements. We have seen variances as much as 0.020" when measuring bullets from base to tip right out of the same lot. The compara-

tor Sinclair makes is a six sided tool that you can use to measure .22 caliber, 6mm, 25 caliber, 270 caliber, 7mm and .30 caliber. You use it free-hand with your calipers, keeping your calipers free for other activities. The Stoney Point comparator uses different inserts for each caliber, and the holder for the inserts attaches to your caliper blade with a thumbscrew. The Davidson seating depth checker (comparator) attaches to your caliper also, and each one is a specific caliber (.17 caliber through .45 caliber). The Davidson comparator has another piece to it that is optional but quite useful. It is a base piece that attaches to the opposing blade of the caliper and acts as an alignment piece for the base of the cartridge. This base piece, along with the nose piece, insures perfect alignment. All three of these comparators work exceptionally well.

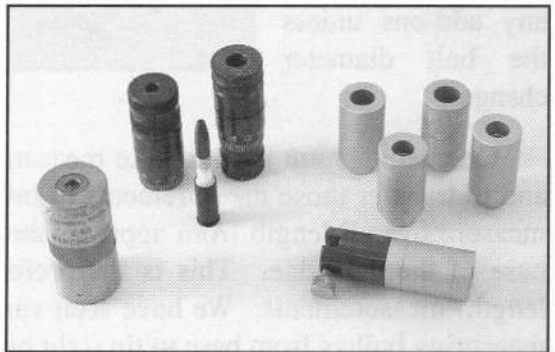


L to R: Davidson, Sinclair, Stoney Point Bullet Comparators shown with calipers

Another important measuring tool that handloaders use are cartridge head-

space gages. These gages assist you in setting up your full length sizing dies and/or your shoulder bump dies correctly. Wilson makes gages for most popular cartridges which are built to SAAMI specifications for that cartridge. When the case is inserted into the gage, the head position at one end of the gage is observed. The case head should fall between two steps which are cut into the gage representing minimum and maximum cartridge headspace. You can use your calipers to measure the case in the gage prior to sizing and after sizing to determine how much sizing is occurring. These gages are extremely easy to use. Wilson also makes gages for magnum cartridges that are adjustable so you can headspace your cases off the shoulder instead of the belt.

Stoney Point Products makes a set of headspace gauges that are used with calipers. You can measure the headspace of a fired case to set up your dies correctly and

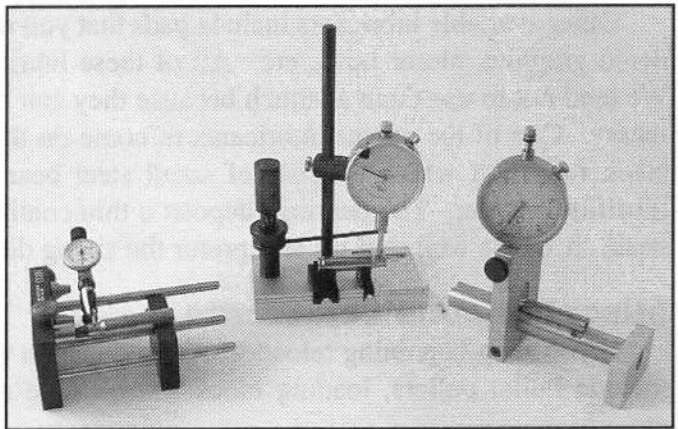


Headspace Gages (Wilson, RCBS, Stoney Point)

re-measure after sizing to make sure you only set back the shoulder the desired amount. The RCBS Precision Micrometer series tools perform the same task. They allow you to measure your cases for headspace and the amount of sizing.

All of these tools serve to minimize the amount of sizing that you do. This in turn minimizes the amount of work placed on the brass and ensures your cartridge is not sloppy in the chamber. The more the brass is worked, the harder it becomes and it usually does not last as long as it would have with minimal sizing.

Concentricity gages are tools primarily designed to determine the amount of runout in a cartridge case or loaded round. This is a tool designed for reloaders wanting to check how concentric their sized cases and completely loaded rounds are so they can see how accurate their reloading procedure is. There are gages ranging in price from \$50-\$150 manufactured by RCBS, Sinclair International, Daryll Holland and NECO. All of these tools are slightly different, but all work around the principle of spinning a case on its main axis underneath a dial indicator. The readings tell the user how concentric the case is at the point where the indicator is resting. More about the use and exactly what this tells us later on.



Concentricity Gages (NECO, RCBS, Sinclair)

Neck wall thickness gages such as the Sinclair, RCBS, or NECO can be used to detect variances in neck wall thickness. These tools use dial indicators for readout and can be used to sort brass quickly for neck wall thickness variance. These tools do not replace ball micrometers since they will not give you a precise measurement of actual neck wall thickness.

Case Lubes

Although not a piece of equipment, a brief mention of case lubricants is in order. These lubricants are extremely important to case preparation for

neck turning, neck expanding, full length sizing, and case forming. Case lubricants are available in paste form, spray cans, lube pads and in bottles. We tend to use the paste type and spray cans more often. There are several good case lubricants, but the best we have found over the years is Imperial Sizing Die wax made for years by LeClear Industries but now made by E-Z Way Systems. This semi-solid die wax comes in a can and is lightly applied with your finger.



Case Lubricants

When we have a couple of blocks of cases lined up for full length sizing, we sometimes reach for a can of Hornady “One Shot Lube”. We spray the cases from both sides while they are sitting in the block, and we are ready to go. More about using lubricants properly in later chapters.

Other available lubricants include pads that you roll your cases on, powdered graphite, motor mica, etc. All of these lubricants work fairly well. We tend not to use them as much because they can be time consuming and messy. One of the newest lubricants to come on the market is the NECO Neck Lube Kit which consists of small steel bearings and molybdenum disulfide powder. The bearings deposit a thin coating of moly on the case neck. It works well, but we still prefer the sizing die wax over everything.

Miscellaneous Comments

If you are a beginning reloader, other items you will need or might need include bullet pullers, loading blocks, stuck case removers, shellholders, etc...

Surprisingly enough, this next statement is coming from people who are in the business of selling reloading gear. Don't buy tools that you don't need. There are dozens of gadgets out there and you can spend lots of money needlessly. If you are planning to load in the field, all the gadgets and needless stuff becomes very heavy to haul around. Buy what you need, talk with friends, go to shoots and see what people are using, read through the catalogs, and ask questions. There is good gear out there and some trash. Try to buy slowly and get tools and equipment that will last. Reloading is an interesting and personally rewarding hobby that you will enjoy for years.

Chapter 3

Case Preparation Activities

In this chapter we will cover the initial case preparation activities performed on brass cases prior to loading. Some of these activities are only performed once during the life of the case, other procedures you will see repeated in the chapter on load testing since they are performed each time you reload.

Some of the steps in this chapter may seem like overkill or going way too far with case preparation. What we are trying to do is show you the things you can do to your cases to prepare them for accuracy reloading. It's up to you to decide on how much work you want to do. There are certain steps we don't skip if we are loading for a benchrest match but there are steps we will skip if loading 1000 rounds for a varmint hunting trip.

Reloading for accuracy has been summed up before with this statement; "Precision reloading is a matter of trifles". The point is that it takes each little step to make an accurate load. Once you find an accurate load that works in a particular rifle, you will try to load all of your cartridges so each one is as close to a perfect duplicate as possible.

Cartridge/Case Selection and Sorting

The first thing you have to do is acquire some cases. Our personal prejudice and strong recommendation is to start with brand new, unfired cases, or at a minimum, fired cases from factory ammo that has been fired in the same rifle you are reloading for. We are talking about getting the most out of your rifle, and trying to save a few dollars on cheap or used cases is a waste of time and effort. These words are coming from two guys whose pictures should be beside the word "tightwad" in the dictionary.

Brass that has been fired and reloaded several times becomes "work hardened" and brittle. Brass in this condition will not respond properly to some case preparation activities. Military brass, even the match type, is of a harder alloy and is usually not manufactured with reloading in mind. Brass life is generally short with this type of brass, and the end result will be frequent replacement.

Remington, Winchester, Lapua, Norma, Sako, IMI, Hirtenberger and Federal all offer new brass cases for the reloader. Some of it is available in boxes of 20 while other brass is available in bulk only. Regardless of how much brass you buy, or where you buy it, insist on the same lot. Those retailers who don't know or don't care about keeping brass separated by lot numbers are not serious about reloading. We have heard from some reloaders who feel bulk brass is inferior to boxed brass. We have checked with several manufacturers, and all the brass comes off the same line. Some of it goes into drums of 2000 and some goes to a boxing line. Our rule of thumb is that if we want to end up with 100 good cases, we need to start with 125. We know from past experience that 20% will usually be sorted out for one reason or another. A lot depends on the quality of the production run and how finite your sorting criteria is. Sometimes, unfortunately, the European brass is of better quality than American brass. Some of the European manufacturers machine the case heads, drill the flash holes and can usually produce cases with more consistent wall thickness and weight. You may reject more cases when using American brass (not always).

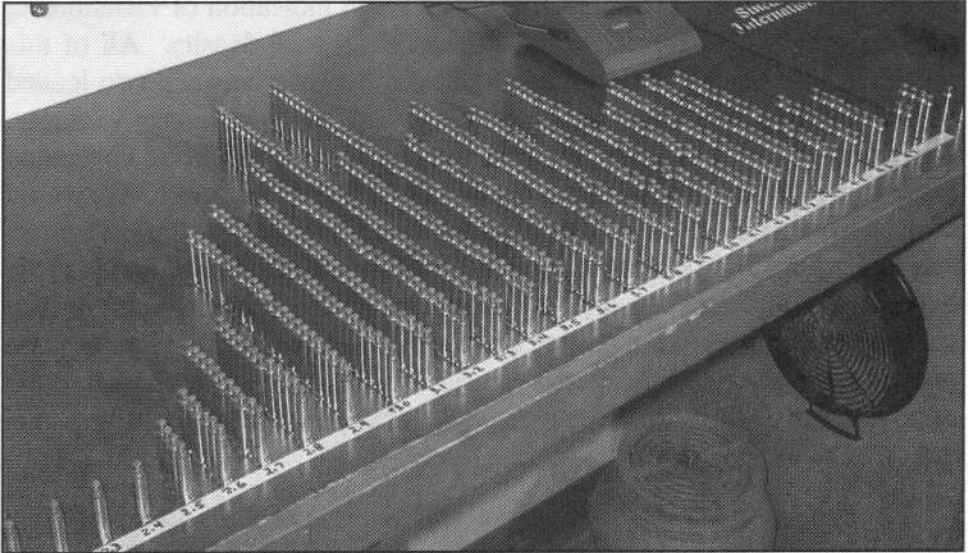
Visual case inspection is the first preparation step after you have rounded up your cases. Look for creases or splits in the neck and shoulder area of the cases and throw these away. Dented cases can usually be straightened. In the photo, the first case from the left is only slightly dented and would be kept. The second and fourth cases are severely dented from shipping and would be culled. The third and fifth cases would be rejected for severe manufacturing defects.



With the popularity of electronic digital scales, weighing cases is becoming a more popular method of sorting. We feel that a variance of 1.5% of case weight or less is an acceptable level for keeping cases in a group. When we select cases for a competition rifle or a varmint rifle, we will weigh 100% of the cases in a batch. In every batch we weigh there are always a few cases that have extreme weight variations (plus or minus). The reason for using case weight as a difference is that body wall thickness

may be different in cases of different weights which, in turn, can affect case capacity. Differing case wall thicknesses will cause cases to react differently when they are fired.

When shooting long range we will especially weigh every cartridge. We feel at these distances the weight variance variable should be eliminated. The photograph below shows how we sorted one batch of 500 cases by weight. The cases are sorted by 0.1 grain variances. A chart showing distribution by count and weight of the brass shown in the photo is located in Appendix III. Note the tape in the photo showing our weight increments of 0.1 grain.



Cases sorted by weight

Flash hole gaging is an operation that some reloaders do, either for a percentage of their cases or for all of them. Most commercial cartridge manufacturers specify a 0.082" flash hole diameter. There are an increasing number of manufacturers using a 0.058" to 0.062" flash hole on some of the target cases such as the PPC, 6BR, and 223 Remington. If you are checking the .082" flash holes, use a #45 wire size drill bit as a gage. We don't worry about the undersized flash holes (.058" to .062"), since the flash hole deburring tool will make them uniform. Checking flash holes is probably a step that should be done more often due to the fact that consistent ignition is so important to accuracy reloading.

The next step in the case prep process is to check the case neck wall thickness. Variances in neck wall thickness are also an indication of body wall thickness. We need to see how the neck thickness of a particular case compares when

measured around the circumference (we usually check 4 points, 90° apart), and how the average neck thickness of the cases varies in a particular lot.

Variances in neck wall thickness can lead to several performance problems. Extreme variations result in misalignment of the loaded round in the chamber. When rounds like this are fired, the chamber seals differently producing pressure and velocity differences. The bullets will not be centered in the rifle's bore if case thickness variance is extreme. Variations in neck tension can also be a result of this problem, especially when one is using bushing type dies.

Body wall thickness variances can lead to the cases laying differently in the chamber from shot to shot. It also can be an indication of variations in case capacity which creates slight differences in load density. All of this sounds a little far fetched, but the slightest difference between two loaded rounds can and will show up down range especially at longer yardages. Depending on what activity we were loading for, we would be concerned about cases that differ in neck wall thickness by 0.0015" or more. We would also be concerned if an individual case had variances of 0.0015" when checked around it's circumference. Either of these situations would indicate the need to cull cases (segregate them into groups by wall thickness) or consider neck turning. We measure neck wall thickness with a Sinclair case neck micrometer or a ball micrometer and we measure for neck wall thickness variance with a Sinclair Neck wall thickness gage which uses a dial indicator to show variances.

For benchrest match shooting, we will sometimes throw out cases that differ in neck wall thickness too much, even though we will be turning the necks down to within a 0.0001" of each other. We cull these cases because of the high probability that case body wall thickness variances exist also.

We are often asked by friends and/or customers which brand of brass they should use. This is a difficult question to answer since some manufacturers brass varies so much from lot to lot. We see hundreds of different lots of brass each year in our own warehouse, and the differences are amazing. The more expensive European brass such as Lapua and Norma tends to be more consistent from lot to lot, but is not always the best. These cases have machined case heads and drilled flash holes as opposed to punched flash holes in American brass, so the brass is manufactured better to begin with.

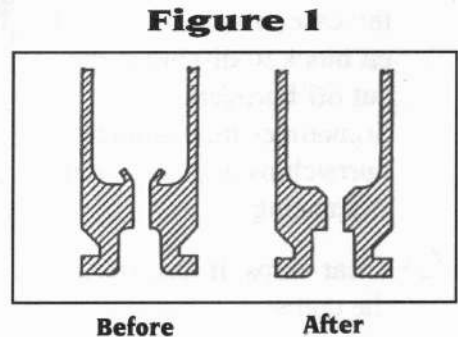
Federal, who had stopped the sale of brass to reloaders at one time, has recently re-introduced some of the standard favorites such as .308 Winchester, .223 Remington, and 30-06. These premium or match unprimed cartridge cases look pretty good so far.

Regardless of what brand of brass you acquire, go through some of the steps in the inspection or sorting process. Set concrete goals for what is acceptable and what is not. By all means, don't skip the visual inspection step even if you don't do anything else.

Flash hole Deburring and Primer Pocket Uniforming

Now that we have sorted and inspected our lot of cases, lets get started prepping them for use. Our first step in this process is flash hole deburring.

During the manufacturing process, burrs will form on the inside of the case where the flash hole is punched or drilled through. Sometimes the burrs will break off along the way, sometimes they won't. Some of these burrs can be quite large and can significantly affect the ignition process. The European brass does not have large burrs because their flash holes are usually drilled and not punched. Looking from the neck end, you can usually hold your cases up to the light and see these burrs. The burrs can cause variations in powder ignition, which can cause vertical dispersion in your group. We believe that the removal of flash hole burrs is one of the most important steps in proper case preparation. A correctly manufactured and set up flash hole deburring tool will remove the burrs and put a slight chamfer or bevel on the inside face of the flash hole. See Figure 1 for a graphical representation of what this looks like.

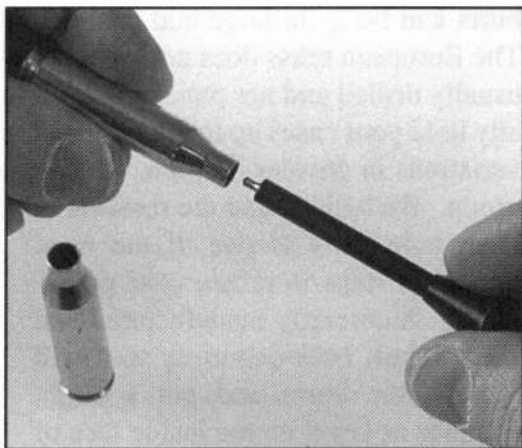


Most flash hole deburring tools consist of a cutter and a depth stop of some type. If you have a deburring tool that does not have some sort of depth stop, be extremely careful when using it. The intention is just to remove the burr and cut a chamfer on the leading edge. We sell a tool designed by us and now made by EJS that works on .22 caliber through .45 caliber cases with the exception of cases with the smaller 0.060" flash holes. It has a cone shaped centering device that helps locate the flash hole and a built-in stop that bottoms out on the case web to prevent excess cutting. RCBS makes a tool for .22 caliber through .45 caliber cases that uses a stop on the case neck to prevent cutting too deep. These stops are caliber specific and are interchangeable on the RCBS tool. You only have to buy one cutting shaft and whatever caliber pilot stops you need.

Critics of this tool (including other manufacturers) object to using case length as a stop. We have seen little effect with the minor variances in the case length of new cases. The RCBS tool has one strong advantage when compared to other tools - chips do not build upon the cutter. This is an important consideration for those wanting to power this operation.

To use most flash hole deburring tools follow these steps:

- 1) Set the stop or centering device, if necessary.
- 2) Insert the tool through the mouth of the case until the cutter engages the flash hole. Sometimes you have to fish around a little (off centered flash holes are sometimes the problem).
- 3) Apply slight pressure on the tool and rotate tool clockwise until you feel the cutting stop.
- 4) Remove the tool and tap the case mouth on a wooden block to discharge the cut off burrs/chips. Sometimes the amount of burrs/chips that come out is amazing.
- 5) Clear chips, if any, from the cutter.



deburring in action

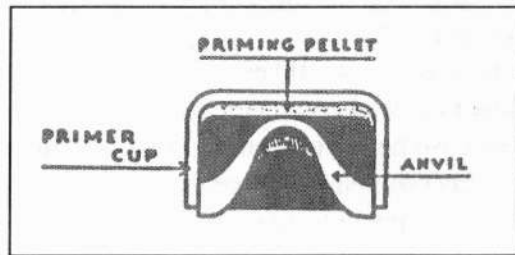
This is a one time operation for each case. Cases with 0.060" flash holes will require a special tool because of the size of the flash hole and the web design. When using these special tools on cases such as the PPC, you must use a light touch and only a couple of turns to complete the task. The flash hole deburring operation on these cases also prevents die punches or decapping pins from sticking in the flash hole since the holes are sometimes smaller than the pins. We also make a .17 caliber tool that has a smaller diameter shaft to enable it to pass through the smaller diameter neck opening.

A couple of warnings are justified here. If using flash hole deburring tools under power in a tool such as a drill press, use low RPM (as slow as you can go).

Secondly, and this is **IMPORTANT**, never perform the flash hole deburring operation on cases with live primers in them. We have never experienced it, but a live primer could be detonated during this operation and cause severe injury. Performing this operation on cases with spent primers would be fruitless since the cutting depth would be restricted by the primer.

Let's turn our attention to the primer pockets. Referring back to Figure 1 (page 41), you can see the radius in the bottom of the primer pocket in the cartridge to the left. Look closely at some of your new cases and notice how the primer pocket is somewhat dish shaped. Now, looking at Figure 2, which is a drawing of a primer, you will observe that the primer cup is square on the edges with the anvil protruding from the bottom. Primers are designed this way so the anvil will rest on the bottom of the primer pocket. When the firing pin strikes the top surface of the primer cup, the explosive pellet inside the primer cup is crushed between the anvil and the cup causing the priming material to detonate. As you can see, the rounded corners of the primer pockets need to be squared off so the primer can be inserted squarely and consistently into the primer pocket.

Figure 2



Just as important as removing these corners, is ensuring that the primer pockets are the correct depth and all the cases have pockets of the same depth. Variations in the depth and the configuration of the primer pocket can and will alter the effect of the firing pin strike. If the firing pin strike varies from shot to shot, it will result in varied powder ignition and thus produce inconsistent pressures and velocities. As a result, you can expect to see vertical shot dispersion, which is when the shots string up and down on the target. If this little trifle seems too far fetched, then consider the following:

Normally, depending on the action you have, the firing pin protrusion will range from 0.045" to 0.060". With a primer seating variance of only 0.010" the influence on firing pin strike can be as much as 20%.

The Sporting Arms and Ammunition Manufacturers Institute (SAAMI) the organization which sets specifications for standard chamber

dimension and case specification tolerances for manufacturers suggests dimensions of primer pockets and the dimensions of primers as follows:

Table I

	DEPTH		DIAMETER	
	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
Sm. Rifle primer pocket	.117"	.123"	.1730"	.1745"
Sm. pistol primer pocket	.117"	.123"	.1730"	.1745"
Lg. rifle primer pocket	.125"	.132"	.2085"	.2100"
Lg. pistol primer pocket	.117"	.123"	.2085"	.2100"

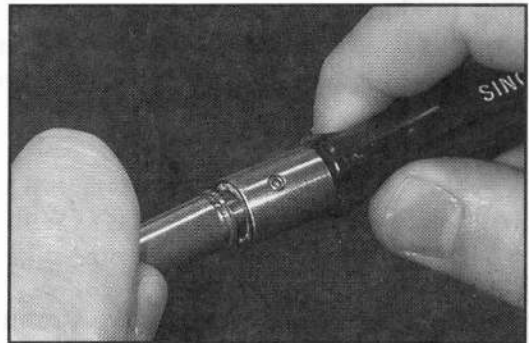
Table II

	HEIGHT		DIAMETER	
	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
Small Rifle primers	.115"	.125"	.1745"	.1765"
Small Pistol Primers	.115"	.125"	.1745"	.1765"
Large Rifle Primers	.123"	.133"	.2105"	.2130"
Large Pistol Primers	.115"	.125"	.2100"	.2120"

Many times the cases you receive will have the minimum depth dimensions and the primers may be at the large end of the specification. You can see how you would end up trying to put a long square edged object in a shallow hole with rounded corners. To prime the case so the primer is flush with the case head you could end up crushing the primer quite a bit. This is why we recommend performing a primer pocket uniforming operation on your cases, especially new cases.

Make sure the primer pocket uniformer has a hardened or carbide stop to prevent cutting the pocket too deep when you uniform. The stop collar or shoulder on your uniformer does two things. First, it will maintain a correct cutting depth so that all the primer pockets have the same correct depth. Remember, everything is about consistency. Secondly, the primer pocket uniformer stop collar should keep the cutter square with the case head. This establishes a parallel relationship between the case head and the bottom of the primer pocket so the primer will also be parallel with the case head.

If you are uniforming by hand, the procedure for uniforming is to insert the cutter into the primer pocket and turn the uniformer in a clockwise direction.

*Uniforming by hand*

Keep firm pressure on the uniformer while turning it until the stop collar of the uniformer ends up squarely seated against the case head. After you have turned the tool completely a couple of turns, remove it to clear the chips. Then re-insert the uniformer and make another turn or so until you can feel it stop cutting. Clear the chips again if any are present and you are finished.

If you are turning under power, the case is usually fed onto the cutter and pushed against the stop collar for a second or so. Then pull back to clear the chips and feed onto the cutter again. When you are uniforming under power with a drill motor or drill press, the tool speed should be kept under 1100 RPM and chips should be cleared frequently.

Some reloaders, when using a primer pocket uniformer for the first time, are surprised about the amount of brass that is removed. This is when the pockets are very shallow. On other cases, you may find that the uniformer won't reach the bottom of the pocket. If you don't see any shiny marks on the bottom of the pocket your primer pockets are probably at the maximum end of the SAAMI specifications. This will happen occasionally. Don't worry about it. As the cases are fired, the brass will flow into the pockets and you should see the cutter start to engage the pockets after a few firings. Generally, even on deeper pockets, the outside edge of the cutter knocks off most of the radius between the wall and the bottom of the pocket. If you have a uniformer with an adjustable cutter stop, we do not suggest setting it deeper to clean the pockets.

We recommend using the uniformer each time you prepare the case for a subsequent reload. As you fire cases, residue from the primer collects in the bottom of the primer pocket and it needs to be cleaned out. Also, you will be maintaining a uniform pocket depth as brass flows into the pocket with each firing.

Remember, primer pocket uniforming tools only cut vertically when used properly. Therefore, any looseness felt in the primer pocket while you are priming new brass is due to the manufacturing process and not the uniforming process. Looseness felt after a few firings may indicate that you have soft brass, or it can be an indication of high pressure. Any signs of high pressure, like loose primer pockets, should be taken seriously.

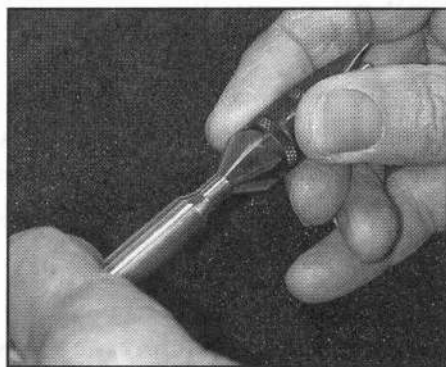
Case trimming/Case mouth deburring/chamfering

We will discuss the mechanics of case trimming in a later chapter. Unless you are using cases formed from a parent cartridge such as 6PPC cases formed from 7.62 x 39 cases, we suggest leaving case trimming until

after the first firing. You may want to check your new cases' length and see how they compare to the dimensions in your reloading manual. If they are longer than maximum, you should trim them down to at least the maximum length recommended. Failure to maintain proper case length can result in bullets being crimped in the case as the end of the case neck and the bullet enter the throat at the same time. This can result in dangerously high pressure. Regardless of whether you trim now or later, you will need to deburr and chamfer the inside and outside of the case mouths prior to using them. If you are neck turning, your new cases can wait for trimming until after you have completed the neck turning operation.

The case mouth usually has a sharp, burred edge that can be a source of trouble, especially when using tightly seated bullets, oversized bullets, and any kind of flat based bullets. The sharp edge formed during the manufacturing process or after neck turning or case trimming will scrape the bullet jackets as you seat them into the case neck. A badly scraped bullet will not seal the case evenly and may enter the rifling canted as the bullet exits the case. Failure to deburr cases properly will probably show up as a higher reading on the concentricity gage.

A standard case neck deburring tool is easy to use and it just takes a few seconds to perform the task. Most tools such as the L. E. Wilson, RCBS, Redding, Lee, etc., are double ended for deburring the outside and chamfering the inside. Begin by inserting the cone shaped end into the case mouth. Press the tool into the case mouth while turning the tool in a clockwise motion. It should only take a couple of twists to cut a nice shiny chamfer on the inside surface. Then change ends of the tool and deburr the outside edge with a couple of twists.



Case mouth deburring

If you are operating a case mouth deburring tool under power using a Sinclair deburring tool holder, maintain low RPM and do not get too aggressive with the cutting. It is quicker to do the chamfering on all the cases at once, then reverse the tool and do the outside deburring. If you are using some of the special deburring tools with a more severe taper, make sure you don't over do it by going too far into the case.

We will come back to the actual task of case trimming later but if you need to case trim now, go ahead and read that section in Chapter 6.

Outside Neck Turning

Outside neck turning is a task that some reloaders may never perform. There are only about three reasons why you would ever want to turn case necks;

- 1) Cases are neck turned to reduce wall thickness, thus reducing the outside diameter of the loaded round neck. This permits the round to be loaded in firearms with tight necked chambers. Usually these cases will be neck turned so that there is approximately 0.001" of clearance all the way around between the case neck of the loaded round and the rifle's chamber. This means the loaded round will measure 0.002" smaller at the neck than the neck diameter of the chamber.
- 2) Cases are also neck turned to create uniform wall thickness. Reloaders wanting to true up brass with inconsistent neck wall thickness will often neck turn.
- 3) In situations where you form a case from a parent cartridge and the wall thickness needs to be reduced, a reloader may use neck turning to reduce the thickness. This is more commonly done, however, with a neck reamer. We feel the best way to do this is to ream a portion of the wall thickness away with the neck reamer, then remove the rest by neck turning. This will result in uniform neck wall thickness.

One of the most common questions we are asked is, "Should I be neck turning my cases for my non-benchrest rifles?" This question has two right answers, yes and no. The answer is yes if the brass neck wall thickness has poor uniformity and it is beyond culling out a few bad cases. The answer is no if your brass is fairly uniform to begin with. As we mentioned during the case sorting discussion, we suggest culling out cases that have neck wall thickness variances greater than 0.0015". In the previous sorting activity you should have identified what cases and how many fell into this limit or whatever limit you set for this group of cases.

If you only have a handful of cases that fall into the unacceptable neck wall thickness variance category, we suggest you do not outside neck turn these cases but cull them out. One good reason not to neck turn would be to prevent excessive expansion of the neck when it is blown out to seal the chamber. This can result in short case life. A second reason might be that there is added case prep work involved in neck turning. This latter reason,

however, should not be a consideration if you are searching for all the accuracy you can get.

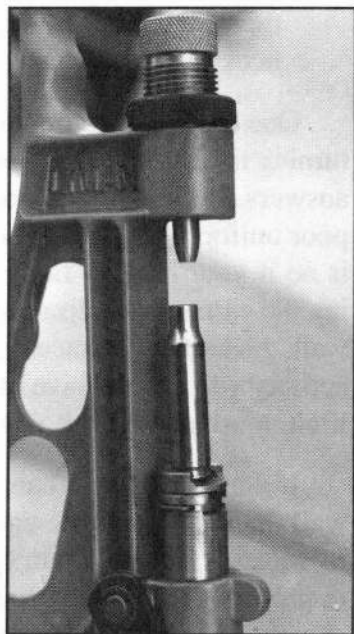
Let's assume though that a high percentage of our brass had neck wall thickness variances outside of our range so we decided to outside neck turn. We are going to use the Sinclair Phase I Neck Turning tool as a basis for the neck turning instructions that follow. There are several other tools out there that will do the job well. The principle is exactly the same whether you are using a Forster, Sinclair, Wilson or some other type of neck turning tool.

One of the most important factors in preparing a uniform case neck is getting a proper fit between the case neck and the mandrel or pilot on your neck turning tool. The desirable relationship will be a case that turns easily on the mandrel but is not so loose that it is sloppy or so tight that it locks up.

To achieve that "perfect" fit you may need to size the case necks prior to neck turning. You can size them with your full length die, a neck die, or a special expander die. To get a good fit on the neck turning tool mandrel, the expander ball in the sizing die or the expanding mandrel should measure approximately 0.0005" to 0.0015" larger than your neck tool's mandrel.

Most expander balls or buttons are pretty close to the above relationship when compared to our neck turning mandrels. But, if you have someone else's tools, check it out. There are a couple of custom tools out there that have oversized mandrels that will require a special sizing mandrel to get the proper fit. If you are using our tool, you may get an ideal fit by using our expander die and our specially sized expander mandrels. These expander mandrels are slightly oversized to open up the neck to just larger than the turning mandrel. They are sized to allow for some brass springback, the amount will differ slightly among brass manufacturers.

Another way to get a good case to mandrel fit is to buy two (2) mandrels for whatever neck turning tool you have and polish one down. Just chuck one up in a drill or drill motor and polish it with emery cloth.



Straightening/sizing a case neck with an expander body (Sinclair)

Use the polished mandrel for the neck turning tool and the unpolished one for an expansion mandrel.

Regardless of the expansion method you use prior to neck turning, make sure you run the cases over some type of mandrel or expander ball. This step "irons" out any wrinkles or dents in the case neck and transfers any irregularities to the outside of the neck where they can be removed during the neck turning process.

After you have straightened out the case necks, make sure to debur/chamfer the case mouth prior to neck turning. We will first discuss setting up a tool to clean up case necks for a standard (not tight necked) chamber. Ideally, we would like to have the cutter clean up approximately 70 - 80% of the neck surface. To set up your tool, use the culled cases you found during the case inspection and sorting process.

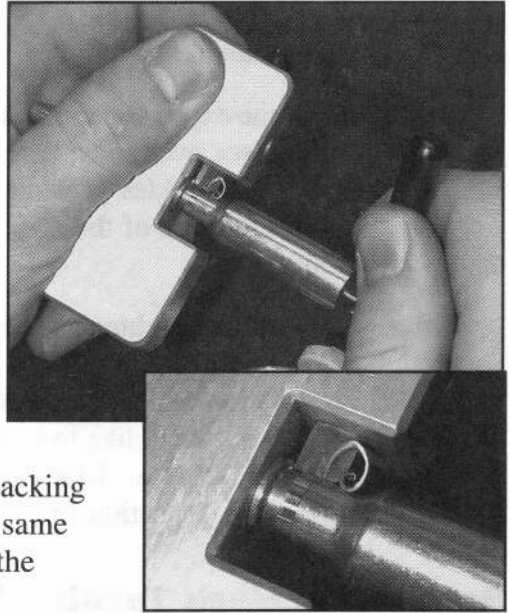
Set up and Neck Turning for standard chambers

- 1) Lubricate the neck turning tool mandrel with a good quality lube (Imperial Die Wax, STP, Hornady One Shot Lube, Pro Blend).
- 2) Back the cutter out, away from the mandrel, leaving room for the case neck to slip underneath the cutter.
- 3) Put a culled case into the case holder or neck turning handle and rotate the case clockwise onto the mandrel until the case neck is in position under the cutting point of the neck tool cutter.

NOTE: Neck turning tool cutters such as ours have cutters ground with a relief angle so only a single point actually cuts, similar to a lathe tool. This is why the entire cutter is not perpendicular to the mandrel.

- 4) Adjust the cutter downward until it almost makes contact with the case neck. Tighten the cutter lock screw firmly, but not too tight.
- 5) Back the case off the mandrel by rotating it clockwise while gradually moving it off the mandrel.
- 6) Without unlocking the cutter lock screw, advance the cutter downward just a bit.
- 7) Advance the same case onto the mandrel while turning it in a clockwise manner. The speed at which you turn the case is not important, but what is important is that you advance the case slowly past the cutter.

8) Continue to advance the culled case onto the mandrel until the cases' neck/shoulder junction reaches the cutter point. For proper neck turning, you need to neck turn all the way up to this junction. Be careful not to cut too far into the shoulder because you can weaken the case in this area.



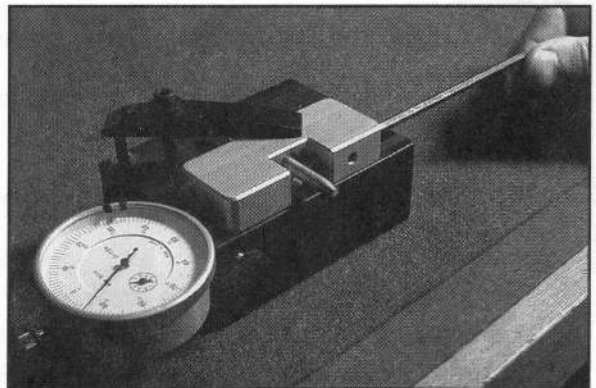
9) Continue to rotate the case in a clockwise motion, but start backing the case off the mandrel at the same speed you used to turn it onto the mandrel.

Neck Turning by hand

10) When the case is off the mandrel, inspect it carefully in strong light. You should see dull and shiny areas if the tool is set up correctly. You may need to advance the cutter a little more so that when you cut the case again the dull spots make up 20-30% of the surface neck area. These dull spots are where the wall thickness is thinner. If you try to adjust the cutter to clean off all the dull spots, then you have probably cut the wall thickness down too thin.

11) If you need to cut a little deeper, repeat steps 6-10. If you have advanced the cutter too far, you need to start over again at step 2. This is the trial and error part that you have to do if you are not using an Adjustment Fixture like ours. It isn't as bad as it sounds.

12) Once you have reached a setting that you feel is correct, lock the cutter down securely to make sure it doesn't change.



Using an Adjustment Fixture to set up a neck turning tool

13) Now you need to adjust the mandrel

position so that when a case mouth hits the stop/shoulder on the mandrel the case shoulder/neck junction is just at the cutting point.

- 14) If you have a case neck micrometer or tubing micrometer you may want to check the wall thickness to make sure too much brass isn't being removed. If you don't have a tubing micrometer (ball style), you can get real close with a pair of calipers. Just load a bullet up into the case neck (no powder/no primers) and measure the outside diameter of the case neck. Subtract the bullet diameter from this measurement and divide by 2 to get the neck wall thickness.
- 15) Now, as you begin to turn cases, try not to rush the cases on and off the mandrel. Cases turned onto the mandrel too fast will be evident by the spiral marks cut into the case neck. Slowly on, slowly off is the secret to good looking turned necks.

Here are some things to remember:

- a) Periodically, you will need to re-lube the mandrel and clean it off using some fine steel wool and solvent. You don't need to remove the mandrel to clean it.
- b) Get a small stiff brush and clear the chips after each case is turned.
- c) Make sure the case is not too loose on the mandrel.
- d) Ackley or other improved cases may need a specially ground cutter since most cutters are relieved for traditional shoulder angles.
- e) Make sure to case mouth debur/chamfer before and after neck turning.

Set-up and Neck Turning for tight necked chambers

Neck turning procedures are not any different for tight neck chambers except for the set-up. For a tight necked chamber you need to turn the case necks to a pre-specified neck wall thickness. For most reloaders who have a tight necked chamber, we recommend turning the cases so a loaded round will measure 0.002" smaller than the known neck diameter of the rifle's chamber. If you don't know this diameter (it's usually stamped on the barrel), contact the gunsmith who chambered it or make a chamber casting with Cerrosafe.

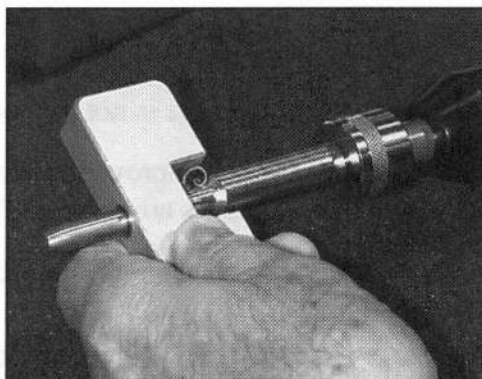
For example, let's say the chamber is a 6mm PPC and is chambered with a 0.262" neck diameter. We would like our loaded rounds to be 0.260" in finished diameter. Let's assume we are using a bullet that mea-

sure a true 0.243". Subtract the 0.243" from the 0.260" and we get 0.017". The 0.017" is the neck wall thickness of both sides together. Divide by 2 to get 0.0085". So, for our 0.262" neck diameter, we need to set our tool to cut wall thickness to 0.0085".

The difference here, from the standard chamber neck turning tool instructions, is that you continue adjusting the cutter downward turning a case and checking it with your micrometer. Continue in this manner until you have reached the desired setting. In this example we would be happy to get within ± 0.0002 " of our 0.0085" goal.

When you are turning cases for a tight neck chamber keep your ball micrometer handy and periodically check the neck thickness to make sure the cutter has not moved. Also, measure a loaded round to check the outside diameter. Measure at the base of the bullet or above if the base extends below the neck/shoulder junction. Once you have the neck turning tool adjusted, the procedure for turning cases is the same as it is for standard chambers. Clear the chips, clean the mandrel frequently, and keep the mandrel lightly lubed. Slowly on and slowly off is the secret. NOTE: If the cases require a lot to be removed in this process you may want to make two passes with your neck turning tool.

Neck turning can be a fatiguing job, and this is a case preparation task that you might consider powering. Use of a powered shellholder similar to the one pictured will turn a hard process into a fairly easy one. Just make sure you control the feed rate of the case onto the mandrel.



Powered neck turning with a case driver (Sinclair)

Inside Neck Reaming

We briefly mentioned inside case neck reaming in a previous section, but now let's go into a little detail. Some reloaders may need to neck ream before fireforming.

The purpose of neck reaming at this point would be to remove any excess wall thickness remaining from a case forming operation. Remember that neck reamers, unless included in a neck reaming die,

remove material by following an existing hole. They simply enlarge the hole. If the wall thickness was not uniform to begin with, it will be that way when you are finished reaming. Since you haven't fired your cases yet, you should full length or neck size the cases. It doesn't matter as long as you use a die that sizes the entire neck.

Standard inside neck reamers are usually fairly large in diameter and may remove more material than desired. Select a reamer that is slightly larger than the inside diameter of the case mouth, but large enough to remove as much brass thickness as you want removed. You may find that you have to order a special reamer.

Neck reaming is simple to do and is usually done on a case trimmer. Mount your reamer in place, put the case in the shellholder or collet, then rotate the reamer and advance it into the case mouth. You may have to back the reamer out and clear chips occasionally depending on the amount of material being removed. If you are tempted to use a cutting lubricant, remember that you will have to clean it out of the cases prior to loading them. Make sure you ream all the way through the neck. You will feel the reamer release into the case as it finishes cutting the neck.

Some forming operations require neck reaming only to remove an internal doughnut at the neck shoulder junction. This happens to some PPC shooters that use 220 Russian brass. When using a reamer for doughnut removal, you should size the reamer so it just barely touches the neck. This way it won't cut too much before it reaches the doughnut, and it usually takes only a few turns to remove it.

Some benchrest shooters neck ream and neck turn to get to their desired case wall dimensions. This gives them a uniform neck, a properly sized neck, and a clean, smooth internal surface for bullet seating. Our cases are now properly prepared, and we are finally ready to move on to some actual loading.

Chapter 4

Initial Loading

We have sorted, deburred, uniformed, neck turned, and reamed our cases and we are finally ready to load them. Our initial load for these new cases is sometimes considered a fireforming load. This is due to the fact that, with some cartridges, we actually finish forming the case in the chamber. For example, the Ackley series of cartridges which have a 40° shoulder angle need to have the shoulder blown out with the first firing. The fireforming loads for some of these cartridges are not always the same load you would use once they are fireformed. There are all kinds of special tricks handloaders have used for fireforming, such as using faster burning powders, putting the bullet into the rifling, using an inert filler, lubing the case lightly etc. We are just mentioning these and if you are fireforming cases for wildcats, we would suggest referring to any literature you can find that is specifically for your cartridge. If you are loading for a standard cartridge you can use loads right out of the reloading manual for the initial loading.

Primer Seating

Let's turn our attention to the case priming operation. Seating primers is something we believe is best done by feel. We have uniformed our primer pockets so all of our cases have a very uniform primer pocket depth. As we discussed in the equipment section, make sure you purchase a priming tool that will allow you to feel the primer bottom out as you seat it.

The priming procedure is no great mystery. With repetitive use of the tool of your choice you will begin to develop a feel for it. Concentrate on feeling the primer "bottom out" in the primer pocket. When you feel the primer "bottom out" ever so slightly, you have already given it a pre-load of approximately 0.005". In some tests that Fred ran several years ago he found that this seemed to be the right amount of pre-load. Take some of your "culled" cases and prime them beyond that point to get a feel of how far not to go.

Some of the big name priming tools on the market today possess exceptional leverage, but are manufactured from materials that inhibit the feel of the seating process because of friction. Always keep the working surfaces

(pivot, cam, etc.) of any priming tool lightly lubed, not only to avoid wear, but to reduce friction and increase feel.

A few words about handling primers. Primers are the most dangerous component in the reloading process. Always keep them in their original container except for the hundred that you have loaded into your dispersing tray. If you have "hoards" of them, as some of us did in the mid-90's when Federal primers were scarce, try to keep them physically separated.

Our opinion on handling primers has not changed over the years. Some reloaders feel that the oil on your hands contaminates them. We do not feel that handling primers by hand contaminates them in any way. It's not like you are changing your truck's oil at the same time. All you are handling is the cup that holds the priming compound and the priming compound is protected anyway. Enough said about that.

Regardless of the tool you choose for priming, keep in mind that most of the tools on the market hold the cartridge case on the upper side of the case's rim. Case rims can become damaged by extractors. When you are inspecting cases, always keep an eye out for this kind of damage. Such damage may result in a "poor feel" and misalignment during primer seating.

We suggest you start out with Remington or Federal primers. Federal offers standard and also Match primers, which we understand are standard primers sorted for uniformity. If you have a few primers left over from one lot but not enough to shoot a match with, you can use these for fireforming or initial loads. Now get your cases primed and we will move on to loading powder.

Loading Powder

NOTE: You may want to review the section after this on bullet seating prior to loading powder. Some of the activities in that section should be performed before dropping powder.

Using your measure and scale properly.

Loading powder accurately and consistently is largely a matter of technique. Each reloader must develop his/her own technique with the powder measure. Your powder measure and your ability to throw powder consistently are extremely important factors in loading for accuracy. This is why you will see some shooters weighing every charge. Your scale is an absolute necessity when changing loads or switching to a new powder that you do not have data for.

Treat your powder measure and scale like the precision instruments they are because they are both important parts of the accuracy equation. Wipe your powder measure out occasionally. Keep a dust cover over your scale, an old towel will do. If you pull the drum out of your measure for any reason, be careful, some of the edges are razor sharp.

Let's set up the powder measure and scale for use. If you are loading at home, you will want the powder measure to be anchored in a powder measure stand and to a very heavy bench or table. The more it can move during use, the greater the chance of inconsistency. Make sure the stand does not flex too much. Locate the measure so it is in a comfortable position to use, and the drop tube is at a height where it is easy to hold either an individual case or a loading block under the drop tube. When your measure is brand new (read manufacturer's instructions first) you may want to cycle several dozen charges through it to break it in. Some new measures may have a film of oil on the drum or insert that should be removed prior to use. Just cycle them into a clean empty container or back into the powder bottle.

The location of your scale is extremely critical. Most importantly, it needs to be used on a level surface. This is critical for the scale to measure correctly. Any fans or vents nearby should be turned off or closed while you are weighing since air movement is extremely detrimental to the accuracy of your scale. Place your scale in a position where you can see the readings comfortably. With a balance beam scale this may mean elevating it so you can see the indicator easily. Once you have your scale in place and your powder measure ready to go you can select a powder.

The initial load for your cases can and should be taken from one of the better reloading manuals that has tried and true proven data. As we mentioned earlier, the Sierra manual, Hornady manual, Hodgdon manual, Speer manual, and Nosler manual are all good examples of manuals which have proven and accurate data. You may also want to consider writing to some of the powder companies such as Hodgdon, Vihta vuori, or Accurate since these companies usually have small pamphlets that cover loads for just their powders. It is also a good idea to cross check one manual against another.

Select a powder for your cartridge that has a mid-range burning rate among the different powders recommended for that cartridge. Do not use a powder that you happen to have a surplus of unless it is recommended. Do not start with someone else's pet load without at least reducing it first, especially a load

from a benchrest shooter. They normally start with a hot load and go up. Start with a low to medium charge weight of powder and work up gradually.

Remember that case capacity is at its minimum when the cartridge is brand new. Also, keep in mind that case volume will differ between manufacturers and from lot to lot. The load that works perfectly in one lot of brass may not work as well in another lot. A good example of this is 220 Russian cases formed to 6mm PPC and 6mm PPC Sako cases. The 220 Russian has a greater case capacity than the Sako, and we have found that while AA2015 worked best in the Sako it didn't work as well as H322 in the Russian case.

The loads in the manuals were worked up in different cases than yours and in different rifles than yours so start low and work your way up watching for pressure signals. (See Table III below). If you have a chronograph, you should chronograph your loads and watch the velocity. If the velocity starts to exceed the maximum velocities listed in the book, proceed with caution. As long as the velocity is somewhere in the listing, don't worry too much if the same load and bullet you used doesn't give exactly the same velocity as the one listed in the book. They may differ as much as 100 to 200 fps.

Table III
Excessive Pressure Signals

- 1) Primer's cratering severely or flowing back around the firing pin hole.
- 2) Blown out primers.
- 3) Gas leakage around primer, pitting on bolt face.
- 4) Enlarged primer pocket.
- 5) Case head expansion.
- 6) Shortened case life.
- 7) Ejector or extractor marks clearly visible on the case head.
- 8) New cases are hard to extract after firing.

Now briefly a few words about powder lots. All powder will vary in burning rate from lot to lot. No matter how tight the controls are at the powder plant the lots won't always be the same. Therefore, the lot you use may be much faster than the lot that was used for the test data in the reload-

ing manuals. H322 is a prime example of a powder whose burning rate differs greatly from lot to lot. Some early H322 was surplus GI powder, current production H322 is manufactured in Australia, and there is the standard Hodgdon H322 made in the USA before the move to Australia. The point is to be aware of what lot of powder and how much of it you are putting in your cases. This is a good reason for not starting with the maximum charge.

When powder is thrown with a powder measure it is thrown by volume. But, we check that volume charge by weighing it on a scale. These are two completely different methods of measuring and both will be affected by temperature and humidity. These two variables can affect the actual size of the powder charge and therefore the velocity and the accuracy of your loads.

If you are loading for a wildcat cartridge, you may need to look a little harder for load data. Use reference magazines or sources such as Wildcat Cartridges published by Wolfe Publishing. Be aware that some of this data may be old and some of the powders listed may not even exist today.

If you are using military cartridges, remember that they are usually thicker walled, and therefore have lower case capacities. Most reloading manuals are written for those using commercial cases and most of them recommend lowering the load when using military cases. We agree with the recommendation in Hodgdon's manual to reduce loads by 15% for military cases.

You have picked a powder and are ready to start. The instructions for most powder measures will list some "approximate point" to set the measures' dispensing meter or micrometer so you are close to the desired charge. Dial it to that setting and throw at least ten (10) throws through the measure to get the powder settled down in the hopper or reservoir. After you have dumped these ten throws, throw one into the scale pan. Be careful that powder doesn't go all over the place. Weigh your charge and move your setting up or down as needed. We usually weigh at least two (2) good throws before feeling comfortable that the setting is correct. Now you can throw your charges.

Some reloaders like to weigh every charge. We started doing it ourselves for longer range competitions. The availability of electronic scales has led to more shooters weighing each charge. We question the accuracy of some electronic scales as they seem to vary by 1/10 of a grain, at least, which may not be any more accurate than your measure. We use a balance beam to weigh charges for long range shooting.

With crank style measures, we suggest that each reloader find their own method of using the measure and develop a feel or rhythm for it. Some reloaders use a tapping stroke to make sure every grain of powder has been dispensed into the drum and then tap again to make sure it has dropped from the drum. The tapping is done by reversing the crank at the end of the stroke and then cranking back so the handle taps again at the end of the stroke. We use two light taps at the top and bottom of each stroke.

Regardless of whether you use a tap stroke or not, make sure you make your strokes/throws consistent in speed. This allows the powder to settle into the drum the same each time and also permits the powder to compress in the case consistently. We suggest throwing all the charges in your loading block at one time instead of throwing one charge and seating a bullet. You will get a more consistent rhythm of throwing this way.

If you have a situation where you are using a powder charge that fills the case completely and you need to get more powder into the case, try using a longer drop tube. A longer drop tube makes the grains of powder fall further and compress better in a natural fashion. We feel a 6" drop tube is the maximum length that most reloaders would need, but we have seen reloaders using drop tubes over two (2) feet long.

Bullet Seating

Bullet seating depth is critical to the accuracy of most cartridges. We suggest seating the bullets for your initial loads so the bullet is just shy of the rifling or possibly just touching the rifling. **REMEMBER, THIS IS NOT DONE WITH A MAXIMUM LOAD, ESPECIALLY WHEN FIRE-FORMING.** We feel that when the bullets are seated just to the rifling during fireforming, the round centers itself in the chamber. This will help give you a more evenly fireformed cartridge. It will also help eliminate the bulge appearance on one side if you have a maximum sized chamber.

To seat a bullet so it is just touching the rifling, one must know the distance from the bolt face to where the rifling begins in the throat of the rifle. This distance will be different for each type of bullet even if they are the same weight and style. For instance, a Sierra 52 grain boat tail and a Berger 52 gr. boat tail might have different ogives which would cause them to contact the rifling at a different point on the bullets surface. Just being made on different dies can make bullets differ in their contact locations. This distance will change over time as the throat erodes from firing. How fast the throat erodes is dependent on the barrel steel, the cartridge, the powder, the bullets, and especially on how hot of a load is being used.

There are several ways to determine the true overall length (OAL) to the rifling, and some are more accurate than others. One method used by some handloaders is to smoke the surface of the bullet with a candle or color it with a marker. They create a dummy round (no powder/no primer) and chamber it. They then play with different seating depths until they can see the engraving of the rifling on the smoked or inked surface. Not only is this time consuming, it can also be very inaccurate. The big problem with this method is that the bullet can be easily disturbed when the dummy round is being chambered and ejected from the chamber. A smoked bullet will not usually show the rifling marks until it is forced into the rifling at least 0.005" to 0.010". If the rifling engraves the bullet to the point where the marks appear horizontal to the bullet's center line, you can be sure that the bullet has been forced into the rifling at least 0.020".

CAUTION:

If you insist on smoking a bullet to check the OAL, never do so with a loaded round. Never chamber a loaded/live round unless you are ready to fire it. We have heard of people doing this at their bench, and it is wrong. We have enough fingers pointing at us already, so let's prevent any accidents.

Another method to obtain OAL is to place a bullet into the chamber (bullet only) and hold it against the throat with a piece of dowel rod or a pencil. Then insert a cleaning rod or long dowel rod into the bore from the muzzle until it just touches the tip of the bullet. You then draw a line on the rod or dowel at the muzzle. Now, remove the bullet and replace the bolt so it is in a closed position with the chamber empty. The rifle should remain in a cocked condition. The rod or dowel is inserted into the muzzle again and positioned against the bolt face. A second line is drawn on the cleaning rod or dowel rod at the muzzle and a measurement is made between the two lines. This measurement gives the handloader the OAL. The biggest problem with this method is marking the lines accurately and taking a good measurement between two pencil lines with calipers. As you can see, some of these homemade techniques have some real pitfalls for accurate measurements.

There are more accurate ways to find this important measurement. One of the tools made specifically for this purpose is the Stoney Point Chamber-All™ OAL Gauge. It is extremely easy to use and takes about 15 seconds to obtain a measurement. This is nice because you may be

trying to find setting depths for many different bullets as you experiment during load development.

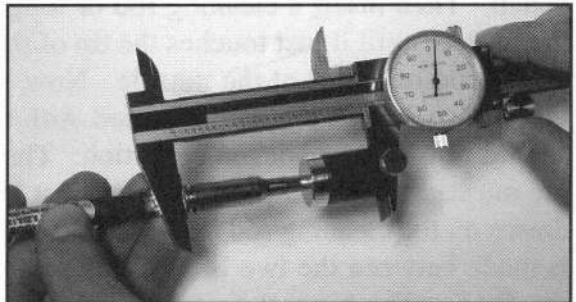
The Stoney Point tool uses a special dummy cartridge which is threaded onto a hollow tube that has a pushrod through the center. The mouth of the dummy cartridge has been opened up at the factory by several thousandths of an inch larger than the bullet diameter. The bullet you wish to find the OAL for is placed into the case mouth on top of the push rod. The cartridge tool combination is inserted into the chamber until the shoulder of the case comes in contact with the shoulder of the rifle's chamber. The push rod is advanced slowly until the user feels the bullet making contact with the rifling, then the push rod is locked in place and the tool and bullet is withdrawn.



Chamber-All™ tool in chamber (Stoney Point)

Even if the bullet sticks in the rifling and doesn't come out with the case, the pushrod is locked in place so the setting is preserved. You can push the bullet out with a cleaning rod if it gets stuck.

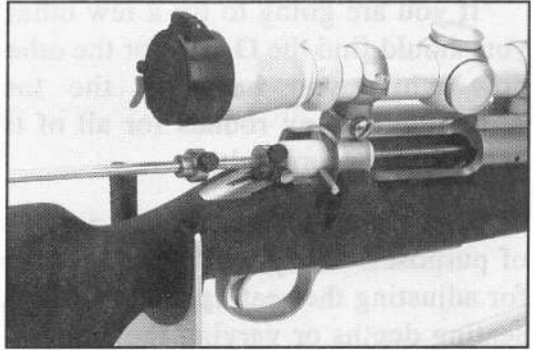
You can now measure the OAL using a caliper from base to tip or with a bullet comparator measuring from base to ogive. More about bullet comparators in a few more paragraphs. The Stoney Point Chamber-All™ tool is quick and fast and the only inaccuracy is that you are using a cartridge that wasn't fired in your chamber. This could result in a maximum deviation of approximately 0.005" which is something you can work with.



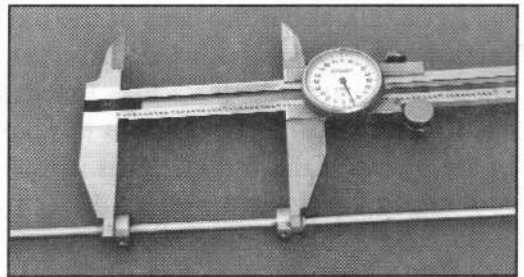
Measuring overall length on Chamber-All™ tool base to tip

The Sinclair Seating Depth Tool is used through the chamber end of the action, and is a two step operation. The tool consists of a Delrin™ bolt guide, a measuring rod, and two measuring stop collars.

To determine OAL, place a bullet into the chamber making sure the bullet is in the throat. Place the guide into the action like a bolt, insert the rod into the guide and move it forward until it pushes the bullet against the rifling. Place a stop collar on the rod and lock it in place up against the bolt guide. Remove the tool and bullet from the action and insert a fired case into the chamber. Leave the spent primer in place and use the measuring rod to make sure the case is all the way into the chamber. Lock down the other stop collar and withdraw the tool. To remove the case just insert the bolt into the action and it will extract the case. Then measure, using your calipers, on the outside edge of the stops to get the distance from the bolt face to the base of your bullet as it touches the rifling. To get the OAL, simply add the length of your bullet to this dimension. When measuring your bullet, measure base to tip or base to ogive with a bullet comparator.



Sinclair Seating depth tool inserted into action



Measuring seating depth on Sinclair tool

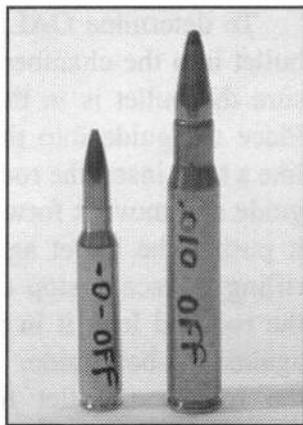
CAUTION!

Seating the bullet to the rifling may increase the pressure with loads you are currently using. Reduce normal loads and work your way up or down until you develop a load that is both accurate and safe. Be cautious not to exceed the measured OAL.

Once you have obtained the OAL for the bullet you have selected, we recommend you assemble a “dummy” round. A “dummy” round consists of a case and a bullet, NO POWDER, NO PRIMER! Use the very same bullet or bullets used to get your OAL measurements. The dummy round should be the same length as your OAL. Mark the dummy round with a marker listing the bullet make, weight, and OAL.

If you are going to try a few other bullets, you should find the OAL's for the other bullets now while you have all the tools out. Assemble dummy rounds for all of them and mark them accordingly.

These dummy rounds will serve a couple of purposes. They will serve as a benchmark for adjusting the seating die when trying other seating depths or varying the amount of "bullet jump" to the rifling. The distance from the bullets ogive to the rifling is sometimes referred to as "bullet jump" or "how far off the lands". Secondly, the dummy round will serve as a reference for determining the amount of throat wear in the future.



dummy rounds - bullet make, weight and OAL is marked on other side

Let's talk about the uses of the bullet comparator. In the equipment section we talked about the different types of bullet comparators, but all of them provide the same information. The bullet comparator is used for measuring OAL from the base of the cartridge to the approximate ogive of the bullet. This information is used to adjust the seater accurately since most bullets differ in length when they are measured from base to tip. Some bullets out of the same box will vary as much as .015" when measured from base to tip. But, when measured to the ogive with a comparator, each bullet should be fairly close in length to the others.

The comparator also enables you to change the seating depth accurately by measuring the newly loaded round against the "dummy" round. If you want to seat the bullet .010" shorter, measure the new round with the comparator and adjust the seater until the measurement is .010" shorter than the "dummy" round comparator measurement.

Let's set up the seater for some initial fireforming loads. If you are only going to shoot one particular bullet, the seater will already be set up since we used it to make the dummy round. One way to make the dummy round is to slowly adjust the stem of the seater down while continuously checking OAL length with a comparator and calipers. It is a trial and error process. You can also use the thread pitch table (Table IV) and get real close with a couple of movements of the seating stem.

If you are using a Stoney Point Seating Depth tool and a Wilson style hand seating die, there is a quick way to set up the seater. Place the Seating depth tool with the modified case and bullet on the edge of a bench top so the case and bullet protrudes above the bench top. Back off the stem of the Wilson seater and place the seater over the top of the modified case and bullet so the base of the seater rests on the bench top. Then screw the stem down slowly until you feel it touch the bullet. Now the seater stem should be in approximately the correct adjustment to seat a bullet on the rifling. Double check this by loading a round and checking it with your comparator against the dummy round.

If you do not want to fireform with the bullet touching the rifling, back off the seating depth 0.005" or 0.010" from the rifling using the comparator to make changes. Your rounds should measure 0.005" or 0.010" shorter than the dummy round you saved.

Adjusting the seater up or down is relatively easy if you have a micrometer based stem. If you don't, a conversion of degrees of rotation calculated for threads per inch is listed in the table below. A Wilson straight-line bullet seater uses 24 TPI, a Redding 7/8" - 14 style seater use 20 TPI, Forster uses 32 TPI on their .22 caliber and 6mm seater and 28 TPI on their 25 caliber and larger seater. At the time of printing RCBS uses 28 TPI and Hornady uses 18 TPI. You can see that it doesn't take much rotation to move the seating depth considerably.

Table IV

DEGREES OF ROTATION				
TPI	90°	180°	270°	360°
32	.008"	.016"	.024"	.032"
28	.009"	.018"	.027"	.036"
24	.010"	.021"	.031"	.042"
20	.012"	.025"	.037"	.050"
18	.014"	.028"	.042"	.055"
16	.016"	.031"	.047"	.062"

If you are planning to shoot moly or Danzac™ coated bullets and will be breaking in a new barrel while you are firing these initial loads, you may want to refer to chapter 10. Moly coated bullets may be somewhat ineffective when used during barrel break-in, and Danzac's™ manufacturer recommends shooting uncoated bullets for the first fifty rounds in a new barrel.

Once you have checked your first few rounds with the comparator for the desired OAL go ahead and load up the rest of your cases. Head out to the range to do your fireforming. Don't forget your cleaning equipment if you will be fireforming a lot of cases at one time or breaking in a new barrel.

Chapter 5

Load Testing/Load Development

Well congratulations, you are back from the range and you were successful with your fireforming. You are now ready to find the best load for your rifle and then fine tune it. Your work during this phase should be well recorded. Everything you try or change should be recorded in a log book. You may want to go back sometime to a load that you tried earlier and it's great to have a record of exactly what it was and how it worked.

Preparation for Sizing

Your cases have now been blown out to conform to the dimensions of your rifles' chamber and will need to be sized. Most bolt rifle cartridges will require only neck sizing at this point, but semi-autos will need to be full length resized. We will discuss both types of sizing in this chapter. Before we size, we need to clean up the cases.

Cases need to be cleaned for a few reasons. One reason is to keep the grit from building up in the dies and wearing them out. The second reason is so that we can inspect the cases for problems. The most important reason is to avoid carrying debris into the chamber.

The first step is to clean the inside and outside of the case neck. Residue from the powder collects on the case neck, but usually will not be heavy on the case body. Streaks of soot on the case body is an indication of poor sealing of the case neck to the chamber. This is usually due to a light powder charge.

Clean the inside first with a neck brush of your choice. RCBS, Redding, Hornady, Lyman, and others make them. Forster makes a five (5) brush case prep tool that cleans the inside and outside of the case neck. They are made to work in a power drill. If you are using the brushes by hand, just insert the brush and twist it on the way in and on the way out. That's all there is to it.

The outside of the necks can be cleaned with all sorts of materials. Some reloaders use Neverdull, a polishing material you can get at your local hardware store. Others use a product called "Krazy Kloth" which is a treated polishing cloth. We usually use a chunk of "000" steel wool. We

like steel wool because it does not leave any residue. Many handloaders use a tumbler with treated media to clean their brass. We tumble our brass almost all the time. If you do tumble, we suggest doing it before ejecting the spent primer so media doesn't stick in the primer pocket.

Look the cases over after they are cleaned up or while you are cleaning them. When the cases are clean it is much easier to inspect for cracks in the case neck area or to see any lines that might suggest case head separation. Inspect the primers and case heads for any signs of possible high pressure. Throw away any cases that are damaged or look as if they may be a potential problem. Some handloaders prefer to deprime their cases in a separate step from the sizing process. They feel it should be kept separate to avoid disturbing case alignment. We feel depriming does not disturb the case geometry and therefore we do it as part of the sizing operation. If you wish to deprime as a separate step, now is the time to do it.

Neck Sizing with Hand Dies

The material in this section deals with neck sizing using hand dies and an arbor press. A large portion of this section is also applicable to those handloaders using bushing style 7/8" - 14 threaded dies.

The hand die is one of the most versatile and flexible dies available. They are portable and easy to use. Hand dies are great if you have limited space to load in. It permits the user to control the amount of sizing being done to the case neck by using interchangeable bushings which are available in 0.001" increments. Hand dies work the brass less than standard dies, and are more portable for field use (mainly due to the press size). The L. E. Wilson dies and similar custom shop dies such as Custom Products are good examples of quality dies in this category.

The bushing feature allows you, the handloader, not the die manufacturer, to control the amount the die reduces the outside diameter of the case neck, regardless of the neck wall thickness. Since it works on outside diameters only, there is no need for an expander assembly. A great deal of sizing problems (non-concentric cases) can be traced back to expander mechanisms.

Since you are in charge of determining the amount of sizing that needs to occur, the selection of the proper sizing bushing is of vital importance. There are two basic methods for determining the correct bushing size. We will discuss both of them.

The first method requires you to load a round with the bullets you are using. If you are neck turning, this needs to be done after neck turning. Load a piece of new brass with the bullet you will be using. Measure the outside diameter of the case neck with calipers or a standard micrometer. Measure just down from the case mouth to make sure that you measure a point on the neck where the bullet body is. Subtract 0.002" from that measurement to get the bushing size. If you are measuring cases that have not been neck turned, you may want to subtract 0.003". Whatever measurement you obtain after subtracting would be the bushing size you would want to start with first. If you are working with brass that has non-uniform wall thickness, you may want to measure several rounds to get an average measurement. Rotate the case 90° and check the diameter at that point to see if there is much difference in the measurements. If you are loading for a bolt action rifle with a magazine, use a bushing diameter 0.003" smaller than your neck measurement. You will need the extra bullet grip to hold the bullet in place under recoil.

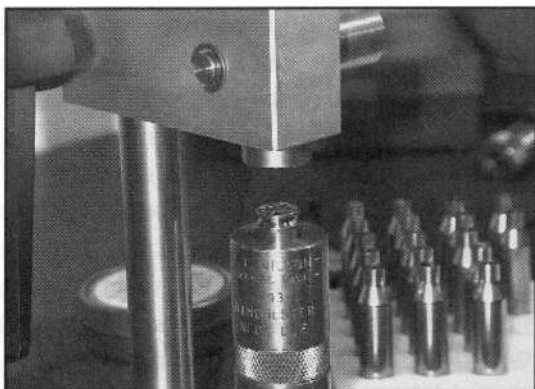
The other way to measure for bushing size is to use a Case Neck Micrometer or a ball micrometer to measure the neck wall thickness. Measure the case neck wall thickness in a couple of different places on the neck. Multiply this dimension by two (2) and add the bullet diameter. If you are using oversized benchrest bullets either measure the bullets with a micrometer or ask your bullet maker what dimension the bullets are. This total dimension is what a loaded round should measure if it were assembled. Subtract either 0.002" or 0.003" from this dimension to obtain the correct bushing size.

Sometimes it is nice to have a bushing on either side of the pre-determined size. As brass is fired and the necks become thicker, you may need to change to a larger bushing. If you are using coated bullets you may need a slightly smaller bushing.

Dies like the L. E. Wilson hand dies size only the upper 40% of the case neck length. The Redding 7/8" - 14 dies that utilize bushings allow you to vary the amount of neck length being sized.

Once you have selected a bushing, remove the top of the die and insert the bushing so the number/size is positioned up. These bushings have a close tolerance fit in the Wilson dies and require careful alignment when being inserted into the die. NOTE: Bushings placed with the number/size down will size approximately 0.0005" smaller due to the slight taper of the hole in the bushing.

Hand neck dies are used with either a leather mallet, an arbor press, or a tong tool. Using an arbor press is, by far, the most popular and preferred method of operating this type of die. Sit the neck die on top of a die base with the opening facing up and insert a case neck down into the die. The die and die base are then moved under the head of the arbor press. The arbor press is worked to push the case completely into the die. The case head should be completely flush with the machined top surface of the die. This simple action sizes the case neck and positions it for depriming. Flip the neck die over and replace it in the die base. Position it under the arbor press head again and use the press to push the decapping rod downward until you feel the spent primer eject from the case. This same stroke also ejects the case out of the die. The spent primers are captured under the die base for future disposal.



Case entering neck die



Arbor press pushing the sized case out of the die while depriming

The following procedure is used when using a mallet for sizing with the hand die. With the die grasped firmly in one hand, insert the cartridge and drive it into the die so it is flush with the die surface. Then flip the die over and one sharp rap with the mallet will knock out the spent primer and eject the case from the die. We don't recommend the mallet method.

Some reloaders do not like the mallet method because they do not like the pounding impact on the case. Others feel this pounding action helps loosen any powder residue that has built up in the case. **If you use a mallet make sure that none of the cartridge cases have live primers in them.** The anvil side of the primer is extremely sensitive, and the slightest rap can set off a primer. If it is set off in an unloaded case, the primer will be propelled out of the case with enough energy to penetrate your hand.

Neck Sizing with Threaded Dies

Many customers, when attempting to upgrade their equipment or technique, ask us “Can I use standard 7/8” - 14 loading dies and still assemble accurate reloads, or must I use hand dies?” The answer for most applications is, yes you can use 7/8” - 14 dies. The 7/8” - 14 threaded dies and press can produce fine reloads, as long as they are producing concentrically sized cartridges and concentrically loaded cartridges. There have been some really great 7/8” - 14 dies produced, especially in the last 5 years.

The concern with threaded dies is due to all of the mechanical complexities involved. When one uses a threaded press, it is not just a matter of screwing a die into the press and pumping the handle. If you stop and think for a moment about what goes on with the operation of threaded press, it should become apparent to you that there can be many factors which could contribute to making non-concentric ammo. Let's look at it.

Put a die and a shellholder into your press and work the handle up and down a few times. Give some thought to what happens when you size a case, take a look at all the machined surfaces on the press casting that must be square or parallel.

- 1) Is the press ram perfectly aligned with the 7/8” - 14 threaded die hole?
- 2) Does the ram have excessive clearance in the hole through the casting? Does it have too much slop?
- 3) Is the shellholder machined parallel? Is it centered in the press ram, and is it parallel to the machined surface of the 7/8” - 14 hole?
- 4) Is the outside diameter of the die concentric with the inside diameter? **IMPORTANT!**
- 5) Is the decapping unit centered in the die?
- 6) Is the decapping shaft centered in the lock nut?
- 7) Is the expander ball drilled and tapped on center? We have seen off centered ones many times.
- 8) Is the decapping shaft straight?
- 9) Is the expander diameter concentric?
- 10) Is the lock ring parallel to the mating surface of the press when installed on a die?

Does all of the above sound like trifles? It really can be, but a half a thousandth contribution by each of these factors could add up to twice the acceptable concentricity of a loaded round.

Thread a die into the press far enough so the press handle can not be lowered all the way. Back off the die body lock nut so that it is not contacting the press, gently move the handle up and down so the ram/shellholder makes contact with the bottom of the die. You should see the die move slightly due to the thread clearance between the die and the press. Hopefully, if you view this from two (2) points that are 90° apart, the movement will be vertical and not a pivoting movement that might indicate some sort of misalignment.

Some alignment problems are supposedly corrected by the loose fit of the cartridge in the shellholder. However, this would mean that the machined surfaces of the shellholder must be smooth and parallel. The shellholder should also attach to the press ram in a manner that will be perpendicular to the die body. Today, the majority of loading presses retain the shellholder with a snap ring. The ring, unfortunately, applies pressure to the left side of the shellholder, automatically placing it off center to the right. Many reloaders replace the snap ring with a small rubber band or "o"-ring. This permits the shellholder to float, allowing the die to align the cartridge. The downside to removing the snap ring is that it allows excessive cartridge case movement which usually requires the handloader to help start the cases into the die.

A very slight amount of lubricant on the mating surface of the press ram and the shellholder may also help improve case alignment. Remember, it is not important that the cases fit tightly in the shellholder, they need to be free enough to self align. Always keep the recesses in the shellholder cleaned out.

To neck size with a threaded neck sizing die, install the die into the press until it is just touching the shellholder when the press ram is in its upmost position. Hold the ram against the bottom of the die while you lock down the die body lock ring. This will help square the die to the ram. Then place a case in the shellholder and, with the decapping assembly lock nut loose, raise the case up into the die. Raise it completely then bring the case down until you feel the expander ball re-enter the neck. While it is in this position, lock the decapping assembly in position with the lock nut. This should help align the decapping assembly. Check the pin alignment to make sure it is centered in the flash hole. Go ahead and neck size.

Generally, no lubricant is needed for neck sizing, although many reloaders use a touch of die wax, some powdered graphite or moly on the neck. If you are using wax, just touch the case neck into the wax so a slight film of wax is on the edge of the case mouth. This should be enough to lubricate the downsizing operation of the neck die body and the upsizing operation of the expander ball.

Full length Sizing

Many of us try to extend the life of our cases beyond their useful and safe limits. Repeated full length resizing will take it's toll on the longevity of case life. In bolt action rifles that are properly put together we have almost always achieved better results with neck sizing as opposed to full length sizing. We have occasionally, however, run into a rifle that would only shoot well with full length sized cases. In each one of these rifles a chamber inspection revealed that the chambers' throat was off center with the bores' centerline. So, if you have a rifle that shoots better with full length resized cases, why fight it. Feed the critter what it likes.

Even though you are neck sizing most of the time, you will have to full length resize your cases from time to time. When the cases are new it may be every four or five firings, then it may be every three or four or even two or three firings depending on the cases and your loads. The cases will become tight in the chamber when they need full length sized. They will be hard to chamber, and especially hard to extract. When you full length resize you are usually doing three things; 1) Setting back or "bumping the shoulder"; 2) Sizing the body inward; and 3) Neck sizing the case. The first of these involves cartridge headspace and it is probably the most important. Before setting up the full length die a brief discussion of headspace is necessary so you understand what you are doing and why you are doing it.

Cartridge headspace in a rifle chamber is very important. Simply stated, headspace is "the amount of forward and backward movement of the cartridge case in the chamber when the breech or action is fully closed". When a chamber is reamed by a gunsmith there are maximum and minimum dimensions that SAAMI specifies for the chamber. This determines the headspace of the rifle's chamber. The gunsmith checks the headspace of the rifle with "go" and "no go" gages to make sure he doesn't have excessive headspace or insufficient headspace. Excessive headspace can lead to serious problems such as case failure. Insufficient headspace prevents the chambering of cases into the rifle. Thus, since each rifle has

potentially different chamber headspace, you can understand why we don't recommend using brass fired in more than one rifle.

When you full length resize, you adjust the headspace of the cartridge case. When brass comes from the factory it usually is sized so that it will correctly chamber with enough headspace. But, if your rifle was chambered to the minimum dimensions and the brass was formed to maximum dimensions you will probably have a problem with headspace until the brass is sized down enough.

Normally most full length resizing dies, if adjusted all the way down in the press, will change the dimensions of a case so that it will chamber easily into your rifle. Easy chambering is fine, but a die adjusted this way can create excessive headspace which presents two problems for the reloader striving for accuracy. One problem is that there will be excessive forward and backward movement of the case in the chamber when it is fired. This could be a cause for a loss of accuracy. Secondly, and as important, this "extra" sizing and movement of the case under pressure can lead to shorter case life. After all the case prep work that was done, no one wants that.

If the handloader desires the standard headspace dimensions for the cases, then setting up the full length die is quite easy. With the arm of the press in its highest position, simply thread the full length die into the press until the die meets the shellholder. Lock down the die body lock ring. This position will give you "standard" headspace, and the die will size the case down to the maximum amount that it can. We only recommend this position in circumstances where you are reloading cases that will be used in different rifles chambered for the same cartridge. What we do recommend is that you adjust the die so that minimum sizing occurs to allow smooth feeding of the cartridge into the chamber. It is important to adjust the die in the following manner if you are loading for "Wildcats" because of the lack of standardized chamber dimensions. Quality die manufacturers will usually have the procedure for achieving minimum headspace with their dies included in their instructions. The instructions might be slightly different than the procedure described below with regards to the amount of initial upward movement of the die, but the rest should be basically the same. This method is one way of setting up the dies for minimum headspace but it is a somewhat "crude" method. We use this method frequently, but not always.

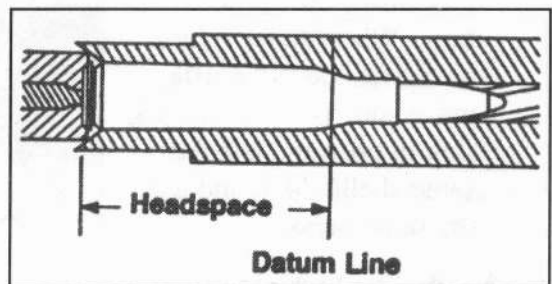
Screw the full length die into the press so the die is in contact with the shellholder when the ram is in its highest position, then back the die off

(thread it back out) approximately a 1/2 turn. Turn the lock ring away from the press flange to permit easy movement of the die. Leave the lock ring unlocked. Place a lightly lubed case in the shellholder and run it up into the die as far as it will go. Remove the case from the die and chamber the empty case in your rifle. A better feel can be attained by removing the firing pin assembly from the bolt. Feel the bolt movement to see if the action/breech closes with difficulty. If it does, which it probably will, reinsert the case into the press and adjust the die downward a small fraction of a turn (try an 1/8 of a turn). Try the case again in the chamber. We want to feel the action close easily, but without sizing the case more than necessary. Repeat the adjustment of the die until you feel the action close easily. When you are satisfied with the way the bolt feels on closing, size another case to be sure of the setting. Now the lock ring can be turned down to hold the setting. The above procedure is a tried and true method for adjusting full length dies correctly, but there are some other ways that are a little more accurate. There are several tools available to help you set up full length dies and achieve the proper headspace adjustment.

L. E. Wilson makes cartridge case gages for almost all of the currently popular cartridges. These case gages are machined to represent a rifle chamber and they have a slightly oversized body and neck to allow for chamber differences. The gages do have the precise SAAMI length from the cartridges' datum line to the case head. Datum line is a term used by reamer and die makers to describe the center of the shoulder. See Figure 3 below.

These gages are extremely accurate and are valuable for setting up sizing dies to achieve proper headspace. By inserting fired brass into this gage and using a caliper you can measure the case prior to setting up the dies. What you are measuring is the length of the case from case head to datum line. This measurement allows you to set up the die, size the same case, then measure it again to see the effect the sizer made on the headspace of the case.

Figure 3



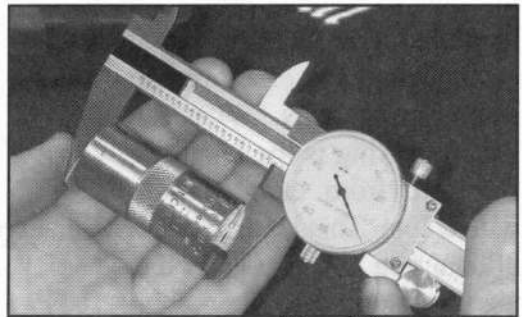
Once the rifle is chambered, you have no control over the headspace of the chamber. You can, however, control the headspace of the loaded

rounds by matching them to the chamber. Setting up the full length die to perform minimal sizing will greatly increase brass life, and more importantly, the safety of your equipment.

When loading for belted magnum cases one can use a Wilson Adjustable case gage. These cases normally headspace off the belt of the case, and the belt dimensions can vary considerably. With the use of this gage the handloader can size the cases so they headspace off the shoulder.

The following are the basic steps to use a standard Wilson case gage.

- 1) Insert a fired, unsized case into the case gage.
- 2) Measure the depth or protrusion of the case head in the gage. Measure from the case head to the top of the gage.
- 3) Record this measurement for future reference.
- 4) Begin adjusting the full length die downward from its original position (1/2 turn above the shellholder). Size the case and remeasure in the case gage. Note the difference between the original measurement and the new measurement. The difference is the amount that the shoulder was bumped back or sized.
- 5) The reduction we want from the fired, unsized case measurement is approximately 0.002". This would be ideal. The difference should never exceed 0.005".
- 6) Keep repeating step 4 until the desired 0.002" of sizing is achieved.
- 7) Once you have reached the correct amount of sizing, lock down the die lock ring. When doing future sizing for the same rifle, make sure to leave the lock ring in position, use the same shellholder, and use the same press.



Using a Wilson case gage

Another tool which will help you set up the full length die accurately is the Stoney Point headspace gauge. This tool attaches to the caliper blade, and is machined to represent the shoulder portion of a chamber. You can measure a fired case at the datum line. Follow the same basic proce-

sure as with the L. E. Wilson gage by measuring a fired, unsized case to establish a reference point, then adjusting the die as needed.

The shoulder sizing amount of 0.002" that we mentioned earlier is ideal for most hunting, varmint, and plinking rifles. Some benchrest shooters only bump the shoulder back approximately 0.001" so the case is well fitted to the chamber. These shooters will usually use a special made bump die which is basically a full length die with the neck opened up to prevent any neck sizing from occurring. The bump die may also be made to use Wilson type bushings to size the neck at the same time. These dies used to be available only through gunsmiths who specially made them for their customers. Redding now makes the same basic die, either as a body die (no neck sizing), or as a full length bushing-type die.

When you begin full length sizing, remember to lube the cases. You only need a light amount of lube on each case to size properly. Excessive lube will build up in the die, and you will see small dents in the shoulder as a result. The excess lube indents the case when the case is put under pressure inside the die. We sometimes lube every other case if we are only doing minimal sizing on a small case. Clean your full length dies regularly to prevent excess lube from building up.

Finishing Case Prep

We usually deprime cases during the sizing operation. We will uniform the primer pocket again to remove primer residue and powder blow back and also to ensure that all of the cases continue to have the same primer pocket depth. Use the same procedure as covered in Chapter 3.

Now is a good time to check the case length against the length listed in the manual. If the cases are near maximum, we need to trim all the cases back approximately 0.010" from maximum. This should set all the cases to the same length. We will discuss case trimming in greater detail in a section later in this chapter.

Using the same brand and lot of primers, prime all the cases in your batch. We may alternate primers later in the load testing process, but it is one of the last things we vary. Remember to prime the cases so the primer just bottoms out in the pocket to achieve uniform ignition. When priming the cases check for primer protrusion as you remove them from the priming tool and put them back in the block. Just run a thumbnail over the case head and primer as you make the move from tool to block. Not a big deal, just an extra check.

Once the cases are all cleaned up, sized (either neck or full length), and primed we are ready to start loading up a series of test loads. There are many ways to approach load testing, and the method we describe is not the only way, but it has worked quite successfully for us. We encourage you to develop your own methods for load testing and follow them as faithfully as a scientist would in a lab. That is essentially what these next steps are; a series of experiments to develop the best concoction of powder, bullets, primers, and seating depth for your rifle. Keep careful records of what you try and what the results of the trials are. We cannot emphasize how important accurate and thorough records are to the reloader. You must know what you have done in the past.

An easy way to keep good records is to get a logbook like the one we make, or make your own and keep it in a 3-ring binder. At a minimum, keep records of the cases you used, primers, powder type, powder weight, lot #, bullet type, bullet weight, seating depth reference, # of shots fired, group size, weather conditions, etc. If you want additional information like chronograph information, allow space for it.

Load Testing

As you begin load testing to find the most accurate load for your rifle, you need to concentrate on only one variable at a time. There are several items that can easily be changed in the loading formula including primer brand, powder, powder weight, bullet type, bullet weight, and seating depth. You can change casings and possibly bullet grip, but leave those for further experimentation. If you change more than one variable a time and there is a change in your grouping (good or bad), how will you know what caused the change?

We normally change the powder first and use the following procedure:

- 1) Select a good match quality bullet such as a Sierra MatchKing or a good custom match bullet such as a Berger, Starke, Fowler, Watson, etc.
- 2) If you have not done so already, obtain the seating depth for the bullet you will be using and assemble a dummy round for that bullet with the overall length touching the rifling.
- 3) Set up the seater to this overall length, then adjust it downward 0.010". Start your load testing with the bullet 0.010" off the rifling.

- 4) Select three powders from the load manual and select a medium velocity load. Some manuals suggest a powder which worked best in their test gun. It may not be best for your gun, but it is probably worth trying.
- 5) Load six (6) cases with each powder (same weight for all 6 cases). This will give you 18 loaded rounds. Load 2 extra for foulers.
- 6) Seat the selected bullets to a seating depth 0.010" off the rifling for all 20 cases.
- 7) Let's head to the range.

You are at the range with your first test loads, and you are ready to start testing. Hopefully, the weather is cooperating and you have calm winds and maybe just a touch of overcast skies. For competitive benchrest shooting we sometimes intentionally test in conditions other than this (more about this later). Use the 100 yard range for testing at this time. Record the conditions, especially the temperature. Fire two (2) different, three (3) shot groups with each different load and measure the groups with your calipers. Use the "burnt" outside edges of the bullet holes furthest apart for the placement of the caliper blades. Subtract the bullet diameter from this measurement to get the group size.

Remember, the record keeping is important since you may want to return to this data later. Looking at the groups you shot, there will probably be one powder that stands out as being a little better than the others. Select that powder as the standard for further load development. Look at the cases fired with that load and the cases fired with the other loads to make sure none of them were too hot. If any cases showed pressure signs, record what you observed. You may come back to these powders again. If there are no pressure signs on the cases which shot the best group, load some more cases with that same powder. Load three (3) cases with the initial load and six (6) cases with a slightly higher load (don't exceed the maximum listed). If you are not doing all of this at the range, you may want to load another six (6) cases with the initial powder charge and adjust the seating depth an additional 0.010" off the rifling. We can keep repeating different load scenarios for you to try, but the important thing is to change only one variable at a time. In this case, you have the initial load that showed promise. Keep everything the same except the powder charge so you can see whether the additional powder was beneficial to accuracy. On the other six rounds you only changed the seating depth from the setting of the initial promising load. We hope you get the gist of this. You

will develop your own methodology with practice, and you will learn where to take shortcuts and where not to. Powder selections are numerous, as is bullet selection for most calibers. Primers are the last variable that we would suggest changing. The difference between a Remington primer and Federal primer is noticeable and worth looking at, but will not normally make as much difference as powder, bullets, or seating depth will make in group size. If you notice a big difference between primers, a firing pin spring problem may exist.

Seating depth variations can have a tremendous impact on accuracy. Seating depth is also one of the factors reloaders can vary unlike shooters using factory loads who are stuck with the factory setting. Our past experience has been that most .22 caliber centerfire rifles perform best with the bullets 0.010" to 0.020" off the rifling. Most .25 caliber and 6mm rifles perform best when the bullet is just touching or 0.010" off the rifling. The larger calibers seem to work best when just touching the rifling. This rule is not "carved in stone" since each rifle is unique, but it generally has been a reliable guide for seating depth. If you are having trouble with a particular rifle and it doesn't seem to respond to minor changes, do not hesitate to increase the amount of "bullet jump". You may find it beneficial.

Once you find the best seating depth for one particular type of bullet, you can normally use it for another bullet. You still will have to find the overall length to the rifling for the new bullet, but the same amount of bullet jump (distance away from the rifling) will probably work.

For example, let's say that you worked up a load using a Sierra 53 grain MatchKing that works extremely well in your 22-250 varmint rifle. Checking the 53 grain Sierra against your original dummy round, you find that it is 0.020" shorter. This, of course, tells you that your good load preferred the bullets 0.020" off the rifling. Remember, the dummy round was assembled from measurements that had the bullet touching the rifling.

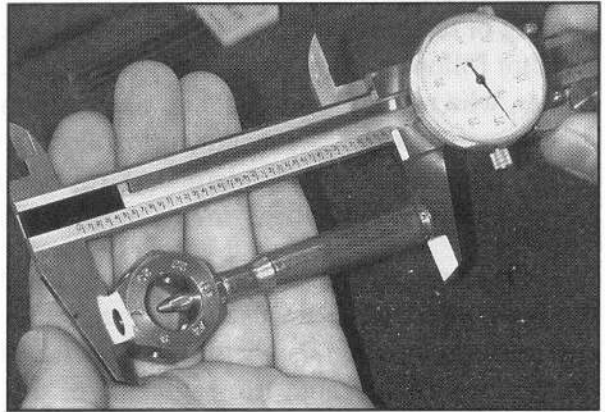
Now try a Nosler 55 grain Ballistic Tip in your 22-250. First find the seating depth to the rifling for the Nosler bullet using your choice of tools and make up a dummy round. Measure the dummy round with a comparator and note the length. Now adjust the seater so the assembled rounds with the Nosler 55 grain bullets are 0.020" shorter than the length of the new dummy round.

Based on our past experience, doing the above steps will provide you with the best seating depth for the new bullet, or it will be very close. It is our belief that the ideal seating depth, (referred to as bullet jump or the

amount of free bullet travel prior to lands contact) is a constant for a given rifle. In other words, while overall cartridge length (OAL) will vary with bullets of different weights and shapes, for best accuracy the relationship of the bearing surface of the bullet and the origin of the bore's lands will almost always remain the same. The OAL, however, must be adjusted occasionally to maintain this relationship by compensating for the amount of throat wear in the barrel. The frequency of adjustment will depend on the cartridge being used, the intensity of the powder charge, and on the number of rounds fired. Two questions are frequently asked by new reloaders when they are learning about the importance of seating depth:

- 1) Why can't I just measure to the tip of the bullet without using the comparator?
- 2) Why is the seating depth for one bullet different than another brand/style of bullet?

Let's address the use of comparators first. Bullets out of the same box can vary (especially hollow points) as much as 0.025" in length when measured from base to tip. These base to tip length variations may not affect the accuracy of the rifle directly, but when these measurements are used to establish the seating depth they will affect the accuracy of the rifle. When you set up a dummy round with one bullet, and then set up the seater using a different bullet, you have probably set up the seater incorrectly with respect to the bullet's relationship to the lands or beginning of the rifling. Your loaded rounds could be as much as 0.025" away from the rifling or 0.025" into the rifling.



measuring cases with a comparator

When you measure two bullets out of the same box using a comparator, the base to ogive measurement that the comparator gives you is a lot more consistent. Thus, when you use a bullet to establish a seating depth baseline, the bullet you use for setting up the seater won't be a problem as long as you use the same comparator.

Remember that comparators are made so they measure a bullet from a fixed diameter on the bullets ogive. Any variation in the bullet's length due to the point of the bullet becomes an insignificant factor. This fixed comparator diameter will be approximately the bore diameter of the barrel. Bore diameter is normally about 0.008" smaller than the bullet diameter.

The comparators are indispensable when adjusting the seater for a different seating depth. It again ignores the variances in base to tip length between bullets so the seater can be adjusted accurately.

The second question of why seating depth is different for different types, brands, and weights of bullets is relatively easy to address. Bullets from different manufacturers or different styles by the same manufacturer often have different lengths from the base to the ogive because of variations in the shape of the ogive. The different bullets will make contact with the lands in different places along with the bullets ogive making the OAL different. Different dies used to manufacture the same bullet will produce different dimensioned bullets.

You will often find that you are handicapped by a throat that is too long when loading for some factory produced rifles. If your rifle likes rounds with bullets seated close to the rifling, the OAL may be too great for cartridges to function through the magazine. This is okay if you are varmint hunting or target shooting and you can load one round at a time using a single shot follower or by hand feeding each cartridge into the chamber. The hunter, who usually wants backup rounds in the magazine, is forced to use the magazine OAL. Some hunters will load a longer, more accurate round in the chamber and put standard OAL rounds in the magazine. This is fine since there is usually no significant point of impact change.

Many competitive shooters shooting CMP or NRA Service Rifle face the same problem. They use longer and more accurate rounds in the slow fire portion of the course of fire then switch to shorter OAL rounds when going through the rapid fire segments of the course. The slow fire segments of fire require the shooter to single feed cartridges.

The OAL measurements of a loaded round published in the loading manuals are only reference figures to use for making cartridges which will feed through the magazines of most commercially produced rifles. This published measurement is base to bullet tip. It doesn't hurt to check against it, but you will mainly be concerned with searching for a more accurate OAL.

WARNING: All of our discussion has been centered around the overall length (OAL) of loaded cartridges. When we discuss not using published OAL data, we are talking about careful measurements of the OAL to the rifling and watching carefully for any signs of high pressure. Rounds should be loaded so bullets are not jammed into the rifling when using maximum or near maximum powder loads. None of our discussion has been about ignoring cartridge length which is referred to as trim length. Excessive case length can lead to crimped bullets and result in dangerously high chamber pressure.

As you work with overall length and experiment with different seating depths you will find that adjusting seating depth is best done in increments of 0.005" until you are reasonably satisfied with the accuracy. At that point you might try smaller changes to see if there is any significant improvement. This phase of reloading is when micrometer seaters such as the Redding, Forster, or Wilson seater equipped with a Sinclair micrometer head comes in handy. These dies enable you to enter micrometer settings in your log book so you can easily switch types/weights of bullets and then return the seater to it's original setting.

In summary, we spent a lot of time talking about seating depth and OAL. We did this because it is an extremely important factor in the accuracy chase. Other than choosing the right powder and bullet, there is nothing you can do to the rounds to make them more accurate than adjusting the seating depth. Let's talk about some techniques you can use during your load testing to help make good adjustments.

Chapter 6

Final Observations on Reloading

When looking at groups for results the first thing you want to make sure of is that there were no other factors, other than the load itself, contributing to accuracy problems.

We will discuss different proven benchrest shooting techniques in another chapter that may help you with good load testing. One important technique with respect to load testing is to “call your shots”. Learn to be aware of what is going on as you pull the trigger and be able to “call your shots” without looking. Calling your shots is routinely done by shooters in several disciplines. Simply put, it is the art of knowing when you flinched or pulled the rifle down and knowing where the shot went. A benchrest shooter may pull the trigger and see a flag change at the last second and say to himself “that shot went left” or a highpower shooter might drop his hold and say that shot went down and right. Why is this important? It serves as a positive correction to a problem so you, the shooter, can make adjustments accordingly instead of wondering why the shot went out. With load testing it helps determine flyers that were caused by shooters and not by the load. This is extremely important.

As you look at the groups, you should look for consistency in your pattern. If you see your shots are in more of a vertical dispersion then there is usually something in the load that is not right. Make sure it is due to the load and not a headwind or tailwind that you may have missed. Ignition problems can lead to vertical groups also. This might include primers that are too hot, a problem firing pin spring, a piece of primer material stuck in the firing pin protrusion hole, a burr on the bolt shroud or a trigger problem. We have seen a lot of problems that are due to faulty triggers.

Horizontal dispersion of your shots is usually a good indication of the wind. They are referred to as “weather reports” by many shooters. Seriously, they are usually a good sign that the load may be okay but the conditions are tough or the shooter is having trouble gaging wind direction, intensity, etc.

If you consistently get double groups (two shots in one hole and three in another separate hole or group) it can be an indication of a scope prob-

lem. If this situation occurs and your groups begin to get larger, check the scope mountings. Loose rings are very often the culprit. Check this before you start changing your loads.

When a gun that shoots fairly well gradually starts shooting worse, you might check throat erosion against one of the dummy rounds. We have restored many so called "shot out" barrels to their original accuracy by simply adjusting the seating depth so the bullet jump was the same as it was originally. On custom rifles, you may want to check that the barrel is on tight. Many shooters have had barrels work loose. This is especially true on switch barrel guns. Check the scope mounts or remove the scope and replace it with a known quality scope. Scopes do go bad and usually all at once.

Fouling can be another reason for the gun failing to shoot well. Make sure the gun is cleaned routinely and that the barrel does not get too hot. If you are shooting moly coated bullets, make sure the coating has not built up in the barrel.

The following is a list of questions to ask yourself regarding your load and/or bench technique when having accuracy problems. This isn't an all inclusive list since we always find something strange that has an affect on accuracy. We are assuming the wind isn't the problem.

Rifle shooting well and then the groups open up, not all of a sudden, just a gradual trend.

- 1) Check scope rings and bases to see if they have worked loose. This condition is especially prevalent in light weight, heavy recoiling rifles.
- 2) Re-check seating depth. Construct a new dummy round with the same type of bullet and compare it to the original round with the same comparator. If throat erosion has taken place it is time to chase the rifling. Those of you shooting hot rods like the Swift and some of the Ackleys need to really watch this.
- 3) Check the bore to see if excessive fouling is evident.
- 4) If you have given up on everything else and you have access to another scope of known quality, stick it on the rifle.

Groups open up suddenly/abruptly, rifle had been shooting well.

- 1) Repeat #1 and #3 of the last problem. Always check the rings and bases. Did you bump the scope?
- 2) Check the powder measure to make sure the setting is correct and hasn't been moved inadvertently. Weigh a charge if you have to.
- 3) Did you change to a new lot of powder? You may have to reset your measure to adjust for the new powder. Many times we have found a new lot just isn't what the old one was. This is frustrating when you buy a 1 lb can of something and it works like gangbusters so you buy an 8 lb can and it doesn't shoot worth beans.
- 4) Have you changed bullets? Did you re-adjust the seater? Did the seating stem vibrate loose? It happens.
- 5) Have you changed primers or the lot number?
- 6) Review your technique at the shooting bench. Go over your equipment. If the rifle is positioned so the pistol grip is too close to the rear bag it can ride up on the ears of the bag during recoil. The result will be inconsistent travel of the rifle causing some vertical stringers.
- 7) How's the weather? Has the temperature changed significantly since the last time you shot? Some powders will be affected by as little as a 15° F temperature change.

For a little more analysis of the quality of your reloads let's look at the concentricity of the sized cases and loaded rounds.

Concentricity Observations

Checking the concentricity of loaded cartridges should be an important consideration to the precision shooter. Observe it, but don't get wrapped up in it too much if you are having success on the target.

Measuring concentricity is usually done on a "concentricity gage", clever name, eh! Some reloaders call them runout gages. They basically all do the same thing. The tool usually centers around a v-block support or some sort of multi-part support that the case rides on and a dial indicator is suspended above the case. The dial indicators recommended usually are capable of displaying 0.001" variances. Anything more sensitive than this would be nearly impossible to use just because of the movement of the case. The dial indicator tip is set so there is slight pressure on the case as

the case is rotated in the v-blocks. The reloader observes the amount of runout or the concentricity amount that the dial indicator displays.

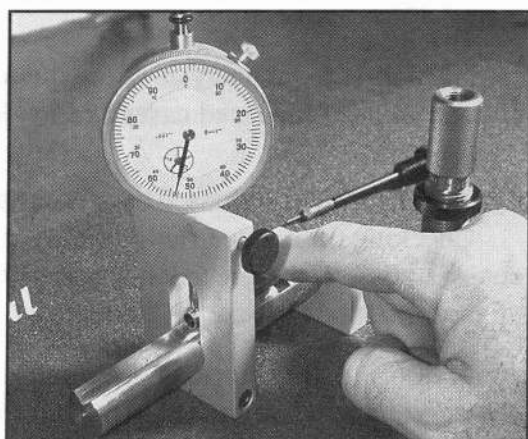
Runout or concentricity is the amount that the case is off center to the centerline axis of the case. Many tasks occur before the brass is ready to shoot which can lead to unacceptable concentricity. This unacceptable runout can occur for several reasons. Neck wall variances or severe body wall variances could be the cause, the reloading dies can cause problems, any burrs on the inside and outside of the case can create concentricity problems. The press can also contribute to additional runout.

What is acceptable concentricity? When loading neck sized cases that have been neck turned, run through the Wilson style bushing dies, loaded, and then run through a Wilson style straight-line bullet seater a reloader should be able to achieve runout around 0.002". If you have cases that have not been neck turned and are being run through 7/8 dies you should be able to achieve finished loaded runout of around 0.004".

Now, if the runout is above those figures, lets look at what we can do to reduce the amount of runout and improve the concentricity. The best way to figure this out is to start at the beginning and see where the greatest impact to concentricity is occurring. It is usually is due to the quality of the brass, the sizing operation, or the seating operation. We normally start by analyzing the sizing operation.

First, check a couple of fired cases right out of the chamber, in a concentricity gage and see what the runout is. They should be pretty close to showing no runout on the gage. If they show significant runout, either your chamber is a little off or you may want to check your use of the gage. The dial indicator tip should be positioned so it is bearing right above the midpoint of the neck.

Next, clean the cases up and run them through your sizer (same procedure for neck or full length sizer) with the decapping assembly removed. This step will give you the amount of runout produced by the sizing chamber in the die. Record the runout for



checking a case for runout

each case and mark the cases on the case head so you can check them later if necessary.

Now, reassemble the die and run the cases back through the die with the decapping assembly in its normal position. Record your observations again. Again, the dial indicator tip should be just above the midway point on the neck with light pressure from the indicator's spring. This is normally where you will find the majority of your problems. It can be an expander not centered on the rod, a bent decapping assembly, an out-of-round expander ball, or a poor finish on the expander ball.

Now, check the cases' concentricity after the seating operation. Place the loaded round in the gage with the dial indicator tip positioned on the case neck just above where the base of the bullet would be. Spin your case and record the runout.

With all of that done, you should have a pretty good idea of where the majority of the runout is occurring. If the runout increases after sizing, with the expander removed, and it is excessive (greater than 0.004") then you may want to try some other brass or talk to your die manufacturer. You probably have a die with an off center or out-of-round neck. Try cleaning the die neck area with some Shooter's Choice Quicksrub and some patches. Dies should be cleaned frequently as residue from the brass and case lubricants can build up in the die. Other than that, you might want to try another shellholder, check your press, or you may want to try a friend's die.

If your data indicates that the excessive runout is occurring when the expander/decapping unit is in the die then you have a good chance of being able to fix this problem. You can begin by looking at the expander ball to see if it is off center on the rod. We have seen some terribly off center expander balls before. If it looks out-of-round check the decapping assembly rod for straightness. You can usually strip them down to the rod and roll them on a flat surface such as a mirror to see if they are crooked. If it is, replace the rod. If the expander ball looks rough, polish the ball a little with emery cloth or even work on the ball with a stone to knock off any rough edges. Try not to reduce the overall diameter because you will increase the bullet grip. Again, this is an advantage of bushing dies - no expander!

Several years ago Forster began installing a silicone "o" ring under the lock nut of the decapping assembly so the assembly would float and find its own center. You may want to try this with your die. Look for "o" rings at your hardware store. You can also try an alternate sizing ball on your

rod. Redding came up with carbide kits a few years ago. You can replace the existing expander ball with a carbide ball that is not threaded but floats freely in a confined section of the rod so it finds the center naturally. There are also other dies manufactured with tapered balls and carbide balls that you can try. You might also try running a case into the die with the expander assembly lock nut loose. Locate the decapping pin in the flash hole and then tighten the lock nut. This procedure helps center the decapping assembly in the threads.

If the problem lies in the seating operation there are only a couple of things we can tell you to look at. One is to pull the seater plug out of the die and look at it closely. The seater plug could be off center. Take a bullet and look how the bullet point is captured by the stem. If the bullet is being grabbed high up on the tip by the stem, you may want to check with the die manufacturer and see if there is an alternate stem that you can try in it. Try a new stem if the stem opening looks off center. You may want to look at the chamfer on the inside of the case necks. If you didn't chamfer well you could be shaving off jacket material and getting the bullet started into the case neck crooked. This would especially be true with flat based target bullets.

If none of this has solved your concentricity problem, you may want to try loading using someone else's press and shellholder. See if a friend has a high quality press that you can use to see how your dies work on their press. Look into purchasing a new press if there is improvement.

Concentricity gages are important tools to the reloader and can provide a wealth of information. We use them when we need to but we don't get carried away with it as it means more time at the bench and less time on the range shooting. It all depends on your perspective. We know a lot of reloaders who only shoot so they can reload and try different things. These generally are the people who come out with the wildcat that occasionally becomes a real winner.

Case Trimming

We briefly discussed case trimming earlier in the book and now intend to cover it fully. Case trimming frequency is one indicator of the useful life of the cartridge. A good rule of thumb for most cartridges is if it has been trimmed 5 to 8 times then it should be ready for the trash. Belted cases should probably be pitched after 3 or 4 trimmings. Case trimming isn't the only gage for when to throw cases away. Others include loose primer pockets, split necks, signs of case head separation, damaged rims, etc...

When we refer to case growth we are talking about the case growing in length due to a redistribution of brass material from somewhere else in the case. As the case is fired, the brass flows from the case body into the case neck. The hotter the load the more the brass usually flows. As the case necks grow, the body wall thickness is usually reduced. In some cartridges it can lead to case head separation. Some cases may be affected more than others by their body taper, shoulder design, and load capacity. A prime example of this is the 303 British cartridge. Rapid case stretching and possible case head separation can occur when hot loads are shot. Cartridges like the 303 British do not fall under the general rule above and should be checked frequently for signs of failure.

Case trimming is, of course, a requirement so that the case mouth does not contact the end of the chamber or even push into the throat area. This can result in the crimping of the bullet and the result can be dangerously high pressure levels. Published trim to length dimensions are available in almost all reloading manuals and should be adhered to unless you know the exact dimensions of your chamber.

The SAAMI specifications for rifle chambers have a minimum chamber length for reamer manufacturers to follow. This minimum chamber length is usually longer than the maximum case length. Obviously, there is a safety reason for this difference.

Our curiosity over this difference was increased when we read an article written by Mr. Roger Stowers in "Handloader Magazine" (Issue #140). His article was about chamber length and how to measure it. After inspection of a factory rifle chamber that we had sectioned for photographic use, we noticed that the particular chamber was much longer than the cases that had been fired in it. A closer inspection showed a charred area between the point where the case mouth stopped and where the chamber ended. This condition must have some effect on throat erosion, be it negative or positive. At the present time we have no idea.

The sectioned barrel we had was a 6mm Remington. We measured the actual chamber length and found it to be 2.298" long. This length is 0.065" longer than the suggested trim length of 2.233". We checked the SAAMI specifications for a 6mm Remington and the minimum chamber length was 2.254". This dimension is 0.021" longer than the trim length. Safety factors are built in to these dimensions by the manufacturers.

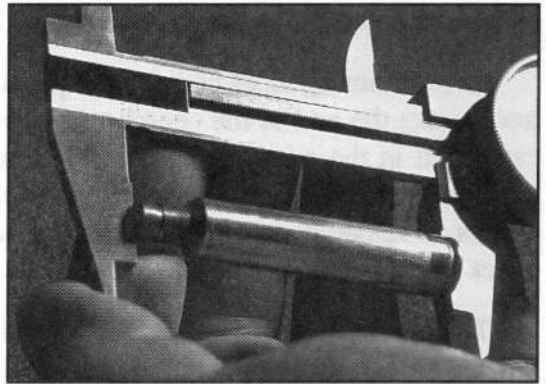
Using the 0.021" "clearance", we took the example above and calculated that our chamber length of 2.298" less the 0.021" "clearance" would

give us a potential trim length of 2.277". This trim length is 0.044" longer than the published maximum trim length and 0.064" longer than the published minimum trim length.

When we checked other rifles using Mr. Stowers procedure we found that each rifle had chamber lengths noticeably longer than published trim lengths.

We offer this information as food for thought. We personally have extended our case trim length in some of our rifles for additional bullet grip. This has enabled us to reach the rifling on a gun with an exceptionally long throat.

We have a tool called a Chamber Length Gage that is used to find out how long the chamber is. They are very simple to use and available from .17 caliber to .338 caliber. If you decide to go beyond published trim length, proceed with extreme caution.



Using a Sinclair Chamber length gage

Case trimming is a relatively easy task to explain but sometimes a tedious one to perform when working with a lot of cases. Whether you are working with a collet style trimmer or a shellholder style like the Wilson, you must make sure the cases are trimmed squarely and to a uniform length. In a collet trimmer you need to make sure the case is pushed into the collet when tightening because there is a tendency, on closure of the collet, for the case to move forward. When putting the case in the collet only tighten the collet a little at first. Then align the neck onto the pilot, and tighten the collet the rest of the way. When using a Wilson style trimmer make sure the case head is against the stop and that the shellholder is sitting down in the alignment rails.

While you are trimming, make sure to clear chips frequently from the cutter and spot check the length to make sure nothing has moved. There is nothing like ruining a whole batch of cases to start your day. If the cutter begins to drag or it feels like it is tearing instead of cutting, consider investing in a new cutter. Wilson has a resharpening/exchange program where you send your cutter in and they will send out another cutter that is sharpened. Also, make sure you keep a light lube on the cutter shaft where it penetrates the cutter housing (bearing surface).

After case trimming, knock any loose chips out of the case and then chamfer and debur the case mouth. This is done to ease bullet entry into the case and to avoid tearing the bullet jacket. Failure to do a good job on this task can lead to inaccuracies due to pressure differentials, non-concentric rounds, and ballistically upset bullets.

Keep careful record of the amount of trimmings so you can discard the cases when you feel they have been trimmed enough. As mentioned earlier, use 5 to 8 times as a guide, and on belted mags 3 to 4 times.

Don't hesitate to power your case trimming operation as it can turn a long job into a short one in a hurry. Most manufacturers have some type of power adapter to convert your trimmer to power by using a drill or rechargeable screwdriver. This enables you to spend more time on the range than at the bench.

Casehead Squaring

This is a subject that you may occasionally hear other reloaders talking about. So we thought we should give you some information on it. Case head squaring is done using a Wilson style trimmer with a large faced carbide cutter. It can also be done on a lathe or mill. It is the act of squaring the case head to the longitudinal axis of the cartridge. We have mixed feelings about this process. Chamber pressures during fireforming should be all that is required to perform this task. The testing we have done has not proven any conclusive results, either for or against case head squaring.

We absolutely do not suggest squaring military cases or cases that have been fired more than one time. It is also not advisable to square cases that headspace off the rim. Case head squaring will also increase cartridge headspace on all cases and once squared, the case must be re-fireformed.

The operation of case head squaring should not be done on unfired cases or those cases that have been full length sized after the initial fireforming. Squaring cases at the unfired state may result in an excessive amount of material being removed due to the new casehead being too much out of alignment with the body. Fireforming will help correct some of this.

If you decide to square your cases do not remove more than 0.002" to 0.003" of material. If you have to remove more than that, you have bigger problems than worrying about case head squaring. You may have some alignment problems between your barrel and action. Once squared, the primer pocket must be uniformed again. In closing, case head squaring is something you should know about, but we do not recommend the process.

Closing Comments on Reloading

This covers our comments and instructions on reloading. The information in the sections on reloading is based on our own experience and where indicated, is what works for us. It definitely should not be considered the final word on accuracy reloading. We are glad it isn't because we enjoy the fact that there is a seemingly endless amount of things one can experiment with that may affect extreme accuracy.

What it all boils down to is to analyze the components of the cartridge, and analyze the techniques of reloading to see how we can improve the quality of ammunition we feed our guns. You really have two goals in your reloading effort. One is to pursue and seek out the most accurate load for your firearm and the second is to reload each round to the degree of consistency that is necessary for the type of shooting that you do. It is extremely important that each round be exactly alike or as close as humanly possible. The amount of time that you spend on all of this is up to you.

We suggest you digest what you have read here and also what you hear others say, and decide what is right for your application. The most important thing to do is SAFELY reload in the fashion and manner that works best for you and your firearms. We hope it will be a hobby that you continue to enjoy for the rest of your life.

Chapter 7

Shooting from the Bench

Whether you are shooting from a bench, shooting offhand or any position, one of the keys to shooting accurately is to do everything consistently. In the last chapter, we stressed how important it is that every round be loaded as identical as possible to each other. This is critical in making a rifle shoot accurately. The same holds true for shooting technique. You must shoot the same way each time. The shooter must make sure that their position, the rifle's position in the rest, trigger pull, and grip are the same each time.

In this chapter we will discuss some equipment for shooting off the bench, bench techniques for different rifles, comments regarding benchrest competition, shooting in the wind, mirage, and our thoughts on practice.

Benchrest Equipment

Equipment for shooting off the bench can range from a couple of sand bags to the most expensive rifle rest that money can buy. Our intent is not to tell you to go buy the most expensive rest on the market. We want to cover some of the equipment used and what is important to look for.

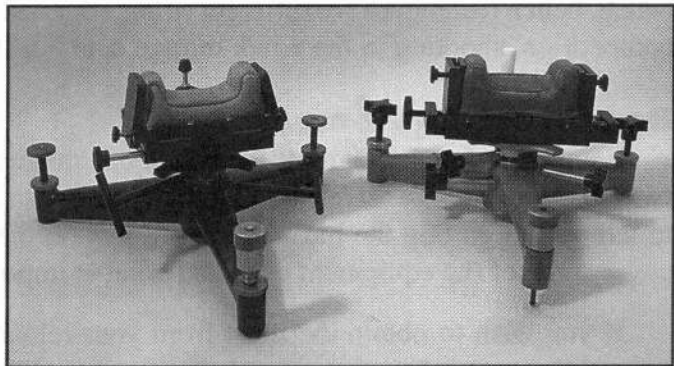
If you wish to obtain the most from your reloading efforts and judge how well your load works, a good shooting bench, rifle rest, and bags are necessities. Your foundation for quality bench shooting is a well made bench. More and more ranges are building quality benches as their members are demanding them. The best shooting benches are made entirely from reinforced concrete and sit on a concrete pad. It is extremely important that they sit level. If you are not blessed with solid concrete benches, then pay careful attention to the way you lean into the bench when shooting. If you don't pay attention, you may end up getting left and right shots which you may blame on the wind. If quality benches are not available at your range and you are interested in building some, contact the International Benchrest Shooters (IBS) or the National Benchrest Shooters Association (NBRSA) for information about construction plans.

A good stool is important to your posture at the bench. If you are always shooting off the same bench you can build one out of wood. Just make it sturdy and of the correct height so that you are comfortable sitting

behind the rifle. If you plan on shooting varmint matches or benchrest matches at different places, you may want to consider investing in or making an adjustable height stool. Several advertisers in "Precision Shooting" and "Shooters News" magazine sell different stools. We use a German made, adjustable, all weather music type stool.

There are quite a few rifle rests on the market and it can get a little confusing when trying to select one that's right for your purposes. We used to make one ourselves that was used by quite a few winners including the 3 Gun Winner at the Super Shoot one year. Selecting a rifle rest depends on what you are going to require from the rest. If you need one for sighting in your hunting rifle once a year, then you might want to just set up some sandbags or shotbags for a rest. If you are going to do load experimentation and/or competitive bench shooting of some type, you will want a little something more.

Almost all of the rests today are aluminum or cast iron, 3 point pedestal type rests with a bag plate. They are equipped with at least two different ways of adjusting elevation. Most can be equipped with a windage adjustable bag plate or they have windage adjustments built into the rest.

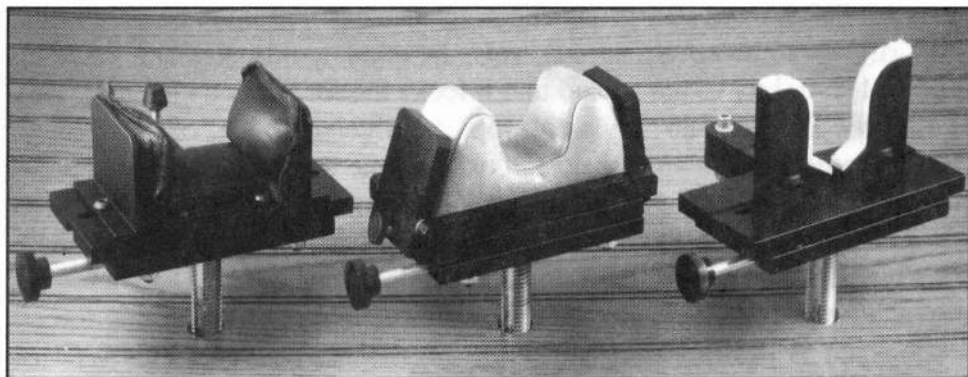


Hart rest with a Sinclair windage top (left) and Bald Eagle rest (right). Both have Sinclair speed screws on rear foot

What to look for in a rest? Look for a rest that is solid with a nice wide footprint. You want a rest that has smooth adjustments for elevation changes and a good bag plate and bag. If you are going with a windage top, look for one that has very little slop in the adjustment threads. You also want a rest that is extremely stable when pushing the gun forward after recoil. Some lightweight rests tend to tilt up on the front two legs when pushing the gun forward. If equipped with a cam or "speed" screw, used for rapid elevation changes during benchrest competition, make sure it can be locked in place or that it doesn't have a tendency to move on its own.

R. W. Hart probably makes one of the most popular rifle pedestals in the world. The large varmint pedestal with a Sinclair rest top or Sinclair

windage top is one of the most popular front rests you will see at benchrest matches throughout the world. Thousands of these cast iron tripods with dual elevation controls have been proven in worldwide benchrest competition. This tripod, with a Sinclair bag plate (top) and front bag, weighs approximately 18 lbs. A handwheel controls minor elevation changes and is locked in place with a T-handle. The major elevation center column is controlled with another T-handle. Steel points on the adjustable legs keep the rest from moving on the bench.



Sinclair Windage rest tops

Wichita makes a smaller rest than the Hart. It comes with a somewhat generic bag plate but it can be equipped with a Sinclair bag plate, Hoehn bag plate, Bald Eagle bag plate, and others. The Wichita rest is cast iron and weighs in a bit lighter than the Hart rest, approximately 11 pounds. Despite its light weight, it is very stable on the bench due to its low profile. It has a single elevation control with a handwheel for easy adjustment and it is a suitable rest for sight-in and load testing work. Some shooters use it for competition benchrest.

Another rest manufacturer is Bald Eagle Machine. They also make rear bags which we shall discuss shortly. Bald Eagle makes two different front rests which have the same general capabilities as the Hart rest. Their price is also similar to a Hart rest depending on which bag plate the user chooses. These rests weigh a bit lighter than a Hart rest but are heavier than a Wichita rest and are used by many benchrest shooters.

Other manufacturers worth mentioning that are in a higher price range are Ransom International, SG&Y and Farley. We would consider all of these rests to be premium priced and they basically have the same capabilities as a Hart or Bald Eagle. The Farley rest is the unique one of the group. It uses a single yoke for controlling elevation and windage.

If you purchase a rest for your bench rifle you may want to equip it with an additional narrower top to shoot your varmint rifle. Bag plates or tops are an important choice and the interchangeability of tops should be considered when putting together a complete front rest. There are many different bag plates available and most resemble each other in design. Bag plates should be selected to suit the style of shooting you are doing and the type of rifle (specifically forend design) you are using.

To begin with, let's discuss competitive centerfire benchrest shooting. In both NBRSA and IBS group shooting matches you must be able to lift your rifle straight up out of the rest. In other words, the bag can't be clamped so tightly to the forend that it locks the forend in a channel. This is why the Sinclair "86" style rest top, the Sinclair Model 5300 windage top, and other tops of similar design exist on the market. These tops use a #3 Protektor owl ear front bag, or similar make, and feature adjustable tilting sides that tighten the bags ears which, in turn, tighten on the forend. This type of plate makes it difficult for a benchrest shooter to lock a forend down, but yet it holds steady and true. They also have an adjustable forend stop which is desirable for returning the rifle to battery. This type of top/bag plate is available through Sinclair International, Bald Eagle, Ron Hoehn Shooters Supply, and other rest suppliers.

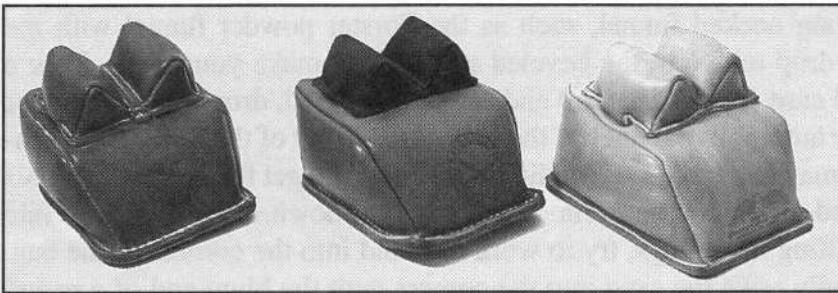
If you are not shooting sanctioned benchrest matches and you are using several different rifles with varying width forends, you will want to use one of the bag plates that adjust to the width of the forend. This style top has adjustable end plates that conform the rest bag to the shape of the forend. Bag plates such as these are ideal for any type of shooter. The competitive benchrest shooter can use them but should be careful not to squeeze the bag too tight. Several other rest manufacturers offer tops like this and they are also available with windage adjustments.

There are several other non-standard style bag plates on the market. Most of these are designed for benchrest rimfire shooting. Some of these have Delrin™ rollers and other devices to track the gun under recoil. These are specialty rest tops and are not allowed in most centerfire matches.

A rear bag is an important compliment to the front rest equipment you choose. Protektor Model, who is known for making all kinds of quality sandbags, offers a couple of rear bag models for benchrest purposes. They make two basic styles of rear sand bags; Rabbit ear and Bunny ear bags. We recommend the shorter bunny ear style for any shooter using a rifle

with a cheek piece. The rabbit ear style is great for rifles without cheek pieces. The cheek piece tends to get caught on the taller rabbit ear style bags and will cause movement of the stock during recoil.

Protektor makes two grades of these rear bags. The standard grade bag is of single walled, leather construction throughout. The “custom” grade has a double thick leather bottom with stiffer side walls and it is taller than the standard grade bag. The height is important to shooters using ranges that slope downhill away from the benches. The custom grade bags are also available with a wider notch between the ears to accommodate flat bottom stocks such as the “Borden” (Jim Borden) stock or “TMBR” (Tom Meredith) stocks commonly seen on bench guns.



*Bald Eagle
and
Protektor
rear bags*

Bald Eagle Machine Company also makes a superb rear bag. It is one of the most popular bags in competitive stool shooting. They are constructed of thick leather throughout with an extremely stiff bottom to prevent movement on the bench. It is available in two models (both bunny ear style). One model has the ears in a v-shape while the other model has the bottom of the v-shape widened so the rifle sits further down in the ears. Both of these bags are great.

When choosing a rear bag choose the one that works best for your rifle(s). The standard grade Protektor model would be fine for the occasional shooter, but the serious benchrest shooter would be advised to choose one of the “custom” Protektor bags or one of the Bald Eagle bags.

This is basically all of the major equipment you need for shooting from the bench. You will need some baby powder to use on your sandbags and a towel or piece of carpet to lay your bolt and cartridges on. It also protects your elbow.

Before we move on to bench techniques, let’s briefly discuss the maintenance of your bench equipment. Routine maintenance to your front rest requires keeping any mating surface or exposed machined surfaces lubed

and protected from rust. On almost all models these places would include: the handwheel mating surface on the bottom, the top and sides of the center column, the threaded post, the leg screws and the T-handle threads. If your leg points get dull, re-grind or replace them. That's about all the maintenance you need to do besides keeping it clean, especially the windage models.

The front bag and the rear bag should be kept full of sand. Some hints on filling sandbags might be of value to those of you who have never filled a sandbag. On rear bags, we suggest filling the ear compartments first and then filling the base of the sandbag. Most sandbags have fill spouts that tuck under a flap after they are filled. The biggest difficulty in filling these bags seems to be getting the sand through the narrow spout. We suggest using a long necked funnel, such as the Forster powder funnel with the extended drop tube (cut the beveled end off), or make your own. Take a 375 H&H case (or similar size) and saw off the head, drop it into a regular kitchen or automotive funnel so the case extends out of the neck of the funnel. You may have to try a few different funnels to get the correct fit. This will extend the funnel neck enough to get sand down into the bag. While you are filling these bags, try to work the sand into the corners of the bag. Occasionally poke the sand into the corners with the blunt end of a pencil or a piece of dowel rod. Slam it down on the benchtop to get the sand to settle and compress better. Use a fine grain clean sand. Children's playground sand will work just fine. There are some speciality heavy sands that are available through benchrest supply houses such as Sinclair International, Russ Haydon's, Bruno's Shooters Supply, etc. These sands are more dense than other sands thus producing a heavier bag.

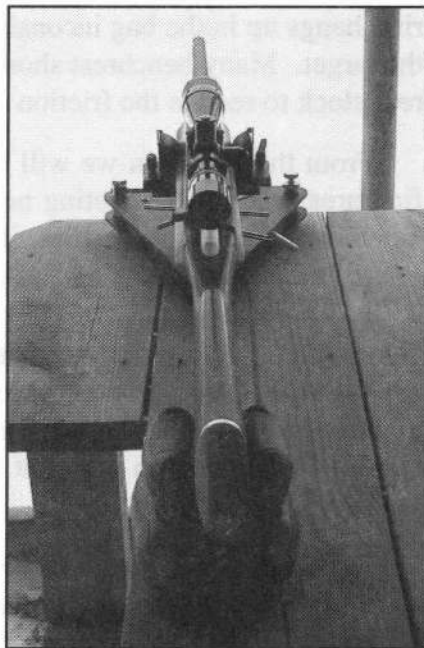
Bench Techniques

We want to go over some bench techniques that may help you get comfortable at the bench and hopefully produce tighter groups. Each shooter will eventually develop their own style and methods at the bench, so we'll just cover some basics.

When you set up your equipment on the bench, usually, you will want to set the front rest close to the left edge of the bench (opposite for lefties). Not so close though, that the left leg is about to fall off the edge. Give yourself an inch or so of relief. The front rest should be positioned so that when the rifle is placed up against the forend stop (if so equipped), the end of the barrel clears the benchtop. Failure to do this can cause a lot of reflected blast onto the benchtop blowing concrete dust and chips, usually at the guy next to you.

The rear bag should be positioned so the v-channel on the rear bag is in direct alignment with the centerline of the front bag. This positioning will help to avoid leaning over the bench and it puts you more directly behind the gun.

After your rifle is aligned on your target, you may find that you have to re-align this set-up a little. The rear bag should be far enough behind the pistol grip so that when the rifle recoils it does not ride up on the pistol grip. Once you have your position established, lay down a pad or towel for your elbow to rest on. This also gives you something to lay your ammo and bolt on.



Proper alignment of rest and bags

When everything on the bench is ready, adjust and position your stool so your torso is somewhat upright and the front of your shoulder is directly behind the butt of the gun. The idea here is to get in a comfortable and natural position behind the gun. You shouldn't be hunched over the bench or reaching out for the gun. Try to avoid leaning into the bench because if you do this for any length of time your ribs will feel it. For people wearing eye glasses, take full advantage of your corrective lenses by positioning yourself so you are looking through the optical center of your lens. You do not want to be leaning sideways into the gun.

Once you have finished positioning the rest, rifle and stool (if you are shooting a heavy varmint or benchrest rifle), lift the rifle up from the bags and lightly dust the bags with baby powder or spray them with women's extra dry powder spray deodorant. Explain this to the wife when you buy it. No kidding, it is a good alternative and it does work! Some serious benchrest shooters use powdered graphite which works well but, it is extremely messy. We would not recommend the graphite to anyone starting out. The improvement would probably only be noticed by someone with years of experience.

The powders described above are used by bench shooters to make recoil consistent for a string of shots. This is as important to the shooter testing varmint loads as it is to the benchrest shooter in competition. If the

rifle hangs up in the bag inconsistently, you will see the vertical effects on the target. Many benchrest shooters add Teflon™ tape to their forend and rear stock to reduce the friction on the bags, this also seems to work well.

From this point on we will break our discussion into two areas. The first area will cover shooting non-benchrest rifles especially those chambered in higher recoiling rifles. The other area of discussion will be regarding techniques for shooting full blown benchrest rifles.

Shooting Non-Benchrest Rifles

We will classify non-benchrest rifles as rifles weighing approximately 10 pounds or less that have a forend configuration that is rounded. Rifles similar to Remington Varmint rifles or standard hunting weight rifles would be in this group.

Benchrest type rifles will be classified as rifles over 10 pounds, with wide forends and some flat surface on the bottom of the forend. A competition benchrest rifle will have a 3" wide flat forend. When it is placed on the proper rest and rear bag, a benchrest rifle just lays there. It is not top heavy and will not roll around in the sandbags like a non-benchrest rifle.

Most competitive benchrest shooters don't even hold onto the stock when shooting. Try that with your favorite 30 caliber hunting rifle and you will either be wearing it or picking it up.

The non-benchrest rifle has to be held onto. The more recoil it has, the more you have to be concerned about consistent shoulder pressure and grip. The amount of recoil is a significant factor. A hunting weight 270 Winchester rifle will be much different to handle than a varmint weight 22-250 rifle. Rifle weight, cartridge, load and most of all, forend configuration will affect the way the gun recoils. Recoil is not just a straight rearward push, it includes some rotational force as well. When fired, the rifle is also trying to roll over due to the rotational forces created by the twist of the barrel's rifling. Most non-benchrest rifles tend to be top heavy, which, combined with a rounded forend, make them much more difficult to control when firing from the bench.

You gotta' hang on, not a white knuckles grip, but a firm consistent grip. Keep firm consistent pressure on the pistol grip while applying shoulder pressure at the same time. Either pull the stock into your shoulder or lean into the stock. If you lean into the stock, do not do so in such a fashion that the butt is riding up on your shoulder. It is best to have full

rifle butt to shoulder contact. The contact area should be at the shoulder joint, not the torso or upper arm, but in the pocket of your shoulder joint when the trigger arm is placed on the pistol grip. If you cannot do this comfortably, change the height of the stool you are sitting on or move your rest and bags. Round to round consistency in your hold is a must.



Good position for shooting a light rifle

A front bag that conforms to the contour of the forend is quite desirable. Do not try to capture the forend, all that is needed is a good 120 degree contact. Light rifles will jump clear off the bag during recoil. Don't worry about it - just let the rifle jump. If your hold is correct, the rifle will pivot on the shoulder and settle back into the bag. If your stock has checkering or is rough textured on the front bag contact area, put tape over it. Remove both swivel studs completely, they just screw in and out. If you do not, they will not only ruin the sandbag, but also your groups.

Place the forend on the front bag so you have at least two inches of forend overhanging in front of the bag. Place the rear sandbag almost to the rear of the stock so that the lower rear portion of the bag contacts your body when your shoulder is firmly against the butt. Your non-trigger hand should be placed on the rear sand bag so that your palm is resting on the front of the bag and the index finger and thumb are gripping the outer front of the bag ears.

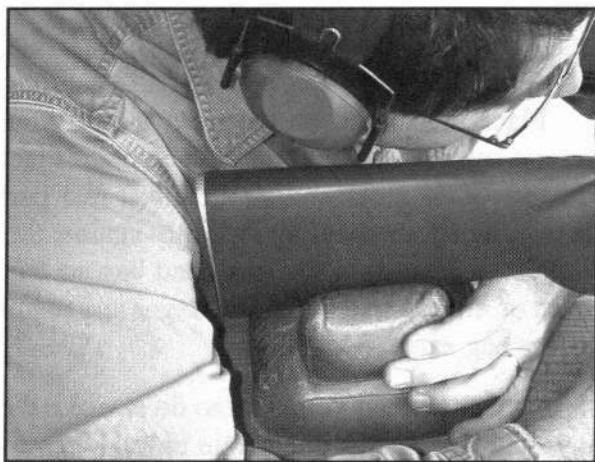
Basically what you want to do is make the stock, rear bag, your shoulder, and both hands one single unit. When the rifle is fired you will have more control of the rotational forces and the forend will just jump straight up rather than recoiling in a twisting motion.

At this point, adjust the front rest and/or rear bag so that your sights are on the desired point of aim. Make sure the rest and rear bag alignment is maintained. By squeezing the bag ears with your thumb and finger, you will be able to make minor changes in elevation and windage as needed.

Shooting Benchrest Rifles

Shooting a benchrest rifle from the bench is somewhat different than shooting a hunting rifle or a varmint rig from the bench. Minimal contact is the rule for most shooters when shooting a benchrest rifle. Many of these rifles are heavy and have low recoil. NBRSA and IBS shooters use 10 1/2 lb rifles and 13 1/2 lb rifles for the different classes. These guns, when chambered in 6mm PPC or a shortened 6mm BR of some sort, don't have a whole lot of recoil. Because of this low recoil, shooters usually use one of two different styles of shooting (free recoil or keeping their shoulder on the rifle).

Free recoil is one style of shooting used by many shooters on the benchrest circuit. The shooters using this method position themselves behind the gun as normal but, he/she pulls their shoulder away from the stock anywhere between 1/4 inch to one inch. The only part of the shooter actually touching the gun is the index finger on the trigger. The trigger hand is brought up from underneath so the trigger guard doesn't run into your hand when the rifle recoils. When you touch the trigger, the gun recoils freely on the aligned bags and front rest and stops when it hits your shoulder. When the gun is repositioned, many free recoil shooters push the rifle against the forend stop and then draw the gun back from the stop about a 1/4" (more or less). Some of the best benchrest shooters in the world use this method. If you are shooting a benchrest rifle in 22 or 6mm PPC or one of the BR's, you may want to try this method to see if you can get comfortable with it. Shooters using this method rely on the mechanical advantage they have with their rest, bags, stock configuration, and gun weight.



Shooter positioned for free recoil

Other shooters will control their bench guns a little more. They will put their shoulder lightly on the butt stock and their trigger hand on the gun. Some shooters prefer to keep their cheek off the gun completely or at best just touching.

If you decide to shoot the free recoil method, make sure your eye relief and scope set-up is sufficient to keep the scope from clipping you in the eye. Don't shoot free recoil on your 416 Rigby please.

Elevation and windage control is something that all shooters handle differently. Benchrest shooters are basically classed as "bag squeezers" or "non bag squeezers". Squeezing the rear sand bag can make small changes in windage and elevation. These shooters are less worried about getting their aiming point perfect and try to get their shots off while the condition is good. These shooters use bags that are not packed as tight with sand so they can actually push on the ears to raise, lower, or shift the stock right or left. Right handed shooters sometimes curl their left arm around the bag and squeeze with their left hand.

Non bag squeezers almost always have a windage top and possibly a fast adjustment elevation screw (speed screw, cam, etc.) They rely on their mechanical devices to move from one aiming point to another. This is a good way to shoot because you don't touch the rifle. Critics of this method cite slower shooting as their main objection. They feel the competitive benchrest shooter using this method fiddles around too much trying to get the aiming point just perfect. There are some shooters who do this and get "burnt" because the condition changes before they can get their five (5) record shots off. More and more good shooters are using this method but, they are practiced at repositioning their gun quickly.

Benchrest Introduction

In this section we will give you a brief overview of a typical centerfire benchrest match. We want you to be aware of what is going on if you shoot a match or if you are simply visiting one. If you have not attended a registered benchrest match, we encourage you to do so.

Centerfire benchrest matches consist of five (5), five (5) shot groups at 100 yards and at 200 yards for each rifle class. Most matches consist of a 10 1/2 lb class and a 13 1/2 lb class. Many shooters will shoot their light varmint (10 1/2 lb.) rifle in both classes. In bigger matches, especially regionals, there will be an unlimited class which allows shooters to use rail guns and/or standard benchrest rifles. These matches consist of five (5), ten (10) shot groups. All targets are fired at from the bench and are measured for group size (center to center). All registered matches must be done at ranges that have some type of moving backer behind the record targets in addition to a stationary backer. This prevents anyone from shooting two or three shots in a small group and then shooting the remaining shots into the dirt.

The five group measurements at each yardage are added up and averaged to calculate the aggregate score (referred to as agg). At 200 yards the aggregate is expressed in minute of angle. The measurements are averaged and then divided by two (2) to get the agg for 200 yards. The 100 yard agg and 200 yard agg are added together and divided by 2 to get the grand aggregate for that gun. If shooting a 10 1/2 lb class and a 13 1/2 lb class the two grand aggs are added together to get the 2 gun aggregate. If unlimited is shot, the 3 gun aggregate is calculated. At the Nationals, the Sporter class is shot making for a 4 gun aggregate. Sporter class, which is shot very rarely, is a class requiring a 10 1/2 lb gun chambered in 6mm or larger. This class was popular before the 6 PPC and 6 BR came along. Before that, a lot of people were shooting .22 caliber rounds.

Because of the way scores are calculated, a shooter can shoot well but not come in first or second place in the agg for yardage, but still might win the grand agg or 2 gun if they shoot consistently.

At some matches, there may be a warm-up match that does not count. It allows shooters to get settled down and check their zeros if they have changed scopes or barrels recently. If there isn't a warm-up match, they may declare the 1st match to be a 10 minute match. Other matches would be 7 minutes long.

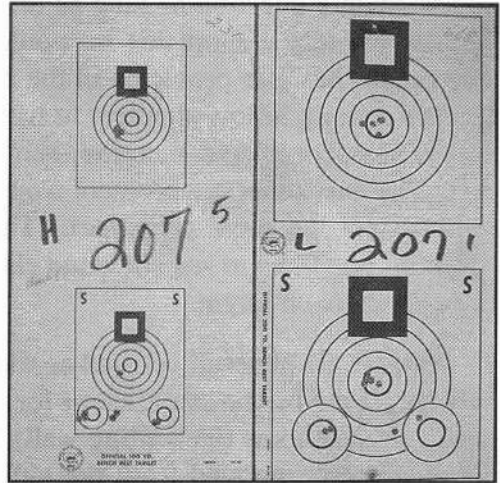
The shooters are divided up into relays. The number of relays depends on the number of benches and the number of shooters. Each relay is called to the bench in turn. The first match usually includes safety instructions prior to starting the match. Sufficient time is given at the beginning of each relay for shooters to move their equipment to the bench and get everything arranged including acquisition of their target.

Benchrest match: notice the carts for moving gear from bench to bench



Targets are held in target frames and are marked with the match # (1-5) and the shooters number (given at registration). Benchrest targets have a record target above and a sighter target directly below. The bull's eye is 1/2 MOA (minute of angle) and the concentric circles are 1/4 MOA apart. The target frames are usually marked with a number corresponding to the bench #. This makes it easier to find your target and also helps to prevent crossfiring.

When the target crew has returned from the target frames and are past the firing line, the range officer will announce the relay and the match number. "This is relay #1, match #1, five shot group at 100 yards." Something similar to this command will be issued. The officer will then say something similar to the following, "Ready on the left, ready on the right, ready on the firing line! Place bolts in rifle, commence firing!" Never, ever place your bolt in your rifle until he gives you permission. We have seen some shooters placing the bolts in as the ready commands are announced, this is not safe and some range officers will disqualify you.



100 yard and 200 yard benchrest targets

Once the commence fire command has been given, you have seven (7) minutes to put five (5) shots on the record target. Any shots above the top line of the sighter box will count as a record shot. Shots outside of the record box but on paper will count towards your group size and you will be assessed a penalty (in inches). Penalties depend on the yardage and the organization.

During the seven (7) minute period each shooter can shoot as many shots at the sighter as he/she desires. The range officer will call time remaining at different stages. Usually at halftime, 2 minutes remaining, 1 minute remaining, 30 seconds, five seconds and then the command "Cease Fire" is called. As soon as he says the words "Cease Fire" no more shots are to be fired. Doing so will disqualify you from the match and could possibly result in losing further shooting privileges. Immediately following the "cease fire" command, the range officer will say "remove bolts from

rifles". At this time, all bolts must be completely removed from the action. The range officer will verify that the line is safe and instruct the target crew to go forward while he calls the next relay to the line.

Depending on the range, the benchrest organization, and the range officer, a procedure similar to the one described above will be followed. At most places you visit, you will find that benchrest shooters are some of the friendliest and most helpful folks you will ever meet. Don't hesitate to ask them a question as long as they are not loading. A good example of how friendly a sport this is, would be the rule on loaning guns. If a competitor has gun problems in the middle of the match, it is an unwritten law among fellow shooters to hand over their own rifle if they themselves have completed shooting their record target and have some rounds left. The only other requirement would be that the rifle has to be the same caliber (not the same cartridge). This is a mark of true sportsmanship since no one likes to see someone else assessed the stiff penalties for not enough shots on target.

Targets are generally posted as soon as they are scored. They are usually measured by the same scorer for consistency. Targets are posted on a wall (referred to as the wailing wall) and can be looked at but should not be physically removed from the nail or holder. If you pull any targets before the aggs are posted it can result in disqualification. You can challenge a measurement for a small fee which is returned if the group was originally measured incorrectly.

Tips Regarding Benchrest Competition

Here are a few tips and reminders if you are just starting out.

- 1) Get set up as quickly as possible on your relay. Check and double check the bench and target #. Getting set up allows you to relax a little. Make sure you have everything you will need (rifle, ammo, bolt, stopwatch, ear protection, etc...)
- 2) Once you are set up, look at the flags and try to figure out what wind conditions are prevalent.
- 3) Develop a method for counting shots when shooting groups. When you are shooting "one holers" it becomes difficult to distinguish individual shots. Some shooters set cases in a separate place on their towel or block to distinguish between the number of record shots and sighter shots.

- 4) When you are shooting sighters, especially the first one, keep them low on the sighter box to avoid flying one above the top of the sighter box. This is an easy way to avoid a penalty.
- 5) If you notice extra shots on your record target, make sure you yell out "Someone's crossfiring on my target (bench #)". If you notice them on your sighter, don't wait until they shoot your record target to yell out, you may help a fellow shooter avoid a penalty. It will probably happen to you sometime. If someone does crossfire on your record target make sure you tell the range officer so he can observe the location of the shot on your target. This way you can shoot your group and the scorer won't be confused. By the way, before you yell about someone crossfiring, make sure you are looking at your target and not someone else's. If it is someone else's target you are the one who crossfired. This has happened many times. If you catch yourself or someone else before they move up to the record target there is no penalty assessed. Just relax and resume shooting, on your own target of course.
- 6) Avoid loud talking during the seven minute relay. You should, as a responsible competitor, avoid talking when a competitor on either side of you is still shooting. Do not get up from the bench. This is very distracting to shooters that still have shots remaining. Some range officers will, and all of them should, crack down on this. Other range officers will allow you to step away from the bench, and this is fine, but leave your equipment alone.
- 7) If you are running out of time and you still have record shots to take, don't take time after the shot to see how you did. You should be loading and re-positioning your rifle. You can look to see where it went while you are re-aligning your point of aim.
- 8) Try to avoid printing on the far left side of the target when there is a good wind blowing right to left. A strong gust can easily blow your shot out of the record frame - then it's penalty time. The same is true for the reverse.
- 9) When shooting in heavy mirage conditions at 200 yards, a shooter is sometimes forced to use the black aiming square as his/her hold point. If you ever have to do this, avoid printing in the black square. Print below the square somewhere. Shots in the black usually score worse as the edges of the holes are more difficult to see and judge.

- 10) Keep both eyes open when shooting. With training, you should be able to see flags with your left eye while looking through the scope.
- 11) Learn to trust your rifle and what the sighters are telling you. If the sighter tells you that conditions have changed a whole inch, trust it. Don't hold over a 1/2 inch just in case it's wrong. If you have a tuned rifle, don't question its ability in the middle of a match.
- 12) Try not to attempt really tiny groups by shooting too many sighters. Top notch benchrest shooters rely on consistency from group to group. Not only can too many sighters be confusing, but you are allowing time for conditions to change. There are times when "running" your (5) shots is best. Once again, knowing the prevalent condition down range is beneficial.

Practice Session

There are many ways to practice for competitive benchrest shooting. As in most competition shooting, the more trigger pulling the better. Unfortunately, benchrest shooters can't benefit much from dry firing as some other disciplines can.

We suggest practicing most of the time in the manner in which a match is conducted. Set up two targets, one above the other and use one for record shots and one for sighters. Have your flags out so you can get familiar with them. Use a timer occasionally so you can get used to shooting at a 7 minute pace. Concentrate on establishing consistent bench technique while practicing. Make sure all the equipment is the same as you will be using in competition.

Try shooting in different weather conditions, and observe where your shots are going. Try holding off your aim point in severe wind to see how well you can place your shots. Practice at 100 yards and 200 yards, but as you get more experienced, spend more time at 200 yards since this is where you can pick up or lose more ground in a match.

If you can, try to find some local informal matches where you can get some good practice. Practice with a friend and bet quarters on each target.

Most importantly, use the same equipment and same ammo when you practice, but don't hesitate to change something if you feel that what you have isn't working. It's always better to make changes during practice time than in the middle of a match. When you go into a match you should not be second guessing your equipment or technique.

Summary

Shooting well off the bench is a skill that comes with practice. Many of the best position shooters have told us how they can shoot better from a prone position than off the bench. This is probably because they have shot thousands of rounds from the ground, and only a few from the bench.

Shooting well off a bench is all a matter of repetitive movement. Making your gun track and recoil consistently from shot to shot is the key. Each person can use tips from others, but, in the end, it's best if you settle on a procedure and method that you are comfortable and confident with.

Now that you know some techniques about shooting from the bench, lets look at our old friends wind and mirage. They, unfortunately, play a major role in shooting accuracy.

Chapter 8

Wind and Mirage

Wind conditions and mirage can be major factors to shooting accuracy whether you are shooting from the bench or in another position. Reading the wind correctly will usually separate the winners and losers. Especially when shooting competitive benchrest.

Before we talk about reading wind and mirage, lets briefly discuss some equipment that could possibly help you.

Wind flags and Equipment

Reading the wind is a little easier if you have indicators near the bullet path providing you information about the wind you are facing. Smoke from chimneys, grass blowing, tree branches moving, the feel of the wind on your face, dust blowing, etc. are all good natural indicators, but they don't give you an accurate look at what the wind is doing in the narrow corridor you are shooting in. A wind flag or set of wind flags will be your best information source. We make them at Sinclair International and there are many other manufacturers that make them also.

Wind flags come in all shapes and sizes. If you want to see a sight to behold go to the Firearms Industry Super Shoot (granddaddy of benchrest) held annually (end of May) at Kelbly's range near North Lawrence, Ohio. There you will see dozens of flags on the range with usually 5 to 6 in front of every bench (60 benches). Every conceivable shape of vane with propellers, different streamers/ribbons, mechanical wind speed indicators, etc.



Benchrest match with flags out. Photo taken at 50 yards.

can be found. A variety of flag stands are available ranging from a plain piece of 3/8" steel rod to elaborate telescoping aluminum stands that extend 12 feet into the air.

If you buy or make a wind flag, make sure it has a good pivot. The pivot point is one of the most important parts of the flag. The flag has to be able to turn freely to show wind direction changes immediately. Slow, unresponsive flags are worthless to the precision rifleman.

Wind vanes come in all shapes and sizes. There are squares, rectangles, triangles, etc. and we have never been able to prove to ourselves that the shape makes much difference. They need to be lightweight and have sufficient surface area to catch enough wind to move them when a light wind shift occurs. Flag vanes should be painted for several reasons. One reason is that they are more visible at longer yardages. Changes in direction of 30° - 35° are hard to detect at longer distances and a variety of painting schemes will help. A different color on each side instantly catches your eye when the wind makes a 180° shift.

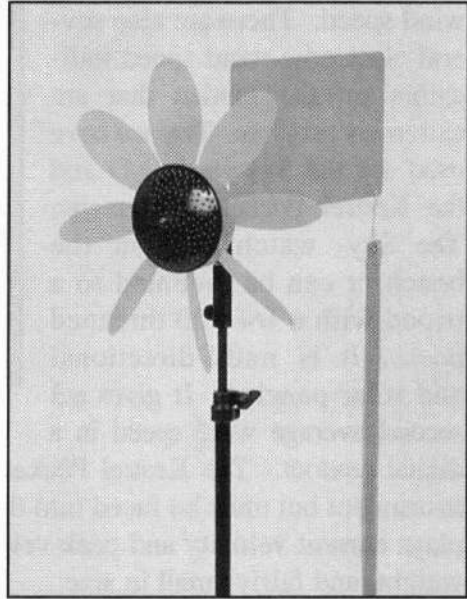
Propellers on wind flags are a matter of personal preference. We use them because they are another indicator of wind speed. Most wheels are a lawn ornament daisy wheel mounted on a simple shaft. The problem some shooters have with daisy wheels is that the wheel keeps spinning when the wind stops. This leads you to believe that the condition is still there. When used in conjunction with the tails, which lets you know immediately what has happened, we feel the wheels offer information that you may be able to use.

The tails are extremely important. We use surveyors ribbon for the tails on our flags. It is a great material for many parts of the country where the wind is light, but switches frequently. It is not the best material for a tail if the wind blows hard and frequently in your area. The surveyor's ribbon will blow straight out because of its lighter weight thus detecting a light let-up or hard blow becomes difficult. Then you will be scratching your head wondering why your shot went way to one side. If you have this type of condition occasionally, you should put a heavier tail on your flag in addition to the surveyors ribbon. Get either a heavier material or add some weight to another piece of surveyors ribbon. Put the lighter ribbon on the outside bottom edge of the vane and the heavier tail an inch or so in from the edge toward the pivot. The light tail will rise up and out of the way when the heavy tail lifts. This will keep the two tails tangle free. Ribbons can be as long as you want them, but the longer the tail, the easier it will be for it to get tangled around the pivot

and daisy wheel. In most cases, keep them two feet long or shorter.

It is good idea to keep a roll of surveyors ribbon in your range box. You will get out to the range sometime and realize you left your flags at home, or you may just want to tie a streamer up on the target frame. Buy it from a shooting supply house or your local hardware store may carry it.

If you decide to build your own flags use lightweight, but durable materials. Arrow shafts make fine center shafts and are reasonably economical. Build it around a good pivot and experiment with different tails.



Typical wind flag

How many flags should a shooter have? A shooter shooting 100 yards should have at least one flag and preferably two. Some shooters use three. We set up three but probably only really look hard at two of them when shooting 100 yards. At 200 yards we will usually have 3 or 4 flags. The problem with getting too many flags out there is that you begin to get information overload. You have four flags in four entirely different angled positions and they are constantly changing while you are shooting sighters and voila, your brain overheats. We have four flags out sometimes, and only pay attention to the closest three and check the fourth one once in a while to see what is happening. A little more later on flag positioning.

A brief note on flag stands. Flag stands can be as extravagant as you want them to be. Most shooters opt for a simple 3/8" rod pushed into the ground, a spiked stand, or a photography light stand. Light stands in heavy winds need a weight or a spike to keep them from tipping over. Go to a big benchrest match and see what other shooters are using. Remember, if you shoot competition there are some ranges where you have to place your flags real close to the ground due to the topography of the range (or vice versa).

Wind speed indicators are a handy tool for a shooter. Dwyer Instruments has been making pocket sized mechanical wind speed instruments for years. They work well and give you a fairly good indication of

wind speed. There are also several electronic wind speed indicators on the market that are extremely accurate. Two we have used are the Skywatch 3-D and the Kestrel Pocket wind meter. The Skywatch sits on the bench or can be mounted to a tripod with a 1/4 - 20 threaded post. It is multi-directional and solar paneled. It gives a 3 second average wind speed in a digital readout. The Kestrel Pocket Wind meter is also a digital readout instrument but must be faced into the general direction of the wind. It displays current velocity and peak velocity. It is extremely well made, lightweight, and fairly small in size.



Wind speed indicators

We have discussed the basic wind equipment. Now let's talk about how we can use it.

Reading the Wind

Reading the wind and applying it to your shooting is an art that can only be acquired with practice. It takes a lot of shots in different weather conditions, range locations, and yardages to learn how wind will affect your shots. This is the type of training that can assist you in becoming a great shooter. We didn't say master reading the wind. All shooters continue to get beat by Mother nature - even the best of the best. The best just don't get fooled by the wind very often.

As we said earlier, you can shoot a lot better in the wind if you know what it is doing. We look at the wind flags for three variables - wind speed or intensity, wind direction, and cycle or duration time. The flags can give us all of this information if we are smart enough to use them. The placement of the flag can be extremely important. Where you place them depends on the terrain of the range and, of course, the yardage you are shooting at. The flags closer to you are usually viewed with more importance. Let's discuss this because it is important.

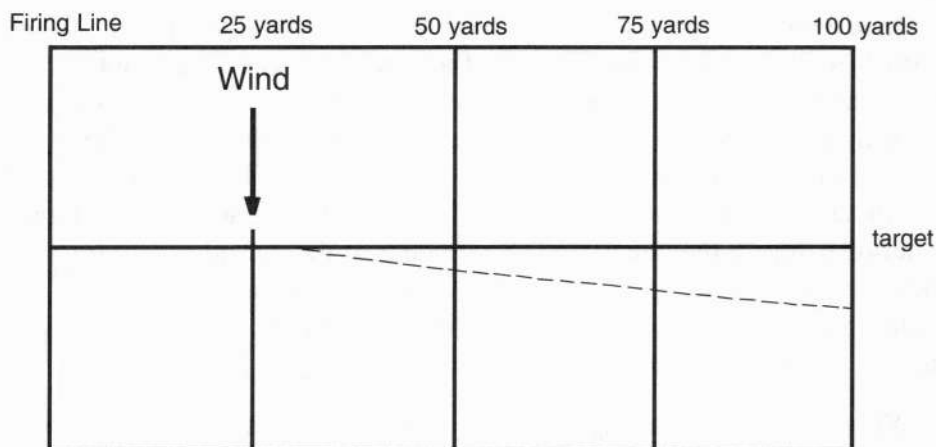
Let's look at Figure 4. Your shots, when first out of the barrel, are enroute to the target along their intended path. In the first example, the bullet is hit by some wind at 25 yards and it is deflected off its path to some degree. In the second example, the wind hits the bullet with the same

intensity but at 75 yards. Since the wind hits the bullet 25 yards from the target the bullet has less time and distance to veer from its course. Therefore, the wind drift shown in the second example is less. Velocity will have some effect on the final results, but at these distances, it will be minimal. Also, the higher the ballistic coefficient and velocity, the less wind drift.

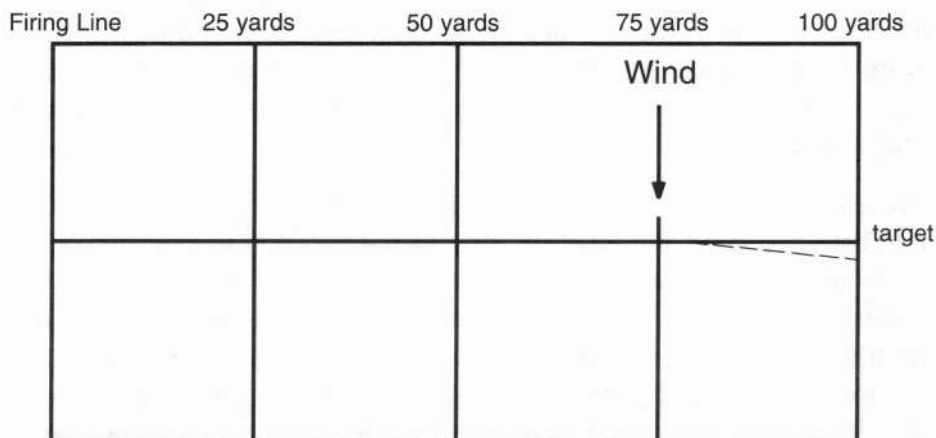
Figure 4

Bullet Path	Unaffected	—————
	Affected	- - - - -

Example 1



Example 2



What the examples show, in a very simplistic manner, is that a shooter wanting to shoot tight groups should pay more attention to the flags near the firing line. If you have two flags to use at 100 yards, we suggest putting one at 30 yards and one at 60 yards. If shooting 200 yards, we suggest having three flags out with one at 30 yards, one at 70 to 80 yards, and the last one at 120 to 150 yards. This should give you a good idea of the range conditions. These distances aren't fixed in concrete and you should locate your flags where the terrain requires it. For example, at our range we have a creek running across the range at about 65 yards. We always put a flag near the creek because some strange winds come along the creek bed. The range at Holton, Michigan, where we often shoot, has a break in the trees on the right side of the range where the target crew access lane comes through. We always watch the flags in line with the opening as wind pickups will come through there.

Once you have positioned the flags you need to study them. Good shooters will always be watching the flags even when they are not on the line. You will begin to observe that the wind will often be in a cycle that can be timed. Observe the different intensities during the cycle. The cycle might be of short duration or last for several minutes. If you feel the cycle is predictable, you can sometimes wait it out during a match for the period of stability during the cycle. When referring to the period of stability we don't necessarily mean a no-wind situation. The period of stability is a condition that may have wind, but it is fairly consistent. It may be of short duration so you may have to run your shots quickly.

When observing the flags, pay close attention to subtle changes that occur. If there are other flags on the range watch them also, but just to observe their general position. This can sometimes give you an early indication of a wind direction or intensity change. Other shooters watch long grass, trees, chimney smoke nearby, flags on flagpoles, etc. But remember, you are mainly concentrating on the conditions within that very narrow tunnel that your bullet travels. What is happening to a tree 30 feet up may or may not affect you.

When observing the flags notice that the flag tails flutter and the wheels turn. That's real good, but what are you looking for? Try to look for consistency by using your sighter target to measure the value of the wind. Look for a condition that seems to be more consistent than others and put a sighter down on your target. If the wind seems to stay, put one up on the record. If the two are in the same respective positions and the conditions stay, then run your shots. If the conditions don't change and the record shots look good, keep

shooting and don't stop to shoot more sighters. There is no need to check the flags again. You have to believe in the gun and the flags. More on this later.

Look at wind direction intensity when observing the flags. Watch the angle of crosswind or degree of tailwind/headwind. Looking at the flags and judging this angle is critical for you to learn to read it. If the tail is too light, it may not help too much. If the tail lifts and drops in rapid succession indicating an unstable wind, try to wait it out if time permits. The old rule for wind speed was to take the angle of the flag and divide by 4 to get the approximate wind speed. Unfortunately, this formula doesn't work for all weights of flag tails. We don't really care what the exact wind speed is, all we want to know is when the wind is the same. The tail angle is a tremendous gage of relative wind speed.

How to Shoot in the Wind

We would all be lying if we said we were perfect at wind reading. We learn something about shooting in the wind every time we go out. That's what makes it fun. What follows is what works for us, others, of course, will have different methods.

The easiest way to shoot well in the wind is to wait for conditions to become consistent. Most of us don't have all day to shoot one group and competitors are shooting a timed course of fire. Try to pick a condition that seems to be most repetitive or prevalent. That way in the time allotted, you should be able to get the condition to reappear long enough to shoot a group of five. Sometimes it doesn't come back fast enough and you have to "hold off" your normal point of aim to finish a group. How much to hold off depends on how much the condition is worth. Let's assume your 1st shot was printing at one point on the target and the condition reverses. Your sighter shot in this new condition is 1/2 inch (center to center) to the left when holding the same aim point. Simply hold off your original point of aim an equal amount. You must trust the rifle and the flags. New shooters, not believing the difference, will typically hold off 1/2 the distance and be dejected when their shot flies out of the group the other half of the distance. We have heard many shooters say they couldn't believe it was that much or that they were afraid to hold off that much. TRUST YOUR RIFLE.

The other bad decision a shooter can make when faced with having to hold off to finish a group is shooting too many sighters. Shoot one or two to verify the condition and then run your shots. Too many of us shoot five sighters into a little bitty hole and then run up to the record and blow the group because now the condition has changed.

To shoot well, especially in competition, you are rarely going to get the flags exactly the same. Be most concerned with the flags close at hand. Also, learn what is happening on each side of the bullet path. It doesn't always directly effect you but observations of radical flag changes can keep you from getting caught by a freak wind change. Get used to glancing upwind and downwind at the furthest flags to see if something is coming. If you detect a radical change, pause to see if it is going to last. If it does, shoot a sighter and get back to work.

Be aware of the wind on your body. If you feel a change, see what's happening with the flags before pulling the trigger. When you get the wind coming straight at you or away from you try to avoid shooting in this condition if at all possible. Wind intensity is very difficult to read. You can get all kinds of vertical trying to shoot these conditions. At our local range, a tailwind gives us a heap of trouble. We feel as the wind comes over the roof that protects the firing line, it disturbs the bullet leaving the barrel.

Always try to let off your shots in the mildest part of the prevalent condition. For example, if we were shooting in a strong left to right wind which was dying down occasionally, we would try to wait for the calmest moments to let our shots go. Sometimes the left to right just turns around the other way without a calm moment during the switch. When this happens we try to pick the direction which is blowing with the lowest velocity. You may get caught once in a while by a "pick-up" or a "let-up", but try to pick the condition with the least wind strength every time.

Listen to the shooters around you while you are shooting. If you are getting ready to shoot and you hear a shooter a couple of benches down swear and yell, back off the trigger and check your flags again. He could have pulled a shot on his own or some condition change could be happening. Shoot another sighter if necessary. Listen to the shooters coming off the line. You will hear them talking about the wind being prevalent from right to left or vice versa. Listen to them, but check it out for yourself while you are getting set up at the bench. It's okay to chit-chat with the guy on the bench next to you while you are waiting for targets, but it's a good idea to watch the flags while you are doing it.

Mirage

Mirage is another problem the shooter faces. Unfortunately, mirage is not always visible, but when you can see it you can sometimes use it to your advantage. Mirage is a visual illusion that displaces the image of the target. On a hot summer day when there is a little breeze, look down the

road at an oncoming car. The heat radiating from the pavement distorts the appearance of the oncoming car's image, and if there is a left or right breeze, it appears as if the car is in your lane.

The same is true on the shooting range. When viewed through a high power scope, mirage can create impact changes when the target image is being displaced by the mirage. When you see the shimmering little heat waves on your target change intensity or direction, it is as if you can see the wind. Actually, what you are seeing are the effects of some wind. Now you are contending with wind and a displaced target image. In other words, because of the mirage you will be aiming where the target is not.

If there is no air movement to influence the mirage, it will radiate straight up from the ground. This condition will cause the target image to appear higher than it is, thus bullet impact will actually be higher than it would normally strike. This condition is commonly called a "boil" and should usually be avoided.

When you get a little breeze pick-up left to right, then the target image will be slightly displaced to the right and slightly lower than the image observed during the boil. Your bullet will strike a little lower than before (during the boil) and slightly to the right. You would expect it to go a little to the right because of the breeze, but not the extra amount because of the displaced target.

Experienced shooters view mirage as an aid in viewing wind shifts and intensity changes. There is a point when wind intensity changes are no longer readable by using mirage. The squiggly lines become a fast tempo of movement and further increases in the wind are impossible to see. But the mirage can help you to see those last second wind shifts or let-ups/pick-ups. Sometimes a flag will react slowly while the mirage movement is much quicker. There are times when the mirage is running one way and the flags are clearly pointing the other way. Trust the flags in this situation. There must be something happening near the target frame that is different from the conditions where the flags are located. Just remember that displacement of the bullet in the last ten yards won't affect the group as much as the same displacement in the first 50 yards.

Some shooters do not use mirage and claim that it doesn't help them at all. It is just another tool to evaluate. Try it yourself sometime and shoot using only mirage as a wind indicator. Intentionally shoot during different mirage conditions and see how the bullets are displaced. You will, of course, see noticeable differences with a highly accurate rifle.

At a registered benchrest match, there are mirage boards on both sides of each individual target frame. These are the black and white striped boards which you see through your scope. Use them if you want, ignore them if you so desire, but when mirage is present it will show on the target whether you like it or not. Mirage is usually present, or has the greatest potential to be present, when the ground surface has a lot of moisture and the sun is out. A sandy surface is often worse, and ground covered in wet vegetation can produce terrible mirage. There are times when the targets at 200 yards will move so violently that you can hardly recognize the target itself. This makes it nearly impossible to get a consistent idea of where to hold. Sometimes you can't see your bullet holes, especially if they are on a black line on the target. Some shooters watch the sky to see if clouds will possibly block the sun before time expires to try to get some relief from the mirage. This sounds pretty far fetched, but once you have shot at some of the ranges which have a lot of mirage, you will become a quick believer. When you have to shoot in these horrific conditions, just console yourself with the fact that all the other shooters on the line have to do the same. Misery loves company.

Summary

Shooting in the wind and mirage is tough, and we all like to moan and complain about it. These conditions really make the shooting (especially benchrest) more challenging instead of being a trigger pulling contest or seeing who has the best barrel. A good wind shooter with a so-so barrel can beat a poor wind shooter with a great barrel in tough wind conditions just about every time. Buy some wind flags or make your own and start learning. Hopefully, the learning will never end.

Chapter 9

Bullet Coating Technology

The subject of bullet coating has, without a doubt, been one of the most dominant topics among accuracy buffs for the last four years or so. Bullet makers from custom shops to Hornady, Sierra, Barnes, Nosler, Winchester etc. have all offered bullets coated with one material or another.

Dozens of articles have been written in gun magazines including numerous articles in Precision Shooting Magazine. Benchrest shooters, varmint hunters, highpower shooters, service rifle shooters, hunters and shooters of other disciplines have tried it. Some shooters have ignored it.

What we would like to discuss in this section is what bullet coating can do for you, types of coatings, ways to apply them, and we will discuss some basic issues regarding bullet coating. There are numerous technical articles on this subject, some written by coating engineers, chemical engineers, and others who clearly have the background to discuss all the science behind this subject. We don't intend to reiterate their work. All we intend to do is to tell you what we have learned about bullet coating through our own efforts, and how you can apply this technology to your own shooting if you desire.

Introduction

A brief introduction to bullet coating is needed before we proceed. Very simply put, bullet coating is the act of introducing a layer of some type of dry film lubricant on the outside surface of a bullet. This coating is intended to reduce friction, reduce copper fouling in the barrel, extend barrel life, reduce cleaning requirements, and possibly improve accuracy. Bullet coating is not something new. Shooters have experimented with dipping bullets in a myriad of different solutions for many years. One of these concoctions included molybdenum disulfide mixed with fuel oil years ago but its use was abandoned. In 1993 NECO introduced its bullet coating process and "Do-It-Yourself" kit to the public. NECO's patented process involved impact plating molybdenum disulfide on the bullet surface using steel bearings. The process is usually performed in a rotary tumbler, but can be done in a vibratory tumbler.

When the NECO Moly-Coat™ process appeared on the market, many shooters were wary at first; but a great number of accuracy oriented shooters eventually began coating their bullets as part of their reloading process. As the process became more popular, shooters from all over began experimenting with different coating materials and methods of application. Today, 6 years later, you can hardly turn a page in a magazine like Precision Shooting without seeing the word moly or an ad offering some type of bullet coating kit. Hornady joined the custom bullet makers when they offered some of their match bullets factory moly coated. Soon after Hornady's appeared, Sierra, Nosler, and Barnes announced their own coated bullet lines.

Recently there has been some adverse publicity regarding moly coating by several individuals in precision oriented publications. We have stopped using moly coating at this time because we are concerned about the variables involved.

Benefits (claimed)

Bullet coating manufacturers and bullet makers claim all kinds of benefits can be realized from shooting coated bullets. Let's look at some of these possible benefits and discuss them.

The prevention of copper fouling in barrels with the resulting benefit of less cleaning is the most frequently claimed benefit of shooting coated bullets. Traditionally, shooters have scrubbed and cleaned with all kinds of bore cleaners, mops, patches, and brushes to remove the copper build-up laid down in the barrel as copper jacketed bullets are shot through them. Benchrest shooters are especially finicky about cleaning barrels after every 10-20 shots to remove any possible copper fouling.

There is possibly some benefit in reduced copper fouling and potentially less cleaning, but the results differ from barrel to barrel. You still need to clean, but in some cases, less than before. One observation we have made by looking closely in some of our own barrels, and the barrels of others which have had moly coated bullets shot through them, is that moly or some other substance, tends to build up over time unless the barrel is cleaned thoroughly and regularly. You need to inspect your own barrels closely to check for built up moly, especially in the first 4 to 6 inches forward of the throat. We suspect this build-up to be a mixture of moly, burnt powder, and copper.

Another benefit claimed by coating specialists is extended barrel life. We have not seen any validated scientific tests that show extended barrel life. We have heard many personal testimonials, but have not seen any real hard data. Shooters using coated bullets from benchrest to high-power have claimed to receive extended "accurate" life from their barrels. Many have claimed also that they have used coated bullets in barrels previously thought to be "shot out", and that it brought back their accuracy. Again, we have not seen any good studies that show this, but many shooters from around the country have reported to us that accurate barrel life has been extended.

Another benefit that has been discussed is that coated bullets possibly have a higher ballistic coefficient. "Precision Shooting" magazine ran a couple of articles by Dan Hackett on this subject. Some tests were run by the lab guys at Norma Precision who reported some improvement in ballistic coefficients on the bullets they used in their tests (approximately 3%). Norma theorized that the bullets stabilized sooner, and much closer to the muzzle, than uncoated versions. Again, this has been theorized and written about but no real hard statistically valid data has been presented to support this theory.

The benefit that very few manufacturers or suppliers of coatings will claim is increased accuracy. This would be a difficult claim to prove since the improvement is probably very slight. The problem would be that to compare coated versus uncoated bullets one would have to use two different barrels and the variable in barrel accuracy is probably enough cause to question any improved accuracy from coated versus non-coated bullets.

We have heard several people, including some reputable magazine editors, endorse coated bullets because the winner of this match or that match was shooting coated bullets. With more and more shooters using them, the law of averages says this will happen, but the important flaw in this logic is that the winners still happened to be top ranked shooters. When Eunice Berger won the 1997 Super Shoot 3 Gun Championship, was it because she was shooting "molys" or because she has been a top ranked shooter who had been pushing closer and closer to the winners circle each year? Obviously, the moly coating did not decrease the bullets accuracy in this case.

Our feelings about bullet coating are generally neutral. We feel the possibility of reduced fouling and cleaning is a huge benefit to the shooter if it can be realized. We still have unanswered questions about the effects

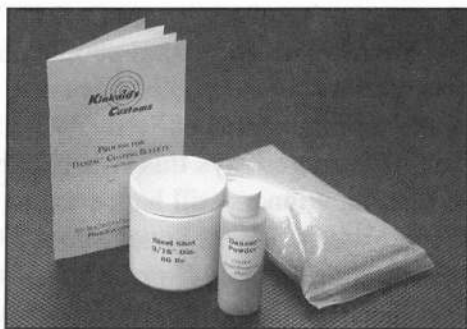
of bullet coatings on accuracy, whether positive or negative. We, along with some of our employees, were shooting coated bullets for several years in matches. As of this printing we still have unanswered questions about bullet coating. Hopefully someone will be able to provide statistically sound answers for these questions in the near future. For now, let's discuss some of the more common types of bullet coatings and their application.

Coating Types

Most of the coating systems on the market as of this book's printing are composed of either molybdenum disulfide or a composition of molybdenum disulfide with additives or solvents which act as carriers for molybdenum disulfide when the coating material is offered in a liquid form.

Molybdenum disulfide is commonly referred to as "moly", and we will call it that throughout this text. Winchester markets cartridges loaded with bullets coated with Lubalox, which is not composed of moly. Lubalox is considered a black oxide product. Barnes Bullets also offers its own line of proprietary coated bullets. Their coating originated in the auto racing industry.

Danzac™, manufactured by Kinkaid's Customs, is another coating material rapidly gaining acceptance by all types of shooters. Danzac™ is a proprietary formula, and according to Kinkaid's Customs, offers the advantages of moly without many of the problems attributed to moly coating systems. Danzac™ does not adhere to Danzac™ as moly adheres to moly. This results in an even coating on every bullet, and there is no need to try to adjust the coating thickness by adding more material or tumbling longer. No wax coating is recommended since Danzac™ does not rub off as easily as moly does. Kinkaid's also states that Danzac™ does not incur chemical breakdown until a much higher temperature than moly.



Danzac™ Coating Kit

The first and probably most commonly used method for applying moly or Danzac™ to bullets is by impact plating or peening. The impact plating of the material onto the surface of the bullet is done with steel balls (approximately 3/16" diameter). This process of impact plating moly onto

the bullets was developed by Nostalgia Enterprises Co. (NECO) who has a patent on the process. The impact plating is done in either a rotary or vibratory tumbler. We will provide our procedure for using this method later in this chapter. The materials used for this method are available separately or in kit form from several different vendors.



NECO - Coat™system

The second method of applying moly to bullets is by spray. There are several different vendors on the market offering a “spray on” moly product that is either in aerosol cans or in a liquid form intended to be used with a small airbrush sprayer. The bullets are lined up and “painted” with moly.

A third method of applying moly is by immersion into a liquid bath of moly carried in suspension. Bullets are dipped into the moly bath then set up to dry. The bullets then need to be briefly polished with a cloth or tumbled for a smooth finish. There are other methods being experimented with, but these three are what most shooters can do themselves.

The plating method for applying moly or Danzac™ requires the user to have a tumbler, powdered molybdenum disulfide or Danzac™, steel balls, untreated media, and carnuba wax, if desired. It can be messy, but this is a relatively quick method of coating bullets. The materials supplied in NECO-Coat™ kits or Danzac™ kits are enough to coat thousands of bullets.

The sprayed moly finish is an easy and economical way to get started moly coating. This is one of the best ways to apply moly to loaded cartridges. The user doesn't need much space for this application, and you can contain any over spray by simply rigging up a cardboard spray booth. The downside to this method is that you can build up more moly on one side than the other if you are not careful with your spray technique. We are not sure if this causes problems with external ballistics, since most of the excess moly should strip off before exiting the barrel, but it may present some inconsistencies for internal ballistics. One of our employees uses this aerosol spray method and he has had success with it.

The dipping method is also an economical way to start moly coating, but we found it a time consuming method of coating. The results look

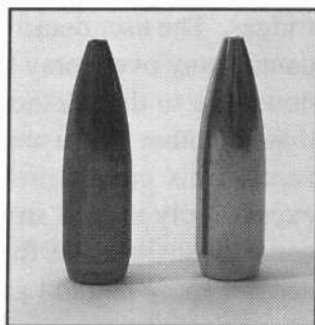
good and we found that dipping was an excellent way to do cast bullets or bullets with exposed lead tips. If you are going to coat a lot of bullets at one time this may not be the best method for you.

How to Bullet Coat

Let's go through all the steps required to coat bullets so you can do it yourself and get as good or better results than the professionals. We will break bullet coating down into three basic areas; 1) Bullet preparation, 2) Bullet Coating, 3) Polishing and/or waxing. We will cover all three methods of coatings; 1) Plating or tumbling, 2) Spray-on, 3) Dipping. In the tumbling method section we will present differences when using moly vs. Danzac™. What we talk about there is what we have found works best for us, but each person who gets into coating bullets seems to develop his/her own methodology which works best for them. We encourage you to experiment. That's what makes this fun.

Bullet Preparation - We found early on that we couldn't expect to get good results from our coating effort if we didn't prepare our bullets properly beforehand. The only chore involved in bullet preparation is degreasing them or cleaning polishing rouge from them. We have coated bullets from Hornady, Sierra, Berger, Nosler, Fowler, Braward, Euber, Barnes, Starke and other custom bullet makers. We found that all of them benefited immensely from cleaning. Hornady bullets, for example, have a polishing rouge or sizing lube left on them from manufacturing that prevents a good coating from adhering properly. Different articles on cleaning bullets prior to coating suggest using a solvent such as lacquer thinner, Gun Scrubber, Break-Free, or other organic solvents. We have found that using Iosso Brass cleaner (liquid) works extremely well, and only takes a couple of minutes. It is available in gallon containers and can be re-used over and over again until it loses its potency.

We use a plastic or stainless steel container to make a solvent bath in. Something about the size of a large Cool Whip container is about perfect. Place the bullets to be cleaned in the container and pour enough Iosso in to cover the bullets. Move them around with a wooden or metal spoon for a few seconds to make sure all surface areas are exposed to the Iosso. Then, using a strainer or screen of some sort, pour the Iosso cleaner into another container. You may want to



*Tarnished bullet (left),
Clean bullet (right)*

keep two storage containers if you want to keep track of the fresh stuff and the used solution. Once you have drained the bullets, wash them under warm water. (By the way, Iosso is safe on sinks and drains according to the manufacturer.) Once the bullets are cleaned you should avoid handling them with your bare hands. Use disposable cotton gloves if you need to touch them.

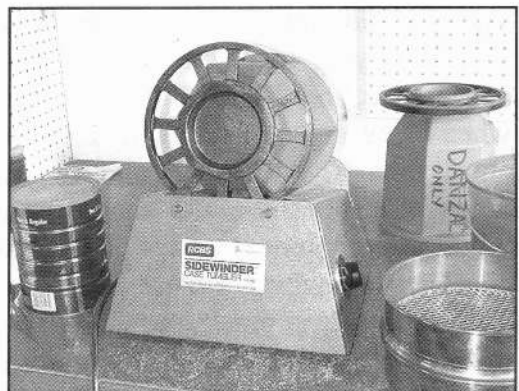
When the bullets have been washed in water spread them out on some paper towels to dry. If the towels get wet just transfer the bullets to some dryer towels. At this point we use an electric heat gun (a hair dryer works fine) to make sure they are good and dry. This also serves to warm them up. We have found, through our own experiences, that the bullets coat best if clean and warm. How warm do they need to be? Others have written that between 120° and 160° seems to be the range which works best and we agree.

This warm up can be done with a heat gun, hair dryer, heat lamp, or just putting the bullets in a conventional oven at 125° - 150°. Use an old tin pan or foil pie plate. Regardless of how you do it, the warming up process only takes a few minutes and is definitely worth it. Remember...no bare hands should contact the bullets once they are cleaned. The oil from your skin will affect the quality of the coating.

Tumbling Method

Your bullets are now cleaned, warmed up and ready to go. Let's prepare our tumbling concoction first. We will assume you are using a rotary tumbler like the RCBS Sidewinder or something similar. If you are using a vibratory tumbler continue on with us since the technique is the same. You just may find you can't do as many bullets at once, and it may take you longer.

What's critical when you are tumbling with moly or Danzac™ are the mixture of bullets, steel balls, moly/Danzac™ and the length of time you run the tumbler. The amount of bullets will determine the amount of steel balls, and the amount of steel balls will determine the amount of moly/Danzac™. We don't usually like to put more than 8



Set-up for tumbling

pounds total weight in our RCBS tumbler. It could probably handle it, but too much weight would shorten the life of the tumbler. The NECO-Coat™ system recommends a 2:1 ratio of steel balls to bullets and we have found this to be a good place to start. Using the 2:1 ratio means we can tumble about 2.7 lbs of bullets or 18,900 grains (7000 grains per lb). For example, if we wanted to tumble .22 caliber 52 grain Berger's we would divide 52 into 18,900. This would give us 363 bullets that we could tumble. If we were tumbling .30 caliber 168 grain bullets we would divide 168 into 18,900, giving us 112 bullets. In the first example, we would put 5.5 lbs of steel balls in the tumbler and dump in approximately 3 1/2 boxes of .22-52's. In the second example we would put in 5.5 lbs of steel balls, and a full box of .30-168's, and throw in an extra 25 bullets.

Put the steel balls in the tumbler and add a 1/4 of a teaspoon of powder. Start the tumbler (always keep the lid closed when running the tumbler to keep moly dust from going everywhere) and run it for 2-3 minutes. Look inside (use a flashlight if necessary) to see if the moly/Danzac™ has coated all the steel balls. If there is just a bit of loose powder among the steel balls you are probably ready. If there is a lot of loose powder, you probably have too much moly or Danzac™ in the mix. If there doesn't seem to be enough moly or Danzac™ add very tiny amounts at a time until you feel there is enough. A new drum absorbs some of the moly initially so it may take more the first time you use the tumbler.

NOTE: The unscientific amounts of moly/Danzac™ most directions instruct you to add raises a question with us.

Once you have the mixture of moly or Danzac™ just right, add the clean warm bullets and begin tumbling. If you are using a Sidewinder Tumbler and moly coating, set the timer for an hour to check the bullets. You are trying to get the bullets so they have a silver grey or black appearance, and the coating should look uniform everywhere. One hour, when using moly, is probably not enough, so you probably will need to check them at 1 1/2 hours and maybe go to 2 hours if necessary. Two hours in a rotary tumbler should be plenty. Again, if you are using a vibratory tumbler expect the process to take a little longer. When we are checking the bullets, we use a big kitchen serving spoon with slots in it. That way we can reach into the drum for a sample lot and avoid getting moly all over our hands. The slots (if you can find the right spoon) allow the balls to fall through but not the bullets.

If you are using Danzac™, set your timer for a half hour and check the bullets. About an hour will be the right amount of total tumbling time if you are using Danzac™.

If the bullets are not getting silvery, you may not have enough powder in the mix. The mixture of powder, steel balls, and bullets may need to be adjusted slightly, but once you get the mixture down, the actual coating process means just putting the bullets in the tumbler, setting the timer and walking away. You should be able to coat 500 to 1000 bullets in an evenings time (.22 caliber). The advantage of the tumbling process is that 90% of the time is hands free allowing you to do other things.

After the bullets are finished in the tumbler you can wax them, tumble them in dry media to give them a little polish, or leave them alone. Let's get them out of the drum first. The easiest way to separate the balls, moly/Danzac™, and bullets is to screen them. You can buy hardware cloth with 1/4" spacing to use for a screen. Use a bowl to catch the remaining contents of the drum. Pour the drum's contents onto the screen and the steel balls and powder should fall through. Some bullets may slip through, especially .22 caliber bullets and .17 caliber bullets, but you can pick these out by hand. Some steel balls may be stubborn and not fit through the screen depending on tolerances. Just poke them through. After screening, check the steel ball/powder mixture thoroughly to make sure no bullets remain. You will use it again and you don't want some 52 grain Berger's and 53 grain Sierra's mixed up in later batches. Put the tumbling mixture back into the drum and tumble some more bullets if needed. Keep an eye on the level of powder because you will need to add a small amount to the mixture occasionally.

Finishing the tumbled bullets - Once the bullets have been moly coated or coated with Danzac™ you need to make a decision about whether to wax the bullets or not. We will go over the process, but we don't apply wax ourselves anymore. Using the wax is a debatable process because its main purpose is to seal the moly onto the bullets so they are not as messy to handle when you load them.

Whether you are going to wax the bullets or not, we suggest you put the bullets in a separate drum and tumble them in some dry untreated corncob media. You only need to tumble them for a minute or so to remove any loose excess moly and buff the bullets slightly for a smooth finish. At this point, the bullets should be ready to reload or ready to wax.

The waxing is done in a separate drum (this would make the third drum) using carnuba wax and steel balls. The amount of balls should be approximately the same amount as calculated previously. Start with a 1/4 teaspoon of carnuba wax and tumble the mix without bullets to coat the steel balls. Add very small amounts of wax to the mixture until you feel the wax is dispersed evenly throughout the steel balls. Work up to the proper mixture very slowly so you don't get too much wax in the mix.

When you have a proper mixture established, add the bullets to the wax and balls and begin tumbling. It is critical to the success of the wax coating that the bullets are at least normal room temperature (68° - 70° F) or warmer. You can pre-warm the bullets if you desire. The tumbling time will vary depending on the tumbler you are using. With an RCBS Sidewinder, it should only take three to five minutes for the bullets to wax properly. If the mix is right, the bullets should come out with a shiny grey/black appearance and the wax coating should prevent very much moly from coming off when you handle them. The bullets should be very slippery to the touch. If the bullets have an uneven appearance and show an excessive build-up of wax, they can usually be fixed by putting them back into untreated media for 30 second intervals until the appearance improves. Don't tumble more than 5 minutes as the moly will start being removed. If this happens, you can always coat them again.

Once the waxing is complete the bullets are ready to load. Remember to keep the tumbling components in separate, well marked containers. The steel balls will eventually need additional moly/Danzac™ and wax. Remember to always add in small amounts. The tumbling media will need to be replaced from time to time. The steel balls and wax mixture will rapidly become black due to some moly/Danzac™ coming off the bullets as you are tumbling. There is no need to worry about this contamination, but if it bothers you, you can run the steel balls in some untreated corncob media and clean them up periodically. Throw the media away if you tumble the wax coated steel balls.

Moly Sprays

The application of any sprayed on moly coatings would essentially follow the same procedure. Refer to the degreasing/cleaning section (Bullet Preparation) earlier in this chapter prior to beginning the coating process. This degreasing procedure is extremely important to a successful finish. Starting with warmed bullets is even more important with sprayed on coatings than it is when using the impact plating process.

Line the bullets in whatever equipment the manufacturer suggests. Marksman Products (Ms. Moly™) provides some foam alignment boards that you sit the bullets in and then lift the foam piece off the bullets to leave them lined up symmetrically for spraying. We suggest doing the actual spraying in a warm garage or outside on a sunny day. Remember, the spray will drift, so build yourself a cardboard booth of some sort.



Bullets lined up to spray

Spray the bullets just like you were spraying paint. Nice, smooth, even sweeps back and forth. Spray from all different angles to make sure an even coat is applied. Two light coatings would be preferred over one heavy coat. Drying time is fairly short, but refrain from handling them too soon. The drying time will be dependent on temperature and humidity, but expect about 20-30 minutes on the average. There is no need for any additional treatment such as tumbling or waxing. When the bullets are dry, they are ready to load.

The spray on finishes are great for cast bullets, sabots, etc. and require very little equipment. Done properly, you can expect to get great results with this method. Some of the spray finishes are contained in aerosol cans, and others are available for use in hobby type spray guns.

Bullet Dip finishes

We have only experimented with one of the bullet dip processes. We found it to be easy to use, a little slow at first, but once we got the hang of it the process went faster. We wouldn't want to dip several hundred bullets at once, but neither would we want to neck turn several hundred cases at once.

At the risk of being repetitive, make sure your bullets are degreased and clean before you start coating. Avoid handling them with your bare hands once they are clean. The kit we have used (Bullet-Dip) comes with small pieces (1") of plastic tubing that you can stick the nose of the bullet in and hold it securely enough to act as a temporary dipping handle. This works fine on fairly pointed bullets, but you would have to come up with larger tubing to dip larger cast bullets or any large blunt or round nosed bul-

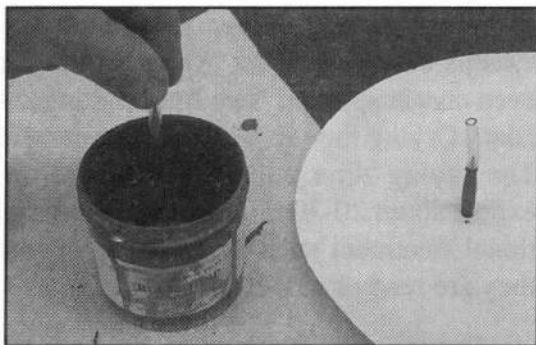
lets. We coated some .311" cast bullets by holding them with a pair of needle nosed pliers. This method worked great for us except that every once in a while you might lose a bullet in the dip solution. No big deal, just fish it out and wipe it off.

Using this method, you don't need to coat the nose of the bullet so it doesn't matter how you hold the nose to do the dipping. All you are concerned with coating is the bearing surface of the bullet. Make sure to shake the liquefied moly up real well prior to beginning the coating process. You will periodically need to do this during the process since the moly won't hold long in suspension. Also, remember to keep the solution covered when it is not in use because the solvent that acts as the carrier will begin to evaporate.

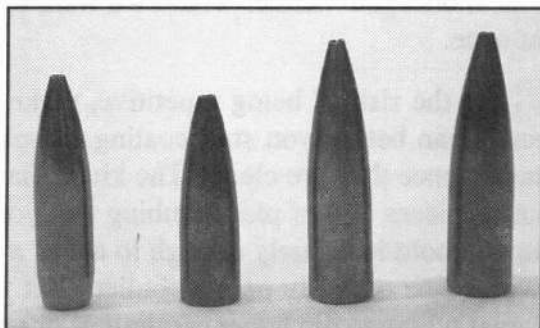
Dip the bullets into the moly mixture as far as the holding device will let you. We don't think you have to be real consistent with the dipping motions, but we don't have any data that supports affects to external ballistics (good or bad). You only have to dip the bullet for a second then remove it from the dip.

We have found that blotting the base of the bullet on a paper towel or tissue removes any excess moly at the base. Then you can place the bullets on a piece of paper, cardboard, paper plate, etc. for drying. The drying time is fairly short, but make sure the bullets are dry before handling them. The cast bullets seemed to take twice as long to dry as the jacketed bullets. The first bullets should easily be dried before you finish the last ones (batch of 50).

When the bullets are dry, rub them gently a few times in a soft cloth or paper towel to polish the moly and they are ready to load. The finish should be shiny grey/black in appearance and should not rub off easily. These bullets seem to be slicker than some of the other finishes we have used, but whether or not this means anything, who knows! No wax or tumbling is needed.



Dipping bullets



Moly tumbled, Danzac™ tumbled, Bullet Dip, Ms. Moly

Bullet Coating Summary

We have covered three different methods of bullet coating, and if you decide to bullet coat we hope this will help you choose the method that will work best for you. We have used the impact plating or tumbling method the most, possibly because we began with this method and are used to it. We like the tumbling method because once you are set up, all you have to do is just dump some bullets in the tumbler and walk away from it. We hope this discussion of bullet coating was beneficial to you. Each person adapts the process to his/her own needs, and if you decide to bullet coat we encourage you to experiment and develop your own procedure or methodology.

Bullet Coating Important Points

- 1) Make sure bullets are clean, degreased, and dry before beginning any kind of coating process.
- 2) Bullets tend to coat better when they are warmed up. Some experts recommend 120° to 160° but we found that anywhere on the low side of that range seemed to be ideal.
- 3) Always use dry, untreated corncob media for polishing or cleaning. Never use walnut based media because the high oil content will prevent proper adhesion of the coating. Do not use treated media at any time. The polishing compound will also impact the coating process.
- 4) Avoid handling the bullets by hand after they have been cleaned. The natural oils in your skin will affect the quality of the coating. Use gloves, scoops, spoons, etc. to handle the bullets. Once the bullets are coated feel free to handle them.
- 5) When tumbling bullets for the first time try a small batch (50-100) until you get a feel for it. Remember, it is easier to add more powder or wax to the mix than to remove it. All tumbler drums, bowls, and linings will absorb some moly /Danzac™ into the surface initially, and some will absorb more than others.
- 6) Do not overload your tumbler. Overloaded tumblers need more power to turn the excess weight, and their motors can burn out prematurely. Some tumblers may be rated by either volume and/or weight.
- 7) If you are using both moly and Danzac™ avoid any cross contamination of steel balls, media, tools, etc. If you have only one drum, try to avoid switching back and forth too often between moly and wax.

- 8) Tumbler drums and the steel balls can be cleaned after heavy use by tumbling some untreated corncob media with the shot. Separate shot and media with an appropriate sized screen. Throw out used media.
- 9) Follow manufacturer's instructions when using any coating product.
- 10) If you plan on tumbling, consider getting a shooting buddy to share in the initial investment. You only use it when you get a new batch of bullets, so why not reduce the cost?
- 11) When spraying bullets with an aerosol coating, don't worry if the tips aren't covered completely. Just make sure the bearing surfaces are well covered. The same is true with the dipping application.

Barrel Pre-Conditioning

You may want to consider pre-conditioning your barrel prior to shooting moly coated bullets or Danzac™ coated bullets. Some shooters prefer to burnish some of the coating into the barrel using a moly or Danzac™ covered patch on a wrap style jag. Run the patch back and forth in the bore 6 to 10 times. This is also a good way to recondition the bore after a cleaning if you are going to continue shooting coated bullets.

Barrels can also be pre-conditioned with the spray moly or the liquid versions. Spray some into the barrel and patch it back and forth. Be careful when spraying since it will usually blast out of the barrel and all over the place.

This pre-coating also works great on shotgun barrels. One of our employees uses it on his shotgun barrels and his barrels all have a mirror like shine inside. Cleaning and plastic wad fouling seemed to be reduced.

Issues Regarding Bullet Coatings

There are many issues regarding bullet coating that you should be aware of. Most of them have been argued to death among shooters, but unfortunately, none of these issues has undergone an unbiased study with statistically valid data presented. You will need to decide for yourself what's important and what isn't.

One big issue with impact plating methods such as the NECO-Coat™ system is what effects, if any, does the constant tumbling of bullets in heavy steel shot have on them. Does tumbling for up to two hours occasionally separate a bullet jacket and inner lead core? Does the tumbling disturb the geometry of the bullet surface? We don't know the answer.

Many shooters have theorized that coating bullets is another variable in the reloading equation that doesn't need to be there. Some feel the tumbling is an uncontrollable variable. Others feel that the shot peening the bullet surface introduces dimples on the bullet jackets similar to what is manufactured into golf balls. The dimples on golf balls help it fly straighter and longer. Does this have the same effect on bullets? We don't know the right answer to this either.

Another issue the above leads to is the idea of tumbling bullets without the steel balls. One Armed Forces shooting team has began tumbling their bullets in moly only, no steel balls. They feel the bullets impacting each other with the moly powder is all that is necessary. Others feel that the moly doesn't adhere to the surface of the bullet well enough when applied without steel shot. We feel this area needs explored some more. We have tumbled some bullets ourselves without the steel balls and felt the coating was fine. The question is, do you want the bullets tumbling around in an almost empty tumbler, or being crashed into by steel balls?

Another question that gets a lot of discussion is whether or not to use Carnuba wax on top of the coating. NECO has always claimed that the main reason for adding the thin layer of wax was to keep your hands from getting so dirty from the moly. Some other respected shooters have claimed that the bullets coated with wax are more accurate at longer distances (600 yards plus) than their uncoated brothers. We normally do not wax ours. We buff the bullets to remove any excess moly or Danzac™ and don't handle them by hand except to seat them. At the time of printing, we understand that one of the military shooting teams have quit waxing because they were getting a touch of yellowish-brown material near the throat and thought it might be the wax stripping off. It wasn't necessarily causing them any problems, but they didn't like it.

Another issue with moly that we feel has not been researched enough is whether blasting moly impregnated bullets down the bore is hard or abrasive on the barrel. An analysis of two barrels (one shooting coated bullets and one shooting plain bullets) by several metallurgist and at least one coating engineer has shown that when comparing the barrels shot with the same amount of rounds (coated and uncoated), the barrel shot with coated bullets is in far superior shape than the barrel shot with uncoated bullets. The uncoated bullets definitely wear harder on the barrels due to a higher coefficient of friction and the lack of lubricity.

A big concern of ours is the built up moly, powder, and copper that we saw in several barrels. Barrels that had been cleaned approximately every 50-75 rounds had a built up layer of moly, powder, and copper in the first 6 inches of the barrel. In two of these barrels we found pitting underneath the layers of fouling unlike anything we had seen before. What impact that this build up has on accuracy is unknown. All of these barrels quit shooting well after 2,000 rounds. We feel barrels that have had coated bullets shot through them need to be cleaned a lot more than people have been cleaning them. In the next chapter we discuss some of the cleaning methods used for cleaning barrels shot with coated bullets.

Summary on Bullet Coating

If you want to start experimenting with coated bullets we suggest you first try some pre-coated bullets made by Berger, Sierra, Hornady, etc. prior to investing in the equipment. Make sure your barrel is clean before you start shooting coated bullets to get the best results.

After you have shot them, decide for yourself whether or not it would be beneficial for you to invest in the equipment and materials. If you only reload a few different bullets and they are available as factory coated bullets, you may want to consider just paying the extra \$2-3 per box of 100. If you play around with a lot of different bullets and/or you load a large amount of bullets you may want to make the investment in coating equipment.

Choose the method that works best for your application. Talk to other shooters and see what they have experienced. We can just give you our opinions and tell you what coating method worked for us.

NOTE: At the time this book was published a lot of us here at Sinclair had stopped shooting coated bullets. We feel there are too many variables involved and not enough valid statistical data to support any claims regarding bullet coatings. We understand that a couple of larger manufacturers may be doing some statistical testing soon that may shed some light on our questions. We will continue to test coating products and try to determine how they can be beneficial in our own shooting. It is possible that moly type coatings may be the first step in the evolution of coating materials.

Chapter 10

Cleaning your Rifle Correctly

Cleaning rifles has changed so much in the past few years that it is sometimes even hard for us to keep up with all of the new “miracle” concoctions that claim to be the perfect cleaning product. There is no single magic product available. Cleaning today still takes elbow grease, the right solvents, the correct equipment and a routine procedure. The introduction of coated bullets, which we discussed in the previous chapter may have reduced the cleaning requirements for some rifles, but it has not eliminated the need for proper cleaning.

We clean our rifles more now than we ever have in the past. We all realize by now that copper fouling in the bore is bad news and a detriment to continued accuracy. Many a new rifle that was considered “shot out” has had accuracy restored by simply giving it a good cleaning. When a bullet is fired through a barrel under pressure of 45,000 psi or more, the bullet swages its way through the barrel leaving a layer or coating of jacket material in the bore. On top of this is the residue from the burned powder. The second round leaves another deposit of jacket material over the powder residue and compresses the bottom layers of copper. This sequence of events occurs every time a bullet passes through the bore. All of this compression takes place around 45,000 psi and at extremely high temperatures. As repeated shots are fired this sequence of events leads to bore conditions that are detrimental to shooting accuracy. At this point, only a proper cleaning will restore accuracy.

All the fancy actions, reloads, triggers, and custom stocks are meaningless to accuracy if they aren't attached to a clean, well made barrel. Competitive shooters know that one characteristic of a good quality rifle barrel is that the bore is uniform from one end to the other. Bore diameter tolerances on match grade barrels are held to ± 0.0001 ". This is great if you keep the bore clean. Without routine proper cleaning, fouling will build up in the rifling grooves starting in the corners and gradually building up toward the center of the grooves. If the grooves are normally less than 0.005" deep to begin with, how can we expect the barrels to shoot well without cleaning? We have seen many barrels, that were supposedly “shot out”, but were really just loaded up with fouling. Once they were restored to their original condition, accuracy returned.

Usually the closer you can get your barrel back to an almost perfectly clean condition, the better it will shoot. If you shoot 10 rounds and clean well enough to remove only 7 rounds of fouling, just think what will be present in the barrel after 1000 rounds.

There are basically three methods of cleaning used on rifles today. Sometimes a combination of these three basic methods is used. Chemical cleaning and mechanical cleaning are the two most popular methods used. Electrochemical cleaning is done with more sophisticated equipment, such as Outers Foul-Out II. This method is more expensive, less portable, and can be time consuming. If you are interested in further information on electrochemical cleaning we suggest you contact Outers. They are the only manufacturer we know of who offers this type of equipment especially designed for shooters.

In this chapter we will cover some of the equipment needed for chemical and mechanical cleaning, an overview of some of the solvents and cleaners, proper barrel break-in, routine cleaning, action cleaning and lubrication. We will cover barrel cleaning specifically for non-coated bullets and coated bullets. Cleaning for coated bullets is much different than our traditional cleaning methods and we don't know if the cleaning being done by many shooters today is the perfect method. It may not be from what we have seen recently in quite a few close barrel examinations.

Cleaning Equipment

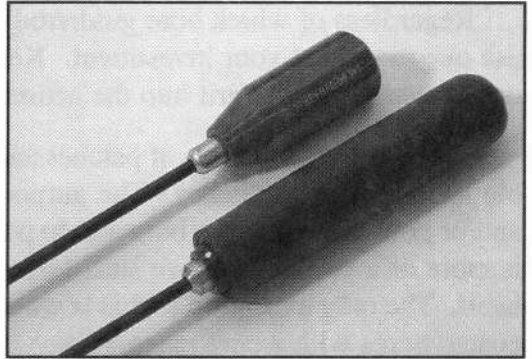
The equipment needed for cleaning depends a lot on what type of firearm you are cleaning, but it boils down to cleaning rods, bore guides (rod guides), muzzle guides, jags, patches, brushes, solvents, lubricants, pastes, cradles, action cleaning tools, bore mops, bolt disassembly tools, etc.

The cleaning rod is one of the most important cleaning tools you can buy. Spend your money wisely, take care of your cleaning rod and it should give you great service. There are all kinds of cleaning rods available from inexpensive three piece discount store rods to high quality one piece coated rods.

We have always preferred one piece coated rods over uncoated rods. The coated rods have less impact on the barrel during the cleaning process. All rods will flex under pressure, often due to a tight patch or new brush. When a rod is flexed it hits the side of the barrel in a peening action. We feel the coated rods have less chance of disturbing the edges of the rifling

when they flex and hit the sides of the bore. The coated rods will pick up debris more than uncoated rods, so if you use one, wipe it down frequently with a patch or rag to remove foreign substances. The steel rods, if nicked, can develop a burr and can be extremely destructive to the inside surface of the barrel. If you get a burr, make sure you sand it off and polish the rod with fine steel wool.

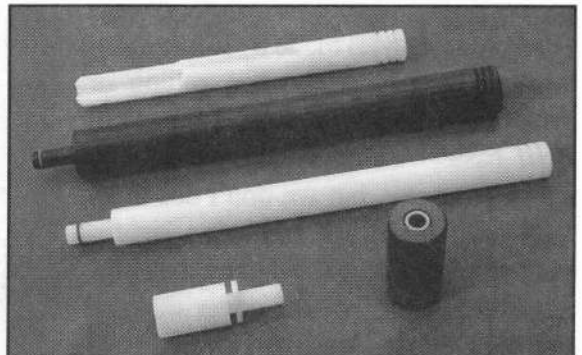
Uncoated rods will generally last much longer than their coated counterparts, but we don't mind a \$20-\$30 rod wearing out as long as our \$400 barrel is well protected. The two coated rods we prefer right now are made by Dewey and Bore Tech. The Bore Tech rods are new, but we have never had a better rod. They are more expensive than the Dewey rods, but we feel they are well worth it. They have the most comfortable handle we have ever used, and the captured bearings work smoothly under the pressure of a tight patch. These rods even have an indicator on them so you can easily determine your barrels' twist rate.



Dewey and Bore Tech cleaning rods

The Dewey rods are high quality, dependable rods that have served us well for many years. Dewey offers many attachments not found from other manufacturers and they cover all the calibers from .17 caliber to the bigger .45 caliber rifles.

Bore guides are something all bolt gun shooters should be using faithfully. Bore guides generally serve a couple of purposes; 1) To protect the throat of the rifle from the rod by centering the jag and rod in the bore, and 2) to protect coated rods from being deeply scratched by the sharp edges of the chamber. The rod guides we make have "o" rings on the snout to seal the



Rod Guides/Muzzle guides

barrel approximately midway in the chamber. This keeps solvents from leaking back into the action and eventually down into the trigger area. Some of the solvents will gum up the trigger, and can account for many trigger problems. Solvents also act as a carrier for grit which does not do the trigger any good either.

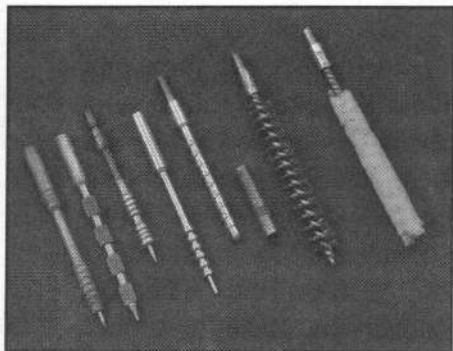
If you are not shooting a bolt gun, there are muzzle guides for semi-autos that protect the crown from damage by the rod. We make rod guides for AR-15's, Thompson Contenders, rimfires, Ruger #1's, HK 91's, etc. There are other manufacturers who have their own, more universal guides, such as the Stoney Point bore guides, which work fairly well.

Regardless of which bore guide/rod guide you use, just make sure you use one to protect your investment. Keep the rod guides clean inside and out to avoid carrying grit into the action.

We have used all kinds of patches and have found none better than double napped flannel patches. The purpose of the patch is to carry solvents and/or bore paste into the bore and to push out loosened debris. The patch is more of a vehicle to move stuff in and out of the bore than a cleaner by itself. The only exception to this is when you wrap a patch and clean moly coated bores with a bore paste.

We have tried synthetic patches, G.I. patches, single-sided napped patches, felts, etc. Some work marginally, others don't work at all. Avoid "t-shirt" material patches because they just aren't absorbent enough and they fray. Buy quality patches and get the right size. (See Appendix II for patch sizing).

Jags are something else you will need. Some type of jag will usually come with your cleaning rod. The better quality rods usually come with a pierce type jag. There are variations of the pierce jags, such as ours, which has a very sharp piercing point. There are wrap style jags (Parker Hale style) made by Dewey, that work extremely well when rolling or wrapping a patch to use with J-B or USP bore paste. Patch loops occasionally serve some use, but we don't use them very often. Get the right size jag for your rifle bore, and avoid extra long jags since the patch will not cover most of the jag. Most standard Dewey, Bore Tech or Sinclair jags are fine.

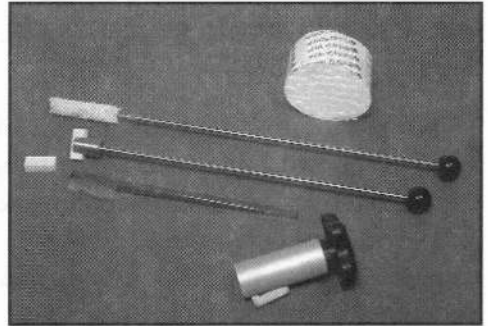


Dewey Jags/Sinclair jags/mops and brushes

We only recommend one type of brush. Use brass core, bronze bristle brushes. Do not use stainless steel brushes. Wherever you buy your brushes, make sure they are larger than the bore diameter by at least 0.008" to 0.015". Throw them away when they start to get loose in the bore. Nylon brushes serve certain purposes but won't clean like a brass/bronze brush. They do serve as good carriers for Sweet's.

Bore mops are handy to have when soaking a bore with copper removers. They are also excellent for coating a bore with an oil or a rust preventative.

Some type of action cleaning tool is necessary to fully clean your rifle. The bolt lug recess area, especially, collects a lot of debris and should be cleaned routinely to prevent wear on the locking lugs. The action body itself also needs to be cleaned to prevent wear on the bolt body. We'll cover the procedure for cleaning the action step by step later in this chapter.



Action Cleaning tool kit and Remington Firing pin removal tool (Sinclair)

Disassembly tools for some bolt action rifles are needed when cleaning mainsprings or changing the lube on firing pin springs. Bolt disassembly tools are easy to use, and every shooter should have one if his action requires one. Don't confuse this tool with a mainspring changing tool which is only needed when changing a spring, firing pin, or bolt shroud.

A cleaning cradle of some sort is a necessity. There are cleaning cradles made of aluminum, plastic, wood, and just about anything else you can think of. The MTM Gun Maintenance Center has some storage pockets, and is a low cost cradle that does work well. It will fit almost all rifles to some degree. Midway and Decker both make a gun vise which holds your rifle securely, but neither is very portable. These are great if you need the



MTM Maintenance center and Sinclair cradle

rifle to be held absolutely still and plan to use it only at home. Sinclair International makes a cradle system that uses different front saddles to fit hunting rifles, varmint rifles, and benchrest rifles. It is extremely portable and can be broken down for compact storage. It holds the rifle extremely well and places the rifle in a muzzle down position so solvents and debris can drip out of the muzzle and not run back into the trigger area. If you are handy with tools, you can make a homemade cradle out of wood and some carpet scraps.

If we tried to discuss all of the lubricants and solvents that are available, this book would be 1000 pages long. In the past five years there has been a flood of new cleaners hitting the market. We can't analyze everyone of them, so talk to your friends, guys at the range, and other shooters to find out what works best for them.

We can definitely recommend Shooter's Choice and Pro-Shot Copper remover as two good bore solvent/copper removers. For an extra strength copper remover, we highly recommend Sweet's 7.62 which we have used for years with excellent results. Barnes Copper remover also works well. A new cleaner RB-17, which is non-toxic and a gel, is a alternative cleaner for those concerned about harsh chemicals.

For cleaning rifles with lead fouling, the lead remover from Shooter's Choice works well.

After the cleaning process, we use Shooter's Choice Rust Prevent to protect the metal surfaces. We also use Rig Grease for long term storage.

For lubricants on bolt guns, we use our own synthetic lube or Shooter's Choice Hi-Tech lube. Pro-Gold Lube by Pro Shot is also a favorite.

Barrel Break-in with uncoated/untreated Bullets

The actual break-in procedure listed here is one we have followed faithfully for many years. It works, and it can be adjusted to fit your own special needs. Most shooters have a strong temptation to shoot a couple of groups right away when they get a new gun or barrel to see if it's a hummer. DO NOT DO IT! Break it in properly, please!

We recommend thoroughly cleaning a new barrel with a standard copper remover solvent (Shooter's Choice, Pro-shot, Hoppe's etc). We run a few wet patches through the bore with a spear/pierce type jag to remove any shop dust or loose debris in the barrel. We then dry patch the bore out with a couple of patches and religiously begin our break-in procedure.

- 1) Fire one shot through the bore.
- 2) Begin cleaning by running 2 wet patches (Pro-Shot or Shooter's Choice) through the bore to push out any loose material and to soak the bore.
- 3) Wet a bore brush (Pro-Shot or Shooter's Choice) and stroke completely through the bore back and forth at least 10 full cycles. Make sure you allow the brush bristles to reverse by pushing the brush all the way out of the muzzle and pulling it all the way back into the bore guide.
- 4) Wipe down the rod with a cloth or patch and run a wet patch of Pro-Shot or Shooter's Choice through the bore.
- 5) Brush the bore again about 10 times with a wet brush.
- 6) Run a couple of wet patches through the bore. Then dry patch out.
- 7) Shoot one shot and clean (repeat steps 2-6).
- 8) Shoot 2 shots and repeat the above cleaning steps (steps 2-6).
- 9) Shoot 2 shots and clean as above (steps 2-6).
- 10) Clean with Sweet's 7.62 or a similar copper solvent. Run a couple of well soaked patches (Sweet's) through the bore and let it sit for 10-15 minutes (no longer). Wipe any Sweet's off exterior surfaces. Dry patch out. Strong blueish-green patches indicate the presence of copper, and a second application of Sweet's may be needed.
- 11) Fire a 3 shot group and clean as in steps 2 through 6. Perform this step a total of 4 times. In other words, shoot a total of 12 shots and clean every 3 shots.
- 12) Clean with Sweet's as in step 10.
- 13) Repeat steps 11-12.

You should have a total of 30 shots through the bore at this time.

- 14) Fire 5 shots and clean as in steps 2 through 6. Do this a total of 3 times then clean with Sweet's.
- 15) Repeat step 13. You should have fired a total of 60 shots after this is complete. If you are getting indications of severe fouling, we would

suggest that you continue shooting groups of five, then cleaning. If you have a borescope you should be using it frequently to check for fouling. Some barrels will really foul during break-in.

If the barrel seems to be cleaning up well you can increase the number of shots between cleanings to groups of seven. You can also begin doing some load testing during this time. Shoot one fouler through the clean barrel, then shoot two groups of three. Once you have gotten the shot count through the barrel up to 100, you can probably start shooting as you would normally. We won't generally shoot more than 20 rounds through a match barrel without routine cleaning. We might shoot a few more in varmint rifles.

Routine Bore cleaning when using uncoated bullets

Once the barrel is broken in, we recommend cleaning it thoroughly before shooting again or before putting the rifle back in your gun cabinet. The procedure for routine cleaning when using uncoated/untreated bullets is basically the same as we used during break-in.

- 1) Run two or three patches wet with copper solvent through the bore. Select as large a patch as you can without it being too tight in the bore. The first patch through the dry, dirty bore will usually be very tight. Sometimes we use the next size smaller patch, or stab the normal size patch slightly off center for the first one. Too tight a patch will wring the solvent out of it. Frequently wipe the rod off.
- 2) Wet a brush with solvent and run it through the bore at least 10 times. Wipe off the rod.
- 3) Run a wet patch of solvent through the bore. Sometimes we run two. Wipe off the rod.
- 4) Brush again with a wet brush at least 10 times. Wipe off the rod.
- 5) Run two wet patches of solvent through the bore. Wipe off the rod.
- 6) Run two or three dry patches through the bore.
- 7) Use Sweet's 7.62 or a similar copper remover every 30 - 50 rounds or so. Use a mop or wet patch to soak bore with Sweet's. Let sit for 10-15 minutes. No longer than 20 minutes at a time. Leaving Sweet's in the barrel longer can lead to evaporation in the bore which can then cause etching or pitting. Do not use Sweet's on bronze brushes - it

will eat them up. Make sure all the Sweet's is removed from the bore. Run at least 3 dry patches through bore to remove Sweet's.

- 8) Run at least 2 patches of a rust preventative or gun oil through the bore.
- 9) Clean the action, bolt, trigger area, and exterior surface.

Barrel Break-in with coated bullets

Breaking in a barrel using coated bullets is quite different than when using uncoated bullets. Our experience has been with molybdenum disulfide and Danzac™ coatings. Our break in procedure for both, is the same. The manufacturer of Danzac™ believes that break-in should be done with uncoated bullets using the traditional Sinclair method we just discussed. This may be a better option. But, for those of you wanting to start with coated bullets, you can try the method below. Many shooters have been using Kroil instead of solvent for break-in on cleaning when they are using coated bullets. Others use a mixture of 1/3 Kroil in 2/3 Shooter's Choice. We have tried all these, and at this time, have gone back to regular Shooter's Choice or Pro-Shot "solvent". Substitute whatever you wish to use for the "solvent" in the procedure outlined below.

- 1) Run one patch, wet with solvent, through the barrel. Dry patch out.
- 2) Shoot one coated bullet.
- 3) Run two patches of solvent through the barrel.
- 4) Short stroke one patch of USP Bore Cleaner or J-B Bore Cleaner through the barrel. By short stroke, we mean running the patch back and forth about 4 inches, several times, then progressing down the barrel while continuing to move the patch back and forth in "short strokes".
- 5) Remove any remaining bore cleaner from the barrel by running several dry patches through the barrel.
- 6) Run one patch, wet with solvent, through the barrel.
- 7) Apply copper solvent to a brush and brush at least 10 strokes.
- 8) Wet patch out debris.
- 9) Dry patch the barrel with at least two patches.

- 10) Repeat steps 4 through 9.
- 11) Shoot 2 shots through the bore and then clean as in steps 3 through 10. Repeat 3 times.
- 12) Shoot a 3 shot group using coated bullets.
- 13) Clean as in steps 3 through 10.
- 14) Repeat steps 12 and 13, four times.
- 15) You are ready to start routine shooting.

Remember, what works for one shooter and a specific barrel may need to be adjusted for another barrel. A rough cut barrel may need more break-in shots. After you have broken in the barrel using coated bullets you should be able to shoot about 50 shots each time before cleaning.

We do caution all shooters to check for any build-up in the barrel and to check for copper fouling. If the barrel isn't clean by the above process you need to take more aggressive measures to remove the built-up material. Our own experiences, and those of many others, has been that copper residue, powder residue and moly tend to layer upon each other if they are not cleaned out sufficiently each time. Do not hesitate to clean more frequently with a brush and a regular copper solvent if the above method of cleaning is not enough to get the barrel clean.

Routine Bore Cleaning when using coated bullets

Just prior to finishing this book we took a second look at what people were using as a standard cleaning procedure when shooting coated bullets. We found a large amount of built up moly and Danzac™ along with layers of burnt powder and copper in our own barrels and the barrels of some customers. Some of these barrels had reportedly stopped shooting. We cleaned these barrels (it took some time) and found that alternating layers of copper, moly, and powder had built-up in the grooves. This was most prevalent in the first 6-8 inches from the chamber. We also looked at a couple of barrels Walt Berger (Berger Bullets) had sent to us. He had been cleaning with his standard procedure using Kroil and USP Bore Paste. His barrels were much cleaner, although the cleaning procedures were the same. On further investigation we felt he (Berger) was a little more aggressive with the bore paste than we had been.

Our personal belief is, whatever method a shooter chooses for cleaning, they must get the barrels cleaned sufficiently so that moly and copper

does not layer up. This is somewhat contradictory to the promised benefits of less cleaning. You do clean less frequently, but when you clean you should be using Shooter's Choice, Pro-Shot, or a similar solvent on a brush to remove any build-up. Remember, each barrel is different and will react differently to fouling and cleaning whether you are using uncoated or coated bullets. Here is the regular cleaning procedure:

- 1) Run a couple of wet patches of solvent through the bore.
- 2) Short stroke the bore with USP Bore Paste, J-B Bore Cleaner or Iosso bore cleaner on a patch. Make sure the patch surface is covered with paste, but there should not be excess paste. Use short (3" to 4") strokes in one spot several times (5-6 strokes) and progressively advance the patch through bore in this manner until the patch exits the barrel. See note below.
- 3) Run two patches of solvent through the bore to remove the bore paste.
- 4) Apply copper solvent to a bore brush and brush at least 10 strokes.
- 5) Dry patch the barrel with at least two patches.
- 6) Repeat steps 2 and 3.
- 7) Look through the barrel to insure that there is no copper fouling or coating material build-up. If it is not clean, brush the bore again. Use Sweet's 7.62 for copper fouling, if necessary.

The above method is a good starting point for you to use when shooting coated bullets. You need to observe the condition of the barrel to make sure the above cleaning is sufficient. Above all, make sure you clean the barrel before putting the rifle away and use a preservative before storage. Even if you have shot less than 50 shots you should clean the gun before putting it away.

NOTE: When cleaning gas guns, such as the AR-15, be careful with paste cleaners. We were cleaning our AR-15, with the gas tube removed, and found paste squeezing out of the gas vent in the barrel. If this paste was left in the tube it would blow back into the action and start lapping bearing surfaces. Be sure if you use the bore pastes that you clean the gas tube thoroughly.

CAUTION: Two barrels we observed just prior to printing had pitting in the first 6-8 inches of barrel under the built-up moly. We don't know whether this was a chemical reaction or a hydraulic effect from the build-up. We do know that it was in barrels that had been left with moly in them for some

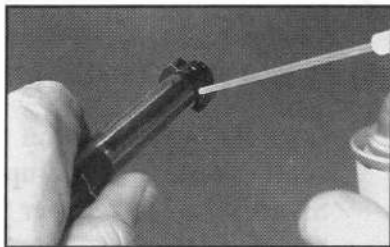
time. Both barrels were stainless steel. We are just writing this to make sure people keep their barrels clean. The use of moly or Danzac™ may reduce routine cleaning needs, but they do not eliminate the need for a regular and thorough cleaning.

Action Cleaning and Maintenance

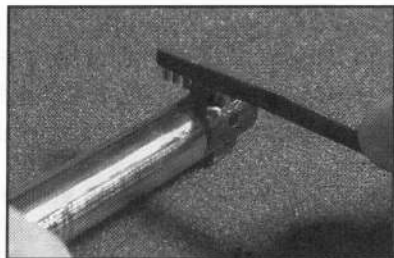
Preventative maintenance for rifle actions is critical. This is especially for custom actions where the fit of the bolt in the action is usually held to very high tolerances. The routine cleaning of your action is necessary to prevent wear on the bolt body, locking lugs, and the action itself. Cleaning the action also helps keep the trigger area free of debris which could lead to trigger hang-ups and failures. The process only takes a few minutes, and it should be done every time you put your rifle away and after every 50 rounds of competition.

Shooters use a lot of grease and oil on their bolts, and, unfortunately, both of these attract grit, powder residue, primer residue, etc. To begin cleaning the action the bolt must be removed from the action and cleaned.

- 1) Degrease the bolt with any gun degreaser like Quikscrub, Gunscrub, etc.
- 2) Use a brush (GI brush or toothbrush) with degreaser sprayed on it to clean the lugs and bolt face. Also, clean the camming area on the rear of the bolt. Bolt disassembly is not normally required for routine cleaning.
- 3) Flush the bolt again with degreaser until it is visibly clean of old grease and residue. Set the bolt aside.



Cleaning the bolt

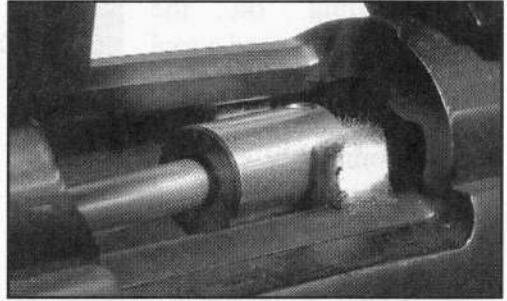


The next step is to clean the action lug recess area. Using a lug recess cleaning tool such as the Sinclair tool, the shooter should thoroughly clean this area. The lug recess area is one of the dirtiest places on a bolt gun.

- 1) Insert a cotton roll or felt into the lug recess cleaning tool and wet both ends with solvent.
- 2) Insert the tool into the action until it is positioned fully in the lug recess

area and rotate several times. Then reverse direction and rotate again.

- 3) Remove the tool from the action and inspect the felt or cotton roll. If there is quite a bit of crud on both sides of the felt/roll, then repeat with another wet felt/roll.



*Cleaning the lug recess area.
Note the grit on the edge of the felt*

- 4) Rotate a dry roll or felt in the lug recess area to remove any leftover solvent.

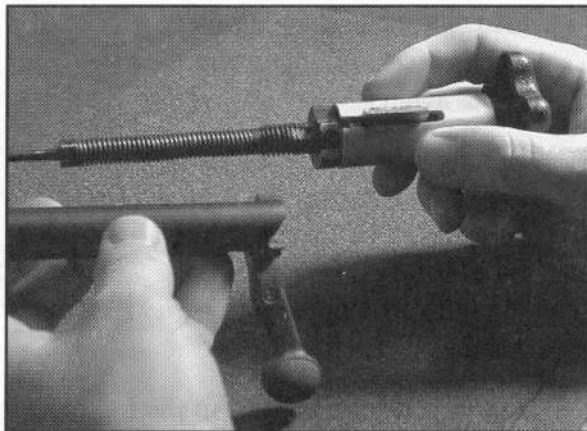
The next step in the action cleaning process is to clean out the chamber. This can be done with a chamber swab on a swab handle, or you can use an old bore brush with a patch or two wrapped around it. Rotate this around a couple of times in the chamber making sure you are well into the throat area. This area, and the previously cleaned lug recess area, collects broken brush bristles, excess solvent from the top of the rod guide, powder debris, etc. Make sure it is cleaned out and dry. Shooters putting a gun in long term storage can oil the chamber but the oil should be removed prior to firing the rifle.

To clean the action itself, just take some patches and solvent and scrub it thoroughly. You can use a swab or a patch wrapped around a brush to get at any hard to reach areas inside the action.

This is a good time to clean the trigger if you feel it needs cleaning. Custom trigger makers like Arnold Jewell recommend flushing out the trigger with some old fashion lighter fluid like you would use to fill a Zippo lighter. Just douse the trigger with it. This is all the maintenance Jewell recommends for his triggers. There is enough lubricant in the lighter fluid to lubricate the bearing surfaces and springs of the trigger. The rest of the fluid will evaporate.

The only part of the action we have not cleaned is the firing pin and mainspring. This doesn't need to be cleaned often, but it should be cleaned and re-lubed a couple of times a season if the rifle is being used a lot. If the rifle is infrequently used this maintenance could be done once every year or even less. If you use your rifle in a dusty environment, you may need to clean the spring and pin more often.

Depending on the action, you may need a tool for disassembling and reassembling the bolt. The tool is commonly called a firing pin removal tool. Sinclair International makes one, as do a few others. Some bolts can be disassembled easily without them. For Remingtons, Stollers, and Halls we recommend using a tool.



Remington firing pin removal tool in use

The tool allows you to remove the shroud and firing pin/spring assembly from the bolt body. There is no need to compress the spring and separate the firing pin from the spring. This can be done with a mainspring changing tool made by Davidson, but it only needs to be done if you are replacing a shroud, pin or spring.

Once the firing pin assembly is out of the bolt body, use a degreaser to flush the body out and wash down the firing pin assembly. Make sure everything is nice and clean before re-lubing the spring on this assembly. We prefer to use a light oil (low temperature range) in winter and a light grease in the summer. Do not use gobs of grease, a light film is best.

When you are done, reassemble the firing pin assembly and bolt body/housing. Use a light lubricant/grease behind the locking lugs and on the mating face of the bolt shroud. A light (very light) layer of lube on the bolt body is a good idea also. On some bolt actions there are some other lube points in the bolt body. Check your owner's manual for instructions.

Summary

Gun cleaning, especially barrel cleaning, is something that is different for every gun. Some guns foul less and clean up easily while others are horrible foulers. We can't emphasize enough how important proper break-in and a good thorough cleaning is for maintaining accuracy.

Different barrels, loads, and environmental conditions will affect the cleanliness of your rifle. Some lots of bullet jackets will tend to foul more than others. Rifles shooting coated bullets must be cleaned regularly to prevent a build-up of coating substances in the barrel.

Many shooters today are investing in borescopes so they can check their bores to see if their cleaning procedure is working. You can spend a few dollars on a simple bore light for a light source and use a pocket loupe on the other end to examine the last few inches of the barrel to get some indication of how things look inside. You can also buy a more expensive borescope that lets you look inside closely at the lands and grooves. If you decide to buy a borescope, consider going in partners with a buddy.

Some other thoughts on cleaning:

- 1) Don't introduce a solvent/chemical into the bore without patching the bore dry to remove previously applied chemicals.
- 2) Don't use steel brushes in the bore.
- 3) Use a bore guide or muzzle guide at all times if possible.
- 4) Keep the bore guides clean on the inside and outside to avoid re-introducing debris into the action.
- 5) Always keep sufficient patch material between the jag and barrel walls.
- 6) Make sure any areas that are lubricated get cleaned frequently because the lubricants act as a dirt trap.
- 7) Use the right size patch, not too tight, but not too loose. Use double napped flannel patches. (See Appendix II).
- 8) Be careful with solvents on gun finishes (wood, synthetic, or painted synthetics). Some of the copper removers are quite destructive to these finishes.
- 9) Clean in a well ventilated area, and avoid any build-up of solvent fumes. Avoid getting solvents on your skin, and wash your hands frequently.

Sources

Optics

B & L/Bushnell
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 9200 Cody
 Overland Park, KS 66214
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 (913) 752-3550 (FAX)

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 Beaverton, OR 97075
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 www.leupold.com

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 (915) 530-2919

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 (970) 356-8702
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 www.tascosales.com

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Mesa, AZ 85207
(602) 373-9499

Dan Dowling
Accuracy Gunsmithing
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Bill Wylde (Service Rifles)
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(217) 923-3266

Phil Arrington (Service Rifle)
Arrington Accuracy Works
7302 East Helm, Suite 2003
Scottsdale, AZ 85260
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(602) 582-5992 (FAX)
araccuracy@aol.com

Compass Lake Engineering
(Service Rifle)
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Medesha Firearms (Service Rifle)
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(602) 380-7331 (FAX)

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Plano, TX 75074
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 10805 South East 84th Street
 Oklahoma City, OK 73150
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 (520) 567-3334 (FAX)

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 TM Stockworks
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 (315) 677-9610 (FAX)

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 (414) 255-9586 (FAX)

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 (406) 826-3083 (FAX)
 lilja@montana.com

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(972) 875 5402 (FAX)
info@shilen.com

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1008 South Quince Road
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Greenville, SC 29615
(864) 244-7948
(941) 635-7948 (Florida)

Starke Bullet Company
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Pierre, SD 57501
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(605) 224-6544 (FAX)
<http://ourworld.compuserve.com>
73770.341@compuserve.com
VHA1@aol.com

Gun Owners of America
8001 Forbes Place, Suite 102
Springfield, VA 22151
(703) 321-8585

Appendix I

Handloading Benefits

During the re-write of this handbook we wanted to show the improvement in rifle accuracy that can be achieved using precision handloading techniques. We selected a Remington 700 chambered in 308 Winchester with a 20" Sporter. It was fresh from the factory and had nothing done to it, except we put it in a Hogue overmolded stock. There was no bedding work done, no trigger job, etc.

We prepared some basic handloads using Sierra 168 grain MatchKings with Winchester brass. We used a load right out of a reloading manual and the only case preparation that was done was chamfering the case mouths. During our inspection we noticed a lot of flash hole burrs but ignored them.

We also purchased some Federal Premium match ammunition that was loaded with 168 grain MatchKings. This was considered the best ammunition available.

Our third batch of ammo was based on Norma brass and Sierra 168 grain MatchKings. We fully prepared the Norma brass including neck turning, flash hole deburring, primer pocket uniforming, and chamfering the case mouths. We checked the seating depth and set the MatchKings .010" off the rifling.

For our test we used one shooter and alternated loads through the rifle while shooting ten (10) three-shot groups for each load. This was done over 3 days in fairly decent weather conditions.

The results are as follows:

Group	Basic Handloads	Federal Premium	Sinclair Prepped Handloads
1	1.90"	0.670"	0.410"
2	1.150"	1.000"	0.430"
3	0.515"	1.090"	0.830"
4	0.810"	0.640"	0.900"
5	1.060"	0.330"	0.470"
6	1.170"	0.880"	0.804"
7	0.250"	0.750"	0.520"
8	2.100"	0.660"	0.510"
9	1.700"	0.850"	0.570"
10	<u>1.160"</u>	<u>0.630"</u>	<u>0.840"</u>
Aggregate	1.182"	0.750"	0.628"

As you can see from this fairly simple test, the basic handloads delivered the worst results, the Federal Premium loads were second best, and the Sinclair fully case prepped cases did the best. What this showed us was that this particular gun was better off with factory ammo than with poorly prepared handloads. But, it does show that there is a benefit in doing a thorough job on case preparation as the Sinclair prepared loads performed about 16% better than the Federal Premium ammo.

Appendix II

Patch Selection Guide

Patch size selection depends on several things; 1) the diameter and design of your jag, 2) the patch thickness, 3) cleanliness of bore, 4) wet patching or dry patching. The following gives some general recommendations on patches to help you in determining the proper size patch. We try to use the biggest patch we can and generally use smaller caliber jags than the bore caliber we are cleaning.

You'll want a patch that is tight enough to feel some resistance when pushing through the bore but not so tight that the cleaning rod flexes significantly. If it is this tight you are probably wringing the solvent out of the patch and it won't get to the bore. Sometimes we use a smaller patch for the first patch or two to wet a dirty barrel and then return to a larger patch when pushing out debris or introducing more solvent. We also may occasionally stab patches slightly off center if we feel they are a little too tight.

The following information is based on using pierce style jags and Sinclair double napped cotton flannel patches:

22 Rimfire

-.22 cal. Dewey Jag	- 1 1/8" square patch is perfect.
-.22 cal. Sinclair Jag	- 1 1/8" square patch is perfect.
-.22 cal. Bore Tech Jag	- 1 1/8" square patch is perfect.

22 caliber (.224" bore)

-.22 cal. Dewey Jag	- 1 1/8" square patch is perfect.
	- 1 3/8" square patch is too tight, even if off center.
-.22 cal. Sinclair Jag	- 1 3/8" square patch is perfect.
	- 1 1/8" square patch is too loose.
-.22 cal. Bore Tech Jag	- 1 1/8" square patch is perfect.
	- 1 3/8" square patch is too tight, even off center

6mm (.243" bore)

-.22 cal. Dewey Jag	-1 3/8" square patch is perfect.
	-1 3/4" square patch is okay if stabbed off center.
-.22 cal. Sinclair Jag	-1 3/4" square patch is perfect.
	-1 3/8" square patch is too loose.
-.22 cal. Bore Tech Jag	-1 3/8" square patch is perfect.
	-1 3/4" square patch is a little too tight.
-6mm Dewey Jag	-1 3/8" square patch is perfect.
-6mm Sinclair Jag	-1 3/4" square patch is good, first patch may need to be off center.
	-1 3/8" square patch is too loose except as first patch on dry or fouled barrel.

25 caliber (.257" bore)

- 22 cal. Dewey Jag -2" round patch is perfect.
- 22 cal. Sinclair Jag -2" round patch is perfect, could use a 2 1/4" patch when bore is already wet.
- 22 cal. Bore Tech Jag -2" round patch is perfect.
- 6mm Dewey Jag -1 3/4" is good.
- 6mm Sinclair Jag -2" round is a little tight but okay if used off-center.
- 2" round patch works the best.

6.5mm (.264" bore)

- 22 cal. Dewey Jag -2" round patch is perfect.
- 22 cal. Sinclair Jag -2 1/4" square patch is perfect.
- 22 cal. Bore Tech Jag -2" round patch is a little loose.
- 6mm Dewey Jag -2" round patch is perfect.
- 6mm Sinclair Jag -1 3/4" square patch is perfect.
- 2" round patch is too tight.
- 2" round patch is perfect.

7mm (.284" bore)

- 270 Dewey Jag -1 3/4" square patch is a little tight centered, okay when stabbed off center.
- 270 Sinclair Jag -1 3/4" square patch is okay.
- 6mm Dewey Jag -2" round patch perfect
- 6mm Sinclair Jag -2" round patch perfect.
- 1 3/4" square patch too loose.

30 cal. (.308" bore)

- 270 Dewey Jag -2 1/4" square patch is okay.
- 2" round is too loose.
- 270 Sinclair Jag -2 1/4" square patch okay, may be a little loose.
- 30 cal. Dewey Jag -1 3/4" square patch is perfect.
- 2" round patch is okay, but some may need to be stabbed off center.
- 30 cal. Sinclair Jag -1 3/4" square patch is perfect.
- 2" round is okay, but some may need to be stabbed off center.
- 30 cal. Bore Tech Jag -1 3/4" square patch is perfect.
- 2" round is okay, but some may need to be stabbed off center.

338 cal. (.338" bore)

- 30 cal. Dewey Jag -2" round is not bad, great for first patch.
- 2 1/4" square patch is great, but would need to be stabbed off center if used as 1st patch.
- 30 cal. Sinclair Jag -2 1/4" square patch is perfect.
- 30 cal. Bore Tech Jag -2 1/4" square patch is perfect.
- .338 Dewey Jag -2 1/4" square patch impossible.
- 2" round patch too tight.
- 1 3/4" square patch is good.

Jag Measurements

(Diameter x length)

.22 cal. Dewey Jag	.183" x 2.69"
.22 cal. Sinclair Jag	.165" x 2.69"
.22 cal. Bore Tech Jag	.182" x 1.96"
6mm Dewey Jag	.205" x 2.68"
6mm Sinclair Jag	.178" x 2.68"
270 cal. Dewey Jag	.229" x 3.09"
270 cal. Sinclair Jag	.222" x 2.66"
30 cal. Dewey Jag	.254" x 3.09"
30 cal. Sinclair Jag	.250" x 2.68"
30 cal. Bore Tech	.254" x 2.31"
338 cal. Dewey Jag	.290" x 3.080"

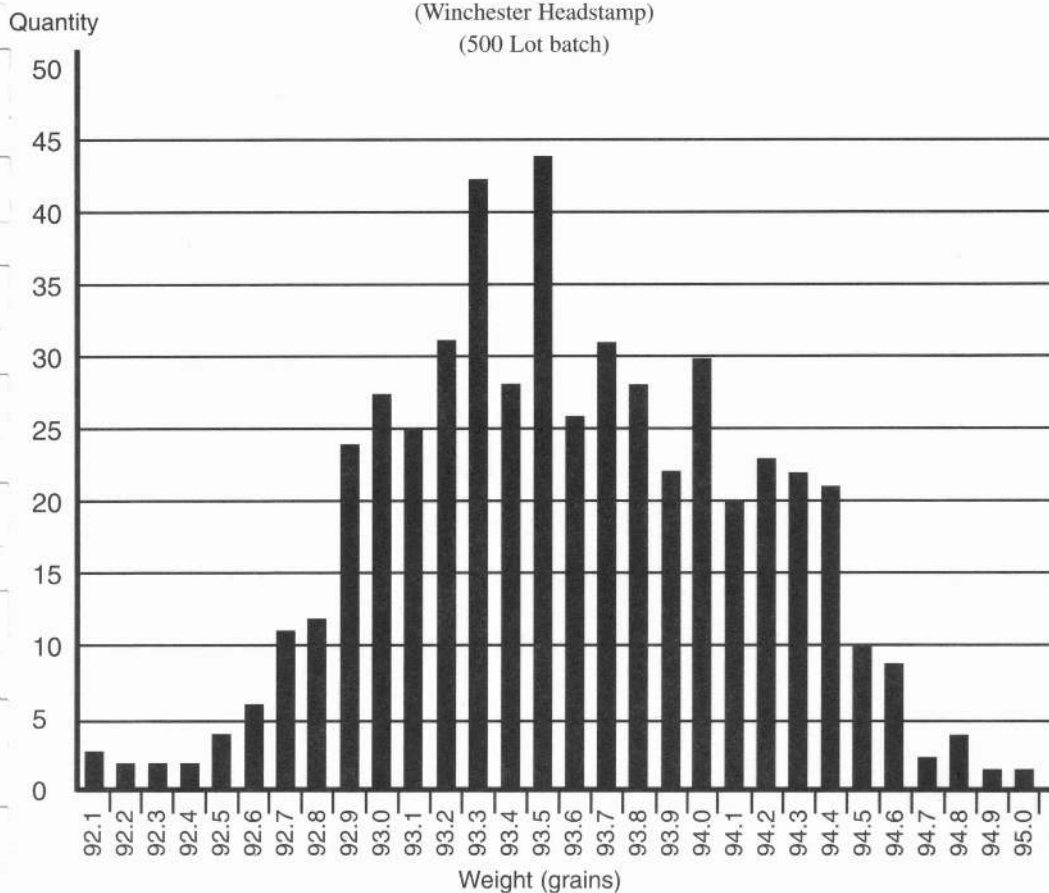
Appendix III

More and more shooters are sorting their brass by weight. The graph below shows the distribution of a 500 piece batch of 223 Remington that we weighed and segregated into increments of 0.1 grain. The distribution of this batch makes a nice bell curve so it was easy to pull out useable lots of brass.

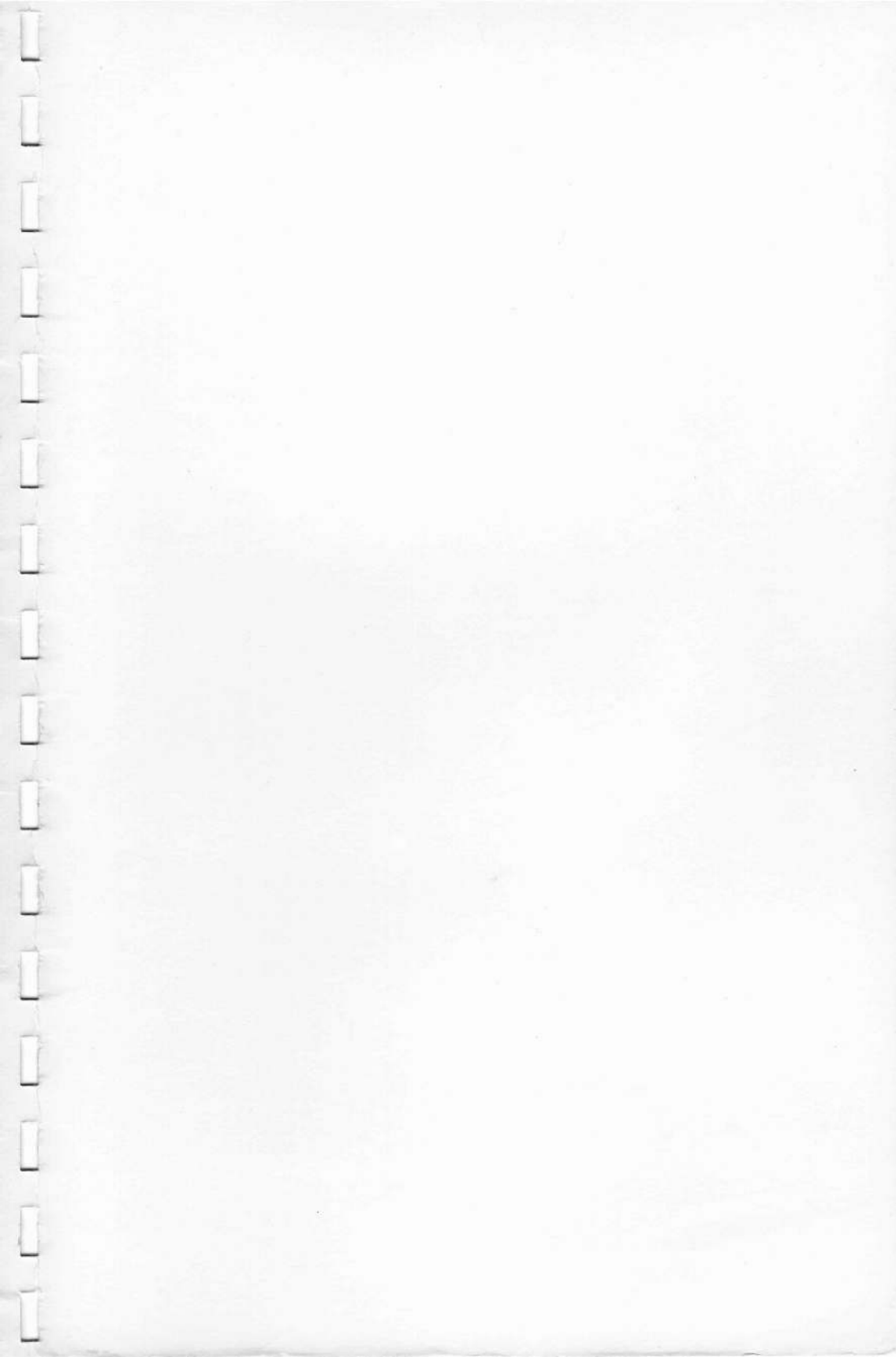
Since this was a large batch, we separated our useable lots into groups of 100. See photo of brass on page 39.

223 Remington Brass

(Winchester Headstamp)
(500 Lot batch)



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About the Authors:

Fred Sinclair has been interested in firearms since he was a young lad. He grew up with guns as his father was an avid outdoorsman. Fred began shooting benchrest in 1971 and gradually began building custom benchrest rifles and sporting rifles. His drive for perfection in building extremely accurate rifles led to two personal world records and recognition as one of the premier benchrest gunsmiths in the world.

He has won numerous benchrest shoots all over the United States. His interest in reloading and the tools he built for himself led to the founding of Sinclair International in 1987. Today, Sinclair International is one of the largest firms dealing in tools designed specifically for extreme precision rifle shooting.



Bill Gravatt grew up on Army bases all over the United States as his father was a career demolition expert. He was interested in shooting at a young age and still has his first rifle from age 12, a Winchester 22 LR.

A graduate of Purdue University, in Engineering, Bill was a Director of Project Engineering and Management Systems at a nuclear power plant prior to becoming President of Sinclair International in 1991.



Bill competes in benchrest matches throughout the United States and is interested in many other areas of competitive shooting including 1000 yard prone (open sight matches) and highpower shooting.

Published by:

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Fort Wayne, IN 46803

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