This sneak preview of your study material has been prepared in advance of the book's actual online release.
About the Authors

Dean A. Grennell’s love of firearms began in his youth. Fortunately, his love of writing began then also. Dean became interested in reloading just after he decided to write. Since 1948, he has come a long, long way. Over the years, he has written, compiled, and consulted in various capacities for many publishers and magazines. Dean has contributed articles to virtually every American gun magazine and digest worthy of mention.

You’ll remember Carl P. Wood as the author of the study unit entitled Rifles.
This study unit has two main parts. The first covers cartridge nomenclature, design, and reloading procedures for metallic cartridges. The second covers similar aspects of shotshell reloading. The unit also contains much relevant historical information, as well as instruction for anyone interested in purchasing reloading equipment, figuring optimum powder loads, and/or casting bullets.

When you complete this study unit, you’ll be able to

- Recognize ammunition and component nomenclature and design
- Identify reloading tools and explain their purposes
- List reloading procedures for metallics and shotshells
- Explain bullet casting procedures
- Discuss the importance of basic ballistics in determining optimum loads
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## Zero In! Answers

## Examination
Note: Although the following safety and health precautions make specific reference to the Alliant Techsystems line of powders, they pertain to reloading safety in general. Therefore, we introduce them as a preface to this study unit.

**Important Safety and Health Precautions**

To perform in a gun, powders must ignite easily and burn rapidly. These characteristics require use of common sense to avoid accidents. **O M S T O S T FO OWI P CA TIO S.**

1. Do not smoke when reloading.
2. Do not use spark-producing tools.
3. Do not mix powders of different kinds.
4. Do not leave powder where children can get it.
5. Do not try to load when distracted.
6. Avoid an open fire or working near spark-producing machinery.
7. Pour out only the amount of powder needed for immediate work.
8. Check the powder measure each time it is used. Make sure the settings have not been accidentally changed. Check-weigh “thrown charges” frequently.
9. Clean up any spilled powders. Use a brush and dustpan; do not use a vacuum cleaner.
10. Store powder only in its original Hercules container, which was carefully designed for this usage. Do not REPACKAGE. Do not purchase or accept any Hercules powder not in its original, FACTORY-SEALED container.
11. Be sure the powder container is completely empty before discarding. Do not use the container to store other powders or materials, or for any other purpose.
12. Keep always in mind that Hercules smokeless powder is an explosive material and highly flammable. It should always be stored and handled in such a way as to avoid impact, friction, heat, sparks, or open flame.
13. Wear safety glasses when reloading.

Hercules powder contains nitroglycerin, which could enter the body through ingestion or absorption, or by breathing the vapors. Symptoms can include headaches. Therefore, the following precautions must be observed when handling Hercules powders:

1. Do not take internally. In case of ingestion, cause vomiting by putting finger down throat. Call physician.
2. Prevent contact with food, chewing material, and smoking material.
3. Have adequate ventilation during handling.
4. Wash hands and face thoroughly after handling.
5. Do not carry powder in clothing.

You must also always remember:

1. Establish a routine for reloading. It will result in more uniform loads and less chance of error.
2. Some primers are more powerful than others (they produce more gas at a higher temperature). Use only the primers specified herein.
3. Shotshell wads differ in their sealing ability. Use only the load combinations specified herein.
4. If you use cast bullets, their diameter, hardness, lubrication, and crimp will all affect the ballistics.
5. The shotshell loads in this booklet are for use with lead shot only!
6. Use only the brands of powder and components shown in our tables. Do not substitute other types.

*Safety and Health Precautions courtesy of Alliant Techsystems, Radford, VA*
INTRODUCTION TO RELOADING

Cartridges and Cartridge Cases

The centerfire primer makes reloading possible and practical. There’s no practical way to reload fired rimfire cases, such as the familiar .22 Long Rifle (Figure 1). For now, we’ll discuss reloading of the metallics, meaning ammunition for use in handguns and/or rifles, with coverage of reloading shotshells to follow.

We customarily refer to a loaded round of metallic ammunition, ready to be fired in a handgun or rifle, as a cartridge. The projectile up front is the bullet. The British tend to call the cartridge a bullet and the projectile a bullet head.

Reloading offers many attractive advantages, one of which is cash savings. One of the most expensive components of a commercial cartridge is its case. The case remains on hand after firing—unless an autoloading gun ejects it into thick brush or tall grass. You can reload a typical empty centerfire case several times. In addition, reloading provides a source of cartridges with specifications that are not available through the usual commercial sources. By trying various combinations of bullets and powder charges—and maintaining careful records—you may be able to isolate loads that deliver tighter groups than factory ammunition. You can also gain a good deal of personal gratification when a reload you’ve assembled turns in an uncommonly good performance (Figure 2).
The cartridge case, customarily formed from brass, assumes certain basic shapes. These shapes are more or less dictated by the guns from which they fire. For example, there may be a distinct flange or rim at the head, as typified by the familiar .30-30 WCF, or Winchester Center Fire (Figure 3). Cartridges designed for use in autoloading guns usually dispense with the rim for the sake of easy feeding. However, they still need something for the extractor to grab in order to pull the spent case from the chamber. Such cartridges use a rimless design, with the head the same diameter as the rear of the case and an extractor groove turned in the head, as illustrated. Typical examples include the .30-06 Springfield, .308 Winchester, and .45 ACP (Automatic Colt Pistol).

A further variation is the semirimmed, similar to the rimless, but with the head flange slightly larger in diameter than the case body. Examples include the .220 Winchester Swift and the .38 Super (Figure 4).

The .284 Winchester represents still another offshoot (Figure 5). It has a typical rimless head with the basic dimensions of the .30-06 Springfield, but the case body is somewhat larger in diameter. As you might suspect, there’s a reason behind such complexities. In this example, the purpose is to provide a comparatively short case, with a greater powder capacity, capable of being used in rifles with bolt faces dimensioned to take the common and popular .30-06 Springfield. A similar approach is the .41 AE (Action Express) for use in autoloading pistols. It has head dimensions identical to the 9mm (millimeter) Luger, but the body of the case is enlarged to accept bullets of .410 inch diameter, up front. The .50 AE has the head dimensions of the .44 Magnum and a case body large enough to work with bullets of .510 inch diameter. We say the cartridges, such as the examples just mentioned, have a rebated rim.
The term *magnum* has become widely used—and sometimes misused—in cartridge terminology. It means bigger than customary and originally referred to oversized wine bottles. At some point along the way, a cartridge designer cranked in a concept termed the *belted magnum* case head. It starts out looking like a standard rimless head but—as opposed to the rebated head—at a point just ahead of the extractor cut, the case diameter is slightly enlarged (Figure 6).

**FIGURE 3**—The .30-30 Winchester is an example of a rimmed rifle case and the .30-06 Springfield is a rimless rifle case.

**FIGURE 4**—From left, a .357 Magnum is a rimmed-type case, the .38 Super is a semirimmed, the .45 ACP is a rimless, and the .41 Action Express has a rim smaller in diameter than the body of the case, a rebated-head design.
That brings up *headspace*, a term that tends to be mystifying when initially encountered. Headspace is the amount of fore-and-aft play available to the cartridge when chambered and ready to be fired. When the firing pin slams into the primer, the cartridge must be supported to remain motionless, rather than being driven bodily down the barrel.

The purpose of the several different types of cartridge case designs is to provide headspacing support in the chamber. They also assist in the chambering of the cartridge and extraction of the fired case.

Some cartridges have straight cases, such as the .45 ACP or .38 Special, with the case walls parallel. Others, such as the 9mm Luger and .30 GI Carbine, have straight case walls that taper slightly from head to mouth (Figure 7). Many others are of the bottleneck design, with a fairly large-diameter case behind a tapering shoulder, with the cartridge neck substantially smaller in diameter. A familiar example is the .223 Remington, also known as the 5.56mm NATO.
The purpose of the bottleneck case is to provide room for more powder behind the bullet, without excessive case length. At the same time, the bottleneck provides headspacing support by contact between its shoulder and the mating chamber area. The primary headspacing support comes from the rim or belt of the belted magnum designs. Contact between the shoulder and chamber gives a more precise and uniform support, all of which contribute to the potential accuracy of the cartridge/rifle combination.

In straight-sided cases with rims, the rim provides the principal support. It’s a popular belief that the headspace of rimless cartridges, such as the .45 ACP, is by contact between the case mouth and mating ledge in the chamber. Actually, the extractor provides some (if not all) of the support for the .45 ACP.

**Primers**

Various chemical compounds will explode or detonate when struck and compressed abruptly. Shooters used one of the earliest examples, fulminate of mercury, as the priming compound for muzzle-loading guns whose powder charges were ignited by percussion caps.
When the brass cartridge case came into use, mercuric fulminate posed a problem. Some portion of its after-firing residue consisted of free mercury. The mercury crystallized and weakened the brass, thus preventing repeated use of the case.

One of the early nonmercuric priming compounds contained some amount of potassium chlorate (chemical formula KClO₃), which provided oxygen for combustion of other portions of the priming compound. Upon firing, the potassium chlorate molecule gave up its three atoms of oxygen and turned into potassium chloride (KCl), a chemical closely similar to sodium chloride (NaCl), or common table salt. Both potassium and sodium chlorides are notably hygroscopic, meaning they attract and retain moisture from the surrounding air. That in turn caused rusting and corrosion when the potassium chlorate primer residue deposited on a steel surface. Unless the shooter cleaned the bore of the barrel promptly and thoroughly after firing, the steel soon rusted into hopeless ruin.

That problem led to the nonmercuric, noncorrosive primers commonly used today. The principal ingredient of the priming mixture is lead styphnate, with specialized additives.

There are two basic types of primers, Boxer and Berdan. The design of the primer pocket in the head of a given cartridge case dictates the use of one or the other.

In the Berdan system, the primer pocket is formed with an integral central anvil against which the priming compound is crushed when the tip of the firing pin strikes the outer surface of the primer cup. The Berdan primer pocket usually has two small, off-center flash holes to deliver the primer flame to the powder charge (Figure 8).

In the Boxer system, the primer pocket has a somewhat larger central-flash hole. The anvil is a piece of stamped brass inserted into the primer cup ahead of the wafer of priming compound (Figure 9).
From the reloader’s viewpoint, the great advantage of the Boxer priming system is that the spent primer can be punched out by a centrally located depriming pin in the resizing die of a reloading set (Figure 10). Removing the spent Berdan primer is considerably more difficult and, for that reason, virtually all domestic ammunition employs Boxer-type primers. About the only exception is the line of Blazer ammunition produced by CCI that uses cases drawn from aluminum.
alloy, rather than brass, as well as Berdan primers (Figure 11). Head-
stakes of the Blazer ammunition carry the letters, NR (not reloadable).
The primary advantage of this ammunition is that its manufacture
permits a substantially lower cost per box for shooters who don’t plan
to reload the empty cases (Figure 12).

FIGURE 11—Shown on top
are CCI small pistol primers
in magnum and standard
type. Note (and heed!) the
warnings printed on the
box. Shown below are the
other sides of the two CCI
primer boxes; the one on
the right dates from the
days before Blount took
over Omark Industries.

FIGURE 12—Shown is the
CCI Blazer ammunition
with the head stamp NR.
Cases are aluminum
rather than brass, and
primers are Berdan type.
Boxer primers are available in two basic diameters, .175 and .210 inch, respectively, termed small and large. In addition, they’re produced for use in nominal handgun and rifle cartridges and are thus labeled as small pistol, small rifle, large pistol, and large rifle. Some primer manufacturers offer magnum primers in some or all of the various types and sizes, as well as the standard variety. The magnum primers are supposed to deliver a hotter flame of slightly longer duration, which produces more positive and uniform ignition of slow-burning powders, particularly at low outside temperatures (Figure 13).

Rifle primers have a somewhat thicker, tougher cup than the pistol type, and therefore require a more powerful strike of the firing pin for reliable ignition. The thicker cup is designed to handle the higher peak chamber pressures typically encountered in rifle cartridges. Primer pockets intended for rifle primers are slightly deeper than those for pistol primers. If a rifle primer is seated in a pistol primer pocket, the exposed cup will protrude slightly from the surface of the case head, and the resulting cartridge may not chamber properly. In addition, the firing pin strike of typical handguns may not reliably ignite rifle primers (Figures 14 and 15).

If a pistol primer is seated in the pocket of a nominal rifle cartridge, the opposite is true. The cup will be below the case head surface, and the thinner, softer metal of the cup may be flattened and distorted considerably by the higher peak chamber pressure when the round is fired.
At present, it’s not uncommon to encounter handguns chambered for nominal rifle cartridges such as the .30-30 WCF, .223 Remington, .35 Remington, and the like. Such cases have the primer pocket intended for use with rifle primers, and, in reloading them, you should use rifle-type primers, even if you intend to fire the loads in handguns. In the examples of rifles that fire nominal handgun cartridges, such as the .357, .41, or .44 Magnums, you should use pistol primers of the suitable diameter.

Primers come packed in compartmentalized plastic trays, usually 100 to the tray. The carton label carries warnings that loose primers are capable of mass detonation if subjected to excessive heat, percussion, jostling, and the like. Heed and comply with these warnings. When seating primers by hand, decant a line or two—10 primers to the line—into a shallow plastic tray for picking up to place in the priming punch of the press.

**Urgent cautionary note.** It’s extremely good and prudent practice to wear eye protection, such as a pair of shooting glasses, while reloading and/or casting bullets, as well as while actually shooting.
Seating Primers

We customarily use Boxer-type primers in reloading. Curiously enough, Edward M. Boxer, a British Colonel, invented them for the Snider breech-loading conversion of the Enfield muzzle-loading army rifle. Hiram Berdan, an American ordnance officer, developed the Berdan-type primer. For domestic applications, the Boxer became favored over the Berdan primer. Meanwhile, in the British Empire and Europe, the Berdan primer came into widespread use for many years. Only in recent times, because of the growing popularity of reloading, has the Boxer primed ammunition come into general British and European use.

When seating the Boxer-type primer, it’s important to seat it to the bottom of the primer pocket firmly, but not brutally. By seating the primer firmly, the legs of the integral anvil are positioned solidly against the front face of the primer pocket and the wafer of priming compound is prestressed to some extent (Figure 16).

Seating the primer in this manner makes for optimum sensitivity and uniform reliability of ignition. If the wafer of priming compound isn’t prestressed, a stronger blow of the firing pin is necessary to assure ignition, and accuracy is likely to suffer.

The various makes and designs of reloading presses have different provisions for seating the primers. Some have primers fed from a tube. Such an arrangement offers convenience, but also presents certain safety problems because the entire tube full of primers can detonate en masse. With that in mind, the more thoughtful and prudent designers of reloading equipment surround the brass primer feed tube with a sturdy steel tube capable of containing the high-velocity particles such as primer cups and anvils. Again, remember to wear suitable eye protection when reloading and casting bullets, as well as when shooting.
One of the more convenient and efficient systems for seating primers is the Lee Auto-Prime, in which a covered, inclined tray holds the supply of primers and the primers flow down a curved chute by gravity. You mount the Auto-Prime on a loading press, and a fresh primer feeds into position each time the handle of the press is operated (Figure 17).

FIGURE 17—A fired .38 Special case rests in a Lee shell holder installed in an RCBS Ammomaster press.

Thus, it’s necessary to put an unprimed case into the shell holder only after seating the previous one, operate the handle, and feed a fresh primer into position for seating.

Reloading is a process of several repetitive operations, and anything that you can do to economize on basic hand operations will help to get the work done sooner and more easily. There’s a well-developed science variously known as time-motion study or work simplification. A man named Gilbreth pioneered this field and his wife continued its development after his untimely demise. In Gilbreth’s science, each separate work-motion is a *therblig*, which is Gilbreth spelled backwards.

When working with single-stage reloading presses—as contrasted to progressive presses—it’s necessary to remove the processed case from the press and then replace it in the shell holder with the next case. In the usual sequence of things, this process involves one hand-up and hand-back to remove the processed case and put it back down, then another hand-up to put a raw case into the shell holder.
Or you can employ what some term the *three-finger shift*. Here, you grasp the raw case between your thumb and index finger of your left hand and bring the case up to the shell holder, which currently carries a case that was just processed.

Grasp the processed case between your left index finger and middle finger and move it forward and out. Replace it with the raw case held between the thumb and index finger. It’s an operation more easily executed than described or photographically illustrated. Basically, it conserves therbligs in a thoroughly useful manner and speeds the operation most gratifyingly (Figures 18A, B, and C).

**FIGURE 18A**—With the “raw” case held between your thumb and forefinger, grasp the primed case between your index and center finger.

**FIGURE 18B**—Remove the primed case from the shell holder.

**FIGURE 18C**—With the primed case held out of the way, position the unprimed case in the shell holder, thus saving a useful amount of time over the usual procedure that involves four hand movements instead of two.
We devoted some discussion to work simplification at this point because it’s one of those pertinent concepts that can prove helpful. It’s up to you to be aware of the essential principles and remain alert for any modification of basic procedures that can trim a therblig here, another somewhere else. Multiplied by the many repetitive motions that go into producing a batch of reloads, it’s possible to conserve a great deal of time and effort, and that’s all to the good.

**Reloading Presses and Equipment**

A reloading press magnifies the strength of the human hand and arm many times through leverage. Reloading presses are available in many makes, models, sizes, designs, configurations, price levels, and degrees of sophistication. There’s some advantage in starting out with a relatively small, simple, and inexpensive press. If you feel you see a need and justification for something more elaborate, you can always acquire it later. That doesn’t mean the original simple press is a dead loss out of pocket. Most reloaders work with more than one cartridge caliber, and you can use the inexpensive press to handle calibers loaded in smaller quantities.

There are three basic categories of reloading presses: single-stage, manually-actuated turrets, and progressive. In the single-stage, the operator installs a reloading die in the top of the press, along with a suitable shell holder on the top of the press ram. After the operator adjusts the press, he or she performs the given operation on all cases being reloaded at the given time.

Upon completion, the operator installs the next die, adjusts the press, and processes the cases through that. These steps continue until all of the cases become fully processed into reloaded ammunition.

Unless you need to produce a prodigious quantity of reloaded ammunition against a short-fuse deadline, there’s nothing wrong with a single-stage reloading press. If you put some thought into time-motion study on a single-stage press, you can increase your personal productivity. It’s one of those rare examples in which top management and the workforce wear the same hat, so it’s unlikely there will be any rumbles from organized labor.

The single-stage press offers some compensation to make up for its modest rate of production. It enables the operator to maintain an extremely tight and close degree of quality control over the various steps of turning empty cases into ready-to-go ones.

It’s ultimately desirable that a round of reloaded ammunition contain a certain number of grains of powder, whatever the selected and intended charge may be. If it contains no powder at all or twice as much as intended, the result is a drastic problem. A case containing no powder may drive the bullet out to lodge in the bore. Should a second cartridge fire—in rapid-fire practice, for example—it’s apt to blow up the gun, the same as two charges in one case.
When working with a single-stage press, you can put the load-ready cases into a loading block, drop the powder charges into each case, and then give a keen visual inspection of the powder level in each case, under good illumination. With that attended to, you can seat the bullets with the certainty that each cartridge has exactly the proper and correct amount of powder behind the bullet.

While manufacturers made and marketed reloading equipment in many different configurations down through the years, recent times have seen a really gratifying degree of standardization. Reloading dies offered by virtually all current sources have their shanks threaded to $\frac{7}{8}-14$ National Fine (NF), with a circular lock-ring to secure them in position after adjustment.

The shell holder is available in many formats as well, but the current trend is toward the so-called universal shell holder that is interchangeable with the various makers of dies, shell holders, and reloading presses.

Some shell holders will handle more than one given caliber of cartridge, and some will handle a rather large number. For example, most of the shell holders that accept the .45 ACP also work with rifle cartridges such as the .243 Winchester, .308 Winchester, .30-06 Springfield, and a broad host of others. Shell holders for the .38 Special will work just as well for the .357 Magnum, .357 Remington Maximum, and will usually perform quite well with the 10mm Auto, .40 Smith & Wesson, or 10mm Magnum.

Some reloading dies will “double in brass” to handle more than one basic caliber. This tends to be more common in the examples of the straight-sided handgun cartridges. While it may not be universally true, it’s often possible to reload .44 Smith & Wesson Russian (an archaic cartridge, seldom encountered), .44 Smith & Wesson Special, and .44 Remington Magnum with a single set of reloading dies, adjusted up or down in the press head as required. There’s also an outside chance that the given die set will serve to reload the .445 Super Mag and perhaps the .444 Marlin as well. In much the same spirit, dies for the .45 ACP may serve for the .45 Auto Rim and possibly for the .45 Winchester Magnum.

Resizing dies having inserts of tungsten carbide or titanium carbide are available for most of the straight-sided handgun cases, including the slightly tapered 9mm Luger and .30 M-1 Carbine. Dies for the latter pair are more expensive because the carbide insert has to work the entire length of the case, rather than a small area at the bottom of the die, as in the example of the cases with parallel straight sides (Figures 19A and B).
The great virtue of carbide resizing dies is that you need not apply case-resizing lubricant before sizing, and you need not remove it afterward. Case lubricant is a necessity with resizing dies made of hardened tool steel. Unlubricated cases may seize up in the die, wrenching the head or rim off the case when you attempt to pull it out by sheer muscle. Such a debacle requires the use of a Stuck Case Remover kit to salvage the die. Several makers of reloading equipment offer such kits. They consist of a No. 7 drill bit, a \( \frac{1}{4} \)-20 tap, a bolt of the same thread, and an extraction collar. Instructions on the correct procedures come with such kits. By the time you go through the drilling process once, it’s quite unlikely you’ll neglect to use sizing lubricant again for quite a while (Figure 20).
The next step after resizing is to use an expander die on the case mouth in preparation for seating the bullet. One of the most satisfactory expander dies is the Lyman M-Die. Its expanding plug has a lower portion about .003 inch smaller than the bullet diameter that enters the neck first, followed by a tapered transition to a section about .004 inch larger than bullet diameter. By careful trial-and-error adjustment, you can get the M-Die plug to the point where it’s possible to seat about the bottom $\frac{1}{32}$ inch or so of the bullet into the case neck, prior to the actual bullet seating. That also simplifies things in the next step, dropping the powder charge and eyeballing the level of the powder in each case. You can go on to put the bullet into the case neck as a preliminary to seating it to the final depth. Cases thus prepared don’t scrape the sides of the bullets when they are seated, and that’s highly conducive to improved accuracy, particularly in cast bullets (Figure 21).

Given access to a metal lathe, you can easily produce custom M-type expanding plugs. The shank that mounts the plug to the die has a 10-32 thread, and the easy way to produce it is to drill a central hole in the upper end of the plug, using a No. 21 drill bit. Thread the hole with a 10-32 tap, cut a suitable length of stem from a 10-32 bolt, and anchor it in place with a drop of red Loctite sealant. The plug can be turned from cold-rolled bar stock, and it will stand up a long while, even if not hardened.
The seating die guides the bullet into the case during the seating process. It should have a seating stem with its lower tip contoured so as not to distort the bullet’s nose. If you have a factory cartridge or a reload of the proper dimensions on hand, you can insert that into the shell holder. Then, run the press ram to the top of its stroke, back out the seating stem of the die by several turns, and turn the die body down in the press head until you feel it make contact with the case of the cartridge. Back the die out by a small fraction of a turn and secure it in that position with the die locking ring. Now, without lowering the press ram, turn down the seating stem until it makes contact with the tip of the bullet. Lock the stem in that setting with its locking ring.

Many reloaders speak of bullet seating depth. To determine this depth, measure the overall length of the bullet and the cartridge overall length (COL) after seating; then do the suitable subtraction. Actually, the COL is much easier to measure and establish than the overall length of the bullet. A pair of dial calipers, such as those marketed by Lee Precision, is invaluable handy for such measurements. When reloading for autoloading arms, the COL must be short enough to enable the shooter to load the reloads into the magazine with at least a trifle of nose-room to spare, so they’ll feed back out of the magazine without problems.

When reloading for revolvers, the tip of the bullet must be a reasonable distance back from the front face of the cylinder. Consider that the fifth or sixth round fired in a revolver has been subjected to the inertia of recoil, which tends to cause the bullets to migrate forward from the
case neck. If even a small amount of bullet tip projects ahead of the front face of the cylinder, it will hang up cylinder rotation and cause the wheelgun equivalent of a *jam*.

In reloads for rifles, the COL must be short enough so the give of the bullet doesn’t come into hard contact with the commencement (leade) of the rifling. Such contact could make it difficult to complete the closing of the action, and it tends to boost peak chamber pressures when the bullet is in a hard “crunch-fit” with the leade. If you elect not to fire the given round and attempt to extract it, the bullet may remain wedged into the rifling, spilling some amount of powder into the action when you extract the case. This would cause problems!

After seating the bullet to the appropriate depth, any flare put into the case neck before seating should be turned in to chamber the reload without undue resistance. If the bullet has a crimping groove or if it’s a jacketed bullet with a coin-edged groove (cannelure) about its mid-section, you can crimp the case mouth. That is, turn it in to help lock the bullet against movement in either direction.

There are two basic types of crimps: *roll-crimps* and *taper-crimps*. Redding/Saeco also produces dies for an in-between version called the *profile crimp*. Opinions concerning the virtues of various versions of crimps are fairly sharply divided. The important point is to hold the seated bullet firmly in place against forces that tend to displace it. When you feed a bullet through the action of an autoloader, there’s a tendency to push the bullet deeper into the case. When fired in revolvers, forces attempt to make the bullet move forward (Figure 22).

*FIGURE 22—You can use a taper-crimp die as the final step after seating the bullet. You can use other dies to perform a sharper roll-crimp to the case mouth.*
If there’s a tight press-fit between the case neck and the bullet base, that tends to hold the bullet securely in place in a thoroughly satisfactory manner, crimp or no crimp. If the grasp of the case neck against the bullet base is no more than casual, even a fairly savage roll-crimp may not suffice to prevent bullet migration. Use of the Lyman M-Die neck expander, discussed previously, tends to produce a satisfactory clench of the case neck on the bullet base.

If you perform a roll-crimp, it’s better to seat the bullet as one step, back out the seating stem, turn down the die body by the suitable amount, and perform the crimp as a separate operation. Only rarely does it work well to seat the bullet and perform a roll-crimp simultaneously.

Exact details as to the dies and shell holders required to reload specific cartridges are available on request from makers of reloading equipment. Addresses are in the Supplier’s Listing that comes with this program.

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Zero In! 1

At the end of each section of Ammunition, Reloading, and Basic Ballistics, you’ll pause and check your understanding of what you’ve just read by completing a “Zero In!”. Writing the answers to these questions will help you review what you’ve studied so far. Please complete Zero In! 1 now.

Indicate whether the following statements are True or False.

_____ 1. A reloading press magnifies the strength of the human hand and arm many times by means of leverage.

_____ 2. Hygroscopic means incapable of attracting and retaining moisture.

_____ 3. Cartridges designed for use in autoloading guns have larger rims for easy feeding.

_____ 4. A bottleneck case provides room for more powder behind the bullet.

_____ 5. There’s no practical way to reload fired rimfire cases.

_____ 6. The British refer to the bullet as the bullet head.

_____ 7. The Berdan primer pocket system is formed with a central flash hole.

_____ 8. Fulminate of mercury is the latest priming compound on the market.

_____ 9. Pistol primers have a somewhat thicker, tougher cup than the rifle type.

_____10. Boxer-type primers are customarily employed in reloading.

Check your answers with those on page 97.
THE RELOADING PROCESSES

Setting Up for Reloading

Typical reloading presses require a moderately sturdy work surface for their operation (Figure 23). If it’s practical in terms of individual circumstances, you can bolt the press to the bench top as a permanent installation. It may, however, be necessary to set up for temporary operation so that you can put the equipment away when you’re finished. In such a situation, it works quite well to attach the press to a small piece of plank and then secure that to the working surface using a pair of C-clamps (Figure 24).

FIGURE 23—The person who owns this loading bench prefers to work while seated. The storage space at the rear has a cover that you can close and lock to keep unauthorized hands out.

FIGURE 24—The gunsmith bolted this RCBS Ammomaster press to a piece of plank and then attached it to the bench by a pair of C-clamps.
You can situate other equipment, such as the powder measure, powder scales, and the like for convenience (Figure 25). It’s extremely important to allow for the highly flammable nature of powder and primers, taking precautions to prevent accidental ignition. For example, don’t cast bullets with an open container of powder nearby. If a flying drop of molten bullet alloy falls into the powder, it can set the powder off, with disastrous consequences.

If you have more than one can of powder or deck of primers on hand, you should store the main supply of such components away from the immediate reloading area. This way, accidental ignition of the components won’t spread through the entire quantity. You should keep one or more suitable fire extinguishers available in a fixed place where you can grab it quickly. Post “No Smoking” signs and strictly enforce the policy.

**The Steps of Reloading**

To this point, we may have gotten slightly out of order with the various reloading sequences. Let’s pause and review the basic operations performed in the course of turning an as-fired case back into a loaded round. The basic steps are as follows.

1. Fire the loaded round (factory or reload).
2. Retrieve and store the fired cases.
3. Inspect the fired cases.
4. Reject defective cases.
5. Sort for headstamps (optional).
6. Clean/polish fired cases (optional).
7. Resize/deprime the fired cases.
8. Seat the new primers.
9. Prepare the case necks.
10. Settle upon the load data.
11. Adjust, measure, and verify powder charges.
12. Drop the powder charges and inspect levels.
13. Adjust for seating depth/COL.
15. Perform final case neck treatment (crimp).
17. Fire the reloaded rounds; repeat steps.

**Retrieve and Store the Fired Cases**

Firing the loaded ammunition, retrieving, and saving the spent cases is an elementary operation. You need to get the empty brass from some source. There are alternative sources, however. Both Remington and Winchester continue to market unprimed empty cases, sometimes termed **virgin brass**, through their distributors and dealers. Sometimes gun stores will offer for sale containers of supposedly once-fired cases at a few cents each. Also, you may be able to collect off the ground spent brass at public ranges, although that can get your fingers stomped upon now and again. Knowing of a place where non-reloaders do a lot of shooting can yield for you a “brassy” treasure in a myriad of assorted calibers.

If reloading intrigues you, pick all of the cases up—except for the rimfire, of course—take them home, sort them, and stash away the calibers of no immediate utility. The heavy-duty Ziploc baggies, available in one-quart or one-gallon sizes, are useful for storing sorted batches of centerfire cases, as they protect them from dust, atmospheric corrosion, and home-building spiders.

Speaking of corrosion, several makers offer case tumblers or polishers to restore the factory-bright sparkle to grange brass (Figure 26). Such devices are relatively inexpensive and well worth their modest cost. If you’re using a solid cleaning medium, such as ground walnut shells, it’s best to tumble the brass in as-fired condition because the granules of the medium tend to block the flash holes in the cases. Then, when you resize/deprime, the decapping pin clears the flash hole.
Another exceptionally good idea is to sort the cases so that all are very close to the same mouth diameter. If you tumble 9mm Lugers together with .44 Magnums, you’ll end up with many 9mm cases wedged tightly into the mouths of .44 cases along with granules of polishing medium.

Cleaning cases by tumbling them takes some hours. It’s possible, however, to put a mirror polish on a case in a matter of only a few seconds. Tumbling requires a drill press or an electric hand drill that you mount on a base or a vise. It also requires a small mandrel with a slight taper and a diameter that makes a friction fit inside the case mouth. Chuck the mandrel into the drill press or electric drill, which you then turn on. Press the case mouth over the end of the spinning mandrel, causing it to spin. Use scraps of paper towel or small tufts of 0000-grade steel wool to take powder residue and other crud and corruption off the case surface.

At that point, you can put a small amount of metal polish such as Happich’s Simichrome, Flitz, Brass-O, or automotive chrome cleaner on a small swatch of paper towel and apply it to the spinning case. The polish will dissolve and loosen the corrosion. After a brief session of that, use a sheet of paper towel to wipe off the cleaner and achieve the final polish.

If the case has been deprimed, you can use a short section of wooden dowel with a small tuft of 0000-grade steel wool to clean the residue out of the primer pocket at the same time.
Once you process the case, you can pluck it off the spinning mandrel and replace it with another dirty one, with no need to turn off the power. The mandrels are a simple project to make from steel bar stock. It helps if you have access to a metal lathe, but you can produce them on a drill press with a flat mill bastard file and some time and patience. If you’re not inclined to make your own, Hanned Precision can furnish them under the trade name of K-Spinners, contoured so that one K-Spinner handles cases designed for several different bullet diameters.

**Inspect the Fired Cases/Reject Defective Cases**

Sooner or later, every cartridge case retires. The trick is to visually identify the unfortunate ones whose time has come, set them aside, and dispose of them appropriately.

After a number of reloadings and firings, cases may develop splits in the sides or necks (Figure 27). If fired from a hostile handgun, the case mouths may become banged into hopeless condition.

*FIGURE 27—This .38 Special case has a cracked neck and you should discard it. Mashing the neck with a pair of pliers keeps it from getting back into use.*

If the shooter fire rounds at an injudicious level of peak pressure, the primer pocket diameter may increase to the point where a new primer is a dismayingly easy “slop-fit.” In such instances, mash the mouth of each bad case with a pair of pliers so there’s no possible chance of it sneaking back into the production line.
You need to check bottleneck cases for excessive case length and/or neck thickness. A pair of calipers, either Vernier or dial-type, makes checking the length easy. Look up the length for the given caliber; you’ll find it listed under the caliber heading in many of the loading handbooks/manuals. Set the calipers for that dimension and lock them in that setting, if the provision is available. Then, merely see if the fired cases will pass through the caliper jaws. Set aside any that don’t.

You can detect excessive case neck thickness by trying to insert the base of the appropriate bullet into the case neck before resizing it. The bullet base should enter the neck of the fired case without undue resistance. If it doesn’t, it will be necessary to inside neck-ream the case or outside neck-turn it to remove the excessive metal at the neck.

If you reload overlong cases and/or overthick necks, they resist release of the bullet at the time of firing. This resistance causes excessive and possibly dangerous peak chamber pressures, even if the powder charge is suitable for the caliber and bullet weight, "by the book."

You can correct excessive case length by using a case trimmer to remove excess brass at the neck (Figure 28). Inside case neck reamers are available from Forster to fit that firm’s case trimmer. Note that you must inside-ream cases overly thick in the necks before resizing them. If you inside-ream the necks after resizing, you’ll remove too much metal and ruin the cases for any further use.

Both Forster and RCBS have accessories for outside case neck-turning to use on their respective trimmers. If extreme accuracy is of the utmost importance, outside turning produces a more uniform case neck thickness, at the expense of added time and effort.

It’s quite unusual to encounter a straight-sided case that is excessively long or too thick at the neck.
Sort for Headstamps

You may regard this step as optional. Minor variations in dimensions occur from one maker to another, and uniformity is quite important if you’re out to shrink target groups into the smallest clusters possible. If you can afford to be casual about all-out accuracy, lucky you! Go ahead and load the cases as they come, without regard to source or headstamp.

Speaking of headstamps, we should note that military cases seldom identify the actual caliber designation of the cartridge. Rather, they identify the armory and year in which it was made. United States military ammunition switched over from corrosive to noncorrosive primers at some point around 1952, varying somewhat from one producer to another. Usual procedure is to include the last two digits of the given year on the headstamp.

Thus, suppose you encounter an ancient cartridge having the basic dimensions of the .30–06 Springfield, with a headstamp of 43 (over) TW, for example. You can assume Twin Cities Arsenal produced it in the troubled year of 1943, a good nine years before any government arsenal commenced using noncorrosive primers. If you fire it in any gun chambered for .30–06, you had better clean the bore thoroughly and promptly, upon pains of ending up in the market for a replacement barrel (Figure 29).

Military-fired cases usually pose still another problem for the would-be reloader, in the form of the stamp-crimped primer. That operation isn’t performed primarily to make life difficult for future reloaders of the spent cases, but rather to minimize stoppages in fully automatic weaponry such as machine guns and submachine guns. If you ever wondered about the difference, a submachine gun is designed to fire ammunition nominally regarded as suitable for use in handguns.

The decapping pin in your resizing die may be able to punch out the stamp-crimped primer. However, when you endeavor to seat a fresh primer into the pocket, it will be impossible for all practical purposes. You can and must remove the stamp-crimp by reaming or swaging. Most makers of reloading equipment offer some manner of facility for doing this.
Resize/Deprime the Fired Cases

Once you inspect and sort the cases, you must resize and deprime them. If you’re not using a carbide sizing die, it will be necessary to lubricate the cases before resizing and to wipe off the lubricant afterward.

Straight-sided cases are usually resized in one step, with the necks being expanded as a second step in a second die. Depending upon the maker of the dies, the depriming pin may be in the resizing die or incorporated with the expander plug in the second die.

Dies for reloading bottleneck cases customarily resize the case and deprime and expand the case neck as a single operation. As the press forces the case up into the die, the spent primer gets punched out and the case neck becomes reduced to a diameter slightly too small. Then, as the case is pulled back down, it moves over the expander plug, restoring it to the precise inside diameter. In so doing, this nullifies any minor variation in case neck thickness, leaving all cases with the correct inside diameter at the neck.

Note: Carbide dies for bottleneck cases exist, but they aren’t at all common. Unlike straight-sided cases, carbide dies for bottleneck cartridges require that the case be cleaned of gritty dust particles and then lubricated. The only virtue of a carbide die for bottleneck cases is that it will last a great deal longer than a hardened steel die.

It’s necessary, of course, to lubricate the bottleneck cases when using resizing dies of hardened steel. Apply the lubricant sparingly and try to avoid getting any of it on the shoulder portion of the case. Excess lubricant on the shoulder is apt to cause unsightly dents.

It’s quite helpful to apply a small amount of lubricant to the inside of the neck of bottleneck cases. It not only helps to mute the blood-chilling “skrawnch!” sound effects as the case is drawn back over the expander plug, but it also minimizes stretching of the bottleneck case.

Some makers of reloading dies offer neck-size-only (NSO) dies for bottleneck cases. These makers usually produce custom NSO dies after they receive three fired cases from the given gun to establish dimensions. NSO dies offer great convenience and exceptional accuracy potential, as the case from head to shoulder remains a perfect, fire-formed fit to the chamber. It should go without saying that NSO dies are suitable only if the reload is to be fired in the same gun as it was previously. In using an NSO die, it’s necessary to apply only the merest smidgen of lubricant to the case neck, perhaps a bit to the inside of the neck. After that you can proceed with almost the same convenience as when loading straight-sided cases with a carbide sizing die.
Seat the New Primers

We discussed the preferred techniques for seating primers earlier, as well as safety considerations in their handling. It’s quite important to make certain that you seat the primers with the surface of the primer cup outward, not with the anvil exposed. Seating a primer backward poses little hazard beyond the fact that the cartridge won’t fire. That, of course, can prove extremely hazardous if you’re counting on it to stop a charging bear, for example! As a rule, you can spot reversed primers when you’re packing the reloaded rounds into cartridge boxes. They should go into the “deep-six jug” for safe disposal. It’s not a good idea to try to salvage them.

Safe Disposal

A deep-six jug is a plastic jug that originally held laundry bleach or anti-freeze that you can label with a felt-tipped marker and set aside to discard defective cartridges and similar items. Periodically, dispose of this jug in a safe and legal manner. If you need to dispose of unwanted powder, you can spread it broadly on the front lawn, where it will decompose and make the grass a little greener.

You need a special disposal container because the reloading operation tends to generate sensitive trash—flotsam, jetsam, and allied detritus—that you shouldn’t set out at the curb with regular garbage. There’s a chance that neighborhood children may look through your trash barrel and cart away items for further investigation. They may manage to set off an explosive or combustible object, such as a cartridge rejected because of a defect. Besides the unfortunate tragedy that could occur to the children and or property, their parents can—and probably will—sue you for damages.

You can drop into a wastebasket relatively innocuous inert brass cases that contain neither a live primer nor powder with no problems. It doesn’t hurt to mash the case mouths with a pair of pliers to assure they’ll never again find their way into the chain of production.

Prepare the Case Necks

We already discussed expanding the case necks of straight-sided cases. Bottleneck cases respond well to inside/outside case neck deburring tools, particularly after they’ve been trimmed, which leaves a pronounced burr, both inside and outside.

Settle Upon the Load Data

We’ll discuss load data sources in detail shortly. You may find them available from makers or distributors of powders at no cost. Or, they may be rather elaborate affairs costing several dollars—but a bargain at twice the price, for all of that.
It’s important that you don’t simply fill the available space in the case with some powder selected at random and go on to stuff a bullet down on top of it. Rather, consult a reliable reloading manual. Look up the given cartridge, mindful of the weight of the bullet you plan to use. Then, select a powder charge from among those listed for use with that caliber and bullet weight.

You’ll find several different powders listed, usually with more than one charge weight and a listing of the velocity that was obtained with the particular combination in the test laboratory of the book’s publisher.

Virtually all such load data sources supply profuse warnings that you must approach maximum loads with caution, and you better believe them! The maximum loads they list may be considerably beyond maximum when you make them up and fire them in your gun. Any number of variables enter the picture:

1. The bore dimensions may be slightly smaller in your rifle.
2. There may not be as much “freebore” ahead of the chamber before the rifling starts.
3. Some makes of cases have less internal capacity than other makes of the same nominal caliber.
4. Some primers are more energetic (brisant is the term, meaning brusque).
5. If you fire the reloads on a day when it’s exceptionally hot, you’ll encounter higher peak pressures than on a cooler day.

All these reasons and several others offer persuasive motivation to start low and work up with caution, as indications may suggest.

Select your charge weight of the given powder to put behind the particular bullet in the specific caliber of cartridge. Then, enter all the pertinent particulars in some manner of journal or notebook so they’ll be available for future reference, if needed. You want to write down all the details for the sake of being able to duplicate the load, in case it turns out to perform well. Make note of the caliber, the make of case(s), the make and type of primer, the charge weight of the selected powder, the make/weight/type of bullet, and the cartridge’s overall length.

Later, you can take the notebook to the shooting site and record the performance it delivers, for the sake of future guidance. Such a notebook, with detailed specifications on reload makeup and hard data on performance, can be of substantial value down the road.

**Adjust, Measure, and Verify Powder Charges**

There are those who weigh every single powder charge on an accurate scale, dead-on to the last one-tenth of a grain. That’s neither dangerous nor shameful, but the rate of production is painfully moderate.
The majority of reloaders prefer to use a powder measure. Such devices fall into two distinct groups, fixed and adjustable. Both types have one thing in common: The actual weight of the dropped charge needs to be verified on an accurate and dependable powder scale. Never take chart listings for granted, as they’re for general guidance only. Put it on a good scale and find out for sure!

It works quite well to drop 10 consecutive charges into the pan of the scale, all at once. Weigh the total and divide by 10 to arrive at an average charge weight for the measure. That’s a good approach, regardless if it uses fixed cavities or adjustable ones (Figure 30).

**FIGURE 30—Lee Precision’s “Safety Disk” powder measure is a handy example of the fixed-rotor design. It comes with four disks, with the three spares held in place by a pair of wooden dowels on the wooden base (not included with the measure). To save time hunting for a screwdriver every time the disk needs changing, the holding screw has been replaced by a homemade version.**

**Drop the Powder Charges and Inspect Levels**

It works quite well to put the load-ready cases in a loading block, a shallow tray with rows of holes to accept the heads of the cases and keep them aligned, mouth uppermost. If you use a dipper-type measure, you can pour the powder into each case in turn using a powder funnel. If you use a powder measure, you can hold the loading block in one hand as the other operates the measure, charging each case in turn.
Many makers of reloading equipment offer loading blocks in various sizes and designs. Given modest wood workshop equipment, it’s a simple project to construct loading blocks from pieces of scrap lumber. The holes can vary in diameter to handle cases with heads of different sizes (Figure 31).

As noted earlier, after you drop the charges, it’s possible to inspect the level of the powder charge in each case under good light to verify that the level of powder is uniform in each.

**Adjust for Seating Depth/ COL**

The outer body of the seating die positions the charged case in correct alignment as the seating stem forces the base of the bullet down into the case mouth when you operate the press handle. Both the die body and seating stem have locking rings to keep the adjustment uniform during the entire process. As a usual rule, the locking rings on the die bodies have set screws to lock them in adjustment. This is so you only need to turn the die into the press head until the locking ring prevents further turning (Figure 32). That assumes you’re still using the same loading press. If you have and use more than one press, you’ll find it necessary to readjust the die body when moving from one press to another. The pertinent dimension isn’t uniform from one maker to another, nor even among different models from the same maker.

As noted, you must make up reloads for handguns to maximum COL dimensions to assure that the cartridges fit into and feed out of the magazines of autoloading pistols. Another reason is so that the bullet tips have sufficient clearance behind the front surface of revolver cylinders.
Similar considerations dictate the COL for rifle reloads. The cartridges must fit into and feed out of the magazine reliably, and they must chamber without undue resistance caused by contact between the bullet ogive and the leade of the rifling.

*Note:* You should never load cartridges carrying bullets with pointed tips into tubular magazines. The force of recoil could set off a chain explosion within the magazine by contact between the bullet point and the primer of the cartridge ahead of it.

**Perform Final Case Neck Treatment**

If the case neck was flared to accept the bullet base in the neck expanding step, you must turn back in the flare to prevent resistance to chambering. Beyond that, the type and amount of crimp at the case neck is a decision for the reloader to make.

If there’s a tight grip of the case neck against the base of the bullet, it’s not apt to move in either direction during normal handling, feeding through the action of autoloaders, or when firing prior shots in revolvers.

**Pack and Identify Reloads**

Several makers offer compartmental plastic boxes to hold reloaded cartridges. You could use empty boxes that formerly held factory loads, or it’s possible to make your own containers (Figures 33 and 34).
It’s quite important to identify the reloads’ pertinent specifications by labeling the container in which they’re packed. The label can be as simple as a reference to the given page or line number in the reloading journal or log book. Various makers also offer self-adhesive labels for this purpose.

**FIGURE 33**—MTM Case-Gard ammunition boxes are available in a number of sizes holding 20, 50, or 100 rounds. They also have plastic boxes for reloaded shotshells.

**FIGURE 34**—This photo shows a homemade cartridge box, with \( \frac{1}{2} \) inch plastic grid from a fluorescent light shade used as a separator.
POWDERS AND RELOADING TOOLS

Notes on Reloading Tools

Reloading has been around since about the time centerfire cartridges arrived upon the scene—back into the nineteenth century. In the early years, the small hand tools—variously termed *tong tools* or *nutcrackers*—were quite popular and continued in production until fairly recently. Lyman’s No. 310 tool was one of the last of the breed, and Lyman discontinued its production only a few years ago (Figure 35).
The virtue of the tong tool was that the shooter could pack it within a small space and employ it without a formal loading bench, provided the shooter had a suitable dipper-type powder measure. The shooter uses the tong tool to resurrect spent cases in the field or around the evening campfire. Some of the early examples of the tong tool were marvels of compactness and design ingenuity, incorporating bullet moulds as well as reloading capabilities.

There’s a trend to categorize reloading equipment in relationship to letters of the alphabet. Thus, although seldom, the tong tools might be termed X-type. Presses that open at the front are C-presses; if they incorporate framework in front of the ram, they become O-presses or O-frames. We could hardly classify a compact press currently marketed by Huntington Die Specialties as anything but a W-press. We might classify the little kits that operate by impact rather than leverage as I-presses. Presses that position one or more dies above a horizontal bar that rides with the top of the ram are H-presses. Presses with a single shell holder and a circular turret to position the dies could be T-presses, although we encounter the term rarely, if at all (Figure 36).

The alphabetical designations peter out at about that point; that is, no one to date has offered designs that we could term S-presses, J-presses, F-presses, and the like.

Turret presses offer an attractive amount of convenience. A circular plate at the top positions anywhere from three to eight dies so that once you place a fired case in the shell holder, you can process it through each die in turn by merely rotating the turret.

The next logical step is to automate the rotation of the turret, resulting in the progressive press. The idea here is that the operator merely places a fired case in the proper place, operates the handle, and performs a few other steps such as putting a bullet in place at the proper point. The turret produces a complete, loaded round at each stroke of the handle. Admittedly, the prospect seems attractive.
The efficacy of such systems depends upon the smooth reliability of the turret-advancing mechanism as well as upon the level of intense concentration the operator is able to maintain. Unlike the procedure with single-stage presses, there’s no ready way to visually verify the level of the powder charge in each case before going on to seat the bullet.

Most progressive presses operate via a revolving shell plate, rather than having the turret advance. In progressive presses, the shell plate takes the place of the usual shell holder.

Beyond the progressive presses are the robot reloaders, driven by electric motors. Robot reloaders require human assistance solely for the sake of keeping the hoppers filled with spent cases, bullets, powder, and primers. As you might correctly suppose, operating such devices demands considerable expertise, and the price tags are more than slightly startling.

**Equipment Manufacturers**

Several names have come and gone in the field of reloading equipment. Hornady purchased Pacific, once an industry leader, and operated for a time as Hornady-Pacific. The line continues today under the Hornady brand. Bair was active for a while and went under, as did Texan,
Mequon Loaders, and various others. Redding acquired SAECO—originally Santa Anita (California) Engineering Company—and both lines remain available from that source. Forster purchased Bonanza and its equipment remains available from that source. Omak Industries purchased RCBS, along with Speer, CCI, Weaver, and Outers (not necessarily in that order). In time, the entire conglomerate came under the control of Blount (pronounced “blunt”), the current owners. A corporate entity called the Leisure Group bought both Lyman and Sierra Bullets, but continue to survive in the marketplace.

Charles Heckman founded C-H, producing both C-type and H-type presses. Heckman and his entire family perished in a head-on collision in the early 1960s, and since then the enterprise has passed through various hands. As of the early 1990s, its former operators in Owen, Wisconsin, sold C-H Tool & Die, which currently maintains a very low profile, indeed if any at all.

Dillon Precision manufactures an extensive line of progressive presses and markets them directly to the end consumer. The Dillon equipment is quite popular with competitive handgunners who expend a great amount of rounds in year-round practice. An early-1991 Steel Challenge event indicated the popularity of Dillon because every one of the top-placing shooters produced his or her ammunition on some model of Dillon press.

Supporting Equipment

Apart from loading presses, dies, shell holders, and components, we can’t regard any reloading setup as complete without a reliable and accurate powder scale, sometimes termed a reloader’s scale. You can also use a powder scale to weigh bullets, and, in a pinch, it can also serve as a postal scale. If the weight of the letter exceeds 437.5 grains, you need additional postage; just that simple.

Powder measures are available in many forms and at several price levels, but all such require an accurate scale to verify the actual weight of the dropped charge.

Dipper-type powder measures are available from Lee Precision, perhaps from other sources, as well. Lee has a kit with all of the available dippers plus a cardboard slide rule. The slide rule gives the approximate weight of charges of various powders out of each of the dippers, which are graduated in decimal portions of a cubic centimeter.

It’s possible to fabricate a custom powder dipper from a fired case, with a spent primer. Merely trim excess brass from the neck with a case trimmer until it holds the desired weight of the given powder, as verified by an accurate powder scale. Then, solder a section of nail or piece of brass welding rod to the case and add a wooden handle. Mark the charge weight of the specified powder on the handle with a nonfading ink and varnish or lacquer it to preserve the identification.
Most commercial powder measures have either fixed or variable metering cavities, and each has its advantages. Once you've established the delivery of a fixed cavity by using a scale, you can rely upon it to drop that amount, so long as you continue using the same lot of powder. If you buy a new can, with a different lot number, it's a good idea to check the weight of charges having the same volume.

Most makers of fixed-cavity measures offer some manner of chart that gives the approximate weight of various powders from the different charge bars or bushings. Never take their word for it. Perform your own checks, using your own scale. Then record the weights you got on a chart for future reference. Don't forget to run another check when you get a new can with a different lot number.

Not all makers and distributors of powder put lot numbers on their containers. If there's no lot number, make it routine procedure to re-check each new can. If there is a lot number and your dealer has two or more cans with the same number, consider buying a substantial supply (Figures 37 and 38).

**FIGURE 37**—You can reduce the problems of coping with various lot numbers of powder by buying larger containers, such as the 8 pound jug at left, instead of the 1 pound size at right. (Courtesy Accurate Arms)

**FIGURE 38**—Not all powder cans carry lot numbers, as in the No. 65 here. This, by the way, is a very old can, from the days before IMR bought the Dupont operation.
Powder measures with adjustable metering cavities have the obvious advantage of being able to deliver any desired charge weight for a given powder. All it takes is patience and a good scale. As noted earlier, you may find it helpful to drop 10 charges into the pan, weigh them, and divide the total weight by 10—an elementary exercise in mental arithmetic. For example, if 10 charges weigh 174 grains, your average drop is 17.4 grains. A weight of 216 grains becomes 21.6 grains and so on. Just move the decimal point one place to the left and you have it. This is, at least arguably, more precise than trying to weigh one charge at a time, particularly when working with the lighter charge weights.

Adjustable measures usually, if not always, have a locking ring on the adjustment stem. Once you have it dropping the desired charge weight, snub the locking ring down at least finger-tight, or give it a gentle torque with a pair of pliers, if you feel inclined. On a long production run, it’s a good idea to recheck the weight of the powder charge periodically to avoid nasty surprises.

**Smokeless Powders**

The early type of gunpowder was a physical mixture of potassium nitrate (KNO₃)—often called saltpeter by Americans, saltpetre by Britons—plus sulfur and charcoal. It would ignite to generate hot, high-pressure gas that would launch a projectile, but the chemical reaction of its combustion left a lot of unburned solids that posed problems for the shooter.

Soldiers fought the American Civil War entirely with the old black gunpowder, as were earlier conflicts. By the time the Spanish-American War came along in 1898, United States forces still armed themselves with single-shot muskets firing the .45-70 Government cartridge. They were so called because the gun fired a .458 inch diameter bullet of about 400 grains weight, motivated by 70.0 grains of the old blackpowder that made copious clouds of white smoke when ignited.

The Spanish forces armed themselves with state-of-the-art Mausers, using the newfangled “smokeless” powder. It produced some amount of smoke, but not nearly as much as did the blackpowder. Mausers shot small-caliber bullets (7mm/.284 inch) at much higher velocities, with proportionally flatter trajectories than did the archaic .45-70 Government rifles. This put our troops at a disadvantage, relieved only slightly by the hasty introduction of the .30-40 Krag rifle and cartridge.

It’s confusing to speak of blackpowder versus smokeless powder because the individual granules of many smokeless varieties are quite black from being tumbled in finely powdered graphite to coat the granules.
The main difference is in the chemical composition. The primary ingredient of smokeless powder is nitrocellulose, plus certain additives, deterrent coatings, and the like. In some examples, a percentage of nitroglycerin (C₃H₅N₃O₉) is mixed with the nitrocellulose during manufacture. Such powders are double-base powders in contrast to single-base powders that are composed principally of nitrocellulose.

Various other organic materials have been nitrated to explore their potential as propellants. An organic material is one that contains some number of carbon atoms in the makeup of its molecule. Nitrated wood pulp, for example, is nitrolygin. Nitrocellulose, sometimes termed guncotton or nitrocotton, remains the preferred ingredient, either straight or mixed with some percentage of nitroglycerin.

In the process, manufacturers soak the cotton lint in nitric acid (HNO₃) until a desired level of nitration takes place. At that point, they wash the product repeatedly to eliminate any residual acid content, because trace remnants of acid tend to cause deterioration in long-term storage. If the powder being manufactured is to be a double-base powder, the proper quantity of nitroglycerin gets blended in. At this point in the process, the powder-to-be has a somewhat doughy consistency. It’s intimately mixed and blended and then forced under pressure through a number of orifices in a plate. As this takes place, a rotary knife on the far side of the plate chops or slices off the extrusions to form the final form of the granules.

If the length of the granule is a lot less than its diameter, the resulting powder is a flake propellant. If the granule length is as great as, or greater than its diameter, we call the powder an extruded propellant.

There’s a further variant in powder manufacturing processes that causes the product to separate out of the solvent in small, more or less spherical globules. Winchester developed the process, and their registered term for propellants of that type is Ball Powder. Hodgdon distributes several such powders, and their registered term is Spherical powders. The generic designation—for want of a better term—is globular powders, and we’ll employ the term here in that context, to distinguish such powders from the extruded types. Most, if not all, globular powders are of the double-base type containing some percentage of nitroglycerin.

Apart from the two basic manufacturing processes, powders differ from each other in terms of burning rate. Such variation is necessary to obtain the best possible performance from the broad variety of firearms and their wide assortment of cartridges. Many sources have endeavored to provide tables that show all of the various powders arranged in order of their burning rates (Figure 39).
The following chart ranks, from fastest to slowest, the current canister-grade powders in order of approximate burning rates.

Some of the Vihta Vuori powders listed here aren’t presently distributed in the United States. The current Vihta Vuori listing didn’t include Accurate Arms No. XMP-5744 (formerly MP-7544). In a previous Vihta Vuori listing, it appeared after VV N120 and faster than IMR-4227. Accordingly, we might give it a tentative position of No. 54.5 in this ranking.

Also missing are Hodgdon Varget and H483 ISC. We can regard the latter as identical in burning rate to Hodgdon H4831 (No. 102). According to Hodgdon, Varget is roughly in the same range as IMR-4064, although by no means identical it.

Accurate Arms rates its No. 2495 equivalent to IMR-4895.

<table>
<thead>
<tr>
<th>Position</th>
<th>Powder</th>
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<tbody>
<tr>
<td>1</td>
<td>Norma R-1</td>
</tr>
<tr>
<td>2</td>
<td>Vihta Vuori N310</td>
</tr>
<tr>
<td>3</td>
<td>Alliant Bulls-eye</td>
</tr>
<tr>
<td>4</td>
<td>Vihta Vuori N3SF</td>
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<tr>
<td>5</td>
<td>Scot Solo 1000</td>
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<tr>
<td>6</td>
<td>Accurate Arms No. 2</td>
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<tr>
<td>7</td>
<td>Alliant Red Dot</td>
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<tr>
<td>8</td>
<td>Vihta Vuori N3SL</td>
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<tr>
<td>9</td>
<td>Hodgdon Clays</td>
</tr>
<tr>
<td>10</td>
<td>Vihta Vuori N320</td>
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<tr>
<td>11</td>
<td>Scot Royal Scot</td>
</tr>
<tr>
<td>12</td>
<td>Vihta Vuori N321</td>
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<tr>
<td>13</td>
<td>Hodgdon HP38</td>
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<td>14</td>
<td>Winchester 231</td>
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<td>15</td>
<td>Scot 453</td>
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<td>Vihta Vuori N324</td>
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<td>17</td>
<td>Vihta Vuori N3SM</td>
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<td>18</td>
<td>IMR Hi-Skor 700-X</td>
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<tr>
<td>19</td>
<td>Winchester WST</td>
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<tr>
<td>20</td>
<td>Hodgdon Intl. Clays</td>
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<tr>
<td>21</td>
<td>Alliant Green Dot</td>
</tr>
<tr>
<td>22</td>
<td>Vihta Vuori N330</td>
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<td>23</td>
<td>IMR PB</td>
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<td>24</td>
<td>Vihta Vuori N331</td>
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<td>25</td>
<td>Accurate Arms No. 5</td>
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<tr>
<td>26</td>
<td>Scot Pearl Scot</td>
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<tr>
<td>27</td>
<td>Winchester WSL</td>
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<tr>
<td>28</td>
<td>Hodgdon Univ. Clays</td>
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<td>29</td>
<td>Alliant Unique</td>
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<td>30</td>
<td>Vihta Vuori N338</td>
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<td>31</td>
<td>IMR SR-7625</td>
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<tr>
<td>32</td>
<td>Winchester WSF</td>
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<td>33</td>
<td>Hodgdon HS-6</td>
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<td>34</td>
<td>Vihta Vuori N340</td>
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<td>35</td>
<td>Winchester 540</td>
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<td>36</td>
<td>Alliant Herco</td>
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<tr>
<td>37</td>
<td>IMR SR-4756</td>
</tr>
<tr>
<td>38</td>
<td>Scot Solo 1250</td>
</tr>
</tbody>
</table>

FIGURE 39—Burning Rate Chart Transcribed by Dean Grennell  (Used with permission from Kaltron/Pettibone)
You should use the burning rate chart as a guide and not for data for two reasons. First of all, the arrangement of powders in terms of their burning rates would depend upon the peak pressure. We measure pressure and quote it in two different units, and we obtain it by two different methods. In one, the tester fires the cartridge from a pressure gun in such a manner that the piston applies the total peak pressure to a small cylinder of copper or lead, compressing or shortening it to some extent from its uniform original length (Figures 40 and 41). Then, the shooter measures the length of the cylinder after firing and checks the resulting dimension against a table of tarage, furnished by the supplier of the cylinders. The table quotes a peak pressure, as indicated by shortening of the cylinder, in increments of .001 inch, across the span of possible measurements. We call the resulting pressures obtained by such testing procedures Copper Units of Pressure (CUP), or Lead Units of Pressure (LUP). We use LUP for the lower pressure figures common to shotgun ammunition.
A distinctly different approach to pressure measurement utilizes electronic equipment, rather than the essentially mechanical method used to obtain the CUP/LUP figures. A device called a strain gauge is incorporated in the breech area of the barrel. It utilizes a crystal that generates a small, but proportional, pulse of electrical energy in response to pressure exerted against it. This occurs in much the same manner as when the crystal attached to the needle of a phonograph translates variations in the groove of a record into impulses that amplify to reproduce the music. The strain gauge, however, operates on a vastly higher scale than the phonograph needle.

At the firing of the test shot, the impulse from the strain gauge feeds into electronic circuitry to be plotted as a trace or line on a cathode ray tube (CRT), which is similar to a television screen or a computer monitor. The advantage of the electronic approach is that it plots the pressure, from ignition to the bullet’s exit from the muzzle, showing the peak pressure in terms of the point at which it was reached in the cycle.

We quote the resulting pressure in a unit termed psi (pounds per square inch), and that brings us to the point of confusion. Testers have tested identical loaded cartridges using both approaches and have often obtained CUP and PSI figures that were quite close, sometimes exactly identical. In other examples, there were substantial variations, in either direction. That’s to say the CUP figure may be higher or lower than the PSI figure for the same identical batch of cartridges. Quite obviously, there’s no handy conversion factor that we can use to change a CUP figure to PSI, or vice versa.

A second reason the chart is just a guide relates to testing procedures. If all the tests were set up to develop peak pressures of 10,000 CUP or PSI, it would be possible to arrange and list the powders on that basis. However, suppose the tests were conducted at a uniform peak pressure...
of 20,000, with other sets at 30,000 and 40,000 pressure units. You could expect a different arrangement of powders in terms of burning rate in either example and still another at the 50,000 level. The problems of setting up such a chart should be painfully apparent.

A further problem is that, given such a chart, some reloaders may interpolate load data from it. For example, they may find a listing for $x$ grains of a given powder for a particular bullet weight in a certain cartridge. No comparable data exists for some other powder, which may be a few notches slower in burning rate, as listed on the chart. So, the reloader who doesn’t know the meaning of fear, decides to use the unlisted powder. Since the powder shows to be slower in burning rate, the reloader boosts the charge weight somewhat. Such procedures may be safer than teasing a rabid cobra, but not much safer!

Therefore, such interpolations from charts of powder burning rates are not at all a good idea, and that’s why we included a chart for guidance only.

**Powder Manufacturers and Suppliers**

The individual manufacturers and suppliers of powder can and usually do rank their own products in terms of relative burning rates. That practice is quite valid and defensible. The problems loom up when more than one supplier offers powders nominally the same as those of others, often with numerical designations that are the same or within a digit or of each other.

We list the powders that are more or less available to reloaders in the United States and their suppliers, although it’s rather unlikely to encounter any retail source that stocks them all.

*Accurate Arms Company*
P.O. Box 167  
McEwen, TN 37101

*Austin Powder Company*
25800 Science Park Dr.  
Cleveland, OH 44122

*Alliant Smokeless Powder Group*
New River Energetics, Rt. 114  
P.O. Box 6  
Radford, VA 24141-0096

*Hodgdon Powder Company Incorporated*
P.O. Box 2932  
Shawnee Mission, KS 66201

*IMR Powder Company*
Route 5, Box 247E  
Plattsburgh, NY 12901
Accurate Arms Powders

We list the following powders for Accurate Arms from fastest to slowest.

**Nitro 100.** A fast-burning, double-base flake propellant developed for target loads in the 12 gauge shotgun; also useful for target loads in handguns.

**No. 2.** A fast-burning, double-base globular propellant for use in handgun target loads, with applications for the 20 gauge shotshell.

**No. 5.** A relatively fast-burning globular propellant developed for use in the .45 ACP; also suitable for .38 Special, .38 Special + P and 9mm subsonic loads as well as target-velocity cast bullet loads in magnum handguns.

**No. 7.** A double-base globular propellant originally developed for 9mm NATO carbine ammunition. It’s suitable for full-power loads in 10mm automatics and works well for magnum handgun cartridges when slightly less than maximum power is necessary.

**No. 9.** A double-base globular propellant well suited for maximum loads in the .44 Magnum, producing less muzzle flash than comparable powders. You can use it in .22 Hornet rifles and .410-bore shotshells.

**1680.** A double-base globular propellant developed specifically for the 7.62 × 39mm cartridge. It works well in the .22 Hornet and .222 Remington.

**2015BR.** A single-base, small-grained, extruded propellant developed specifically for “bench rest cartridges,” such as the 6mm PPC or Remington’s BR series (Figure 42).

**2230.** A double-base globular propellant developed specifically for the .223 Remington (5.56mm NATO). It’s useful in several medium-capacity cartridges such as the .30-30 WCF.

**2460.** A double-base globular propellant of medium burning rate. It’s useful in the .223 Remington through the .30-06 Springfield and is a good performer in the .308 Winchester.

**2520.** A double-base globular propellant of medium-slow burning rate. It’s exceptionally suitable for the .308 Winchester.
2700. A double-base globular propellant of moderately slow burning rate. It’s suitable for rifle cartridges from the .22-250 Remington up through the belted magnums. It requires fairly heavy bullets for shot-to-shot consistency.

4350. A single-base extruded powder with comparatively slow-burning rate. It’s suitable for heavy bullets and/or magnum rifle cartridges.

3100. A single-base extruded propellant of slow-burning rate. It’s useful in the .243 Winchester up through the belted magnums.

8700. A double-base globular propellant with the slowest burning rate available to reloaders in the United States. It’s best for the .264 Win Mag and the 7mm Rem Mag on up to and including the .50 Browning machine gun cartridge.

You’ll find the *Loading Guide for Accurate Smokeless Powders* to be a helpful guide. Copies are available on request from Accurate Arms at the address listed previously.

**Austin Powders**

Until the spring of 1991, Scot Powder Company marketed Austin powders. All are manufactured from a select grade of nitrocotton, except for Royal Scot and Pearl Scot, which are a single-base type.

**Royal Scot.** A bulky, but fast-burning, double-base flake-type powder for use in 12 gauge shotshells. It contains some orange-colored granules as an aid to identification.

**Pearl Scot.** A double-base, flake-type powder of medium burning rate for target and upland game shotshell loads. It contains occasional white flakes for identification.

**Solo 1000.** A fast-burning, single-base, flake-type powder for use in target shotshell loads, with applications for target loads in handguns.
Solo 1250. A medium fast-burning, single-base, flake-type powder for 12 gauge hunting shotshell loads or target loads in 20 or 28 gauge. You can use it in handgun loads, per supplier’s load data booklet. Like Solo 1000, it has exceptionally low levels of muzzle-flash in handguns.

Solo 1500. A single-base, flake-type powder with a slower burning rate. It’s suitable for .357, .41, or .44 Magnum and 10mm Auto loads with heavier bullets. You can use Solo 1500 for 10, 12, 16 and 20 gauge hunting loads with lead shot and it has some application for 12 gauge steel shot.

Brigadier 4197. A single-base extruded rifle powder with a relatively fast burning rate. It’s suited for varmint loads in the smaller cartridge cases.

Brigadier 3032. A single-base extruded rifle powder with a burning rate slower than Brigadier 4197.

Brigadier 4065. A single-base extruded rifle powder, still slower in burning rate.

Brigadier 4351. A single-base extruded rifle powder with the slowest burning rate of the Brigadier series.


Alliant Powders

Bulls-eye. A double-base, flake-type powder with one of the fastest burning rates of any powder available to reloaders. It’s suitable for target loads in handgun cartridges, and Alliant lists a few loads for it in 12 gauge with 7/8 ounce of lead shot.

Red Dot. A double-base, flake-type powder with occasional red flakes for identification. Slightly slower in burning rate than Bulls-eye, Red Dot is traditionally a favorite for target shotshell loads. You can use it for target-velocity loads in handgun cartridges.

Green Dot. A double-base, flake-type powder with occasional green flakes for identification. Green Dot is slower in burning speed than Red Dot, and you can use it for target and upland game shotshell loads as well as for handgun cartridges (Figure 43).

Unique. A double-base, flake-type powder with granules of uniform dark gray color. Unique is slower in burning rate than Green Dot, and you can use it in reloading shotshells and handgun cartridges and for light loads in rifle cartridges.

Herco. A double-base, flake-type powder with uniformly dark gray granules. Slower in burning rate than Unique, it’s for heavy hunting shotshell loads, and it works quite well in several handgun cartridges, particularly the 9mm Luger.
Blue Dot. A double-base, flake-type powder with occasional blue flakes for identification. Slower in burning speed than Green Dot, it’s suitable, per Alliant’s listing of load data, for heavy hunting loads in shotshells, as well as the more energetic handgun reloads.

2400. A double-base, flake-type powder with uniformly dark gray granules. It’s suitable for .410 bore shotshell loads and magnum handgun cartridges.

Reloader 7. A double-base, extruded propellant for use in rifle cartridges, with occasional applications in handguns. Reloader 7 is the sole survivor of a trio of rifle powders introduced by Hercules (now Alliant) in the mid-1960s that, at the time, also included Reloader 11 and Reloder 21. The numbers had no special relation to the burning speed but supposedly were selected because they’re the “three lucky numbers at Las Vegas.”


Reloader 15. A double-base, extruded propellant, slower in burning rate than Reloader 12, and listed in the Alliant booklet for many medium-sized rifle cartridges.

Reloder 19. A double-base, extruded propellant, slower in burning speed than Reloder 15, and listed for medium to large rifle cartridges.

Reloder 22. A double-base, extruded propellant, slowest in burning rate of the current Alliant line. It’s suitable for heavy bullets in large, magnum-type rifle cases.

The 56 page booklet, Reloading’s Guide for Alliant Smokeless Powders, is available at no charge from many dealers who stock the powders. If you can’t find a copy locally, request one from Alliant at the address listed earlier.
Hodgdon Powders

Shortly after the end of World War II, Bruce Hodgdon began buying surplus quantities of powder left over from the rather frantic years of that global conflict. He went on to package the powder and resell it, through wholesale and retail outlets. His earliest offering was 4895, used in military loads for the .30-06 Springfield. Hodgdon sold 150 pound kegs of it for $30.00 plus freight! He went on to add 110 used in the .30 M-1 carbine and 4831 that had powered 20mm aircraft cannon cartridges. Along the way, he also marketed BL-C, later replaced by BL-C(2).

With rare exceptions, Hodgdon no longer buys and distributes surplus powders. Hodgdon makes most of their powders “from scratch” at the facilities of Imperial Chemical Industries (ICI) Nobel Explosives Co., Limited, in Scotland. Olin makes most of Hodgdon’s Spherical powders. The current line of Hodgdon powders follows, ranked in approximate order of burning rate, from fastest to slowest.

*Spherical HP38.* A fast-burning spherical powder adapted to light or target loads in a broad range of handgun calibers. It’s particularly suitable for target loads in .38 Special.

*Spherical Trap 100.* A powder adapted to trap, skeet, and similar light loads in 12, 16, and 20 gauge shotshells, with applications for light target loads in handguns.

*Spherical HS6.* A powder for heavy field loads in shotshells, as well as midrange to heavy handgun loads.

*Spherical HS7.* A slow-burning powder for magnum shotshell loads in the larger gauges. Rated the best powder for use in the 28 gauge, it’s also usable for midrange to heavy handgun loads.

*Spherical H110.* Originally developed for use in the .30 M-1 Carbine, H110 works well in .410 bore shotshells and magnum handgun loads.

*H4227.* An extruded powder of fine granulation, similar to IMR 4227, but usually slightly faster in burning rate. You can use H4227 in the .22 Hornet, .222 Remington, and similar rifle cartridges. You can also use it in magnum handgun cartridges, in which it reduces lead fouling with cast bullets.

*H4198.* An extruded powder at its best in small- to medium-capacity cases. H4227 is useful for lightweight bullets in several rifle cases, and it also works well for reduced loads with cast bullets.

*H322.* An extruded powder that works well for target loads in rifles with small- to medium-capacity cases.

*Spherical BL-C(2).* Popular among bench rest shooters, its best performance is in the .222 Remington and similar cases smaller than the .30-06 Springfield.

*Spherical H335.* Similar to BL-C(2), H335 works well in medium-capacity rifle cases from .222 Remington to .308 Winchester.
H4895. A versatile extruded rifle propellant, useful in almost all cases from .222 Remington through .458 Winchester Magnum. Reduced loads as low as 60 percent of maximum still give decent target accuracy.

Spherical H380. Said to fill the gap between IMR 4320 and IMR 4350, H380 performs extremely well in cartridges such as the .22-250 Remington, .219 Zipper, .22 Swift, the 6mm's, .257s, and .30-06 Springfield (Figure 44).

Spherical H414. A powder that works well in medium-to medium-large-capacity rifle cases, often providing outstanding accuracy. H414 gives good performance with lightweight bullets in large-capacity rifle cases.

H4350. Introduced in April, 1982, H4350 is an extruded number, slightly slower in burning rate than IMR 4350.

Spherical H450. A powder that gives best results in medium- to large-capacity rifle cases. Its burning rate is similar to the 4831 powders.

H4831 Newly Manufactured. A recreation of the original surplus powder, it gives outstanding performance with medium to heavy bullets in 6mm/.243 through magnum rifle cartridges (Figure 45).
H1000. An extruded rifle powder, quite slow in burning rate and well adapted for use with the heavier bullets in the larger magnum rifle cases.

Spherical H870. A powder adaptable to overbore-capacity magnum cases in diameters from .257 to .300, with heavy bullets.

**IMR Powders**

IMR is a designation for *Improved Military Rifle*, once employed by Dupont for several of its rifle powders. Some years ago, Dupont decided to get out of the powder business and sold the operation to IMR Powder Company, which adopted the abbreviation as their corporate moniker. Dupont has used at least two other abbreviations: SR for *Sporting Rifle* and PB for *Porous Base*.

Several other suppliers offer powders with numerical designations identical, or closely similar, to those of the IMR series. The burning rates and other properties of such powders aren’t necessarily identical to those from IMR, and you shouldn’t substitute non-IMR powders when using IMR load data. Rather, you should use load data published by the supplier of the given powder.

The current lineup of IMR powders, ranging from fastest to slowest in burning rates, follows.

“Hi-Skor” 700-X. A double-base, flake-type propellant for use in reloading shotshells and many handgun cartridges. It has occasional flakes colored yellow for identification.

“Hi-Skor” 800-X. A double-base, flake-type propellant for use in shotshells and handgun cartridges, with occasional tan flakes for identification. It’s sufficiently slow in burning rate to provide some interesting velocities in magnum handgun cartridges.

PB. A single-base, flake-type propellant for use in shotshells and handgun cartridges. PB sometimes delivers exceptional accuracy in the 9mm Luger cartridge.

SR 7625. A single-base, flake-type propellant for use in shotshells and handgun cartridges.

SR 4756. A single-base, flake-type propellant for use in shotshells and handgun cartridges.

SR 4759. A single-base, extruded propellant, SR 4759 has no application for reloading shotshells, but IMR lists it for a few bottleneck handgun cartridges such as the .221 Remington Fire Ball, with listings for nearly all of their rifle cartridge headings. Other data sources often list SR 4759 for reduced loads in rifle cartridges.

IMR 4227. A single-base, extruded propellant, IMR 4227 is the fastest in burning rate of the IMR series. IMR lists it for use in the .410 bore shotshell, for most of their handgun cartridge headings, and for most of the rifle cartridges, as well.
The remainder of the IMR series, in order of fast to slow burning rates, are as follows.

- IMR 4198
- IMR 3031
- IMR 4064
- IMR 4895
- IMR 4320
- IMR 4350
- IMR 4831
- IMR 7828

IMR lists data for powders as slow as IMR 4895 for use in bottleneck handgun cartridges such as the .221 Remington Fire Ball. The remaining four are mostly simon-pure rifle propellants, hardly at their best in barrels shorter than 16 to 18 inches.

### Winchester Powders

All of the Winchester powders are Ball-type, and all are the double-base variety. Winchester continues to distribute a booklet of load data originally published in December, 1985, with periodic updates. A list of their current line of powders, not necessarily ranked from fastest to slowest in burning rates, follows.

**231.** A fast-burning powder for target and standard loads in handgun cartridges.

**29.** A moderately slow-burning powder for use in magnum handgun cartridges as well as in .410-bore shotshells.

**WSL.** The initials stand for Winchester Super Lite, and it’s primarily a shotshell propellant with some applications in handgun cartridges, as listed in the current Winchester data booklet.

**WST.** Winchester Super Target, which replaces their number 452AA for use in shotshells.

**540 and 571.** Propellants intended primarily for use in shotshells.

**748 and 760.** A pair of popular rifle propellants.

**WAAP.** This is the cleanest, lowest charge weight powder Winchester markets for reloading target shotshells.

**WSF.** This is the propellant of choice for Winchester 20 gauge AA Target Load and 12 gauge 3¾ dram equivalent Super-X load. WSF is an ideal choice to maximize velocities in 12 gauge 1¼ ounce and 1¾ ounce loads.
**WAP.** This is a high-velocity, clean burning, low muzzle flash, highly consistent powder for your reloads. WAP has a lower flame temperature than competitive products, which extends barrel life. Ideal for use in competitive action pistol applications and high performance Law Enforcement and self-defense applications.

**WMR.** This is a low-flame temperature propellant, and has ideal flow characteristics. It’s an excellent magnum rifle propellant.

### Vihta Vuori Powders

Vihta Vuori has been manufacturing its powders since about 1926. They’ve only recently become available in the United States.

Their N100 series is a single-base nitrocellulose propellant, ranking from fastest to slowest as follows.

**N110.** For use in small and medium volume cases with lightweight bullets.

**N120.** A multipurpose powder for 5.56mm calibers.

**N130.** Suitable for 5.56mm cases with heavier bullets.

**N133.** Especially tailored for the .223 Remington/5.56mm NATO.

**N135.** Especially tailored for the .308 Winchester/7.62mm NATO.

**N140.** Especially tailored for caliber .30 rounds with 155+ grain bullets.

**N150.** For use in medium-bore rifle calibers.

**N160.** For use in magnum rifle calibers or .30-06 with heavier bullets.

**N165.** For use in magnum cartridges with heavier bullets.

The following N300 series of porous powders are suitable for handgun or shotgun reloading and are single-base nitrocellulosic propellants.

**N310.** For use in revolvers and smallbore pistols.

**N320.** For use in revolver and pistols.

**N330.** Slightly slower for handgun use.

**N331.** Especially designed for the 9mm Luger.

**N340.** Slower, for handgun use.

**N350.** Slower, for handgun use.

**3N37.** Especially for 9mm handguns.

The high-energy N500 series is a double-base with nitroglycerin added, for use in reloading rifle ammunition and from fastest to slowest, and consists of N540, N550, and N560. It’s especially used for 9mm handguns.

You can order the Vihta Vuori Reloading Manual, with data listings from handgun and rifle cartridges, from Kaltron-Pettibone.
Bullets and Ballistics

Buying Bullets

Bullets for reloading metallic cartridges are available from a great many sources and in a near-infinite variety of weights, diameters, and designs. The major manufacturers are Hornady, Nosler, Remington, Sierra, and Speer (Figure 46). Winchester used to market its bullets, but no longer does so.
Jacketed bullets have cores of lead or lead alloy enclosed by jackets of gilding metal, an alloy of copper and zinc. The jacket may enclose the base and leave the nose exposed, which we term a jacketed soft point (JSP). If it has a cavity in the center of the exposed lead tip, we call it a jacketed hollow point (JHP). Alternatively, the jacket may leave the base exposed, termed a full metal jacket (FMJ). Speer has designed a bullet with the jacket deposited on the core by electroplating, and that design is a totally metal jacket (TMJ).

Rifle bullets may have a tapered portion at the base, called a boat tail, with a full jacket, exposed soft point, or hollow point up front. The front portion may be a spitzer point, spire point, or round nose. A unique design is the Nosler Partition Bullet. It has a segment of jacket metal separating the base and nose portions of the core to assure that expansion of the front will be backed by deep penetration by the base. Nosler has another design called the Ballistic Point, with a plastic tip—distinctively colored to identify the various calibers—to fill in the hollow point. Hornady has a line of handgun bullets termed XTP for extreme terminal performance. Sierra has a similar line called Power Jackets.

Several suppliers offer unjacketed lead handgun bullets in bulk packs, usually 500, for substantial savings over the usual pack of 100. The lead bullets are lubricated and ready to use.
Casting Bullets

Note: Casting bullets requires eye protection. Never forget it!

Moulds—sometimes spelled molds—for producing cast bullets are available from Hensley & Gibbs (H & G), Lyman, RCBS, and Redding/SAECO, among others. H & G offers only molds (their spelling) for handgun bullets, but includes designs for the .45-70, for handguns that fire the cartridge. The others offer moulds for rifle bullets as well (Figure 47).

The mould blocks may have a single half of the cavity in each side, although two-cavity designs have come to be more customary (Figures 48 and 49). Larger blocks are available with four, six, eight, or even more cavities. As a rough rule of thumb, using an electric, bottom-pour casting furnace and a six-cavity mould, it’s possible to produce 100 bullets in about six minutes.
Cast bullets have one or more grease grooves running around the full-diameter base portion, and it’s imperative that you apply some manner of lubricant to prevent lead from fouling the gun bore (Figure 50).
Lyman, RCBS, and Redding/SAECO manufacture machines that size the cast bullet to the desired diameter—usually .001 inch over groove diameter of the barrel—and deposit lubricating grease in the grease grooves at the same time. Some cast bullet designs have bases dimensioned to accept a shallow cup of gilding metal, called a gas check. You can use the lubricant/sizing machines to put the gas checks in place while performing the rest of the operation (Figure 51).

Lee Precision makes bullet moulds for what they call Micro-Band bullets, which don’t require sizing before loading. Lee Precision also provides Liquid Alox lubricant in which you can tumble the bullets, as in the bottom of a rinsed-out milk carton, for example. After tumbling, you decant the bullets upon a piece of waxed paper to air-dry. You can load the processed bullet without further work. The Micro-Band bullets usually group in a thoroughly gratifying manner and save copious therbligs of expended effort on the part of the reloader, as well as out-of-pocket funds.
Casting Alloys

Three elementary metals commonly used in casting bullets, in terms of percentage, are lead, antimony, and tin. Popular sources for casting alloy metal include wheel weights, linotype metal, salvaged lead pipe, and plumber’s wiped joints. Unsuitable sources include telephone cable sheathing and plates from discarded auto batteries. The cable sheathing contains some manner of metal that prevents the molten alloy from flowing freely. The battery plates contain arsenic that, when melted, can generate toxic gas with fatal effects.

**Warning:** Lead itself is a toxic substance, eliminated from the body slowly, if at all, once ingested. You should undertake bullet casting with adequate ventilation, and keep your fingers that have touched the lead away from your mouth until you’ve thoroughly washed them. Blood tests made in routine physical examinations don’t detect lead in the blood. Detecting lead requires a special heavy-metals test, and any person who works with lead extensively should have one. Discuss the matter with your physician.

You can sometimes obtain wheel weights from filling stations or tire stores and similar sources. It’s necessary to melt them down, skim off and discard the little steel clips, and flux the remaining metal before decanting it into pig moulds for future use. If you can obtain the upper portion of an old stainless steel GI mess kit, that makes a perfect
pig mould for salvaged casting alloys, producing two kidney-shaped pigs that weigh about six pounds each.

Wheel weights are mostly lead, with some antimony and a little bit of tin. When you clean them up and process them, it’s possible to cast marginally satisfactory bullets from wheel weight metal. If you can introduce a bit more tin, resulting performance improves greatly.

Linotype metal contains lead, antimony, and a good ration of tin. That’s the good news. The bad news is that linotype metal is getting scarcer with each passing year as printers shift over to “cold-type” processes.

If you can get some linotype metal, melt it down and cast it in one-pound pigs. One pound of linotype metal will sweeten six pounds of wheel weight metal to produce a highly satisfactory casting alloy. Lacking lino alloy, purchase a few pounds of 50/50 (lead/tin) solder and use that to sweeten the alloy.

The problem with a straight mix of lead and antimony is that the melting point of antimony is higher than that of lead and the antimony crystallizes, all by itself. The lead solidifies in the crevices between the antimony and rubs off onto the bore just about as badly as dead-soft lead might. Added tin has a melting point below that of lead and stays with the lead as it solidifies to prevent bore fouling; just that simple.

Once the casting alloy melts, you need to flux it. One of the best materials for that is Marvelux, obtainable from Brownells (Figure 52). You sprinkle a small amount, \( \frac{1}{4} \) teaspoon or so, onto the surface of the alloy and stir it into the mixture. Use an old spoon to stir and skim the impurities that rise to the surface. You should heat the spoon used for fluxing before plunging it into the molten alloy, as Marvelux tends to gather moisture from the air and that, flashing to steam, can cause the alloy to spatter. The same applies to water in any form, a drop of rain, a drop of perspiration falling from your brow—all can turn a pot of molten alloy into a silvery geyser. Wear safety glasses!

**FIGURE 52**—Marvelux, from Brownells, is a highly effective flux for lead-base alloys. It helps remove foreign materials from the alloy and increases its liquidity, resulting in better cast bullets.
Casting Temperatures

Thermometers are available from various sources, such as Brownells, for measuring the temperatures of casting alloy. Use them for occasional checks, as they’re not designed for continuous immersion. Try to stay below the level of 700°F (371°C) because higher temperatures will burn away the scarce and expensive tin. The same applies to casting furnaces with thermostatic heat controls.

Swaging Bullets

Swaging, pronounced SWAY-jing, refers to the cold forming of metal under high pressure. The principal supplier still active in the field of equipment for swaging bullets is Corbin Manufacturing & Supply, 600 Industrial Circle, White City, OR 97503. If you send Corbin an inquiry, noting you’re studying to be a gunsmith, you’ll receive details on the products Corbin offers.

Corbin’s products include swaging presses—both manual and hydraulic—swaging die sets, lead wire, jackets, and dies for producing washers from sheet copper. They also have dies to attach the washers to the bases of swaged, but otherwise unjacketed, lead bullets. Corbin also makes and supplies loading presses, that can both reload and swage. Corbin also sells dies for making your own bullet jackets.

The steps in swaging a jacketed bullet are fairly simple. Start by making the core. One way is to use an adjustable core cutter to cut lengths of lead wire into short pieces. Another approach is to cast your cores in a bullet mould from soft lead. Select a mould of smaller diameter than the bullets you’re swaging and slightly greater in weight than the desired core weight. You put each section of lead wire or cast core through the core-swaging die, which extrudes a short length of lead wire in the course of bringing the core to dead-uniform diameter and weight. Save the bits of lead wire for reasons that we’ll discuss shortly.

You install a core-seating die, adjust it in the press, and use it for seating the core firmly into the jacket. If you’re adamant about producing JHP bullets, you’ll form the nose cavity during this step.

To complete the process, install and adjust the nose-forming die, and run the seated cores through it. The press and die sets come with detailed instructions.

There are also other interesting possibilities. You can make cast bullets from fairly soft alloy, lubricated and sized, and put them through a swaging press to modify configuration of the nose portion. The lubricant is incompressible, has no place to go, and thus remains in place to prevent bore fouling. A slightly whimsical term for these bullets is swast bullets, for sw(aged) after being (c)ast. The obvious advantage of the swast approach is that it avoids the substantial cost of the jackets (Figure 53).
Ballistics

The bullet’s progress from the instant of primer ignition to its exit out of the muzzle is interior ballistics. Its passage through the air, en route to the target is exterior ballistics. Its performance upon reaching the target is terminal ballistics.

Mass in motion carries kinetic energy, and if you know the velocity in feet per second (fps) and the weight in grains, you can calculate the foot-pounds of energy (fpe) a bullet carries.

The equation is velocity squared, divided by 7000, divided by 64.32, times weight in grains, equals foot-pounds of energy. (64.32 is twice the usual accepted rate of falling objects.) The obvious shortcut is to multiply the 7000 (grains in one pound) by the 64.32 (acceleration of gravity on this particular planet) to obtain 450,240. Then, divide by 450,240, rather than dividing by each separately. Either approach yields the same answer, but dividing by only one number conserves a bit of expended effort (therbligs, remember?).

In algebraic format, the equation is as follows.

\[
\frac{V^2}{450,240} \times G = fpe
\]

or

\[
V \times V \div 450,240 \times G = fpe
\]

For example, a 150 grain bullet at a velocity of 2700 fps carries 2428.7 fpe. A 230 grain bullet at 870 fps has 386.65 fpe, and so on. It’s common practice to round to the nearest whole number, so we would write 2429 for 2428.7 and 387 for 386.65. We quote the ballistics of a given load as fps/fpe, or 2700/2429 and 870/387.
The equation provides a useful correlation between bullet velocity and weight, but some feel it puts undue emphasis upon velocity. For example, the actual effect of 400 foot-pounds isn’t the same as that of a one pound weight that has fallen 400 feet, or of a 400 pound weight that has fallen one foot.

Some competitive shooting sports utilize another standard, termed the major power factor (mpf), which we obtain by multiplying velocity by weight and dividing the product by 1000. Thus, a 200 grain bullet at 890 fps would carry an mpf of 178 \((890 \times 200 \div 1000)\). Typically, rules for such sports decree a minimum of 175 mfp.

Once a bullet leaves the muzzle, gravity draws it downward and the bullet gets deflected sideways by any wind at an angle to its line of flight. At the same time, velocity is lost because of atmospheric resistance. The net effect is a departure from the original point of aim, varying with the distance and conditions in effect at the given time.

**Ballistic Coefficient**

The weight, diameter, and profile of a bullet have an effect upon its ability to retain velocity during its passage to the target. The math concept that takes this into account is the **ballistic coefficient**, or BC. Typically, we quote the BC as a three-place decimal, and a BC of .337 indicates a greater degree of streamlining than one of .193, for example.

The major bullet makers work out and publish BC figures for their various bullets. Usually, they specify only one figure. Sierra Bullets, however, provides more than one BC for each, based upon spreads in velocity.

Given the pertinent data as to velocity, weight, BC, height of sights above bore, and angle of departure above or below horizontal, it’s possible to calculate a respectably accurate prediction of a bullet’s path, or trajectory.

If you have access to a personal computer, there are several software programs available for determining the details of exterior ballistics. Some programs have the capability of working out interior ballistics as well.

**Load Data and Information Sources**

We regard a source of reliable loading data as a mandatory essential. Accurate Arms, Alliant, Hodgdon, IMR, and Winchester have booklets of load data for their respective powders available at no cost. Austin (formerly Scot) charges $2 for the booklet of data for using their powders (Figure 54).
In addition, there are books that provide much more information and cover a broader assortment of powders, at a somewhat higher cost per copy. Some are called handbooks, others manuals; there’s no discernible difference. We’ll review a few examples as follows.

**Lyman Reloading Handbook** puts considerable emphasis upon load data for use with cast bullets but also covers jacketed bullets.

**RCBS Cast Bullet Handbook** lists load data for use with bullets cast from RCBS moulds in the cartridges for which they’re appropriate.

**Speer Manual No. 11** has 621 pages, covering data on rifle cartridges, handgun cartridges, and nominal rifle cartridges used in handguns, such as the .30-30 and .30 M-1 Carbine, as well as nominal handgun cartridges in rifle-length barrels.

**Hornady Handbook**, third edition, was published in 1980. It contains 665 pages of load data for rifles and handguns, as well as a great deal of pertinent information on reloading. The fourth edition is in two volumes. The first contains the load data for both rifle and handgun ammunition. The second carries the charts and tables of ballistic data for the various Hornady bullets (Figure 55).
Sierra Manual, currently in its third edition, comes in two volumes, one for rifle ammunition and the other for handgun cartridges. Each volume provides charts and tables of downrange data for the Sierra bullets.

Nosler Reloading Manual, third edition, has 516 pages of load data for use with Nosler bullets in rifles and handguns, together with other information on reloading.

Hodgdon Data Manual No. 25 has 544 pages of load data for rifle and handgun cartridges, and you should consider it essential if you use Hodgdon powders. It not only lists data for the Hodgdon powders, but has sections of data on other powders as well. Most sources, in covering powders such as 4895, 4350, or 4831, list the IMR versions that are similar, but not identical, to those from Hodgdon (Figure 56).

FIGURE 56—Loading manuals by Speer, Hodgdon, and Nosler give specific recommendations as to charge weights with various powders, bullet weights, and cartridges.

Wildcat Cartridges

By accepted definition, a wildcat cartridge is one that isn’t available through the usual commercial channels. Usually, wildcat cartridges are produced by modifying the cases of standard factory loads, and sometimes a wildcat proves so popular that a major ammunition maker adds it to its line of factory loads.

Initially, the .22-250 Varminter was created by reducing the neck diameter of the .250 Savage case from .257 inch to accept bullets of .224 inch diameter. In much the same manner, the .30-06 case was “necked down” to use .257 inch bullets, thus becoming the .25-06. When the .30-06 neck was opened to take .358 inch bullets, it became the .35 Whelen. Remington adopted the .22-250 and the .25-06 in 1969 and the .35 Whelen in more recent times.

A staggering number of wildcats remain “unbranded.” Nearly every standard cartridge case has been necked up, necked down, or blown to an improved shape by firing a factory load in a modified chamber. Improvements consist of sidewalls more nearly parallel or shoulders that have been moved forward or given a sharper angle for the sake of holding more powder.

Occasionally, the sales of factory cartridges sag to the point where ammunition makers drop them from their catalogs, causing them to revert to wildcat status. An example is the .219 Zipper. It’s possible to produce .219 Zipper cases from .30-30 cases by forming dies available from the RCBS Custom Shop. Owners of guns chambered for the .219 Zipper have no recourse except to produce their own cases and reloads.
Shotloads for Handguns

Speer produces empty plastic shot capsules in both .38 and .44 sizes. The reloader can fill such sizes with shot pellets of the desired size to load them into cases such as the .38 or .44 Special, .357 or .44 Magnum, and other cases taking the same bullet diameter (Figure 57).

You’ll find load data with suggested charges of suitable powders printed on the cartons of the capsules. You’ll find additional data listed on page 461 of the Speer Manual No. 12.

When we discussed production of swaged bullets, we recommended saving the short pieces of lead wire extruded when swaging the cores. You can fill the Speer shot capsules with the bits of lead wire to produce an uncommonly effective load for use on venomous snakes or similar targets.

Unsuspected Hazards

You should never load cartridges loaded with bullets having pointed tips into tubular magazines. The force of recoil can cause the tip of a bullet to set off the primer of the cartridge ahead of it. Such a reaction could produce a chain explosion of all but the rearmost of the rounds in the magazine.

Warning: A cartridge case insufficiently resized can become stuck quite tightly in the chamber of a gun. There’s a natural tendency to use a piece of rod and a hammer to drive the cartridge back out. That’s not a good idea because you would force the bullet from the case neck down against the top of the powder charge. It’s possible for powders, particularly double-base powders, to ignite from sharp impact. Such forcing can and has caused severe injuries and deaths.
Instead of forcing the cartridge out, try the following preferred procedure. Use a pipe clamp to exert pressure against a piece of cold-rolled steel rod of suitable diameter. Put one padded jaw against some portion of the gun breech and the other jaw against the end of the rod projecting from the muzzle. After you’ve pushed back the bullet from the case neck, pour a penetrating lubricant, such as Break Free, down the bore from the muzzle, with the barrel muzzle-up. That serves two useful purposes: It reduces the force needed to extract the stuck case, and it tends to make the powder less apt to ignite.

Zero In! 4

Indicate whether the following statements are True or False.

_____ 1. An unsuitable source for bullet casting alloy is plates from discarded auto batteries.

_____ 2. One of the best materials for fluxing melted casting alloy is Marvelux.

_____ 3. The equation for foot pound of energy provides a useful correlation between bullet velocity and weight.

_____ 4. The bullet’s progress from the instant of primer ignition to its exit from the muzzle is barrel ballistics.

_____ 5. Rifle bullets may have a tapered portion at the base, called a boat tail.

_____ 6. Gilding metal, used to jacket bullets, is an alloy of copper and lead.

_____ 7. Several suppliers offer unjacketed lead handgun bullets in bulk packs, usually 5000, for substantial savings over the usual pack of 100.

_____ 8. When melting casting alloy, try to stay below 700°F or 371°C, as higher temperatures will burn away scarce and expensive tin.

_____ 9. An ideal source for bullet casting alloy is linotype metal.

_____ 10. Swaging refers to the hot-forming of metal under low pressure.

Check your answers with those on page 97.
Shotshell reloading can be an extremely interesting and gratifying experience. By purchasing components in bulk at wholesale prices, it’s possible to make excellent, top-performance reloads at less than half the cost of factory shotshells. Almost all of the reloading manuals have chapters that show how much money you can save by reloading your shotshells. By purchasing shot in large quantities, you can often purchase it at less than half of the retail cost. Shot is by far the most expensive item in the cost of reloading a shotshell, assuming that you already have the hulls.

You can also realize considerable cost reductions by purchasing primers in carton lots and powders in large kegs. For obvious reasons, the best time to buy shot and other components is just after the close of hunting season.

Many shooters who belong to shooting clubs pool their resources to buy enough reloading components to meet the needs of the reloading members for a year or longer. This allows even more significant savings in the cost of their shooting sport. For those who shoot trap or skeet, reloading is absolutely essential unless the shooter has unlimited finances.

For many, the real satisfaction and greatest value of shotshell reloading comes from experimenting with different loadings. Through experimentation, you find the most effective combination of shot, powder, hull, and wad for the particular gun and game.

Flexibility of Shotshell Reloading

More than in any other reloading situation, you can develop shotshells to meet the specific traits of a particular shotgun and the exact shooting situation in which you’ll use the loads. It’s easy to make almost any modern repeating shotgun or double gun in good condition perform as the perfect gun for such diverse applications as the following.

- Long-range turkey hunting
- Pass shooting on doves
- Crow shooting, squirrel podgin’, woodcock hunting
- Upland grouse shooting
- Quail hunting with dogs and jump shooting without a dog
- Ringneck pheasant hunting
- Rabbit hunting with and without dogs
- Predator calling of fox, coyote, and bobcats
- Deer hunting with both slug and buckshot loads
- Ground shote (woodchuck) control in populated areas where it’s unsafe to use rifles

Until recently, we would have included duck and goose shooting in this list. However, the steel shot laws make it necessary that the shooter accept the very limited flexibility and capability of steel shot loads. The above sounds like a tall order to fill, but by the time you’ve finished this section, you’ll be a believer.

**Damascus Barrels**

The first shotshells were brass and used primers similar to rifle and pistol primers. Occasionally, we still find this type of shotshell reloaded by persons interested in making special reloads for shotguns having Damascus (wire twist) barrels. In this way, they can avoid getting the shells for Damascus barrels mixed up with modern smokeless loads, which may damage a Damascus barrel. This is a specialty reloading situation that only those who have studied blackpowder loading should do. Blackpowder loading is outside the parameters of this chapter.

You should be aware that shooters often ask gunsmiths and others who reload to reload some blackpowder shells. Then, the present owner of grandfather’s old Damascus double can put the much revered relic into service for at least a few rounds. We must give you a cautionary note here. Damascus barrels often have hidden defects that render them unsafe even with blackpowder loads.

Actually, many Damascus barrels have hidden voids that render them totally unsafe for any loads. Damascus barrels are made of many strands of steel wire, forged by blacksmithing methods into a tube. The tube was formed around a mandrel and then bored out to proper bore diameter. The problem occurs when tiny cracks in the welds between the wires collect water and sulfuric acid, which is one of the burn byproducts of blackpowder. The action of these materials corrodes and eats away deep within the barrel, leaving sizable voids and cracks in it. These defects are not evident upon visual examination. The only safe way to find them is by using Magnaflux, Magnaglow, or X-Ray examination procedures.

If you’re contemplating reloading shotshells for use in Damascus barrels, you should insist upon at least a Magnaflux exam of the gun you’ll use the shells in—before you agree to reload the shells. You can have this exam done at any good crankshaft shop for a few dollars. It
would be better to use an X-ray exam. However, the Magnaflux exam, while more suitable for use on homogeneous steels, will show any sizable voids or cracks in the barrel. It will also indicate whether the barrel is at least reasonably safe to fire. This assumes, of course, that the operator knows how to read the magnetic particle patterns properly.

An examination will also indicate to a court that the reloader exercised reasonable caution to protect his or her customer. Many recognize Damascus guns as having a high likelihood of being dangerous. If you reload for one of these guns without having a safety examination done, and the gun barrel bursts with your reload, you may be liable for not having exercised due care and caution. If you insist on this examination, the gun’s owner can make the decision as to whether the gun is safe to fire, based on scientific testing procedures.

Warning: Unless the Damascus barrel passes safety testing by an ordnance laboratory, no one should fire it with any type of load. If the barrel has unseen internal flaws, the shooter risks fatal injuries.

**History of Shotshells**

For many years the commonly available shotshell, as loaded by the various ammunition manufacturers, was a short brass head and rim into which the manufacturer inserted a waxed cardboard tube. They made the tube by wrapping many layers of waxed paper around a mandrel and then cutting the resulting tubes to proper length. There were many variations on this design, depending on the manufacturer (Figures 58 and 59).
Current manufacturers are making many shotshells of extruded plastic tubes inserted in a brass shell head with a cardboard base wad that holds the plastic in place. The better grades of modern shotgun hulls are made of one-piece plastic in which the inside base is formed by compressing the plastic into the desired internal and external conformation. Some brass/paper hulls are still made for use in trap and still target shooting where cost is a major consideration and there’s no interest in reloading the fired shells. We can still reload paper hulls, just as they were for many years, but most reloaders prefer the greater durability of plastic hulls.

It’s of prime importance to remember that there’s less gas blowby in plastic hulls than in paper hulls. The less blowby is due to the smoother, less porous surface of plastic shotshells, which allows for a better gas seal. Therefore, if you intend to use loads listed for paper hulls in reloading plastic hulls, you should reduce the loads a few grains of powder to avoid excess pressure. The best way to avoid this problem is to use only those load listings intended for plastic hulls. In modern reloading manuals, you’ll normally find those loads intended specifically for paper hulls labeled paper hull loads, as the majority of load listings in modern manuals are for plastic hulls (Figures 60, 61, and 62).

**FIGURE 60**—Until a few years back, shotshells contained as many as 14 components, including a variety of wads (numbers 4, 2 and 3, and 14).

**FIGURE 61**—Early “age of plastic” shells had a shot cup, a paper or plastic case, and filler or base wads.

**FIGURE 62**—Modern compression-formed cases are one-piece plastic and employ a combination shot cup, wad, and crimp that eliminates all base, filler, and top wads. These are best for reloading.
Caution: If you are using an older manual from the 1960–1970 era, a great number of the load listings will be for paper hulls, and not necessarily labeled as such. The more recent the manual, the more likely you’ll find any paper hull listings as such.

From their inception in the latter part of the eighteenth century until after World War II, shooters loaded shotshells using an overpowder Nitro Card hard cardboard wad over the powder. On top of this they placed enough fiber/felt wads to bring the internal length of the wad column out to the length needed for crimping when they added the shot. They then placed an overshot wad on top of the shot. Shooters used the roll-crimp (Figure 63) for many years until the presently used star-crimp came into general use. For a short time there was a frangible wad used with the roll-crimp. Frangible wads, which fragment upon firing, came into general use about 1947 and the star-crimp without any overshot wad shortly replaced the frangible wads. The frangible wad was developed to avoid the disruption of the shot pattern caused by the overshot wad. The present star-crimp uses no overshot wad and avoids this problem, which plagued shotshell shooters for many years. The star-crimp is also a little more forgiving if the wad and shot column length is a bit more or less than optimum.

FIGURE 63—The old-style roll-crimp cases (b and d) were longer, with comparable charges, than modern pie-crimped cases (a and c). Overall length of the opened cases after firing was the same.

With the advent of the one-piece plastic shot cup wads, the whole shotshell reloading picture changed. Reloaders no longer need to keep a large inventory of various wads and components on hand to meet the needs of various reloading situations. With a few specialty load exceptions, they need to keep only a supply of primers, a can of Alliant Unique powder, a bag of Lage Uniwads, and Pacific Versalite cup wads, or other collapsible-base, self-adjusting wads for each gauge to be reloaded. Add to this a Lee Shotshell Handloader for each gauge and a person can enter the shotshell reloading business for a reasonable price for each gauge.
Shotshell Reloading Machines

Today, manufacturers offer many shotshell reloading machines to the reloader. As a prospective reloader, this is to your advantage, as it gives you a large group from which to make your choice. The quantity of shells you plan to reload should determine the reloading press you buy. As stated earlier, a simple Lee Handloader will do nicely if you plan to load shells only for your own hunting needs. This simple tool allows you to design a load to meet your specific needs as well as any other reloading press. Or maybe you plan to offer custom reloading services as a part of the services of a gun shop or gunsmithing business, or to engage in custom reloading as a full-time business. You can spend over $1,000 on the really advanced machines that operate on hydraulic rams and have rotating roll crimpers as built-in parts. These are excellent machines, but you’re going to have to do a lot of reloading work to justify the expense.

It’s probably better to purchase a tool without enough capacity than to spend a lot of money on a tool that requires reloading many thousands of shells to pay for itself. You’ll simply be working to pay for the tool instead of making money from your reloading business. You can reload a lot of shotshells on a single-stage press (Figure 64).

**FIGURE 64**—This photo shows the “91” shotshell loader from Hornady Manufacturing Co.
We'll now discuss different types of reloading machines. You decide which would be best for your needs.

Cast iron is by far the best basic material for the frame of a reloading press, and other cast metals and even molded high-tensile plastics are acceptable as shotshell reloading press materials.

One heavy-duty, high-production press is the Pacific DL366 progressive reloader with a heavy cast-iron base and steel shafts and columns. This is definitely a no-nonsense, high-production machine that turns out a perfect reload every time, if used correctly.

Next in production capacity is a Lee Load Fast press (Figure 65). It’s a solidly built progressive reloader and undoubtedly one of the best buys on the market. Unless you plan to reload thousands of shells a week, it will fully meet the needs of even the most active trap or skeet shooter in addition to loading all of your hunting loads. It loads most empty hulls without a problem, except for the Activ shotshell hulls. The Activ hulls don’t have brass heads. Since the Lee press mounts the hulls on brass heads, it doesn’t handle the active hulls well. This is a shame because Activ has one of the nicest and most complete lines of wads, hulls, and components available at very competitive prices. The Lee Load Fast press is also available with an automatic primer feed at a slight extra cost. It turns out factory grade, nicely crimped reloads fully equal to the same shells reloaded on a much more expensive press.

FIGURE 65—Here’s a “Load Fast” shotshell press made by Lee Precision.
Next in reloading capacity is the Herters model 72 (Figure 66). With the Herters model 72, you can adjust to an infinite number of shot and powder charges by adding or deleting small metal washers from the charge chambers. This allows perfect crimping because you can add or subtract a small amount of shot to allow for a perfect crimp length. It’s necessary to consult loading tables to ensure that you don’t push pressures to unacceptable heights when adding shot weight. Also, the addition of another washer’s worth of shot may require the deletion of a few grains of powder for safety reasons. This requires that you use a powder scale. However, anyone doing any type of reloading should have a powder scale to check the weights of both powder and shot being thrown when setting the charge bar up with new bushings or using adjustable charge bars.

FIGURE 66—The Herters Model 72 is no longer on the market, but it may be possible to obtain a used one at a gun show.

The Herters is a single-stage press that’s easy to operate. It seems to lend itself to establishing a natural loading routine and nicely sizes the hulls as easily as the presses that don’t resize. Unfortunately, Herters has gone out of business, and these presses are no longer available. However, there are many thousands of them scattered all over the country. Chances of picking up a used one are good.
Next in capacity is the Lee Load All II (Figure 67). You can purchase this press, available in 12, 16, and 20 gauge, from discount stores and catalogs, complete with a set of shot and powder bushings that will meet all your needs. An automatic primer feed will cost extra but is an excellent investment in time savings. It doesn’t take long to change bushings to whatever load you desire, but it’s nice to keep them set up and ready to go. You can mount them on heavy wooden bases drilled to fit bolt holes in the bench. This way, you can easily remove them.

The Load All II will easily reload all the shotshells even an active trap-shooting family will need. It turns out a nicely tapered and crimped reload that will feed easily through almost any magazine shotgun action. This is something that one can’t say of some more costly presses, which leave a ridge too sharp around the outside of the crimp and catch on the edge of the chamber in some repeating shotguns. Some persons have said they don’t like the “springy” feel of the Load All, and, admittedly, there’s a certain amount of give in the handle. However, it might give you a feel from which you can tell just where the wad is in the hull.

There’s also a “Load All Jr.,” which is a simple, single-station press. It’s very useful for making up a few loads to test the performance of a new shotshell load to see if it’s worthwhile setting up powder and shot bushings in one of the other presses. This is just a step up from
the original Lee Handloader but, unfortunately, is also no longer made. Reloaders seem to prefer spending a few dollars more for the Load All.

If you’re a beginner, you shouldn’t buy an expensive shotshell reloading press until you find out what your requirements are going to be after having done considerable reloading. Then, you should try various presses before buying an expensive progressive reloader. Unless you’re going to reload large quantities of shotshells, it’s difficult to justify the considerable additional cost of a really good progressive or automatic press.

One thing to watch is that many of the progressives will spill shot all over the place if they get out of cycle. Make sure the press you buy has positive shot and powder cutoffs so it won’t dispense shot or powder unless there’s a shell in place to receive the charge. Some presses require that the hulls be inserted into a sleeve for the reloading process, and then the sleeve gets knocked off at the last stage. This does help keep the hulls from expanding during reloading. However, this is another part to handle while handling the hulls, the biggest job in reloading. In selecting a shotshell reloader, check out a lot of the available presses and remember that a higher price doesn’t necessarily guarantee a better finished reload.

If you’re going to do high-volume reloading, two popular, progressive presses are the Dillon RL 550B and the Dillon RL 1050 reloading machines (Figures 68 and 69).

The RL 550B will load over 120 different rifle and pistol calibers. It has a quick-change tool head that allows the user to change calibers without having to readjust dies. The production rate for the RL 550B is 500 reloads per hour.

The RL 1050 is a reloading machine that will align the cases and feed them into the shellplate. It sizes and swages the crimp out of military primer pockets. It also expands, primes, and charges the case with powder. Then it checks the charge, seats the bullet, crimps the case and ejects the loaded rounds. Its production rate is 1000 per hour.
Charge Bars and Bushings

Nearly all shotshell presses, regardless of design, incorporate a charge bar (Figure 70), which drops specified amounts of powder and shot. Some presses don’t use charge bars, but mount the bushings immediately under the hoppers; they’re tripped in a preset sequence.

Charge bars, such as those used by Lee, MEC, Pacific, Redding, and Bair, hold two interchangeable bushings: one for powder and the other for shot. When the bushings move back and forth, the powder or shot drops down a common drop tube and into the case (Figure 71).
As Figure 72 shows, a given powder bushing throws different amounts of different powders. For example, P-W bushing size H will throw 17.9 grains of the rather bulky Dupont 700X powder, and a charge of 37 grains of the dense Hodgdon HS-5 powder. The reason is that a given bushing holds a given volume of powder, and dense powder has less volume and more weight than light, bulky powder.
Suppose you carefully checked recommended powder charges for the various medium and heavy loads, and compared those charges with the throws of a given bushing for the various powders. You would find that one bushing will often serve for both heavy and medium loads, and in a few cases serve for two powders in the same general load area.

FIGURE 72—Data sheet from the Ponsness-Warren catalog, showing how one powder bushing throws different amounts (weights) of different powders.
For example, find bushing L on the chart in Figure 72. You’ll note that this size bushing will drop 19 grains of Alliant Red Dot or Green Dot powder, which is often used with medium, 1 1/8 ounce loads. Reading across to the right, you see that bushing L also drops 31 grains of the denser AL-5 powder, which is commonly recommended for high-power, 1 1/4 ounce field loads.

Shot bushings involve no “match-up” calculations. All lead shot is considered to weigh the same per unit of volume. We make this consideration even though it’s known that the shot charge thrown by a given bushing will vary slightly when different shot sizes are used. For example, No. 9 shot in a given bushing will weigh slightly more than No. 4 shot in the same bushing. We don’t consider the difference in weight, since it’s not enough to increase pressures nor present any hazard.

Thus, the bushing selected for 1 1/4 ounce, as an example, is based on an average. You simply select the bushing that drops the required amount of shot for a given load—1 1/4, 1 1/8, etc. You’ll find standard P-W shot bushings listed at the top of Figure 72.

One of the most important safety considerations in shotshell reloading is that the reloader be able to correctly read and understand shot and powder bushing charts. It’s imperative that the proper shot and powder bushings be in place when setting up a charge bar. After setting up a charge bar, weigh several shot and powder charges as thrown by the newly installed bushings before reloading any shells. It’s necessary to drop and dump several powder and shot charges back into their respective reservoirs to allow the machine to “settle out” before weighing the charges. Then check the weight of both shot and powder against the recommended loads you’ve selected to load. There shouldn’t be more than two- or three-grains weight difference in the powder as weighed from the listed loading. You can expect slight variations due to changes of moisture content of the powder. Powder bushings will give slightly different weights of powder from different lots of the same powder, since they work by measuring the volume of powder rather than the actual weight.

**Adjustable Powder Bars**

The invention of the adjustable powder bar eliminated the need for separate loading bars, each with a hole for a given powder charge and another for the specified shot charge (Figure 73). Prior to the development of bushings, which have only come out recently, a single bar was used for each charge at about four times the cost.

**FIGURE 73**—Adjustable powder bars, like the Lyman unit shown, eliminate the need for interchangeable powder bushings.
There are three sizes of powder bars, with only the powder charge changed by screwing in a bolt held at the desired position by a lock nut. It had several advantages, since you could use any powder in a wide range of charges. A scale was near-mandatory, of course, to establish the desired weight. The shot charge holes were drilled to match the powder range (light, medium, or heavy), more or less. They were expensive, but served well, until the simple expedient of using bushings for powder replaced the single nonadjustable bar. Most shotshell loaders stick with the bushings, as they’re convenient and inexpensive. Just recently, a new bar was developed that has a micrometer adjustment for both powder and shot.

Another discovery many reloaders have made is that, in a cold room, powder seldom drops uniformly. We’re all for conserving energy, but if your powder charges are uneven, your shooting will be too—and you’ll be wasting energy (gunpowder). Do your loading in a room that’s comfortably warm—68°F to 70°F.

**Shotshell Components**

**Primers**

While there are many shotshell primers available today, the assortment is relatively simple compared to the great array of sizes and energy formerly available (Figure 74). Although you may encounter an occasional Remington size .223 in. diameter primed hull in reloading old shells, shotshells of current manufacture are all primed with the Winchester size .243 in. diameter primers.

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**FIGURE 74**—This drawing shows a cutaway view of a shotshell primer. (Courtesy of CCI)
Primers fall into two basic groups, *Mild* and *Hot*. Most reloading manuals recommend that you only use the primer listed for that loading with a given powder, hull, shot, and wad combination. This is good advice, and a sure way to avoid pressure troubles. Pressures from Hot primer loads are generally within a pretty close range regardless of manufacturer, and the same is true of mild primer loads. We don’t recommend that anyone interchange primers of different brands. Some shooters never find any need for Hot primers, even with the large ball powders, which are supposedly hard to ignite. You may find that shotshell loads primed with Mild primers such as the CCI 209 will give better patterns with closer and more even shot dispersion than the same loads using Hot primers. This is most likely the result of less violent ignition, which doesn’t deform the shot as much before it starts moving down the barrel.

In the event that you do ever encounter ignition problems, you might use magnum Hot primers if you could find such a loading in a reloading handbook. If you couldn’t find such a loading, you could run pressure barrel tests with the primer and powder charge you wish to use. If pressures were too high, you could drop that loading in favor of something similar using an easily ignited powder. We realize that not many people have access to pressure barrels, so the logical thing to do is find a more easily ignited load. Pressure tests show lower pressures generated by Mild primers, with almost the same velocity as loads using the more violent primers, and, as stated earlier, patterns are better. *Never, under any circumstances, replace a mild primer with a hot one.* Some consider the CCI 209, Winchester 209, and Remington 209P Mild primers, and all others as Hot or Medium (somewhere between Hot and Mild).

**Shotshell Powders**

Several types of shotshell powders are available. Years ago, there were very few suitable shotshell powders, and it wasn’t difficult to pick the proper powder to make up the sort of loads needed. You can experiment to find which particular load combinations will best suit your purposes.

Some shotshell powders presently available are Bulls-eye, Unique, X58, Herco, Red Dot, Green Dot, Blue Dot, HS6, HS7, 540, 571, 452, 473, 296, H110, Trap 100, 800X, PB, SR4759, SR4756, SR7625, IMR4227, AL-7, Hi-Skor, Solo 1000, and Royal Scot powders. There are a number of noncanister powders in the powder magazine. Simply too many shotshell powders are available to keep up with! Fortunately, it’s not really necessary to do so. Many “old-friend” powders do the job quite nicely. If one of the new ones shows up to be a real go-getter, the word will spread quickly. You can then obtain it and try it for your own purposes.
If you’re a newcomer to shotshell reloading, you should get copies of the reloading tables furnished by powder manufacturers from your local dealers, or, if necessary, directly from the maker or supplier. Read the recommended loads to see which powder best suits the types of loads you’re going to need. A can of Unique would be suitable for most of your field and trap loads, and a can of Blue dot for the high-velocity loads. You might also need a can of WW571 for a full range of reloads. Load a few of whatever loads you need and try them. As you become more experienced, you can try different powders to see if any of them meet your needs better than these.

Don’t buy a large selection of various powders until you have determined which powders you really need. The three powders mentioned previously should meet any shooting need very well.

**Shot**

There are great variations in shot from different manufacturers—variations in size, uniformity, roundness, hardness, and overall quality (Figure 75). There seems to be a lot of variation in quality from one manufacturer’s lot to another. You might look at two different bags of shot of the same brand and size and be astonished at the difference in the two bags. It would seem that different manufacturing facilities made the shot by different processes. This may be the case, in certain brands. The quality of shot from certain brand names has deteriorated, but generally quality seems to be improving. Despite the general improvement in shot quality, shot sold under the Winchester/Western brand name is probably the best. This certainly applies to the copper-plated “Lubaloy” shot bearing this name.

![Figure 75—Various Shot Sizes](image)

Copper-plated shot will indeed pattern better than unplated shot, all other things being equal. Activ has a very hard shot that gives excellent performance. It’s hard enough that very little deformation occurs upon firing, and this results in significant pattern improvement (Figure 76).
Some brands will have shot of a diameter that should be #4, but it comes packed in a bag marked #2. Other times, you’ll find several different sizes of shot packed in the same bag. This certainly makes it necessary to count the shot in any loads with which you’re trying to establish a pattern percentage.

In some brands, roundness is a great problem. This is especially true of shot made on a shot wheel. Round shot will definitely pattern better. Experiments have shown that teardrop-shaped shot has better retained velocity at longer ranges, but scatters widely before it aligns into the flight pattern.

You should try to get the hardest, roundest shot you can find.

**Shotshell Wads**

As mentioned earlier, the advent of the plastic shot cup-type wad has greatly simplified the selection of suitable wads for a given load. You must consult a reloading handbook for information as to just what wad, shot, and powder combination will work in the hull you wish to reload. First, go through the manual and find loads for the shot weight you wish to load. Next, decide how much velocity you really need,
bearing in mind that pattern density and uniformity decrease as the velocity goes up. Then, see which wads are listed for this loading. You may not have the exact wads called for, and if you do have them, you may find they don’t crimp properly in your particular reloading press due to variations in wad column length.

The best answer to the wad column-length problem with loads that don’t quite fit is the Lage Uniwad made by Eldora Plastics Inc., Box 127, Eldora, Iowa, 50627. These wads will serve where no other wad will do, although the Pacific Versalite is indeed versatile and a notably good wad.

You can take a batch of mixed shotshell hulls of many different brands and base heights. As long as they’re all 12 gauge and in good condition, you can load them with almost any desired shot and powder charge.

The Lage Uniwad doesn’t require any adjustment of the load, as it accommodates itself to whatever space is left for a wad column. This greatly simplifies the reloading process. The only problem you might ever encounter with these wads is with powders such as Red Dot, which is sensitive to wad pressure. Sometimes this will result in a “blooper,” or load that doesn’t fire properly due to the initial firing shock blowing away powder from the primer. The obvious answer here is to use a powder such as Unique or 700X, which isn’t wad pressure-sensitive, for loading with the Uniwads. The same applies to the Versalite or any other such adjustable wads. In the event a round doesn’t sound right, and you suspect it may have been a blooper, make sure the barrel is clear before firing another round.

Another way to adjust wad column length with shot cup wads of larger-than-needed capacity is to use 20 gauge felt wads under the shot inside the shot cup. You can add $\frac{1}{8}$ inch or more wadding to reach the length that will crimp out properly. Some reloading tools are much more sensitive to wad column length than others. One very popular reloading tool is so sensitive to wad column length that it requires an almost exact wad length to get a good crimp. On the other hand, the Lee Load All will accommodate as much as $\frac{1}{8}$ inch discrepancy and still give a durable crimp. The Pacific DL366 will accommodate somewhat less variance, but still does pretty well at crimping loads that are less than perfect in wad column length. The Herters Model 72 must have an almost exact wad column length. A wad column too long will result in a crushed hull and a column too short will come out with a hole in the center from which shot will leak.

The adjustable wads make it easy to get perfect shotshell reloads almost every time. Custom wads allow you to get just the performance you want by slitting an unslit shot cup to whatever length you desire. This holds the shot together for a distance downrange to make a tighter shooting load. Ballistic Products, Inc., P. O. Box 408, Long Lake, MN, 55356-0420, offers a complete line of specialty wads that allow you to develop custom long-range turkey or goose loading. These products do work well. Ballistic Products Inc. also offers a buffering compound
of finely ground plastic that helps to prevent shot deformation in long-range loads.

This buffering powder is a great help in building long-range loads with large diameter shot. There’s not much benefit from using shot buffering in loads with shot smaller than #4. When using shot larger than this, the buffering does help stop the deformation of shot. The benefit gained from the buffering is directly proportional to the hardness of the shot used in the load. Loads using shot such as the Activ high-antimony hard shot won’t benefit nearly as much, if at all, from buffering, while ordinary soft shot will benefit greatly from buffering. Some suppliers offer buffered steel shot loadings. This seems to be nothing more than an attempt to cash in on the word buffered, as the steel shot isn’t in need of protection from deformity.

You should add enough buffering powder to come about three fourths of the way up the shot charge. There’s no pattern improvement when the shot charge completely fills the spaces between the shot, compared to when it’s filled to about three fourths of the charge. You should use as little buffering as possible, as the buffering adds weight to the shot charge.

You must then reduce the shot charge to allow for the weight of the buffering compound. You first weigh the charge with enough buffering to do the job. Then, count the number of shot pellets required to bring the charge weight down to the nominal charge weight by removing the shot one at a time with the load on the scale pan. For example, using #2 shot in one of the loads, this method shows that you must remove eight pellets of shot from the charge to compensate for the weight of the buffering compound.

One method of loading buffered shot charges is to catch the shot in a small container and remove the desired amount of shot from the load. Then, using one of Lee’s powder dippers, dip half the buffering compound and pour it in the shot cup, which has been loaded into the shell. Next, pour in the shot charge and add the second half of the buffering compound. Before crimping, tap the side of the loaded hull several times with the dipper you have in your hand. This settles the buffer down into the shot charge and the shot down into the buffer that you poured in first. Finally, crimp the finished load.

You can do the following if you wish to avoid the tedium of removing shot from the load. Take a shot bushing of smaller diameter bore than that of the load you’re removing shot from, and bore it in a lathe to give the proper weight of shot. One shooter developed a 1 ½ ounce, 1425-FPS buffered load to use frequently for shooting foxes, coyotes, or woodchucks in closely settled areas where rifles are unsafe. The shooter loads enough of this recipe to make it worthwhile to go to the trouble of making up a special shot bushing. For top performance, it’s very important to properly distribute the buffer throughout the shot.
You must be careful when reducing the shot charge to compensate for the weight of the buffer compound. The loads in which it’s necessary to use shot buffering are usually right at the maximum pressure, since you’re trying to get maximum performance for long-range shooting. When you’re loading at maximum pressures, any slight increase in shot charge weight may push the pressure over the safety line. Even if you’re very careful with these super-hot loads, someone may fire them in an old gun in poor condition and not originally intended for such heavy loads, possibly injuring him/herself. If you plan to make up such loads, use a waterproof Magic Marker to write a word of caution, such as Danger, on the shell. This way, it’s impossible for anyone to fire them without being warned that the loads are not ordinary.

The Reloading Procedure

The first step in reloading a shotshell is to carefully inspect the fired shell for dirt or foreign matter inside, and remove any such matter. Look for defects such as splits in the walls, separation of sides from the base, small pinholes around the area where the brass base stops, enlarged or deformed primer holes, and frayed or split crimp sections. The splitting and fraying of the hull’s crimped section are natural results of repeated loadings, and not a particularly dangerous situation. The most likely result from frayed hull mouths is spilling shot, or, with a powder that requires heavy wad pressure, an occasional blooper may result from the lack of a good hard tight crimp. You can load such hulls for target or trap shooting where they don’t have to withstand much handling or abuse until they reach the point where you’ll use them.

Alliant Unique is a good powder to use in such weak crimped loads. If you do get a blooper, be sure to clear the barrel so that no powder or wads remain.

Unless you’re really desperate for reloadable hulls, it’s a good idea not to try reloading those that can’t hold a tight crimp. Simply throw them away, as they’re extra trouble, and you should never carry them in hunting situations. It’s not unsafe to reload hulls with some splits and wear on the crimp section, as compared to the very real danger of reloading shells with split sidewalls, brass separation, or loose base wads.

After you clean and inspect the shotshell hulls you plan to reload, sort them by brand and type. Next, look up each of the various hulls in a good reloading manual or powder manufacturer’s specification sheet. Determine which of the various listed loadings will best meet your needs. Then, which components you have on hand will likely influence your decision. Perhaps you won’t have the needed components, and you’ll need to purchase them. If so, remember the guidelines given earlier on purchasing components.
Let’s assume that you want to load a 12 gauge, 2 ¾ inch, 1 ¾ ounce field load using #6 shot for a rabbit hunting load. Rabbits aren’t particularly difficult to kill, and ranges aren’t extreme, so there’s not much point in using expensive plated or hard shot. You won’t need extreme velocity, so you can use a medium-velocity load with ordinary shot, ordinary wads, and a medium-velocity powder. Suppose you have on hand a quantity of Federal Gold Medal plastic target hulls, and the 1 ¾ ounce shot cup wads you have are Winchester WAA12F114. You also have CCI 209 primers.

Look in The Complete Reloading Manual for the 12 Gauge Shotshell, published in 1990 by Loadbooks USA, c/o Shotgun Sports Magazine, P. O. Box 6810-LB, Auburn, CA 95604. Find the Federal Gold Medal 2 ¾ inch hull for a 1 ¾ ounce medium-velocity load using a powder you have on hand. You find a 1220 FPS load using a CCI 209 primer with 24.0 grains of Alliant Unique, the WAA12F114 wad, and 1 ¾ ounce shot. Since you already have all these components, this seems to be just the load you need.

The next step is to look in the powder and shot bushing tables that came with the shotshell reloader. For this instance, assume you’re reloading with the Lee Load All press. Look at the Alliant Unique line and follow it across to the point where it shows that the #.155 bushing gives a charge of 24.0 grains of Unique powder (Figure 77).

Next, remove the charge bar from the press. Then, insert the 1 ¾ ounce shot bushing and the #.155 powder bushing in the charge bar, and replace it in the loading press. Then, place a sufficient quantity of powder and shot in the proper reservoirs. Don’t allow the powder level to fall below about one-quarter full, as the powder doesn’t settle into the bushing as well when the weight of powder over it becomes too light.
You can use shot until the reservoir is almost completely empty as the weight of the shot makes it flow well.

Use small cups or medicine bottles to catch the charges, one for shot, the other for powder, and move the charge bar back and forth several times catching the powder and shot in the cups. This will get the powder and shot flowing evenly. Move the bar to the left and catch the shot charge. Then, pour the powder and shot back into their respective reservoirs.

Now you’re ready to reload. Place one of the Gold Medal Hulls in the first station and pull the handle all the way down. This will resize the hull and push out the spent primer. Next, move the shell to the second station, and if you don’t have the automatic priming feature, place a primer in the priming seating punch and pull the handle all the way down. This will seat the primer.

Move the shell to the station under the wad fingers and powder drop tube. Lower the powder drop tube through the wad fingers and move the charge bar handle smartly to the right, allowing it to tap the end of its travel gently so as to jar all the powder from the charge bushing. Raise the handle enough for the powder drop tube to clear the wad guide, and insert the WWAA12F114 wad. Ensure that all the guide fingers are inside the hull. Sometimes it helps to rotate the hull slightly with the wad guide well inside. This will allow the guide to smooth out the rumpled edge of a hull, so it isn’t protruding in such a manner as to catch the edge of the wad.

Now, seat the wad down firmly on the powder. This is where the single-stage loader has an advantage over the progressive press because it allows a feel for wad seating. Move the hull to the next (shot) station, and move the charge bar to the left to drop the shot.

Next, move the shell to the proper crimp starting station and pull the handle down until the crimp fully starts. You may not always want to pull the handle all the way down in this station. It should not crease the hulls too deeply. Use common sense. The eight-point crimp starter is in front and the six-point in the rear. If you were loading a shell which was already loaded with a six-point crimp, you would naturally use the rear station. You should use the front starter for the Federal Gold Medal, as it is an eight-point crimp.

In the next (final crimping) station, pull the handle down until the shell becomes fully crimped. Again, it’s necessary to use a modicum of judgment in this station. You can tell from looking if the shell is properly crimped. You should now have a loaded shell with a nicely formed crimp—ready to fire.

The procedure would be quite similar for any comparable reloading press. There are some variations in the procedure, but if you follow the instructions that come with the press, you should have no trouble turning out serviceable reloads from a good reloader.
This sums up the procedure for reloading shotshells on a single-stage press. On a progressive press, the hulls will advance around the stations automatically, and there will be many things going on at the same time. This situation doesn’t allow for the individual care and attention to each hull that you would exercise with the single-stage press.

Steel Shot

Loading steel shot requires extra care and a few extra steps to make a proper reload. The best source of both steel shot reloading components and loading information is Ballistic Products, Inc.

You may not be able to justify the high cost of reloading steel shot. Consider that the most active waterfowl hunter will fire, at most, only two boxes of shells at waterfowl in a year, and consider the high cost of steel shot reloading components. Also, look through the best and most complete reloading handbooks—such as the 12 Gauge Reloading Manual by Loadbooks—and most other sources. You’ll read constant messages of warnings such as: Do not use steel shot in the shotshell loads listed in this guide. You’ll also find this type of warning repeated in the Winchester, IMR, and Scot reloading manuals.

There are undoubtedly those who wish to try reloading steel shot. If you are among these rugged individuals, obtain a copy of the BPI catalog and order enough steel shot reloading components to meet your needs.

Two barrel-protection approaches help to contain steel shot. In the BPI steel shot kit, there are sections of thin brass sheet which you must cut to length with tin snips and roll up and insert inside the BPI shot cup. You’ll find the instructions for this included in the kit. Then, load the steel shot into the cup and proceed with loading in the usual sequence.

It seems best to make up a quantity of shotcups with the brass inserts before you start loading. Then, you only have to follow the usual procedure in loading steel shot.

The other approach to barrel protection is the use of heavy walled shot cups to load steel shot. You might find you’ll prefer the brass inserts, as they give more barrel protection.

Figure 78 shows the various sizes of steel shot. The size of shot, whether lead or steel, is based on American Standard shot sizes. Thus, a steel No. 4 pellet and a lead No. 4 pellet are both .13 inches in diameter.
Warning: Under no circumstances should any reloader use lead shot wads and powder charges to load steel shot. This practice will invariably damage the gun in which the loads are fired, and, quite possibly, the one who fires it. **Se only those loads and components specifically listed for use with steel shot in a reliable reloading manual or guide to load steel shot.**

**Patterns**

There’s much misinformation regarding shotshell patterns. The standard patterning procedure is to fire at a pattern sheet at 40 yards. The specifications for various chokes require a given percentage of the shot to be within a 30 inch circle at a distance of 40 yards from the muzzle. It’s necessary to have a standard of reference in shotshell patterns as in all other situations where shooters evaluate efficiency and performance. This doesn’t mean that all pattern testing must be at 40 yards, as some think.

Shooters should perform patterning at ranges where he or she intends to shoot. In quail hunting over dogs, the shooter fires the first shot at about 15 yards. The shooter should develop a load that will give optimum shot pattern at 15 yards for use in the first barrel (Figure 79).

The shooter usually fires second shot at around 25–30 yards, so the load used in the second barrel should give optimum coverage with no bird-sized holes at this range. In a Franchi Custom Falconet O/U, the current quail load for the first barrel is a 1200-FPS, 1 1/8 ounce load that provides excellent shot distribution and a 60 percent pattern in a 30 inch circle at 10–20 yards. In the second barrel, is a 1350-FPS, 1 5/16 ounce load that gives similar patterns at 25–30 yards. It would be of little use to give you the specifics of these loads, as each shotgun will perform best with loads worked out specifically for the individual barrel. The shooter should fire such loads in the gun they’re intended for at the range at which they’ll perform best. That is, you should pattern the first barrel at 15 yards and the second barrel at 25 yards. Only then will you get the optimum performance from your gun.
It’s best not to fall into the method of patterning a gun on a large sheet of paper and then drawing a 30 inch circle around the center of the pattern. This doesn’t give the true delivered pattern of your gun. You should use a 30 inch circle drawn on a sheet or one of the excellent 30 inch degradable foam targets with an aiming point in the center as shown in Figure 79. Sight Right Co. of Victor, New York 14564, sells the targets under the name “Visible Impact Targets.”

The Visible Impact Targets are fine shotgun targets. Contrary to what you might expect, the cost isn’t prohibitive for serious shooters. To test your pattern, hold dead on the aiming point. Count the number and note the location of the shot hits to determine the true, delivered performance of your loads.

The number of shot delivered in any spot other than those centered around the point of aim isn’t relevant to the true performance of your gun and loads. Using quail-sized 2 ½ inch circles to check for the number of places where a quail could pass safely within your pattern will give an entirely different perspective on gun performance.

One of the most important aspects of shotshell reloading is the ability to correctly read recommended loading data to find the loads you wish to produce. Then, you must be able to correctly read and implement a load bushing chart. It’s also important to have a powder scale to check the loads being delivered by the bushings and to be absolutely sure you’re using the correct powder. Never use powder from unknown
sources, and be careful to return unused powders from the powder hoppers into the proper cans to avoid a deadly mix-up. Most importantly, use common sense in reloading.

**Slug Loads**

In recent years, rifled slug guns have become popular in the areas of Virginia and Ohio, as well as other places where regulations restrict deer hunting to shotgun use only. Slug guns with rifled barrels are capable of very high accuracy if fitted with good sights and given good ammunition.

Except for the Winchester Sabot Slug load—formerly supplied by BRI—and the Activ Servo Slug load, currently manufactured loads use slugs of a diameter that’s too small to fill the rifling grooves properly.

Given all this, it’s difficult to get a top-notch slug load using available components other than the Activ Slug. You can purchase the Activ Servo Slug from Activ Industries, 1000 Zigor Road, P.O. Box F, Kearneysville, WV 25430.

Failure to expand and deliver energy into the body of the target animal is a common problem with shotgun slugs. The slugs seem to pass through the deer and carry most of their energy with them. The large hole they make will kill the animal within a hundred yards or so. However, in today’s deer hunting situations on open hunting land, a load that stops the game on the spot is essential.

Most shotshell reloading manuals list a few slug loads. You load them by the same general procedure as other shotshell reloads, with one exception. Unless you’re reloading hulls previously loaded with slugs, you’ll have to shorten the hulls by trimming 1/8 inch off the front of the hull. After you insert the recommended wad column and place the slug atop it, you close the case by using a roll crimper in a drill press.

If you’re using a Foster-type slug, be sure you don’t run the roll-crimp down too tightly upon the slug. It will sometimes ride up over the crimp edge and raise the breech pressure to unsafe levels, degrading accuracy at the same time. The Activ and Brennecke slugs don’t present this problem, but the Brennecke is of a diameter smaller than what’s preferred for good accuracy. IMR’s SR4756 powder is the best canister powder for reloading shotgun slugs.
Zero In! 5

1. Some reloading tools are much more sensitive to _____ than others.

2. Under no circumstances should any reloader use _____ and _____ to load steel shot.

3. Overall, the quality of shot obtainable from different manufacturers varies ______ (greatly, little).

4. Primers fall into two basic groups, ______ and ______.

5. The rounder (more spherical) a shot is, the ______ (better, worse) it will pattern.

6. Patterning should be done at the ____________________________.

7. The advent of the _____ has greatly simplified the selection of suitable wads for a given load.

8. ______ is a great help in building long-range loads with large diameter shot.

9. The most important things in shotshell reloading come down to (1) the ability to correctly read ______ and (2) being able to correctly read and implement a ______ chart.

10. Failure to expand and deliver energy into the body of the target animal is a common problem with ______ slugs.

Check your answers with those on page 98.
1. True
2. False. If something is hygroscopic, it attracts and retains moisture from the surrounding air.
3. False. Cartridges for autoloading guns use a *rimless* design, with the head the same diameter as the rear of the case and an extractor groove turned in the head.
4. True
5. True
6. True
7. False. In the Berdan system, the primer pocket is formed with an integral central anvil.
8. False. It’s one of the earliest priming compounds.
9. False. Rifle primers have a somewhat thicker, tougher cup than the pistol type.
10. True

2. a
3. j
4. i
5. b
6. f
7. d
8. e
9. h
10. c

3. 1. sulfur, charcoal
2. fixed cavity powder measure
3. extruded
4. adjustable metering cavities
5. tong tools, nutcrackers
6. flake
7. burning rate
8. progressive
9. reloader’s
10. C-presses

4. 1. True
2. True
3. True
4. False. It’s *interior ballistics*.
5. True
6. False. It’s an alloy of copper and zinc.
7. False. They come in bulk packs of 500.
8. True
9. True
10. False. Swaging is the cold-forming of metal under high pressure.
1. wad column cup length
2. lead shot wads, powder charges
3. greatly
4. Mild, Hot
5. better
6. ranges at which the shooter intends to shoot
7. plastic shot cup-type wad
8. Buffering powder
9. loading data, load bushing
10. shotgun
When you feel confident that you have mastered the material in this study unit, complete the following examination. Then submit only your answers to the school for grading, using one of the examination answer options described in your “Test Materials” envelope. Send your answers for this examination as soon as you complete it. Do not wait until another examination is ready.

Questions 1–20: Select the one best answer to each question.

1. The amount of fore-and-aft play available to the cartridge when chambered and ready to be fired is called
   A. chamber space.  
   B. headspace.  
   C. breech play.  
   D. obturation.

2. To inspect bottleneck cases for excessive case length and/or neck thickness, use a
   A. microscope.  
   B. ruler.  
   C. pair of calipers.  
   D. protractor.

3. Who produces Bulls-eye, a double-base, flake-type powder with one of the fastest burning rates of any powder available to reloaders?
   A. Alliant  
   B. Hodgdon  
   C. Accurate Arms  
   D. Winchester
4. The desired diameter of a cast bullet is usually
   A. the same size as the diameter of the barrel.
   B. .001 inch over the bore diameter of the barrel.
   C. .001 inch over the groove diameter of the barrel.
   D. .001 inch under the groove diameter of the barrel.

5. The first shotshells were made of
   A. steel.
   B. paper.
   C. copper.
   D. brass.

6. It's customary and correct to refer to a loaded round of metallic ammunition, ready to fire in a handgun or rifle, as a
   A. bullet.
   B. case.
   C. cartridge.
   D. shell.

7. To determine major power factor (mpf), you multiply velocity by weight and divide the product by which of the following numbers?
   A. 10
   B. 100
   C. 500
   D. 1000

8. From what do we customarily form cartridge cases?
   A. Lead
   B. Iron
   C. Steel
   D. Brass

9. Which of the following IMR (Improved Military Rifle) powders has the fastest burning rate?
   A. IMR 1
   B. IMR 4227
   C. IMR 4895
   D. IMR 7828

10. Dies, shell holders, powder scale, and loading presses are all equipment you would need for
    A. casting bullets.
    B. muzzle-loading.
    C. patterning.
    D. reloading.

11. Shotshells of current manufacture are all primed with the “Winchester size” ______ inch diameter primers.
    A. .243
    B. .300
    C. .320
    D. .357

12. Reloading dies offered by virtually all current sources have their shanks threaded to
    A. ¾ 14 National Fine (NF).
    B. ¾ 14 National Course (NC).
    C. ¾ 14 National Fine (NF).
    D. ¾ 14 International Fine (IF).

13. To remove powder residue and other crud and corruption from a case that is being prepared for reloading, use
    A. course sand paper.
    B. a metal file.
    C. 0000 grade steel wool.
    D. flux.

14. One of the best basic materials for the frame of a reloading press is
    A. aluminum.
    B. steel.
    C. brass.
    D. cast iron.
15. One metal commonly used in bullet casting alloys is
   A. zinc.  
   B. copper.  
   C. tin.  
   D. bronze.

16. A 150 grain bullet traveling at a velocity of 2700 fps carries ______ fpe.
   A. 2123.5, or 2124  
   B. 2428.7, or 2429  
   C. 2500  
   D. 2632

17. For reloading shotshells, which of the following powders is of great help in building long-range loads with large-diameter shot?
   A. Black  
   B. Buffering  
   C. Fine-grade talcum  
   D. Sulfur

18. A wildcat cartridge, simply stated, is
   A. used for hunting wildcats.  
   B. illegal.  
   C. unsafe to use.  
   D. one that's not available through the commercial channels.

19. The grease groove(s) circling the full-diameter base portion of a cast bullet should
   A. provide better accuracy.  
   B. be trimmed prior to loading.  
   C. be lubricated.  
   D. be wiped clean of lubricant when reloading.

20. All of the following have an effect upon a bullet's ability to retain velocity during its passage to the target except which one?
   A. Profile  
   B. Powder  
   C. Weight  
   D. Diameter