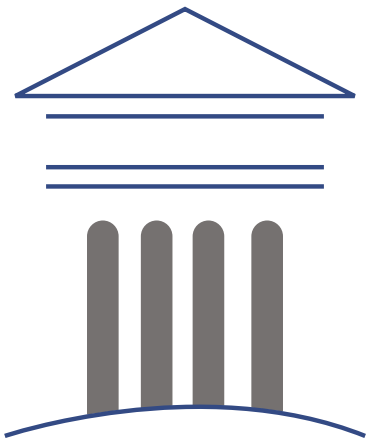
Shotshell Components and Reloading (#) Lesson: 2202

OBJECTIVES	3
INTRODUCTION	3
SHOTGUN BASICS	5
Gauges	5
Range	8
Drams Equivalent	8
Self-Test Questions	8
SHOTSHELL COMPONENTS	9
Shotshell Primers	9
Shotshell Cases	11
Shotshell Wads	11
Lead Shot	12
Steel Shot	14
Powders For Shotshell Reloading	14
Self-Test Questions	17
SHOTSHELL	18
Self-Test Questions	19
ANSWERS TO SELF-TEST QUESTIONS	20
LESSON QUESTIONS	21





Objectives

In this lesson, you will learn

1. The gauge of a .410-bore shotgun.
2. The amount of shot in a standard 20-gauge load.
3. What type of primer a shotshell uses.
4. The maximum breech pressure produced by a modern shotgun.

Introduction

Shotshell reloading is not as popular or as interesting as loading for centerfire rifle and handgun cartridges. Even so, millions of shotshells are loaded annually in the United States, mostly for skeet and trap shooters, and also for shooters participating in turkey shoots using shotguns.

Hunters who can reload their own shotshells will take home more game with the least amount of trouble, using fewer firearms. For example, a person who has a 12-gauge shotgun with a modified choke can reload the shells and use the gun in different ways. By inserting a shot column (power piston), the hunter can tighten the choke to improved modified; using copper-plated shot will increase the choke another degree to about full choke. Just by reloading, the shooter has three different chokes for three types of hunting conditions. Add to this the interchangeable choke tubs on the newer shotguns, like the one in Figure 1, and the possibilities are endless.



***Figure 1**: The modern shotgun is a versatile tool in the hands of a capable shooter, and with the proper loads.*

On the other end of the spectrum, if the hunter wants a spreader load for upland game, where the average shot is less than 25 yards, a cardboard X inserted into the shot column will open the pattern up to improved cylinder. The same can be done by dividing the shot into three different compartments by inserting thin cardboard wads in the shot compartment.

A shooter can reload for about one-third the cost of factory-bought ammo. Skeet, trap, and competition shooters almost always reload their own ammo. One reason is for the savings, but another is for the loads. Each shooter has a favorite combination that gives the best scores. These shooters would not think of using factory ammo in competition.

The gunsmith or dealer will make the most money in the shotshell field by selling reloading equipment and its related components: shot, wads, powder, primers, etc. However, some dealers do a very good business loading for local shooting matches. No. 10 shot is used almost exclusively for these matches, and shells are difficult to find. Therefore, during the game season *(usually from October 1 through January 1)* the dealers get orders for as many as 1,000 reloads per week. Many dealers only make a profit of about 10 cents per round, but this still gives them a profit of about $100* per week. With an MEC progressive reloader, a dealer can produce 1,000 shotshells in 3 hours or less, at a profit of at least $33 per hour.

Some dealers reload hard-to-find short shots hells for older shotguns with shorter chambers so that these weapons can be used safely. Others load black powder for the older shotguns.

**Costs are generalizations and vary with type of ammunition and other factors.*

Initially, shotshell reloading may seem simple when compared to rifle or handgun reloading, since the latter group has a wide variety of bullet weights, velocities, etc. But when you start studying shotshell reloading in detail, the number of different cases, shot columns, etc. can be confusing, and you may consider the practice anything but simple.

In shotshell reloading, you must first decide what the load will be used for, then use a good reference book or chart to select a trial load. (These charts are normally available free from manufacturers or distributors of shotshell components.) Then, try different powders until you find the one that patterns best in your shotgun.

One word of caution: Shotshells have relatively low breech pressure when compared to modern, high-velocity rifle reloads. Still, reloading can be dangerous if you do not take certain precautions. Most shotguns are not built to withstand pressures over 15,000 psi, whereas many modern rifles will handle breech pressures of 60,000 psi or more. You will be using fast-burning powder in shotshells, and just a grain or two too much can increase the breech pressure tremendously.

Never exceed the factory recommendations, and if a load does not look right to you (even if it is printed in a reloading manual), always double check with another source before using the load.

Before practicing loading shotshells, let's look at the components that make up the various types of shotshells. Then you will be able to approach the practice of reloading with more authority.

Shotgun Basics

As their name implies, shotguns are made to shoot shot. They are the only practical firearms for bird and waterfowl shooting. They are predominately used on small game, such as rabbits, and for trap and skeet shooting.

Like its muzzleloading predecessor, the shotgun has a smooth bore. Because its charge is a load of shot pellets, the shotgun bore is large in diameter. The size of the bore is designated by its gauge. Years ago, 4- and 8-gauge guns were fairly common. However, today, only 10, 12, 20, and 28 gauges and .410 bores are manufactured in the United States.

GAUGES

The term gauge refers to the number of round lead balls required to make a pound. So, a 12-gauge shotgun has a bore the same diameter as a lead ball weighing of a pound.

Although this antiquated means of measurement is no longer used in manufacturing, the term is still used in the marketplace because it describes the gun well. Actually, because of the choke, solid balls for 12-gauge guns weigh only 1 ounce, or 16 balls to the pound. The British, as well as many Americans, usually use the term bore instead of gauge.

The smaller the number, the larger the diameter of the bore. Twelve-gauge guns have larger-diameter barrels than 16-gauge guns; 16-gauge shotguns are larger than 20-gauge guns; and so on. Since the bore is larger, the 12-gauge can efficiently handle more shot than a 16- or 20-gauge.

The .410-bore shotgun has an actual barrel diameter of .410 inch. Because it was developed later than other shotguns, it escaped the older nomenclature. In all actuality, it is about 67 gauges. See Figure 2 for actual sizes of various shotgun bores. These true cylinder-bore sizes represent the barrel diameter, but when the shotgun barrel has any choke, the diameter at the muzzle is somewhat smaller, depending on the amount and type of choke.

Below are the standard factory shotshell loads available in 12, 16, and 20 gauges in 2¾" length. Load refers to the amount of shot in the shell.

Gauge	Magnum Loads
12	1½ oz.
16	1¼ oz.
20	1 1/8 oz.

Gauge	Heavy Loads
12	1¼ oz.
16	1 1/8 oz.
20	1 oz.

Gauge	Standard Loads
12	1 1/8 oz.
16	1 oz.
20	7/8 oz.

There are also 3" shells with even more shot in them. Since you can load more shot in a 12-gauge shell than in a 16- or 20-gauge shell of the same length, the relationship doesn't

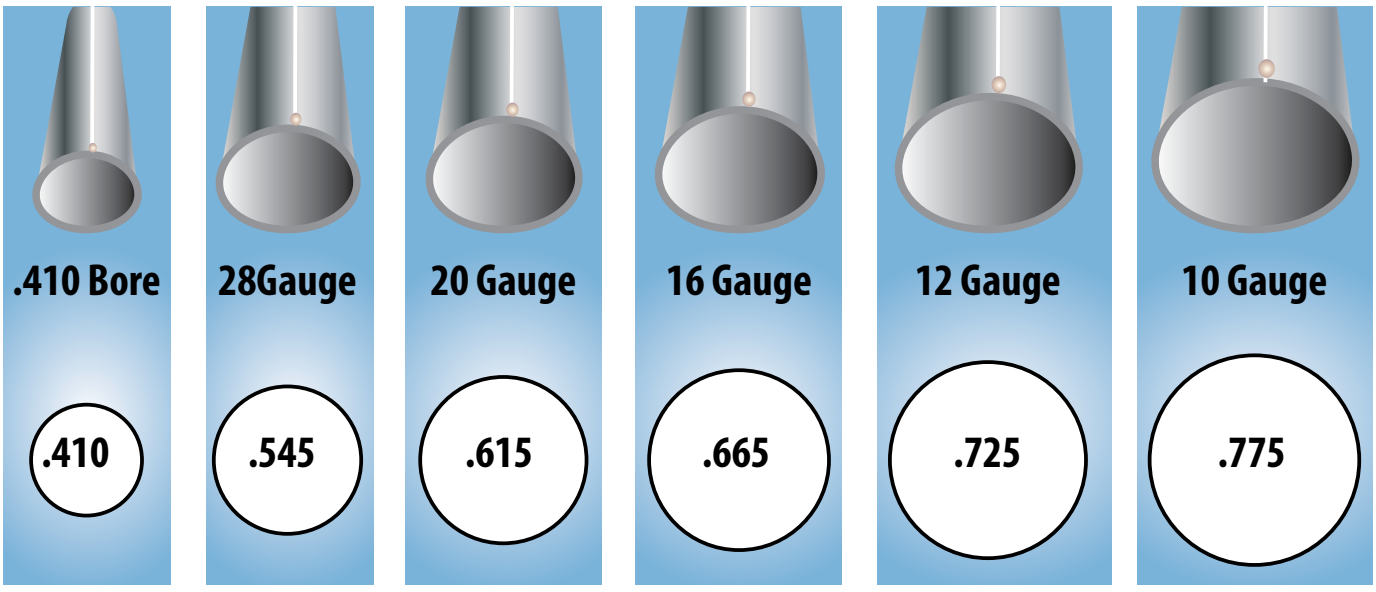


Figure 2: *This chart represents the true size of cylinder bores of the gauges indicated.*

change. The amount of shot in a charge greatly affects the efficiency of a shotgun.

Barrels. A barrel must be long enough to allow complete combustion of the powder. Generally, combustion of smokeless powder occurs when the shot charge has traveled about 20" of barrel length.

Shotgun barrels start at a length of 18" and can be found as long as 36" in 12-gauge guns. Smaller gauges usually come in 26" or 28" lengths.

Short barrels give the advantage of faster gun handling, which is useful in upland shooting of quail, grouse, woodcock, etc.

Long barrels with more weight out front steady the swing and contribute to a more accurate aim and lead for the longer-range—more deliberate gun pointing required to shoot at ducks and geese.

All barrels have a chamber at the breech end that is larger than the barrel proper. The chamber holds the loaded shell and is long enough to allow the crimp to unfold. The cone is a funnel-like construction between the chamber and barrel. The rim of the shell fits into a groove at the rear of the chamber, which also has a cut large enough to house the extractor or ejector under the shell rim.

Most shotguns made in this country are chambered for 2¾" shells. This applies to 12-, 16-, and 20-gauge shotguns. Some 12- and 20-gauge guns are furnished with 3" chambers for use with extra-heavy 3" magnum loads. The .410-bore shotguns are usually chambered for 3" shells.

Some shotguns, especially trap guns, have barrels fitted with a ventilated rib. The rib serves as a straight-edge to assist in gun pointing, and is supported by stanchions, or stands, leaving an open space between the rib and barrel. The rib breaks up the heat mirage that shimmers up from a barrel hot from continuous firing. This heat mirage would otherwise distort the shooter's view of the target. Many skeet guns and some field guns have ventilated ribs.

Chokes. A choke is a constriction at the muzzle of a shotgun barrel. True cylinder bores (with no chokes) are confined to riot guns; barrels made especially for shooting rifled slugs; and most recently, barrels intended for skeet shooting. Shotguns are patterned by shooting at a large square of paper. The standard distance is 40 yards from the muzzle. A black bull's-eye is used as an aiming point.

After shooting, the target is inspected and a circle 30" in diameter is drawn around the greatest number of shot holes. This is done without reference to the bull's-eye, which may or may not be in the center of the resulting circle. The shot holes in the circle are then counted and compared to the number of shot known to be in identical shotshells that have the same shot size and weight.

Chokes are made to certain constrictions to produce the following results:

- Full Choke: 65% minimum of charge in a 30" circle at 40 yards.
- Improved Modified Choke: 60%- 70% of charge in a 30" circle at 40 yards.
- Modified Choke: 500/0-65% of charge in a 30" circle at 40 yards.
- Improved Cylinder Choke: 35%-50% of charge in a 30" circle at 40 yards.
- Cylinder Bore: 25%-35% of charge in a 30" circle at 40 yards.

Full-choke barrels are limited to about .040 constriction. Tighter constrictions produce adverse effects. At one time, cylinder bores patterned poorly, with too few pellets in the center of the pattern and too many around the edges, in a sort of cartwheel effect. However, over the past decade, steady improvements in shotshell loading have offset this tendency, and cylinder-bore patterns, which are the widest of all, now have good distribution. However, cylinder-bore patterns thin out rapidly, and their effective range does not extend much beyond 25 yards.

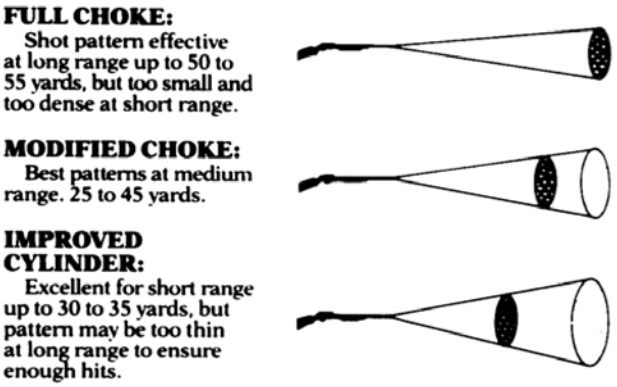


Figure 3: Comparison of the three most popular types of shotgun chokes.

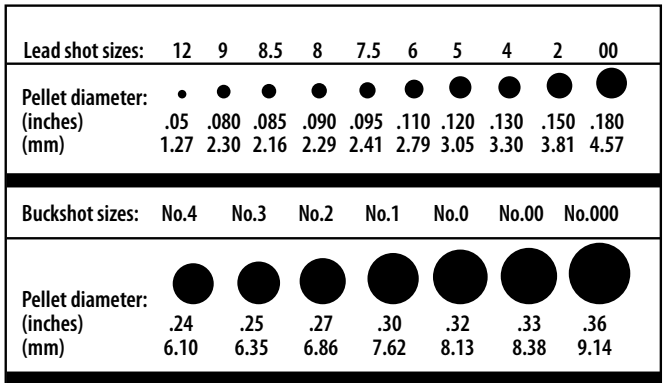


Figure 4: Comparison chart of shot sizes.

SHOT PELLETS PER OUNCE (Approximate)

LEAD				STEEL	
Size	Pellets	Size	Pellets	Size	Pellets
				F	40
BB	50	6	225	BB	72
2	87	7½	350	1	103
4	135	8	410	2	125
5	170	9	585	4	192
				6	315

Figure 5: The approximate number of shot pellets per ounce.

Full chokes narrow the degree of dispersion, concentrating the shot pattern, and are preferred for long ranges typical in shooting waterfowl, ducks, and geese (Figure 3). Improved cylinder chokes allow a wide dispersion, and are therefore more suitable for closer shooting of quail, grouse, and other upland game.

Modified chokes are very useful under certain conditions. A compromise between the full choke and the improved cylinder choke, the modified choke is an all-round boring often used with more success than the full choke.

Chokes, which are an integral part of the gun, are made either by cutting or swaging. Cut chokes are formed during reaming of the barrel, with the reaming tool carrying the shape, radius, and dimensions of the desired constriction. Swaged chokes are first formed on the barrel exterior by grinding metal from the muzzle end to a shape and dimension that forms an interior constriction when the muzzle is swaged in a heavy press. There are several adjustable chokes that screw into a threaded muzzle. Both cut and swaged chokes are sometimes coupled with recoil-reducing attachments called compensators, which allow powder gases to escape sideways from vents at the muzzle. The recoil is reduced to some extent, but the report, or noise, is accentuated.

Shotgun Performance. Gauges, barrel lengths, and chokes affect performance. Here are a few simple facts:

- Long barrels do not shoot harder.
- Barrel length has no effect on dispersion.
- Choke does affect dispersion.
- Gauge does not affect dispersion. (The .410 bore is an exception.)
- A 20-gauge does not shoot harder than a 12-gauge.

A 12-gauge, full-choke gun and a 20-gauge, full-choke gun will throw the same spread of shot. In other words, they will have the same dispersion.

The 12-gauge has more shot in its load than the 20-gauge — usually 14 oz., or 24% more pellets. This means that at 40 yards, the 12-gauge will put 25% more shot in a 30" circle than the 20-gauge. To put it another way, a 12-gauge at 50 yards will put the same number of pellets in a 30" circle that a 20-gauge will at 40 yards.

The 16-gauge is right between the two. What the 20-gauge will do at 40 yards, the 16 will do at 45 yards.

It follows then, that a 12-gauge magnum load of ¼ oz. shot will give about the same density at 60 yards as the 1¼ oz. load at 50 yards.

Carrying it further, a 12-gauge, 3" magnum load of 1⅞ oz. shot should duplicate our previous performance at 75 yards.

Shotguns can be effective only up to the distance where the individual pellets have enough velocity to penetrate game and retain some shocking power. Even large shot loses velocity quickly, limiting shotgun performance regardless of the gauge or amount of shot.

Why is there a need for the smaller 16- and 20-gauges if the 12-gauge consistently outperforms them? Simply because the smaller-gauge shot is lighter to carry, faster to handle, more pleasant to shoot, and adequate for many uses. Most upland shooting is done within 40 yards, and the 20-gauge will provide effective patterns at that range, the 16 even better, and the small .410 bore will perform effectively up to 30 yards if in modified choke or tighter.

Moreover, on upland shooting, smaller shot is used in combination with an open choke, the smaller pellets filling up the wider pattern. This combination provides clean kills, leaving the game intact.

Small shot (7½-, 8-, and 9-gauge) is ideal for close-up shooting of small birds, since small shot fills up the wide pattern thrown by improved cylinder choked guns. However, small shot loses velocity quickly and lacks killing power at longer shotgun ranges. Heavy loads of larger shot, in full-choke guns, are required for the longer shotgun ranges and for larger species like ducks and geese. The chart in Figure 4 shows a comparison of the different shot sizes, while the chart in Figure 5 gives the approximate number of shot pellets per ounce. The chart in Figure 6, on page 8, may be used as a shotshell selector for various applications.

Lead Shot Unless Indicated "Steel"

	Type of Shell	Size
DUCKS	Magnum or Hi-Power	4, 5, 6 Steel 2, 4, 6
GEESE	Magnum or Hi-Power	BB, 2, 4 Steel F, BB, 1, 2
PHEASANTS	Magnum or Hi-Power	4, 5, 6, 7½
QUAIL	Hi-Power or Field Load	7½, 8, 9
RUFFED GROUSE & HUNGARIAN PARTRIDGE	Hi-Power or Field Load	6, 7½, 8, 9
OTHER GROUSE & CHUKAR PARTRIDGE	Hi-Power or Field Load	6, 7½, 8
DOVES & PIGEONS	Hi-Power or Field Load	6, 7½, 8, 9
RABBITS	Hi-Power or Field Load	4, 5, 6
WOODCOCK, SNIPE, RAIL	Field Load	7½, 8, 9
SQUIRRELS	Hi-Power or Field Load	4, 5, 6
WILD TURKEY	Magnum or Hi-Power	4, 6
CROWS	Hi-Power or Field Load	5, 6, 7½
PREDATORS	Magnum or Hi-Power	4 Buck, BB, 2

Figure 6: Shotshell selector.

RANGE

Waterfowl hunting usually involves the longest distances for shotgun shooting. The practical range for taking ducks and geese is 35-50 yards. However, individual pellets often travel great distances. For safety, consider the following to be extreme ranges:

00 Buck	610 yards
No. 2 Shot	337 yards
No. 6 Shot	275 yards
No. 9 Shot	225 yards

DRAMS EQUIVALENT

The drams equivalent is a guide number found on shotshell boxes which gives the weight of black powder used in the past to obtain established velocities for each load. Black powder is no longer used, so the figure does not represent the actual amount of smokeless powder used.

A dram, therefore, is a unit of measure. There are 16 drams (dry measurement) in 1 ounce, or 256 in a pound. In the early days of black powder shotshells, the powder charge was measured in drams. Measure for measure, today's smokeless powder is more powerful. When loading a shell with smokeless powder, a smaller weight of powder is necessary to give the same muzzle velocity as would be obtained with black powder. For example, to load a 12-gauge shotshell to 314 drams equivalent may require 23.5 grains of one type of smokeless powder, or perhaps 30 grains of another type of smokeless powder. In other words, the amount of smokeless powder needed to acquire a certain velocity of shot in shotshells can vary, depending upon the powder type. Consequently, the terms "3 dram equivalent," "3¼ dram equivalent," etc. describe the amount of smokeless powder used to produce the same shot velocity as would 3 drams, 3¼ drams, etc. of black powder.

SELF-TEST QUESTIONS

Please check your answers on page 20.

1. ***True or False*. A 10-gauge shotgun has a smaller bore than a 16-gauge shotgun.**
2. **What is the bore diameter of a .410-gauge shotgun?**
3. **Arrange the following choke sizes in order from tightest to loosest:**

   Modified

   Full

   Improved cylinder
4. **What is the weight of the shot load found in standard 12-gauge shotshells?**

Shotshell Components

Figure 7 is a sectional view illustration of the various components that make up a modern shotshell. The primer is secured in the head of the case. When struck by the shotgun's firing pin, it explodes to ignite the powder contained inside the shotshell case. The heat and gas produced by the burning powder force the wad and shot out the end of the case, down the barrel, and out the muzzle. This is, in general, how a shotshell works. Now let's examine each of these components individually.

SHOTSHELL PRIMERS

The battery cup primer is the most common primer used for shotshells in the United States. It is larger than the common boxer-type primer used for centerfire rifle and handgun ammunition (Figure 8). Sporting ammunition primers contain carefully engineered mixtures of chemical ingredients. Primers are designed to explode and produce the heat, gas, and hot particles necessary to ignite propellant powders in sporting ammunition when the firing pin of a firearm strikes them.

Properties of particular importance to the dealer and user of primers are discussed below.

- Primers may explode if subjected to mishandling. Explosions can be caused by friction and by percussion, such as hammering, pounding, dropping, or bullet impact. Heating by fire, static electricity, sparks, and hot ashes may also cause primers to explode.

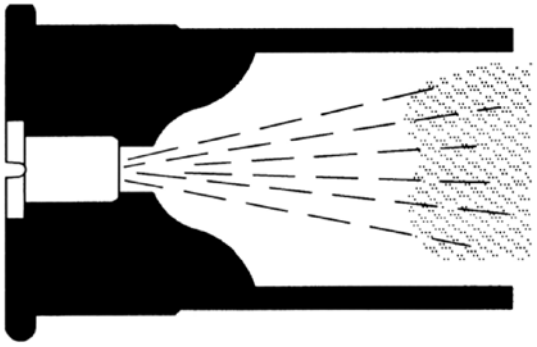


***Figure 8**: The batter cup primer is the primer used most for American shotshells.*

- If primers, loose or in bulk, have contact with each other, one exploding primer can cause a violent simultaneous explosion of all primers nearby. This could cause all of the primers to explode in one violent blast.
- Primers may "dust." Small particles of priming compound may separate from the primers in the form of dust, especially when they are subjected to shaking or jolting. Accumulation of this dust in primer feed tubes, loading machines, and loading areas is extremely hazardous, since it can cause explosions or fires.
- Primers exposed to water or any organic solvent, such as paint thinner, gasoline, kerosene, oil, grease, etc., may deteriorate, resulting in misfires or poor ignition.

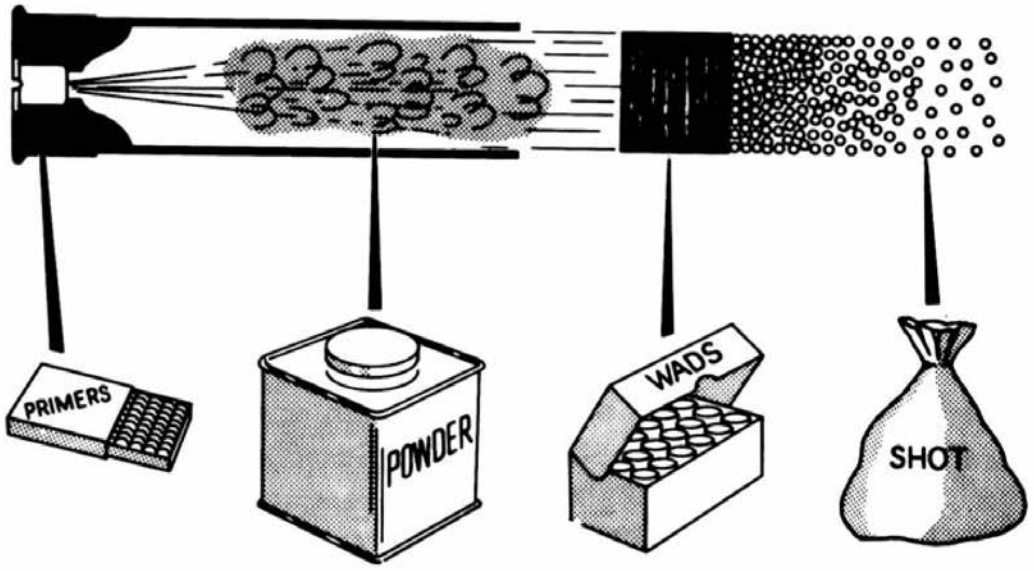


***Figure 7**: Sectional view of a modern shotshell showing the various components required to make a finished round.*

- Modern sporting-ammunition primers will not absorb moisture under normal or even severe conditions of atmospheric humidity. Therefore, airtight containers offer no real advantage. The factory containers in which they are packaged need only normal conditions for storage. However, these containers should be kept dry and not exposed to high temperatures. If exposed to wet conditions or high temperatures, they may deteriorate, causing misfires or poor ignition of the propellant powder.

Handling Primers. *Primers do explode*. This is the purpose for which they have been designed. They demand the respect and careful handling as do any devices containing explosives.

Primers should never be handled, used, or stored in bulk, since primers in bulk can explode simultaneously.

The manufacturers of primers do not recommend using primer feeds for reloading shot without protection from possible explosion. Placing primers in tubes or columns, or using other bulk systems in which the explosion of one primer may cause the explosion of all primers, is a potentially hazardous condition. Manufacturers of primer handling systems are responsible for providing safety and protective features for their equipment. It is best to handle primers individually unless adequate safeguards are provided and used.

- Be careful when handloading to avoid rough handling and undue force where a primer is involved, since the primer may fire. Any malfunction of equipment must be cleared with extreme caution. Avoid decapping shells or cases containing live primers.
- When handling primers or when handloading, be careful to avoid buildup of static electricity. Loading equipment should be electrically grounded.
- All loading equipment and adjacent areas must be kept clean and free of primer dust and powder accumulations. Work areas and loading equipment must be wiped clean with a damp cloth or sponge, which should be thoroughly rinsed after each use. Fired primers, primer cups, anvils, or other bits of hard, abrasive material are a hazard during loading operations, since contact with them may cause primers to fire.
- Spilled primers should be picked up immediately, since they can explode if stepped on.
- An absolute minimum of primers should be kept at the loading operation. Only one packing tray at a time should be removed from the primer storage.
- When a priming operation is completed, any remaining primers should be returned to the package in which they were originally contained. These packages have a specific alloy designed to protect primers during shipment.
- Primers should not be accessible to children, pets, or persons not recognizing them as potentially hazardous.
- Never have an open flame, source of sparks, or hot particles in the vicinity of primers or any ammunition loading operation.
- Do not smoke when handling primers.
- You must wear safety glasses when performing any handloading operations. Additional protection such as face shields or machine guards are strongly recommended.

Storing Primers. Storage cabinets containing only primers are recommended. These cabinets should be constructed of lumber at least 1" thick to delay or minimize the transmission of heat in the event of fire.

- Keep your storage and working areas clean. Make sure the surrounding area is free of trash or other readily combustible materials.
- Be sure the storage area is away from any source of excessive heat and is isolated from open flame, furnaces, water heaters, etc. Do not store primers where they will be exposed to direct sunlight. Avoid storage in areas where mechanical or electrical equipment is in operation.
- Do not store primers in the same area with solvents, flammable gases, or highly combustible materials.
- Store primers only in their original factory containers. Do not transfer the primers from this approved container into one which is not approved. The use of glass bottles, fruit jars, plastic or metal containers, or other bulk containers for primer storage is extremely hazardous.
- Do not smoke in areas where primers are stored. Place "No Smoking" signs in these areas.
- Do not store primers in any area where they might be exposed to gunfire, bullet impact, or ricochets.
- Do not store primers with propellant powders or any other highly combustible materials.
- Observe all regulations regarding quantity and methods of storing primers.

SHOTSHELL CASES

Shotshells have been made from a variety of materials since their introduction over 100 years ago. Brass shotshell cases were popular during the first 75 years of the shotshell's existence — especially for military and law enforcement use — since they could be reloaded an almost endless number of times. Furthermore, the less expensive rifle primers are used in brass cases rather than the battery-cup shotshell primers. However, American-made brass shotshells have not been on the market for over 20 years, and all have now become collector items. However, there are some imported brass shotshells available from suppliers, but most, if not all, of these require the use of Berdan primers, which require special tools to remove.

The most popular type of shotshell used in this country for the first half of this century was the paper case with a brass base. A rolled crimp, shown in Figure 9(A), was used until the 1950s. A rolled crimp consisted of a thin paper or cardboard overshot disc placed over the shot charge; the end of the shotshell case was then rolled over to hold it in place.

Today, the star crimp, shown in Figure 9(B), is by far the most popular and widely used shotshell crimp. It lends an attractive appearance to a shotshell and is also easier to reload than the rolled crimp. About the same time as the star crimp was introduced, plastic shotshell cases were also introduced. Plastic cases remain the most popular at the present time.

Sometime between the rolled crimp and the star crimp, the now defunct Alcan company introduced a zinc shotgun shell case. These cases were die cast by Alcan and used a cone crimp, shown in Figure 9(C). The cone crimp consists of a thin cardboard disc placed over the shotshell with the end of the case tube slightly coned over to hold the over-shot wad in place. They did not prove to be very satisfactory. If dropped, they easily bent out of shape and would then jam the action.

SHOTSHELL WADS

Traditionally, shotshell wads have been made from felt, cork, cardboard, and more recently, plastic. When separate wads are used, the first wad, placed over the powder, is appropriately called the over-the-powder wad or nitro wad. They are made from cardboard or from plastic. These wads must never be lubricated, since the lubrication would deteriorate the powder charge. However, they must form a perfect seal so that the wad seals in all the powder gases, forming a sealed gas chamber.

Most of the powder wads are shaped like a cup with its skirt or flange cupped downward over the powder charge. When the shell is fired, the resulting gas pressure spreads the skirt and seals the cup wad against the gun barrel. Consequently, the powder gases are completely imprisoned, keeping them from rushing into the shot column.

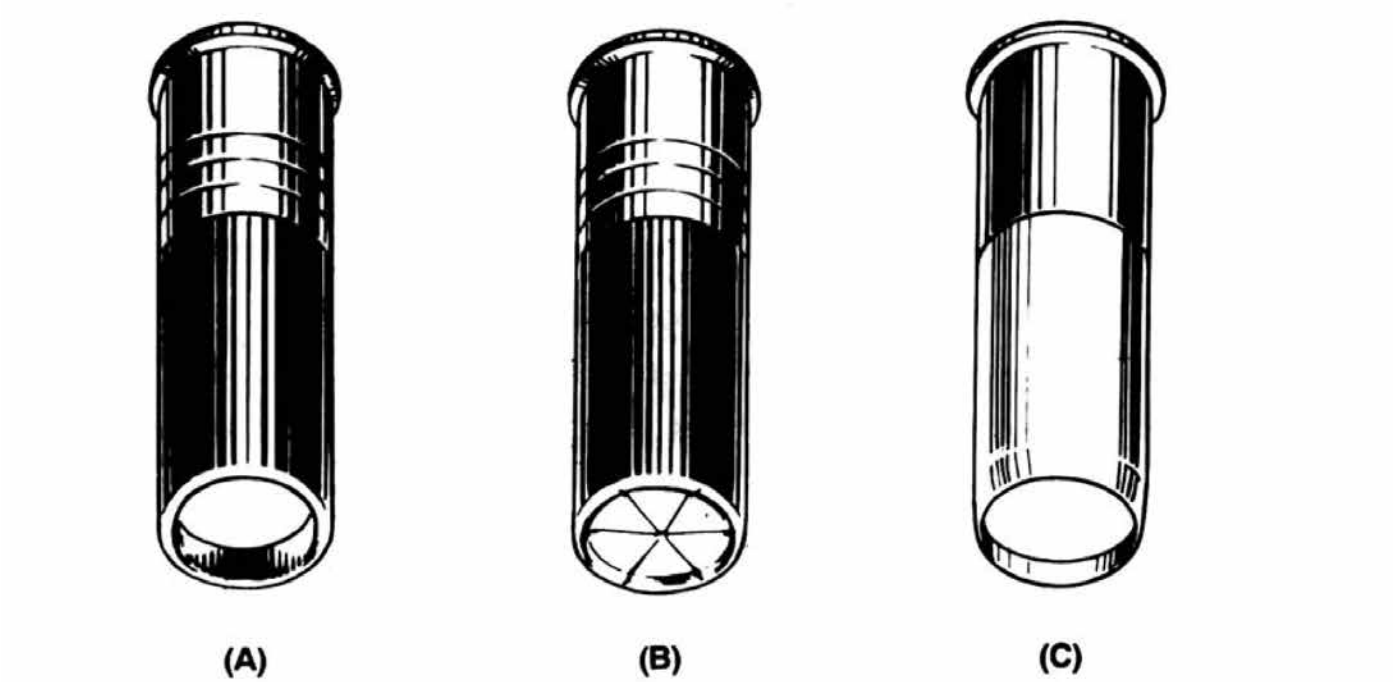


Figure 9: *Three basic types of shotshell crimps used in the United States and abroad: (A) rolled crimp, (B) star crimp, and (C) cone crimp.*

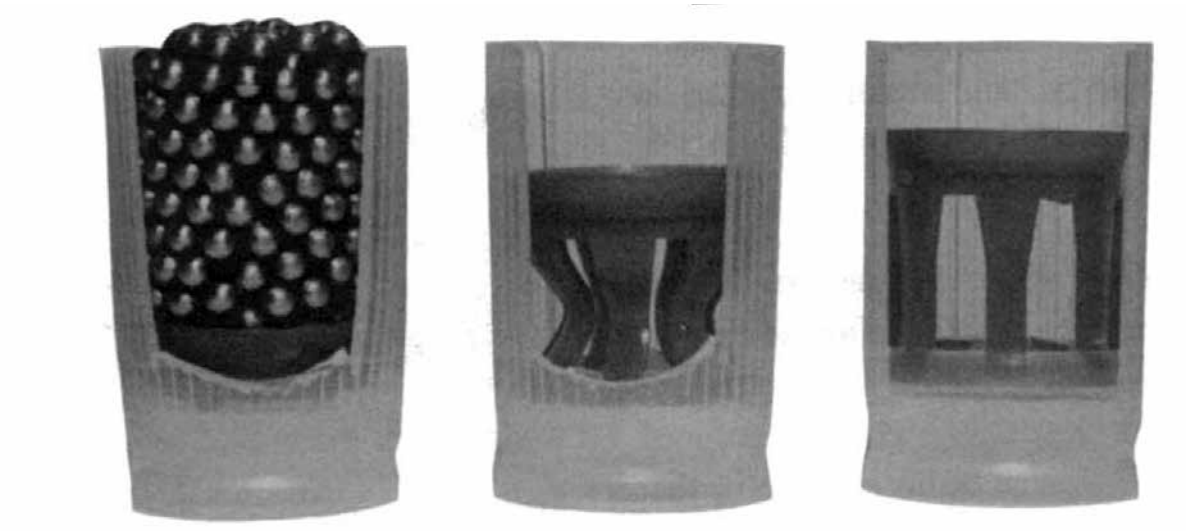


***Figure 10**: The plastic combination wad is now the most popular for loading shotshells.*

Next to the cup is the base wad, which functions similar to the over-the-powder wad. The upper-cupped base wad effectively seals off the powder gases from the base of the shell. No gases should be able to work into or beyond the layers of the base wad to cause head expansion or swelling.

These days, most reloaded shotshells use a single plastic wad (sometimes called a power piston) that incorporates all the necessary wads into a single unit, plus the addition of a collar that protects the shot column (Figure 10). This type of combination wad saves the reloader time and is considered as good as multiple wads.

LEAD SHOT

Lead is an ancient metal. It was first used in the year 3000 B.C. at the present site of the Dardanelles in a city called Abyeos. Lead was well known in Biblical times and is mentioned in Exodus and many other places in the Old Testament.

In the days of the Pharaohs, lead was used to make solder and lead pipes, and to glaze pottery; The Egyptians made the first crude dropped lead, which was used as projectiles in slings.

The method of manufacturing lead shot in modern shot towers was invented in 1782 by William Watts, a plumber in Bristol, England. One night he dreamed that he was in a rainstorm and the raindrops were round, lead spheres. When he awoke in the morning, he was so impressed by his dream that he decided to try dropping melted lead from a great height to see if it formed a sphere while dropping. He poured molten lead through a sieve from the tower of St. Mary Redcliffe Church into some water below. The shot was indeed round. Watt sold the invention and became a wealthy man.

One of the first shot towers to be built in America was constructed in Philadelphia in 1808. Another shot tower in southwest Virginia is still open for tours, although it is no longer in operation.

Lead is ideal for shot, since it gives maximum striking power with the least surface for air to slow down the shot as it travels through the air. It is estimated that there are five tons of shot made for every ton of bullets made in the United States. Shot is usually sold in 25-pound bags, as shown in Figure 11.



***Figure 11**: Lead shot for reloading shotshells normally is available in 25-pound bags.*

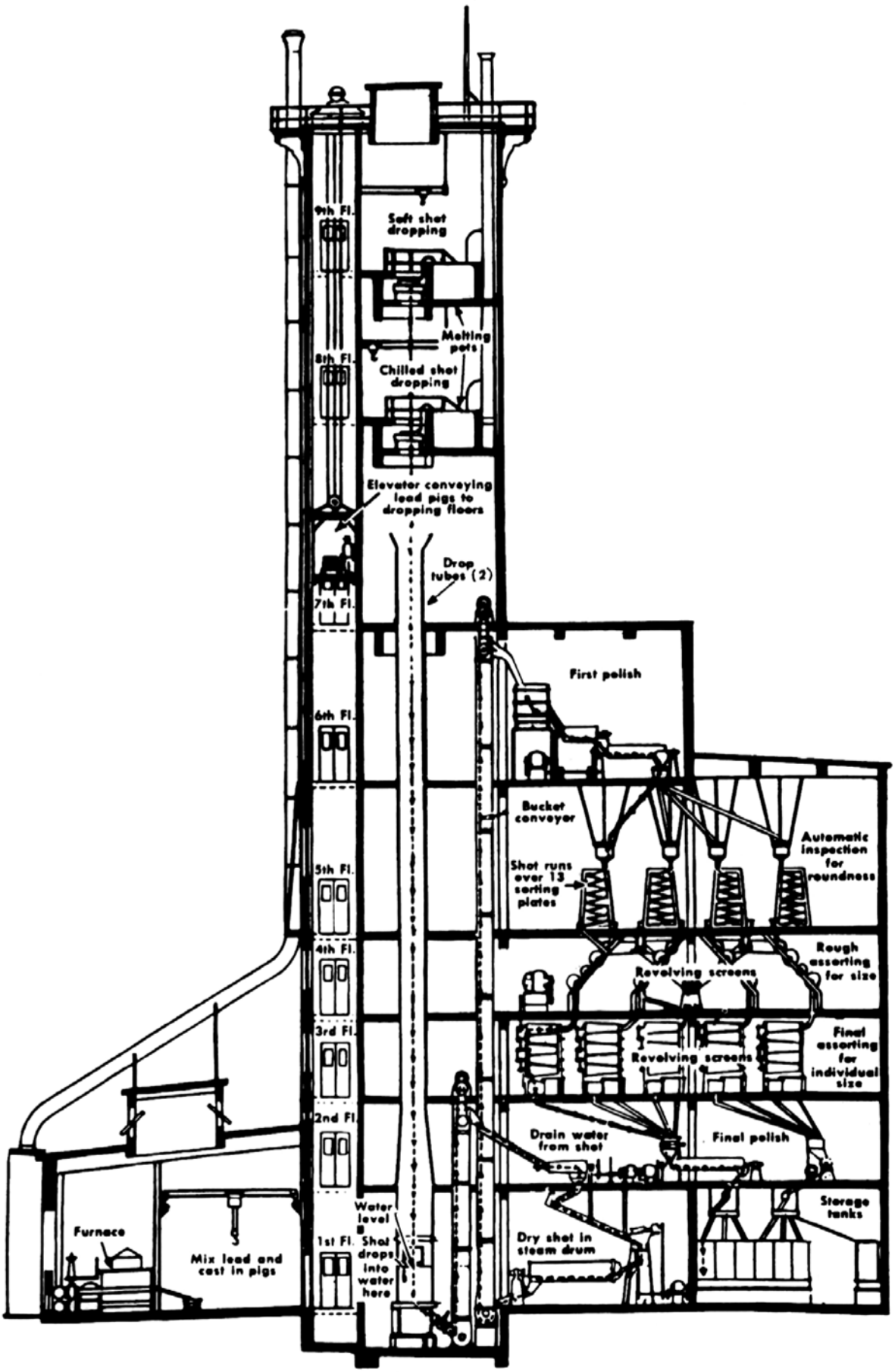


Figure 12: Cross section of a typical shot tower.

Shot up to 0.23" in diameter, or nearly ¼", can be made in shot towers. Shot larger than this diameter dropped from shot towers is too teardrop-shaped to be practical. Larger shot is cast in revolving split ring molds.

Soft lead shot made from pure lead is no longer made. Chilled lead shot is simply a lead shot that has antimony added to make it hard. Tin is not used to make lead shot, since tin greatly lowers the melting point of lead, causing the shot to smear more easily in a hot barrel.

Dropped shot can only be made by pouring molten lead and antimony alloys through a sieve from a tower. Most shot towers are about 120' high. The larger the shot, the higher it is dropped in the tower. Air is sometimes blown up the tower to aid in forming large-sized shot. After the shot is dropped, it is sorted and tumbled in graphite. The graphite keeps the shot from oxidizing and lubricates it slightly. Figure 12, on page 13, shows a cross-section of a typical shot tower.

Machined chilled shot has been used in Europe for decades and has found its way to America in recent years. Machined chilled shot is made from a mixture of 1 part antimony to 40 parts lead. Lead wire is extruded from a lead wire extruder. The wire is then run into the shot-making machine and made into balls. Forming the shot into balls gives the shot a tough skin, somewhat harder and tougher than that found on dropped chilled shot. Furthermore, machined shot requires no graphite to keep it from oxidizing or for lubrication.

STEEL SHOT

Hunting with steel shot is rapidly becoming the rule, rather than the exception. Today, steel shot laws affect nearly every flyway in North America. That means changing loads and, more importantly, changing hunting habits.

Steel shot is 30% lighter than lead shot, but is loaded to shoot with increased initial velocity. However, this lighter pellet weight means velocity will drop more quickly. The result is that you will need to change your forward lead when using steel shot.

If you decide to adjust the way you lead your target, you'll have to consider steel shot's increased loss of velocity. At 20 yards, you will not need to make any noticeable change. Yet at 40 yards, you will want to lead your target about 5" or 6" more than you would with lead shot.

Perhaps the best way to make the adjustment to steel is to make it act more like lead. Since steel is lighter than lead, you should select a shot that is two shot sizes larger than the lead shot you would normally use. That way, a pellet of #2 steel shot will have about the same velocity, deliver similar energy, and require the same forward lead as #4 lead shot through the ranges. Patterns stay dense because there are more pellets per ounce of steel than lead, and because steel pellets deform less, which means fewer stray out of the pattern. However, a shotgun shell has a fixed amount of room for shot. And the larger steel shot takes up more of that room. So, if you really want pattern density of #2 steel to match more closely that of #4 lead, you must increase shot weight. The 12-gauge, 3½" magnum was designed to solve this problem. It delivers a bigger load of larger steel shot at extended ranges. Comparisons between lead and steel shot are shown in the charts and tables in Figure 13.

POWDERS FOR SHOTSHELL RELOADING

Smokeless powders, or propellants, are essentially mixtures of chemicals designed to burn under controlled conditions at the proper rate to propel a projectile from a gun.

Smokeless powders are made in three forms and are available in various sizes of containers. The three forms are

- Thin, circular flakes or wafers
- Small cylinders
- Small spheres

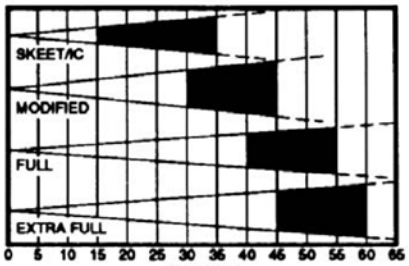
Single-base smokeless powders derive their main source of energy from nitrocellulose. The energy released from double-base smokeless powders is derived from both nitrocellulose and nitroglycerin.

All smokeless powders are extremely flammable; they are designed to burn rapidly and vigorously when ignited. Oxygen from the air is not necessary for the combustion of smokeless powders since they contain sufficient built-in oxygen to burn completely, even in an enclosed space such as the chamber of a firearm.

In effect, ignition occurs when the powder granules are heated above their ignition temperature. This can occur by exposing powder to the following:

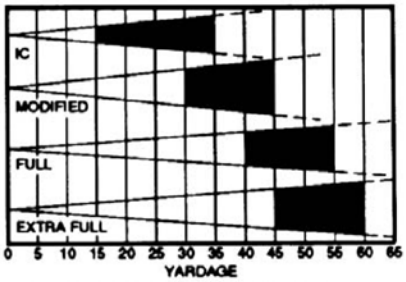
- A flame such as a match or primer flash.
- An electrical spark or the sparks from welding, grinding, etc.
- Heat from an electric hot plate or a fire directed against or near a closed container, even if the powder itself is not exposed to the flame.

LEAD SHOT WITH
MOSSBERG ACCU-CHOKE TUBES



SHADED AREA REPRESENTS MOST EFFECTIVE
USE OF SHOT

STEEL SHOT WITH MOSSBERG ACCU-STEEL
AND ACCU-MAG CHOKE TUBES



SHADED AREA REPRESENTS MOST EFFECTIVE
USE OF SHOT

LEAD

LEAD SHOT SIZES	9	8 1/2	8	7 1/2	6	5	4	2	BB
PELLET DIAMETER	●	●	●	●	●	●	●	●	●
(INCHES)	.080	.085	.090	.095	.110	.120	.130	.150	.180
(mm)	2.30	2.16	2.29	2.41	2.79	3.05	3.30	3.81	4.57
1/2oz.	292	249	205	175	112	85	67	43	25
11/16oz.	402	342	282	241	155	117	93	60	34
3/4oz.	439	373	307	262	169	127	101	65	37
7/8oz.	512	435	359	306	197	149	118	76	44
1oz.	585	497	410	350	225	170	135	87	50
1 1/8oz.	658	559	461	394	253	191	152	98	56
1 1/4oz.	731	621	512	437	281	212	169	109	62
1 3/8oz.	804	683	564	481	309	234	186	120	69
1 1/2oz.	877	745	615	525	337	255	202	130	75
1 5/8oz.	951	808	666	569	366	276	219	141	81
1 7/8oz.	1097	932	769	656	422	319	253	163	94
2oz.	1170	994	820	700	450	340	270	174	100
2 1/4oz.	1316	1118	922	787	506	382	304	196	112

STEEL

STEEL SHOT SIZES	6	5	4	3	2	1	BB	BBB	T	F
PELLET DIAMETER	●	●	●	●	●	●	●	●	●	●
(INCHES)	.1	.12	.13	.14	.15	.16	.18	.19	.20	.22
(mm)	2.79	3.05	3.30	3.56	3.81	4.06	4.57	4.83	5.08	5.59
3/4oz.	236	182	144	118	94	77	54	46	39	30
15/16oz.	295	228	180	143	117	97	67	58	49	37
1oz.	315	243	192	158	125	103	72	62	52	40
1 1/8oz.	354	273	216	178	141	116	81	70	58	45
1 1/4oz.	394	304	240	197	156	129	90	77	65	50
1 3/8oz.	433	334	264	217	172	142	99	85	71	55
1 1/2oz.	472	364	288	237	187	154	108	93	78	60
1 9/16oz.	492	380	300	247	196	161	112	97	81	62
1 5/8oz.	512	395	312	257	203	167	117	101	84	65

LEAD

SIZE	DUCKS	GEESE	PHEASANTS	QUAIL	RUFFED GROUSE & HUNGARIAN PARTRIDGE	OTHER GROUSE, CHUKAR PARTRIDGE	DOVES & PIGEONS	RABBITS	WOODCOCK, SNIPE, RAIL	SQUIRRELS	WILD TURKEY	CROWS	FOX
	4	BB	5	7-1/2	8	5	6	4	7-1/2	4	2	5	BB
	5	2	6	8	7-1/2	6	7-1/2	5	8	5	4	6	2
	6	4	7-1/2	9	8	7-1/2	8	6	9	6	5	7-1/2	4
							9				6		

STEEL

BIRDS/RANGE	RECOMMENDED STEEL SHOT SIZES	RECOMMENDED MINIMUM SHOT WT.
DUCKS UNDER 35 YDS.	2,3,4,5,6	3/4oz.+
DUCKS 35-45 YDS.	BB,1,2,3	1oz.+
DUCKS 45 YDS. OR MORE	BB,1,2	1-1/8oz.+
SMALL GEESE UNDER 45 YDS.	BBB,BB,1	1-1/4oz.+
LARGE GEESE, ANY RANGE/ SMALL GEESE OVER 45 YDS.	F,T,BBB,BB	1-1/4oz.+

LEAD

SHOT TYPE/SIZE	MUZZLE VELOCITY (F.P.S)	PELLET ENERGY IN FOOT/POUNDS AT RANGE (YARDS) 30	40	50	60
LEAD 7-12	1330	1.6			
LEAD 6	1330	3.0	2.3		
LEAD 4	1330	5.6	4.4	3.4	
LEAD 2	1330	9.5	7.5	6.1	4.9
LEAD BB	1330		15.0	12.0	10.0

THE MINIMUM ENERGY REQUIRED DEPENDS ON
THE TYPE OF GAME BEING HUNTED

STEEL

SHOT TYPE/SIZE	MUZZLE VELOCITY (F.P.S)	PELLET ENERGY IN FOOT/POUNDS AT RANGE (YARDS) 30	40	50	60
STEEL 6	1365	1.8			
STEEL 4	1365	3.5	2.5		
STEEL 3	1365	4.0	3.0		
STEEL 2	1365	6.0	4.4	3.4	
STEEL BB	1365	11.6	9.0	7.1	5.5
STEEL T	1365		13.0	10.0	8.5
STEEL F	1400		18.0	15.0	13.0

THE MINIMUM ENERGY REQUIRED DEPENDS ON
THE TYPE OF GAME BEING HUNTED

Figure 13: Comparisons between lead and steel shot.

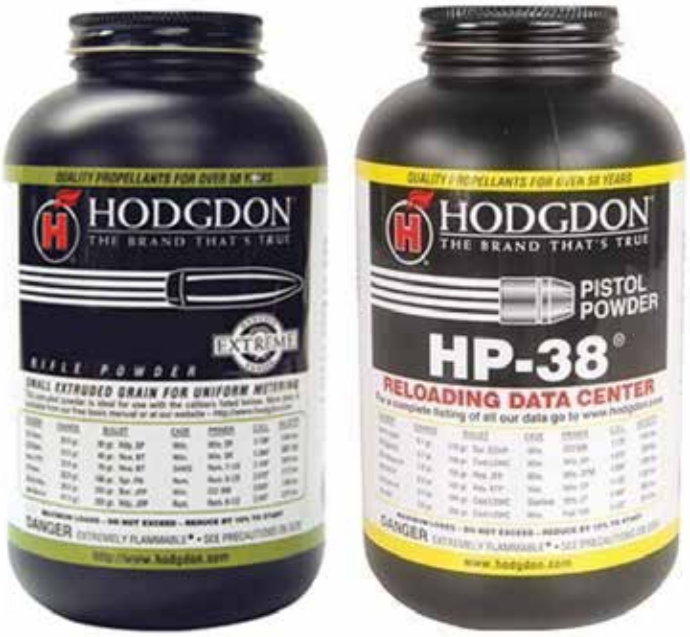


***Figure 14**: Hodgdon TiteWad Powder (left) is the preferred powder for light to medium shotshell loads. It is specifically designed for 12-gauge target loads. While Hodgdon HP38 (right) is great for low velocity and mid-range target loads in the .38 Special, .44 Special, and 45 ACP.*

When smokeless powders, like the ones shown in Figure 14, burn, they form a great deal of gas. If the powder is confined, this gas will create pressure in the surrounding structure. The rate of gas generation is such that the pressure can be kept at a low level if sufficient space is available or if the gas can escape.

In this respect, smokeless powder differs from blasting agents or high explosives such as dynamite or blasting gelatin, although smokeless powder may contain chemical ingredients common to some of these products. High explosives such as dynamite are made to detonate—to change from a solid state to a gaseous state with evolution of intense heat at such a rapid rate that shock waves are produced.

Smokeless powder differs considerably from common black powder in its burning characteristics. Black powder burns essentially at the same rate when out in the open (unconfined) as when in a gun.

When ignited in an unconfined state, smokeless powder burns inefficiently, with an orange flame. It produces a considerable amount of light-brown, noxious-smelling smoke. It leaves a residue of ash and partially burned powder. The flame is hot enough to cause severe burns.

The opposite is true when it burns under pressure, as in a cartridge fired in a gun, where it produces very little smoke, a small glow, and leaves little or no residue. The burning rate of smokeless powder increases with increased pressure.

If burning smokeless powder is confined, gas pressure will rise and may eventually cause the container to burst. Under such circumstances, the bursting of a strong container is similar to an explosion.

Powder Deterioration. Although modern smokeless powders are basically free from deterioration under proper storage conditions, safe practices require a recognition of the signs of deterioration and its possible effects.

You can check for powder deterioration by opening the cap on the container and smelling the contents. Deteriorating powder has an irritating acidic odor. (Do not confuse this with common solvent odors such as alcohol, ether, and acetone.)

Make sure powder is not exposed to extreme heat, since this may cause deterioration. Such exposure produces an acidity which accelerates further reaction and has been known to cause spontaneous combustion because of the heat generated by the reaction.

Never salvage powder from old cartridges, and do not attempt to blend salvaged powder with new powder. Do not accumulate old powder stocks.

The best way to dispose of deteriorated smokeless powder is to burn it out in the open at an isolated location in small shallow piles (not over 1" deep). The quantity burned in anyone pile should never exceed 1 pound. Use an ignition train of slow-burning, combustible material so that you may retreat to a safe distance before powder is ignited.

Storing Smokeless Powder. Smokeless powder is intended to burn, so it must be protected against accidental exposure to flame, sparks, or high temperatures. For these reasons, it is best that storage enclosures be made of insulating materials to protect the powder from external heat sources.

Once smokeless powder begins to burn, it will continue to burn (and generate gas pressure) until it is consumed.

Containers approved for smokeless powder should be constructed to open at low internal pressures to avoid the effects produced by the rupture or bursting of a strong container. Storage containers for smokeless powder should be constructed of fire-resistant and heat-insulating materials to protect the contents from external heat. They should also be large enough to vent the gaseous products of combustion which would result if the smokeless powder accidentally ignited.

If a small, tightly enclosed storage space is loaded to capacity with containers of smokeless powder; the walls of the enclosure will expand to release the gas pressure if the powder is accidentally ignited. This release of gas pressure is similar to an explosion. Therefore, only the smallest practical quantities of smokeless powder, like the 1-pound, 8 ounce containers shown in Figure 14, should be kept in storage, and then in strict compliance with all applicable regulations and recommendations of the National Fire Protection Association (www.nfpa.org).

- As with primers, powders should be stored in an area free from any possible sources of excess heat, and isolated from open flame, furnaces, hot water heaters, etc. Do not store smokeless powder where it will be exposed to sunlight. Avoid storage in areas where mechanical or electrical equipment is in operation. Restrict from the storage areas heat or sparks which may result from improper, defective, or overloaded electrical circuits.
- Never store smokeless powder in the same area with solvents, flammable gases, or highly combustible materials.
- Do not smoke in areas where powder is stored or used. Do not subject the storage cabinets to close confinement. Storage cabinets should be constructed of insulating materials and with a weak wall, seams, or joints to provide an easy means of self-venting.
- Do not keep old or salvaged powders. Check old powders for deterioration regularly. Destroy deteriorated powders immediately.

SELF-TEST QUESTIONS

Please check your answers on page 20.

5. ***True or False*. Some smokeless powders specially designed for reloading shotshells can also be used for some pistol and hand-gun cartridges.**
6. **Name one way that powder deterioration can be detected.**
7. **What type of shot must be used when hunting waterfowl over America's flyways?**
8. **What type of shotshell wad is used more than any other?**

Shotshell

Shotshell reloading tools are available in a variety of types from simple (and slow) hand reloading tools to highly sophisticated, progressive reloading machines that are capable of turning out hundreds of rounds per hour. Study the various descriptions of shotshell reloading tools online or in catalogs and then select the type that you feel will best suit your needs.

The simplest shotshell reloading tool is one manufactured by Lee Precision, Inc. (leeprecision.com) It is easy to use and efficient for the reloader who loads only a few boxes of shells per year (Figure 15).

For those who do a great deal of reloading, a progressive reloading tool is better — and still relatively inexpensive. An MEC progressive shotshell reloading tool can be purchased for around $300 (www.mecreloaders.com). A typical tool is shown in Figure 16. The two plastic containers mounted on top of the tool are for holding powder and shot—powder is in one container and shot is in the other. Pulling the handle one way first drops a measured powder charge into the base of the shotshell. Once the wad is in place, pulling the handle in the opposite direction releases a measured charge of shot.

Reloading shotshells will vary with each type of shell. The following paragraphs describe the general steps involved with loading shotshells. The serious reloader will want one of the larger loading manuals containing recommended loads for shotshells. Every shotshell reloading tool operates in a similar fashion, but each may be a little different. Therefore, study the manual accompanying the tool before using.

Resize and Deprime. Place the empty shell in position at station 1 (in a progressive reloading tool), making sure the depriming punch is in the case mouth and the shell is reasonably cantered under the size die. Lower the operating handle to the stop. Make sure the handle is not being stopped by some object (like the workbench). Before raising the handle make sure that the die has made contact with the rim of the shell. When you raise the handle, the case (resized and deprimed) is ejected from the die and is ready for the next operation.

Priming. To prime, place a shotshell primer, striking side down, in the hole of the seating pad. Place the shell over the seating punch and lower the handle. The shell will line up directly over the primer and be seated to the bottom of the primer pocket when the handle reaches the bottom of the stroke.

Dropping Powder. To drop powder, place the shell under the wad guide, making sure the wad guide spring fingers enter the mouth of the case and do not catch the edge. Lower the operating handle to the full stop. While the handle is down, push the charge bar to the right until it stops. The powder will then be released from the bushing and fall through the drop tube into the case.

Raise the handle and place the wad over the wad seating stem/drop tube. Lower the handle, making sure the wad enters the wad guide. The handle will reach the full stop when the wad is seated. Lowering or raising the seating stem will increase or decrease wad seating depth and pressure. Most wads for the compression-formed shell have the same column, so very little adjustment is needed when changing wads.



***Figure 15**: Simple shotshell reloading tool.*



***Figure 16**: More advanced, professional level, shotshell reloading tool.*

Now, before raising the operating handle, push the charge bar back to the left. This releases shot from the bushing through the drop tube and into the shell with wad in place.

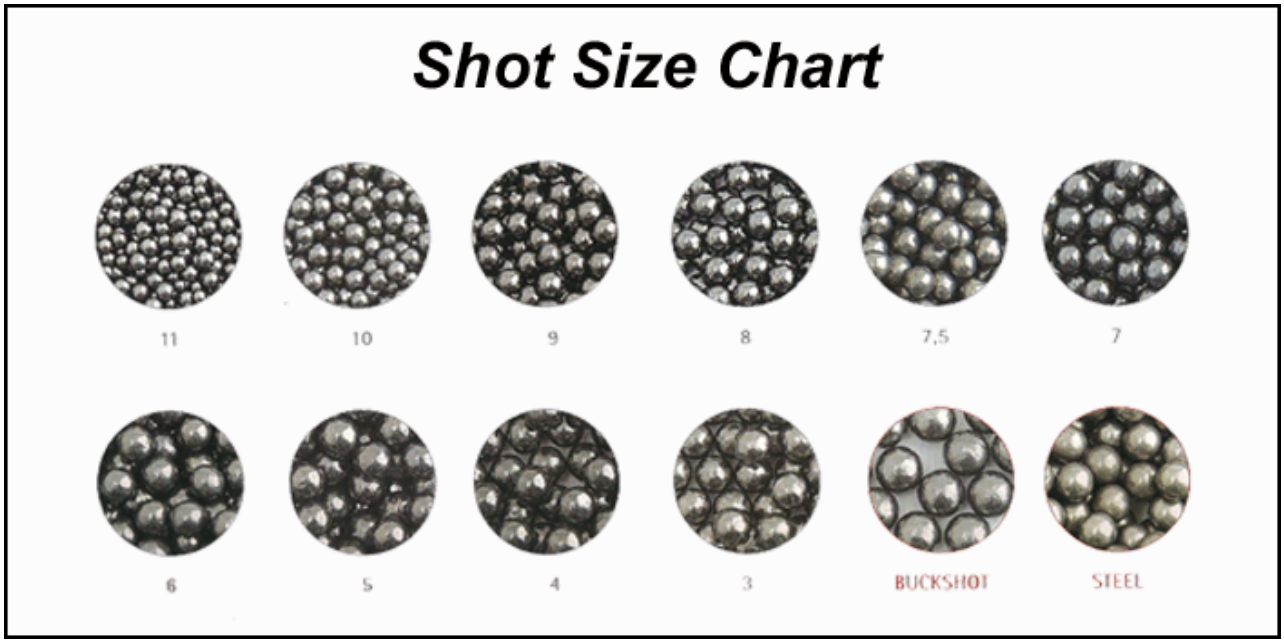
Crimping. To start the crimp, place the shell in the crimping station. The crimp starter easily aligns with the existing crimp. The knobs on the outside of the starter crimp die are to help in manually aligning the crimp when folded crimps are reloaded. Now move the shell to the next position. You are ready to crimp the shell. Make sure the handle is firmly depressed during this operation. Inspect each loaded round to make sure the crimp is properly folded and gives a good, professional appearance.

NOTE: There should be about 1/2"-9/16" between the shot and the mouth of the case for proper crimping. If your measurement is different, you may be using the wrong combination of components.

SELF-TEST QUESTIONS

Please check your answers on page 20.

9. **When using a progressive shotshell reloading tool, what are the first operations that occur after placing the shell in the shellholder?**
10. **How much room should be left between the shot and the mouth of the shotshell case for proper crimping?**
11. ***True or False*. The Lee Reloading Tool is inexpensive and very slow.**
12. ***True or False*. The last operation in loading shotshells is crimping.**



A close up view of the various sizes of shot.

Answers to Self-Test Questions

1. False.
2. .410 inch.
3. Full, Modified, Improved Cylinder.
4. $1^{1}/_{8}$ ounces.
5. True.
6. You can detect powder deterioration by smelling the contents. Powder undergoing deterioration has an irritating acidic odor.
7. Steel shot.
8. A plastic combination wad.
9. Decapping and resizing.
10. $^{1}/_{2}$" - $^{9}/_{16}$".
11. True.
12. True.

Lesson Questions

THIS IS LESSON NUMBER 2202.

Make sure you print your name, student number, and lesson number in the space provided on the Lesson Answer Form. Be sure to fill in the circles beneath your student number and lesson number.



REMINDER: A properly completed Lesson Answer Form allows us to evaluate your answers and send the results and additional study material to you. Do not hold your Lesson Answer Forms to send several at one time. You may run out of study material if you do not send your answers for evaluation promptly.

You may also complete your exam online at www.sdi.edu, click on the *online exams* tab.

1. **Which of the following statements is true concerning the cost of loading shotshells?**
   a. A person can reload for about one-third the cost of factory-bought shells.
   b. A person can reload for about one-half the cost of factory-bought shells.
   c. A person can reload for about two-thirds the cost of factory-bought shells.
   d. A person can reload for about three-fourths the cost of factory-bought shells.

2. **What is the approximate maximum breech pressure that is generated in shotgun chambers?**
   a. 60,000 psi.
   b. 40,000 psi.
   c. 25,000 psi.
   d. 15,000 psi.

3. **Which of the following shotgun gauges are still currently manufactured in the United States?**
   a. 2-gauge.
   b. 4-gauge.
   c. 10-gauge.
   d. 14-gauge.

4. **What is the approximate gauge size of a .410-bore shotgun?**
   a. 37-gauge.
   b. 57-gauge.
   c. 67-gauge.
   d. 77-gauge.

5. **How many round lead balls, .410" in diameter, will it take to make 1 pound in a .410-bore shotgun?**
   a. 37.
   b. 57.
   c. 67.
   d. 77.

6. **How many ounces of lead shot are loaded into a 20-gauge standard load?**
   a. $^{5}/_{8}$ ounce.
   b. $^{7}/_{8}$ ounce.
   c. 1 ounce.
   d. $1^{1}/_{8}$ ounce.

7. **What is the minimum percent of shot that is required to be delivered in a 30 circle at 40 yards for a full-choke shotgun barrel?**
   a. 50%.
   b. 60%.
   c. 65%.
   d. 70%.

8. **Which of the following shot sizes are best for upland game shooting with the shotgun?**
   a. 00 buck.
   b. No. 2.
   c. No. 4.
   d. No. 8.

9. **Which of the following types of hunting usually involves the longest ranges?**
   a. Quail hunting.
   b. Rabbit hunting.
   c. Waterfowl hunting.
   d. Grouse hunting.

10. **What type of primer is used in the modern American shotshell?**
   a. Berdan.
   b. Battery cup.
   c. Boxer.
   d. Sharpe.