STUDY UNIT 6 – PART 1

DEVELOPMENT AND DESIGN OF THE MODERN RIFLE BULLET

BEGINNING BALLISTICS

The first projectile was likely a rock which some Alley-Oop type, in the dawn of pre-history, bounced off the bean of a baby brontosaurus. We don't know how the belt in the belfrey impressed the brontosaurus, but "Alley" may have learned something about sectional density. Sooner or later he appreciated the fact that the heavier the rock for its size, the farther it could be hurled by his hair-matted muscles.

The concept of hitting a target more or less impersonally and from a distance was established, and with it the need for more efficient, longer-ranging projectiles. Through the ages, in man's never ending quest for a better way to lay low his enemies and keep his larder filled, deadlier missiles (and delivery systems) evolved. The rock led to the spear, the spear to the arrow and the crossbow bolt. David's sling was the forerunner of the giant catapults or "ballistas" of the Dark Ages, from which our term *ballistics* is derived.

With the invention of gunpowder and the hand and field cannon that followed, the development of the bullet, as we know it today, was inevitable. Some of the earliest "ballisticians" were on the right track in designing projectiles patterned after the streamlined crossbow bolt (see Figure 1). However, poor obturation (the missiles lacked a flat base and merely popped out of the barrel) sent the disgruntled savants back to the old drawing scroll. The obvious solution was the round ball, which *was* used for centuries in smoothbore cannons, muzzleloading muskets and pistols, cap and ball revolvers, and in the first rifles — the famed Kentucky and Pennsylvania long arms.

THE "MINIE BALL" WAS THE FIRST REAL BULLET

It wasn't until the mid-1850's, and the introduction of the first rifled musket (the U.S. Government Model 1855), which was designed for the hollowed-out and elongated "minie ball" that the concept of conical bullets really arrived (see Figure 2).

The perfection of the breechloading system, and the self-contained metallic cartridge which soon followed, led to the widespread adoption of the new "bullet." There was no denying the vast improvement in accuracy and trajectory that the new configuration provided. Also, a long-bodied projectile was necessary for proper seating in the new metallic cases (see Figure 3).

The first bullets were cast of lead. Not an awful lot was known about ballistics at the time, and bullet caliber, weight, and shape were governed more by expediency than scientific principle. Bullets were blunt because they were easily cast (besides, they "worked"), and were of a weight the cartridge manufacturer or shooter/handloader *considered "right"* for the intended game. Weight naturally dictated bullet length (and sectional density) for a given caliber, which had more to do with trajectory than most riflemen realized.

The first repeating rifles employed tubular magazines which required the blunt bullets of the time. (Such bullets wouldn't detonate the primer of the next cartridge in line in the tube.) The correct charge of blackpowder for a given bullet was largely determined by guesswork, and lay somewhere between the gun blowing up and the gun failing to spit unburned powder out the muzzle. The science of bullet design and construction may have grown out of the diaper stage, but it was still in short pants.

SMOKELESS POWDER FORCED THE INVENTION OF THE JACKETED BULLET

The introduction of smokeless powder between 1880 and 1885 was the forerunner of today's bullet. As chamber pressures and velocity went up, bore diameters shrank. Bullets that were long in relation to bore diameter became commonplace (see Figure 4).

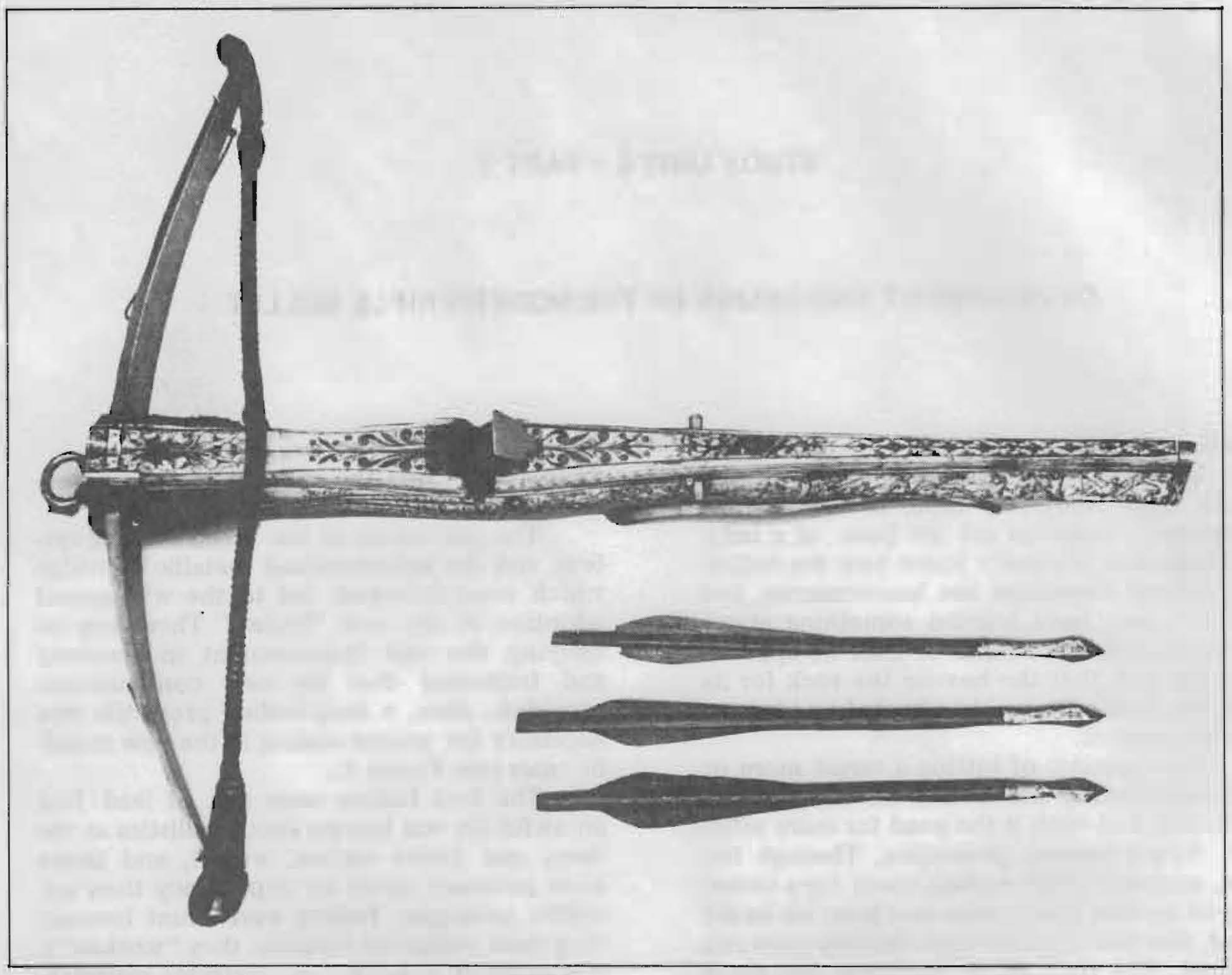


FIGURE 1 — The crossbow bolt or "quarrel" shown was the first high-velocity non-gunpowder missile. The long, slender configuration resulted in an excellent ballistics coefficient. (Illustration courtesy Jack Lewis's Archer's Digest)

FIGURE 2 — Minie balls, identical to the originals, can be easily cast by hobbyists for use in antique or replica muzzleloaders.

Naturally, sectional density went up, too, resulting in bullets that shot flatter than ever before. But the higher velocities created some problems.

The lead bullets, because of higher chamber pressures and heat, were melting at the base. The increased friction between the bullet and the bore was causing the barrel grooves to fill with lead. As a result, bullets were skidding as much as rotating in their passage through the rifling. Accuracy was, of course, less than remarkable. Some manufacturers added antimony to harden the lead, but this was a stop gap measure at best.

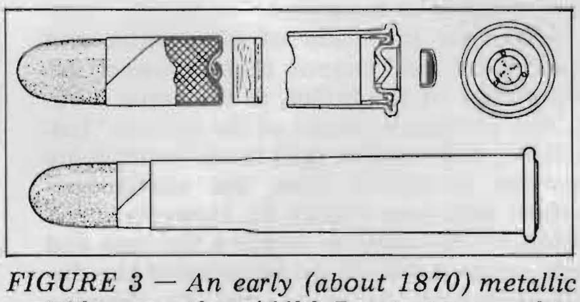


FIGURE 3 — An early (about 1870) metallic cartridge was the .44/90 Remington, used in the Sharps rifle on buffalo. Detail shows the 520-grain lead bullet, paper-patched, the cardboard underwad, and Berdan primer.

The jacketed bullet, which was invented before smokeless powder, but was not widely used until around the turn of the century, was the solution. The "bullet" or core was enclosed in a relatively soft, but harder than lead, metal jacket or "envelope," as the British called it. However, the new jacket soon caused nearly as many problems as it cured. When the first jacketed commercial bullets came out, velocities were in the 2,000 fps range and under. As contemporary bullets were either flat or round-nosed with plenty of lead exposed, this velocity resulted in satisfactory bullet expansion at normal game ranges.

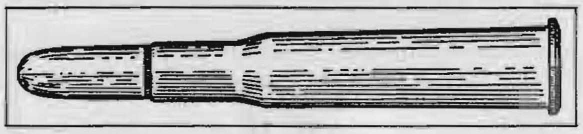


FIGURE 4 — The first high-powered smokeless cartridge to use a jacketed bullet was the .30-40 Krag, developed in 1892. The 220-grain bullet had a muzzle velocity of 1,960 fps out of a 30" barrel.

Troubles arose when the efficiency of the new smokeless powder increased, hiking velocities to 2,500 fps, then 3,000 fps (see Figure 5). The original sleeve-jacketed, blunt bullets simply didn't work at these higher bullet speeds. As often as not, the bullet disintegrated at the target without penetration. Bullet-making soon became a science. Designers found that a pointed bullet with a bit of lead exposed at the tip not only "mushroomed" more or less correctly, but provided flatter trajectories than had ever before been achieved.

Unfortunately, as velocities climbed, so did the incidence of jacket/core separation. More efficient methods of anchoring the core within the jacket had to be found. Soon, the first inside-contoured jackets arrived on the scene. The great race for a better bullet was on, and after nearly 75 years it continues.

THE "MODERN" LEAD BULLET

The oldtime lead alloy cast rifle bullet is still very much on the scene. Few manufacturers make them, but plenty of hobbyists do. And the owners of genuine antiques and such modern replicas as the .45-70 Trapdoor Springfield made by Harrington and Richardson (Figure 6) constitute somewhat less than half of the total market.

When brewing up the old blackpowder loads, ordinary lubricated lead bullets are fine. When, however, a light charge of smokeless powder is used for a slight velocity increase, the shooter usually adds a gas check to the bottom of his bullet. Gas checks are cups, or sometimes merely plates, of gilding metal which are sized or crimped into the base of the bullet to keep it from melting (see Figure 7). The multiple grooves in cast bullets are to hold lubricant, which cuts down on the barrel leading.

Probably even more lead bullets are fabricated for modern rifles than for the oldtimers. And the choice of calibers, styles, and weights is wide (see Figure 8). Many riflemen who shoot often rely on the lead projectiles —

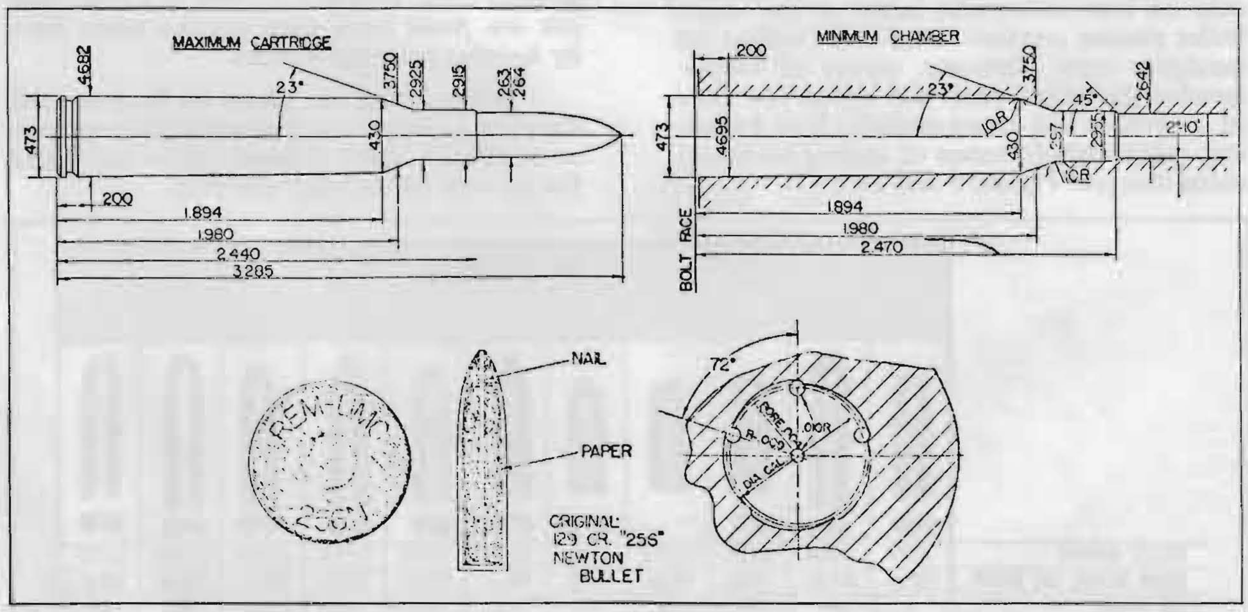


FIGURE 5 — The .256 Newton, one of the first high-velocity cartridges, achieved a muzzle velocity of nearly 3,000 fps with a 120-grain bullet. Cross-section of a 1913 Newton bullet shows its unique construction. The pure lead core was jacketed in pure copper. The nail, with its base on the bottom, was supposed to "strengthen" the bullet while protecting the tip against buffeting in the rifle's magazine.

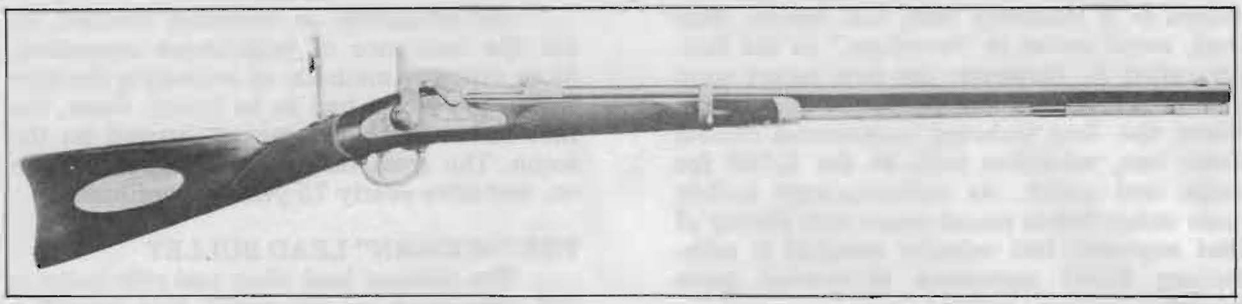


FIGURE 6 — Harrington & Richardson reproduction of the 1873 Trapdoor Springfield, Officer's Model.

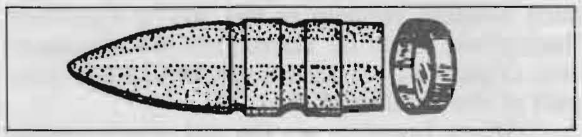


FIGURE 7 — Gas checks, small gilding metal cups, are usually affixed to the bases of high-velocity cast or swaged lead bullets to prevent the bases from melting.

usually with gas checks — for fun and economy. The major cost of any handload is the bullet, and cast projectiles cost only a fraction of the commercial, jacketed variety. More big game hunters than you think make a habit of carrying a few low-velocity gas checks in their pocket for bagging an occasional rabbit or fool's hen for the pot. A rifle's high-velocity sight setting is usually very close to being "on" with the short-range lead bullets.

Few "standard" loading manuals contain data on lead bullet rifle loads, as the major bullet makers produce swaged lead bullets for handguns only. However, plenty of recommended gas check loads for center-fire rifles of .22 caliber and up are available from Lyman and other manufacturers of casting tools and sizing dies (see Figures 9 and 10).

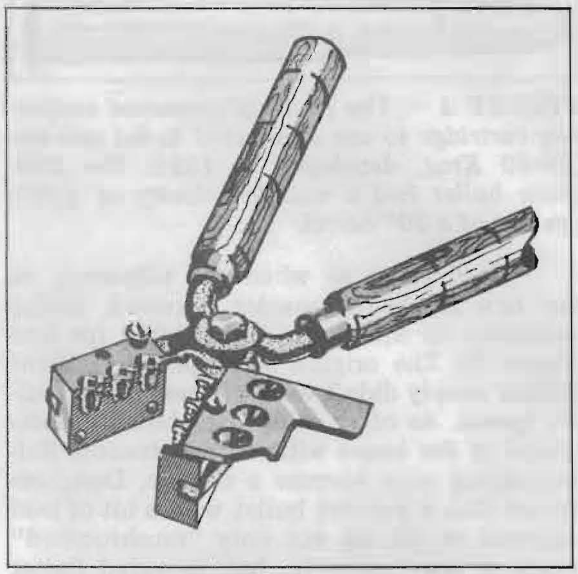
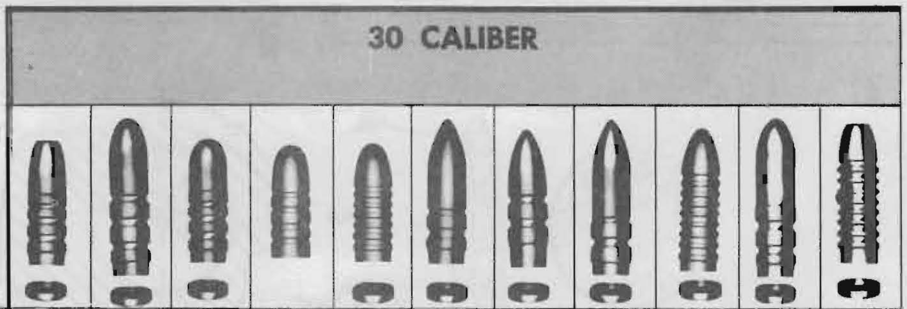


FIGURE 9 — This bullet mold by SAECO permits three bullets to be cast at a time. Bullets are freed from their cavities when hard by levering open the handles.

Before going on, please do Programmed Exercise 1. Make sure you write your answers on a separate sheet of paper before looking at the answers on the page specified.



BULLET NUMBER	31141	311284	311291	311241	311466	311332	311413	311334	311467	311290	311407
GRAIN WEIGHT (#2 ALLOY)	**173 gr.**	**214 gr.**	**170 gr.**	**155 gr.**	**152 gr.**	**180 gr.**	**169 gr.**	**190 gr.**	**180 gr.**	**210 gr.**	**180 gr.**
TOP PUNCH	8	467	291	465	467	413	413	413	467	467	445
SEATING SCREW	8	467	465	465	467	413	413	413	467	467	445

FIGURE 8 — Lead bullets in a variety of calibers, shapes, and bullet weights are frequently used in modern rifles. Shown are just a few of the .30-caliber versions available (with molds) from Lyman. Note that most have gas checks.

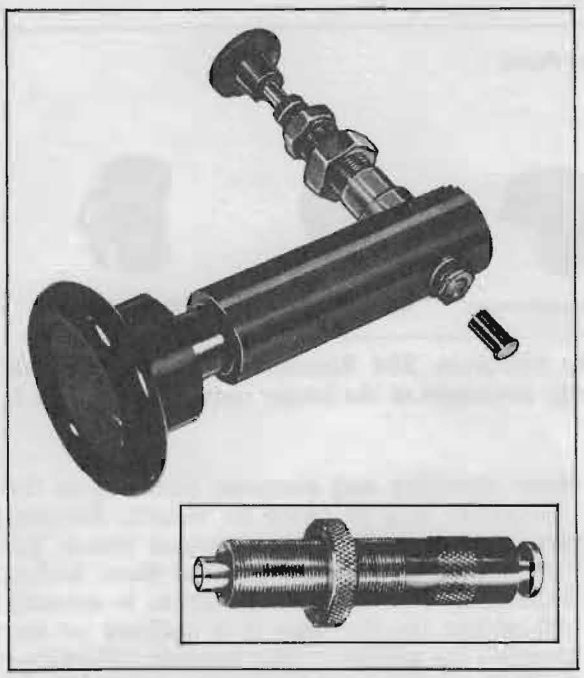


FIGURE 10 — After lead bullets are cast, they are usually sized and lubricated with a tool such as the Herter No. 47 shown here. Some models also seat the gas checks. Different dies (see inset) are inserted for different calibers.

PROGRAMMED EXERCISE

100%

1

Identify which of the following statements about cast lead bullets are true or false.

1. F Lead alloy cast bullets are no longer in use for rifles.
2. T Few cast lead bullets are being produced by manufacturers.
3. T Many reloaders and hobbyists swage their own lead bullets.
4. F It is more expensive to cast your own lead bullets than to buy commercial bullets.
5. F Lead bullets can be used only for replicas or "oldtimers."
6. T Multiple grooves in lead bullets hold lubricant to reduce leading.

Answers on Page 6

THE IDEAL HUNTING BULLET

The ideal hunting bullet is one which is highly accurate and, when driven into a reasonably vital area, expands to two and a half to three times its original diameter, drops the animal in its tracks, and winds up intact just under the skin and opposite the entry hole — having delivered its full energy to the quarry.

This does happen, and *surprisingly* quite often in view of the many problems involved in the design of any hunting bullet. For example, consider a 150-grain soft-point .308-caliber bullet, designed primarily for deer. This bullet may be used in a .300 Savage, .308 Winchester, .30/06, or .300 Winchester magnum, with muzzle velocity ranging from about 2,600 fps for the Savage to about 3,400 fps for the magnum.

The deer may be shot close to the muzzle, where velocity is still relatively high, or it may be dropped at 400 yards or so, where the projectile is more or less loafing along.

The bullet may enter the rib cage or the water-filled paunch; it may pierce the heavily muscled neck or the muscle and bone framework of the front or rear quarters. Or it may run the gamut from anus to breastbone on a straightaway shot.

Yet that 150-grain .308 bullet, despite these variables, is expected to expand properly and kill cleanly, or win everlasting condemnation by the (average) shooter. The remarkable thing is that the bullet usually does perform its job, and well! See Figure 11.

BULLET DESIGN REPRESENTS A COMPROMISE

All bullets represent a compromise. A perfect bullet *could be designed* — providing it was used only on a *perfect* target by a *perfect* shot. Game animals aren't overly obliging about standing still and broadside at a rifle's zero point. If one did cooperate, the average shooter would probably still miss his aiming point by six to ten inches, as a charitable estimate.

A "compromise" 150-grain .30/06 bullet will usually expand perfectly at 200 to 250 yards, and expand to a lesser extent at 300 to 400 yards. That same bullet, striking a deer at 50 to 100 yards, will expand sooner and wider. Yet in most cases, providing a vital area has been struck, the result is an exceedingly dead deer.

Situations where a bullet *blows up* or just "slips through" at close range, or doesn't expand at all at long range, are usually caused by the wrong bullet choice. For example, a .30/06 110-grain spire-point, which is basically for coyote-sized varmints, will often blow up and cause a shallow, crater-type wound on

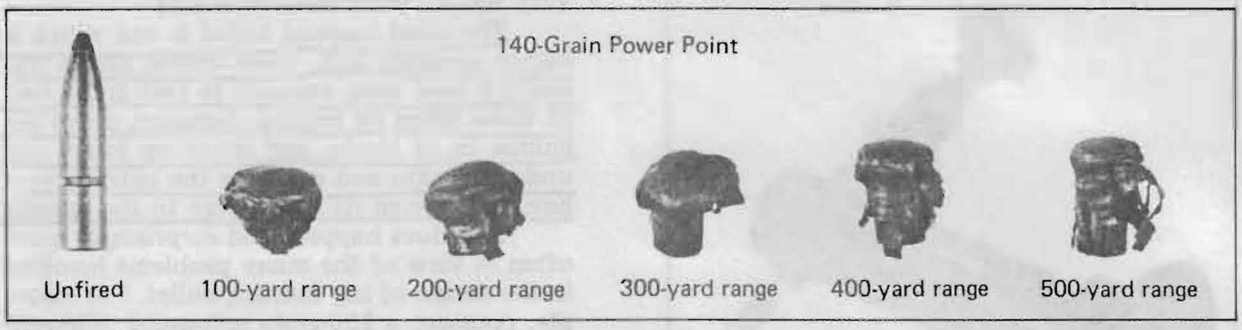


FIGURE 11 — A properly designed bullet such as the 140-grain .264 Winchester magnum expands satisfactorily at all hunting ranges. Note that as velocity decreases at the longer ranges, expansion is less.

deer shot at short range. At medium range it will expand more or less properly, but because of the light bullet weight and rapid velocity fall-off, the remaining energy or killing power is borderline. At long range, the same bullet, due to still lower velocity, may not expand at all. The animal fully absorbs what remaining energy the bullet has, but it isn't enough to bring him down!

On the other hand, a too-heavy deer bullet like the 180-grain .30/06 spitzer may whistle cleanly through a deer at 50 to 100 yards, wasting its energy on the ground beyond. Such bullets generally require more tissue resistance to open properly than is provided by the average small deer, except at fairly long range — where they do perform well. See Figure 12.

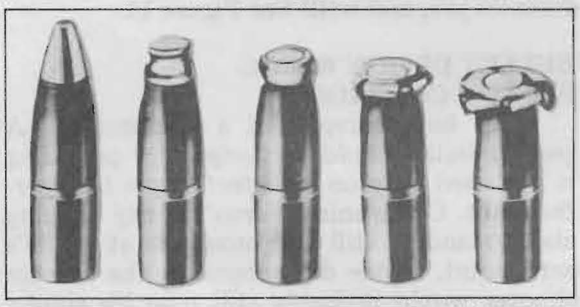


FIGURE 12—Progressive expansion of a 180-grain .30/06 Silvertip bullet. At close range, the "mushrooming" is minimal.

BULLET CALIBER IS NOT ALL-IMPORTANT

Bullet caliber has less to do with killing power than bullet construction and the amount of energy delivered at impact. For example, a fast-stepping 6mm Remington 100-grain bullet delivers about 1,140 foot pounds of energy at 300 yards; the .35 Remington, with a 180-grain bullet leaving the muzzle at 2,000 fps, racks up only about 1,000 foot pounds at the same range (see Figure 13). Both bullets are designed to expand properly on deer-sized game. Therefore, the 6mm has substantially more shocking and stopping power than the .35-caliber slug of twice its weight. Remember, once a bullet enters animal tissue, the "caliber" changes rapidly. That 6mm bullet, expanding two and a half times, is actually .60-caliber by the time it is halfway or less through the animal. The heavier .35-caliber bullet, moving slower, may expand only twice — to about .70-caliber.

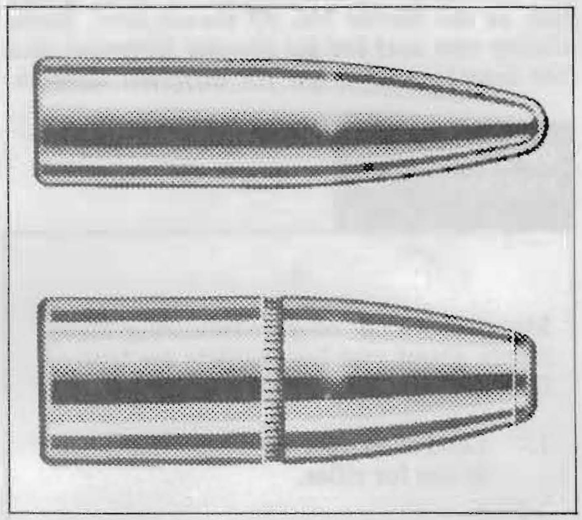


FIGURE 13 — Light bullets driven at high velocity and with correct jacket thickness, like the 6mm bullet shown, are often deadlier than bullets weighing twice as much that move more slowly.

ANSWERS

	1		
1.	False	4.	False
2.	True	5.	False
3.	True	6.	True

Wider, slower moving bullets often leave slightly larger wound channels, which make for more visible blood trails. On the other hand, the smaller missile entering the rifling more rapidly rotates faster, thus increasing hydrostatic shock (the explosive effect on liquid-filled tissue). In any event, the idea is to kill cleanly without need for trailing, and the foot pounds of energy delivered (and retained by the animal) is the generally accepted measure of a bullet's stopping and killing power.

We emphasize that most causes of bullet "malfunotion" are caused by not matching the bullet to the job. The biggest complainers about "lousy bullets" are those uninformed souls who equate muzzle velocity with "power," not realizing that the short, light bullet steaming out of the muzzle like a goosed missile is often moving slower at game-hitting range, and possesses less energy, than the heavier bullet that *should* have been used. The light bullet also has a higher trajectory at the longer ranges, thus compounding errors in range estimation.

When ultra-high-velocity varmint bullets (60 to 70-grain 6mm's and 60 to 87-grain .257's, for example) are used on deer, a short-range hit usually produces a shallow, but wide "crater-type" wound that fails to drop the animal, leaving him to await a miserable death hours or even days later. A long-range hit with such a bullet is less messy, but just as unmerciful. The still intact bullet will usually kill, but much, much later. See Figure 14.

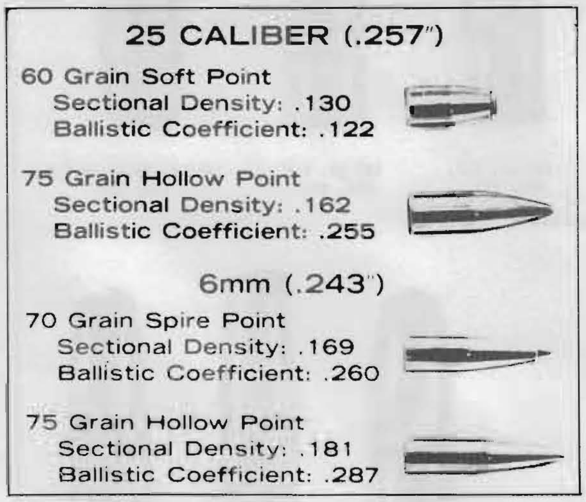


FIGURE 14 — Varmint-type bullets such as the above do a splendid job for the purpose intended. They should never be used on deer-sized game.

EXPANSION CONTROL TESTS

Bullet expansion and the ability of the core and jacket to stay together at impact are controlled by a number of factors, primarily the amount of lead exposed and the jacket thickness at various points, relative to velocity and to the density (resistance) of the target's tissues (see Figure 15).

Expansion of game bullets is tested by firing, at various ranges, into cotton, clay, or blocks of polyurethane or gelatin (see Figure 16). The latter most closely approximates animal tissue (see Figure 17).

To narrow down the performance parameters, most manufacturers make a number of bullets for a given caliber — each designed for a specific type of animal, whether rockchuck or elk (see Figure 18). There are a great many different types of jacketed bullets, many shapes, and many methods of controlling performance. These factors will be discussed a bit later. First let's talk about how a jacketed bullet is made.

JACKETED BULLET MANUFACTURE

Most jacketed bullets start out as a large roll of gilding metal (a brass alloy), of a thickness specified by the bullet manufacturer for a particular caliber and type of bullet. This roll or sheet is fed into a specialized press which punches out little round discs (see Figure 19). These discs are then drawn into elongated cups by another type of press. The process is quite similar to that used in forming .22 rim-fire cases, and the embryonic jackets indeed resemble rim-fire cases (see Figure 20). (Vernon Speer, of Speer, Inc., started his company by manufacturing .22 center-fire bullets from discarded .22 shooting gallery cases.)

Jacket wall uniformity is extremely important, as even a near microscopic difference in wall thickness at one side can influence the bullet's gyroscopic stability, causing accuracy loss.

The lead cores reach the bullet manufacturer in the form of heavy lead "wire," which is wound around large spools. This rough wire (see Figure 21), to which 1% to 3% antimony has been added (and sometimes tin), is then drawn or extruded to a precise, slightly-wider-than-jacket diameter and chopped into specified lengths. These cut sections are the cores which, in the "cold" process, are then machine swaged into the open end of the jackets. This technique, used by the smaller manufacturers, provides a reasonably tight core/jacket "fit" to keep the components together during rotation in the barrel, and when striking the game.

Hot Cores are Frequently Used

This stage of bullet manufacture — in-

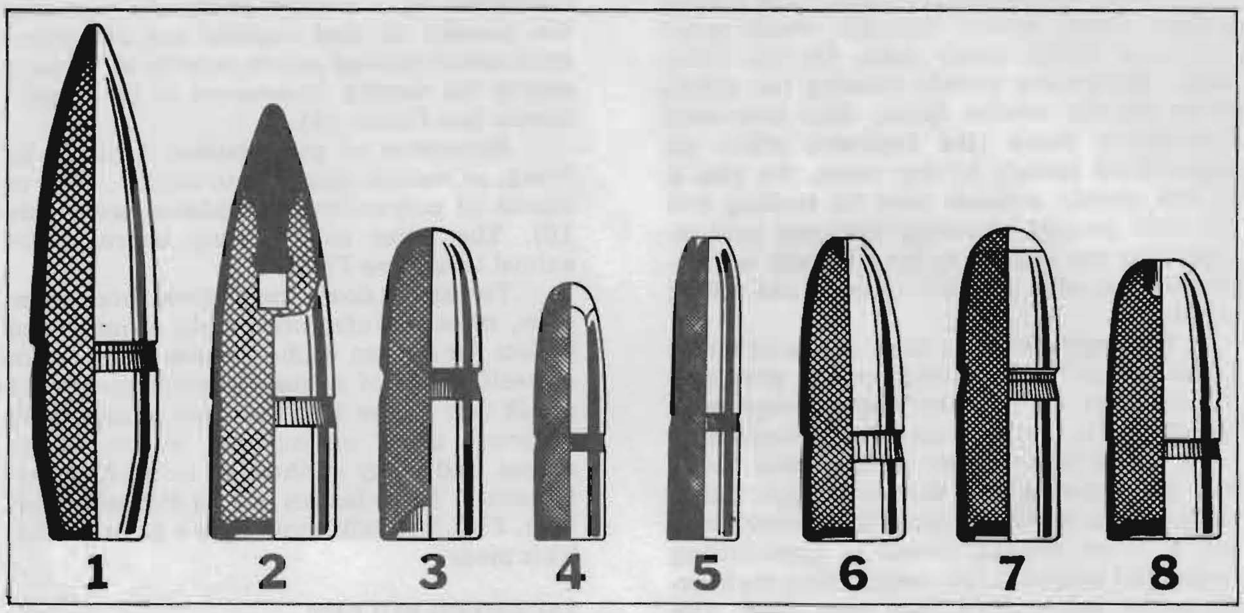


FIGURE 15 — Modern bullet design is exemplified by these Remington bullets: (1) metal jacket boattail; (2) bronze-point expanding; (3) metal jacket, solid or "full-patch" point; (4) inner belted soft-nose; (5) "Core-Lokt" hollow-point; (6) metal jacket hollow-point; (7) soft-point; (8) metal jacket hollow-point. (Cross-hatching represents the lead core, the heavy black line the jacket.)

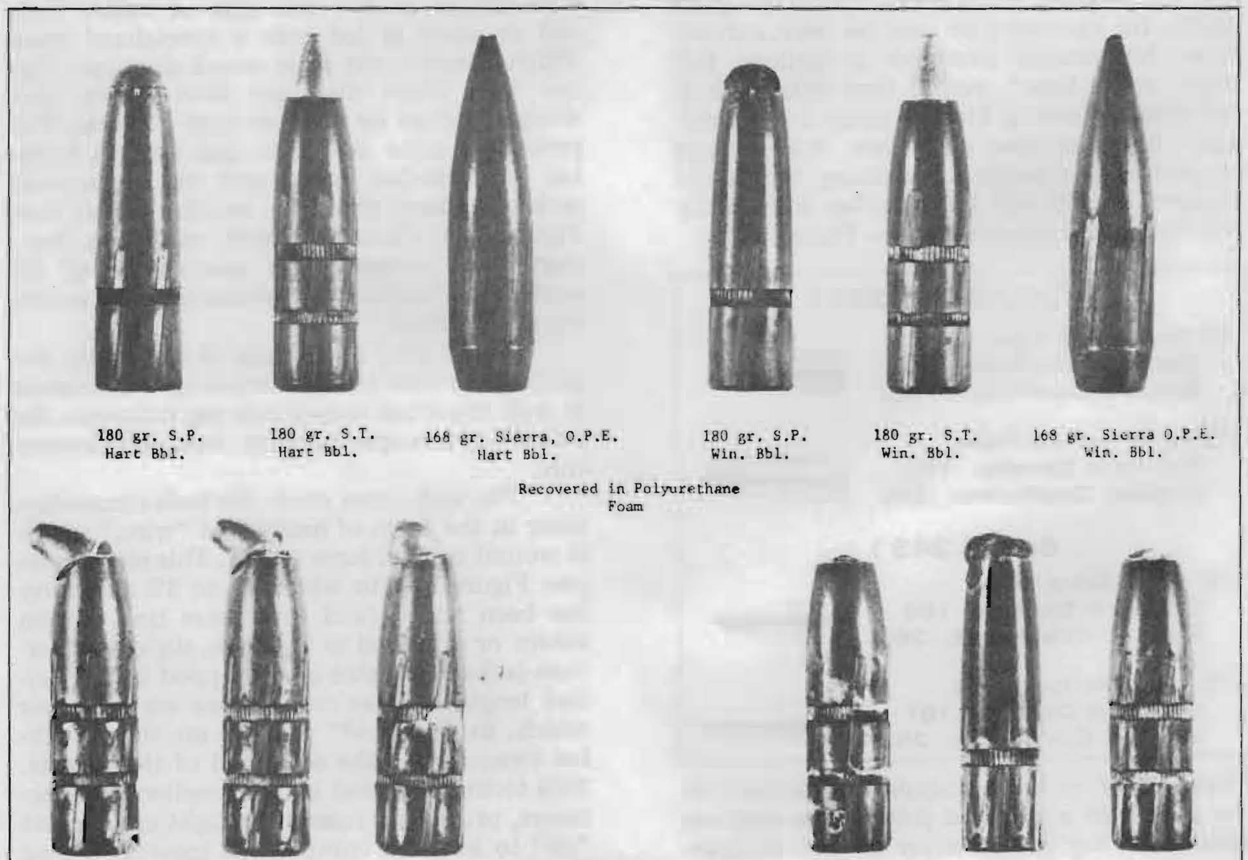
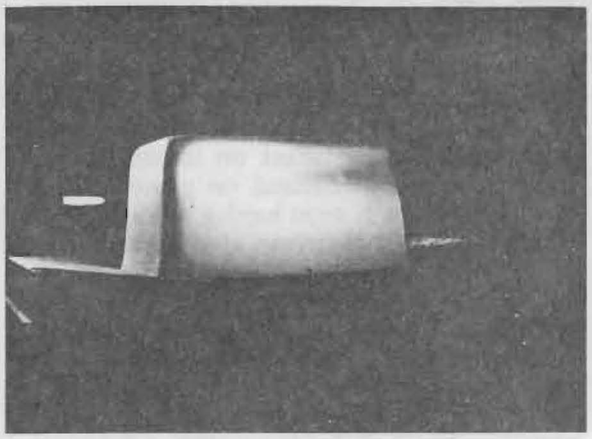
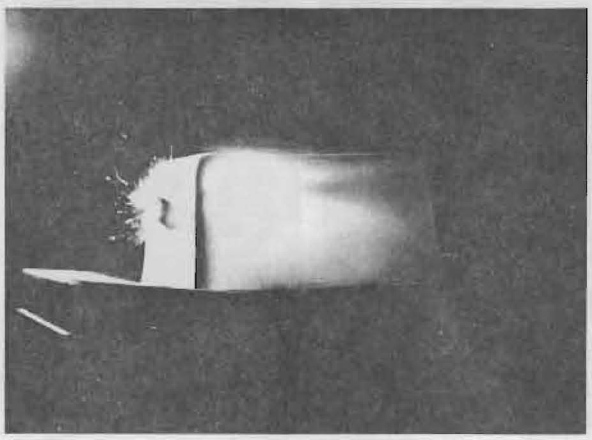


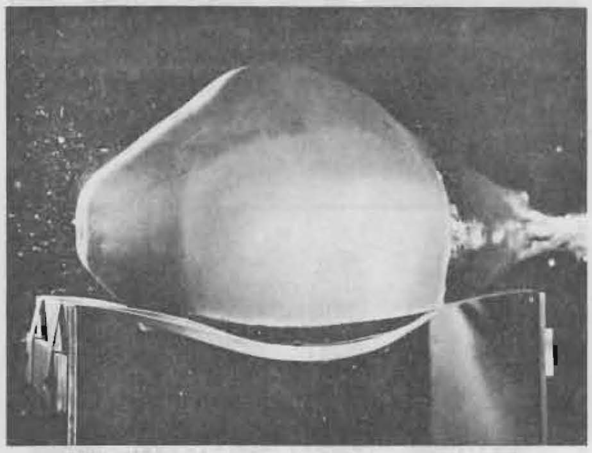
FIGURE 16 — Comparative study of bullets fired into polyurethane foam (top) and absorbent cotton. Spent bullets recovered in the foam revealed no expansion or point deformation.



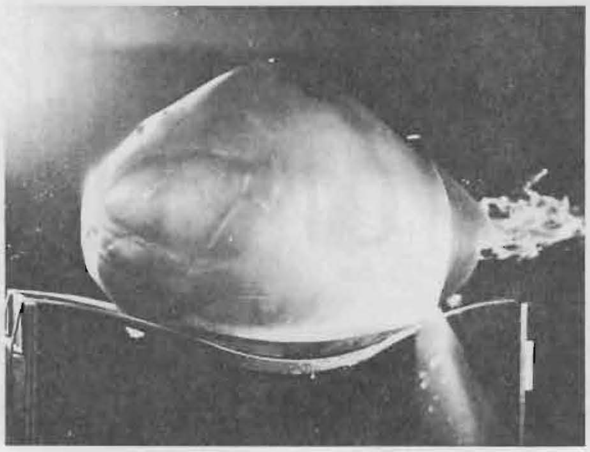
Bullet approaching gelatin block.



Bullet contacting gelatin block.



Full expansion of the Silvertip bullet at 100-yard velocity.



Full expansion of the Power Point bullet at 100-yard velocity.

FIGURE 17 — Bullet expansion on game is closely approximated by firing into gelatin blocks.

30 CALIBER (.308")

100 Grain Short Jacket
Sectional Density: .151
Ballistic Coefficient: .130

110 Grain Spire Point
Sectional Density: .166
Ballistic Coefficient: .256

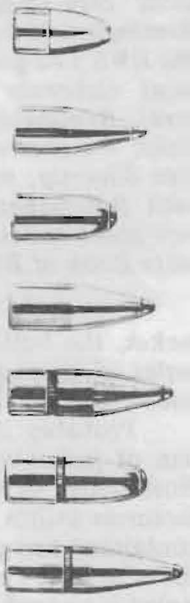
110 Grain Round Nose
Sectional Density: .166
Ballistic Coefficient: .135

130 Grain Spire Point
Sectional Density: .196
Ballistic Coefficient: .292

150 Grain Spire Point
Sectional Density: .226
Ballistic Coefficient: .359

150 Grain Round Nose
Sectional Density: .226
Ballistic Coefficient: .210

165 Grain Spire Point
Sectional Density: .248
Ballistic Coefficient: .382



168 Grain Boat Tail H.P. Match
Sectional Density: .253
Ballistic Coefficient: .550

170 Grain Flat Point
Sectional Density: .256
Ballistic Coefficient: .204

180 Grain Spire Point
Sectional Density: .271
Ballistic Coefficient: .482

180 Grain Round Nose
Sectional Density: .271
Ballistic Coefficient: .228

190 Grain Boat Tail H.P. Match
Sectional Density: .286
Ballistic Coefficient: .610

220 Grain Round Nose
Sectional Density: .331
Ballistic Coefficient: .290

220 Grain Full Metal Jacket
Sectional Density: .331
Ballistic Coefficient: .315

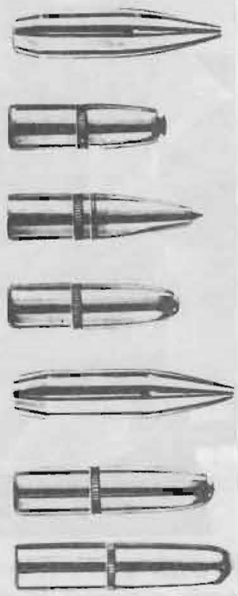


FIGURE 18 — More bullets, of different shapes and weights, are made in the popular .30-caliber than in any other bore size. Above is the .308" lineup available to reloaders from Hornady.

FIGURE 19 — A gilding metal strip is fed into the specialized cupping press at Sierra Bullets, where the jackets are blanked and cupped.

FIGURE 20 — As many as four steps are necessary to transform the blank disc into a jacket ready for core insertion.

FIGURE 21 — A craftsman at Sierra Bullets inserts a heavy lead alloy billet into an extrusion press which forms lead "wire" used in core manufacturing.

stalling the core in the jacket — is so critical that the larger companies often use hot lead cores, or soldered-in-place cores, for better bonding. A core that comes loose and rattles around inside the jacket during flight, and/or separates from its jacket on impact, is both inaccurate and inefficient on game. This potential problem is even harder to engineer out when the bullet is driven at ultra-high "magnum" velocity, from 3,300 to 4,000 fps.

Modern high-velocity bullets often employ a hot lead core *plus* a jacket which is contoured on the inside (see Figure 22). The variances in internal wall thickness provide a better grip on the core while controlling expansion. The soft lead core "flows" into the jacket, conforms to the wall contours, then hardens. Regardless of the method used to bond the core to the jacket (and there are many), extreme care is taken to assure that no foreign matter, lubricants, or even oxidation (forming lead oxide) gets between the jacket and the core.

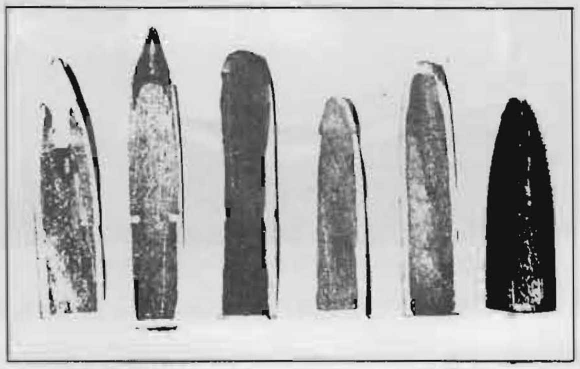


FIGURE 22 — Hunting bullet cross-sections show core/jacket construction. From left: Remington 180-grain .30-caliber Bronze Point; the RWS 173-grain 7mm boattail, possibly the most elaborate bullet ever constructed (see text); Remington 220-grain .30-caliber Core-Lokt; Winchester-Western 130-grain .270-caliber Silvertip; military 175-grain 7mm round with full jacket; Speer 150-grain .30-caliber soft-point spitzer. (Photo courtesy of "Complete Book of Rifles and Shotguns")

Following swaging of the core to the jacket, the bullet is given its final form by a series of shaping dies which also help assure concentricity.

Probably the best solution to the problem of jacket/core separation is provided by Nosler, and by RWS of Germany. Both manufacturers utilize an "H-partition" type jacket, containing *two* cores. After the rear and sometimes heavier core is placed in the jacket, the jacket is swaged closed just in front of the rear core; a second core is inserted in the front of the jacket, which is then tapered to the point configuration desired. The front core is designed to expand, while the rear core retains its original diameter and shape for good penetration.

The jackets of Nosler partition bullets, unlike the drawn variety, are drilled out of lengths of gilding metal rod (see Figure 23). In Nosler solid copper-base bullets, the rear section is left solid; only the front section is drilled to accommodate a core. Regardless of design, Nosler bullets have an enviable reputation in the game field. They cost more, but they hang together under any and all conditions.

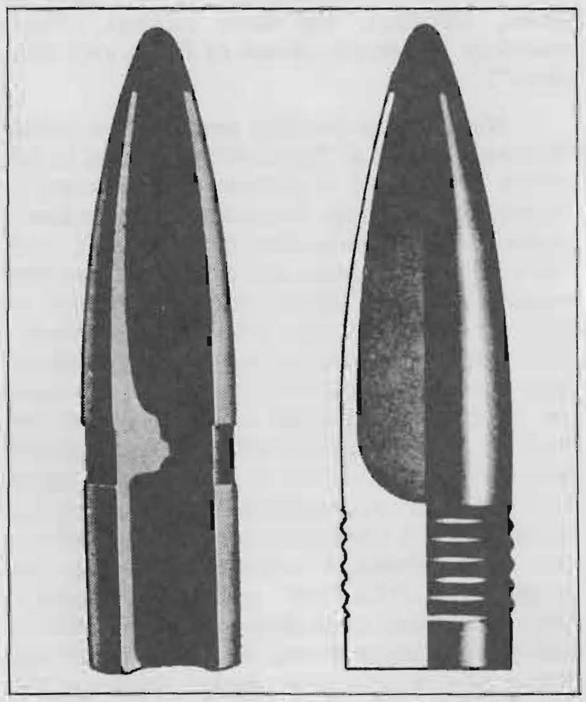


FIGURE 23 — The Nosler partition bullet (left) utilizes two lead cores; the Nosler solid-base (right) has one core over a solid copper base. The annular ridges at the base are to achieve a better gas seal (they are not cannelures).

Probably the most complicated bullet ever developed is the famous 177-grain 7mm job produced by RWS (see Figure 22). Like the Nosler partition, it has two lead cores. The back core is hard for maximum penetration; the front core is soft for expansion. The bullet has a tapered boattail at the rear, and a hollow-point tip which is covered by a sharp metal shield. The cost today probably exceeds that of the silver bullets favored in Transylvania (and silver bullets are expensive, even when they're mythical).

Before going on, please do Programmed Exercise 2. Make sure you write your answers on a separate sheet of paper before looking at the answers on the page specified.

PROGRAMMED EXERCISE

2

"Diagnose" the impact performance of a bullet, listed in the top list, with the cause, listed in the bottom list.

___ 1. Ideal bullet for the game being hunted.

___ 2. Bullet too light and fast for game at short range.

___ 3. Bullet too heavy for game and range.

___ 4. Bullet too light for game at long range.

___ 5. Core/jacket not properly bonded in manufacture.

A. Travels cleanly through the target without expanding.

B. Core and jacket separate on impact.

C. Expands two and a half to three times original diameter and stops intact just under the skin opposite entry.

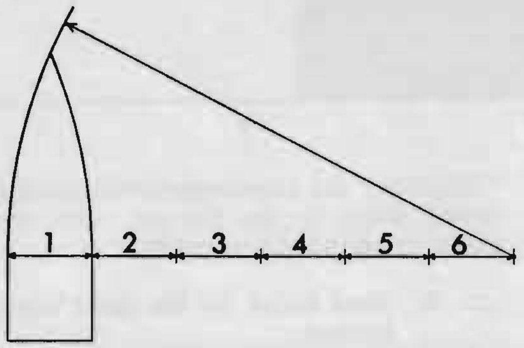
D. Bullet enters target and remains intact and unexpanded.

E. "Blow-up" occurs or a large, shallow wound is inflicted.

Answers on Page 12

Many Manufacturing Options are Available

The finished bullet may have a pointed spitzer, semi-spitzer, or round-nose shape; a long or short ogive (see Figure 24); a flat, tapered, or stepped (lapua), boattail base. The tip may be of soft point with wedge, hollow-point, or solid design. The jacket may be notched or serrated to peel back like a banana on impact. A cannelure (groove or grooves around the jacket diameter) may be incorporated, into which the case mouth will be crimped (see Figure 25). The caliber, velocity, type of game, and sometimes even the kind of gun, all determine a given bullet's design, construction, and performance characteristics.



BULLET OGIVE ON A RADIUS OF SIX DIAMETERS

FIGURE 24 — Bullet "ogive" refers to the taper just in front of the cylindrical portion of the bullet. The radius of the ogive is usually measured in caliber diameters, as shown above. The blunter the bullet, the more abrupt the curve or ogive and the fewer the diameters required to "describe" the radius.

338 CALIBER (.338)

200 Grain Spire Point
Sectional Density: .250
Ballistic Coefficient. .384

200 Grain Flat Point
Sectional Density: .250
Ballistic Coefficient: .200

225 Grain Spire Point
Sectional Density: .281
Ballistic Coefficient: .452

250 Grain Round Nose
Sectional Density .313
Ballistic Coefficient: .280

250 Grain Full Metal Jacket
Sectional Density 313
Ballistic Coefficient: .301

FIGURE 25 — Cannelures are usually incorporated on the heavier bullets for a given caliber, and on all heavy, large-bore bullets like the .338" Hornadys shown. The better case mouth-to-bullet fit provided by cannelures helps prevent bullets of heavy mass from "popping out" of the case necks when in the magazine and under heavy recoil.

Composition of Jackets

Most bullets of U.S. manufacture use a gilding metal composed of 90% to 95% copper and 5% to 10% zinc. The relatively few bullets made for large and dangerous African and Indian game, usually called solid or full-patch, aren't really "solid" at all — but have the usual lead core jacketed in mild or soft steel, or in an alloy of copper, zinc, and nickel. The object is to produce a jacket soft enough to avoid barrel damage, yet hard enough to drop an elephant or Cape buffalo without the bullet deforming or flying apart (see Figure 26).

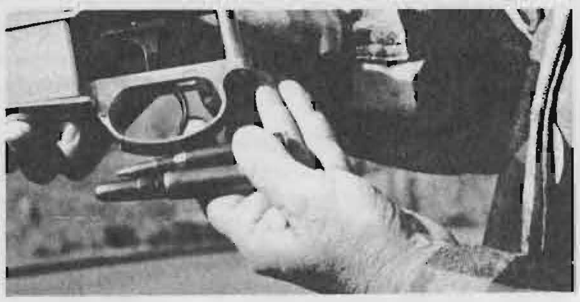


FIGURE 26 — The massive .416 Rigby (shown with a .30/06 for comparison) is typical of the cartridges loaded with heavy solid or "full-patch" bullets which are used on rhino, elephant, and Cape buffalo. (Photo courtesy "Complete Book of Rifles and Shotguns")

Norma, the Swedish ammunition manufacturer, makes a "Tri-Clad" soft steel jacket which represents a unique development in bullet manufacture. Norma's jacket material starts out as a brick-sized block of soft steel. Thin slabs of a special alloy consisting of 90% copper and 10% nickel are then welded to each of the four sides of the steel "brick." This brick is then rolled to the desired thickness for a given caliber. The result is a sheet or "sandwich" with the soft steel center layered on top and bottom with the copper/nickel alloy. The steel jacket is thus coated inside and out with copper/nickel, resulting in a bullet that won't harm the bore, or rust, and one that is sufficiently accurate for use in fine target rifles. "Tri-Clad" jackets aren't new — they have been used since the early 1900's in the world's game fields, and in Swedish and Swiss rifle competition. Jacket thickness and whether or not lead is exposed at the tip (and how much) determine the suitability of given "Tri-Clads" for everything from elephants to paper punching.

Jackets are Multi-Functional

The most obvious purpose of the jacket is to control expansion, contain the core, and keep the bullet together at impact. A less obvious purpose is to protect the bullet from the heat of the burning powder. Once the bullet is jacketed and prevented from melting, the manufacturer must concern himself with bullet performance at impact (unless it's a target projectile).

ANSWERS

2

1. C 2. E 3. A 4. D 5. B

Target-type bullets are usually the easiest to manufacture from a design standpoint, although extreme quality control must be exercised for uniformity and consistent shot-after-shot accuracy. Such bullets may have a flat base; if used for long-range shooting, they usually incorporate a tapered or step-boattail design which, together with a high ballistics coefficient, results in minimal drop at extreme ranges. The tips may be of either the solid or hollow-point variety. The latter incorporates relatively small "hollow points" and is not to be confused with the hollow-points used in light varmint and small game bullets.

Target hollow-points have a heavy jacket thickness at the nose, and at the comparatively low target velocities utilized, expansion in game animals is usually inadequate. Target hollow-points are also a poor choice for ground varmints as such bullets will ricochet (see Figure 27).

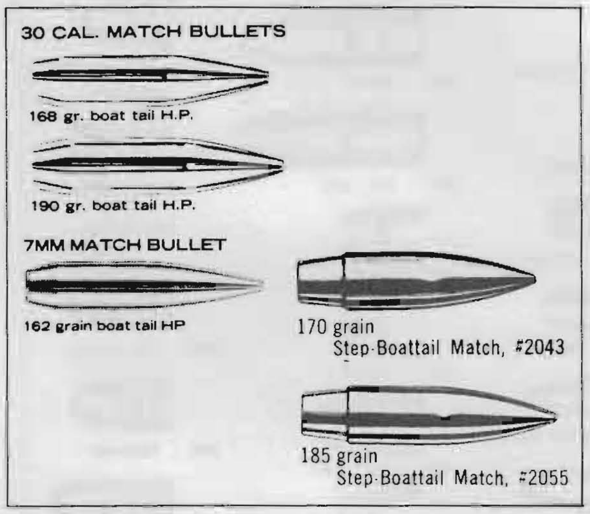


FIGURE 27 — Target bullets are most often made in 7mm and .30-caliber and with small hollow points. The tapered boattail design, as exemplified by the Hornady designs at left, are the most familiar. The new stepped boattail "lapua" design offered by Speer is becoming increasingly popular. The latter, for closer bullet/bore fit, are made in both .308" and .309" diameters.

Bullets designed for game compound the manufacturer's problem. To narrow the requirements for a given bullet, there are five different types of game bullets, at least four of which are usually available for a given caliber. Classifications follow.

The Five Classifications of Hunting Bullets

Light Bullets. These are of either hollow-point or soft-point spitzer construction with thin jackets. They are designed to be driven at high velocities and to blow up (fragment) upon striking the game animal or the ground. They are used on ground varmints up to coyotes in size, where a ricocheting bullet could endanger the inhabitants of adjoining farms and towns. Examples are the 100-grain .30-caliber spitzer, the 60-grain 6mm bullets, and the 60-grain and 75-grain .257-caliber projectiles.

Medium Bullets. These are usually one bullet weight "up" from the large varmint variety, utilizing hollow-point or exposed lead tips and heavier jackets. These bullets, such as the 130-grain .270-caliber and the 150-grain .30-caliber, are designed for medium-sized big game like smaller deer and antelope.

The "All-Around" Bullets. Examples here are the 165-grain and 180-grain .30-caliber and the 150-grain .270-caliber, which are large enough for moose and elk, yet with a jacket thin enough to expand satisfactorily on smaller deer-sized game — which may be encountered in the same hunting country.

Heavy Soft-Point Bullets. These, like the 200-grain and 220-grain .30-caliber, are designed for deep penetration in large, soft-skinned, and sometimes dangerous game such as the polar, Kodiak, and grizzly bears. Such bullets usually have extremely thick jackets.

Heavy, Steel-Jacketed "Solids." These bullets are normally used in guns of .375 to .458 bore diameter and are capable of penetrating the skulls of elephant or Cape buffalo or driving through large, dangerous animals like buffalo or rhino.

To further complicate the issue, medium to big-game bullets are usually made in two shapes — spitzer and round-nosed — for a given bullet weight. They expand about the same, but the round-nosed type does a better job of penetrating brush. It sheds velocity faster, but because it is customarily fired at short range, no particular disadvantage is imposed by the blunt tip.

Yes, there are many ways to build a bullet to accomplish a specified design objective. The manufacturer can use one or two cores; he can make a core lighter and harder by adding an alloy; the jacket can be thick or thin at the nose; the tip can expose a great deal of lead or just a smidgen; he may elect to use a hollow point and the cavity can be wide or narrow, shallow or deep. The manufacturer may even use a wedge (like the Remington bronze-point) to protect the tip in the magazine and to split the jacket on impact.

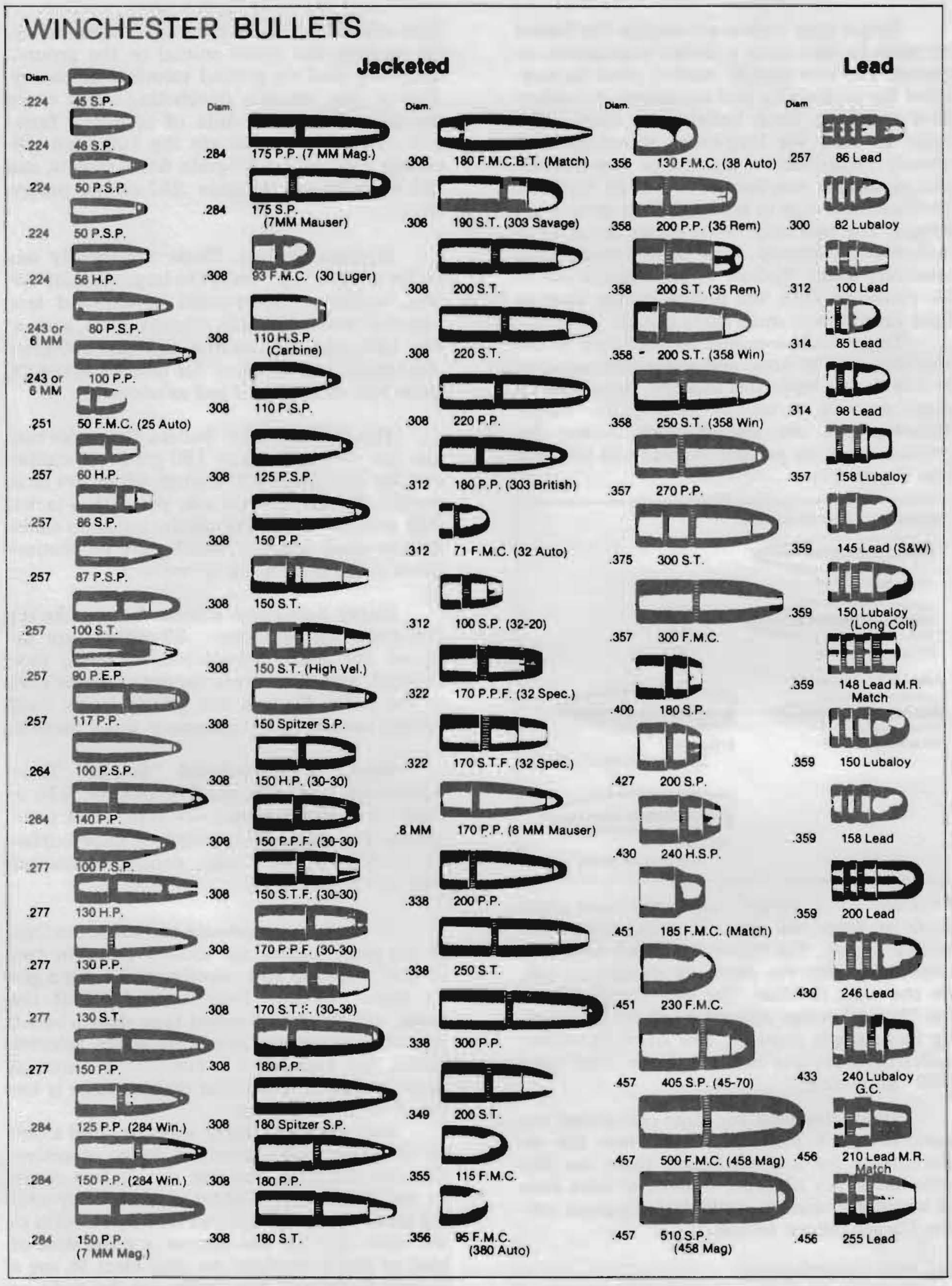


FIGURE 28 — The major ammo manufacturers, Winchester and Remington, also offer a wide variety of jacketed and lead bullets for the reloader. This listing of Winchester bullets shows the wide variance in bullet design and construction within a given caliber.

There are even more electives than those mentioned for the manufacturer to consider when putting a bullet into production. How well the bullet maker juggles these alternatives for an "average" animal at an "average" range and at an "average" velocity determines the performance of the bullet in the field. It may not be possible to please "all the customers all the time," but most bullet manufacturers come admirably close.

Before going on, please do Programmed Exercise 3. Make sure you write your answers on a separate sheet of paper before looking at the answers on the page specified.

PROGRAMMED EXERCISE

3

Match the bullet classifications in the top list with the summaries from the bottom list that best describe them.

___ 1. Light

___ 2. Medium

___ 3. "All-around"

___ 4. Heavy soft-point

___ 5. Steel-jacketed "solid"

A. Designed for heavy penetration with heavy jacket.

B. Hollow-point or soft-point spitzer tip with thin jacket, designed for high velocity and fragmentation.

C. Extremely heavy jacket, designed for the greatest power and penetration.

D. Hollow-point or exposed lead tip with mid-weight jacket, designed for mid-size big game.

E. Mid-range, mid-weight, designed for versatility mid-size to large big game.

6. What are the purposes of a bullet jacket?

Answers on Page 16

Know What Type of Bullets to Recommend

As a gun pro, you'll frequently be asked for recommendations as to what type of bullet to use for a particular species of game. Your geographical location (or where your customer is going to hunt) has everything to do with the basic choice. If he's going to be shooting in dense brush or heavily wooded areas, regardless of his quarry (and bullet weight), he should use blunt, round-nosed bullets — the heavier the better — driven at moderate velocity. Such bullets do a good job of bulldozing through brush and will not be appreciably deflected by a small branch or twig. Game is usually shot at relatively short range in such cover because of the visibility factor, and your client can forget about trajectory. Even shots across clearings in wooded country are seldom over 150 yards, where drop is minimal with heavy bullets from modern rifles.

Conversely, hunters who shoot in the wide open spaces should not use blunt, heavy bullets unless they plan to hit their quarry on top of the head. The ticket is the long, pointed spitzer bullet of a weight matched to the game. These projectiles, when driven at a respectable velocity, shoot much flatter than round-nosed bullets and minimize the errors in range estimation that are so easy to make on long, cross-canyon shots.

Spitzer bullets moving at high velocity do not perform well in wooded country, as a mere brush against a twig can wildly deflect the bullet or even cause it to blow up.

Flat-Nosed Bullets and Spitzer Speeds

Occasionally you'll come across a gent who has the bright idea of loading flat-nosed .30/30 type bullets to super velocities in .30/06 or even .300 Winchester magnum rifles with the idea of producing a "super shocker" (see Figure 29). Or he may have some old bullets on hand that he wants to use up.

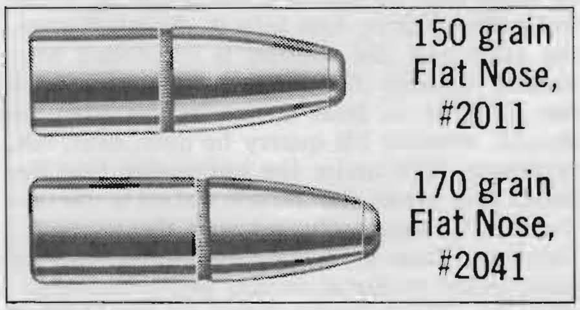


FIGURE 29 — Flat-nosed bullets, like the Speers illustrated, are intended for use in .30/30's with tubular magazines. They are not designed to be driven at magnum velocities on medium or big game.

ANSWERS

3

1. B 2. D 3. E 4. A 5. C

6. To control expansion, contain the core, hold the bullet together on impact, and protect the bullet from the heat of burning powder.

There's a big difference between round-nosed and flat-nosed bullets. The latter are designed for velocities of around 2,200 fps maximum. Drive them at around 3,000 fps and they shed velocity so fast that at medium and long ranges you might as well throw rocks. Short-range hits can result in bullet disintegration because of the large amount of lead exposed. Load such bullets down to the original velocities and performance is satisfactory.

Flat-nosed bullets shouldn't be driven at high velocity any more than spitzer-type bullets should be used in tubular magazines. Either way, the results can be "explosive."

While we are on the subject of flat-nose bullets, let's discuss legendary "Dum Dums," as all expanding bullets are still called by uninformed members of the press. The term originated in the 1890's when English troopers, in trying to control their territory in East India, found that their opponents could absorb two or three .303 full-jacketed slugs without even slowing down. Someone came up with the idea of filing off the noses and exposing the cores of the military bullets. These did the trick, no doubt about it. As a result of the grievous wounds caused by "Dum Dums," expanding bullets of any type were later outlawed for warfare at the Geneva Convention.

Other than recommending a basic bullet type, you'll be called on to recommend proper bullet weights. Here, your job will probably be more that of talking a client out of something than talking him into it. As mentioned, the rank and file shooter is enamored with muzzle velocity figures and often wants to use a bullet at least a size lighter than he should, whether his quarry be deer, bear, elk, or moose. He's under the impression that the bullet that leaves the muzzle fastest is the one that hits his target "fustest with the mostest." Tain't so. There are a couple of things involved here, called sectional density and ballistics coefficient, which make your customer dead wrong. We have discussed these factors previously and briefly. Let's expand a bit on the subject (you may have skipped over it before) and nail it down once and for all. Explain to your customers just why heavier bullets are better at game ranges in all respects and they may leave shaking their head — but agreeing that you know your stuff!

SECTIONAL DENSITY

Relax, we're going to make this painless. The subject is rooted in math, but the principle of proportion and resistance is no more difficult than understanding why a nicely proportioned woman encounters less resistance — among males, that is.

Let's talk about sectional density first. Sectional density is the ratio of a bullet's weight to its bore diameter, expressed as a number. Okay, let's simplify. The material from which a bullet is made, basically lead, is constant. So, the more a bullet weighs for its bore diameter, the longer it has to be — and the higher its sectional density number. For example, a 150-grain .30-caliber bullet (regardless of the shape of its nose) has an SD (sectional density) number of .226. The 190-grain .30-caliber match bullet, being heavier, is also longer — and has an SD of .286 (see Figure 30).

100 Grain Spire Point
Sectional Density: .242
Ballistic Coefficient: .376

250 Grain Spire Point
Sectional Density: .279
Ballistic Coefficient: .383

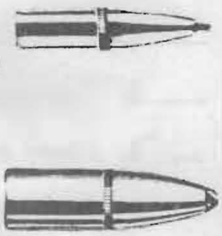


FIGURE 30 — Sectional density and ballistics coefficient have nothing to do with caliber. The "numbers" of the 6mm bullet (top) are almost identical to those of the .358 bullet shown for comparison. Trajectories of these bullets, when driven at the same velocity, would be almost identical.

In other words, for a given caliber, the lighter (and shorter) the bullet, the lower its SD number; the heavier (and longer) the bullet, the higher its SD number. The SD number gives a basic or preliminary idea of a given bullet's performance characteristics because a long bullet retains velocity while a short bullet sheds velocity. But, nobody shoots rifle bullets that are plain cylinders and flat at the nose. The shape of the bullet's nose is as important as the bullet's length in determining flight characteristics.

BALLISTICS COEFFICIENT

The shape of the bullet's nose is described, in effect, by its BC (ballistics coefficient) number, another arbitrary figure that "tells" how easily a given bullet will overcome air resistance and slip through the atmosphere. The BC number isn't based on the bullet's nose shape alone; it's based on the sectional density *plus* the nose shape (see Figure 31). The reason is that a short bullet with a sharp nose will drop faster than a long bullet with the same sharp nose. The BC number, therefore, "describes" the performance of the bullet as a whole.

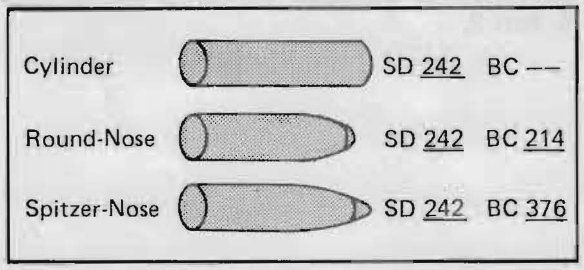


FIGURE 31 — All three forms have the same sectional density. The more streamlined the nose, the higher the ballistics coefficient number.

The higher the BC number, the flatter a given bullet will shoot. A pointed-tip and a round-nose bullet of the same caliber and bullet weight will have the same sectional density number. But the BC number of the pointed-tip bullet will be higher than that of the round-nose bullet. Which tells you that the high-BC bullet will shed velocity less rapidly. As if you didn't know.

WHY HEAVY BULLETS CATCH UP

As an example of why heavier and longer high-BC bullets are usually moving faster at game range than a lighter bullet with a lower BC that starts out faster, consider the 130-grain, 150-grain, and 165-grain .30-caliber bullets with BC's of .292, .359, and .382 respectively.

The 130-grain bullet, starting out at 3,000 fps, is down to 2,082 fps at 300 yards where our hypothetical deer is standing. The 150-grain bullet, commencing at 2,900 fps, is clocking off 2,154 fps at the same range. The 165-grain bullet, with a muzzle velocity of 2,800 fps, is moving along at 2,111 fps at 300 yards. The heavier bullets are moving faster at impact, and their trajectories to the deer were almost identical to that of the 130-grain. Residual energy (killing power) of each of the two larger bullets far exceeds that of the 130-grain, and expansion of the heavier bullets is superior to that of the light bullet — which probably didn't open at all!

Light bullets, relative to medium and big game, are impressive only at the muzzle and at close range, where the projectile often completely disintegrates upon impact!

Do everything in your power to dispel the myth of light, fast-moving, varmint-type bullets being "pure poison" on medium and big game. They are, only in the sense that they cause crippling and lost game, *and* a bad name for hunters.

The various bullet manufacturers' tables found in the leading loading manuals clearly indicate the superiority of proper weight bullets over the lightweights (see Table 1). Bullet energy tables will enable you to quickly compute the energy of any bullet when you know its velocity. We'll discuss muzzle velocity computations in Study Unit 7. And there are dandy little computers that we'll show you later which enable you to quickly and easily determine down-range velocities and residual energies at all hunting ranges.

30-CALIBER (.308" Dia.) 130-GRAIN SPIRE-POINT
Sectional Density: .196   Ballistics Coefficient: .292

VELOCITY (fps)	3000	2670	2363	2082	1825	1595
ENERGY (ft. lbs.)	2599	2058	1612	1251	962	735
DROP: 100 yd. zero	-1.5"	0.0	-3.5"	-13.4"	-31.5"	-60.0"
DROP: 200 yd. zero	-1.5"	1.8"	0.0	-8.1"	-24.5"	-51.3"
DROP: 300 yd. zero	-1.5"	4.5"	5.4"	0.0	-13.6"	-37.6"
DROP: 400 yd. zero	-1.5"	7.9"	12.3"	10.3"	0.0	-20.5"
DROP: 500 yd. zero	-1.5"	12.0"	20.5"	22.6"	16.5"	0.0

30-CALIBER (.308" Dia.) 165-GRAIN SPIRE-POINT
Sectional Density: .248   Ballistics Coefficient: .382

VELOCITY (fps)	2800	2556	2326	2111	1911	1725
ENERGY (ft. lbs.)	2873	2393	1983	1633	1338	1090
DROP: 100 yd. zero	-1.5"	0.0	-3.8"	-14.2"	-32.8"	-61.3"
DROP: 200 yd. zero	-1.5"	1.9"	0.0	-8.4"	-25.1"	-51.6"
DROP: 300 yd. zero	-1.5"	4.7"	5.6"	0.0	-13.9"	-37.6"
DROP: 400 yd. zero	-1.5"	8.2"	12.6"	10.4"	0.0	-20.2"
DROP: 500 yd. zero	-1.5"	12.3"	20.7"	22.6"	16.2"	0.0

TABLE 1 — Excerpts from the Hornady Handbook Ballistics Tables show that heavier bullets retain velocity better at the longer ranges, while trajectories are nearly identical.

As a gun pro, an important part of your job is educating your customers. And education in the selection of proper hunting bullets, and their ballistics, is sorely needed — for the protection of game and hunting in our "gun-controlled" country.

Before going on, please do Programmed Exercise 4. Make sure you write your answers on a separate sheet of paper before looking at the answers on the page specified.

THE BULLET MANUFACTURERS

Reloading has become such big business that the bullet manufacturing industry has become highly competitive. Today's high standard of excellence has resulted in present "hunting" bullets being more accurate than the match bullets of a decade or two ago. Winchester and Remington make fine bullets not only for their own cartridges, but also for the reloader. The big three independents are Speer, Sierra, and Hornady, all of whom produce ballistics and reloading data of a quality at least equal to their products.

To have in-depth information on all bullets and their performance characteristics,

PROGRAMMED EXERCISE

4

1. Which of the following .30-caliber bullets will have the highest sectional density number?

   150-grain
   165-grain
   130-grain
   170-grain

2. Which will be shortest?
3. Which will be longest?
4. Which will have the greatest residual energy?
5. Which will have the least residual energy?
6. Which will be the heaviest?
7. Which will be the lightest?
8. What two factors combine to determine the ballistics coefficient of a bullet?

Answers on Page 20

you should obtain the loading manuals (or at least catalogs) of the three independents mentioned.

The more you know about bullets (upon which depends the performance of the finest rifle or handgun), the better equipped you'll be to serve your customers and convince them of your know-how!

Now, that covers the modern rifle bullet for the time being. Next we'll turn to a consideration of handgun bullets in Study Unit 6, Part 2.

ANSWERS

4

1. 170-grain.

3. 170-grain.
4. 170-grain.
5. 130-grain.
6. 170-grain.
7. 130-grain.
8. The nose shape and the sectional density.

STUDY UNIT 6 – PART 2

DESIGN AND DEVELOPMENT OF THE MODERN HANDGUN BULLET

CAP AND BALL SIX-SHOOTERS OF THE OLD WEST

The familiar TV spectacle of the frontier marshal (or the black-hatted "bad guy") casually picking off a darting opponent at 100 yards with his trusty six-gun is a case of fiction being stranger than truth. Revolvers of the "Old West" were of the cap and ball variety, usually .36 or .44-caliber, and short-range, low to medium-power guns at best. Small-screen "shoot-outs" to the contrary, a ball-firing revolver capable of hitting a post-mounted playing card at 25 yards, much less the post, was as rare as a sheepherder at a cattlemen's convention.

The fact is, conical bullets and metallic center-fire cartridges, with a few exceptions like the .44 S&W Russian, weren't widely used in handguns until the introduction of the Colt single-action Army revolver, the famous "Peacemaker" six-shooter, in 1873 (see Figure 1). This gun, which fired the then-new .45 Colt cartridge, wasn't widely used on the frontier until the 1880's, when the West was largely won. The second most popular cartridge revolver, the hinged-frame .38-caliber Smith & Wesson, didn't appear until 1877. The accuracy and power of these handguns were far superior to that of their cap and ball predecessors.

THE FOUR TYPES OF HANDGUN BULLETS

Handgun bullets share many similarities with rifle bullets; there are also important differences. The similarities are mostly concerned with manufacturing or fabricating procedures; the differences — and there are many — stem from the fact that a handgun bullet is driven at relatively low velocity and is designed for short-range shooting. The four classifications of handgun bullets are as follows . . .

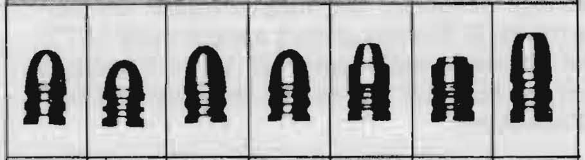
The Lead Bullet

The first revolver bullets were cast of pure lead, as were the balls for muzzleloaders. As velocities were low, in the 750 to 800 fps range, leading posed no particular problem when the bullets were lubricated. Early lead bullets were invariably round-nosed, and in

FIGURE 1 — The legendary .45 Colt "Peacemaker" of 1873, the first Colt to fire metallic center-fire cartridges.

the larger .44 and .45 calibers were effective man-stoppers with or without expansion (which usually resulted only when bones were struck). After more than a century of use, cast bullets are still the first choice of many revolver owners — for use in old guns capable of handling only low-pressure loads, and in new guns as inexpensive target and small game projectiles (see Figure 2).

30 & 32 CALIBER



311227	311252	313226	313249	313445	313492	3118
84 gr.	77 gr.	93 gr.	84 gr.	95 gr.	93 gr.	115 gr.

FIGURE 2 — Molds for casting bullets in a wide variety of shapes and bullet weights are available from Lyman. The full and semi-wadcutter designs appear, respectively, second and third from the right.

Modern cast bullets are almost identical to their early counterparts (see Figure 3) except for the fairly recent availability of the semi or full wadcutter point design. Today's lead bullets, like the early versions, are usually "sized" (by the manufacturer or handloader) after casting for more precise tolerances.

Usually, some older guns, like the .45 Colt revolver, have wider groove diameters (.454) than newer guns of the same caliber, which run from .451 to .452. Since cast lead bullets have a cavity at the base, the bullet will constrict slightly upon entering a slightly undersize bore, thus relieving any potential pressure problem. Cast bullets are sometimes used with gas checks; more often, gas checks are used with the swaged lead bullet.

The Swaged Lead Bullet

Swaged lead bullets (see Figure 4) are relative "Johnny come latelys" and represent the ultimate development of the lead handgun projectile. They are formed by running thick wire, usually hardened with tin or antimony, up into a swaging die. Tolerances and concentricity are much more precise than are afforded by casting, and swaged bullets have no base hollow to affect balance. They work best at medium velocities, up to 1,000 fps, and are splendid for targets and small game. Swaged bullets, whether made by manufacturers or by the reloader with proper dies, are available in a variety of bullet shapes and with or without gas checks (see Figure 5). Most informed reloaders use gas checks because leading can be a problem in the velocity range for which these bullets are intended.

Like cast bullets, swaged lead bullets are most frequently used in revolvers. Swaging die manufacturers make their products for the specific bore size of a given handgun, as the bullets, being solid, will not compress in undersize bores. The semi and full wadcutter design bullets offered by leading manufacturers are invariably swaged of lead alloy. Such bullets are never semi-jacketed (see Figure 6).

The Jacketed Bullet

Jacketed or "full-patch" handgun bullets (see Figure 7) have been around a long time, since the 1890's when the first semi-auto pistols were introduced. Probably the most popular autoloading handgun of all time was invented by John Browning in 1905. It later became the famous U.S. Government Model 1911, which used the 230-grain bullet.

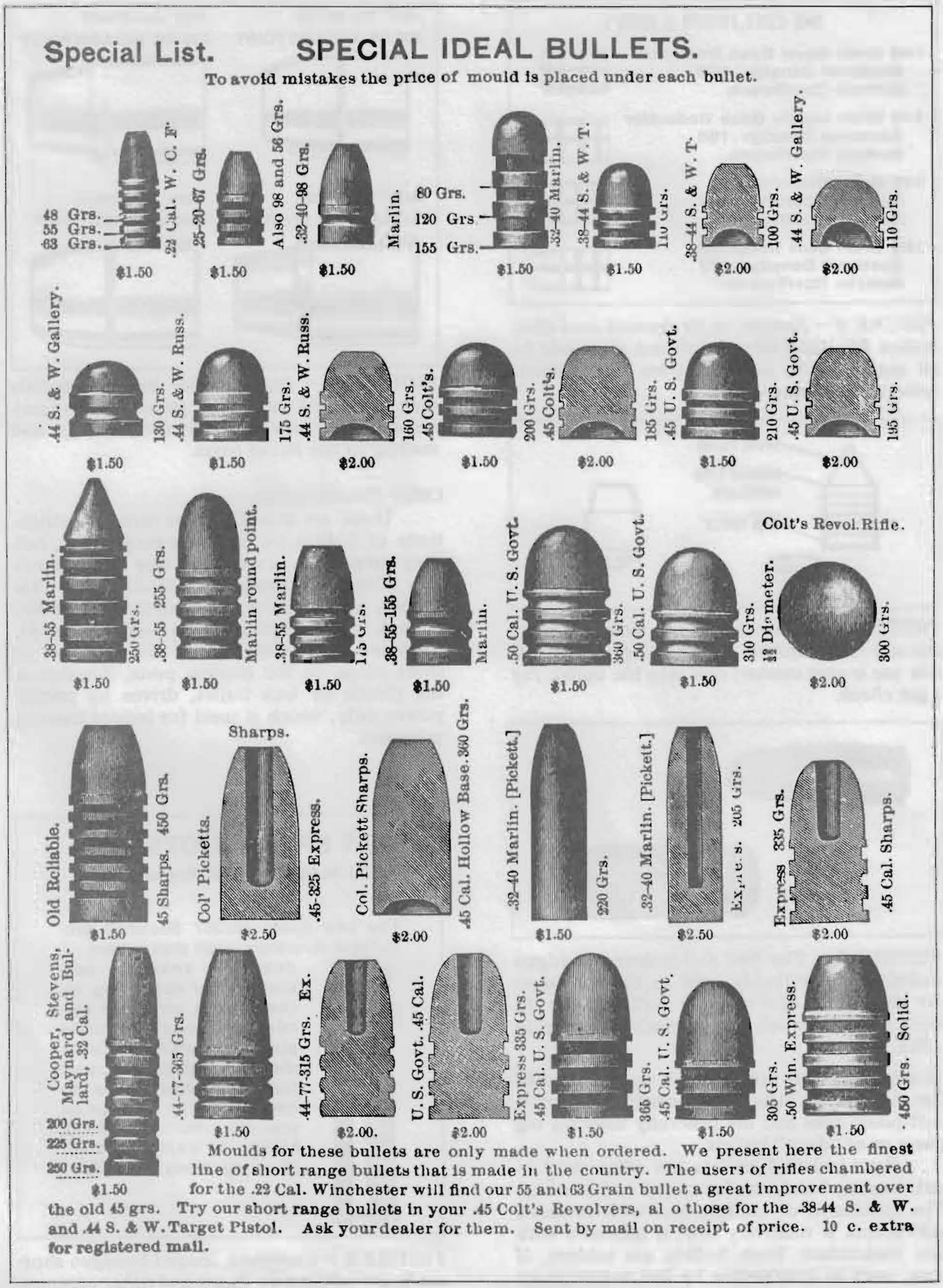
In semi-autos, jacketed bullets were and are necessary not because of velocity (which is usually lower than that of comparable caliber revolvers), but for reliable functioning. The smooth, hard, round-nosed bullets are much less likely to hang up in the magazine or jam against the feed ramp than soft lead alloy bullets. Today, the majority of commercial, semi-auto pistol ammo is full-jacketed. Such bullets, while used primarily for home and self-protection, have little shock value. For this reason, few autoloading pistols are used by U.S. law enforcement officers. Semi-autos are preferred by most foreign police.

Full-jacketed bullets are also used in military handguns, both autos and revolvers. The armor-piercing ammo used in heavy police revolvers, primarily for smashing through motor blocks, is also jacketed, and in mild (soft) steel.

The Semi-Jacketed Bullet

Such bullets, with the jacket extending anywhere from half to three-quarters the length of the bullet, date back to about the end of World War II. They are designed for high velocity, from about 1,000 fps to the over 1,500 fps achieved with light bullets in the .44 magnum and .44 auto magnum. The jackets prevent the bullet from melting, reduce bore friction (the bearing surface is small), and, of course, eliminate any possibility of leading.

The lighter jacketed bullets for a given bore size, like the .38-caliber 110-grain and 120-grain bullets by Hornady, have hollow-point tips for rapid expansion on small game.



Special List. **SPECIAL IDEAL BULLETS.**

To avoid mistakes the price of mould is placed under each bullet.

Moulds for these bullets are only made when ordered. We present here the finest line of short range bullets that is made in the country. The users of rifles chambered for the .22 Cal. Winchester will find our 55 and 63 Grain bullet a great improvement over the old 45 grs. Try our short range bullets in your .45 Colt's Revolvers, al o those for the .38-44 S. & W. and .44 S. & W. Target Pistol. Ask your dealer for them. Sent by mail on receipt of price. 10 c. extra for registered mail.

FIGURE 3 — This reproduction page from the Ideal catalog of 1891 shows that the design and shape of cast bullets have changed little over the years.

38 CALIBER (.358")

148 Grain Bevel Base Wadcutter
Sectional Density: .165
Ballistic Coefficient:

148 Grain Hollow Base Wadcutter
Sectional Density: .165
Ballistic Coefficient:

158 Grain Round Nose
Sectional Density: .177
Ballistic Coefficient:

158 Grain Semi Wadcutter
Sectional Density: .177
Ballistic Coefficient:

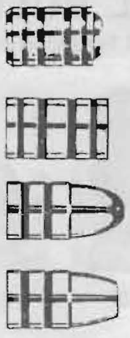


FIGURE 4 — Swaged or die-formed lead alloy bullets like the Hornadys shown are made by all major bullet manufacturers for medium-velocity loadings.

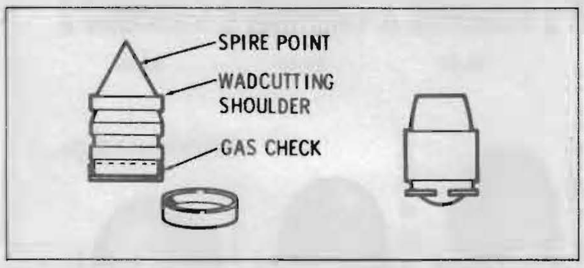


FIGURE 5 — Gas checks are most often of the cup configuration shown at left; some bullets use a zinc washer, cast into the bullet, for a gas check.

FIGURE 6 — The first full-jacketed handgun bullets were probably used in the cartridges for the 9mm Luger of 1902 (left) and the .45 Colt M1911, which was actually invented in 1905.

Heavier jacketed bullets, such as the .38-caliber 158-grain, also by Hornady, employ a soft-point nose and are generally used for big game or as "duty" bullets.

Semi-jacketed bullets are often used in autoloading handguns for target and hunting. The incidence of malfunction with rounded soft-points is relatively low; it increases with the wadcutters. Such bullets are seldom, if ever, used in autoloaders by law enforcement personnel, where a jammed round could make the difference between life and death.

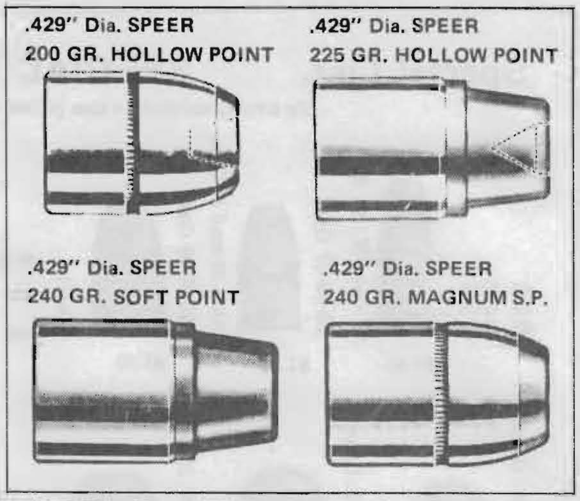


FIGURE 7 — High-velocity handgun bullets such as the .44-caliber Speers are always semi-jacketed to prevent excessive leading and melting of the bullet bases.

Other Classifications

There are actually three more classifications of bullets (or handgun projectiles), but they merit only a mention. One is the handgun shotshell charge, in .38/.357 and .45-caliber, which contains a small amount of No. 9 shot under a plastic cup (see Figure 8). They are used primarily for killing snakes at short range, or for routing pests. Another is the plastic or wax bullet, driven by primer power only, which is used for indoor training purposes.

NEW SPEER SHOTSHELL
. . . for 38 Special & 357 Magnum

The new Speer 38/357 Shotshell produces a consistent, even shot pattern . . . deadly on snakes . . . outstanding for controlling rodents, pests and small varmints. A special-formula plastic capsule holds the #9 shot and protects the barrel from wear. Add a new dimension to your handgun on your next hunting, fishing, hiking or camping trip! (Great for home protection.)

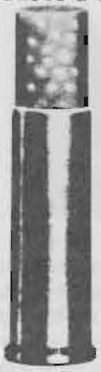


FIGURE 8 — Complete, loaded handgun shotshells are offered by Speer and other companies. Shot capsules, ready for seating by the reloader, are also available.

The last in this category are the projectiles fired in the specialized single-shot pistols such as the Remington XP-100 and the Thompson Contender. Because of the high velocities attained (usually with shortened and/or necked-down rifle brass), these guns use rifle bullets. The new .30-caliber Herrett, for example, is designed for standard .308" diameter 110-grain round-nose and 130-grain hollow-point rifle bullets (see Figure 9).

FIGURE 9 — Examples of handgun cartridges which utilize rifle-type bullets are (from left): the .22 Jet and the .221 Fireball by Remington, and the Winchester .256. (Photo courtesy Speer, Inc.)

Before going on, please do Programmed Exercise 1. Make sure you write your answers on a separate sheet of paper before looking at the answers on the page specified.

PROGRAMMED EXERCISE

1

Match the bullet types in the top list with the type of handgun or the situation from the bottom list with which they would most commonly be used.

D 1. Colt "Peacemaker" or low-velocity revolvers.

F 2. Medium-velocity revolvers.

B 3. Semi-autos and all military handguns.

G 4. High-velocity autoloaders.

E 5. Short-range pest routing.

A 6. Indoor target practice.

C 7. Specialized high-velocity pistols like the Thompson Contender, the Herrett, or the Remington XP-100.

A. Plastic or wax bullet.

B. Jacketed or "full-patch."

C. Shortened or necked-down rifle brass.

D. Cast lead.

E. Shotshell charge.

F. Swaged lead.

G. Semi-jacketed.

Answers on Page 6

METHODS OF MANUFACTURE

A few small companies manufacture and sell cast bullets, but they are most often made at home by the hobbyist/reloader. Bullet casting and molding equipment is relatively inexpensive and is available from many manufacturers, including Lyman (see Figure 10).

Swaged lead alloy bullets are available from the major bullet makers and are produced on automated equipment which swages pre-cut lengths of heavy lead alloy wire into the desired configurations. Gas checks, if any, are usually added in a separate operation. Special bullet-making dies are available to the reloader and may be used with any heavy-duty, metallic-cartridge loading press (see Figure 11). The cost of equipment necessary for the hobbyist to set up shop is greater for bullet swaging than for bullet casting.

Jacketed and semi-jacketed handgun bullets are made in essentially the same way as jacketed rifle bullets. Sheets of gilding metal are punched into cups of the desired length and thickness. The lead cores, sometimes preformed, sometimes formed later with shaping and/or recessing dies, are then swaged into the cups. Unlike rifle jackets, which are most often contoured on the inside, handgun jackets, because of the relatively low velocities involved, are usually straight-walled. The core may be hot or cold-bonded; whichever method is used, however, the fit isn't as secure as that of a high-velocity rifle core. There simply isn't as much core/jacket contact area. Separation of the core from the jacket is unusual when impacting in animal tissue, when bullets of the proper weight and nose shape are used.

FIGURE 10 — Before casting bullets, the lead must be melted — in a container as simple as the old Ideal pot offered by Lyman (top) or as "advanced" as the Potter Electric Furnace (bottom).

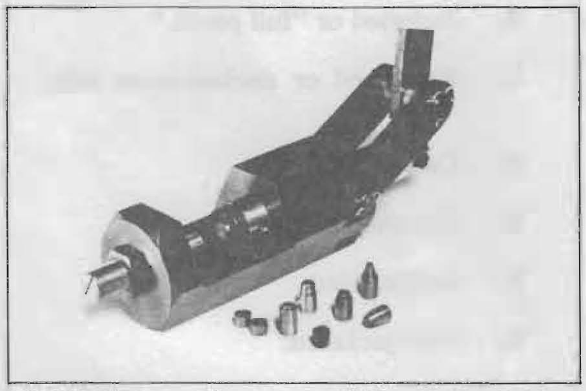


FIGURE 11 — The Herter 9-Ton Bullet Maker uses adjustable dies to swage jacketed or lead alloy bullets in a variety of nose shapes.

However, the combination of full or semi-jacketed bullets and reduced loads can result in the bullet popping out of the barrel while the jacket stays inside. For this reason (and the fact that hollow or soft-point jacketed or semi-jacketed bullets won't expand at low velocities), many loading manuals specifically warn against using jacketed bullets of any type with low-velocity charges (see Figure 12).

If you want to load down, use cast or swaged lead alloy bullets.

HERCO	**5.2**	**914**	**270**
POWDER	5.0	879	250
UNIQUE	**5.6**	**998**	**322**
POWDER	5.1	932	281

The 146-grain HP and 160-grain SP straight-sided, jacketed bullets may separate core from jacket if fired at low velocities, with the possibility of the jacket remaining in the barrel. The lighter charge shown for each powder should be considered MINIMUM.

FIGURE 12 — Because of the hazards involved in firing jacketed bullets at low velocity, bullet manufacturers often include warnings in their loading data. The above is from the Speer Manual No. 9.

BALLISTICS EFFICIENCY

Handguns are strictly for short-range work. Regardless of muzzle velocity, and the optimum is about 1,500 fps, the speed of the short, stubby bullet falls off so rapidly that 100 yards is the maximum effective hunting range with the highest powered handgun.

It is a rare handgun bullet that has a ballistics coefficient higher than .200. Most range from .123 to .173. When you realize that even a short-range .30-caliber 110-grain rifle spitzer has a BC of over .250, you get an idea of the handgun's ballistic limitations.

Comparing handgun power to rifle power is like comparing apples and oranges. They are two different species, designed for two different purposes. Today's most powerful handgun doesn't come close to delivering the knockdown power at 100 yards possessed by many rifles of a century ago.

Consider, for example, the .44 Auto Mag (see Figure 13), one of the "ultimate" pistols. Velocity with a 200-grain soft-point is 1,450 fps at the muzzle with an energy of 932 foot pounds. The .45-70 rifle of the 1870's, with its 400-grain bullet moving out at 1,700 fps, had a muzzle energy of about 2,560 foot pounds. The down-range energy of the rifle bullet was even better, proportionately, because of its much higher ballistics coefficient.

ANSWERS

1

1. D 2. F 3. B 4. G 5. E

6. A 7. C

FIGURE 13 — The .44 Auto Mag is the most powerful semi-auto pistol ever designed, even surpassing the bellowing .44 magnum revolver.

Even the venerable .30/30, in the old 170-grain flat-nose loading, delivers slightly more energy at 200 yards than the Auto Mag load mentioned does at the muzzle!

The most powerful commercial handgun loads in existence, the Super Vels (see Figure 14), deliver impressive energy at short range. However, even the powerhouse .44 magnum, as loaded by Super Vel, has its energy listed only out to 50 yards. At 100 yards and beyond, the energy figure is no longer impressive as far as killing power is concerned.

SHORT BARRELS PENALIZE POWER POTENTIAL

Barrel length (or lack of it) also has much to do with a handgun's low velocity. As a case in point, take the popular .44 Remington magnum cartridge, which is fired in rifles and revolvers (see Figure 15). Using the same 240-grain soft-point jacketed bullet, the handgun with a 7½" barrel produces a muzzle velocity of 1,300 fps for a muzzle energy of 900 foot pounds. When fired from a rifle with an 18" barrel, that same bullet exits the muzzle at 1,900 fps with an energy of 1,922 foot pounds. Even the same powder is used — Unique 630 — 19.6 grains for the handgun and 24.5 grains for the rifle, which can contain the higher pressure generated.

The point is, handguns do their job, and admirably, for the design purpose intended — hitting and stopping live targets at 25 yards, and certainly at no more than 50 yards. Scant admiration is due those men who set out after large bear, elk, or moose with a handgun — no matter how powerful. Such "sportsmen" are much more apt to wound than kill; when after dangerous game, they're usually backed up with a heavy magnum rifle. There are exceptions, of course: expert handgun shots who won't shoot until they've worked in close to their quarry. Generally, however, the "trip" involved in such hunts is more a matter of ego than distance.

THE MOST POPULAR BULLET

Most of the handgun bullets fired today are made of a lead alloy, cast or swaged in a bewildering variety of sizes, shapes, and styles. The most popular for small game and mid-range target shooting is probably the .38 Special Wadcutter. The sharp flat-nose cuts a neat hole or "wad" out of the paper target, eliminating arguments over group center-to-center measurements. When loaded to a velocity of 700 to 750 fps, such bullets generate scant recoil, but show outstanding accuracy in revolvers and semi-autos. They also make fine rabbit and grouse loads for pistols taken on big game hunts.

A wadcutter variation, also used for target work, is the "Double-Ender" bullet (see Figure 16). Aptly named, the reloader can insert either end into the case and enjoy good accuracy.

When casting .38 Special bullets for target use in revolvers, a mixture of 1-16 (one part tin to 16 parts lead), available from gun shops and supply houses, works well. The tin hardens the lead and virtually eliminates leading at target velocities of 700 to 750 fps.

The same bullets, when used in a semi-auto or for "hot" loads, should contain a 1-10 mixture. The harder bullets seem to function much better through the action than the softer 1-16 variety.

Generally, cast bullets used in revolvers and semi-autos should be about .001" larger than the bore diameter. If the bullet is .002" or more larger than the bore, it will, in effect, be swaged into the bore and raise pressure at firing while causing accuracy problems.

The harder, swaged bullets are normally held to exact bore diameter, as are jacketed bullets. An exception on swaged bullets is the .3854 S&W, also known as the .38 Colt. While the "standard" .38 bore size for this cartridge is .357 to .358, the bullets are often swaged to .356 or .357. The reason is that many older revolvers, by various manufacturers, have bore dimensions that are slightly undersize. Currently, only Smith & Wesson, Iver Johnson, and Harrison & Richards make revolvers for this 1877 vintage cartridge.

THE COLT .45 ACP

The second most popular handgun cartridge is undoubtedly the .45 ACP. This round is usually used in autoloading pistols, and sometimes in revolvers (see Figure 17) such as the Smith & Wesson and Colt Models 1917, chambered for this cartridge.

Here, the same lead/tin percentages apply as for the .38 Special. For revolver use of the .45 ACP, use a commercial alloy of 1-16; for semi-autos, a ratio of 1-10. In revolvers,

CALIBER	CARTRIDGE	REMINGTON Order No.	Primer No.	BULLET Wt.-Grs	BULLET Style
22 REM. "JET" MAG.		R22JET	6½	40*	Soft Point
221 REM. "FIRE BALL"		R221F	7½	50*	Pointed Soft Point
25 (6.35mm) AUTO. PISTOL		R25AP	1½	50*	Metal Case
30 (7.65mm) LUGER AUTO. PISTOL		R30LUG	1½	93*	Metal Case
32 SHORT COLT		R32SC	1½	80*	Lead
32 LONG COLT		R32LC	1½	82*	Lead
32 COLT NEW POLICE		R32NP	1½	100*	Lead
32 (7.65mm) AUTO. PISTOL		R32AP	1½	71*	Metal Case
32 S. & W.		R32SW	5½	88*	Lead
32 S. & W. LONG		R32SWL	1½	98*	Lead
32-20 WIN.		R32201	6½	100*	Lead
357 MAG.		R357M1 R357M3 R357M4 R357M5 R357M2	5½ 5½ 5½ 5½ 5½	125 158 158 158* 158	Semi-Jacketed H.P. Soft Point Metal Point Lead Semi-Jacketed H.P.
9mm LUGER AUTO. PISTOL		R9MM2 R9MM1	1½ 1½	124* 115	Metal Case Jacketed H.P.
38 S. & W.		R38SW	1½	146*	Lead
38 SPECIAL		R38S1 R38S4 R38S5 R38S9 R38S7 R38S3 R38S8 R38S6	1½ 1½ 1½ 1½ 1½ 1½ 1½ 1½	95 158 158* 200 158 148 158 158	Semi-Jacketed H.P. (+P) Targetmaster, Lead Lead Lead Metal Point Targetmaster, Lead W.C. Lead (+P) Semi-Wadcutter See Note 8
38 SHORT COLT		R38SC	1½	125*	Lead
38 LONG COLT		R38LC	1½	150*	Lead
38-40 WIN.		R3840W	2½	180*	Soft Point
38 SUPER AUTO. COLT PISTOL		R38SUP	1½	130*	Metal Case (+P)
38 AUTO. COLT PISTOL		R38ACP	1½	130*	Metal Case
380 AUTO. PISTOL		R380AP	1½	95*	Metal Case
41 MAG.		R41MG2 R41MG1	2½ 2½	210 210*	Lead Soft Point
44 S. & W. SPECIAL		R44SW	2½	246*	Lead
44 REM. MAG		R44MG1 R44MG2 R44MG3	2½ 2½ 2½	240* 240 240	Lead Soft Point Semi-Jacketed H.P.
44-40 WIN.		R4440W	2½	200*	Soft Point
45 COLT		R45C	2½	250*	Lead
45 AUTO.		R45AP4 R45AP1 R45AP3 R45AP2	2½ 2½ 2½ 2½	230* 185 230 185	Metal Case Metal Case Wad Cutter Metal Case, Targetmaster Jacketed H.P.
45 AUTO. RIM		R45AR	2½	230*	Lead
BLANKS: 38 S. & W. also available in: 32 S. & W., 38 SPECIAL		R38SWBL R32BLNK R38BLNK	1½ 5½ 1½	—* — —	Blank Blank Blank
BLANKS: 5 IN 1†		R5-18L	2½	—*	Blank

Cartridge illustrations approximate size. *Illustrated Above.

†For use in 38/40 and 44/40 Rifles and 38/40, 44/40, and 45 Colt Revolvers
"Specifications are nominal." Ballistics figures established in handguns. Individual guns may vary in cylinder gap, chamber and bore dimensions, etc.

"JET", "FIRE BALL", and "Targetmaster" are trademarks registered in the United States Patent Office by Remington Arms Company, Inc.
Note 8: Ammunition with (+P) on the case headstamp is loaded to higher pressure. Use only in firearms designated for this cartridge and so recommended by the gun manufacturer.

FIGURE 14 — One of the things you should do as a gun pro is secure complete information on cartridges available from as many sources as possible. The above, for example, has excerpts from just two pages in the Remington catalog.

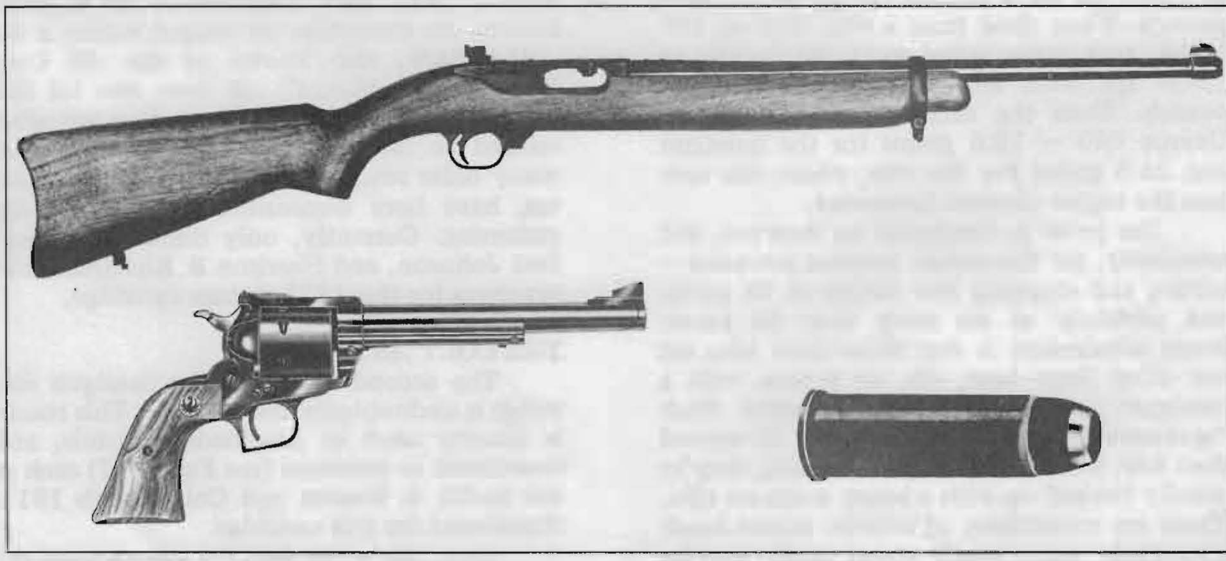


FIGURE 15 — The .44 magnum cartridge, designed for rifles and revolvers, is an efficient deer and black bear cartridge out to 200 yards, when fired through a barrel 18 inches or longer.

the shape or style of the bullet has little or no effect on the mechanical functioning of the arm. Round-nose or wadcutter, they work equally well.

In semi-autos, and especially in the .45 ACP, the bullet must be long enough to facilitate feeding from the clip and into the chamber. This rules out some of the wadcutters. If and when you load this round, you will find information aplenty as to which type of bullet should and shouldn't be used, in the various listings by bullet manufacturers.

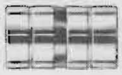


FIGURE 16 — You hit the target "coming or going" with a "Double-Ender" wadcutter. Either end of the bullet can be inserted into the case.

FIGURE 17 — Some revolvers, like the Smith & Wesson target model shown here, are chambered for the .45 ACP cartridge because of its excellent accuracy potential.

Now let's get into Gun Shop 6, which deals with handguns. There, among other things, you'll learn about some of the common malfunctions and required repairs caused by using the wrong size and kind of bullet. Then, when you are ready, complete and mail in Exam 6.

Before going on, however, please do Programmed Exercise 2. Make sure you write your answers on a separate sheet of paper before looking at the answers on the page specified.

PROGRAMMED EXERCISE

2

1. What are the two most popular handgun cartridges? .38sp .45ACP
2. As a general rule, how much larger than the bore diameter should cast bullets be? .001"
3. What is the maximum effective hunting range with even a high-powered handgun? 50yds
4. What type of handgun bullet should not be used with low-velocity charges? JACKETED Bullets

Answers on Page 10

ANSWERS

2

1. .38 Special and the .45 ACP.
2. .001".
3. 50 yards.
4. Jacketed bullets.

NOTES

NOTES