Jean-Pierre BEURTHERET
Freddy DRUBIGNY

CARTRIDGE HANDLOADING

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Sample of jacketed bullets of different calibers.

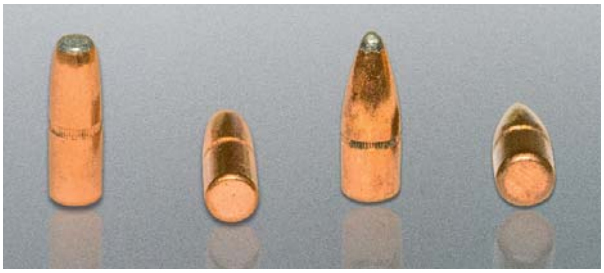
Some bullets are completely enclosed by a jacket made of at least two parts, where the lead core is not apparent at all. These include, but are not limited to, some composite hunting bullets. The aim is to control expansion and mass conservation at the impact.

To detect a steel jacket, use a magnet. If the magnet sticks to the bullet, it is steel. However, if the bullet has a steel core, as is often the case with Russian calibers surplus ammunition, the magnet will stick too. With the magnet, it is impossible to know if we are dealing with a standard bullet with a lead core and a mild steel jacket, or if it is a steel core projectile with probably also a mild steel jacket . To be sure, it is necessary to disassemble a cartridge and examine the bullet. A steel core is visible at the base of the bullet.

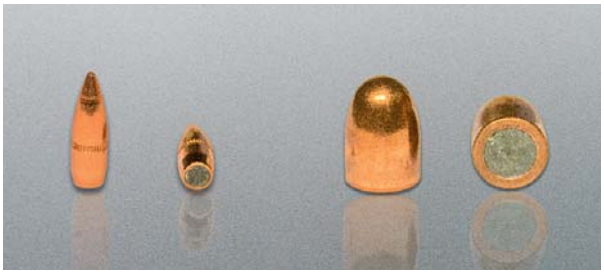
In some cases, the bullet may be color-coded.

It is important to know if a bullet contains a steel core. Using brass or mild steel jacketed bullets makes no difference in a standard shooting range. The mild steel jackets are not harder than the brass jackets on the bullet baffles.
It is different with a steel core, even if these standard Russian surplus bullets are not true armor piercing bullets.

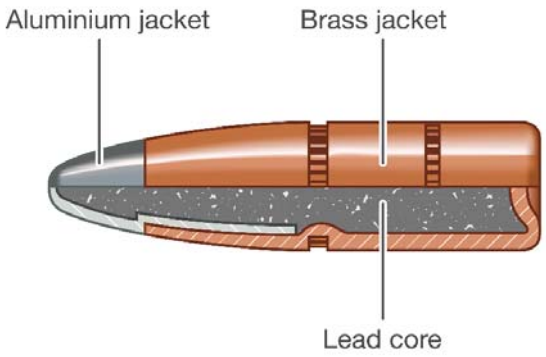
True armor piercing bullets have a core made of hardened steel or of another metal having the desired hardness (tungsten alloy for example). The surplus bullets quoted here have a mild steel core. This metal was chosen to save lead. They are not labeled «armor piercing» from the military standpoint. But even if their performances are inferior to true armor piercings, the installations of the shooting ranges are generally not designed to properly stop them.



Soft point bullets. The lead core is apparent at the tip of the bullet.



Full metal jacket bullets. The lead core is apparent at the base of the bullet.



Example of a totally jacketed bullet. This is the sectional view of a Winchester Silvertip bullet. The jacket of the body and the base of the bullet is brass and the jacket of the nose is aluminum. It is a controlled expansion hunting bullet.

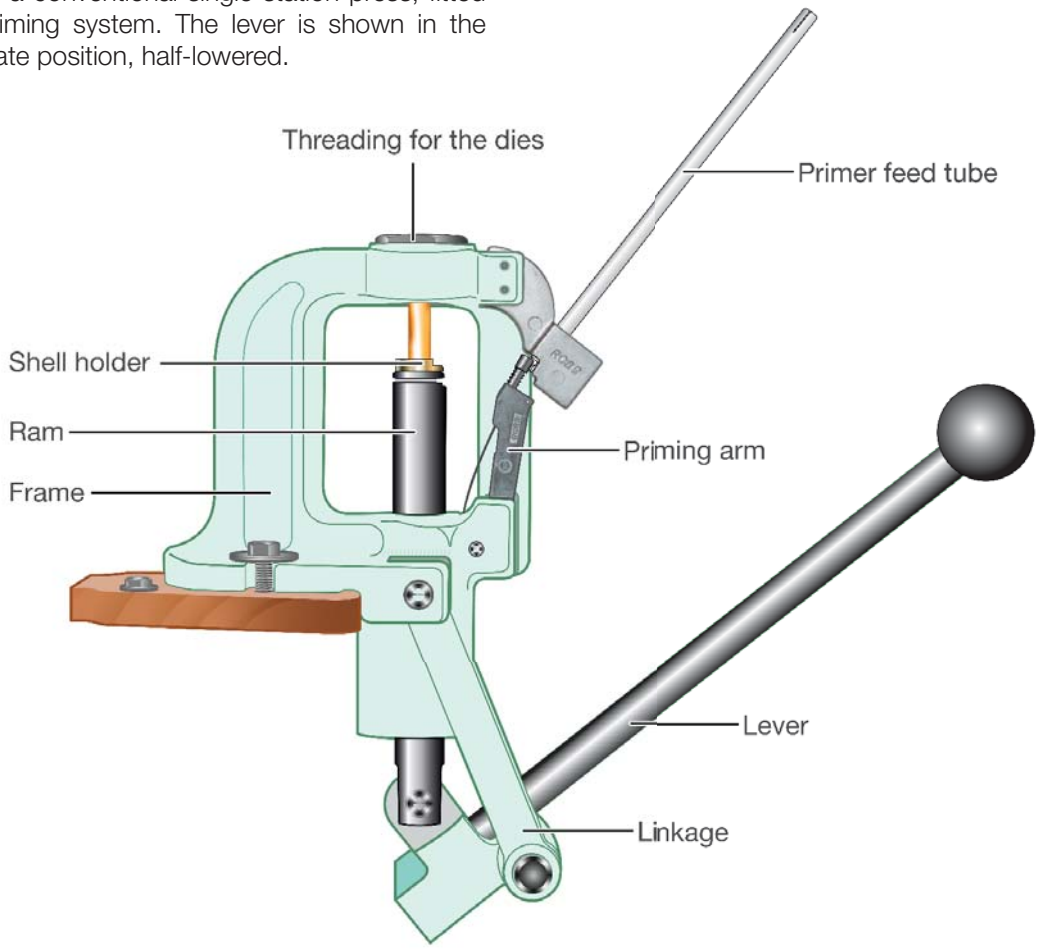
Photos courtesy of Redding

Redding Big Boss II

Photos courtesy of Lyman

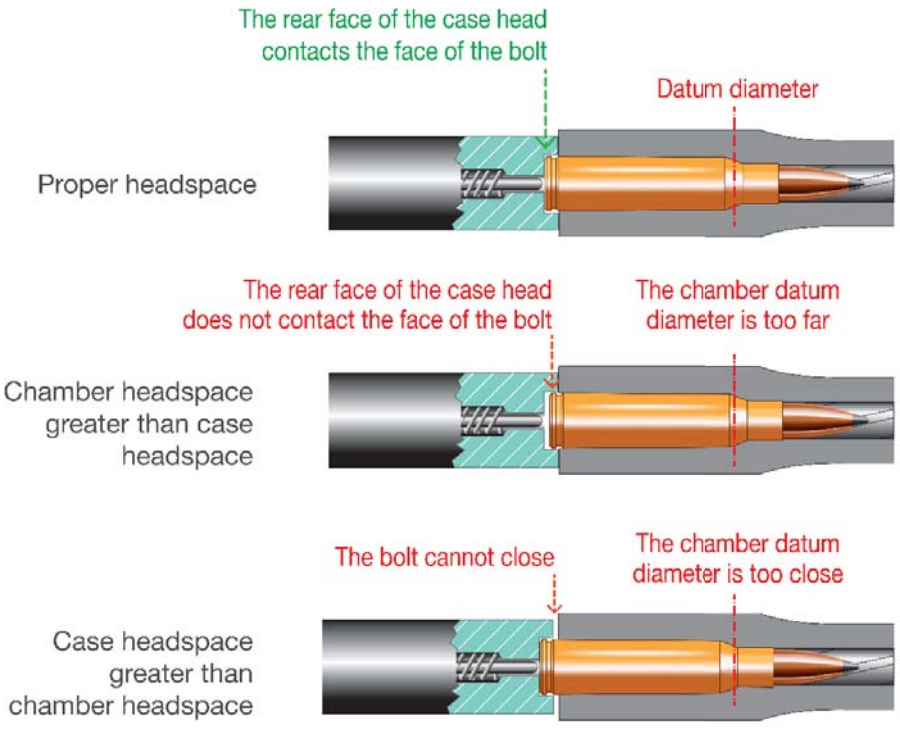
Lyman Crusher 2

Sketch of a conventional single station press, fitted with a priming system. The lever is shown in the intermediate position, half-lowered.




RCBS
RCBS
CASE MASTER

The headspace



Most rimless bottleneck cases have a 0,1778 mm (0,007 ") headspace tolerance between the minimum and maximum dimensions. The chambers may have a headspace tolerance up to 0,254 mm (0,010") between the minimum and maximum dimensions. Since these two tolerances overlap it should not be possible to cumulate up to the maximum value of 0,4318 mm (0,017"). However, between a chamber at the maximum dimension and a resized case at the minimum dimension, it is possible to have a difference of 0,33 mm (0,013"), which is more than double the maximum value beyond which safety is not ensured. Hence the importance of checking the headspace. These data are from Forster and can be found in the documents of the SAAMI or the CIP.

Military firearms tend to have slightly oversized chambers. The rifle must operate under the worst conditions, with soiled ammunitions, etc. This is why military cases are sturdier than civilian cases and have greater headspace tolerances values. Even if there is a chamber headspace excess relative to the case, the latter will stretch without breaking.

And since handloading is not a military concern... This information is to be taken into account when we reload for our historical firearms.

These tolerance issues are the same for the other types of headspaces.

If the case headspace is greater than the chamber headspace

It will be difficult or impossible to close the firearm. **NEVER force**. As a general rule, a jamming means a problem and overcoming it by applying force is a very bad method.

However, the breech may partially close on a chambered cartridge. Most firearms have a safety preventing the percussion of the cartridge if the breech is not fully locked. But, like any mechanical device, this safety may fail. If the breech is not fully locked and if the safety works properly, the firearm will not let off when pressing the trigger. **CAUTION: for safety reasons**, always manage this type of incident as a hang fire, waiting 15 seconds, with the firearm pointing towards the targets, before opening the breech. It is hard to tell the difference between such an incident and a hang fire.

CASE RESIZING ADVANCED TECHNIQUES

The three paragraphs of this chapter look alike, so it is important to tell them apart.

The first paragraph deals with the full length external resizing ***of straight wall, conical or slightly bottleneck cases, regardless of the shape of their head.***

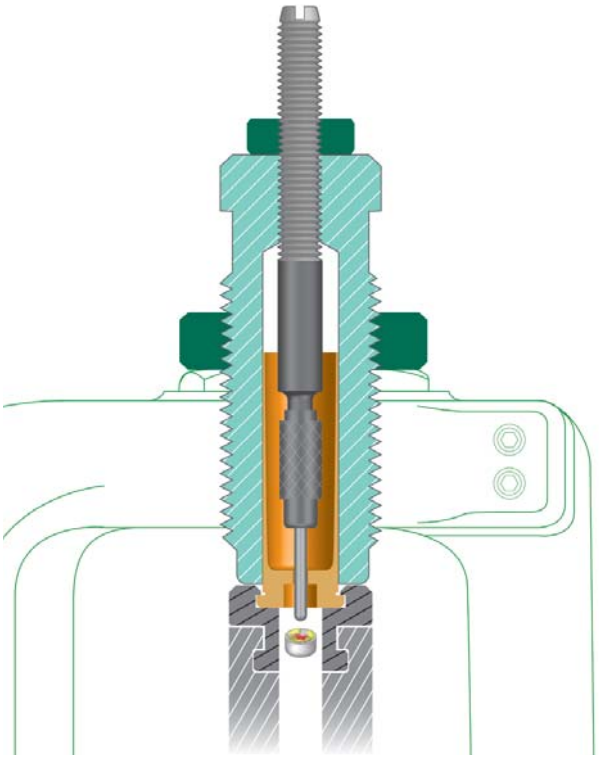
The second paragraph deals with the full length external resizing ***of rimmed, semi rimmed or belted bottleneck cases.***

The third paragraph deals with the full length external resizing ***of rimless or rebated rim bottleneck cases.***

Full length external resizing of straight wall, conical or slightly bottleneck cases

Steel sizing die

The sizing die will be set on the press in a standard fashion.
Slightly bottleneck cases (44-40 WCF, 22 Hornet, etc.) can also be resized in this way. However, we will see in the next paragraph that a more sophisticated procedure is possible.



Full length external resizing of a rimmed straight wall case (357 Magnum).

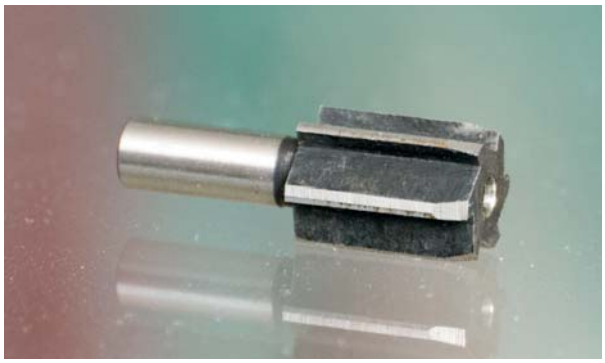
1 - Neck reaming before resizing

The inside of the neck is reamed to reduce its thickness. This operation is performed on a case trimmer fitted to do it. The reamer is set in place of the case trimmer pilot. The reamer diameter is chosen according to the desired neck tension. For some case conversions, it may be necessary to ream unfired cases.

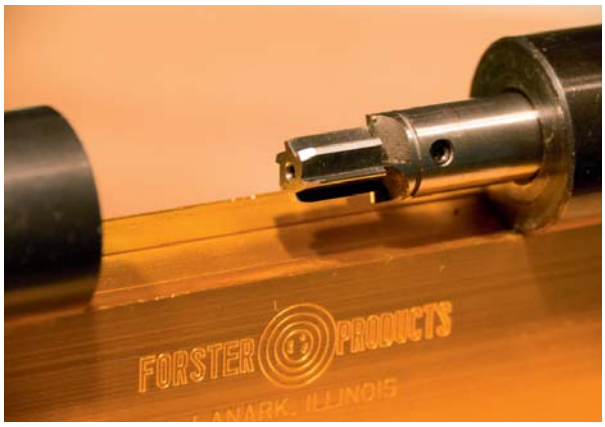
Some people put forward two things against this method:

- The reamer may not exactly center into the neck. The thickness of the neck will not necessarily be uniform around the whole circumference.
- The quantity of brass removed is determined by the reamer diameter.

In practice, this procedure works rather well, but it is true that the neck thickness is sometimes thinner on one side than the other after the operation.



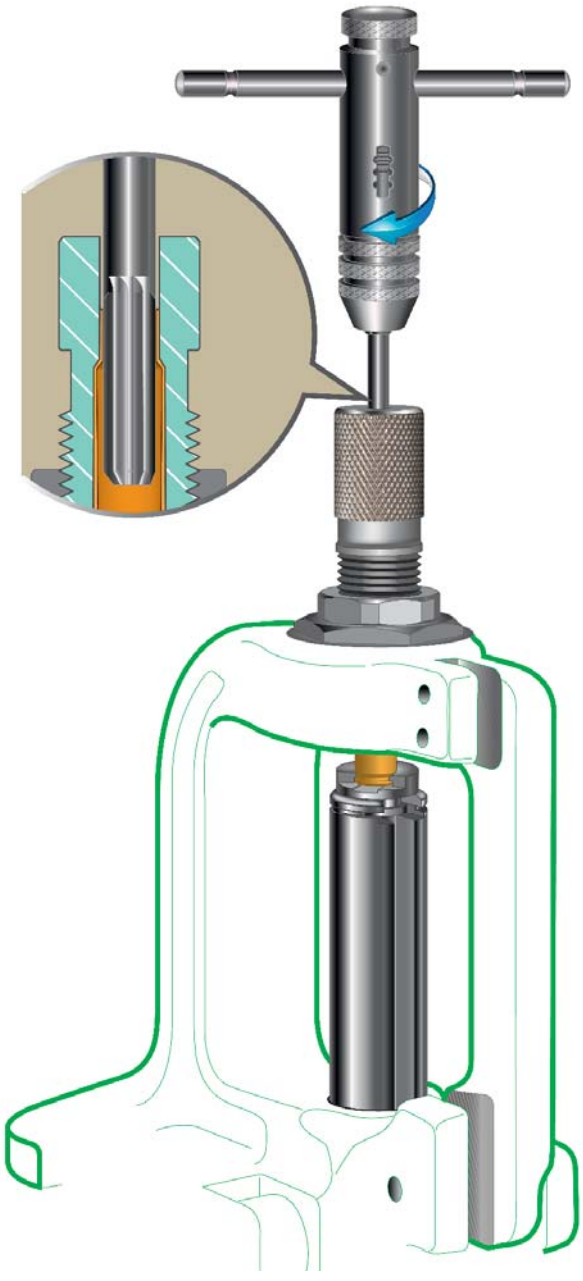
Forster neck reamer



The reamer set on the case trimmer.

2 - Neck reaming during resizing

This technique is used for a case conversion, when the neck diameter is heavily shrunk or when the new neck is located at a place where the walls of the original case are thick. The amount of brass to be removed is important. RCBS and some other manufacturers market a specific full length resizing die, including a reamer used with a T handle tap wrench or a drill. The specific resizing die firmly holds the case and preserves the external dimensions of the neck during reaming. With this method, the reamer enters concentric into the neck.



Priming arm without primer feed tube on a RCBS press

I think it is better to use a hand priming tool. It gives a better feeling to seat the primer.

Hand priming tools

RCBS hand priming tool. The appropriate shell holder is set on the tool. A priming rod is provided for each of the two primer diameters (small and large). The tool tray acts as a primer reservoir as well as a primer flip tray.

Lyman hand priming tool. The appropriate shell holder is set on the tool. Each primer diameter has its own primer reservoir tray, including the priming rod. These reservoirs are also primer flip trays.

K & M hand priming tool. The appropriate shell holder is set on the tool. There is no primer reservoir. The primers are manually fed, one at a time.

There are hand priming tools of other brands working on the same principles.

BULLET SEATING

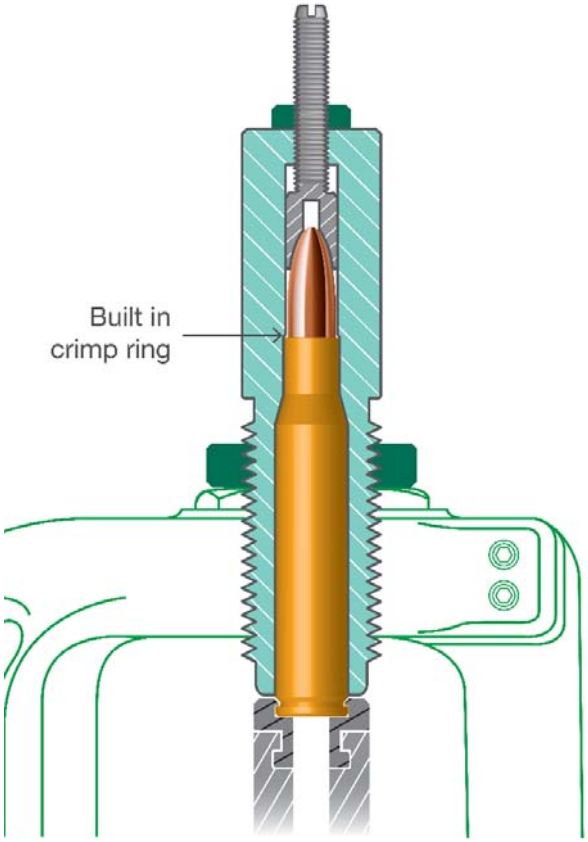
Manufacturer's data indicate a maximum cartridge length not to be exceeded. It is a standard measure designed to ensure that any cartridge of a given caliber operates correctly in any firearm chambered for that cartridge. But this does not necessarily correspond to the optimum cartridge length for a specific firearm.
This optimum cartridge length depends on:

- The shape and length of the bullet.
- Where the beginning of the rifling is located in the barrel (free bore length).
- The distance at which the shooter wants to position the beginning of the bullet's bearing surface in relation to the barrel rifling.

The bullet can be seated in the case in order to have more or less free travel before reaching the rifling, or even no free travel at all in order to contact the rifling when chambered. For a given powder load, the pressure will be higher with a bullet contacting the rifling, compared to a bullet having some free travel before reaching the rifling, even if, in this case, the deeper bullet seating reduces slightly the volume available for the powder. The chambers of the high-capacity magnum calibers are designed so that the bullet has a longer than average free travel before reaching the rifling. This is especially true for the Weatherby rifle calibers. Weatherby manufactured cartridges are loaded for maximum performance and the free bore of nearly 10 millimeters of the chambers in which they are used is designed to handle the pressure generated.

Some Weatherby calibers.
From left to right: 224, 240, 257, 270, 7 mm, 300, 340, 378, 460.

Redding 223 Remington seating die.



Cross section of a seating die for bottleneck cases.

Redding 6 BR Norma precision seating die with a bullet seating micrometer.

The same one taken apart. From left to right: the body, the bullet guide, the bullet guide return spring, the seating plug, the micrometer. This tool does not crimp.

RCBS 222 Remington precision seating die with a bullet seating micrometer. Unlike the other dies where the bullet is introduced from the bottom, the bullet is introduced through a side window built into the body.

A special shell holder which gets inside the body is provided.

Taken apart: the body, the bullet guide, the seating plug and the micrometer.

With all these dies, the bullet seating depth is adjusted by screwing more or less the seating plug. The concentricity of the bullet in relation to the case can be improved by seating the bullet in two steps. The bullet is halfway seated. The cartridge is removed from the die by raising the press lever, and then manually rotated half a turn in the shell holder. The press lever is lowered to complete the seating of the bullet. Watch your fingers. A faulty timing of the right and left hand during the second ram stroke may leave fingers between the shell holder and the die, and then...

The strain gauge is used to determine a pressure from the instantaneous expansion of the metal of the chamber. Knowing the peak pressure of the cartridge, we can try to determine if there is a real correlation between the case head expansion and a given pressure.

Many years ago (1991 to be precise), I conducted some tests with a friend of mine. We glued strain gauges on T/C Contender pistol barrels chambered in 7 TCU, 30-30 WCF and 357 Magnum, to see if it was possible to evaluate the pressure of a cartridge with this technique. The gauges were connected to an electronic circuit in charge to decipher the information. Prior to the experiment, the cartridges of 30-30 WCF and 357 Magnum were fired in a pressure barrel at the SNPE (Société Nationale des Poudres et Explosifs; National Society of Powders and Explosives) in order to calibrate the gauges and have reliable comparison means. The SNPE did not own a 7 TCU pressure barrel, so the only indication we had for this cartridge was the peak pressure given by the manufacturer (the GIAT now Nexter). If my memories are correct, the pressure barrel used was of the crusher type. This notion is explained at the end of this chapter.

The tests were performed with 5, 8 or 10 cartridges. The Vectan TU3 used in the 30-30 WCF is no longer manufactured. The Vectan SP3 used in the 357 Magnum is still in production.

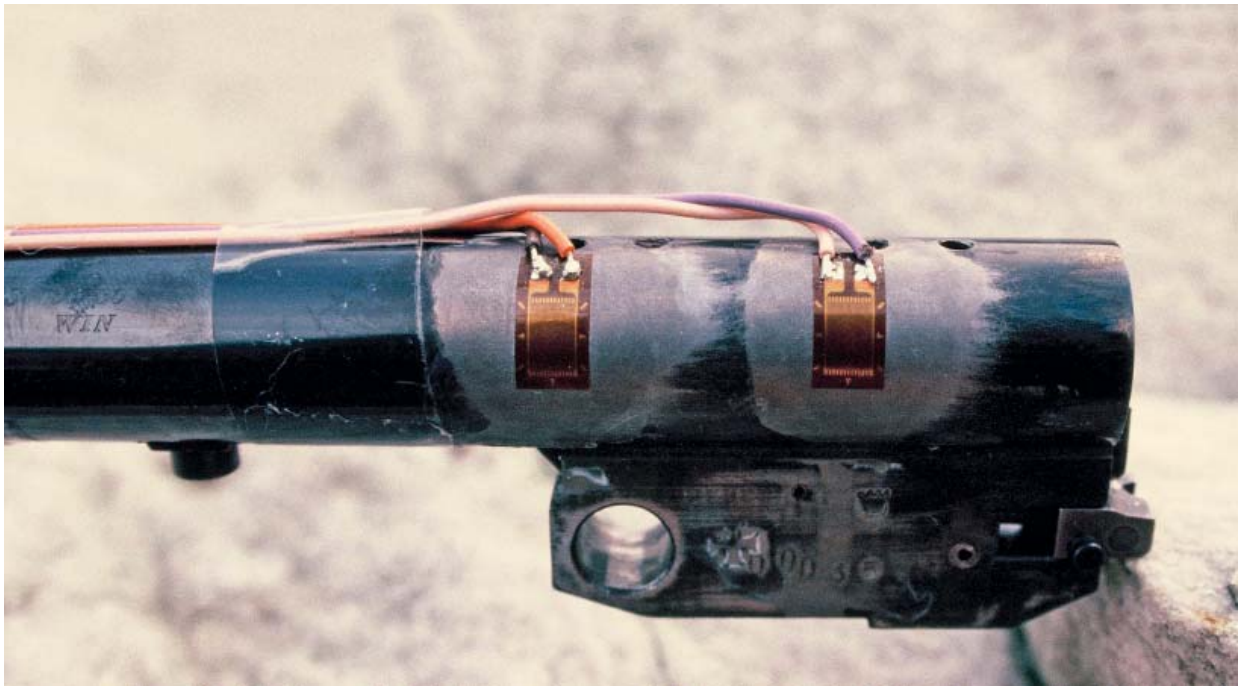
The standard deviation quantifies the dispersion of the results. I develop this notion at the end of the book. Statistically, two standard deviations from the mean account for 95% of the values.

Example with a mean of 2 000 and a standard deviation of 100. Statistically speaking, 95% of the values lie between 1 800 (mean minus two standard deviations) and 2 200 (mean plus two standard deviations).

The smaller the standard deviation, the more the values are gathered around the mean, indicating that the values are consistent. To get a meaningful measurement, the sample studied must be representative of what is being measured.

The larger the sample, the more statistically significant the measurement. Here, the samples are small, and they only allow one to begin to get an idea.

7 TCU results:
The pressure given by the manufacturer is 3 350 bars (48 587 psi). The gauges gave an average pressure of the same value with a standard deviation of 121 bars (1 755 psi).



Strain gauges glued to a Contender barrel

The case

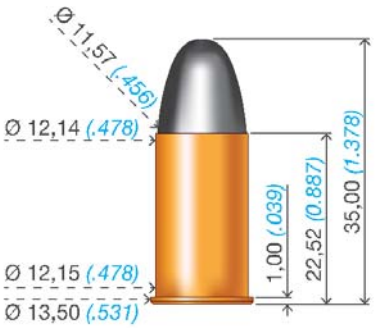
The case of 45 Auto Rim can be used. It has the right size, apart from the rim whose thickness has to be reduced from the front side. This conversion is simple, but 45 Auto Rim cases are difficult to find.

455 Mk I

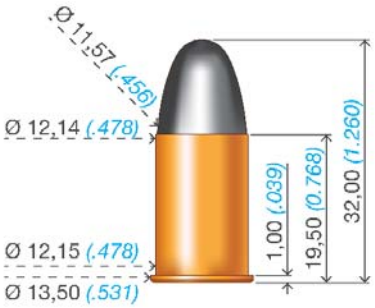
45 Auto rim

The 45 Colt case can be found everywhere. Cut it to the correct length and reduce the thickness of the rim (from the front face) to 0,8 mm (0,0315").
Since the 45 Colt case is quite long, you can choose between making 455 Mk I (length of 22,5 mm; 0,886") or Mk II (length of 19,5 mm; 0,768") cases. Personally, I cut the cases to the length the chambers could handle, that being 23,5 mm (0,925"), a little longer than the Mk I.

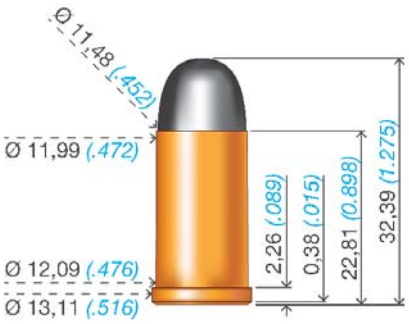
I'm talking about the 45 Colt, which is the real name of the cartridge often called 45 Long Colt. This Long Colt appellation dates back to the time (years 1875 - 1895) where the American army used the Colt Army 1873 in 45 Colt and the Smith & Wesson Schofield in 45 Schofield. The 45 Schofield cartridge is identical to the 45 Colt except for the length. It is 4,7 mm (0,185") shorter. The 45 Colt has been prefixed with «Long» to better distinguish it from the 45 Schofield. Lee makes a carbide die set for the 455. Redding proposes a regular steel set.



455 Webley Mk.I



455 Webley Mk.II



.45 Auto Rim

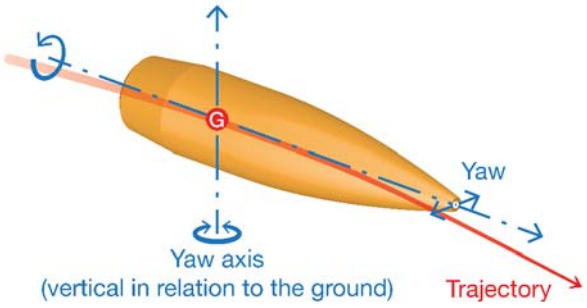
45 Colt

The movements of the bullet

The bullet is the seat of several combined movements.

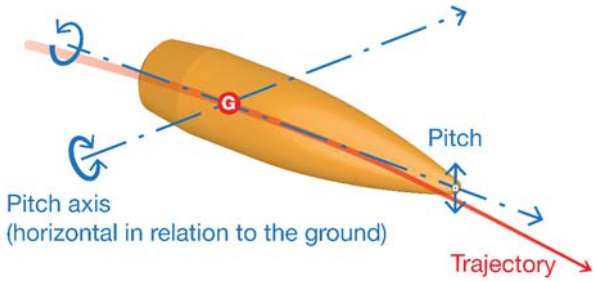
Yaw

Horizontal oscillation. Its axis is vertical, located in the plane of the trajectory and perpendicular to the velocity vector. It goes through the centre of gravity of the bullet. The amplitude can be of about 1 to 5 degrees at the beginning of the flight.



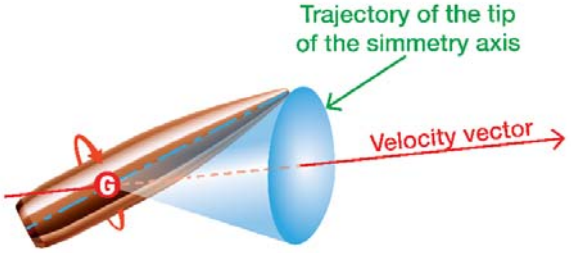
Pitch

Vertical oscillation. Its axis is horizontal, perpendicular to the plane of the trajectory and goes through the centre of gravity of the bullet. The amplitude can be of about 1 to 5 degrees at the beginning of the flight. The combination of yaw and pitch is sometimes referred to as total yaw.



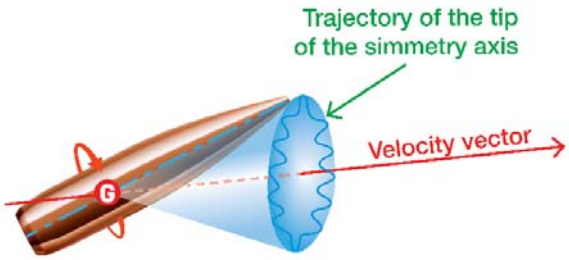
Precession

Conical rotation of the bullet symmetry axis around the velocity vector, with the centre of gravity as a pivot point sliding on the trajectory (remember: the velocity vector is tangent to the trajectory at the centre of gravity).



Nutation

Small periodic movements, small oscillations of the bullet axis around its average position. They are in addition to the precession and, in reality, the shape of the precession circle looks like the following sketch.



Total yaw and precession movements decrease once the bullet has travelled some tens of meters. When exiting the barrel, the bullet, which was guided until then, is in free flight and must confront the remaining gas under pressure which overtakes it, the atmosphere, the gravity.

This has a destabilizing effect. It takes a little time for the gyroscopic stabilization effect to regain control and properly stabilize the bullet. This explains why, sometimes, a grouping is proportionally slightly smaller at, for example, 100 meters than at 50 meters. The grouping at 100 meters will always be larger than the 50 meters grouping, but it will be smaller than the double of the 50 meters grouping.

With all these combined movements, the end of the axis of symmetry at the tip of the bullet, has a movement resembling the helical development curve on the next page drawing.

The drawing represents this pseudo spiral seen from the front. It is the movement of the end of the axis of symmetry of the bullet seen from the front, shortly after the exit from the barrel, between time t=0 and time t=x.

The movement is centered on the centre of gravity of the bullet (red dot in the centre).

Imagine the situation in three dimensions:

- Each point of the spiral represents the position of the tip of the axis of symmetry of the bullet at time t.
- At each time t, the axis of symmetry of the bullet passes through the point of the spiral concerned and through the centre of gravity.

Test n° 3

Materials tested (five layers)

Layer 1: a pine board 65 mm (2,6") thick, set perpendicular to the firing axis.

Layers 2 to 5: four ordinary steel sheets (24 kg/mm²), 3 mm thick, set perpendicular to the firing axis and spaced 30 mm apart, with the first sheet of the series set 60 mm behind the pine board.

All the bullets get through the pine board.

22 Hornet: 45 grs (2,9 grams) soft point bullet V0 709 m/s (2 326 fps): stopped by sheet 1 which is bulged.

55 grs (3,6 grams) full metal jacket bullet V0 619 m/s (2 031 fps): sheet 1 pierced, stopped by sheet 2 which is very bulged.

7 BR: 150 grs (9,7 grams) Match bullet V0 556 m/s (1 824 fps): sheet 1 pierced, stopped by sheet 2 which is pierced too (the bullet disintegrated while making the hole in sheet 2, sheet 3 is intact).

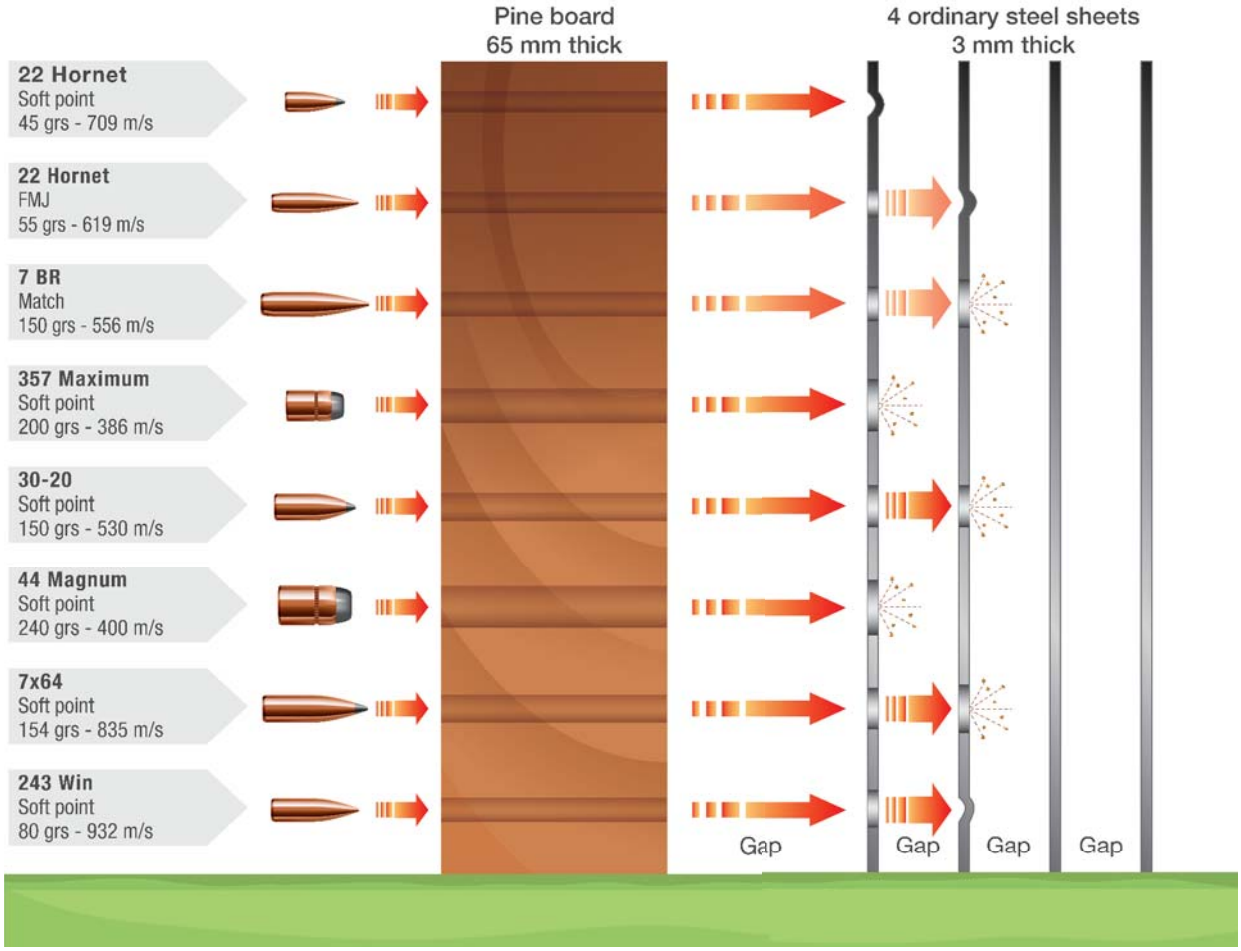
357 Maximum: 200 grs (13 grams) soft point bullet V0 386 m/s (1 266 fps): stopped by sheet 1 which is pierced (the bullet disintegrated, sheet 2 is intact).

30-20: 150 grs (9,7 grams) soft point bullet V0 530 m/s (1 739 fps): sheet 1 pierced, stopped by sheet 2 which is pierced too (the bullet disintegrated, sheet 3 is intact).

44 Magnum: 240 grs (15,6 grams) soft point bullet V0 400 m/s (1 312 fps): stopped by sheet 1 which is pierced (the bullet disintegrated, sheet 2 is intact).

7x64: 154 grs (10 grams) soft point bullet V0 835 m/s (2 740 fps): sheet 1 pierced, stopped by sheet 2 which is pierced too (the bullet disintegrated, sheet 3 is intact).

243 Winchester: 80 grs (5,2 grams) soft point bullet V0 932 m/s (3 058): sheet 1 pierced, stopped by sheet 2 which is bulged.



Ordinary steel plates are effective when set in separate layers, but the impacts are destructive.

The author

Jean-Pierre BEURTHERET

Member of the French Shooting Federation since the beginning of the 70's, he is a competitor, practicing several shooting disciplines and more specifically metallic silhouette shooting, in which he won three individual champion titles (two national and one European) and one world team champion title.
He has been practicing handloading for more than forty years.

The illustrator

Freddy DRUBIGNY

Member of the French Shooting Federation since 1976, he won two individual champion titles (one national and one European) in metallic silhouette shooting. He worked for thirty years in an engineering and design department. This experience allowed him to shape and achieve the technical drawings of this book as well as the post processing of the photographs. He also performed the layout.

The book

The aim of this book is to explain the subject from a different standpoint than usually found.

You will find in it a brief history of the metallic cartridge and the description of its components (the primer, the case, the powder, the bullet) and of the various tools used for handloading.

The detailed description of advanced handloading procedures and die adjustments departs from the usual specialized literature and will allow the production of ammunition totally adapted to a specific firearm, using the standard reloading tables of the powder manufacturers. Cartridge conversions, ballistics, security of the shooters and on the range are not forgotten. The last chapter is devoted to a short description of the automatic and semi-automatic firearms operation.

This book will allow you a didactic approach into the exciting world of perpetual research which is:

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