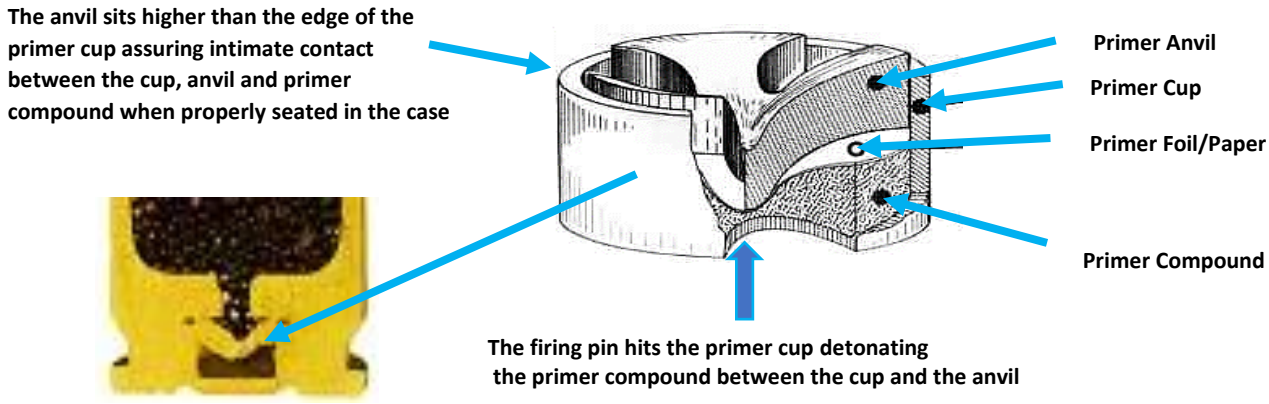
PRESSURE SIGNS IN THE RELOADED CARTRIDGE

By
Ron Colvin

The prudent reloader should become knowledgeable and carefully monitor the normal and abnormal appearance of fired brass and primers and other indicators of excessive pressures that are outlined below. ***Always use and carefully follow the reloading guidelines/" recipes" in reputable reloading manuals. Use multiple manuals as a safety measure. Avoid using Maximum loads and in general, loads found on the internet.***

When a cartridge is fired, the firing pin initiates the "go-bang" event by compressing the shock-sensitive primer compound (commonly lead styphnate) between the bottom of the primer cup and the anvil in the primer. Primers must be seated .002" to .006" below the base of the case to properly compress the primer compound between the anvil and the primer cup base for reliable detonation by the firing pin.



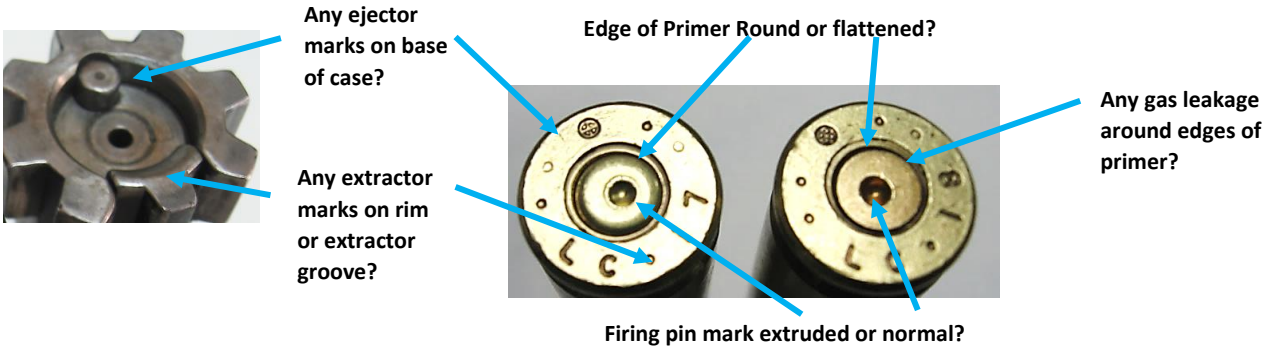
The exploding lead styphnate (~.3 grains for small primers and ~.5 grains for large primers) flashes through the flash hole in the case igniting the powder/propellant in the case. This pushes the primer cup back against the breech face of the firearm. (We are discussing non-crimped primer reloads.) The burning propellant generates gas pressures as high as 65,000 psi with temperatures of 3000-4000^{o} F in .0002-.0003 of a second (2-3/10,000). In this short period, the gases expand the case and the neck releasing the bullet. The case effectively seals the gases inside the chamber—it is the "sealing gasket." The bullet is accelerated down the barrel by the gas to more than 2000 MPH, in the case of a .223 cartridge (3200FPS). In about .0008 seconds from being fired the bullet leaves the barrel and the pressure drops immediately, allowing the case to relax. It is the nature of cartridge brass to relax— "spring back" so the case can be extracted and ejected. <u>The case does not return ("spring back") completely to its unfired size and that is why it must be resized during reloading</u>.

Courtesy of Geco-Munitions—www.geco-munition.de

Primer initiating powder | **Powder/propellant burning** | **Bullet being propelled down the barrel**

The primer cup is also a part of the case gas sealing mechanism and is also made of cartridge brass. It is the weakest part of the cartridge case at .017"-.025" thick for small primers and .020"- .027" thick for large primers. Primer cup brass can be work-hardened just like a cartridge case. The hardness of a primer cup varies by manufacturer. The primer is subject to the same temperatures and pressures as the cartridge case. The appearance of the exterior edge of the primer cup is an indication of pressure during the firing event (round or

sharp-edged). Also, the shape of the firing pin indentation, as well as any gas leakage around the primer cup including ejector or extractor marks in the face or rim of the case are indicators of cartridge internal pressure.

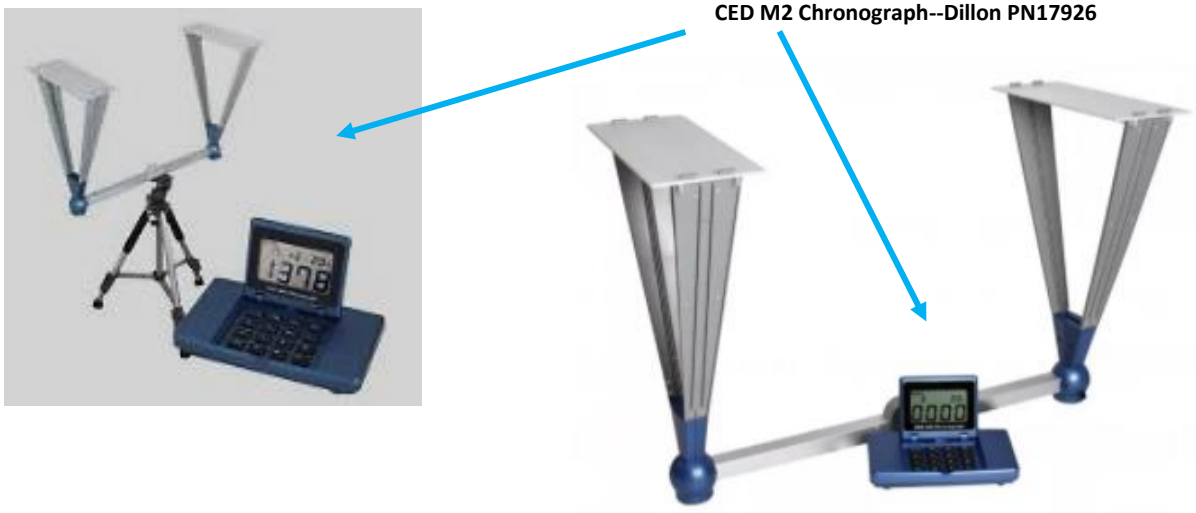


CAUTION!--Always use a reloading manual's starting loads and carefully work-up from there—preferably use more than one manual. Again, avoid maximum loads. Pay close attention to what the reloading manual stipulates as to what brass is used, what primer is used, what bullet, and the cartridge overall length (COAL) prescribed. Also, powders can vary as much as ±15% in burn rate lot-to-lot. Primer energy also varies by manufacturer. Changing powder lot numbers or primers, as well as using different manufacturers' brass that has different internal volumes as well as ambient temperature variations can vary the peak pressure. A cartridge fired on a hot summer day can exhibit higher pressures than on a winter day. Allowing a cartridge to sit in a hot chamber can also elevate pressures. Some powders are temperatures stable such as Varget and 6.5 StaBALL®.

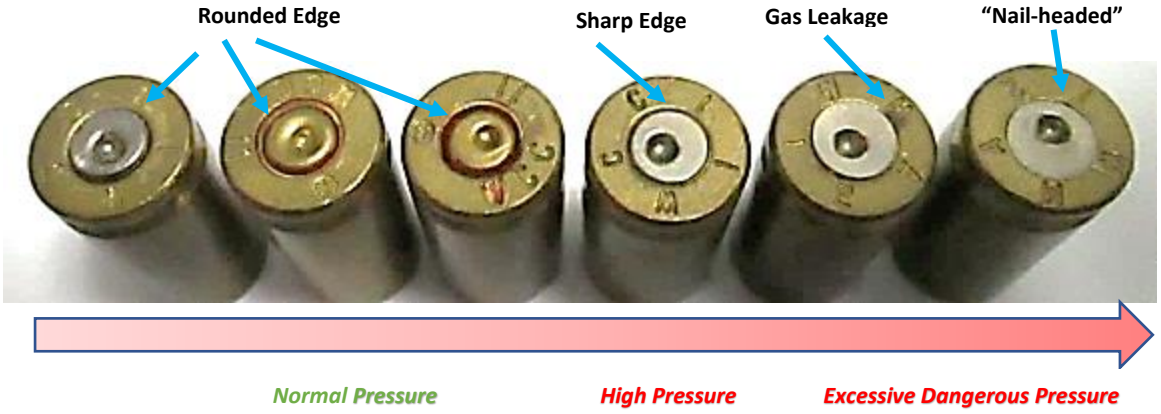
Firearms or barrels of the same caliber from different, and in some cases the same manufacturer will exhibit different pressure and velocity results due to differences in throating and barrel smoothness. What is a safe load in one gun of the same caliber may not be a safe load in another.

A representative listing of 16 indicators that should be monitored for excessive pressures in reloaded ammunition is outlined below. *It is common to see multiple occurrences of these indicators in an overpressure situation:*

1. ***Velocity higher than the maximum load velocity as specified in an approved reloading manual***--for the same bullet, primer, powder charge and barrel length. Velocities higher than the max load data are typically a sign of dangerous pressure. Note--some barrels "run faster" than others, which also means they run higher pressures. A chronograph **is essential** in working up maximum/higher pressure/velocity loads along with paying close attention to signs of over-pressured cases. Generally, high velocity goes hand-in-hand with high pressure. That last 50-100 fps can get you in trouble! A good load rarely needs that last few feet per second. One of the best chronographs is the CED M2 available from Dillon PN17926. A good addition to the CED unit is the Infrared Upgrade Kit Dillon PN 12116 for "seeing" bullets in low light, darkness or indoors.

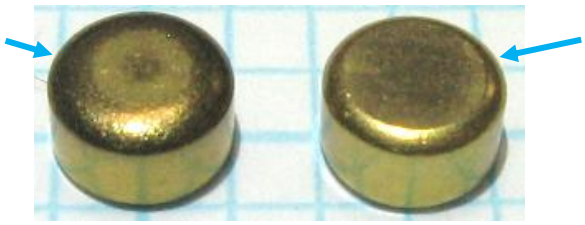


2. ***A primer flattened by overpressure***—**the corner radiused edge of a primer can get extruded by dangerous pressure into a sharp corner, leak gas around the cup and can be "nail-headed."**



- **Be careful "reading" primers--**
  - **Some primer cups are "softer" than others i.e. Federal primers are "softer" than CCI. Other primers like Sellier and Bellot have a "sharper" radiused edge.**

Winchester Large Pistol Primer



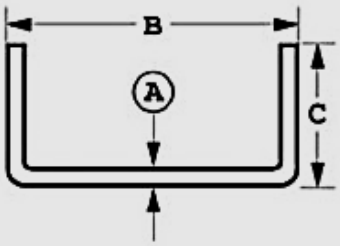
Sellier and Bellot Large Pistol primer with sharper radius compared to Winchester

  - **Small rifle primer cups can vary in thickness from .019" to .025". The thicker cup primers can withstand higher pressures. Large rifle primers are all .027. Small pistol primers are .017" thick and large pistol primers are .020" thick.**

Rifle Primer Dimension Chart

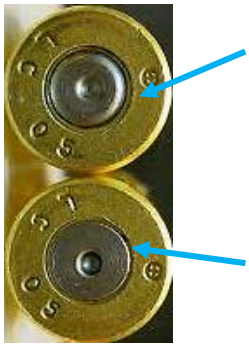
Manufacturer	Number	A Cup Thickness	B Cup Diameter	C Cup Height
Small Rifle				
CCI	400	.020"	.1753"	.109"
	450	.025"	.1750"	.113"
	BR4	.025"	.1755"	.109"
Federal	200	.019"	.1757"	.111"
	205M	.0225"	.1744"	.1075"
Remington	6 1/2	.020"	.1753"	.109"
	7 1/2	.025"	.1752"	.110"
Winchester	SR	.021"	.1750"	.109"
Large Rifle				
CCI	200	.027"	.2112"	.118"
	250	.027"	.2113"	.118"
Federal	210	.027"	.2120"	.117"
	215	--	--	--
Remington	9 1/2	.027"	.2100"	.119"
Winchester	LR	.027"	.2114"	.121"
	Mag	.027"	.2114"	.121"

Rifle Primer Dimensions



Source James Calhoon

- **Primers can be flattened by improper headspace--a gap between the base of the case and the bolt face can result in a primer that gets pushed back out of the cartridge's primer pocket by the ignition of the primer itself and then gets "nail headed" by the case as the sides of the unsupported primer cup are extruded sideways into the gap as the case is forced back into the bolt face. This can happen with normal pressure loads with too much headspace. An extreme example of too much headspace and high pressure is shown below--right. It is essential to use a headspace gauge to size cases for the proper head spacing for bottleneck cartridges.**



Primer edge is showing normal pressure

Primer flattened and edge extruded-- showing high pressure probably over 60.000 PSI

Extremely extruded edge of primer from high pressure and possible excessive headspace— "nail headed"

Courtesy of Western Powders

3. ***Primer "blown-out or lost"***—**is almost always a high-pressure indication, especially if coincident with a powder charge increase or if the cartridge was "loaded long" with the bullet touching/jammed into the rifling. Imprints on the case base of the ejector hole in the bolt face can also be attributed to high pressure. Cartridges that are loaded into and touching the rifling/lands can increase pressure by 7000-8000 psi. Pistol bullets that errantly get pushed back into the case can also show excessive pressures. Some new rifles/barrels with a rough leade produced by a dull chambering reamer can "blow-out" primers even with factory loads. The rough leade can smooth-out over time or be polished-out. As a side note, a" blown-out" or a "holed" primer can be accompanied by smoke emanating from the action. If this is in a semiauto firearm, stop and check the action, chamber and bore for the primer and/or the primer anvil. Immediately stop using this ammo!**

Primer "blown-out" and brass extruded into ejector hole— the case is not reloadable— very high pressure

4. ***Primer firing pin indent extruded/cratered***--**may mean excessive pressure. If there are no other indicators of excessive pressure, the cratering may be caused by a worn firing pin or a large, worn or chamfered firing pin hole in the bolt face.**

Primer cratered-extruded into firing pin hole and primer showing a sharp edge

5. ***Primer piercing/holing/shearing***--**could indicate high pressure, especially if coincident with an increase in the powder charge, or it may mean incorrect firing pin protrusion, incorrect firing pin nose shape, a large diameter firing pin/hole in a high-pressure application, soft primer cups or insufficient**

hammer spring energy that doesn't keep the firing pin "buried" in the primer until the pressure falls in the barrel or a combination. If you suddenly see smoke coming from the action of your firearm, look for a hole in a primer or a lost primer. Verify that the primer or parts of the primer are not in the action or the barrel. **Immediately stop using this ammo!**

Large Diameter .082" Firing pin in an AR-10--is the cause of this cratering/hole. This was not high pressure--note no ejector or extractor marks and relative round edge of the primer.

Small diameter .060" firing pin in an AR-10 using a high pressure bolt –

Large diameter .082" firing pin in an AR-10– same load as with small dia. firing pin on the left

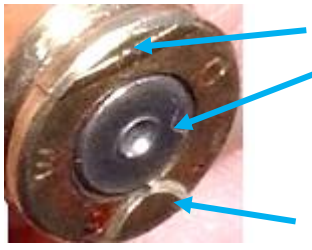
6. ***Primer leaking gas around the edges of the primer pocket***—is usually an indicator of high or excessive pressure. This can also be caused by excessive chamber headspace if the reloaded cartridge headspace is set too short for that specific firearm, or a loose primer in a "blown-out" case.

Gas leakage-indicative of high pressure or a loose primer

Primer Extruded into firing pin hole

Courtesy of Western Powders

7. ***Ejector marks on case base***—high pressures can extrude the case head into the ejector hole leaving a circular bump or a burr on the base of the case. In gas guns (ARs), this can show up as a wipe mark or a smear. Ejector holes with burrs or sharp edges can leave a ring, a smear, and or a raised brass burr <u>at normal pressures</u>. This can be corrected by deburring the ejector hole.
8. *Extractor damage to the cartridge rim*-- this can indicate high pressure which can also be caused by a timing issue in a gas-operated gun i.e. trying to extract the cartridge before the bullet has left the barrel and the pressure dropped.



AR extractor mark caused by high chamber pressure – also note primer cratering

Brass flow into the AR ejector hole caused by high chamber pressure

9. **The fired cartridge case is split, cracked or separated**—High pressures may be indicted by split and separated cases especially if the primer is blown out at the same time. Be careful here, since <u>cases can split and separate</u> as well as necks can split due to being overworked, embrittled, or stretched (discussed below) due to too many reloading cycles <u>even at normal pressures.</u> Brass work-hardens and

becomes brittle by being fired and sized. In a bottle-necked cartridge, the shoulder and neck are worked the most and can develop cracks. High pressures exacerbate this and shorten the life of the brass case. Annealing the neck and shoulder may be able to rectify these work-hardened areas. *If you have a separated case that is left in the chamber, a "trick" for removing this remnant is to use a tight-fitting bronze/copper bore bush inserted from the breech face side pushed ½ way through the remaining piece then pulled back causing the bristles to toggle over grabbing and pulling the piece out of the chamber.*

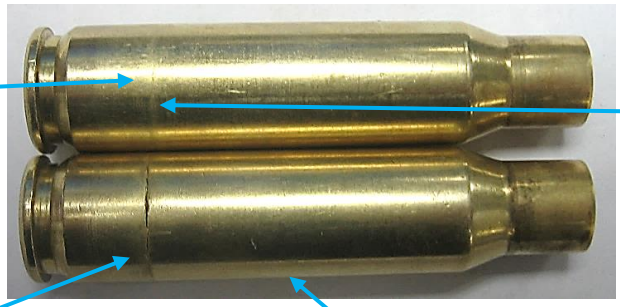
Split base

Split and cracked necks

Separated body/lost primer

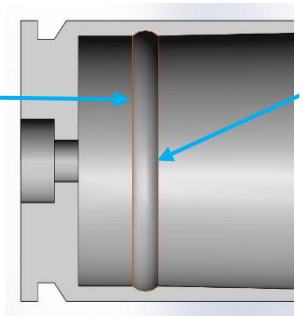
Split body—Pistol case

- An example of stretched/failing brass is shown below. The brass "flows" towards the neck during the firing process and causes the case wall to get thinner in a "groove" on the inside of the case as shown below:



"Halo" indicating impending brass separation

Separated Brass



Brass thinning from the inside out

Examples of "stretched brass" --impending case separation

  - Case Head body or neck separation can also be caused by improper(short) head spacing on a resized case causing excessive stretching of the case in addition to excessive pressure.

11. ***Side of the case extruded-blown-out into the ramp area on a semi-auto pistol***—This is usually a sign of high pressure but could also be an excessively ramped barrel where too much of the case support was relieved.

Side of case extruded into ramp on semi-auto pistol—"frown"

12. ***Hard bolt lift***— (Bolt Guns) --high resistance to raising the bolt to remove a fired round especially with a new load or a new gun is almost always a sign of excessive pressure!

13. ***Hard case extraction***—**(Revolvers)-- when there is abnormal resistance to eject cartridges in a revolver it almost always means excessive pressure, especially if it occurred with a new load with an increased powder charge.**
14. ***No resistance when seating a new primer***—**could be an FC/American Eagle .223 case or an over-pressured case with an expanded or a "blown-out" primer pocket. This is easy to feel on Dillon 550 or 750.**
15. ***Violent cycling in a gas-operated gun***—**The ejected case is thrown farther or in a different direction to the side could be an indication of high pressure.**
16. ***Case Head Expansion***—**Case Head Expansion and or Pressure Ring Expansion (the area just above the extractor groove) of a cartridge case can indicate high pressure. <u>These results are often debated.</u> This method requires meticulous before and after firing measurements of the cartridge head diameter at the same spot just above the extractor groove with a precision blade micrometer that measures in .0001" or .00001". Over annealed cases will also exhibit excessive case head and primer pocket expansion. The case head in this instance can grow .004"-.008" and will not hold a primer!**

It takes time to learn to read pressure signs since it is not an exact science, but it is a skill set needed by the accomplished reloader. A final word of warning!!!- using an excessive load, using the wrong powder or other components, having an errant double or multiple charge of powder, using unknown or mixed powders, or firing the firearm with an obstructed bore can result in the complete and total failure of the firearm causing severe injury or death. Reloading ammunition requires the complete and absolute attention to detail, of a) the "recipe" used and b) to the reloading process and c) careful monitoring the load for signs of excessive pressure during the "go-bang" event.

Ron Colvin –2-15-21