SMALL CALIBER INTERNAL BALLISTICS FAILURE ANALYSIS

NDIA PRESENTATION
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50 BMG WITH BLACK POWDER

OUR OBLIGATION IS TO OUR PEACE KEEPERS

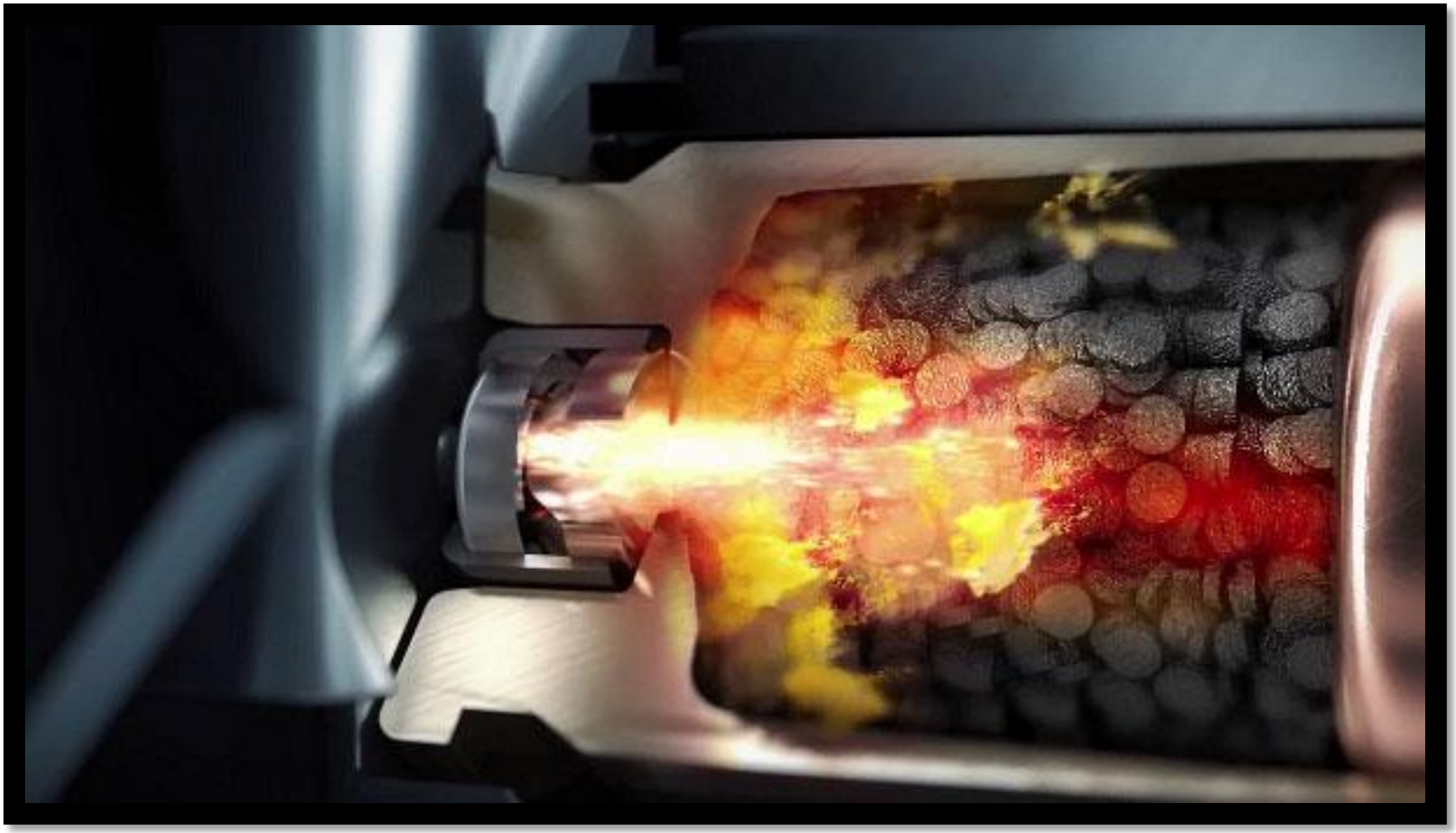
FIRING SEQUENCE

- Firing pin strikes the primer
- Primer mix is detonated between cup and anvil
- Primer sometimes backs out of primer pocket as much as .010” and pushes case forward
- Flame and ambers from the primer travel through the primer vents, through the flash hole into the powder charge
- The powder charge is ignited and starts to generate gas pressure pushing against the case walls, the chamber, bolt, and bullet

FIRING SEQUENCE

- Gas pressure escapes around the bullet until it is sealed in the barrel by moving forward
- Case shoulder expands, case body stretches and head is forced against bolt and seats primer
- Peak pressure is achieved when the bullet is about 3 to 4 inches in front of the chamber
- Chamber pressure in a typical rifle achieves about 55-65,000 psi and temperatures of +3,000°F

PRIMER FIRING



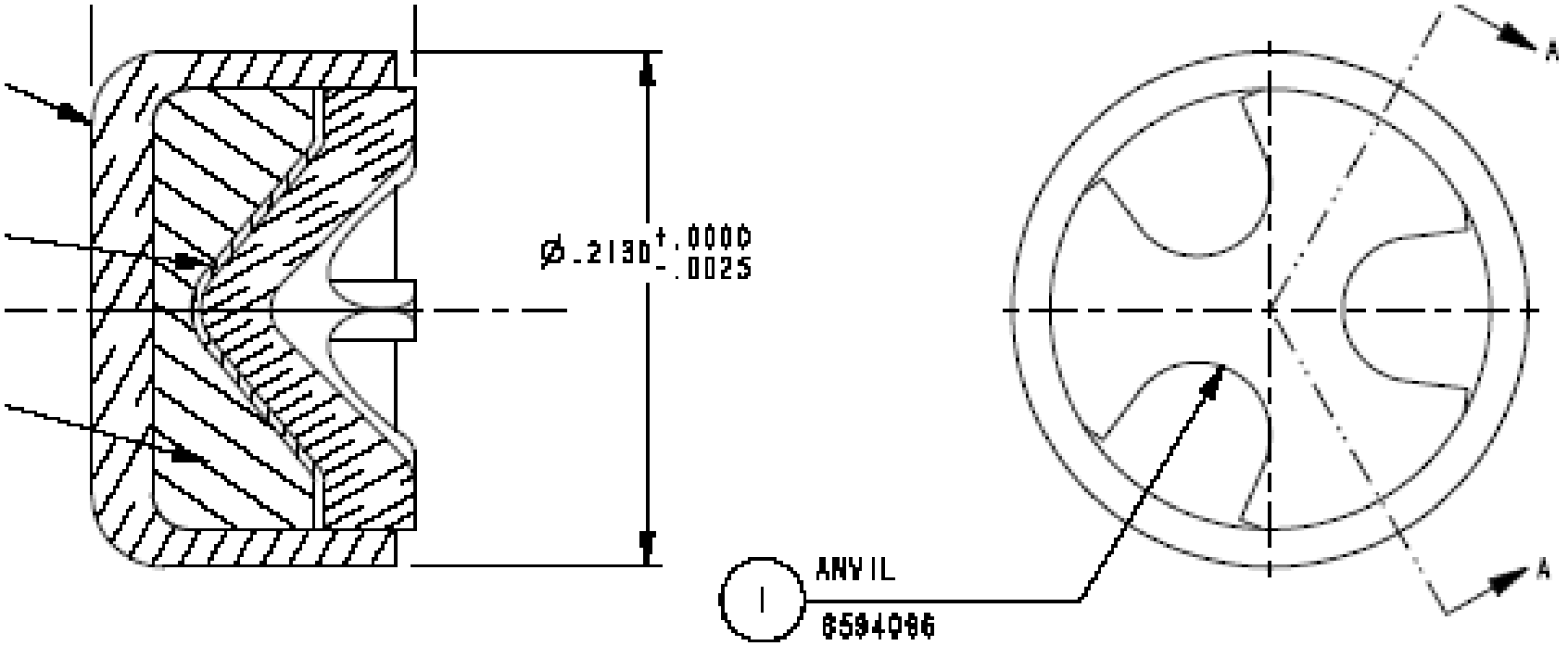
OVER PRESSURE

CHAMBER OVER PRESSURE

PISTOL CASE OVER PRESSURE

What Happened Here???

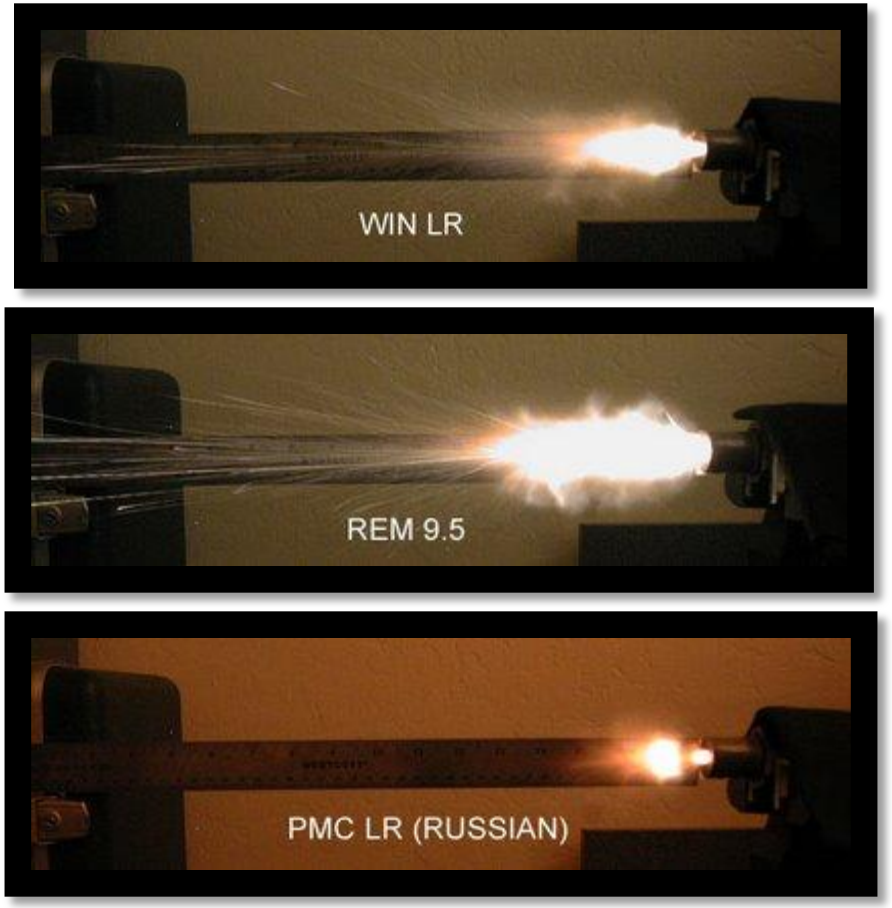
SMALL PISTOL BOXER PRIMER



PRIMER PROBLEMS

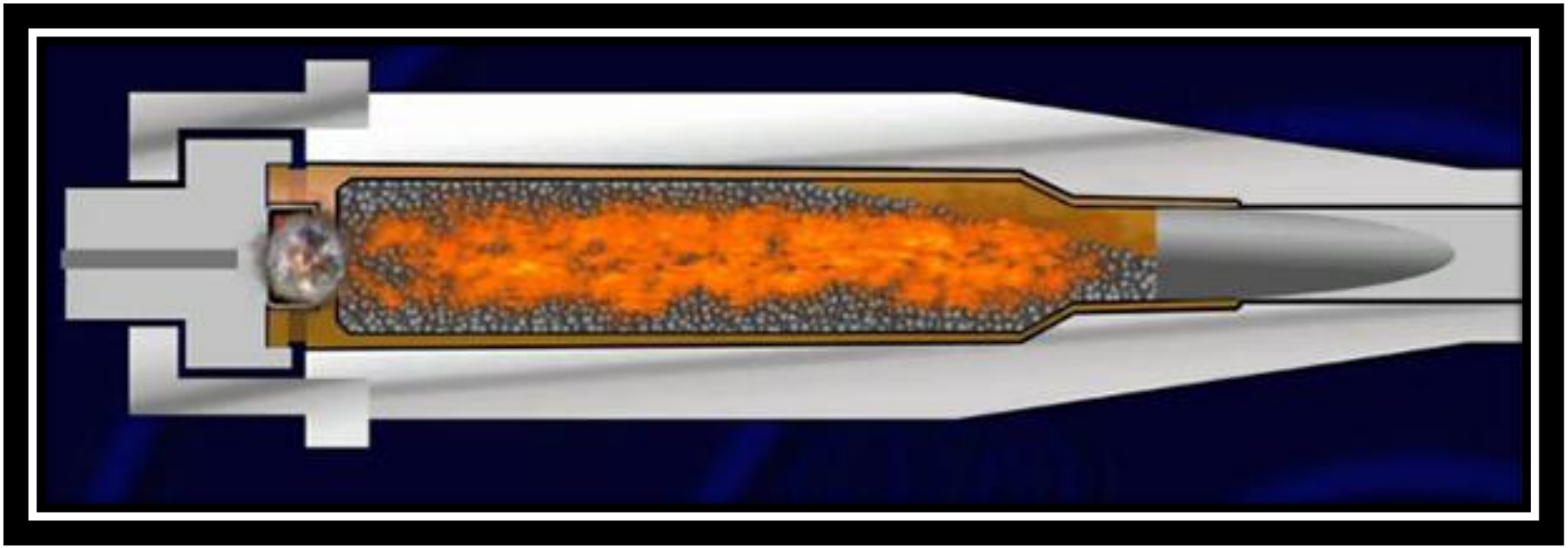
- Primer not seated in pocket
- Mix – break up, wet, low or no mix
- Anvil – missing, defective, not seated, or double
- Defective cup
- Defective case primer pocket damaged the cup
- Blocked vent holes — double anvil
- Gun issues — Off center hits or light hits
- An important attribute for accuracy

BOXER TYPE PRIMER FLASH

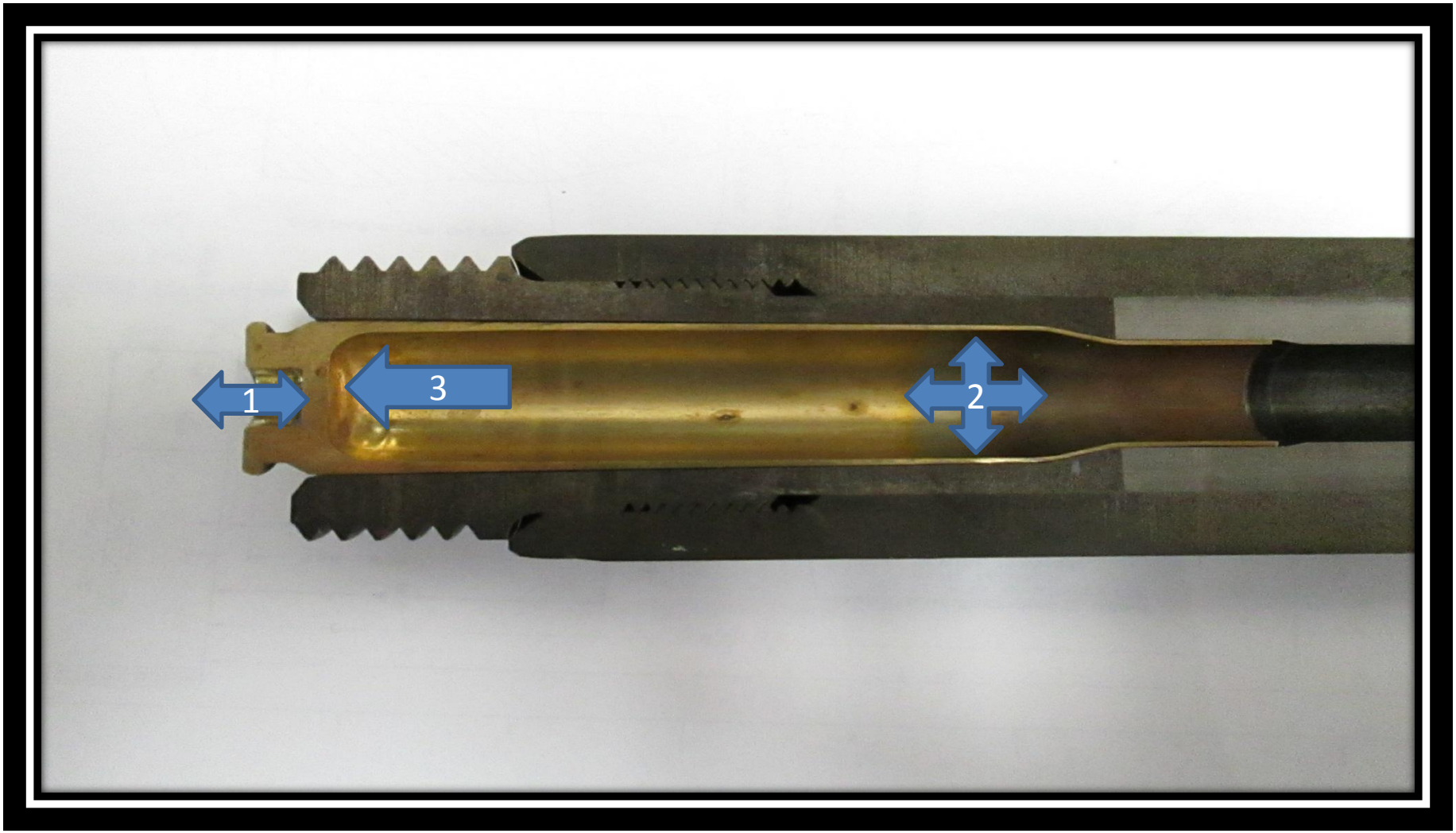


9MM PRIMER PRESSURE SIGNS

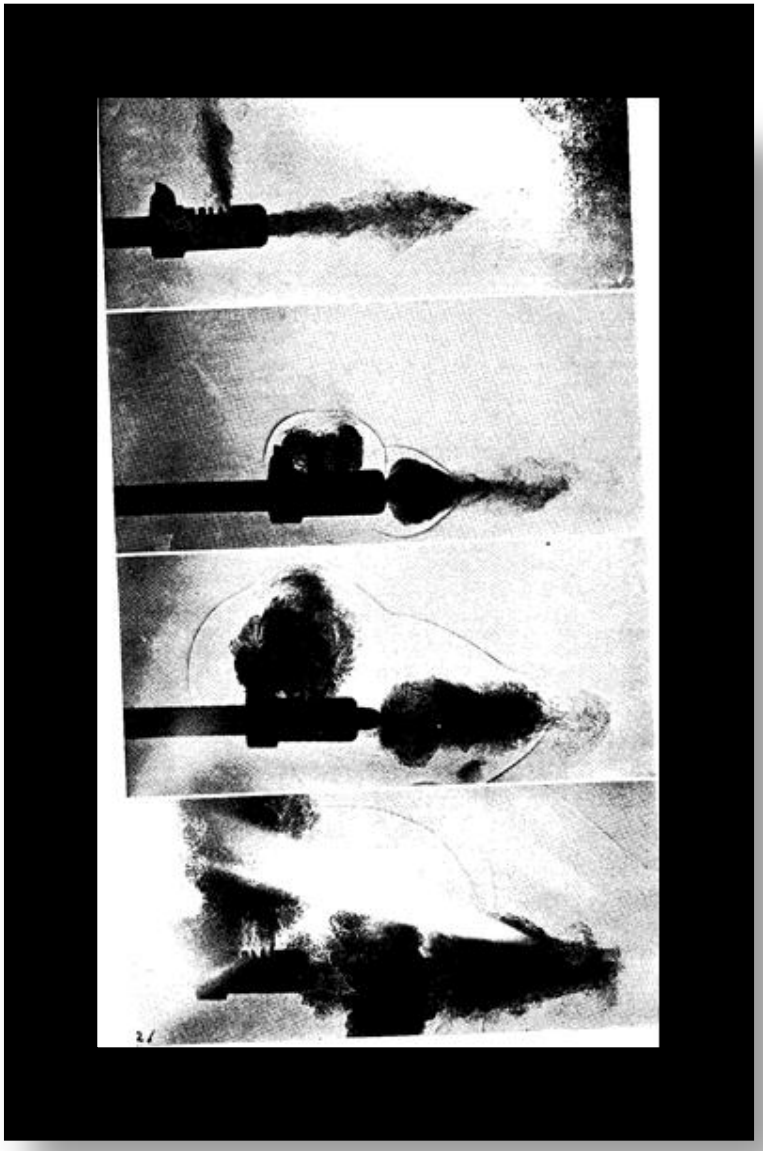
RIFLE CARTRIDGE



PRESSURE SEQUENCE ON THE CARTRIDGE CASE

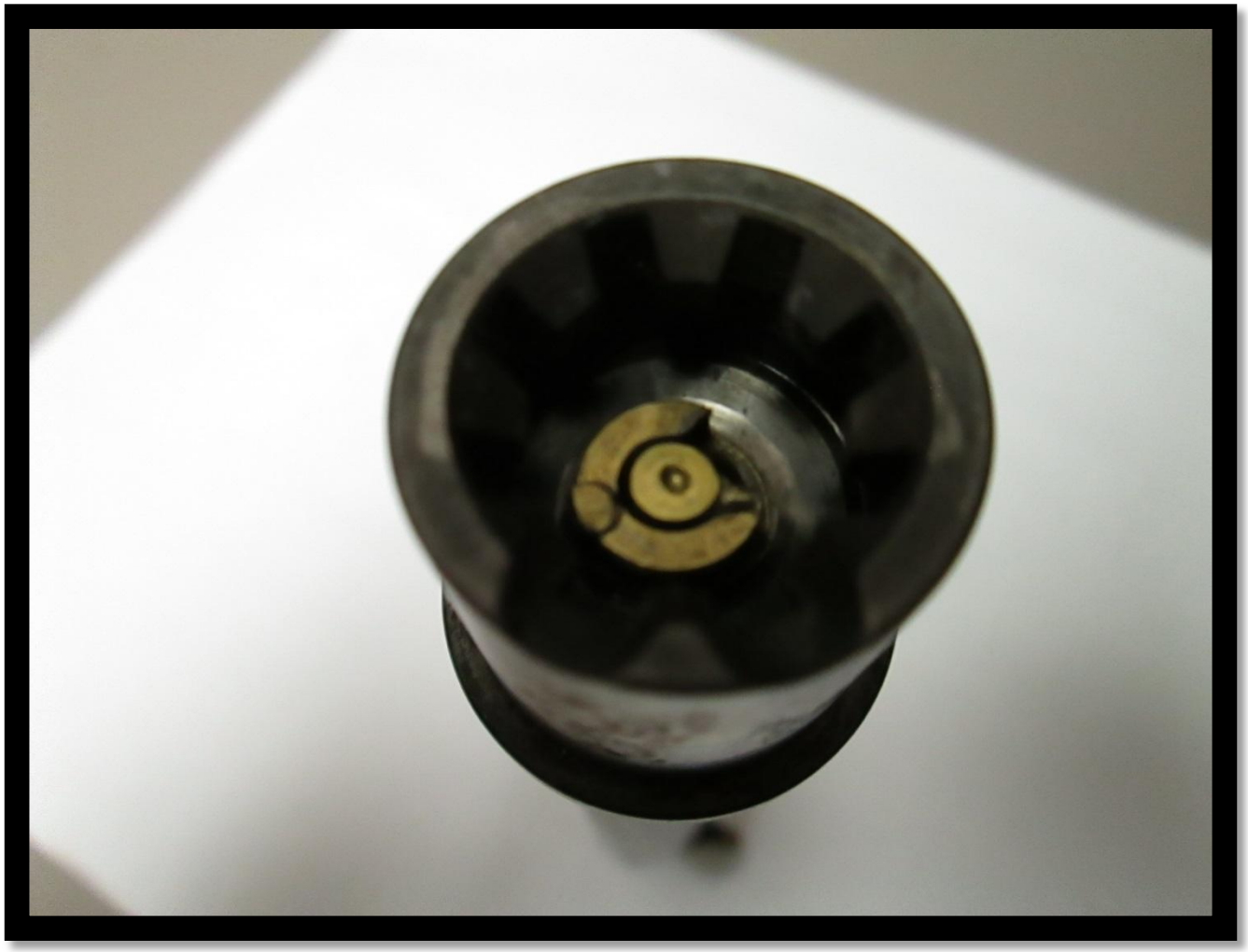


CARTRIDGE GAS RELEASE



PRESSURE ON RIFLE PRIMER

OVER PRESSURED CASE (BLOWN)



30 CALIBER BULLET IN A 22 CALIBER BARREL 300 ACC FIRED IN A 5.56

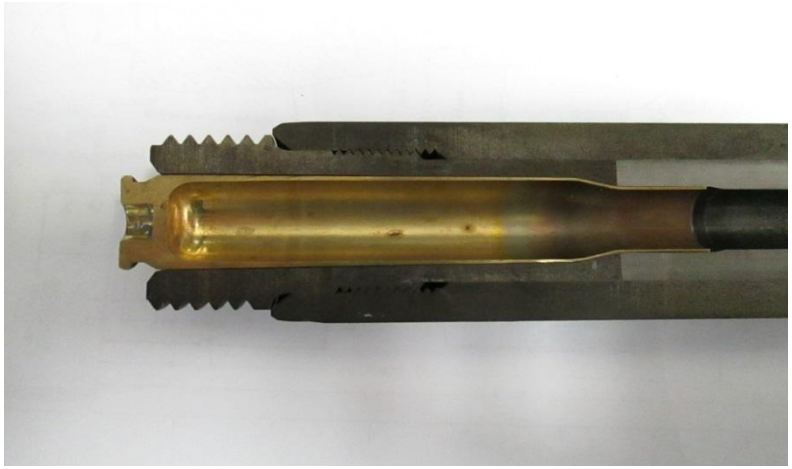
HEAD SPACE

WHAT HAPPENED WITH THE BOTTOM 50 BMG CASE???

CASE SEPARATION

CARTRIDGE CASE FAILURE

- The case head is the least supported in the chamber
- The primer and primer pocket is the weakest area
- A cartridge case depending on design can only take so much pressure



RESULTS OF A BULLET IN BORE

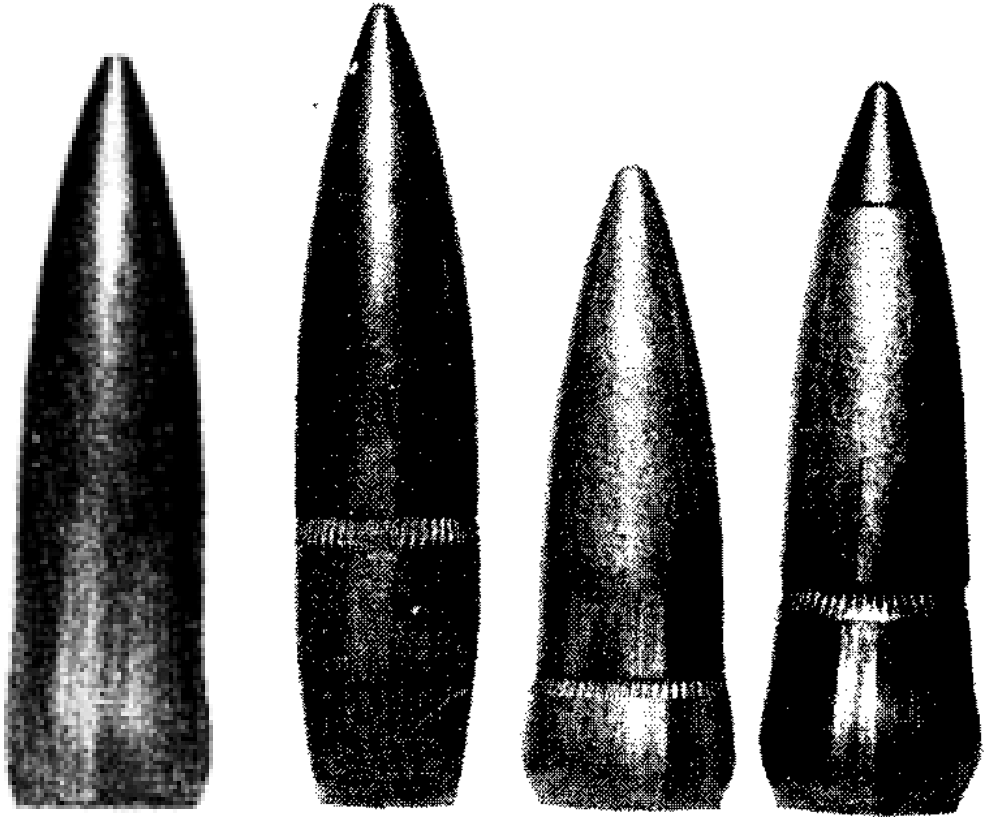
GUN POWDER

- Over a hundred types with different burn rates
- Gas generator for pressure
- Charge is dependent on case volume and shape
- Affected by humidity and temperature
- Important for accuracy
- Powder type controls the pressure curve for gas gun operation and performance
- Produces barrel fouling and erosion, some more than others
- A solid flammable that produces tremendous heat

BULLET STRESS

- Gas pressure against the base
- Engaging the rifling of the barrel
- Flaws in the barrel
- Alignment at the throat of the chamber
- Friction and heat
- Twist rate of the barrel
- Bullet material limits Lead, Copper, or Plastic

GAS PRESSURE ON BULLET BASE



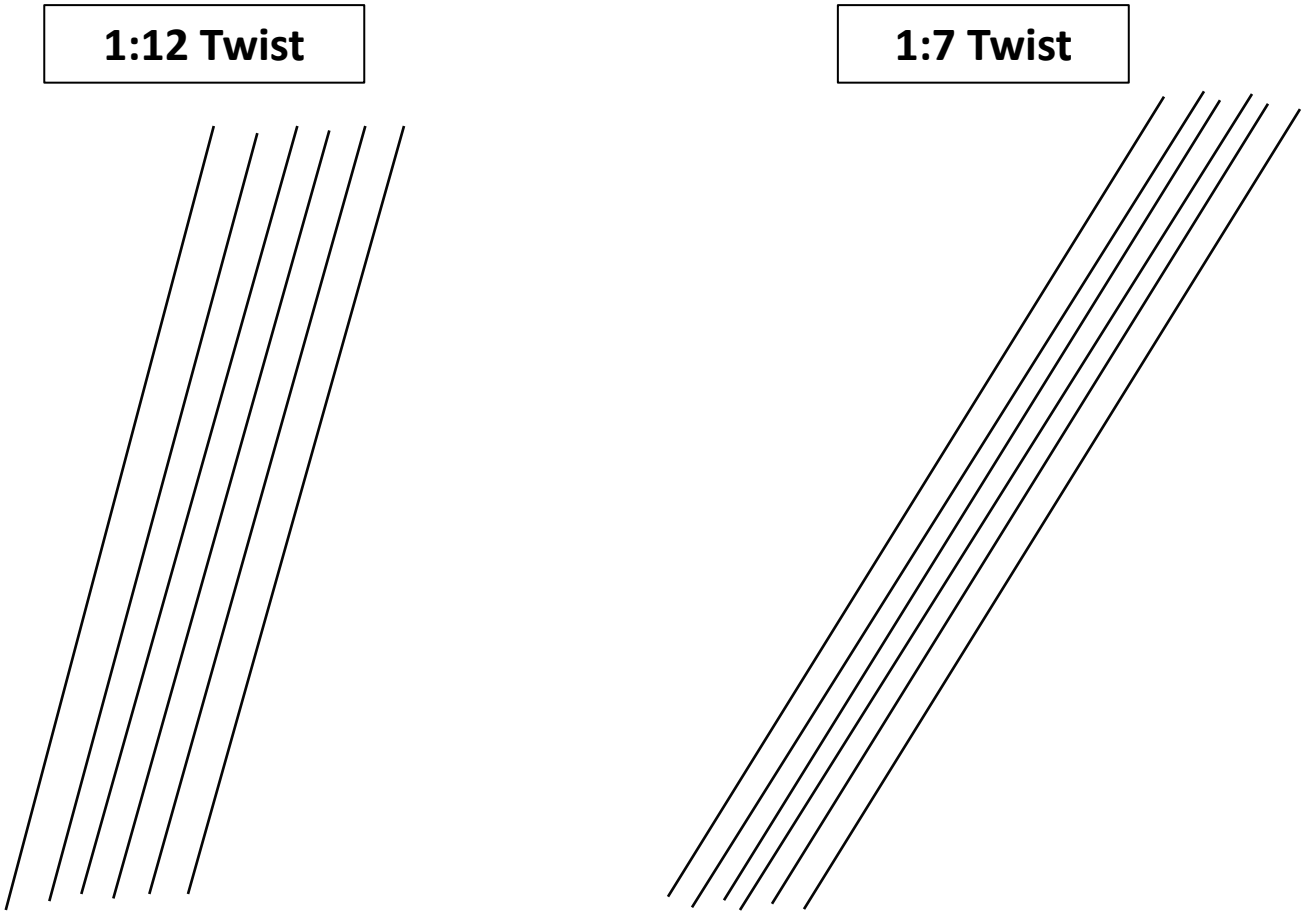
BARREL FRICTION

- A bullet with a velocity of 3,000 fps in a 1 in 17 inch twist barrel develops 127,058 rpm
- A bullet with a velocity of 3,000 fps in a 1 in 12 inch twist barrel develops 180,000 rpm
- A bullet with a velocity of 3,000 fps in a 1 in 7 inch twist barrel develops 308,571 rpm

M856 TRACER BULLET

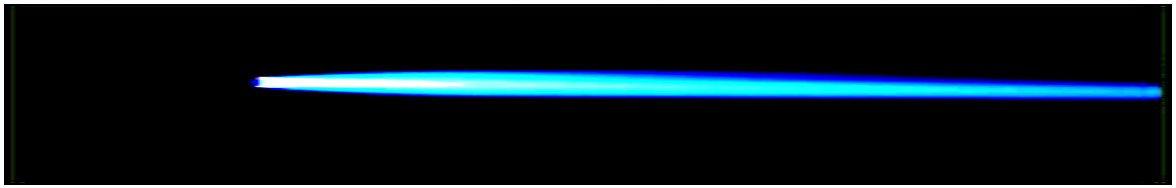
BARREL RIFLING

- Rifle twist rate



PROPELLANT CHEMICALS INTRODUCED IN INTERNAL BALLISTICS

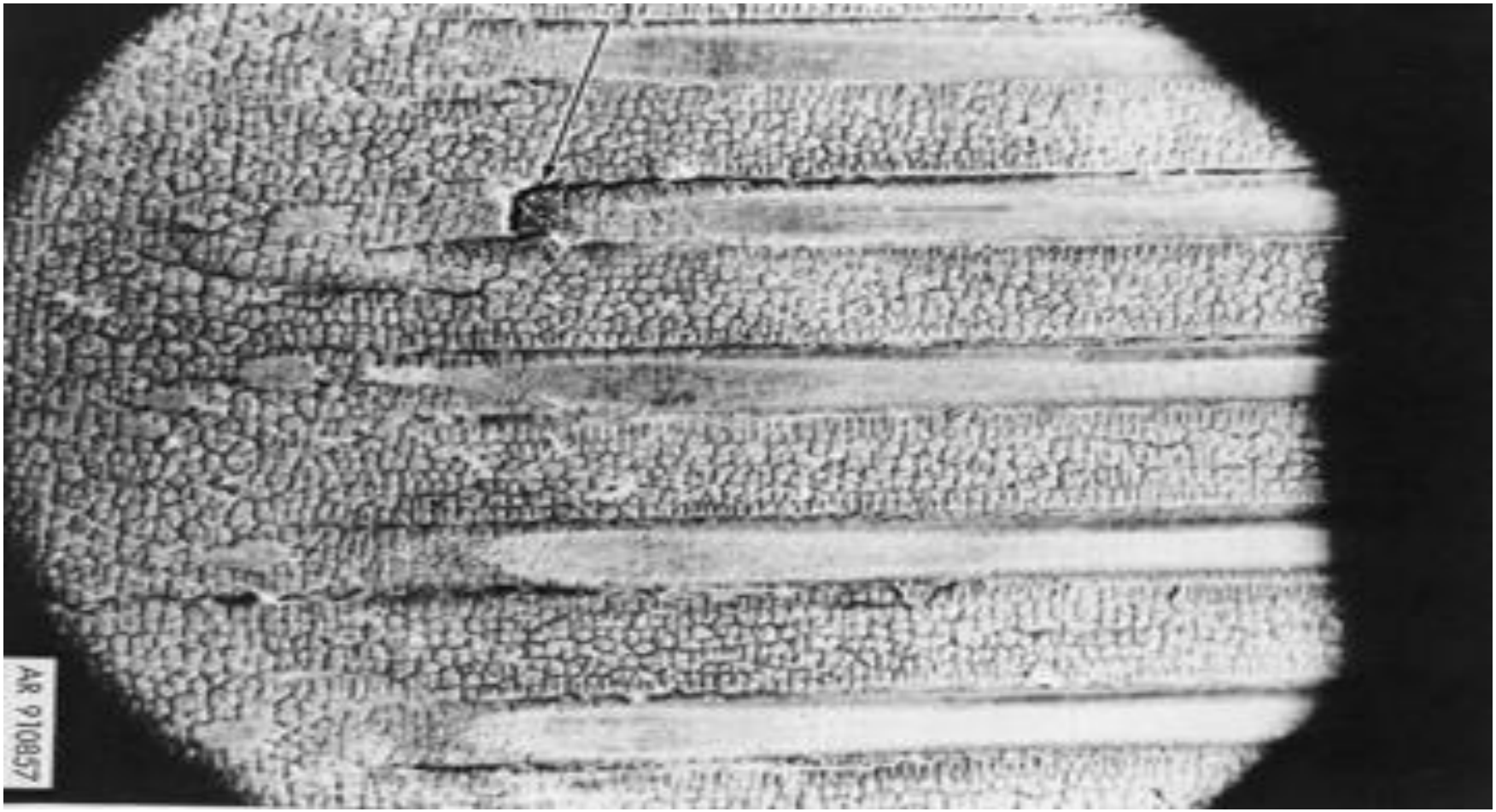
- Nitrocellulose
- Nitrogen in Nitrocellulose
- Dinitrotoluene
- Graphite
- Potassium Salt
- Calcium Carbonate
- Nitroglycerine
- Diphenylamine
- Dibutyl Phthalate
- Tin Dioxide
- Dust



PRIMER MIX CHEMICALS INTRODUCED IN INTERNAL BALLISTICS

- Lead Styphnate
- Tetracene
- Penteaerythritol Tetranitrate (PETN)
- Barium Nitrate
- Antimony Sulfide
- Aluminum
- Hydrogen
- Carbon
- Nitrogen
- Oxygen

HEAT CHECKING IN A BORE

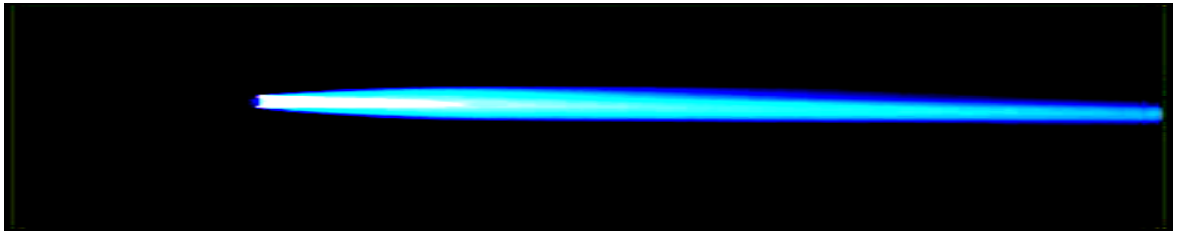


BARREL EROSION CHEMICAL REACTION

- Burning powder, thousands of degrees (3500°F) produces a gas that is plasma, ions rather than molecules and are very reactive
- The atmosphere created in the bore is high in hydrogen, carbon, and nitrogen
- Under these condition, coupled with the pressure, minute amounts of the gas plasma reacts with the adjacent steel, forming new compounds with mechanical properties differing from the steel, generally harder and less ductile

PROPELLANT CHEMICAL

- Hydrogen is known to embrittle alloys, which contribute to micro cracking and removal of material
- Carbon atoms can diffuse in the barrel material lattice structure
- Oxygen under pressure increase temperature



BARREL FOULING

- Primer mix fouling
- Powder fouling
- Carbon fouling
- Lead fouling
- Copper fouling
- Gas cutting
- Barrel machining flaws
- Cleaning solvents and care

WHAT CAN CAUSE A DROPPED PRIMER?

- Primer pocket dimensions (bunted with oil)
- Primer dimensions – too small (very rare)
- Web too weak (too soft or too thin)
- Excessive case pressure
- Chamber dimensions incorrect
- Fouling in the throat increasing pressure
- Case head support of the bolt

WHAT CAUSED THIS?

CASES WERE TOO BRITTLE

When Internal Ballistics Are Correct, THESE ARE THE RESULTS

5 SHOTS – 30BR CALIBER @ 100 YARDS
Groups can be covered by an aspirin