

# Failure Analyses and Metallurgical Studies



## Historical Perspective

*Sporting Guns and Gunpowders: Comprising a Selection from Reports of Experiments, and Other Articles Published in the "Field" Newspaper, Relative to Firearms and Explosives, 1897*

<https://books.google.com/books?id=inQCAAAAYAAJ>

Experiments on Strength of Gun Barrels

<https://books.google.com/books?id=inQCAAAAYAAJ&pg=PA14>

The Bursting of Small-bore Guns

<https://books.google.com/books?id=inQCAAAAYAAJ&pg=PA86>

Obstructions in Gun Barrels, pp. 92-95

<https://books.google.com/books?id=inQCAAAAYAAJ&pg=PA92>

A Burst Gun

<https://books.google.com/books?id=inQCAAAAYAAJ&pg=PA227>

The Cause of a Bulged Barrel

<https://books.google.com/books?id=inQCAAAAYAAJ&pg=PA228>

Burst or Bulged Gun-Barrels

<https://books.google.com/books?id=inQCAAAAYAAJ&pg=PA335>

A discussion of Damascus and Steel barrels is on the same page.

Tom Roster, “Understanding Obstruction Barrel Bursts”

<https://www.shotgunlife.com/shotguns/tom-roster/understanding-barrel-obstruction-bursts.html>

Interesting video from Fieldsports with attempts to burst barrels with various obstructions

[Blowing up barrels – Fieldtester, episode 8 - YouTube](#)

## **A Damascus Failure Analysis**

“A Blow-Up Post-Mortem”, published in *The Double Gun & Single Shot Journal*, Vol. 27, Issue 3, p. 17, 2016

### **Study Barrel**

The burst occurred toward the end of the shooter’s second round of Skeet, with the 46th shells through the c. 1905 Remington Hammerless Model of 1894 A Grade since it had been acquired. The barrels are “Oxford 2 S.J.” (Remington’s nomenclature) Two Iron Crolle Damascus.

The temperature was well below freezing with snow on the ground.

Prior to first using the gun, the shooter did not measure chamber length, bore diameter, or minimum wall thickness, and does not recall specifically inspecting the interior and exterior of the barrel for evidence of a bulge.

He recalls that **every shot, from the first shot, had an abnormal report from the left barrel only.**

The burst occurred on shooting the doubles incomer at Skeet station 7. The previous round from the left barrel (high house single) had the usual (abnormal) report, and **the target was broken**. Recoil with that shell seemed the same as with the previous shells.

Bystanders heard an abnormally loud report with the burst, and came to investigate. Fortunately, a physician and a physician's assistant were in the shooter's squad and provided immediate First Aid.

### **“The Diagnosis of a Burst”**

Major Sir Gerald Burrard wrote the second edition of *The Modern Shotgun*, Volume 3, *The Gun and The Cartridge*, “The Diagnosis of a Burst”, in 1948, prior to the development of sophisticated technology such as Scanning Electron Microscopy (SEM), X-ray Photoelectron Spectroscopy (XPS or ESCA), Energy Dispersive X-ray Spectroscopy (EDX or EDS), and the ballistic application of piezoelectric transducers. These modern diagnostic tools provide a precise mechanical, structural, and chemical analysis of barrel steel, but there remains no better protocol for the evaluation of a burst shotgun barrel than Burrard's.

“In order to give the investigator every possible chance of arriving at the truth the gun should be sent up for examination as soon as possible, and without being cleaned. Accompanying the gun should be the fired case of the cartridge which actually caused the burst; if possible the fired case of the round immediately preceding the burst, a few fired cases, and as many unfired cartridges as possible...of the batch which was being used at the time.”

“With this evidence available it should be possible to diagnose the cause of the accident with certainty. By far the most common cause of burst is some obstruction in the bore, and so the first thing to do is to look for evidence of an obstructional (*sic*) burst, that is for a ring bulge. **If a ring bulge is detected the cause of the burst becomes established beyond any shadow of doubt.**” (*My emphasis*)

“Every effort should be made to try to ascertain what the obstruction could have been; and in this connection the owner of the gun should be asked...the following questions:”

1. “Was the accident caused by the first shot of the day through the barrel which

actually burst?”

2. “If the accident was not the result of the first shot of the day, what was the result of the shot from the barrel which burst immediately previous to the one which caused the damage? Did anything in the least abnormal occur in the case of the shot fired through the burst barrel immediately before the round which caused the burst?”
3. “Was the chamber apparently empty when the gun was opened for re-loading (prior to the burst)?”
4. “Was any member of the party using a smaller bore of gun? What size?”
5. “Does the shooter own a gun and cartridges of smaller gauge than the one which burst?”
6. “Under what conditions was the shooting taking place?”
7. “What was the nature of the ground on which the shooter was standing or walking at the time of the accident?”

“The answers to these questions and the actual position of the burst in the barrel should...provide sufficient data to determine the nature of the obstruction with comparative certainty.”

“(The) fired case of the round which caused the burst and also that of the round immediately preceding the burst should be examined...(and) in order to complete the investigation a most careful examination should be made of as many live cartridges as possible from the same batch. Some should be opened, and the weights of the powder and shot charges checked in order to test for regularity of loading.”

**As received**



The barrels were received with both empty shells in the chambers, along with 19 empty shells that had been used during the round of Skeet, and 4 unused reloads; a total of 25 shells. On careful examination of the empties, there were **no** missing pieces of plastic, inside or out, nor evidence of case head separation.

The loading recipe used by the shooter:

Remington Gun Club Unibody hull (**which does NOT have a two piece base**)

1 ounce shot

Winchester 209 primer

WAA12SL wad clone

17.5 grains Clays powder

The recipe from the Hodgdon site states:

15.7 grains = 7100 LUP at 1125 fps (feet per second)

17.0 grains = 8200 LUP at 1180 fps

18.4 grains = 9500 LUP at 1235 fps

Note the pressure is expressed in LUP (Lead Units of Pressure) rather than modern piezoelectric transducer PSI (pounds/square inch) measurement,

which would be about 10% higher.

The reloading machine was a MEC 9000G and the bushing chart indicates #31 could be lighter than 17.5 grains so #32 was used. The shooter had been using this same recipe for some time, and had experienced issues with the charge bar not returning fully for the powder drop, and had noted an occasional shell with a light report.

The four remaining loaded shells were carefully disassembled, and both shot and powder weighed:

Shot: .90, .95, .95, and .95 ounces.

Powder: 17.4, 17.6, 17.6, and 17.8 grains.

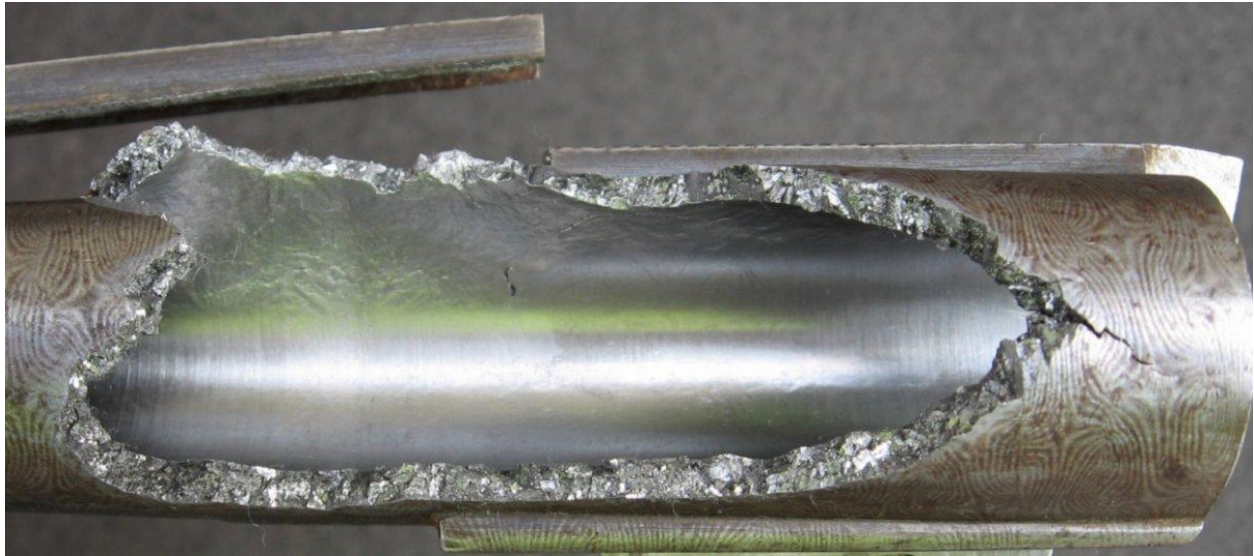
An experienced reloader attempted to duplicate a **double** powder charge with a Gun Club hull and **35 grains** of Clays, Downrange clone of Winchester WAA12L wad, and 1 ounce of shot. With wad pressure on a MEC 9000 of 40 pounds, the hull would not hold the entire shot charge; about 1/16 ounce spilled over the mouth of the hull. (Courtesy of Joe Wood)



“Then all the remaining cartridges should be tested for ballistics; that is pressure and velocity, and if possible recoil.”

The remaining 4 shells were sacrificed to weigh the shot and powder.

“Then a most careful examination should be made of the fractured edges (and) the thickness of the wall...”



**Wall thickness around the edges of the burst:**

Starting to the right, 5/8" from the breech WT was .150".

At the bottom 1 1/8" from the breech .130".

Moving along the bottom to the front was uniformly .121" to .123".

At the top, 1 1/8" from the breech was .126", 1 1/4" from the breech .122", and 2 5/8" from the breech .119".

The thinnest section was at what I believe to represent the apex of the ring bulge from 2 1/4" to 2 1/2" from the breech and WT was .110".

"In the case of an obstructional burst the really essential evidence is the ring bulge.

**If there is a ring bulge, there must have been an obstruction..."**

Burrard made the point that the bulge usually occurs 3/4" to 1 1/4" beyond the leading edge of the obstruction, and may be asymmetric related to varying wall thickness, especially at the breech, and is invariably associated with lifting and bending of the rib.

"The most difficult of all obstructional bursts to diagnose with certainty is a burst which is clearly the result of an obstruction, but which occurred suddenly in the middle of a series of shot, when there was no possibility of any mud being picked up in the muzzle, and when the previous shot killed a bird. In such a case the explanation must be arrived at by a process of elimination..."

A study by the Royal Military College of Science, sponsored by the Birmingham Proof House and the British Association for Shooting and Conservation, showed that an obstruction by 2 fibre wads (total weight of 4 grams) was sufficient to bulge or burst a 12 gauge barrel shooting a 28 gram (slightly less than 1 ounce) load. Peak pressure occurred 22mm (.866") past the leading edge of the obstruction.

“If the burst was **not** caused by an obstruction it must have been the result of some excessive pressure or of some abnormal weakness in the barrel. A pressure burst can only occur in the immediate neighbourhood of the chamber; and so if the burst occurred ahead of the chamber cone an excessive pressure can be ruled out. But if the burst occurred at the breech, and was the direct result of a high pressure, confirmatory evidence will be found in the appearance of the brass head of the cartridge which caused the accident. For it is utterly impossible for a very high pressure to be developed without it leaving its mark on the fired case.”

Burrard identified an **indentation of the extractor on the case head**, enlargement of the case head, flattening or fracture of the rim, lifting of the primer from the pocket, flattening of the primer against the breech face, and deep striker indentation, especially in comparison to shells of the same batch, as evidence of excessive pressure.

Extractor imprint on the shell in the burst barrel



“It is essential that the barrel should be submitted to an expert for metallurgic investigation...”

The examination of the subject Remington Hammerless Model of 1894 “Oxford 2 S.J.” Two Iron Crolle barrel was performed in March and April, 2014 by Adam W. Haskins, P. E., Metallurgist at Metals Engineering and Testing Laboratories, METL, in Phoenix, Arizona. <http://metl.com/>

**Ring bulge with rib separation and burst**



Plastic deformation (wrinkles) and small cracks. On 10X magnification, some cracks followed the crolle pattern; others were across the crolle pattern.



**What could be diagnosed with confidence prior to the Metallurgical study?**

The ring bulge establishes that the burst was caused by an obstruction.

**What was suspected, but not confirmed?**

1. The burst barrel had a pre-existing defect causing the abnormal report, possibly a bulge.
2. The obstruction was likely the wad, or part of the wad, from the previous shell, lodged in the forcing cone, caused by a light powder drop while reloading possibly combined with incomplete combustion from the very low temperature. Partially melted snow in the barrel just forward of the shell seems improbable but is possible.
3. The wad may also have stiffened related to the very low temperature and lost flexibility or fractured.

**What may be reliably excluded?**

1. A double load of powder. Substitution with another powder is quite unlikely.

2. Loading a 20 gauge shell, attempting to shoot the target and upon hearing only a 'click' opening the gun and loading a 12 gauge shell. Other members of the squad no doubt would have been aware if a failure-to-fire had occurred.
3. Inadequate wall thickness.

### **Questions answered, and Damascus myths refuted, by the Metallographic Examination:**

1. Did the barrel fail related to low cycle fatigue? **NO**

The fracture surface exhibited a mixture of ductile overload (plastic deformation with both tensile overload and shear) and transgranular cleavage, indicating a ductal failure mode with rapid failure. The cleavage failure appeared to form preferentially in the iron component.

**No evidence of fatigue failure was observed;** there were no striations on the fracture surface.

2. Did the barrel fracture at a ribband edge weld or between rod welds? **NO**

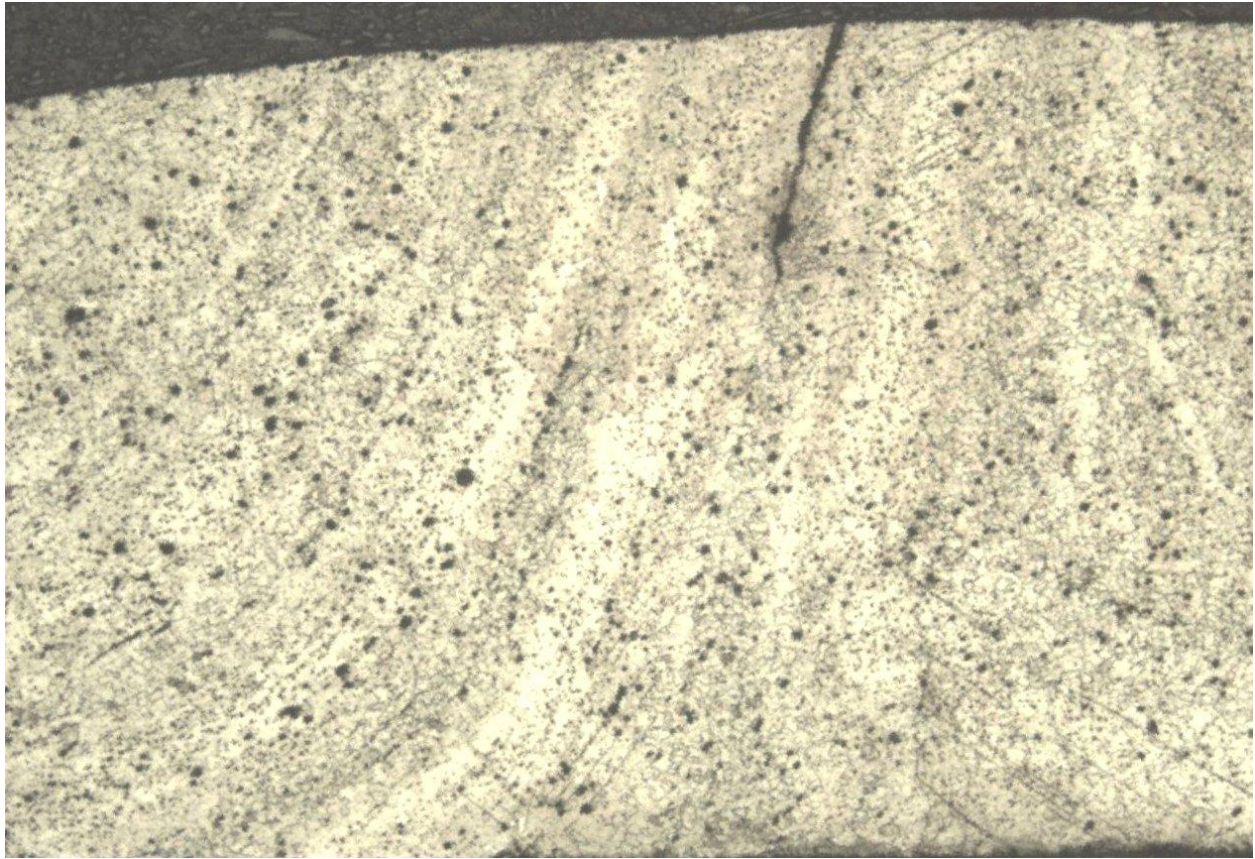
The material appeared as a single piece of metal without microstructural defects. The burst fracture did **not** trace along the spiral (ribband) welds. Some cracks were seen between the individual bands (*alternee*) within the crolle pattern, but this was not a consistent finding.

The bands had different inclusion content and inclusion form. The Nital etched grey **steel** had globular inclusions, the white **iron** had linear inclusions. It is possible that the inclusions in the iron were originally globular but 'stretched' during the rolling, twisting, and hammer forging process.

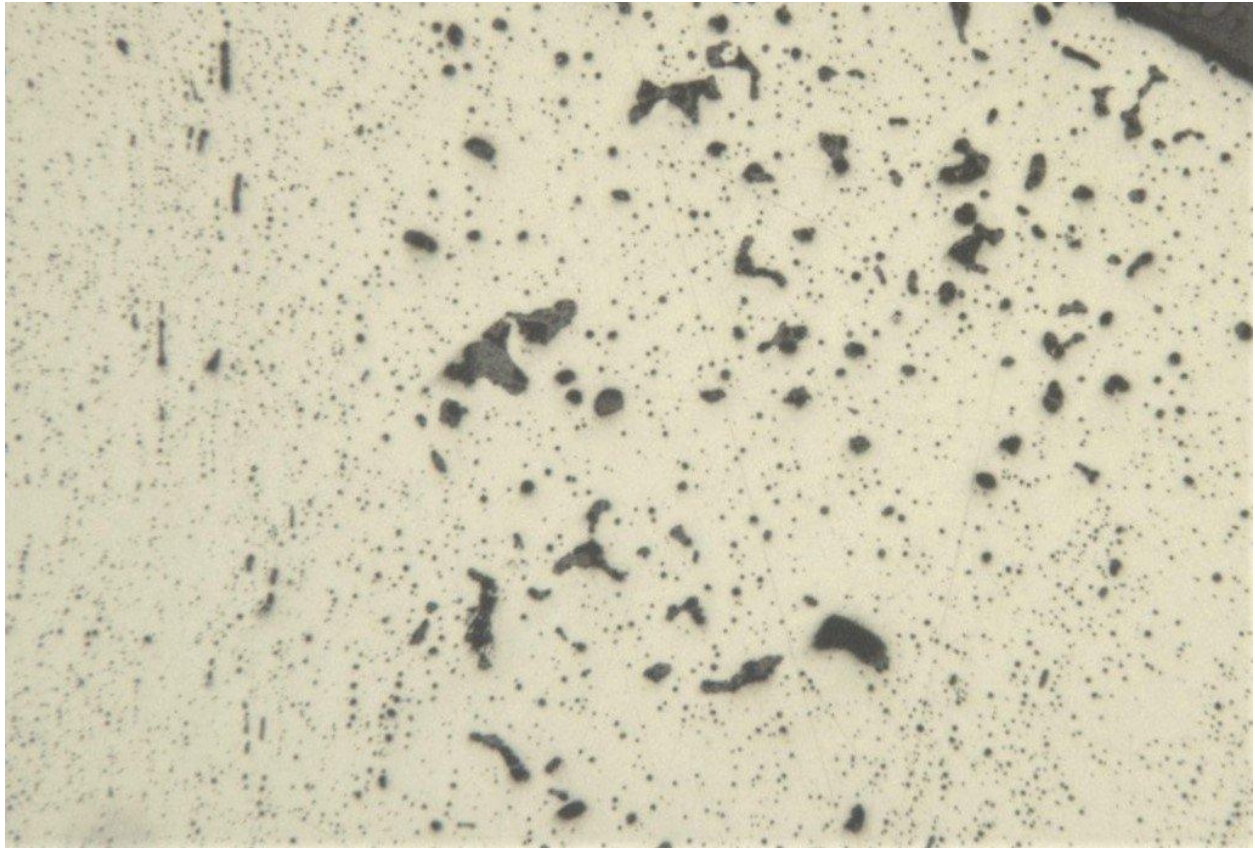
20X photomicrograph after etching with 3% Nital solution showing the bands (*alternees*) and a crack probably within a steel *alternee*, but possibly at an iron-steel interface.

The parallel lines inferiorly may be related to shear forces during the rolling and hammer welding manufacturing process.

The globular inclusions are predominantly within the grey etched steel *alternees*.



3. Did the barrel burst related to rust, inclusions, voids, or embrittlement? **NO**  
No voids, evidence of embrittlement, nor interlaminar rust were observed. There were a large number of non-metallic inclusions, especially within the steel *alternees*, but micro-fractures extending from one inclusion to another were **not** seen. The inclusions are composed predominantly of silicon, phosphorus, and sulfur.



The report from METL contains much more information, some of which is quite technical. The Energy Dispersive X-ray Spectroscopy (EDX) study suggests that element migration between the metals occurred during the manufacturing process; the pressure rolling, twisting, and hammer welding of iron and steel laminates produced essentially a mono-metal.

It appears that this statement from the **1901** Edition of *Chambers's Encyclopaedia: A Dictionary of Universal Knowledge* is indeed true.

**“The complete and almost perfect heterogeneity of the material of the Damascus barrel produces a homogeneous whole, which, when soundly welded, has no weak spot.”**

The chemical composition of the barrel (as a mixture of iron and steel) was similar to AISI 1005 low alloy steel based on Optical Emission Spectroscopy (OES). The compositions of two other Crolle samples and 1 Twist sample were also similar to

AISI 1002 - 1005 low alloy steel by OES, suggesting that the iron component was wrought iron and the steel was low carbon, low alloy “mild” steel.

What then may we determine from this Metallographic Examination and Failure Analysis? **The idea that Damascus barrels are a mass of rusting welds, voids, slag, flux, and corrosion is wrong.** Along with Zircon’s confirmatory examination, we now have evidence which may be used to correct the errors that have been “known to be true” and repeated as such for the last 75 years.

### **A Confirmatory Metallurgical Study**

The pseudonymous Zircon posted “Contribute Junk To Advance Barrel Strength Knowledge” on two public internet forums in 2005 requesting vintage barrels for composition and strength testing. By 2006 he had accumulated almost 40 samples, both Fluid Steel and Pattern Welded. Part of the collection included the Damascus barrels from the Parker GH and the Vulcan Steel barrels from the Parker VH that had been the subjects of destructive testing by Sherman Bell, with the technical support of Tom Armbrust, published in *The Double Gun Journal* Vol. 10, Issue 4, Winter, 1999, “Finding Out For Myself” Part II and Vol. 16, Issue 2, Summer 2005, “Finding Out For Myself” Part IX.

Both guns were subjected to sequentially higher pressure loads at about 2,000 pounds/square inch (psi) increments. The GH testing started at 11,900 psi and one chamber ruptured at 29,620 psi. The VH started with a Proof Load of 18,560 psi. Both chambers bulged at 29,620 psi and ruptured at 31,620 psi.

I personally communicated with Zircon in February 2008 and he shared this information regarding his Metallographic Examination of the GH Damascus barrel:

“The forge-welded joints were 100% bonded. There was no indication of any kind of discontinuity, seam, inclusion of welding flux, or any other sort of defect along the welds; both between the...rods, as well as in the spiral weld where the skelp (*ribband*) was joined together around the mandrel.”

## **“The Southern” Chamber Burst**

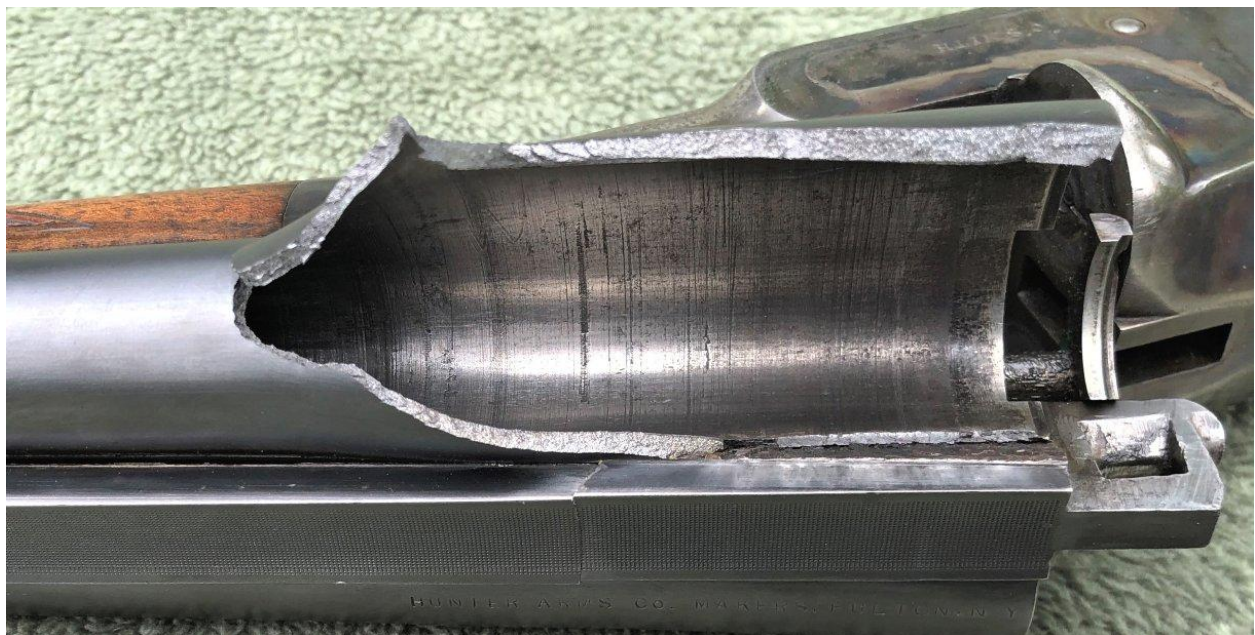
The subject gun is a 1908 Regular frame 16g No. 00 L.C. Smith with fluid steel barrels; though without the usual “Armor Steel” barrel mark .

The shells were Cheddite for Herters “Select Field Dove and Quail” 1 oz. at 1165 fps, or the old 2 1/2 Dr. Eq. Independent pressure testing of (a different lot) Herters shells showed pressure averaging 12,500 psi with one at **13,400 psi**. Another sample was measured by Tom Armbrust at 1,200 fps and 11,500 psi.

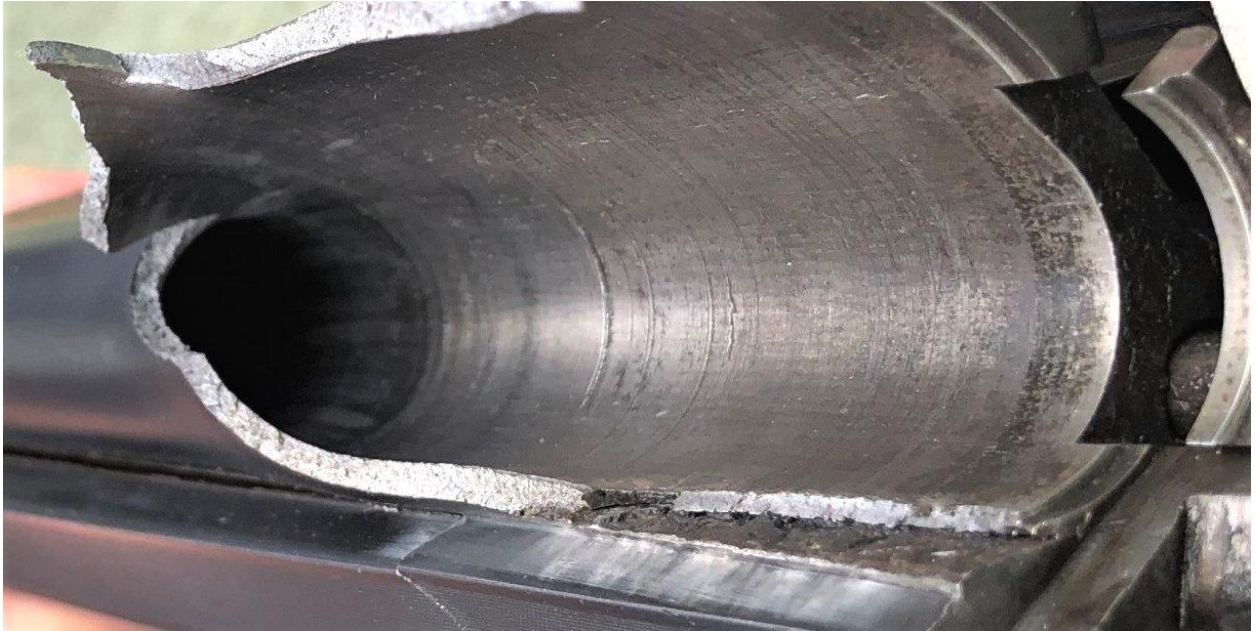
The gun has been used regularly since purchased 2 years ago. The owner states that the chambers have been measured at 2 3/4”.

The burst occurred at the 2019 “Southern” on the Sporting Clays course. The shooter did not perceive anything out-of-the-ordinary before or with the blow-up; other than the loud report in his ear. No increased recoil. A piece/pieces of barrel struck the tree to the right but was not recovered. The shot through the barrel immediately before the burst was normal; no FTF or soft report.

Images courtesy of Cheryl Stubbendieck



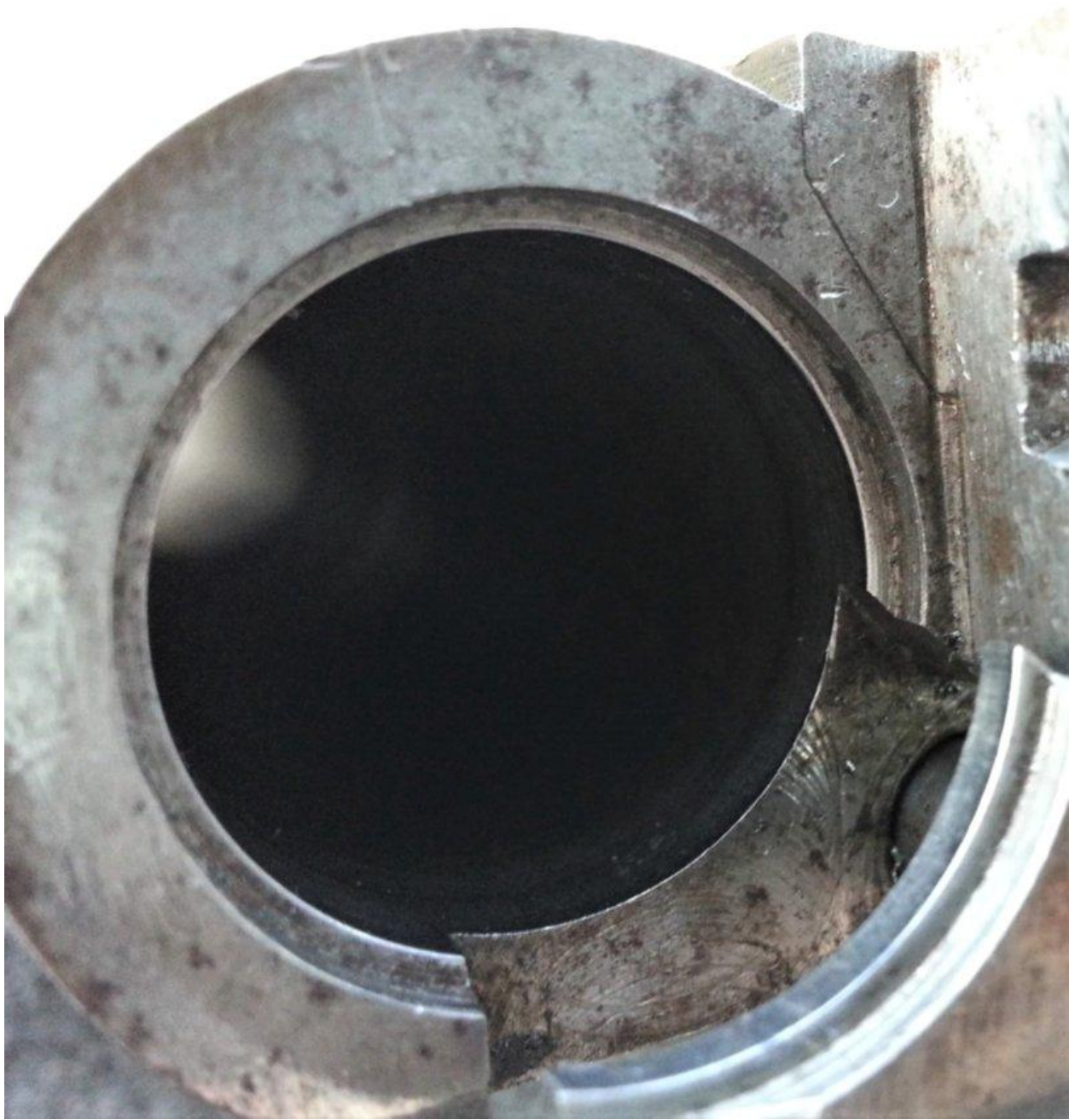
Note that the rib has been lifted



Hunter Arms used a brazed hook and rib extension; courtesy of David Elliott



and the wall adjacent to the wedge hook piece and top rib extension piece is flat;  
a 12 gauge



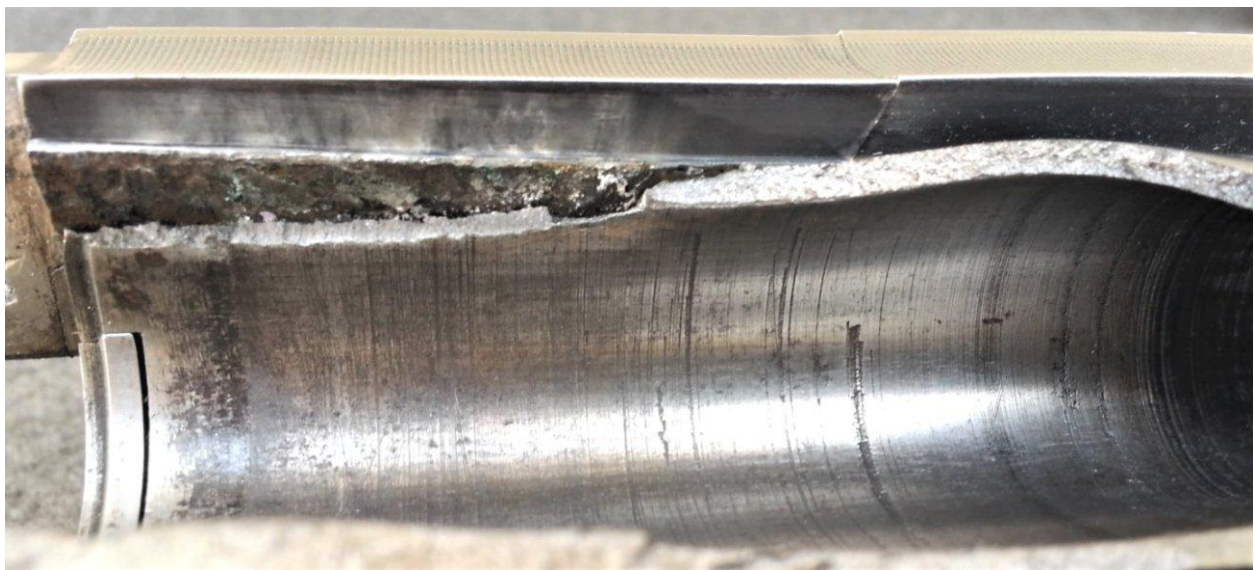
The subject 16g gun



It was initially proposed that the failure initiation point was the dark divot shown here, with failure of or defect in the braze joint + the now unsupported thin wall +/- a flaw (?inclusion) at that point; with the gasses being vented superiorly



After wiping with Shooter's Choice, without using an abrasive cleaner



The shell used in the burst chamber. Clearly the Cheddite hulls have a separate plastic base wad, part of which is missing. The brass base has fractured and a section of the base and hull are missing.



Examination of the 7 empty shells used immediately prior to the burst (**saved for reloading**) shows the base wads are in place and complete, and each has a factory primer. 8 unfired factory shells have the same primer.

**The burst shell IS A RELOAD** with a Cheddite Clerinox 209 primer. The primer has been displaced out of the pocket, is bulging outward, and the (partial) base of the shell has a distinct extractor indentation.

Clerinox primer on left, burst shell, factory Cheddite/Herters on right



Fractured and flattened rim



Extractor imprint



Major Sir Gerald Burrard, *The Modern Shotgun*, Volume 3, *The Gun and The Cartridge*, “The Diagnosis of a Burst”, 1948 identified an **indentation of the extractor on the case head**, enlargement of the case head, **flattening or fracture of the rim, lifting of the primer from the pocket**, flattening of the primer against the breech face, and deep striker indentation, especially in comparison to shells of the same batch, as evidence of excessive pressure.

## **Measurements**

The left chamber is 2 9/16" measuring .750" at the breech to .738" at the end of the chamber. Superficial tool marks are present in both chambers.

The left forcing cone is 9/16"; right could not be measured but visually appears the same.

Both bores at 9" are .650".

A 1907 Hunter Arms engineering drawing specifies 16g chambers as .745" tapering to .732" with a 1/2" forcing cone to a bore of .650".

**Impression:** Slight disparity in numbers likely insignificant. **No evidence of modification to chamber or bore.**

## **Wall thickness**

End of the chamber L .096"; R could be measured and .105"

Forcing cone L .112"; R .126"

9" from breech L .046"; R .042"

9" from muzzle L and R .032"

MWT was several inches in mid barrel and both .028"

**Impression:** adequate wall thickness

## **SUMMARY**

1. There is no evidence of chamber, cone, or bore modification; and wall thicknesses are compatible with other measured 16g Regular frame Smith guns.
2. The burst shell was a reload, and shows evidence of over-pressure.
3. There is visual evidence of failure of the braze joint, and a suggestion of a defect in the barrel wall which served as the failure initiation point.

## **METL's Metallurgical Report and Summary**

The cut section



**The initiation point**

Rib extension wedge above

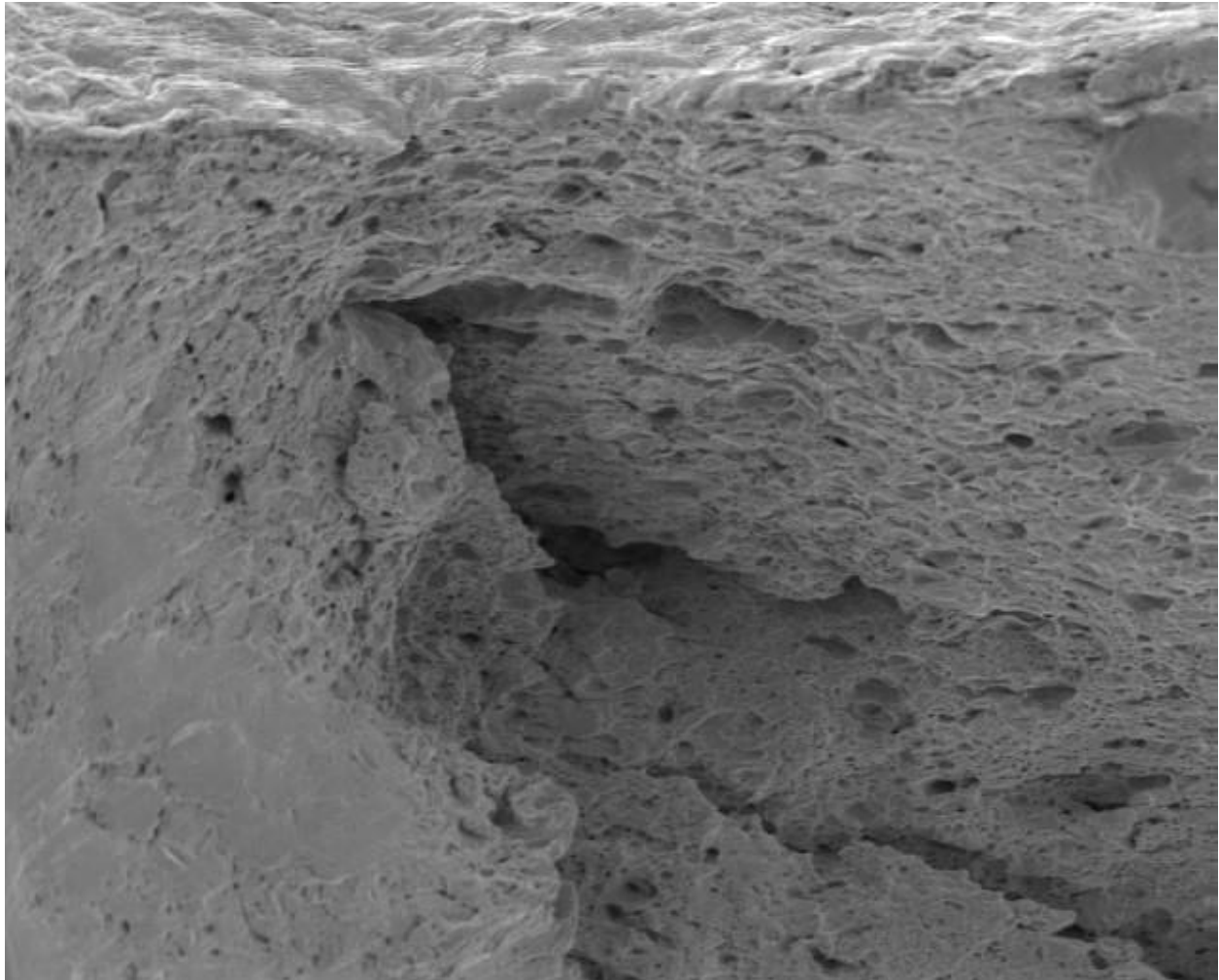
Below left to right: porous steel - black contamination/corrosion (metal oxides - iron and filler material) - gold braze - porous steel



### **METL's summary**

- The fracture surface near the center of the barrel wall showed quasi-cleavage and transgranular brittle fracture. The inner and outer diameter surfaces displayed ductile dimpling features, indicative of overload.
- Ductile dimpling was observed along the inner and outer diameters of the barrel as well as near the suspected initiation site. **No microscopic indicators of fatigue were observed.**
- The suspected initiation site showed a large cavity surrounded by what appeared to be voids **left by inclusions**.

Initiation point cavity with cleavage and voids.  
**No low cycle fatigue “beach marks” (striations).**



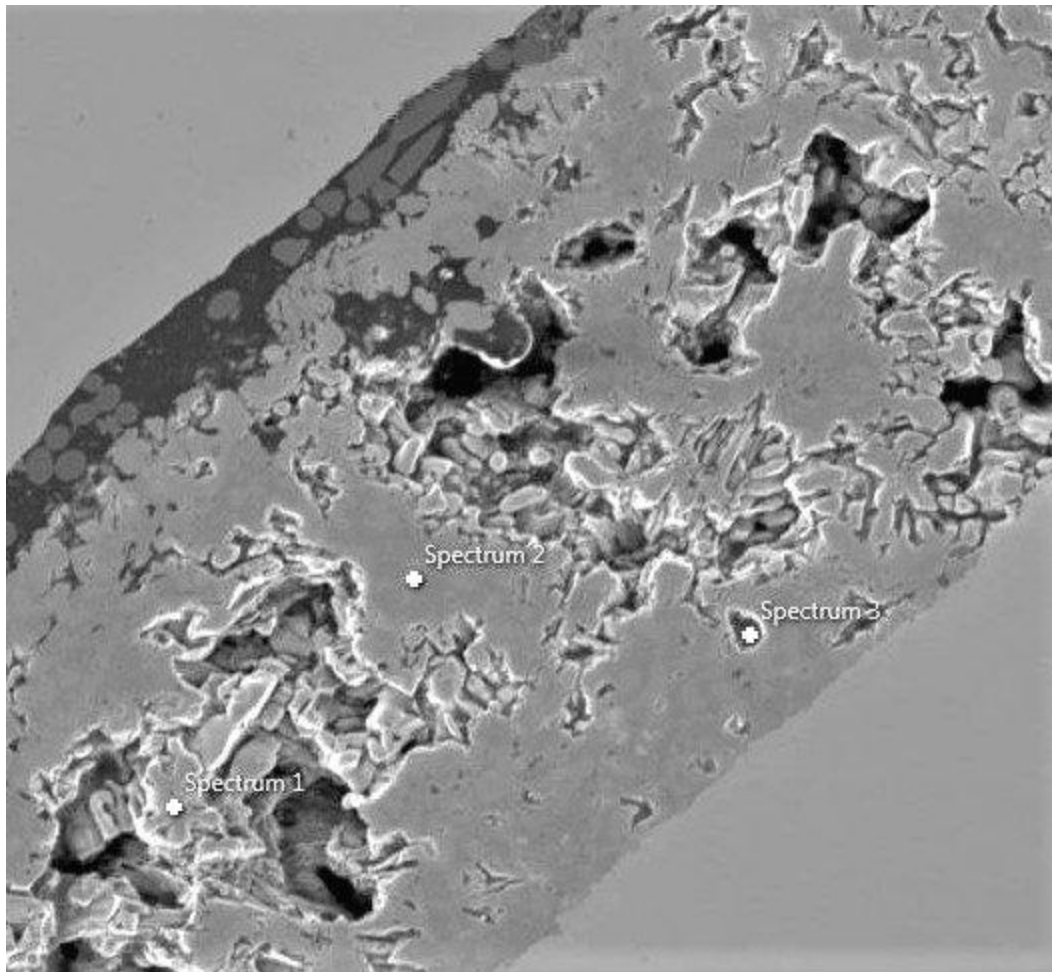
- The braze was extensively contaminated, particularly near the suspected initiation site.
  - The contamination in the braze was ferrous and appeared to be heavily oxidized.
- “The braze was examined at high magnifications. The region where contamination was observed was consistent with ferrous, oxidized debris. The braze material was consistent with a copper-zinc braze filler. Substantial contamination was observed throughout the inner braze surface.”
- “The braze contamination descriptions are kept vague because that's about as conclusive a statement we can make based on the data. The concentrations of iron and oxygen detected could technically be consistent with **corrosion (rust) or**

**overheated steel.** Based on where it was observed in the braze, we need to refer to it as ferrous braze contamination. We don't know exactly what it is. This could have occurred during the brazing process (likely) and been exaggerated over time by successive heating cycles, moisture, etc via possible alloy segregation effects, electromigration and such phenomena.”

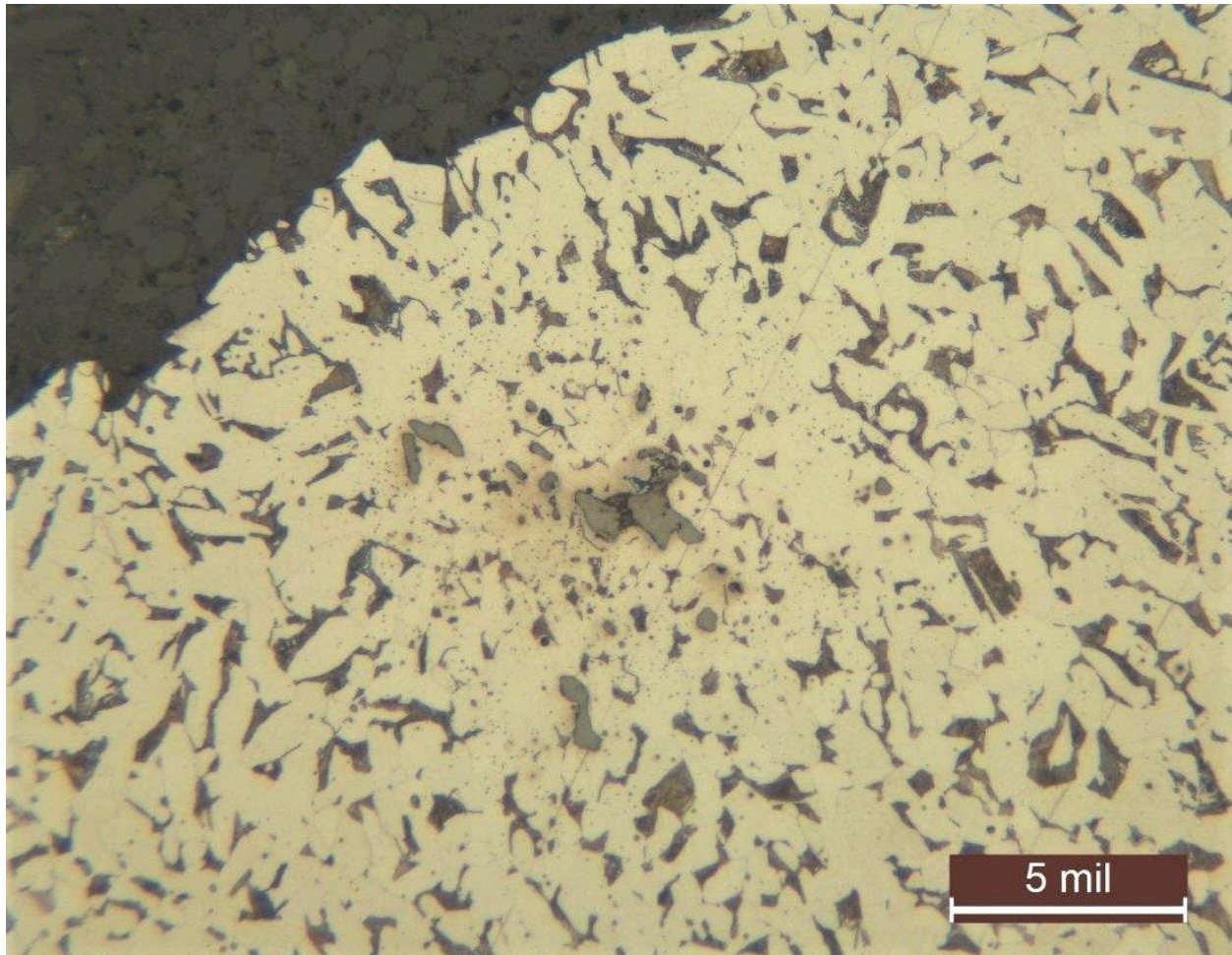
Bad braze with oxidized ferrous debris



“Contamination” region at 150X with inclusions; primarily ferrous oxidized debris



200X of the contamination region (upper left) - oxidized steel (likely over-heated)  
with extensive manganese sulfide inclusions



### **Barrel composition analysis:**

Non-standard AISI 1018 low alloy low carbon steel, with a slightly high phosphorus and sulphur, and a low concentration of nickel

### **SUMMARY:**

The barrel failed because of the critical juncture of 3 factors:

1. An over-pressure load
2. A defective braze of the top rib extension wedge to barrel.
3. Inclusions (possibly a large inclusion) in the barrel wall.

The barrel did **not** fail because of low cycle metal fatigue.

## Unanswered questions:

Did the use of 2 3/4" shells in a 2 9/16" chamber add to the apparent reload over-pressure?

The once fired Cheddite hulls are a full 2 3/4". Sherman Bell's study of 2 3/4" shells in 2 1/2" chambers with a 7/16" forcing cone showed a rise in pressure from 228 psi to 1216 psi compared to 2 3/4" chambers with a 1" forcing cone.

Hunter Arms produced about 530,000 Smith sidelocks, and another about 80,000 Fulton boxlocks. If the top rib extension wedge brazed to the thin medial barrel wall was an intrinsic design flaw which created time-bombs, one would think a plague of blown barrels would be apparent by now. Clearly THIS 110 year old barrel had a manufacturing defect and inclusions (and likely a large inclusion) in the barrel tube, **but would it have failed without an over-pressure load in a short chamber?**

A study complimentary to the Birmingham Proof House Trial was published in *The Field* June 6, 1891 by Horatio F. Phillips, a "staff experimenter", comparing brazed and unbrazed Steel and Damascus barrels

<http://books.google.com/books?id=inQCAAAAYAAJ&pg=PA14&lpg>

"These experiments serve to show what a very large margin of strength there is in a good gun barrel, when ordinary charges are used. The (Damascus) barrels which gave way earliest...had withstood the strains of...about four times as great as the regulation proof; while the steel barrels (Siemens-Martin and English "Superior Barrel Steel") were tested...**with charges averaging nearly five times as much as the ordinary proof-charge.**"

It would seem that this large margin of safety was what saved this gun until 2019. It is significant that there was **no microscopic evidence of low cycle fatigue** - the pressures to which the top rib extension wedge braze and barrel were subjected was below the yield strength of the braze joint and steel. The failure was initiated at an area with inclusions and a contaminated non-fused braze joint - **not** low cycle ductile fatigue progressing to plastic deformation (stretching) and terminal cleavage.

**Special thanks** to Andrea Pagliuca, Metallurgist and Ryan Scalf, Materials Engineer at METL <http://metl.com/>

## **Model 12 Obstructional Burst**



Ring bulge



## **L.C. Smith Trap Grade Burst**

<https://members.boardhost.com/lcsmith/msg/1605215123.html>

## **Burrard's Precautions To Avoid Bursts**

1. Always buy cartridges from a reliable firm.

Or pay the utmost attention, at every moment while reloading, using the best components in an established recipe. "Close enough" is never "safe enough":

Julian S. Hatcher, *Hatcher's Notebook*, 1966

"E.C." blank powder burns with extreme speed...to give a sharp report when it is not heavily confined. An enthusiast once got hold of some of this powder, being familiar with "E.C." shotgun powder...and loaded a bunch of shells. To try out his new load he got out his fine Lefever gun, and put up a target in the shooting gallery to get the pattern. There was a terrific detonation, and a big piece was blown out the side of the barrel near the breech, flew across the room and buried itself in a wood bench.

2. Always adopt every possible precaution to prevent different sizes of cartridges being intermixed.

3. Always look through the barrels before starting out on a day's shooting.

4. Always carry a pull-through when out shooting.

5. Always unload and look through the barrels on the faintest suspicion of the muzzle touching the ground or undergrowth.

6. Always look through the barrels after the trigger is pressed with no result.

7. Always look through the barrels on the slightest suspicion of anything peculiar happening in the sound of the report, or the fall of the hammer.

8. Always look through the barrels if an abnormal amount of smoke is seen to issue from the breech after unloading.

9. Always look through the barrels if the recoil seems abnormally weak.

10. Never continue to use any cartridges from any particular lot if one or two give an altogether excessive recoil.

11. Always have guns overhauled periodically by a competent gunmaker.

## **Questions to answer in evaluating a burst barrel**

1. Exact chamber and forcing cone length

2. Exact chamber dimensions

The entrance to the chambers of c. 1900 12g U.S. doubles is usually

.809” - .812”, tapering to .795” - .798”.

3. Exact bore dimensions
4. Is there pitting in the chamber, forcing cones, or just past the cones?
5. Is there evidence of chamber and/or forcing cone lengthening?
6. Minimal wall thickness at the forward end of the chamber
7. Minimal wall thickness at the forcing cone
8. Minimal wall thickness around the burst edges
9. Does the burst barrel appear to have a “ring bulge”? Is the rib lifted?
10. Confirmation that the load was factory? Which load? If not, what was the reload recipe and the expertise of the reloader?
11. Is there visual evidence of over-pressure on the remains of the shell? Extractor imprint on the brass? Cratered primer? Fractured or flattened rim?
12. Did the shooter notice anything abnormal the **previous** shot through the burst barrel? Sound? Recoil? Was the target broken?

## **Burst Court Decisions**

**Favo vs. Remington Arms, 1901** - shell loading error

<https://books.google.com/books?id=z8rDNNNcjQ4C&pg=PA788&lpg>

1933 lawsuit against **Remington Arms** related to the burst barrel of a Baltimore Arms Co. shotgun after using a Nitro Club marked Proof Load.

<https://books.google.com/books?id=7pcbfeEwkDwC&pg=PA120&lpg>

<https://books.google.com/books?id=7pcbfeEwkDwC&pg=PA127&lpg>

1936 testimony by W.A. King, **Parker Gun Co.** regarding a barrel burst, likely a 20g shell inserted before a 12g

<https://books.google.com/books?id=jUhOAQAAIAAJ&pg=PA802&lpg>

**A separated hull barrel burst with Tom Roster's testimony**

[https://ecf.utd.uscourts.gov/cgi-bin/show\\_public\\_doc?116cv0094-40](https://ecf.utd.uscourts.gov/cgi-bin/show_public_doc?116cv0094-40)

**AYA barrel burst with expert testimony by Hugh Lomas**

[https://www.govinfo.gov/content/pkg/USCOURTS-ned-4\\_09-cv-03221/pdf/USCOURTS-ned-4\\_09-cv-03221-8.pdf](https://www.govinfo.gov/content/pkg/USCOURTS-ned-4_09-cv-03221/pdf/USCOURTS-ned-4_09-cv-03221-8.pdf)

**Loitz vs. Remington Arms** - use of AISI 1140 Modified (with manganese sulfide)  
<https://law.justia.com/cases/illinois/supreme-court/1990/68367-7.html>

## **Options for Proof Testing, NDT, and Failure Analysis**

Entropy Engineering Corporation

[Entropy Engineering Corp: Forensic expert witness, reconstruction, and analysis.](#)

Chesapeake Testing

[NTS Chesapeake \(Belcamp, MD\) | Ballistic & Materials Testing Lab](#)

Dayton T. Brown

<https://www.dtb.com>

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