

Rimfire Firing-Pin Indent Copper Crusher (part 2)



Fig. 2. Bill Cox, president and owner of Cox Manufacturing, Inc. in San Antonio, Texas



As a reminder to readers, the Sporting Arms and Ammunition Manufacturers' Institute Inc., also known as SAAMI, is an association of the nation's leading manufacturers of firearms, ammunition and components.

This article picks up where part 1 left off in February. If you missed that, find out more about the background of the copper crushers by going to February's online archives, or go to www.industrialheating.com/rimfire for the rest of the story.

Expect the Unexpected

With 47 years of experience in design and manufacturing, I learned to expect the unexpected. So I wasn't too concerned when, early in 2013, I received two communications from SAAMI-member firearms manufacturers indicating that their research, development and quality-assurance department's inventories of SAAMI rimfire firing-pin indent copper crushers were running critically low and planning to coordinate an order soon.

My response: "Coordinate an order? Let me look into that and get back with you." This was the first I had heard during my short time with SAAMI that my office was responsible for coordinating group purchases of specialty gauges and tooling to support industry activities.

A quick investigation on my part found that there was, indeed, a documented process and protocol for the rimfire firing-pin indent (RFPI) measurement contained in the SAAMI technical manuals. There were also pieces of the technical data package that were needed to develop a request for quote (RFQ). The RFPI process contained the necessary mechanical drawings for the RFQ, but what I found perplexing was the "Material and Process Specifications" (MPS) were scant to say the least – "Material, Copper Development Association Alloy 102."

The RFPI crusher was made of the same material specified in the SAAMI technical manual for the cylindrical pressure measurement used by ballistic test laboratories to measure the chamber pressure generated when a cartridge is fired and served as the firing-pin indent crusher used for testing centerfire firearms. Also, both articles were utilized to qualify the firing-pin indent, and there was a detailed material and process specification for the pressure measurement/centerfire firing-pin indent (CFPI).

It seemed a logical assumption to make (surely, my astute predecessors had seen no need to call out a material and process specification specific to the RFPI crusher), so they must have intended that those who followed in their footsteps would use the detailed material and process specification called out for the pressure measurement/CFPI copper crushers.

In June 2013, an RFQ was issued for the 22 short/long/long rifle, 22 Winchester Magnum rimfire/17 Hornady Magnum rimfire and 17 Winchester Super Magnum RFPI copper crushers (Fig. 1).

A Potential Disaster

In mid-July 2013, I was up nights thinking that the lack of a specific reference to a material and process specification for the RFPI crusher was a potential disaster waiting to happen. With

that in mind, I rallied around one of my colleague's favorite sayings: "Singly we cannot know everything, but collectively we have a tremendous depth of knowledge." I was determined to see if any of my industry colleagues had more insight into the previous production runs of the RFPI crushers than the limited information available to me.

The natural place to start would be Olin-Winchester, Ammunition Division, which manufactured the SAAMI RFPI crushers for decades. Paul Szabo of Olin (retired 2016) responded that the last run of SAAMI RFPI crushers that Olin-Winchester ran was completed in the mid-1980s, and everyone involved in the project back then was now retired. A file folder of correspondence regarding the most recent production run of SAAMI RFPI crushers (circa 1997-98) was discovered and forwarded for review and future reference. A document revealed that SAAMI had contracted for production with an outside vendor. It became apparent that our predecessors had concerns about the raw copper bar stock, the heat-treat process and the post-anneal grain structure.

In the meantime, the RFQ was moving forward, and Cox Manufacturing (Cox) of San Antonio, Texas, was chosen by SAAMI as the preferred vendor for this production run of what was rapidly becoming known internally at SAAMI as the "infamous RFPI copper crusher."

The choice of Cox (Fig. 2) was based on a number of key factors: Cox was known to many SAAMI-member companies – both firearm and ammunition manufacturers – as a trusted supplier for contracted-parts manufacturing. Art Raynes, vice president of business development, and Tia Good, contract manufacturing specialist at Cox, expressed the desire and willingness to accommodate the unique demands of this order, including an assurance of delivering a quality part at a competitive price. Good became one of my "triad" of key people, including Steve Davis, manager of process engineering and metallurgical laboratory at Olin-Winchester, and Peter Hushek, president and owner of Phoenix Heat Treating, whose collective knowledge, expertise and bulldog determination would be essential to the successful completion of this project.

Olin-Winchester Joins the Copper-Crusher Team

Given the apparent simplicity of the "copper-crusher team," if someone had told me it would be close to two and a half years to take this project from conception to completion, I would have been the first one to say, "No way in hell, not on my watch, this is manufacturing simplicity."

That thought would come back to haunt me numerous times over the next two years. One of

the attributes of a good project manager is to realize your own professional limitations and not be afraid to reach out for the knowledge and expertise required to ensure the project reaches a successful conclusion.

As the project moved into the fall of 2014, I quickly realized that – with insufficient technical data history available from previous orders of rimfire crushers – I needed someone with metallurgical experience to help develop, optimize and document the entire process and ensure we achieved the desired RFPI crusher performance. Szabo pointed me in the direction of Steve Davis, Olin-Winchester’s manager of process engineering and metallurgical laboratory.

I reached out to Davis in October 2014 about participating in the effort to produce a new lot of Rimfire copper crushers for the industry, and he welcomed the challenge to join the copper-crusher team. Davis brought to the table 20 years of metallurgical/process engineering experience in the defense industry, including 16 years with Winchester Ammunition. For reasons already discussed, his experience with the copper-crusher component used for centerfire firearms was invaluable. Also important were the resources available at the Winchester plant in Oxford, Miss., including a metallurgical lab with materials-testing equipment and a state-of-the-art ballistics facility.

Oxygen-Free C10200 Copper

During the previous months, based on the original technical data package and the rather vague material specification, Cox moved forward in sourcing the raw material – bar stock CDA Alloy-102, also known as C10200, which is 99.95% oxygen-free (Fig. 3). This copper alloy is one of the purest forms of commercially available copper, and procurement of the required 3,500 pounds of the alloy was the first challenge that Good would encounter. C10200 is not your everyday off-the-shelf copper.

At this point we needed a benchmark, since it was imperative to re-create the material and process specification that would exactly replicate the test results of decades past. Davis started by thoroughly testing and analyzing older lots of rimfire copper crushers to find the required metallurgical properties. This step was crucial in determining the suitable raw material necessary to achieve the same final crusher performance as older lots currently in use.

By the time Davis came on board, Cox had already received the required production quantity of C10200 rod. However, he quickly determined the rod was processed with mechanical properties not suitable to achieve the desired performance of the final part. Davis worked with Good and the copper smelting facility to ensure the new order of rod was processed and

delivered with the proper combination of rod diameter, reduction in area and tensile strength and that it was produced with the correct ASTM standard and certifications.

We were slowly overcoming every hurdle encountered in reconstructing the manufacturing process and protocol of the RFPI crusher. And I was confident with two of the three main elements: a qualified manufacturing facility and an exceptional metallurgist who understood metals' properties and had an extensive test and ballistic laboratory facility at his disposal to help overcome the underlying issue of a very simple part with complex heat-treating requirements, which were required to achieve the desired critical balance of metal hardness and microstructure of the finished parts.

The Third Pillar

What we needed now was a third pillar on the triad team – an exceptional heat-treating facility. Once again, Good answered my call for help. Cox has a long-established working relationship with one of the preeminent heat-treat houses in the U.S., Phoenix Heat Treating in Phoenix, Ariz. Little did I know that one of Phoenix Heat Treating's guiding principles mirrors Cox's customer focus and hands-on expertise. Hushek's background is a four-generation heat-treating family that began in Milwaukee in 1915 (Fig. 4).

Upon receiving the new rod, Davis and Hushek began the preliminary thermal processing and verification testing. They worked long hours and weekends testing and optimizing thermal-processing parameters. Phoenix Heat Treating took on the challenge of finding the heat-treat solution for required target hardness microstructure.

After completing the optimization process, Cox began machining production quantities of crushers into lot sizes. A random sample of finished crushers were subjected to a first-article test (FAT) that consisted of metallurgical analysis and firing tests in different firearms to validate the copper-crusher performance compared to older lots. Prior to delivery, every lot of crushers was required to pass a lot acceptance test (LAT) that included dimensional, metallurgical and performance criteria to ensure each lot performed to standards.

New Material Specifications for SAAMI

Based on this success, Davis began developing a new material and process specification document for SAAMI. The new specification serves as a guideline to ensure continuity of crusher performance for future production. The proposed specification covers details such as raw material, processing, inspecting, testing, performance and packaging requirements. This ensures the ammunition and firearms industry many years of uninterrupted critical testing of cartridge pressures and firing-pin indents.

In August 2015, two and a half years after the project began, Cox delivered the last of the three patterns of RFPI crushers on schedule. SAAMI is in the final stages of documenting the material and process specification, the FAT process and procedure, and LAT protocol.

In all probability, by the time the next production run of SAAMI rimfire firing-pin indent crushers is needed by the industry, everyone involved in this project will be enjoying retirement. I, for one, will be able to look back knowing those who follow in our footsteps have a clear road map of where they are going and how they are going to get there. For that, I have the likes of Peter Hushek at Phoenix Heat Treating, Steve Davis of Olin-Winchester and Tia Good of Cox Manufacturing to thank for their knowledge, expertise and unfailing fortitude to get the job done.

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