

THE SHOT TOWER

by Walter Minchinton

How do you make perfectly round lead balls for shooting? With a truly simple technology that has hardly changed for centuries.

Ever since the invention of firearms sometime around the thirteenth century, ammunition makers have confronted the problem of making spherical lead shot. One obvious early way was to pour molten lead into molds, but this was a laborious process that too often left an unaerodynamic seam in the shot. Another way was to pour molten lead through a sieve suspended several inches above a barrel of water; this often produced egg-shaped shot with a tail. For a long time no method was satisfactory, and the demand for shot, both for military purposes and for sport, continually grew.

The one great breakthrough in the history of shot making came in 1782, when a British plumber, William Watts of Bristol, received a patent for a method to produce shot that was "solid throughout, perfectly globular in form, and without the dimples, scratches, and imperfections, which other shot, heretofore manufactured, usually have on their surface". According to legend, inspiration struck Watts when he noticed that raindrops formed perfect spheres as they fell. The idea he had is still the best we have.

The key, he realized, was to drop molten lead from a great height, not just a few inches. His method was simple: Melt the lead in an iron pot, add arsenic to help it flow more smoothly, and pour it through a sieve into a pool of water far below. In the earlier short-drop method the water cooled and hardened the shot. In Watt's method the shot cooled during the fall; the water cushioned it on landing and prevented it from deforming. For the smallest shot Watt's patent specified that the sieve had to be at least 10 feet above the water; for the largest shot 150 or more feet were required.

To put his patent into practice; Watts erected a tower on top of his house, fashioned in a style he optimistically

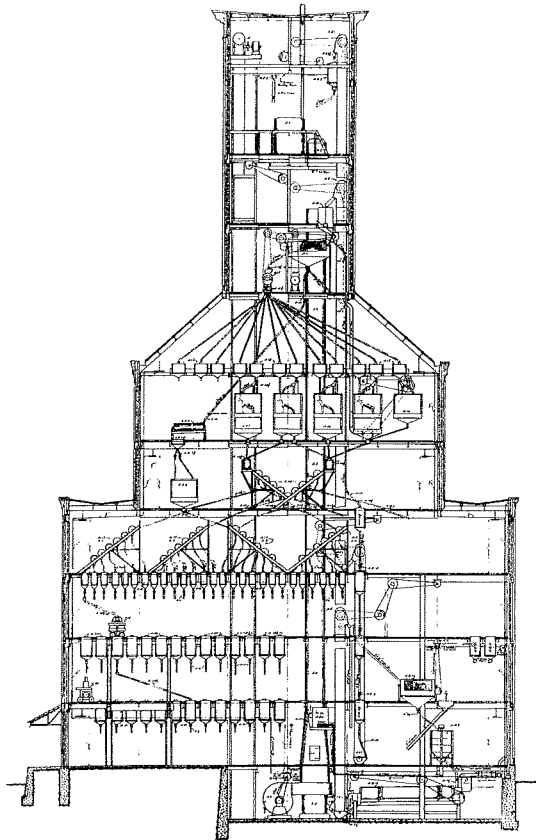
described as Gothic, in order, he wrote, "to remind citizens of the prospect of Westminster Abbey". He cut holes in the floors of his house and dug a well beneath it to achieve the necessary drop. His 150 foot tower was an immediate success and made him rich. Taken over by the Sheldon Bush & Patent Shot Company in the 1860s, the Watts Tower manufactured shot until it was demolished in 1968.

The new technology spread swiftly. Shot towers appeared in London beginning in 1789 and across Europe soon after. The United States relied almost exclusively on imported shot until President Thomas Jefferson imposed the Embargo Act in 1808. Almost immediately two shot towers were built in Philadelphia: the Paul Beck Tower on the Schuylkill River and, near the Delaware River, the Bishops-Sparks Tower, which still stands. Their customers included the Du Pont powder works, established a few years before in the nearby Brandywine Valley. Other towers were built in the lead-mining regions of the Mississippi Valley, and in the 1820s, 1830s, and 1840s towers sprang up in New York, Baltimore, and St. Louis. Baltimore's Merchant's Tower (1828), now a national historic landmark, manufactured some six hundred thousand 25 pound bags of shot a year during the Civil War.

Shot production peaked in the decades just following the Civil War. After the 1860s the military demand declined as rifles replaced shotguns, but field sports provided a continuing market. Manufacturers found they could ensure a more uniformly spherical product by rolling newly made shot down an inclined plane with gaps. Only the perfectly spherical shot would clear the leaps over the gaps to the bottom of the incline. The imperfect shot fell into bins below the gaps, where it was collected and remelted. After being sorted, the shot was usually polished before being packed for dispatch. Shot was also improved by adding antimony to the molten lead; hard or chilled shot, as the alloy came to be called,

deformed less during firing, providing not only more accurate flight but better velocity and deeper penetration.

Before the mid-nineteenth century loose gunpowder and shot were loaded separately into the barrels of guns. The introduction of cartridges, combining powder and shot in a single unit, made the loading of shotguns easier and more precise. For the next fifty years or so, cartridges and shot were manufactured by separate concerns. In the early 1900s the Winchester company built its own shot tower in New Haven, Connecticut. Remington erected a similar tower in nearby Bridgeport.



A cross section of a tower in Bridgeport, Connecticut, built in the 1900s.

(Courtesy of Gary Hayduk, Distec, Inc.)

American shot towers were built in a surprising variety of shapes. The most common forms were circular tapering towers resembling chimneys, but some, like the Bristol Tower, were square; the Youle Tower, in New York City, was hexagonal, while the Colwell Tower, also in New York, had ten sides of brick infill between iron pillars. The architect William Gibbons Preston erected a Romanesque tower in Boston that operated from 1887 to about 1915. When San Francisco's original shot tower was destroyed in the fire that followed the 1906 earthquake, the tower built to replace it was an open steel latticework rather than a solid masonry structure. Most towers were about 150 feet high, but a few were much higher. Baltimore had the tallest of them all, the Merchant's Tower, which was 215 feet high.

There have been other ways to drop shot besides building towers. Perhaps the crudest was simply to use abandoned mine shafts; that was done for a time in Wisconsin and in parts of Europe. In the early 1800s William Carruthers made shot at Virginia's Natural Bridge, fourteen miles from Lexington; the geological oddity gave a drop of 215 feet. Some early American towers consisted of platforms projecting from the tops of high bluffs along the Mississippi River. Yet another variation involved boring a vertical shaft near the edge of a cliff and surmounting it with a timber or stone tower to secure the required height. A horizontal tunnel from the cliff wall to the bottom of the shaft provided access to the dropped shot.

Because building the tower was by far the most costly part of shot making, manufacturers often sought ways to reduce the height needed. In 1849, David Smith of New York obtained a patent for the use of an ascending current of air to cool the falling lead, thus reducing the length of the drop. In 1858, another New Yorker, Albert Borth, secured a patent for dropping the molten lead through a fine, dense spray of water. But no such scheme worked very well. The Watts method continues to be used for producing lead shot to this day.

Because of the environmental hazard posed by lead, steel shot has been replacing lead shot in recent years. Steel shot is cast rather than dropped; with the metal's much higher melting point a steel shot tower would have to be impossibly tall. Lead shot is still used, though. Today about thirty towers drop lead shot worldwide; they include five towers in the United States, one of which, in Summit, Illinois, produces lead dust so fine it is used not in guns, but as an additive to steel to make it easier to machine.



Molten lead becomes a rain of shot at Remington Arms Plant in Lonoke, Arkansas.



(Photographs by Wesley Hitt)

Some technical developments come about through incremental change; others, like the shot tower, result from a single quantum leap. The improvements in shot-tower design since the 1700s have been largely peripheral: an elevator to transport workers and lead to the top of the tower, different fuels to melt the lead, and in some cases, a controlled mechanical feed to the sieve. The essentials of the 1782 patent design remain unchanged. In the history of technology, William Watts deserves to be recognized for bringing to the problem of shot making a simple solution that has never been excelled.

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