SPANNING THE PROD

by Dick Salzer

Synopsis - Telling the story of more than 2500 years of the development of the first and longest-lived ranging weapon is beyond the scope of any single article. I have chosen to tell the story based on inevitable desire to increase strength and power of those weapons and how engineering first principles were applied to managing that strength.

As with so many early, iconic developments, the inventor and point of origin of the crossbow will forever remain a mystery. Based on archaeological revelations and early graphics, it is generally accepted that about 2500 years ago, a short bow was first attached to a cross member and a new class of weapon was born. The idea must have had a lot of appeal because within a few centuries, crossbows were popular across much Europe and into Asia and ultimately Africa.

Side Note: The names of the parts of the crossbow vary with the country of use. The bow section, in English, was called the "lath" and later the "prod". The stock was called the "tiller". For the purpose of clarity in this paper I chose to use the descriptive names –the "bow" and the "stock instead of period names". Spanning is the act of pulling the bowstring to firing position.

Like the conventional bow, power was limited to the arm strength of the individual archer. As the crossbow evolved, demands for more power resulted in more robust bows. Consequently, they required more strength to cock or "span". The early crossbows were limited to about 60 pounds or less of draw pull. Initially, like long bows, the crossbow bows were carved from resilient woods like yew or ash. Power could be increased by using thicker members so spanning required ingenuity beyond sheer arm strength. By using a waist belt and hanging strap with a claw to grab the bowstring, it was possible to use leg strength to span a heavier crossbow. That was a first step in evolving a series of spanning devices that enabled the development of stronger and heavier crossbows. This article will examine that progression of spanning devices from the Early Middle Ages to the late Medieval Period.

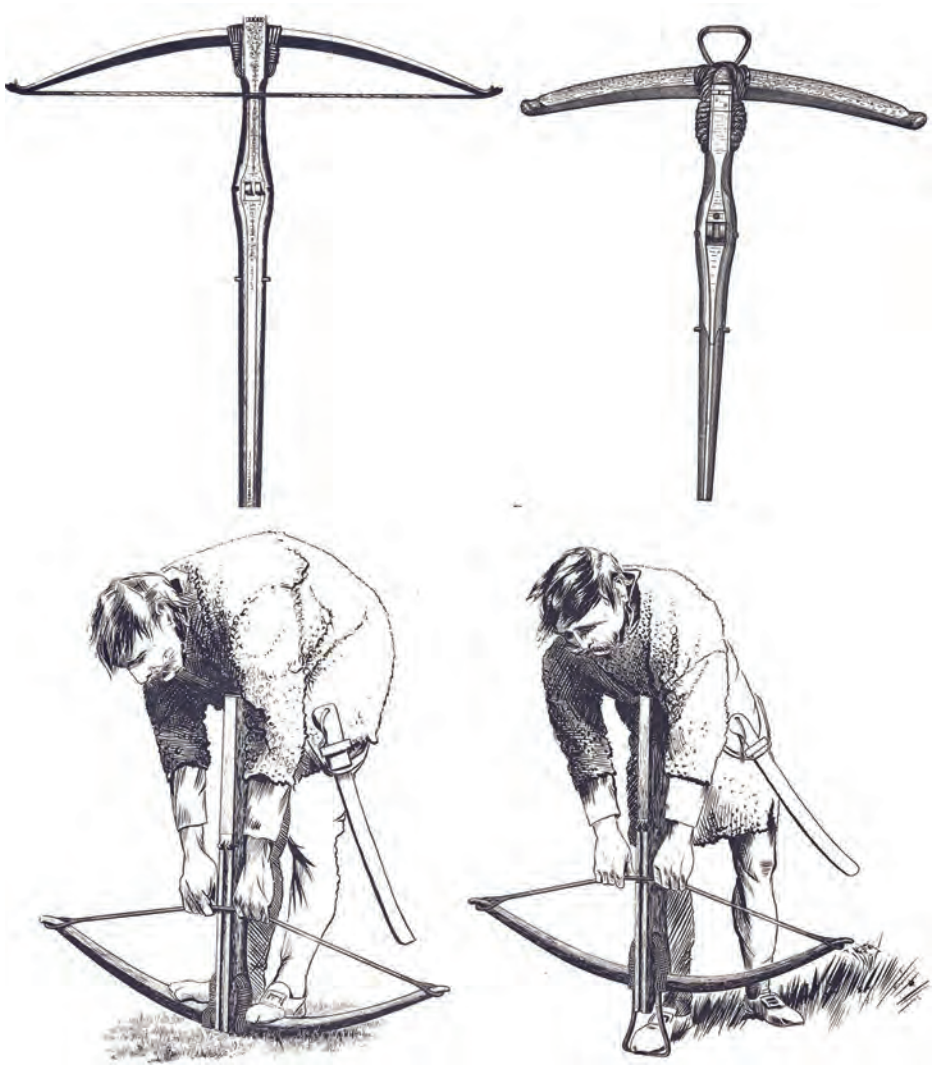

Figure 1. The basic crossbow is very simple (top left). Just a short bow lashed to a wooden stock, a bowstring and a lever to kick the bowstring out of a notch in the stock. The Composite Bow (top right). Wooden bows tended to weaken with repeated use. Composite bow material was developed using combinations of bone, wood, sinew and leather. Very few of the composite bows have survived. Leg-Assisted Spanning (bottom). Use of the leg and back muscles enables more spanning power. The first improvement was the addition of a foot stirrup to aid in manual spanning (bottom right). As shown in other Figures, this feature continued throughout development—sometimes as a foot brace, other times as a hand brace or fulcrum for a lever spanner.

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Three Eras

There were three distinct eras associated with crossbow evolution:

The Early Era – From onset through the early 1300s

As with any weapon, the first thing its users want to explore is how to make it more powerful. The limiting factors with crossbows were the available material and how much power was available to span the bow into cocked position. The first crossbows were little more than long or short bows lashed to a cross member (Figure 1). They were hand spanned and fired by a primitive wooden lever that eased the bowstring out of its cocking notch and released an arrow. (Later heavier, more compact missiles called "bolts" took the place of arrows). Material for the bow was basically limited to natural sources, mostly wood, chosen for its resilience and inherent strength. Considerable experimentation took place to optimize material, bow length, cross-section, draw pull and power stroke.

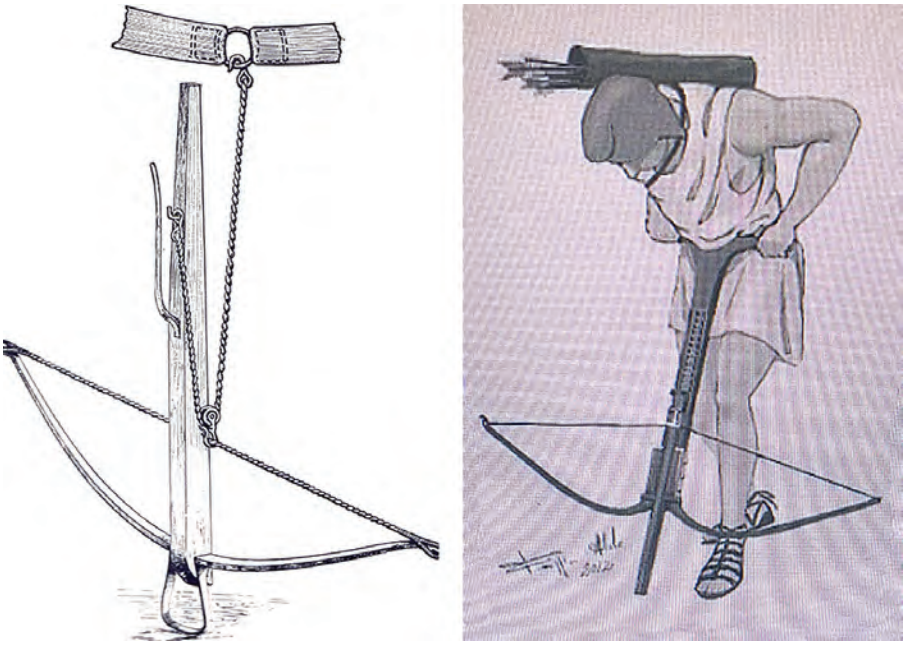

Figure 2. The Belt Claw (left) is a simple device that enables the archer to use his leg strength to span the crossbow. A simple strap is hung from a sturdy belt around the archer's waist with a claw on the end. A later improvement adds a pulley into the system to double the pulling force. The Gastrophetes (beely Shooter; right). One of the more interesting innovations was the Gastrphetes, a 5th century Greek device that utilized the weight of the archer to span the bow. Two sliding elements of the stock enable a ratcheting device to engage the two sections, one of which carried the trigger.

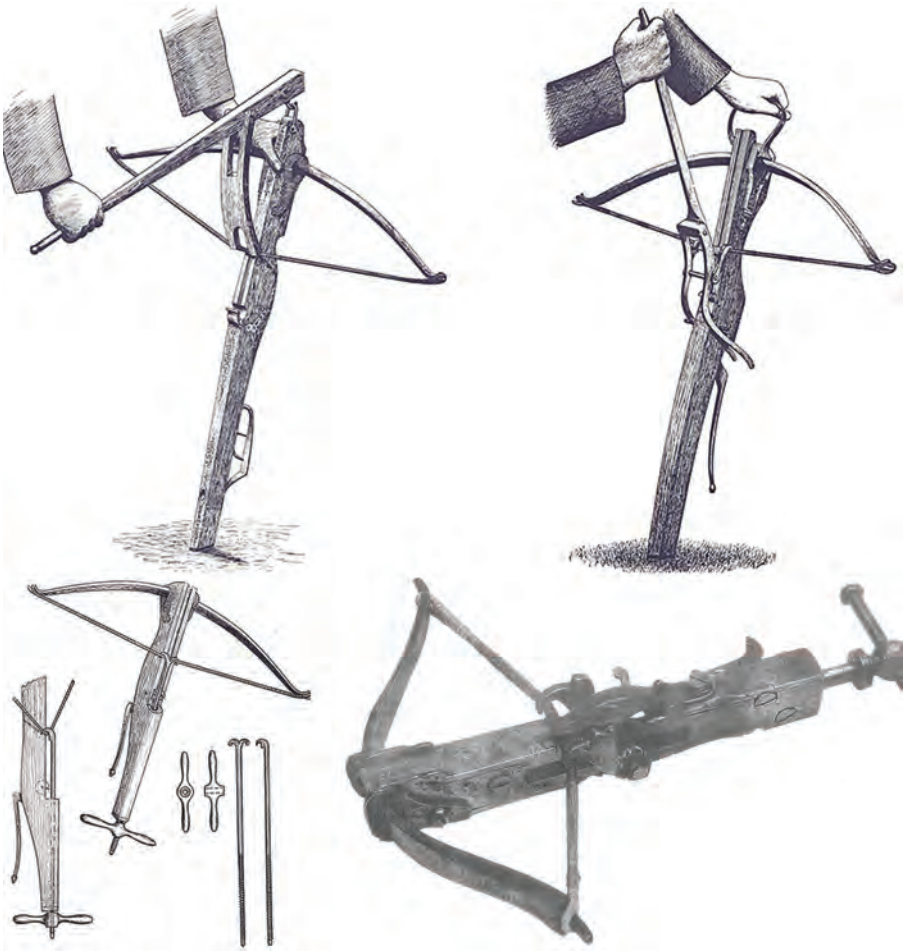

Figure 3. The wooden lever system was used over a period of time to span relatively light crossbows (top left). The stock was equipped with a heavy steel loop at the bow end. A simple two-part lever system had a hook at one end and an articulated hinged cocking piece at its midpoint. Unlike the Gaffe (Goatsfoot) that pulls the bowstring is pulled into span, the articulated lever (top left) pushes the bowstring. The Gaffe (top right) is the rather complex looking two-part hinged metal lever. The main lever has two lower curved prongs that fit over pegs in the stock. The hinged portion carries a claw that engages the bowstring. As the lever is pulled, the prongs slide down over the pegs, increasing the pulling power as the fulcrum shortens. The Screw Jack (bottom), one of the rarest spanning devices was the lead screw system. The components, seen here, consisted of a twist handle and a threaded rod with a claw end (bottom left). Though it apparently worked, cycling would have been slow. The Balestrino (bottom right) is a rare example of a screw jack spanner crossbow.

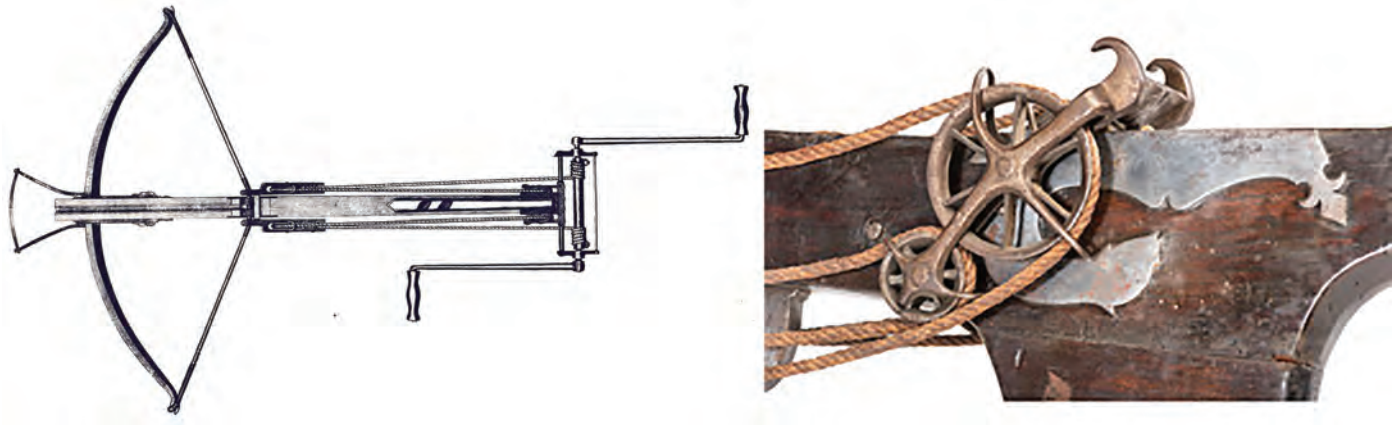

Figure 4. Showing the basic arrangement of the windlass spanner – pulley and rope providing a high mechanical advantage (top left). The pulleys were made of cast iron and well finished (top right). The author spanning his 16th century 1400-pound siege crossbow (bottom).

Since wood eventually loses some of its resilience due to repeated usage and moisture intrusion, composite bows were developed using combinations of wood, bone and animal glues.

The first bows were hand cocked and power was limited to strength of the archer (Figure 1, bottom). As time went on, innovations involving simple mechanical principles were applied such as pulleys and levers to enable power increases from that of basic hand cocking (about 100 pounds maximum) to 300 to 400 pounds using those later mechanisms (Figures 2 and 3). Typically, crossbows throughout this protracted era would have been used as military weapons but also for hunting and, inevitably, for competitions.

The Steel Bow Era From early 1300 until the late 1500s

Although steel in various forms was known in the BCE period, it wasn't until the 14th century that metallurgy had evolved to a point where high-grade tempered steel became available and was used in crossbows. Steel bows provided the means to exponentially increase power. Spanning such bows required the development special power- multiplying equipment, based on the application of simple engineering principles to be developed. Two such systems resulted—the "windlass" that used a rope and pulley device (Figure 4) and the "cranequin" (Figure 5) that employed gears with a rack and pinion. Both of the devices were cleverly engineered and well made. They enabled draw strength to span bows needing up to 1400 pounds of draw force. Such bows could project a bolt several hundred yards with impressive striking power. Throughout the development of more sophisticated crossbows, triggering mechanisms became more complex although the standard common factor was a circular rotating "nut", usually made of bone which worked with a sear type release.

Although the use of lighter bows continued during this era, the heavy siege bows were the artillery of the day. They were used both offensively and defensively. Offensive usage involved teams of archers, protected by full-length shields called a "pavise". A group of several archers would gather behind a barricade of several pavises and shoot their bolts. The spanning devices – windlass or cranequns were shared. They were removed for shooting and were cycled to other shooters crossbow for respanning after his bolt was fired. That way one spanning device could serve several archers in turn.

The Sporting Era from the late 1500s until present day

By the end of the 16th century the advent of firearms – matchlock and wheelock, gradually phased out the military use of the crossbow and the reliance on plate armor. It ushered in a new popularity of crossbow sporting competitions especially in France and Saxony (Figure 6). Many of the host cities were involved in the manufacture of fine fabrics and the decorations for crossbow festivals were a chance to show off fine draperies, banners and exotic clothing. These tournaments were very democratic and enabled commoners to compete directly with nobility.

Pellet Bows

During the 16th century, an offshoot of the crossbow evolved. It was variously known as the "stone" or "pellet" bow. Instead of the aerodynamic projectiles of the crossbow, they fired round projectiles such as stones or lead pellets. Since they were of little practical use as serious weapons, they were used more for amusement such as competitions and for hunting small animals. They were of light construction and were spanned by hand. That they

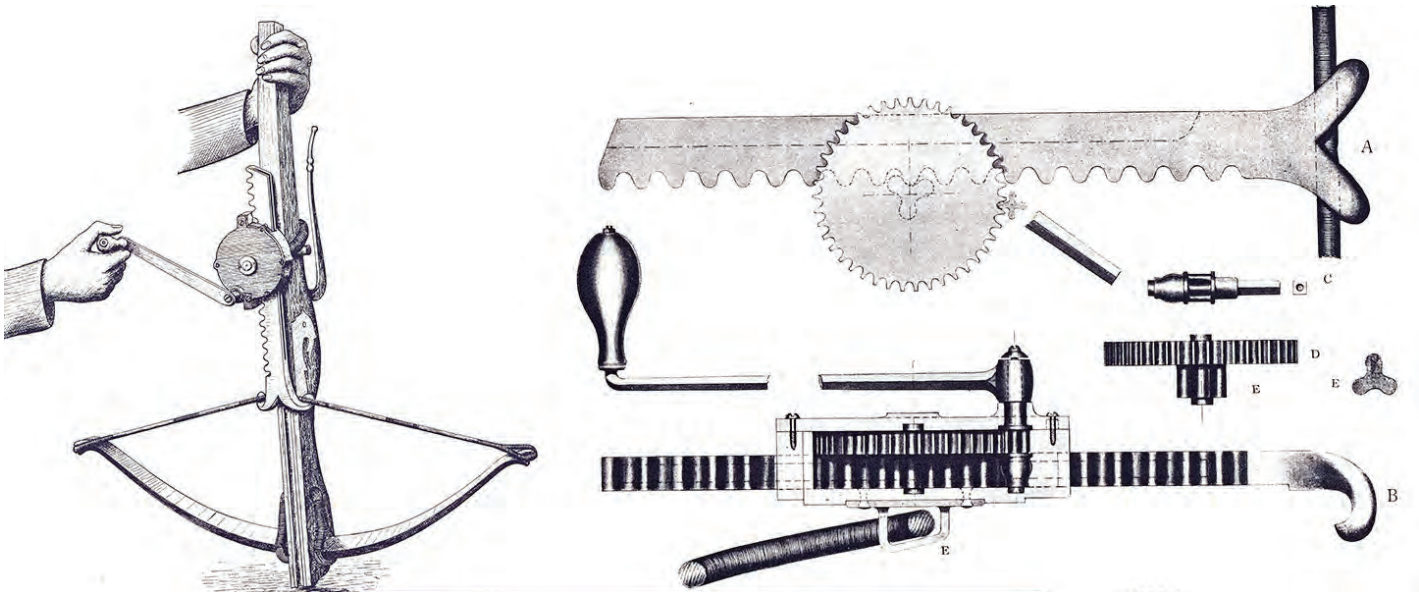

Figure 5. As an alternative to the windlass, the Cranequin could be used to span heavy siege bows. As shown above it was a clever combination of gears and rack and pinion, creating a great mechanical advantage that could span the heaviest crossbows. A superb example of a Cranequin, dated 1558. (bottom, authors Collection).

were pretty much rich men's toys is illustrated by surviving specimens, found in museums that show extravagant carving, inlays, engraving and other embellishments. They were only in vogue for a short period.

Bullet Bows

A few centuries later, at the beginning of the 19th century, a small group of English gunsmiths revived the concept and created a simpler version, the Bullet Bow (Figure 7). Unlike their forebears, bullet bows were basic utilitarian devices, devoid of ornamentation. The few makers were situated in Wigan, Manchester and London. Although the steel bows were thought to have been imported from Liege, each maker developed his own distinctive style. They all had features in common—a self-contained spanning lever, a "peep" type rear sight, an adjustable bead front sight, a trigger release mechanism and sometimes a set trigger. Power was provided by a hefty steel bow. They were fairly powerful and accurate. The principal usage was for hunting small game and birds.

The Connecticut Muzzle Loaders Association conducted some elaborate tests using an original bullet bow. Using a digital chronograph, they measured velocities using pellets of various weights. The average was around 150 feet per second. Accuracy was stated to such that one could regularly hit a target the size of a playing card at 50 feet. I frequently use mine, firing a half-inch lead ball, and can confirm their conclusion on accuracy.

Spanning Methods – Comparisons

Method	Ratio	Max. Draw (approx.)
Hand Span	1:1	100 pounds
Sitting Span	1:1	150 pounds
Stirrup	1:1	150 pounds
Spanning Belt	1:1	175 pounds
Doubler Belt	2:1	275 pounds
Lever	4:1	400 pounds
Goats Foot	5:1	450 pounds
Screw Jack	47:1	800 pounds
Windlass	78:1	1400 pounds
Cranequin	164:1	1850 pounds

From: Todeschi, Leo. Videos TodWorks on YouTube

Figure 6. The Dresden Schnepper. This masterpiece is typical of the Dresden style sporting crossbows. Probably made by Gottfried Hanusch the elder in 1728. Profuse intricate inlays, carved metal parts and original pompoms in Bavarian colors (authors collection).

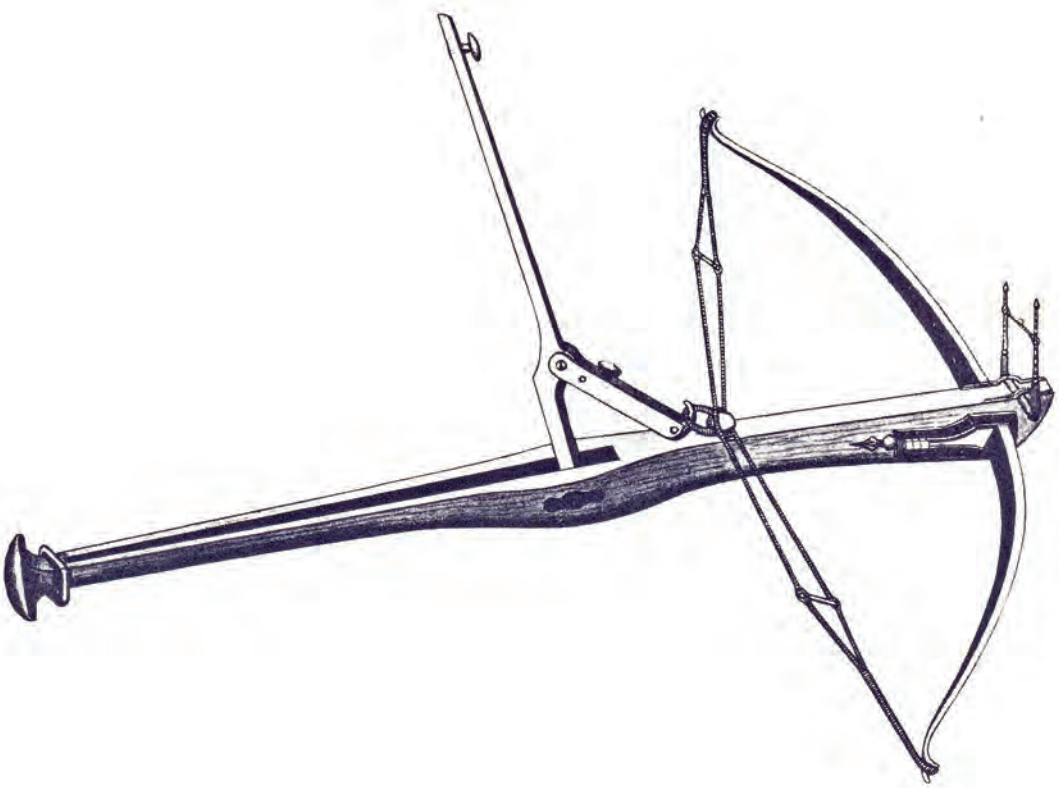

Figure 7. The Bullet Crossbow was developed in England in the early 1800s. It shoots a half-inch lead ball with surprising power and accuracy. It has a built-in spanning lever.

Figure 8. A pair of heavy siege crossbows. On the right is a 1000-pound draw piece accompanied by the cranequin shown in Figure 5. On the left is a 1400 pound--draw bow with its windlass spanner. Typically, these siege pieces weigh between 30 and 45 pounds. (authors collection).

Note: Most of the line drawings used in this paper were adapted from the Payne-Galway book *The Crossbow*.

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