



LATHES DRIVEN BY ENERGY STORAD IN A SPRING POLE

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Abstract

The following paper presents the history of usage of a bow as a spring storing energy and which is used to drive lathes. Technical solutions presented by the authors of Renaissance time are shown in this paper.

Key words: *springs, bow, lathe, drive, historical inventions*

BOW AS A SPRING

Humanity since the beginning of its history has tried to make use of forces and laws of nature. The observation of nature gave man new possibilities and mobilized him to create new and bigger accomplishments. Man often tried to use springy forces to perform work for him. In modern technics the term „spring“ is almost always associated with metals, however the first springs were made from wood. Maybe a man climbing trees felt and saw bending branches and tops of trees has learnt to put to practise in different ways this phenomenon. The first form of spring was a wooden bow. Histories of other springs are very short in comparison with a flat wooden spring bent by a piece of string. The history of bow as archeological excavations suggest, started around 50 thousand years ago!

Springs can be treated as one of the oldest flexible construction elements used to take over and pass on forces at considerable deformation. These properties are gained by selection of appropriate shapes and usage of appropriate materials. Springs especially are fitted to store mechanical work in the form of potential energy, finding different application as for example: measuring, vibrating, dumping, stabilizing, and storing energy elements [1].

Applying vegetal or animal products (wood, tendons, hair, and leather) different springs were constructed. Mechanical properties of biological construction materials which were used in old bows are compared with contemporary steel materials – Table 1.

Table 1. Properties of construction materials used for bow production

Construction material	Working deformation ε [%]	Working stress σ [MPa]	Absorbed elastic energy E_s [J/ m ³]	Material density ρ [kg/m ³]	Absorbed energy E_p [J/kg]
Yew wood (Taxus L)	0,9	120	$0,5 \cdot 10^6$	600	900
Animal tendon	8	70	$2,8 \cdot 10^6$	1100	2500
Deer horns	4	90	$1,8 \cdot 10^6$	1200	1500
Contemporary spring steel	0,3	700	$1,0 \cdot 10^6$	7800	130

CONSTRUCTION OF PEDAL LATHES WITH SPRING POLE

Among others this resilience was used at constructing lathe drive in the late Middleages and Renaissance times [2,3,4,7]. Treadle drive was used where the spring could be a wooden log fastened by one end and bent by a tendon wind on a spindle nd driven by a foot lever.

This string was fixed to foot lever from one side and to springy element from the other side. It enabled return of a spindle after the movement caused by the lever pressed by a turner.

Woodbury [8] speculated, that spring-pole and treadle drive were used as a consequence of economical growth and demand for turned elements. It resulted in new lathe constructions which signified an enormous step forwards in their technical development. According to Woodbury, the spring-and-pole drive was recognized as a genuine improvement, for after its first appearance it spread very rapidly.

Some of the most important inventions of the 15th century are depicted in *Leonardo da Vinci's 'Codice Atlantico' (c.1500)* and they include:

the first floating mandrel for screw-cutting;
- a longbow in place of the traditional pole thus taking up less floor space;

This illustration is also the first to show:-

- a drive between two bearings of the headstock and a tailstock with screw adjustment to turn work-pieces of different lengths between centres.

Fundamentally the late model projected in the 13th century outlasted with small changes nearly to the 19th century. It can be provided by Diderot's illustration (Fig.2 below) in *L'Encyclopedie* by D'Alembert, which was published in the second half of the 18th century.

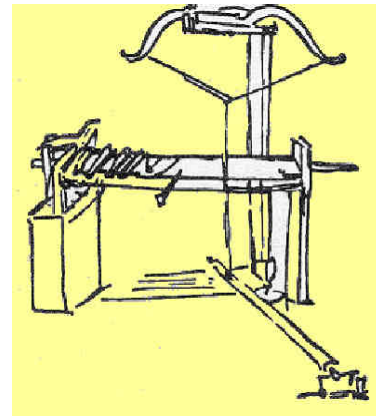


Fig.1 Longbow in place of the traditional pole thus in Leonardo da Vinci's projects

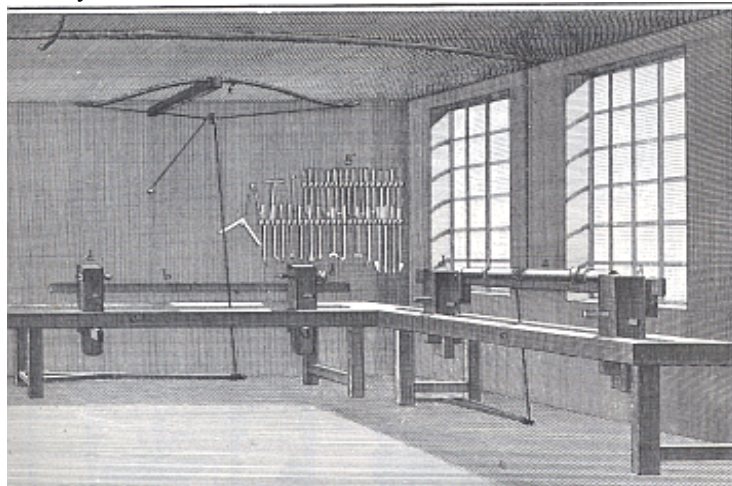


Fig. 2 Turner's atelier

The changes consisted of longbow and modified regulation of lathe **fly** span.

During turning the machined piece of wood was set in rotatory movement by advance movement of a lathe tool.

The construction solutions of treadle lathes with a longbow as a spring are shown in the illustrations from old literature showing technical history.

To obtain very complicated shapes of machined materials turning was not limited to surface one but also the inside one was used to get wholes, bore chambers, reliefs, and so on. Both variants of turning show illustrations Fig.3 placed in Jacques Besson publication *Teatrum Instrumentorum et Machinarium* published in year 1578 [1]. Fig.3a shows cross turning of rolls / a roll with differentiated shapes / whereas Fig.3b longitudinal turning / forming caving in turned material to get a cup or pot/ from the side of support. The products manufactured by a turner are presented on the shelf in the depth of the illustration. Both lathes are treadle driven supported by longbow fixed at the ceiling of the laboratory. Thanks to such transmission system drive the alternate movement was obtained.

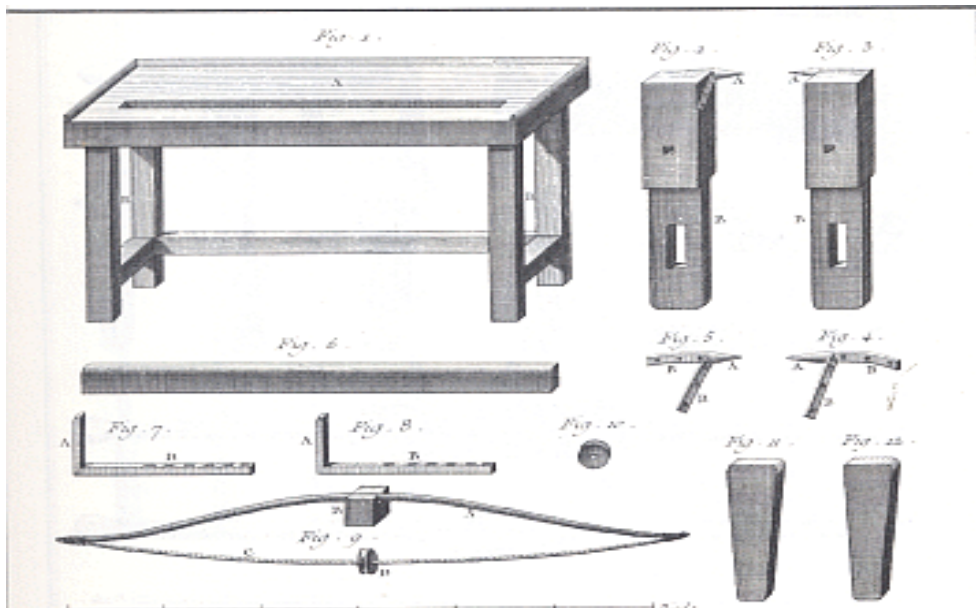


Fig. 2 Detail from the Diderot and D'Alembert *Encyclopédie*, the article "Tourneur" or "tour en bois". Notice the "bow" near the ceiling

The lathe of 1671 portrayed at left comes from a work on optics by Father Cherubin d'Orleans. It is not generally appreciated that the curved mirrors so fashionable in this era, as well as lenses for glasses and scientific equipment were ground on lathes such as this. Cherubin was particularly concerned with reducing friction, accurate bearings and adjustable speeds, as this ingenious lathe shows. (Fig.4).

This solution is characterised by application of crank drive cooperating with longbow which supports crank mechanism. In this solution a big flywheel which not only accumulates energy but also assures more uniform work of transmission system and eliminates influence of cutting resistance on spindle rotation.

The upside: (1) the rotation power is probably increased
(2) the number of revolutions per stroke is increased

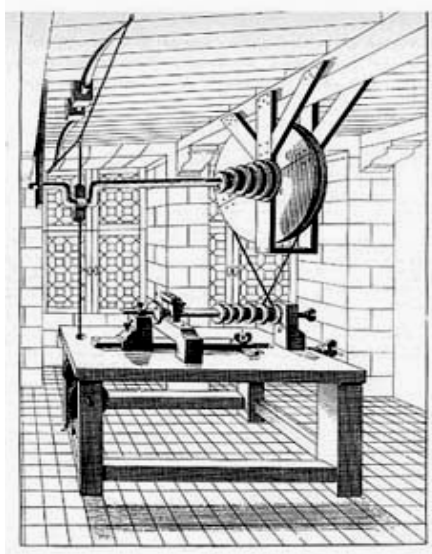
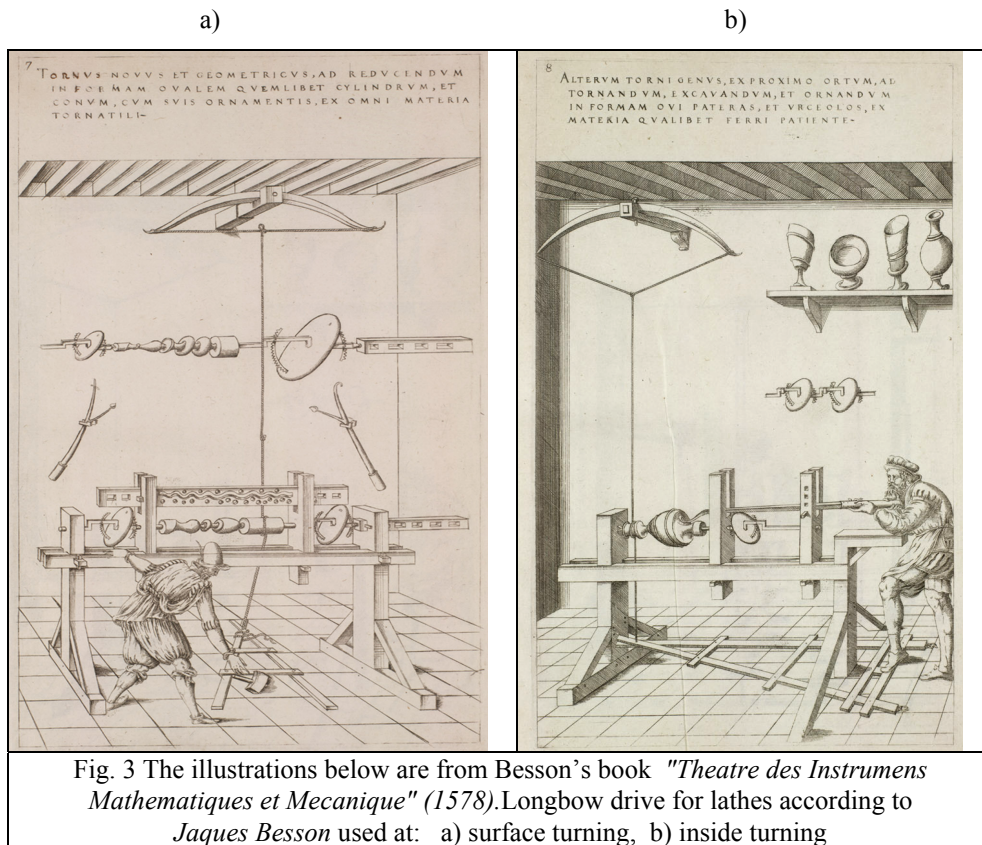


Fig. 4 Lathe with flying wheel and longbow - crank drive (Cherubin d'Orleans) [9]

The downside:

- (1) an alternating rotation of the workpiece is the same
- (2) the speed of the workpiece's rotation is the same.

Above:

"Some turners that work light work, such as cane-heads, ink-horns, &c. for which they need scarce remove the Puppets off their Lathe, use a common Bow, such as Archers use. The middle of this Bow the fasten over Head, with its string Horizontally downwards, and in the middle of of that String the fasten another String perpendicularly downwards, whose other end the fasten to the Treddle, and the String wound round their Work brings it around" -Joseph Moxon on using a bow for a spring. The spring-pole-and-treadle drive lathe is certainly much more convenient than the simple cord or the bow drive.

TEST OF RECONSTRUCTION

One of my shop assistants working my foot-powered lathe in front of our booth at the Minnesota Renaissance Festival. It uses a bow instead of a spring pole. The metal bow was a spring that was scavenged from an antique baby buggy. I originally tied the cord directly to the bow string, but the bow was too stiff for me to work with for very long, so I added a pulley to the bow string following.

CONCLUSION

The above described drive had long lasting life and was used up till vapor drive was invented and longbow occurred very useful.

It should be mentioned In the conclusion that in the history of **technic** we can find tendency to being the first in an invention which espies the picture of collective character of technical development. It is also presented in historical literature, where the given factographic material depends on the origin of the author.



Fig. 5 Spring-pole-and-treadle drive lathe - reconstruction

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