

Epilogue

Leonardo's Legacy and Impact on Modern Technology

Leonardo's life-long career as a roboticist would bridge the fifteenth and sixteenth centuries. Leonardo's relationship with his teacher Verrocchio was doubtless the foundation of his work with robots. Perhaps Leonardo even sought to outperform his mentor, striving for even greater technological glory. Not surprisingly, it would take exactly that type of teacher/student relationship in our modern time to reassemble Leonardo's lost robots. Obviously in love with the technological challenges of mechanisms, Leonardo at an early age shows an astonishing grasp of how to integrate multiple subsystems to accomplish his goal of a self-propelled, compact programmable automaton, perhaps located in the base of a mechanical lion, which would follow a prescribed pattern. In mid-life, he would create an animatronic knight, also for entertainment purposes. Towards the end of his life, he would invent a hydraulic clock in homage to the clepsydres of the ancients but with very modern concepts of components and packaging.

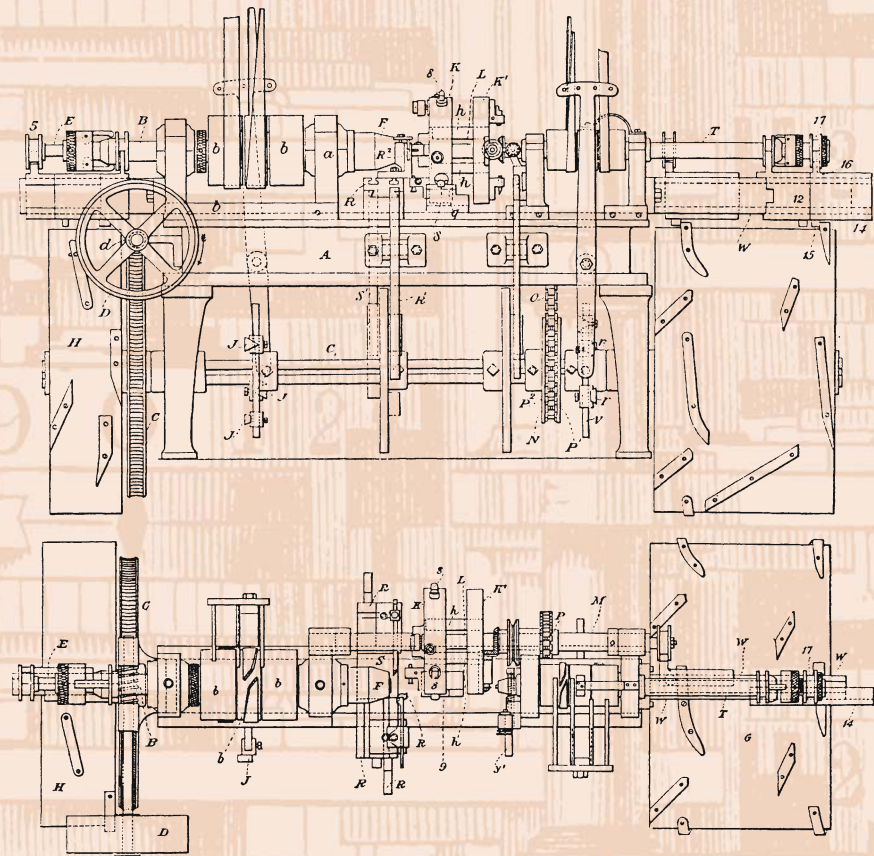


Fig. 5.1.
Spenser lathe

In the Programmable Automaton, with its beautiful nested subsystems and dual spring power supply, we see the foundation of the first programmable machine tools, to say nothing of the first Autonomous Ground Vehicle (AGV) that would become common on the twentieth century factory floor for moving manufactured components and subassemblies. Flexible programming is provided by removable cams for steering and actuating additional subsystems—dare I say subroutines? The spring return cam followers actuate stop and start functions and steering. This is a clear anticipation of the nineteenth-century cam-operated machine tools. In 1893, Christopher M. Spenser filed his patent on a “Fixed Head Type of Automatic Lathe for Making Metal Screws Automatically.” Controlled by curved plates on rotating drums, it was very similar to Leonardo's some four hundred years earlier. Leonardo's machine is a direct anticipation of the technology that fueled the industrial revolution, with the same use of rotating cams to control machining operation (Fig. 5.1). Spenser's would be the prototype for countless cam-controlled automatic machine tools. From these numerically controlled machine tools would evolve machines controlled by punched tape and eventually modern software.

In the Robot Knight, with its remote control potential and anthropomorphic physique, we see the birth of animatronics, or entertainment robots. No doubt designed for a fifteenth-century amusement park, it must have shocked and amazed visitors who came upon the mechanical apparition standing up and outstretching its arms. That the unique differential cable drive system for the arms would be reborn 500 years later as an exercise machine shows Leonardo's wonderful cleverness in designing multi-functionality using a few simple components. Animatronics would in the twen-

Fig. 5.2. Robotic surrogate proportions of robot

