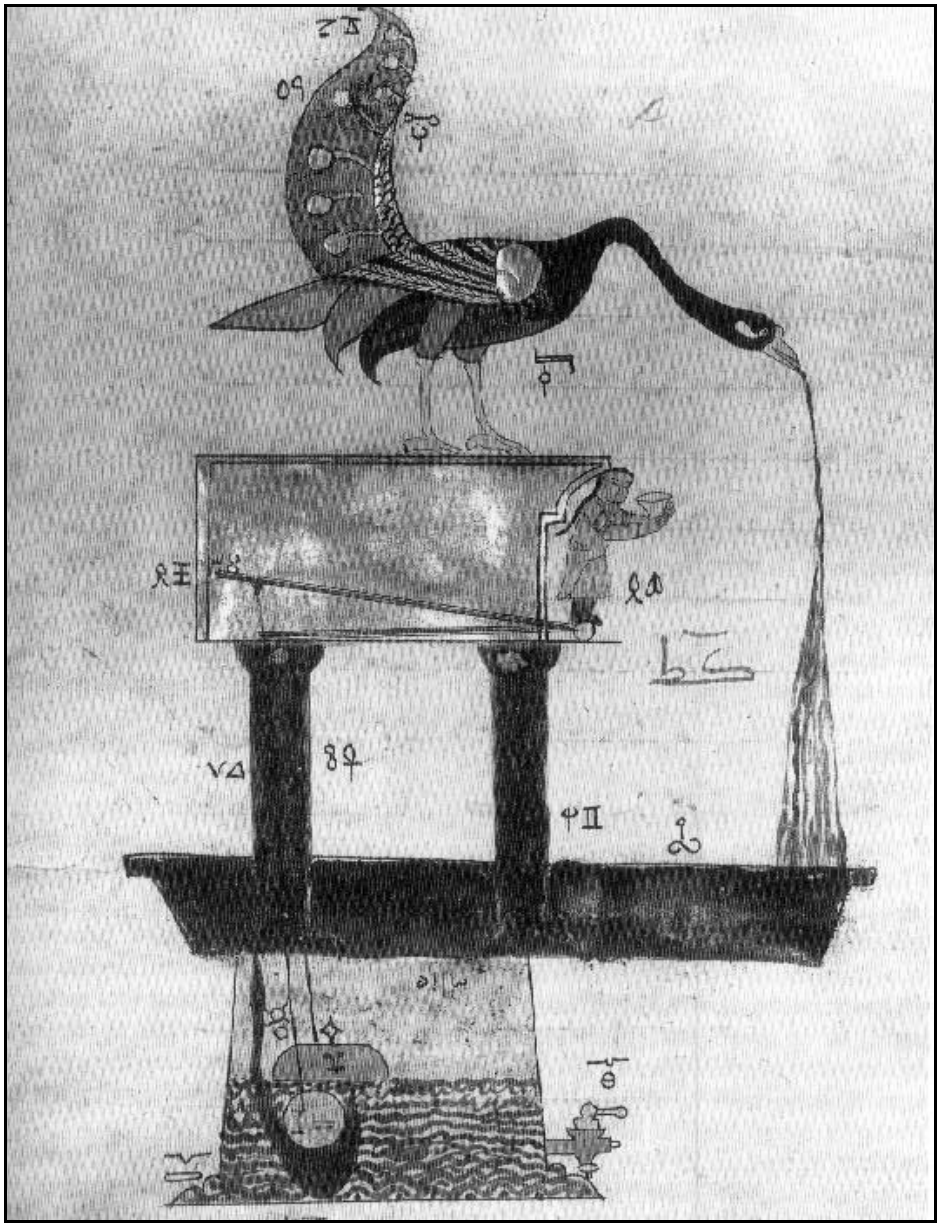


Fig.3 An Arab design of an automaton by al-Jazari in XIIth century, [1].

- The fact is that most of the automatic/robotic devices in Antiquity are lost but their memory can be found in some documents, artistic representations and even in humanistic literature.

Indeed, the understanding of these sources requires the strict co-operation of technical experts and humanistic archeologist people (indeed this is now known as Technical Archeology) with the aim to give more that few examples or even only tales on automatic devices in Antiquity.

AUTOMATION, AUTOMATA AND EARLY ROBOTS

Early automata, that can recall robotic systems and indeed promoted evolution to robots, can be recognized in the early systems related to

clocks, theater machines, looms, automatic toys, mechanical calculators

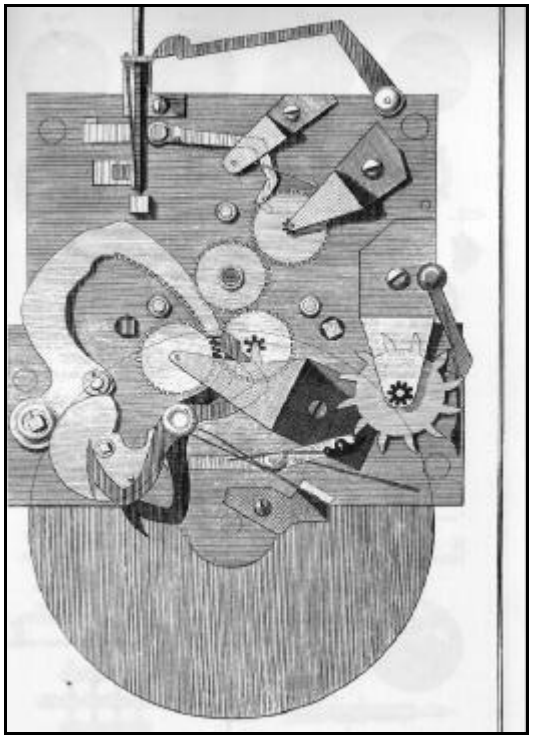
that were developed since the XIIIth century.

- Most of the automatic devices of the past were based on mechanical design of suitable mechanisms.

The study of these mechanisms were considered a secrecy

- restricted to few people and the circulation was achieved only when the teaching purposes were considered necessary.

Clock mechanisms were built since the beginning of XIIIth century.



by J.B. D'Alembert and D. Diderot in (1774).

They are even described by Dante Alighieri in the Holy Comedy as first automatic devices.

In fact, clock mechanisms can be considered the first completely autonomous devices since they run autonomously once enough energy is stored in suitable springs or weighted systems that are also the motors of the devices.

They have always given the impression that mechanical systems could be arranged in compact designs to work autonomously.

Devices for theatre

were built over the time mainly to astonish the audience, in agreement with the tradition of Classical Theatre.

Automation was attempted and obtained with practical applications in work activity

- mainly to increase the production and/or the product quality.

even in the past pure research aims addressed great attention and efforts.

A brilliant example is Leonardo da Vinci, who was artist, engineer, inventor, and researcher.

Fig. 3 shows a study of feasibility by Leonardo in which one can find details useful for a robotic arm, but they are related to a wing arm for a flying machine.

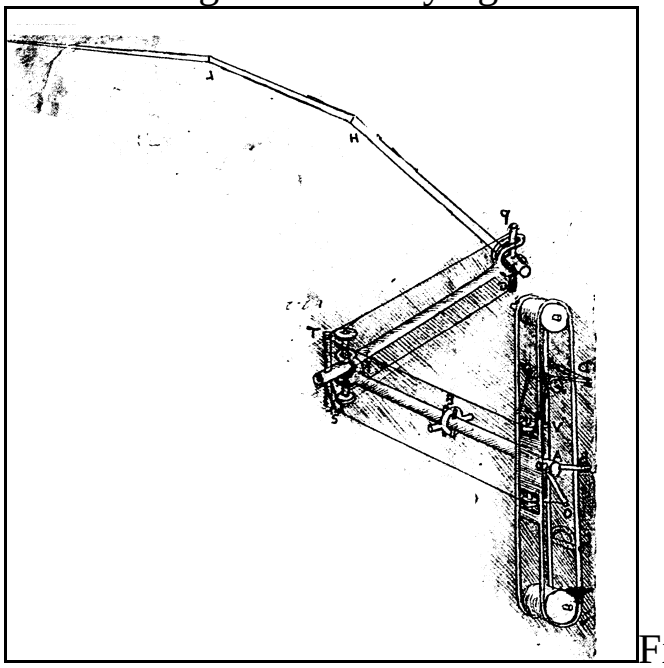
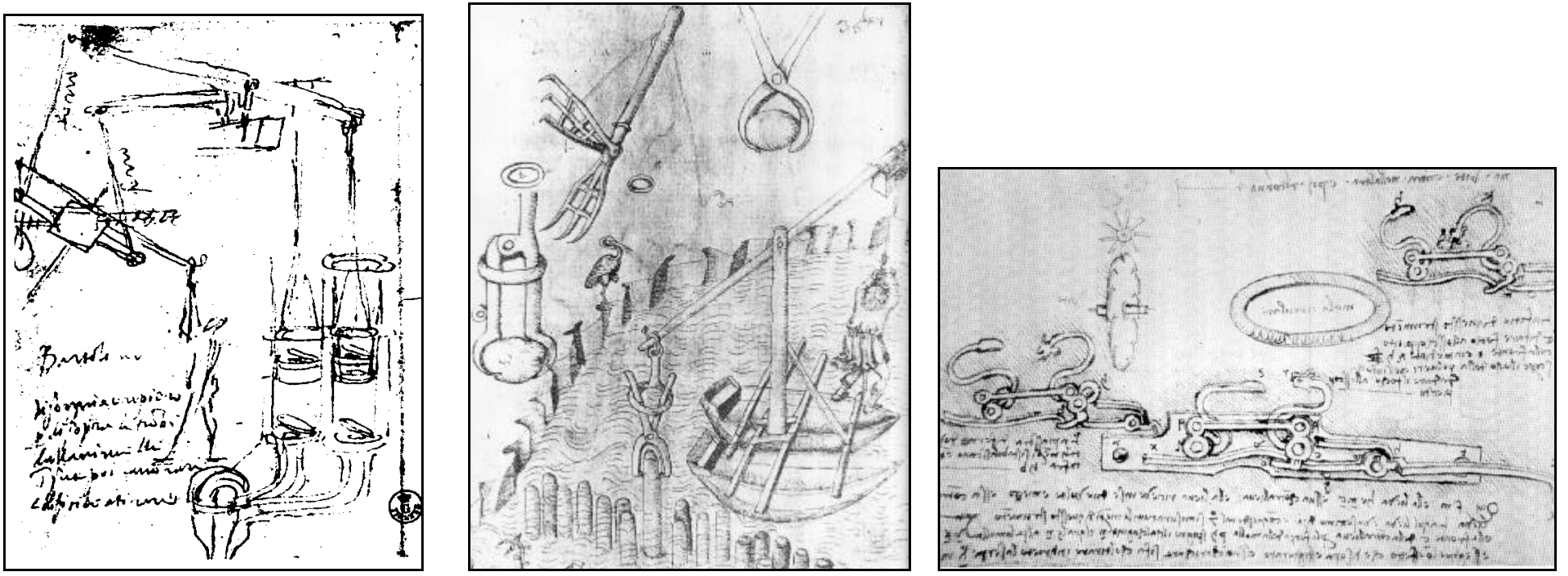


Fig. 3: A mechanical design by Leonardo Da Vinci for a wing.

Mechanisms, mechanical design, and automation evolved considerably during the Renaissance because of the increased needs of technical means.

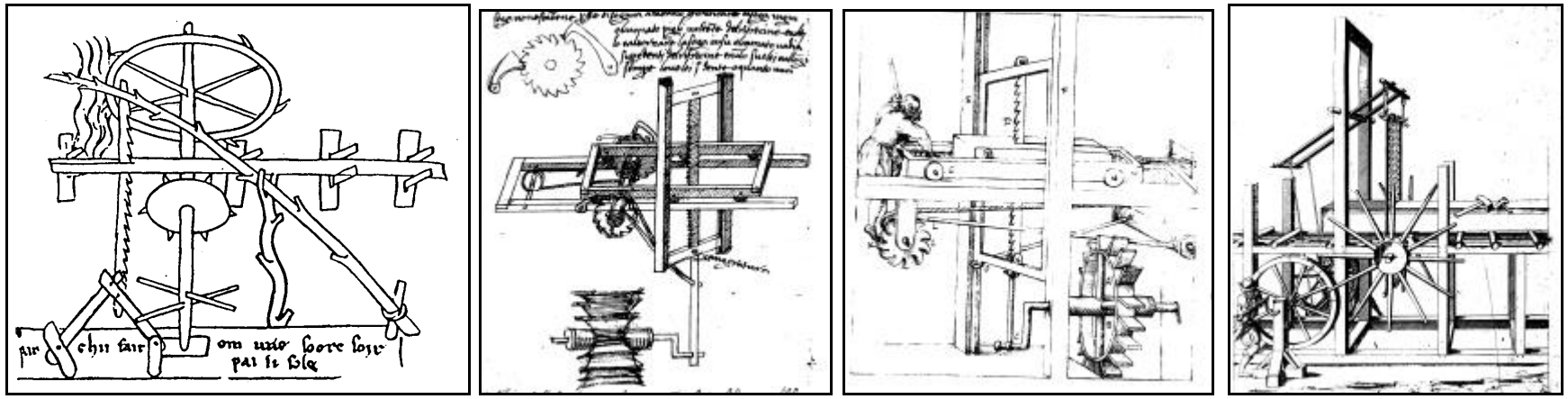
At the time of Renaissance there was somehow the establishment of a mature technical culture whose expression is **the work of many personalities**

and Leonardo da Vinci is the only most famous one, because of his great encyclopedic knowledge and skill.



a) b) c)

Fig.6 Early mechanical designs of machinery in the Renaissance period (XV-XVI th centuries): a) by Antonio da Sangallo Il Giovane, (Frommel 1994); b) by Mariano di Jacopo (Il Taccola) (1969); c) by Leonardo da Vinci, (Cianchi 1984)



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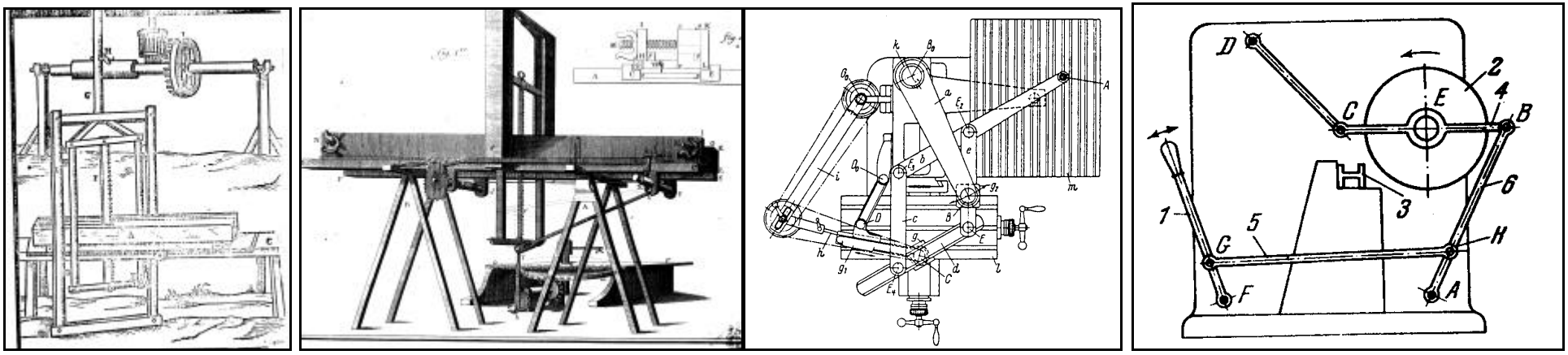


e) f) g) h)

Fig. 6: Automatic wood sawing machines by: a) Villard de Honnecourt in XIIIth century, [16]; b) Leonardo Da Vinci in XVth century, [15]; c) Bernardo Puccini in 1520, [17]; d) Jacque Besson in 1578, [18]; e) Giovanni Branca in 1629, [19]; f) from French patents in XVIIIth century, [20]; g) Kurt Hain in 1961, [21]; h) Ivan I. Artobolevsky in 1975, [22].

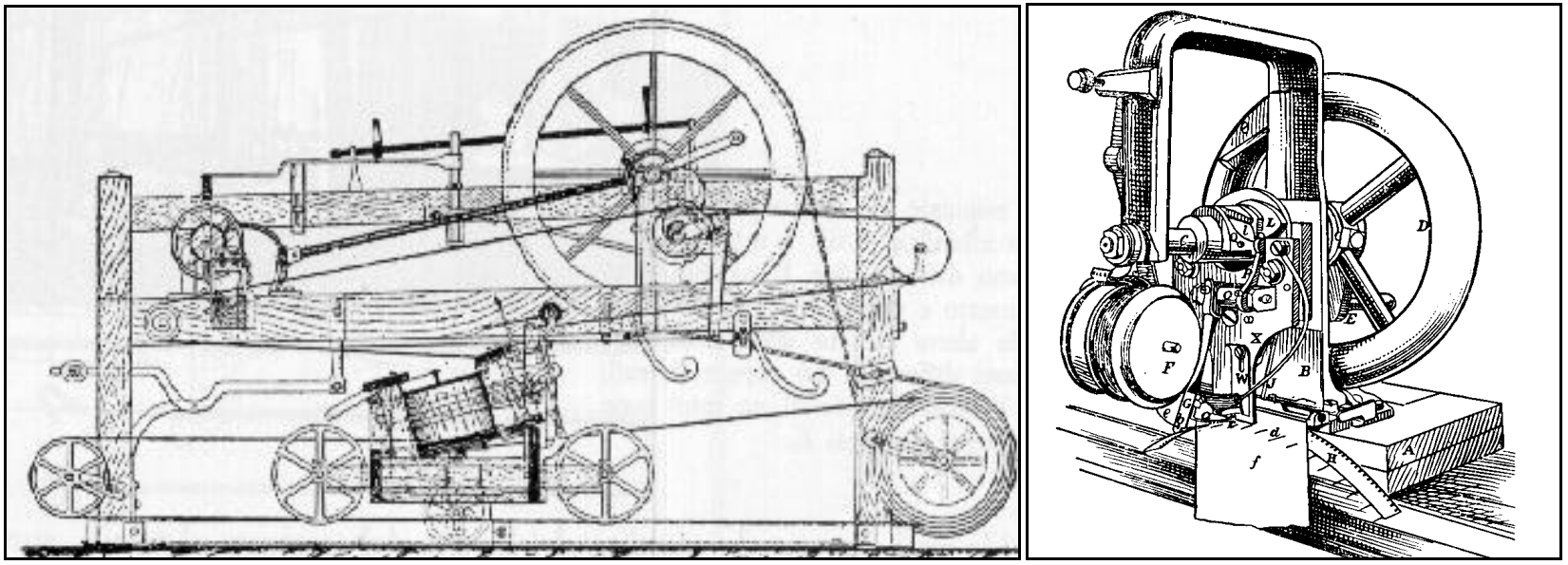
textile manufacturing.

In particular, looms

evolved from manually operated systems at the beginning of XVIIIth century to fully automatic machines at the end of XIXth century.

The mechanisms used in the looms were improved with suitable design and complex architectures in order to obtain several kinds of manufacturing and high-speed production.

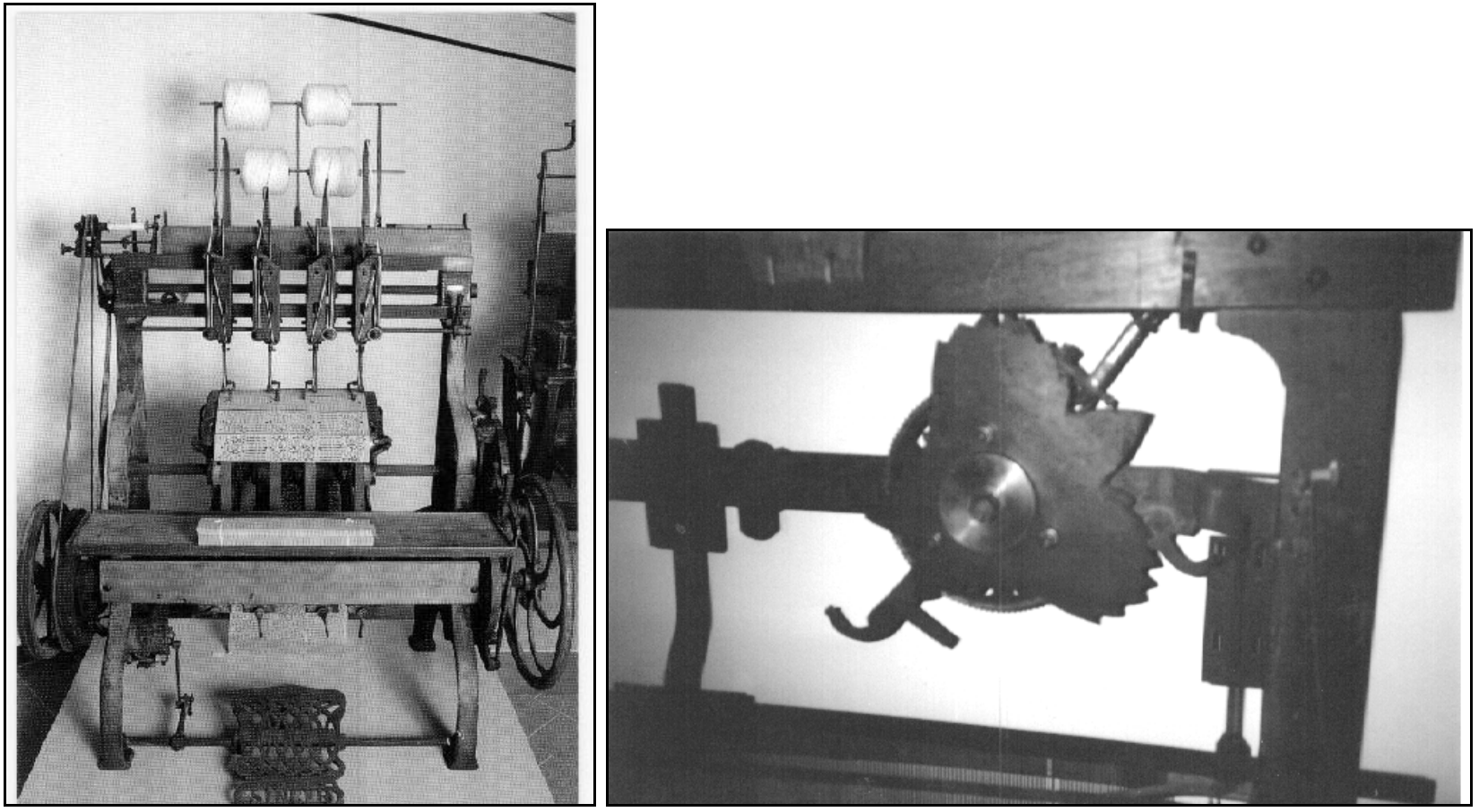
At the same time they were made automatic by using the steam power and later electric motors.



a) b)

Fig.18 Examples of early modern machines using mechanisms designs in XIXth century: a) in a Compton loom; b) Howe sawing machine for textile manufacturing;

- The programming was achieved by using suitable mechanisms that were able to perform the work that is coded in suitable cards. The operation speed was regulated by other suitable mechanical devices.

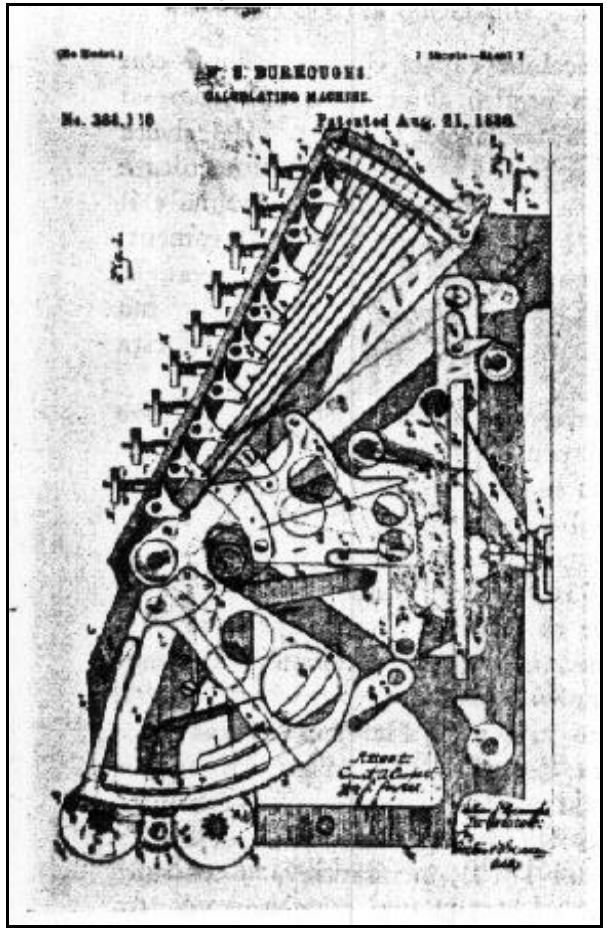


a) b)

Fig. 5: Components of an automatic machine for textile manufacturing at the end of XIXth century, [10]: a) a machine for making the programming cards; b) a cam for motion regulation.

Similar evolution was experienced with **writing machines**

in XXth century, since they passed from pure mechanical devices with very amusing mechanisms in the 50s to mechatronic systems in the 80s.



In addition, the writing machines are near to disappear

because they can be substituted by PCs with other additional features.

Much of the robot evolution can be considered as based on computer evolution.

But computer is not a conceive of this century, only its electronic construction.

In fact, calculators were built in the past by using mechanical devices to perform several kind of computations. Famous are the computing machines by Des Cartes, Pascal, Leibniz.

In the 1820s Charles Babbage

designed a computing machine based on systems of gears that addressed great attention. He obtained even considerable funds to build the final design of an “universal calculator”.

But Babbage never completed the project, although the efficiency of the systems has been proved by his early prototype and even today with partial reconstruction of the Babbage design.