Calculations with tools

in old and recent times

Calculations with tools

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Introduction

- Last years presentation on Kaktovik numbers triggered this presentation
- Hans' and Mikael's work on math typesetting gave the impulse for a math-day with a broader scope
- When embarking on a trip into the unknown one might encounter a hornets nest
- Confusion is there about developments parallel or copied
- Necessity of a stable counting system (5,10,20,60)

Ancient Calculating Tools

Finger-counting

Lets be honest: the first tool for counting are our fingers…

Notched Stick / Tally Stick

- One of the oldest way of keeping records of amounts, debts.
- The use was to make notches on a stick indicating normally accounting issues. After notching the stick was split into two halves lengthwise
- For a valid record the products involved were written on it with ink
- At that time there were no invoices and receipts
- The parties involved got each half of the stick

  At the moment of payment, the sticks were again fitted together in order to proof, that the payment concerned the same account.

Figure 2.1 Tally stick

- After payment the notches were eliminated.

- In German exists a saying:

  “Jemand hat etwas auf dem Kerbholz/ Kerbstock”

  “Somebody has something on the notched stick”

  Indicating, that the person in question had done something unlawfully.
  Normally the notched stick had to do with debt, and that is the reason why it got a negative connotation.

Mesopotamia

- Sumerians 6th to 5th millennium BC Babylonians (18th to 15th century BC) exercised systematic and consistent mathematics in a sexagesimal system (base 60)
- The numbering system was strictly positional
- Our division of the circle in 360 degrees or the the time division in 60 minutes and seconds is derived here off
- They used clay tablets with inscriptions of squares and cubes of numbers
- They dealt with quadratic and cubic equations and had an approximation of $\sqrt{2}$ up to the sixth decimal
- The roots of the abacus is thought to be in Mesopotamian area

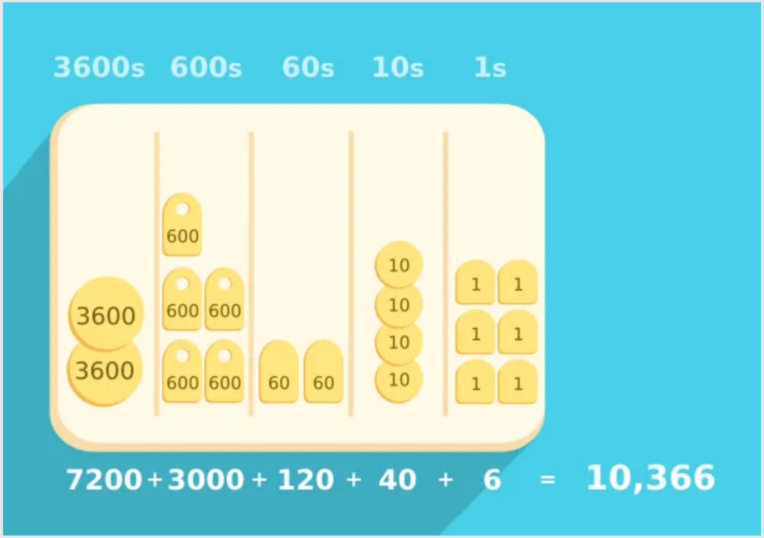

Figure 2.2 Sumerian calculation tablet

Central and South America

- **Aztec** (13th to 16th century) and **Maya** culture (before 9th century) had mathematical systems with base 20
- **Nepōhualtzintzin** abacus has 13 rows with 7 beads each, totaling 91 pieces

Figure 2.3 Nepōhualtzintzin

- There are indications that they used also knotted cords with inserted coloured strips to represent amounts …However how they were used is not known

- How they used calculating tools is not entirely unraveled. However it is quite sure, that they used such for their records of e.g. land ownership, detailed accounting
- **Incas** used the **Quipu**, cords with knots as advanced tally sticks, probably not for counting

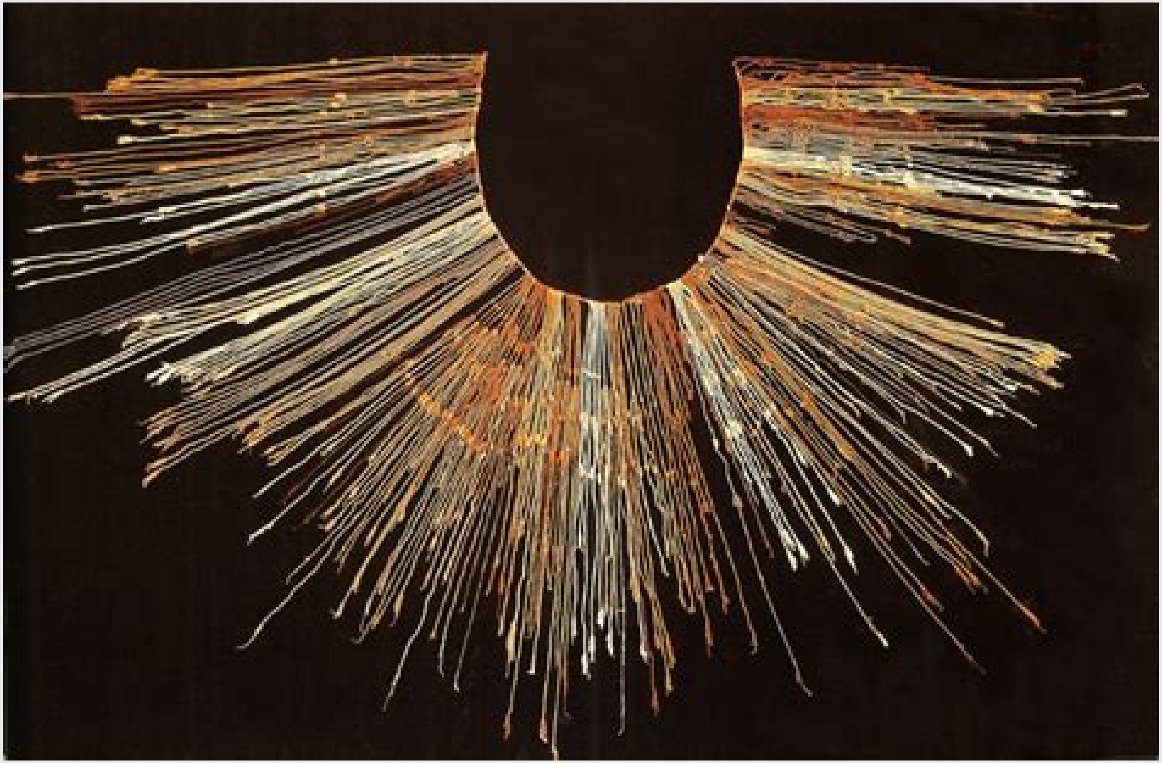

Figure 2.4 Quipu

- For counting the Incas used the **Yupana**. How this tool was used is not unraveled

Figure 2.5 Yupana

Roman Time

- Romans firstly had no numbering concept of zero
- They used counting boards where pebbles on a grid could be placed for counting
- After time the zero concept was adopted
- They built the first handheld calculator with moveable beads sliding in grooves
- This tool had two sections. The lower section contained 5 beads the upper only one.
- This abacus also had shorter grooves to the right, these were probably used for fractions.

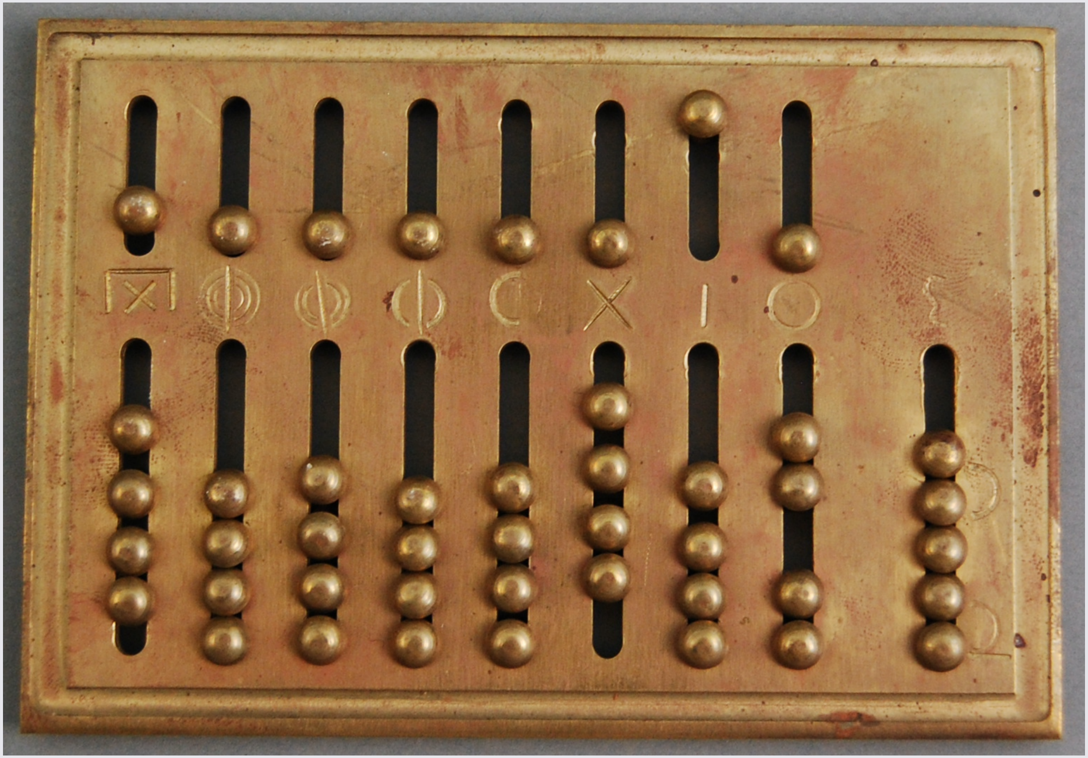

Figure 2.6 Roman Abacus

China

- The Chinese abacus is called **Suanpan** (calculating board).
- The tool is mentioned in a document from the 2nd century BC. It is estimated that such Suanpan versions were used even thousands of years before this time
- The Suanpan is a frame with two sections.
- The beads are aligned vertically. The lower section has 5 beads and the top section 2 beads.
- This abacus can perform hexagesimal counting (unlike Roman and Japanese versions which are for base 10) (as some author said the Suanpan is designed for this [www.chinahighlights.com])
- In the history of the Suanpan were versions with 1:4, 1:5 and 2:5

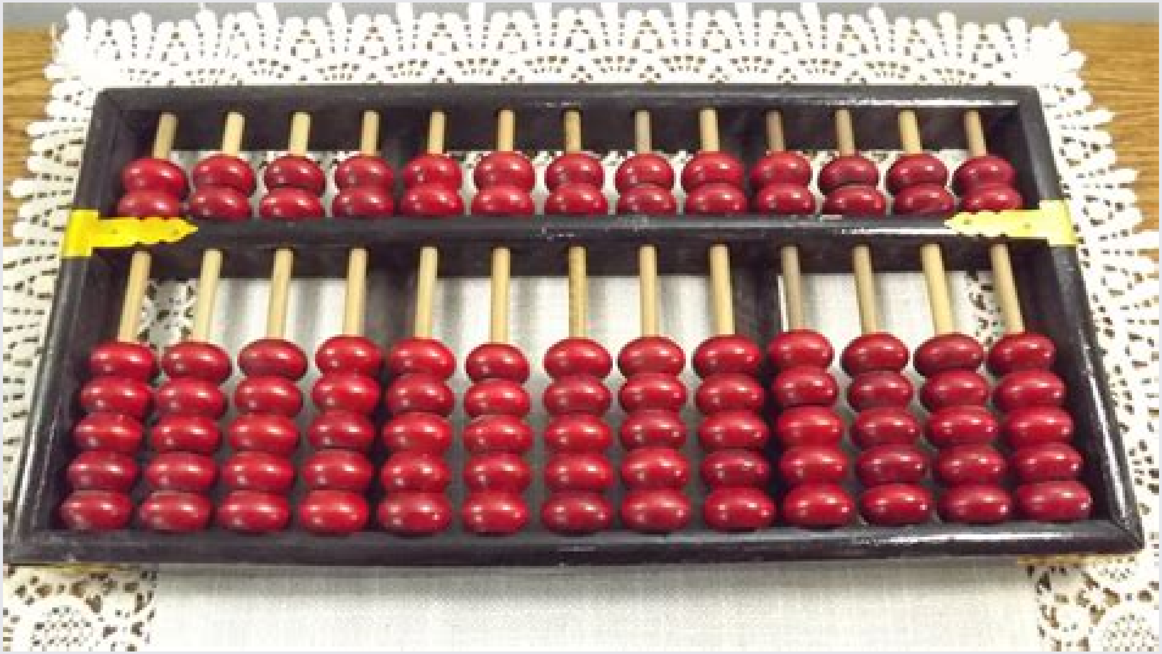

Figure 2.7 Suanpan

Japan

- The Suanpan from China came to Japan in about the 14th century
  Firstly it was a 2:5 abacus. In later time this was reduced to the 1:4 version.
- 1:4 represents the least number of beads needed to calculate in a 10 base counting system
- The Japanese call the abacus **Soroban**
- The Soroban can be built with 7 up to 23 and more columns of beads

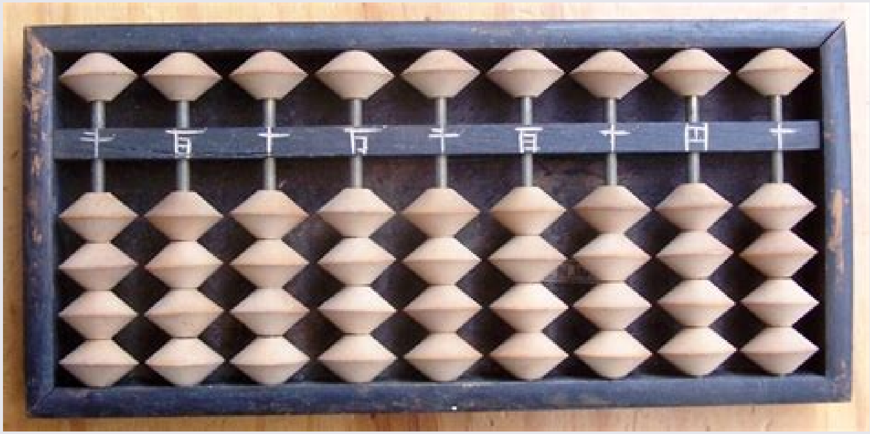

Figure 2.8 Soroban

- The Soroban is still in use at least in primary schools up today

Working Time!

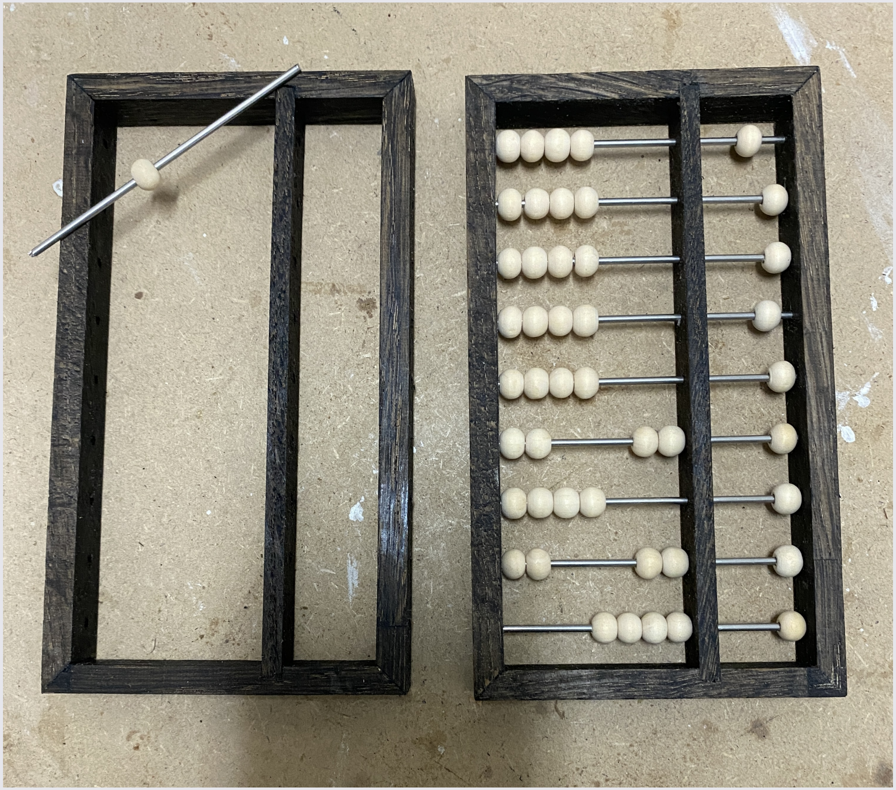

Figure 3.1 Our Project

Continuing Calculating Tools

Russia

- The Russians invented the Scioty (Polish notation), Stschoty (German notation), Schoty (English notation), счёты (Russian notation)
- Specific design for counting money
- - 11 rows, 10 beads per row, 8th row 4 beads only
  - Beads 5 and 6 often of different colour
  - Beads 2 and 3 of the 8th rod different colour
  - The first bead of the thousand row highlighted
- Operation mode different from regular abacus, counting takes place from the right to the left.
- The Scioty was still in use in the Soviet time (until 1990).

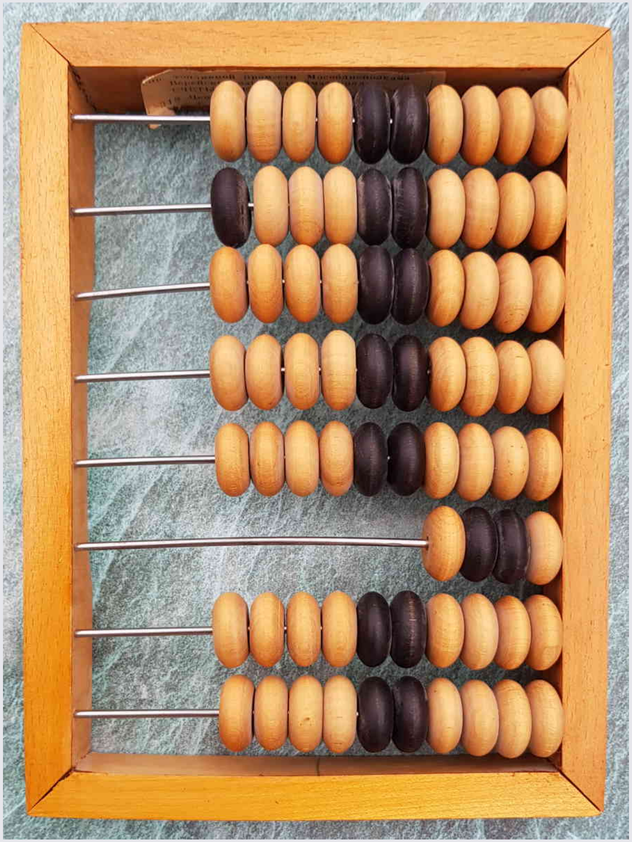

Figure 4.1 Scioty (счёты)

Europe

- Calculating on lines Adam Ries: Rechnung auff der linihen (1550)
- Calculating board (Rechenbrett)
- Special coins were produced for the calculating boards

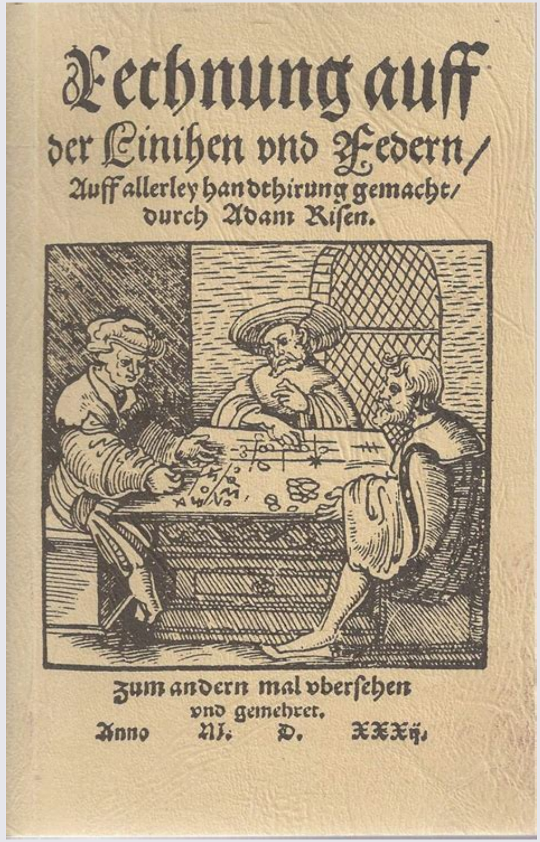

Figure 4.2 Adam Ries: Rechnung auff der linihen

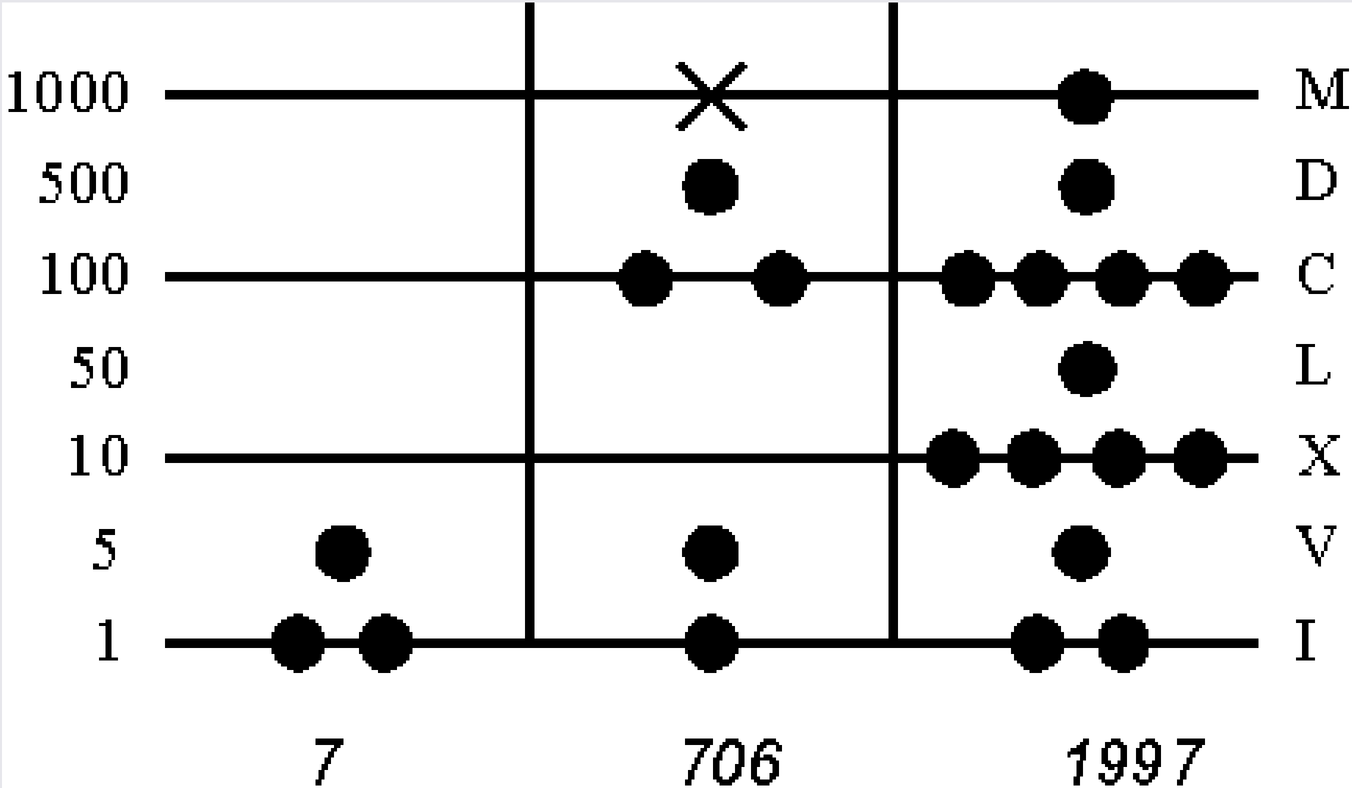

Figure 4.3 Calculating board

Mechanical Calculators Since the Middle Ages

John Napier

- Born 1550, died 1617
- Scottish mathematician and theological writer
- Concept of logarithms (1614)
- Invention of the Napier bones for multiplication and division
- Napier bones are the predecessors of the slide rule

Figure 5.1 Napier bones

Edmund Gunter

- Born 1581, died 1626
- English mathematician, professor for astronomy
- Inventor of the Gunter's chain
  It measured 20.1 meters long with 100 links.
  Used for measuring acres.
- Gunter's quadrant was used to find the hour of the day, the azimuth of the sun and the altitude of an object in degrees
  (Gunter's quadrant, the gunter as called by seaman) was a large scale with logarithmic marks on it. With the aid of two compasses it enabled the user to perform multiplications and divisions
- The Gunter's scale is a forerunner of the slide rule

Figure 5.2 Gunter chain

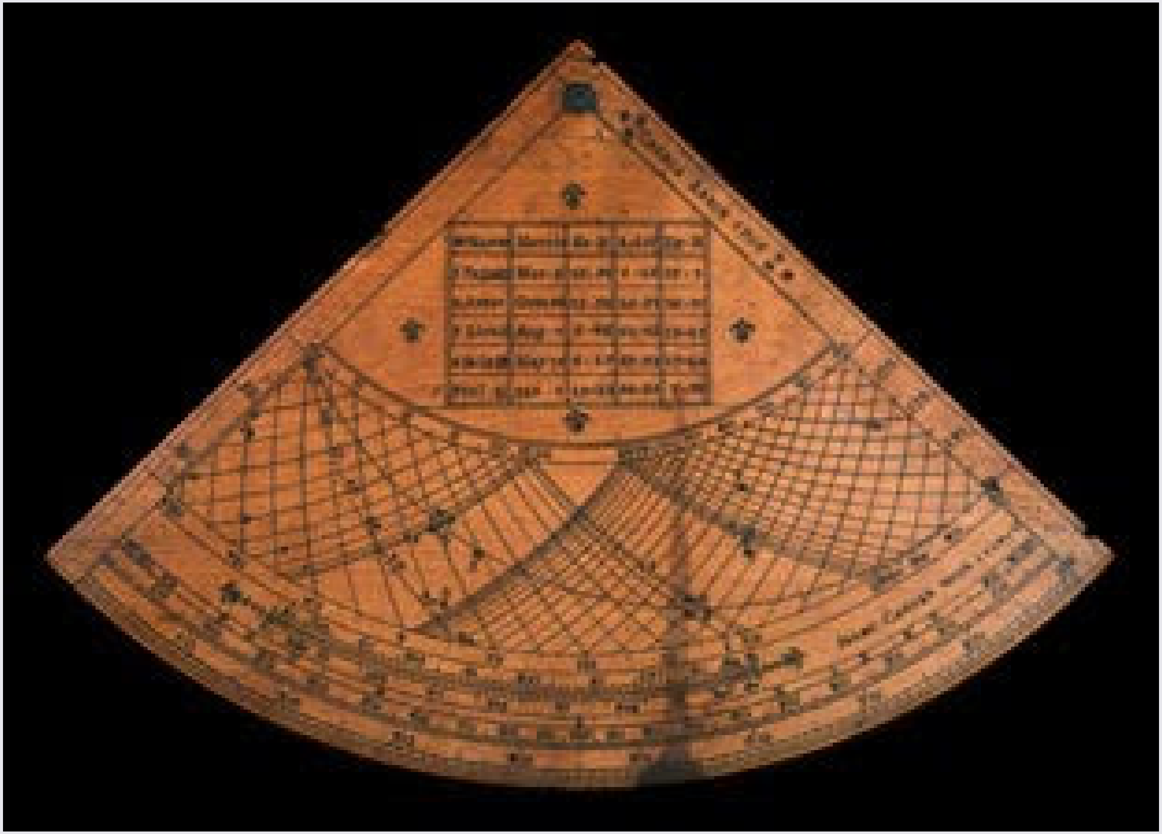

Figure 5.3 Gunter quadrant

William Oughtred

- Born 1574, died 1660
- English mathematician and clergy man
- Invention of the first circular slide rule, adjustable, having two logarithmic scales.
- Invention of the first straight slide rule. However the familiar inner moving ruler was invented by Robert Bissaker an English instrument-maker
- Many improvements as increased accuracy, sliding cursor and the log-log scale were introduced by a number of engineers and physicians like Mathew Boulton, James Watt and Peter Mark Roget
- The slide rule became one of the most operated and valued instruments in engineering and was in use until the 80ies of last century, when they became obsolete due to the power of electronic devices

Figure 5.4 Oughtred's circular slide rule

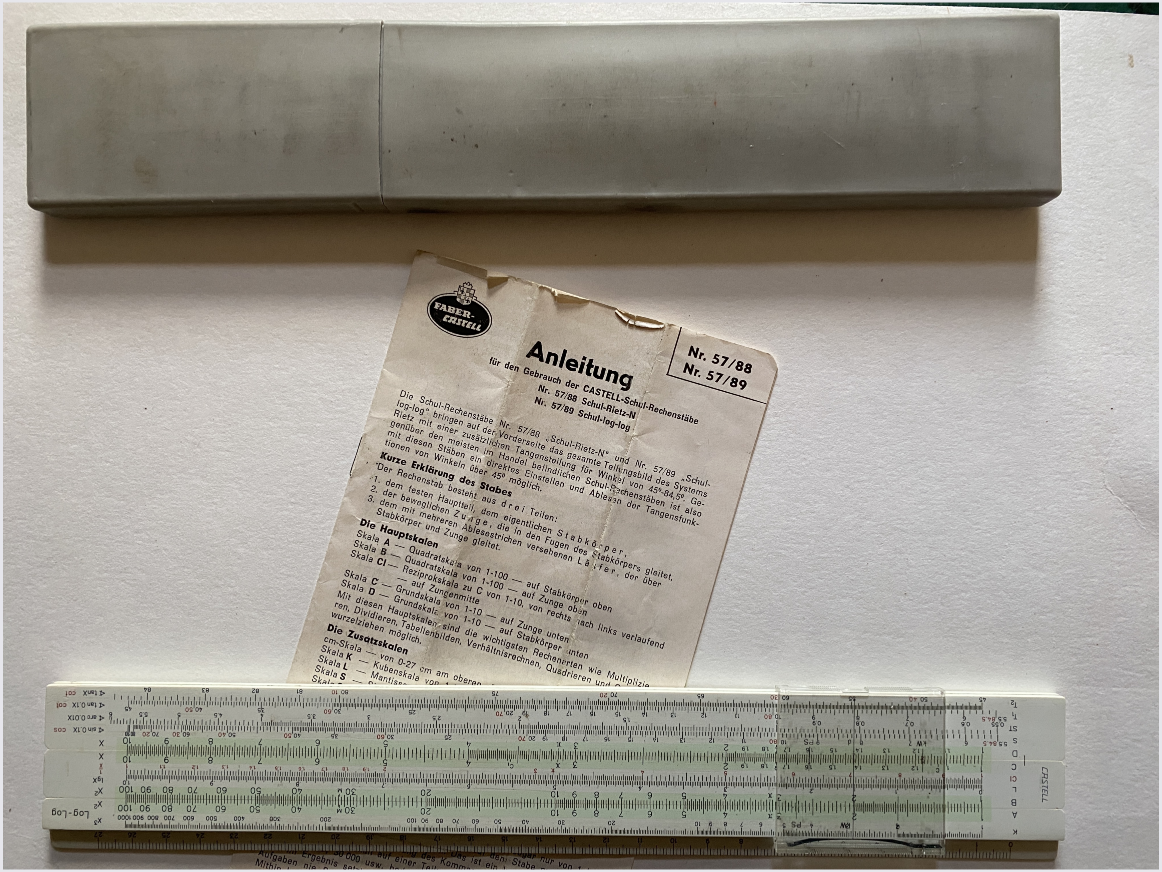

Figure 5.5 Faber Castell slide rule

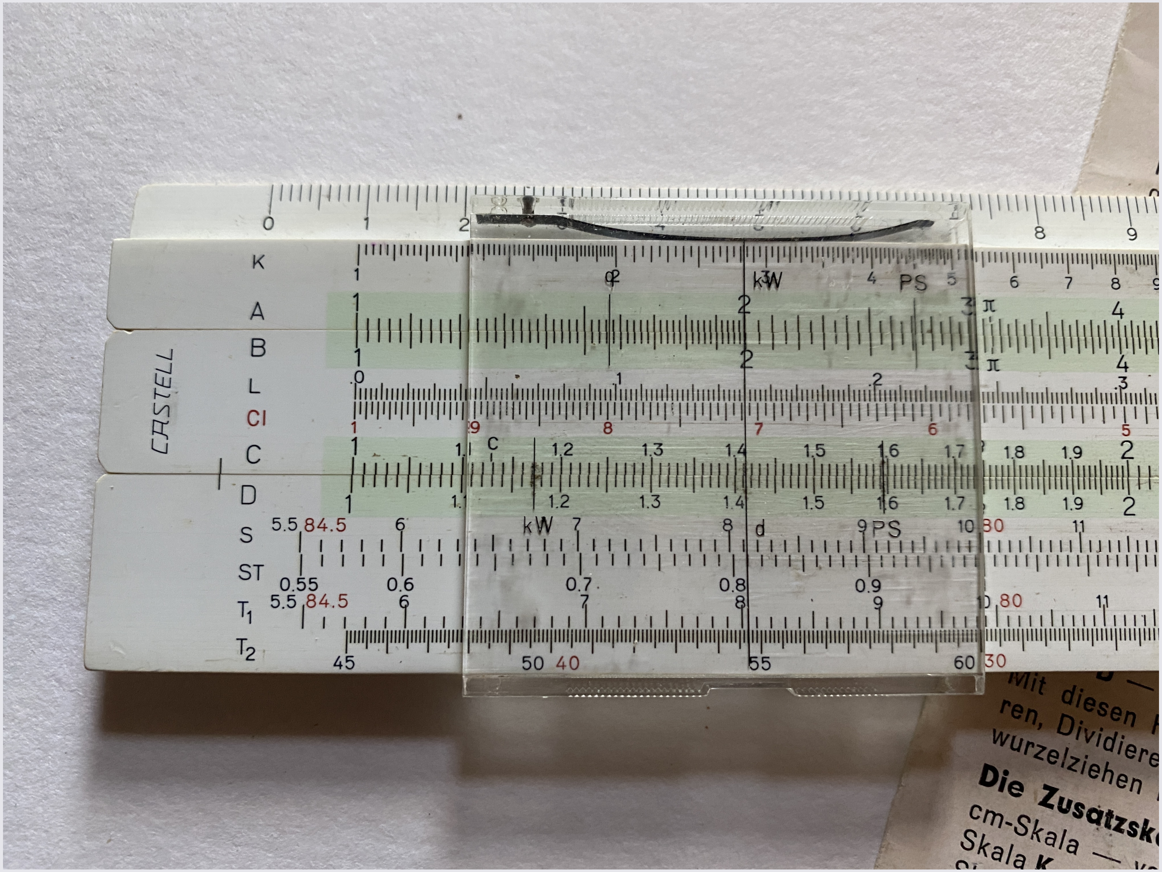

Figure 5.6 Faber Castell slide rule

Wilhelm Schickard

- Born 1592, died 1635
- German Hebrew and astronomy professor
- Hand planetarium
- Mechanical calculator drawings: uncomplete
- The design is based on Napier-bones

Figure 5.7 Wilhelm Schickard mechanical calculator (reconstruction)

Blaise Pascal

- Born 1623, died 1662
- Mathematician, physicist, philosopher
- Between 1642 and 1644 he built the first mechanical, digital calculator, so called because it used continuous integers, named **Pascaline**
- The machine could only perform addition and subtraction
- Pascal received for his invention a royal privilege: he was granted the exclusive right to produce these calculators. – He made some 50 of them during 10 years.

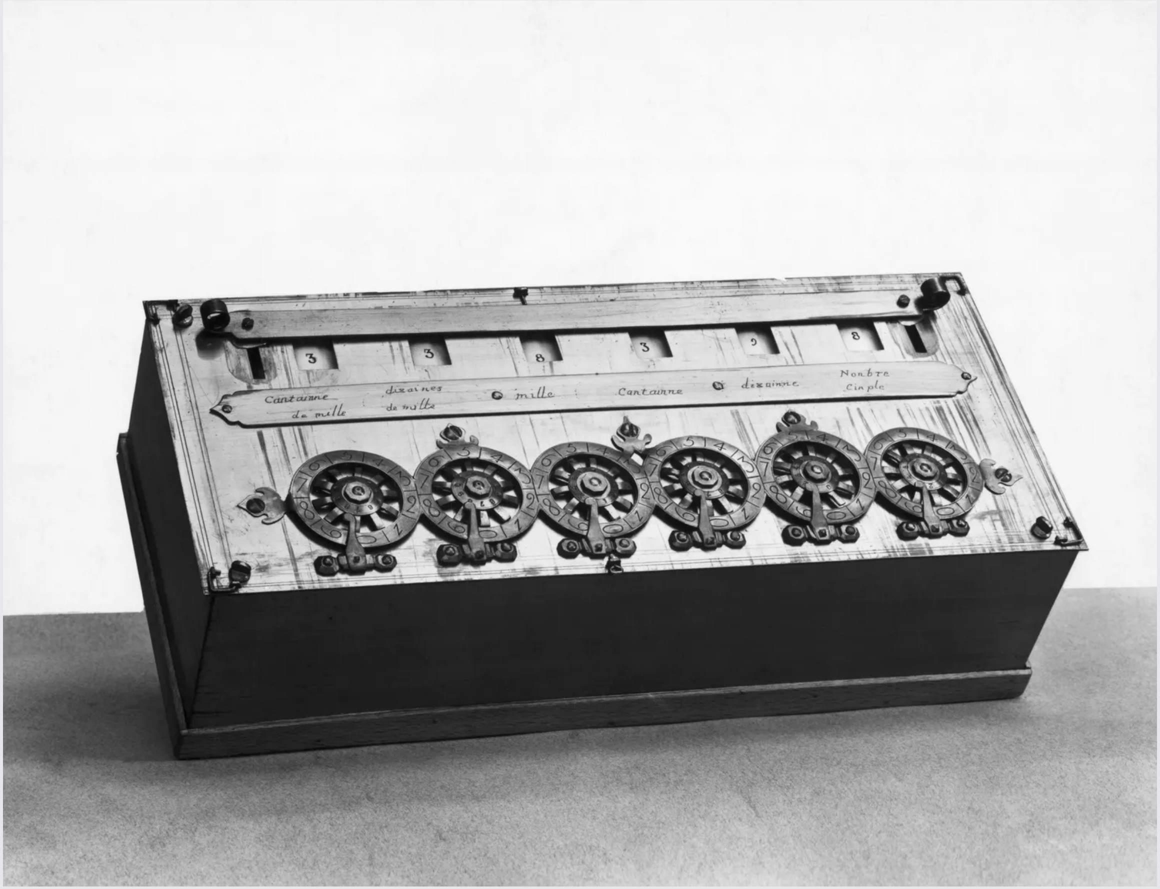

Figure 5.8 Blaise Pascal: Pascaline

Gottfried-Wilhelm-Leibniz

- Born 1646, died 1716
- German mathematician
- Inventor of the foundation for differential and integral calculations
- Advocate of the binary system
- Inventing the **Leibniz wheel**, the stepped reckoner
- He designed the first mechanical calculator being able to perform addition and subtraction, multiplication, division
- Early models in wood and metal are not preserved
  Only one of the later prototypes has survived and is in the National Library of Saxony

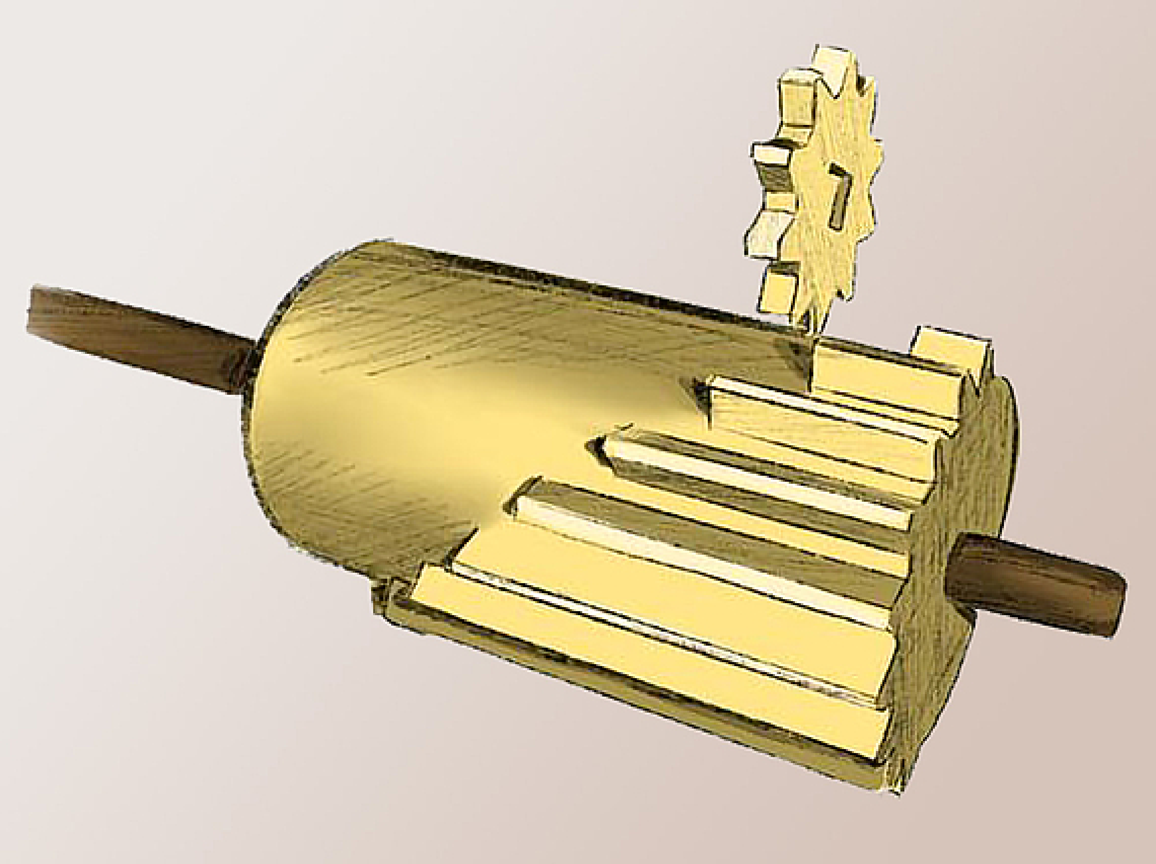

Figure 5.9 Gottfried-Wilhelm Leibniz wheel

Figure 5.10 Gotfried Wilhelm Leibniz calculator

Charles Xavier Thomas de Colmar

- Born 1785, died 1870
- French mathematician
- In 1820 he built the first mechanical calculator which could perform next to addition and subtraction also multiplication and division: the **Arithometer**
- First calculator becoming a commercial success, wide spread use and still being used up to the Word War I

Figure 5.11 Charles Xavier de Comar Arithometer

Comptometer

- **Comptometer** is a trade name of the Felt and Tarrant Manufacturing Company of Chicago. However this name is used as a generic name for various manufacturers
- The **Comptometer** is a machine allowing to enter numbers and doing calculations by pressing keys only
- Models can be mechanical or electro-mechanical
- The design is such that one can press multiple number keys simultaneously, enhancing herewith speed
- Such machines where widely in use and operated into the 1990s, but are replaced nowa-days completely by software driven machines

Figure 5.12 Comptometer

Figure 5.13 Comptometer

Curta

- Curt Herzstark, born 1902, died 1988
- His father was Jewish, his mother Austrian
- Based in Vienna, his father operated a firm. They had specialized in calculation machines
- From 1930 Curt Herzstark was director of this company
- His first invention was a mechanical memory for vertical totaling on multi-column calculation sheets
- At the beginning of the II. world war the company was forced to leave their original business and start to produce gauges for the German army
- Until 1943 Curt Herzstark was able to escape arrest. However then he was taken and sent to the concentration camp Buchenwald
- Thanks to people of the german camp management, who knew him from his company, he got a position as efficiency monitor at the Gustloff-Werk II
  The camp management allowed him to work on his calculator project on Sundays and other free time, enabling him to prepare construction drawings
- After the factory was bombed by the Americans he was given a job in underground weaponry production (Kohnstein?) which probably saved his live. However after a certain time he had to walk back to Buchenwald. Finally after the liberation of the camp by the American army, he could move forward

- He visited old relations from before the war in Weimar. He was brought into contact with Rheinmetall-Werke. Also there he met people whom he knew from before the war. Rheinmetall offered him a job and helped him to build three **Curta's** as preproduction models
- He had to flee from Weimar because he was afraid of the Russians who might have captured him and brought to Russia. Again with help of old relations he was able to reach at last Vienna
- He found the family factory from before the war existent, but the state was such, that he concluded that it would be too difficult to get it up to date again. – He decided to emigrate
- He was offered a possibility to establish business in Lichtenstein
- Bad enough it appeared that after the first startup, the firm called Contina had to be refinanced
- This resulted in the loss of promised money to Curt Herzstark for the **Curta**
- . The lucky thing in this situation (1950) was, that the management had overseen, that all the patents were still on Herzstark's name
- After time the patents were transferred to Contina (1952), which finally restored the originally promised money.
- The production of the Curta started in 1949. After settling the issues concerning the patents Curt Herzstark left Contina.
-

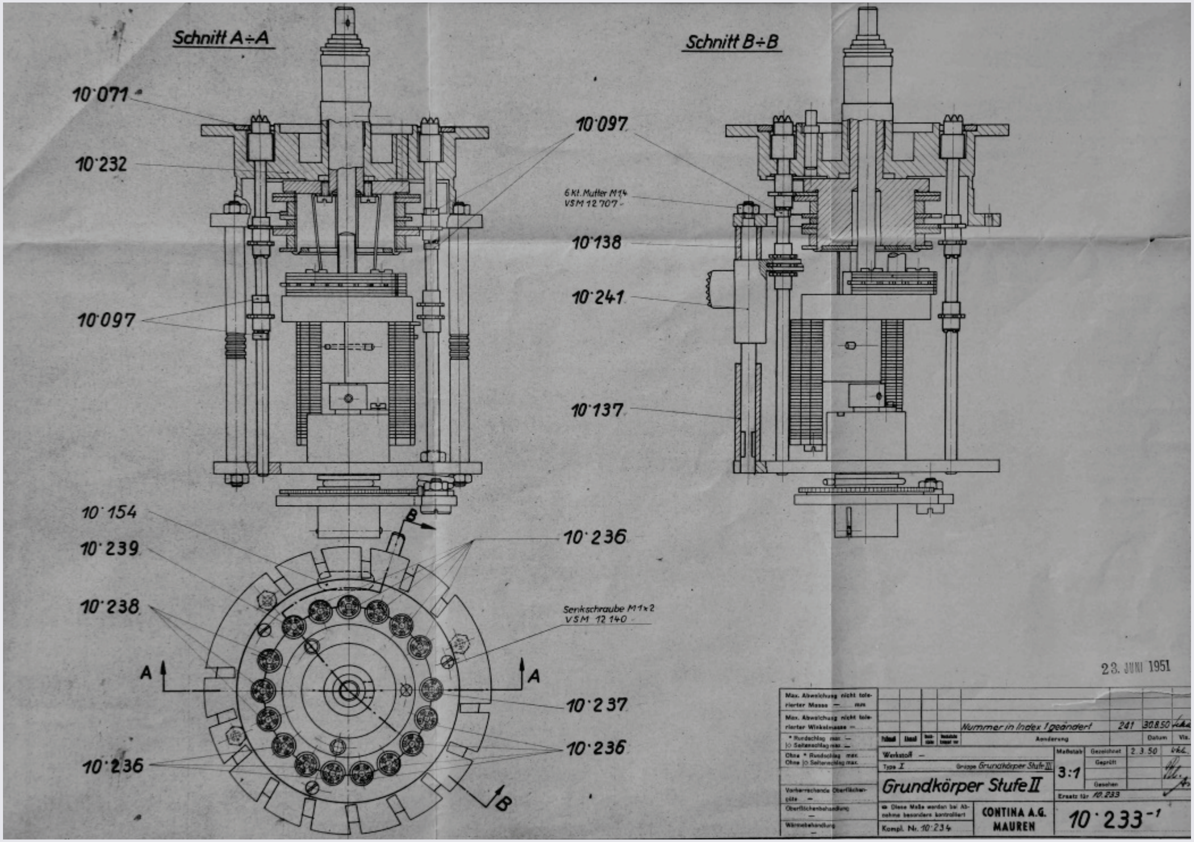

Figure 5.14 Drawing of the Curta

Patent	Filing date	Publish date	Name	Description
DE 747,073	19-08-1938	27-01-1944	Curt Herzstark	Prototype of Curta

DE 747,074	13-04-1939	27-01-1944	Curt Herzstark	Prototype of Curta
US 2,525,352	09 Jan 1948	10 Oct 1950	Curt Herzstark	Curta
US 2,533,372	20 Jan 1949	12 Dec 1950	Curt Herzstark	Zeroizing mechanism
US RE 23,553	20 Jan 1949	30 Sep 1952	Curt Herzstark	Zeroizing mechanism (Reissue of previous patent with additional claims)
US 2,566,835	27 Apr 1950	04 Sep 1951	Curt Herzstark	Locking mechanism (locks crank when lifting top for clearing ring)
US 2,588,835	27 Oct 1949	11 Mar 1952	Curt Herzstark	Independent actuator tens-transfer mechanism
US 2,661,155	22 Mar 1952	01 Dec 1953	Franz Mark	Accumulator-carriage and drive-shaft interlock for miniature-type calculating machines
AT 195,147	15-12-1954	25-01-1958	Curt Herzstark	Dual Curta

- Contina kept going on with the production of the **Curta**, but they did not update it at all. Further the company still was directed by the governmental office of administration, where they still had not developed any sense for marketing. As a consequence of this the sales in total of the **Curta** was only something between 140 and 160'000 since 1949.

Figure 5.15 Curta by Curt Herzstark

Furthermore they miscalculated their possibilities when diverting into all kind of other productions e.g. a film-camera

- In 1966 the company was sold to HILTI. This company kept the production of the **Curta** up until 1972. At that moment, there were electronic calculators taking over the market and that meant the end of the mechanical calculators including the **Curta**

Other developments

- Cam meter / cam gauge
  A tool for measuring distances on maps
- Multiplication tables
  Aid for learning multiplication
- Distance charts
  A map of a country where one can choose a town as starting point
  The distances to all other towns is shown next to the town name

Figure 6.1 Cam meter

Figure 6.2 Kids training multiplication

Modern Times Tools

Figure 7.1 HP55

Thank you for your attention

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https://www.britannica.com/biography/Blaise-Pascal
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