Date: 27 March, 2023
Course: Machine Lab
By: Nouf Alabbasi

Ismail Al Jazari

Al-Jazari's full name is adi Al-Zaman AbulI-Izz Ibn Ismail Ibn Al-Razzaz Al-Jazari. He is a scholar, inventor, mechanical engineer, artisan, artist, and mathematician. He was a mechanical engineer for Artuqid kings of Diyar-Bakir from 1174-1200 CE. He wrote a book called "the book of knowledge of ingenious mechanical devices" ("Kitab fi ma'rifat al-hiyal al-handasiya"). In the book, Aljazari describes 50 mechanical devices with details on how to create them. The book was presented to the Sultan, devised for both educational and entertainment purposes. In addition to useful machines, the book also contained practical joke machines like trick drinking vessels that appeared to contain water but could not be emptied. It is important to note that the book goes into extreme details describing the machines, what they do, and how to construct them and depicts those things with diagrams and drawings. Al Jazari divided the book into categories which include ("Clocks", "Vessels and figures suitable for drinking sessions", "Pitchers, basins and other things", "Fountains and perpetual flutes", "Machines for raising water" and "Miscellaneous") these categories are divided into chapters, each chapter dedicated to a specific machine. Each of those chapters has many sections which could be roughly divided into those categories: "how the machine looks", "what it does", and "how it is constructed". He has laid the foundation for many elements that

One of the machines the book describes is the "Elephant water-clock" (which is one of Aljazari's most famous inventions). The clock consists of an elephant and a mahout with an axe and a mallet in either hand. There is also a decorated dais on the elephant's back. On top of that structure, there is a man sitting with each hand on the beaks of a falcon. Behind the man is a semi-circle with 15 holes. These are covered with rings from inside the structure and show the number of hours since sunrise. Two dragon-like creatures are hanging from a pole on the structure. There is also a bird on the roof of the structure. Sitting in the structure is a man with a pen and an arc of a circle divided into 7 ½ degrees (which I believe based on the later description are half-an-hour intervals).

The clock does not only isn't only visually interesting, it also has some interesting functionalities. Every half an hour(7 ½ degrees) the bird on top of the structure on the elephant whistles and rotates, and half of the holes at the top turn white. The man sitting in the structure removes his right hand off the beak of one falcon and places his left hand on the beak of the other falcon. A ball falls from the beak of the right falcon and into the mouth of one of the dragon-like creatures. The weight tilts the creature down and the creature drops the ball into a vase on the elephant then rises back up. The mahout strikes the head of the elephant with the mallet and axe, then the ball falls through the elephant's chest onto a cymbal which results in sound. The man with a pen inscribes on the arch and so on. The process continues until the day is over.

Al Jazari divides the construction of the clock into those into many sections (each is described in a section in ch4. A list of the sections is attached in the appendix).

The Elephant Water Clock is a more elaborate machine with many elements but the part that makes it a water clock is the mechanism inside the elephant. There is a pool of water inside the elephant with a basket that has a hole in it. The basket is tied to a string connected to other elements and slowly sinks and after half an hour it would completely sunk and it would trigger various actions starting with the ball being released from inside the roof of the structure on the elephant, dropping out of the mouth of the falcon and into the mouth of the dragon-like creature.

Appendix:

The Elephant Water Clock

Sections describing the construction of the Elephant water clock:

- Construction of the elephant and the dais
- On what is fitted inside the elephant, and its method of operation
- On the construction of the dome above the floor of the dais, the platform above the dome, the scribe above the platform and his movement
- On the construction of the mahout and that which moves his hands
- On the construction of the four pillars
- On the construction of the castle
- On the construction of the channel in which the balls move
- Construction of the trough into which the balls fall
- Construction of the ring, which is half white and half black, and which covers the apertures; construction of its movement; construction of the wheel upon which the bird on the castle's dome rotates; completion of the channel for the balls
- Construction of the balcony and the man sitting thereon
- Construction of the two serpents upon an axle
- Construction of the instrument that whistles

- On the construction of the two vases on the shoulders of the elephant, the hanging cymbal, and the preparation of the water-clock

Work cited

Ahmed, waqas. “Ismail Al-Jazari: The Muslim Inventor Who May Have Inspired Leonardo Da Vinci.” *Europeana*, https://www.europeana.eu/en/blog/ismail-al-jazari-the-muslim-inventor-who-may-have-inspired-leonardo-da-vinci.

Al-Hassani, Salim. “Al-Jazari: The Mechanical Genius.” *Muslim Heritage*, 12 Feb. 2020, https://muslimheritage.com/al-jazari-the-mechanical-genius/.

Al-Hassani, Salim. “Al-Jazari's Third Water-Raising Device: Analysis of Its Mathematical and Mechanical Principles.” *Muslim Heritage*, 29 Dec. 2020, https://muslimheritage.com/al-jazaris-third-water-raising-device-analysis-of-its-mathematical-and-mechanical-principles/.

Elices, Jorge. “Ismail Al-Jazari, the Muslim Inventor Whom Some Call the 'Father of Robotics'.” *History*, National Geographic, 26 Jan. 2022, https://www.nationalgeographic.com/history/history-magazine/article/ismail-al-jazari-muslim-inventor-called-father-robotics.

UZUN, Abdullah, and Fahr VATANSEVER. “ISMAIL AL JAZARI MACHINES AND NEW TECHNOLOGIES.” *Acta Mechanica Et Automatica*, vol. 3, no. 2, 2008.

Z., AL-JAZARA IBN AL-RAZZA. *Book of Knowledge of Ingenious Mechanical Devices*. SPRINGER, 1973.

אבי ,גולן. “The Basin of the Peacock and the Magic of Automata.” *The Book of Knowledge of Ingenious Mechanical Devices*, 30 July 2019, https://aljazaribook.com/en/2019/07/30/the-basin-of-the-peacock_en/.