

Rediscovering the Waterwheel


“Noria Al-Muhammadiyya”

ASME International Historic Landmark

by

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ASME Landmarks

- ASME History and Heritage
- Program began in 1971
- Landmarks, sites, and collections
- 238+ landmarks designated
- Vast majority in the US

International ASME Landmarks

- **11 Countries**
- **Austria, Australia, Canada, China, France, Germany, The Netherlands, Japan, Sweden, Switzerland, United Kingdom**
- **And now....(after 5 years)... #12 Syria**

Waterwheels

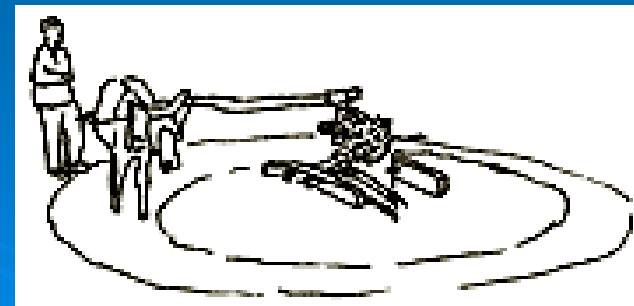
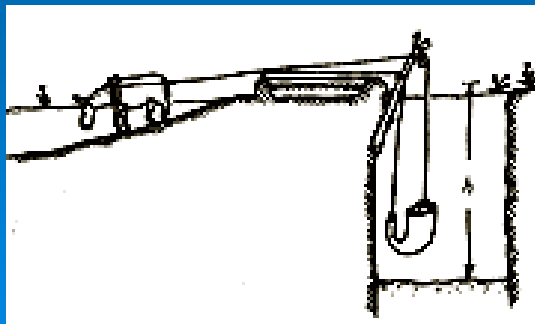
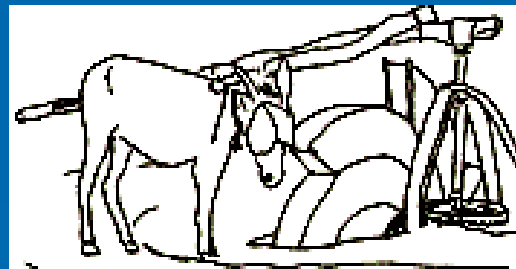
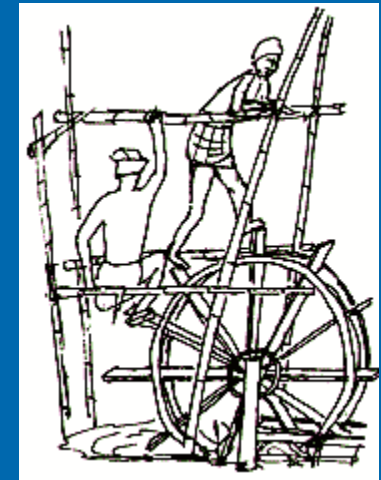
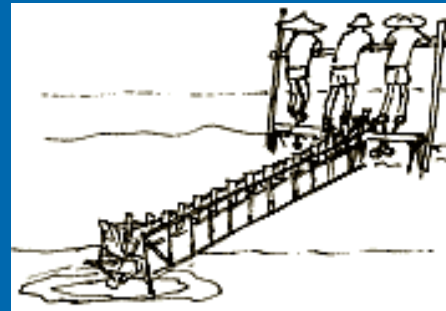
Webster's:

- 1: a wheel made to rotate by direct action of water
- 2: a wheel for raising water



Waterwheels

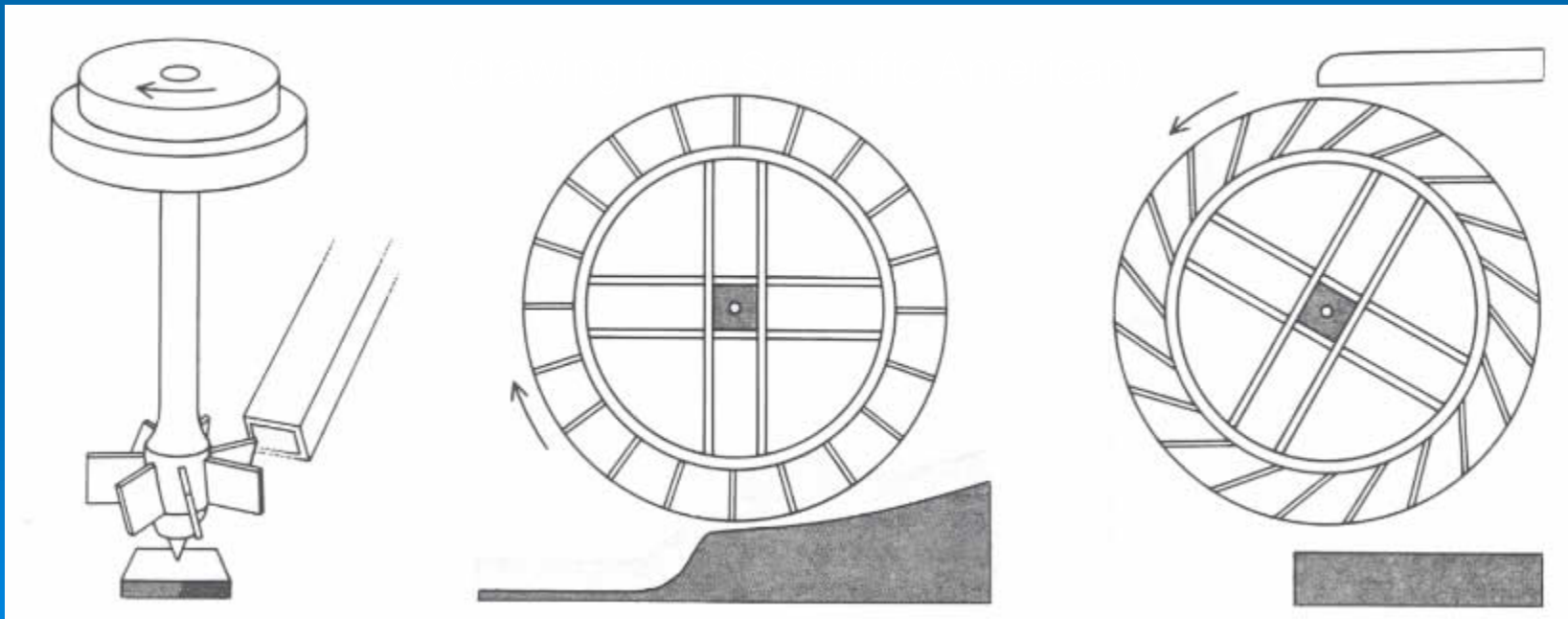
- Human-driven
- Animal-driven
- **Water-driven**



Water-driven waterwheels

- Horizontal (Norse wheels)
- Vertical (undershot, overshot)

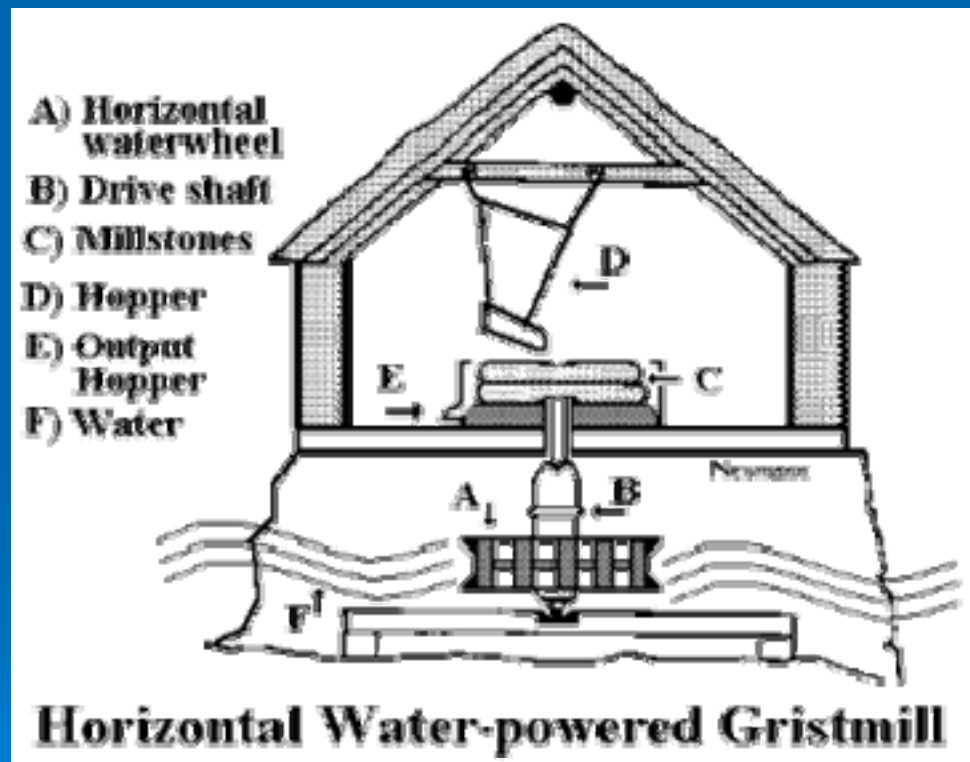
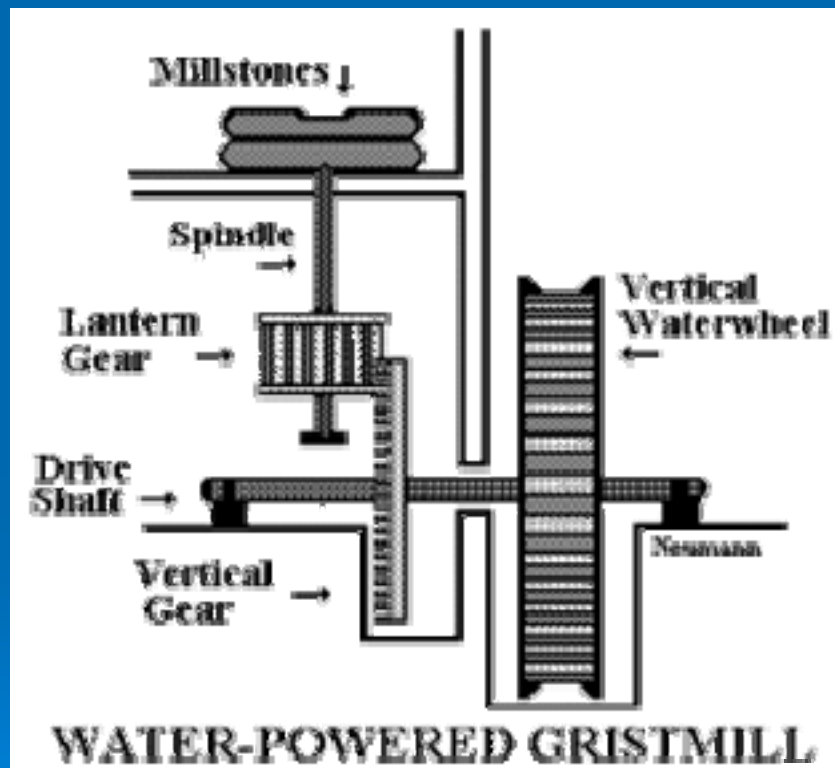
(drawing from Scientific American)



History

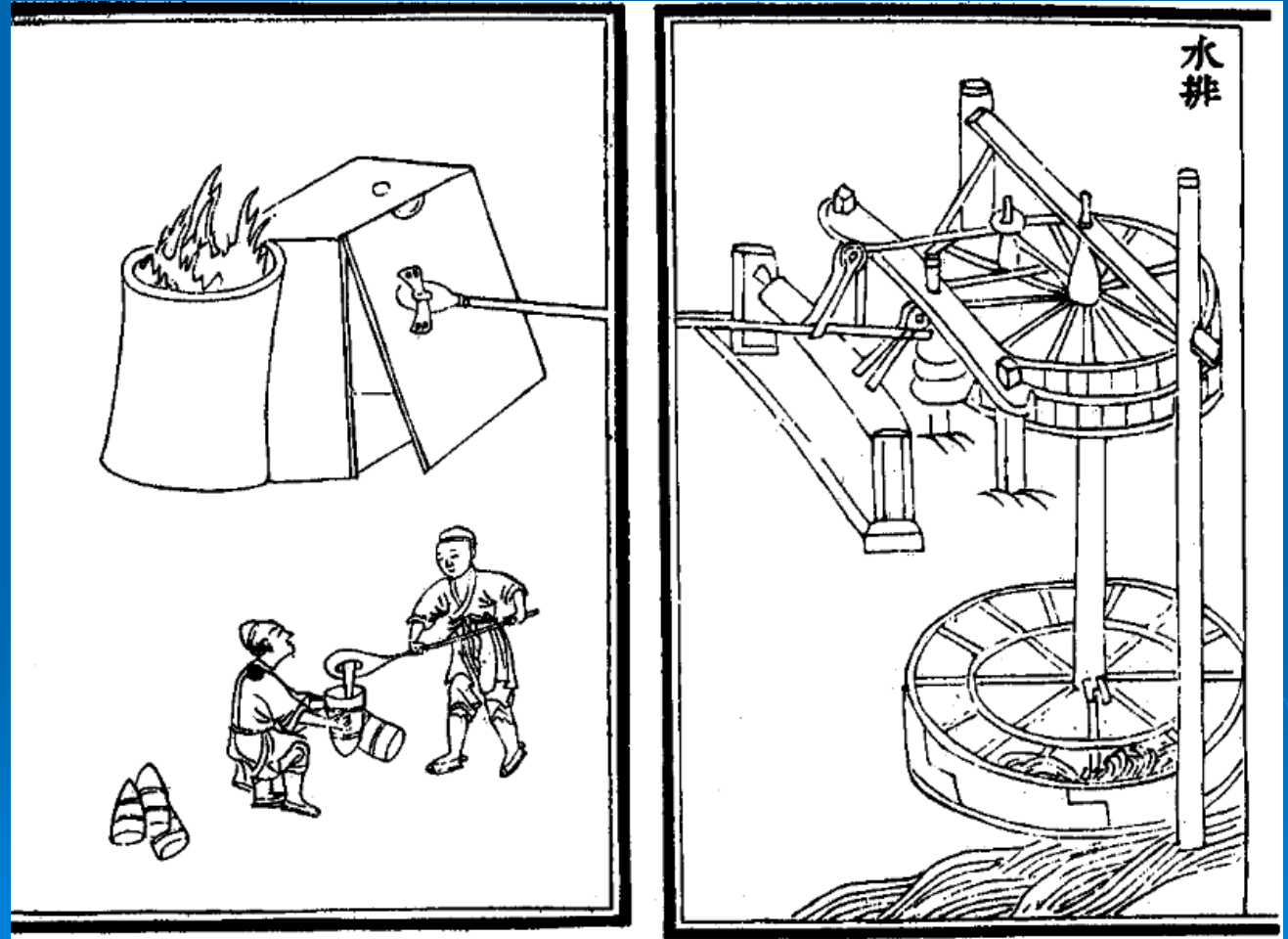
- Originated in the east of the Mediterranean where the fast-running River Orontes flows. (circa 400 BCE)
- The horizontal wheel dates to about 200 BCE.
- The Romans took this invention to Europe in the first century BCE. (Vitruvius, 27 BCE)
- In 1085 CE, **5,624** wheels were in use in England south of the River Trent. (Domesday Book)
- London pumped its water supply from the river using water wheels until as recently as 1822.
- In the U.S. as late as 1870, water wheels and water turbines provided more power to factories than did steam engines.

Gristmill



Chinese Bellows

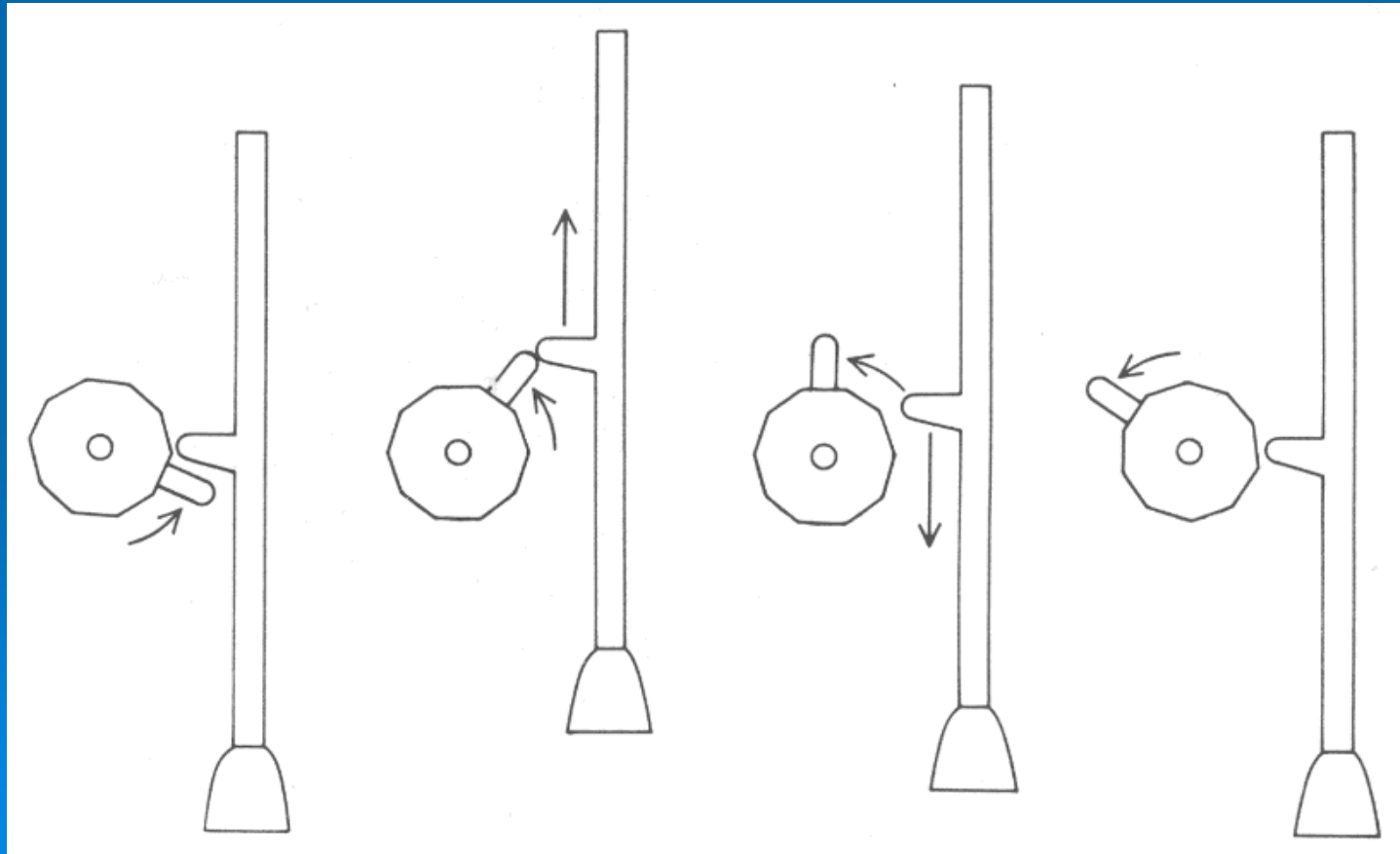
- Metallurgical bellows, powered by a horizontal waterwheel, from the Chinese work of 1313 AD



Metal working

- Transformation of rotary motion into linear motion can be achieved by having a cam on the axle of the wheel.

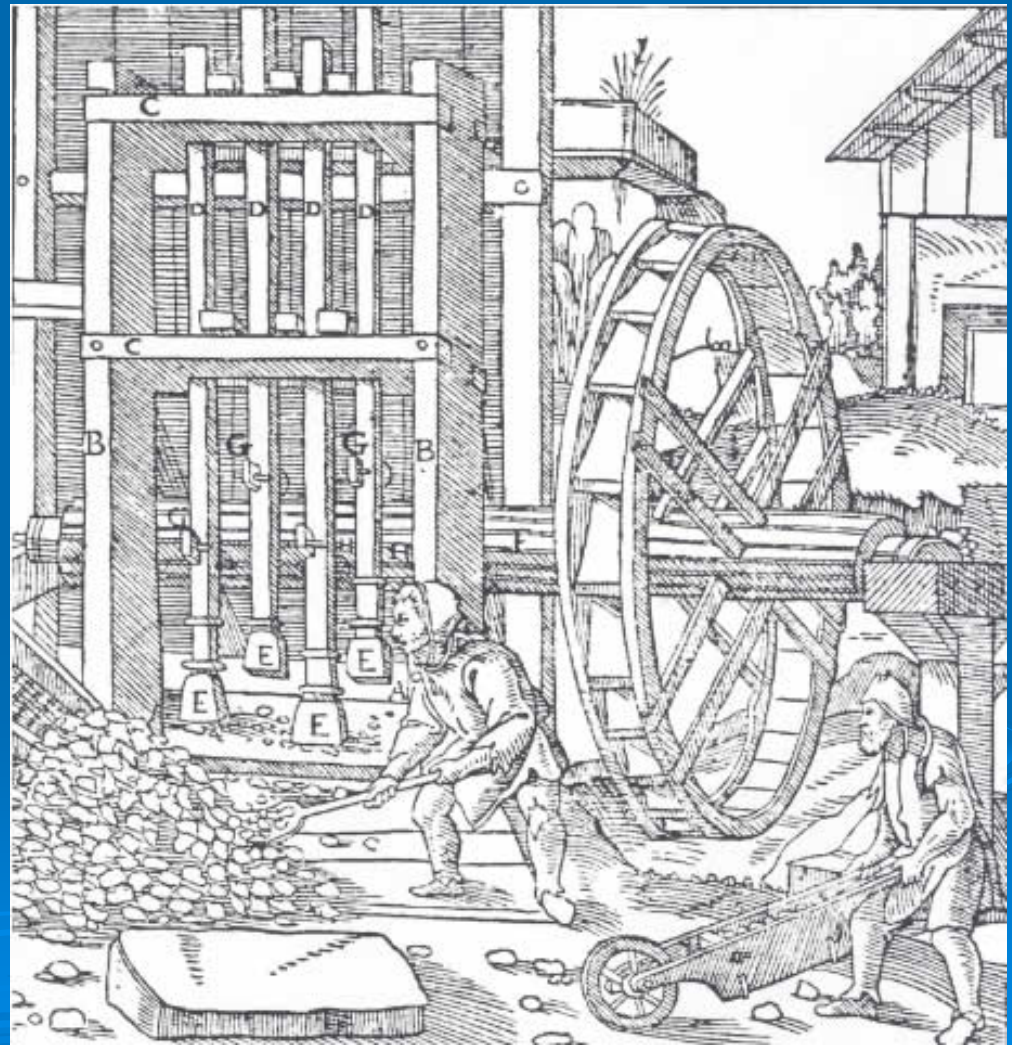
(drawing from Scientific American)



Rock crushing

- The cam principle applied in a rock-crushing mill

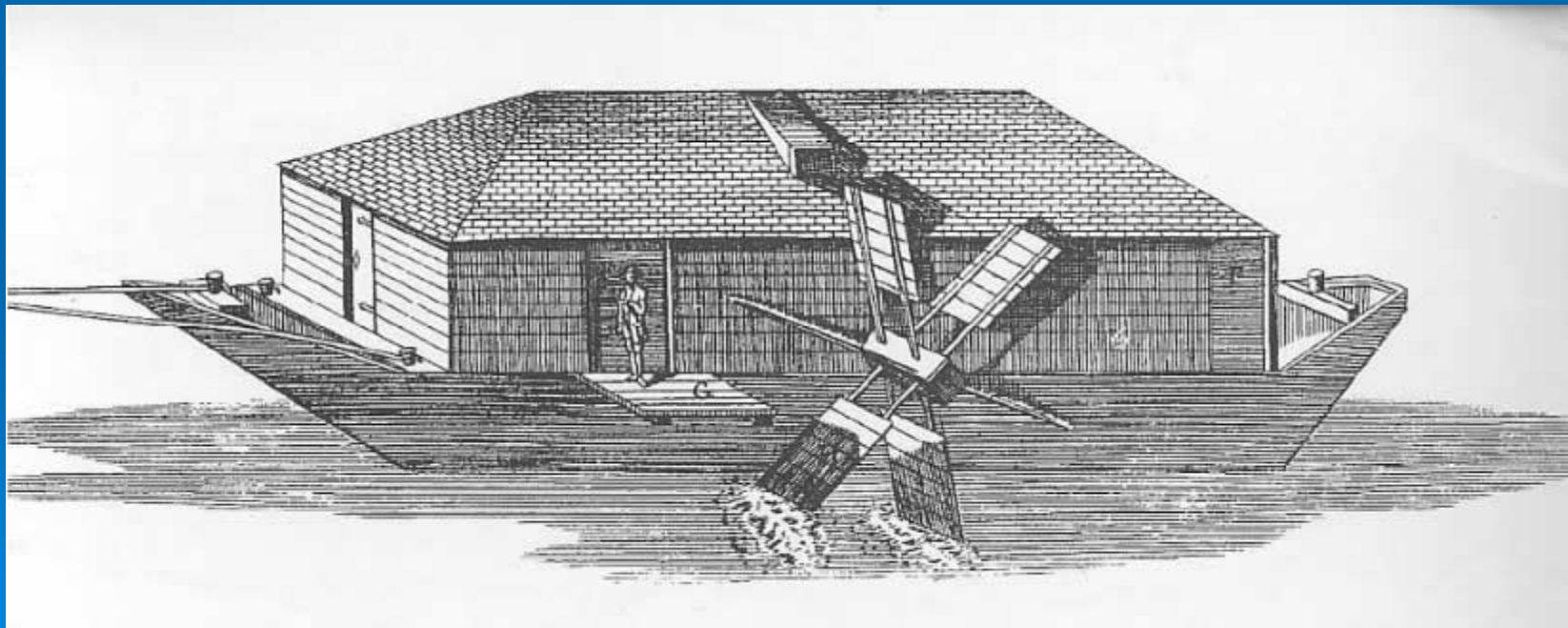
Georgius Agricola's *De Re Metallica* (1556).



Ship mill

- Independence from water height

Georgius Agricola's *De Re Metallica* (1556).

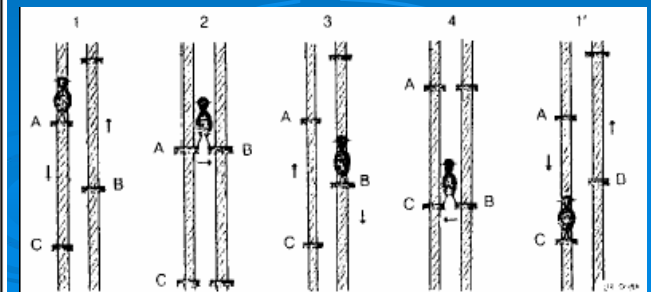
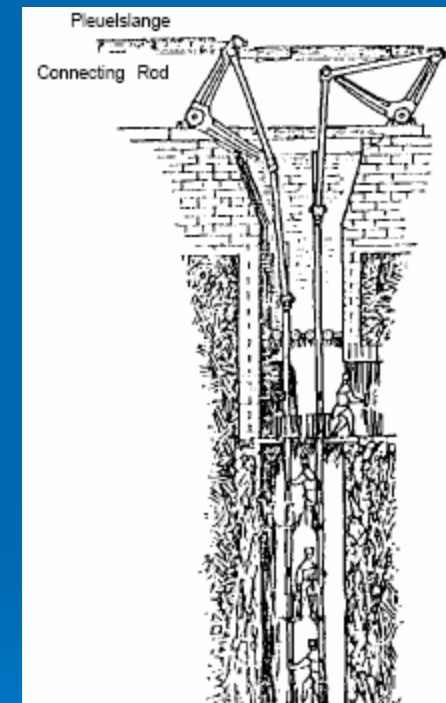
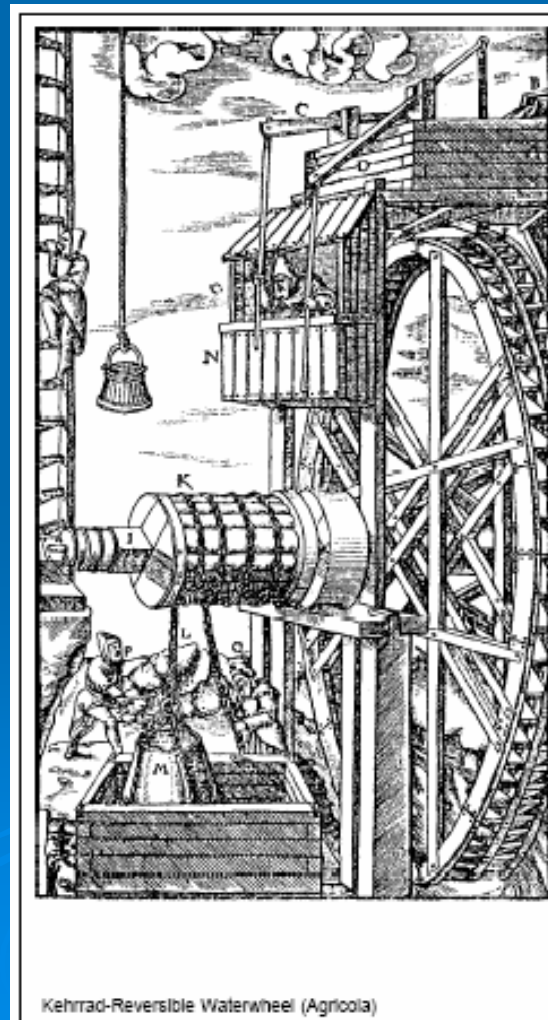
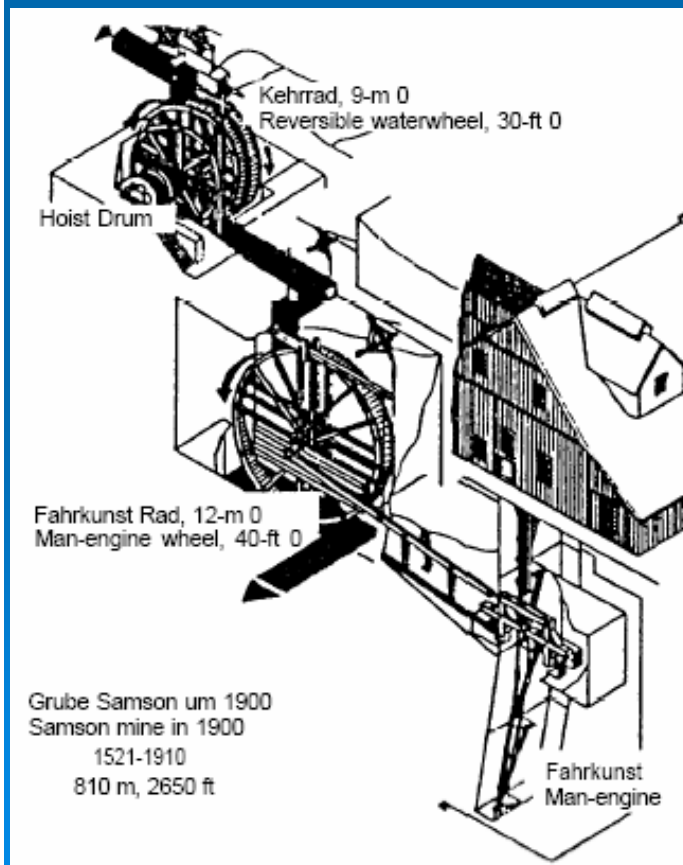


Mining: Ore / Man-Lifting

GRUBE SAMSON SILVER MINE REVERSIBLE WATERWHEEL AND MAN-ENGINE (1521-1910)

(International Historic ASME Landmark, Germany, 1987)

Reversible: Full container raised while empty one is descended

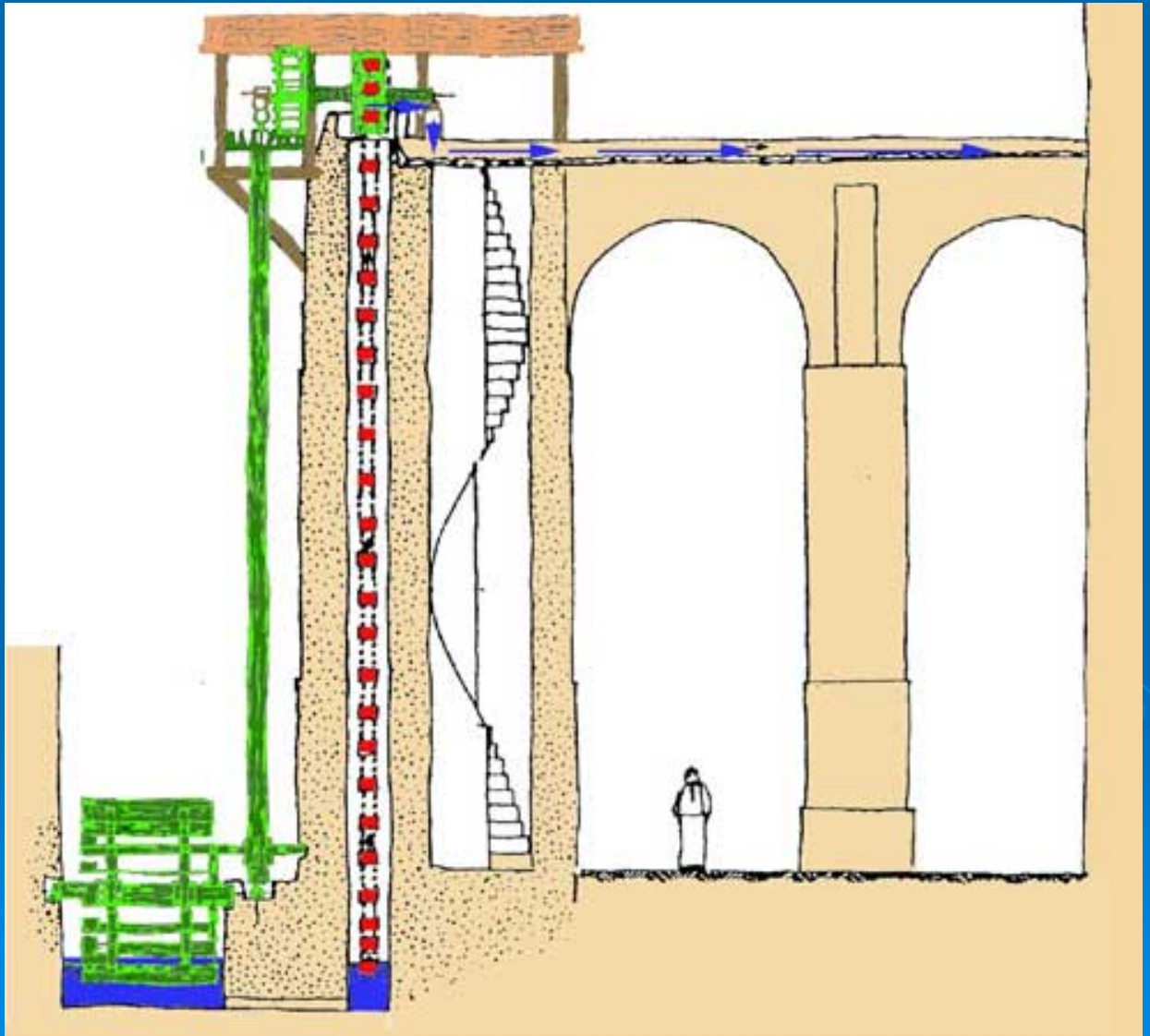


Waterwheel-powered water-lifting

- The river is directed to a waterwheel => right angle gear => fifteen-meter vertical shaft transmits the power to the top.
- Pot garland wheel: From the pots, the water is conducted along an aqueduct to a mosque.

Damascus, Syria

(Schiöler- Experimentarium)



Water lifting

- **Hydraulic waterwheel**
- **Water pump**
- **Noria**



Noria vs. waterwheel

- **All norias are waterwheels but not all water wheels are norias.**
- **A waterwheel typically drives something else (e.g. a grindstone, machinery etc.)**
A noria is a stand-alone pump that raises water from a river and discharges it at a higher elevation.

Noria

- An English word that finds its origin in the Arabic word “naurah” - used in Syria for bucket-type waterwheels.
- Literally means “**the wailer.**” The name refers to the wailing sound made during operation that is created by its wooden bearings.
- The sound is a mixture of noise and true musical notes that is often compared to organ music. The deepest notes are in the range of 120 - 170 Hz, or nearly two octaves below concert pitch.
- Used by some Spanish-speakers.

The wailer



Egypt



Morocco



Thailand



Denmark



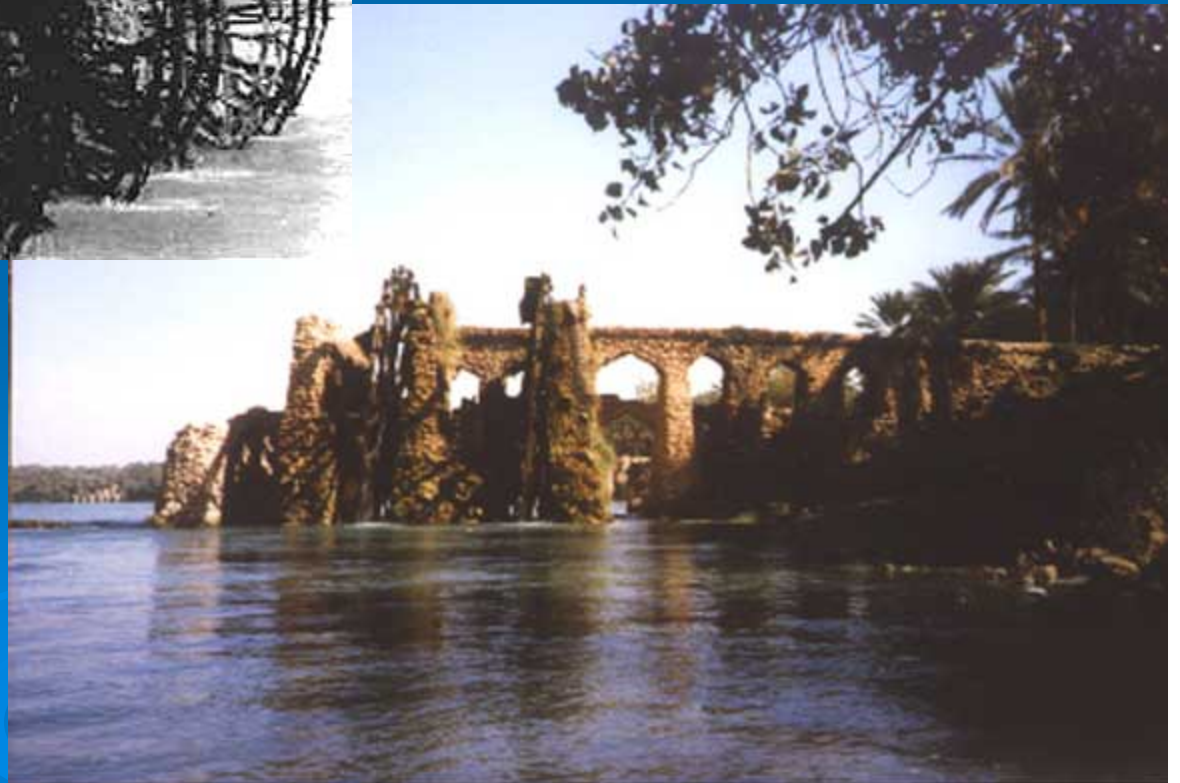
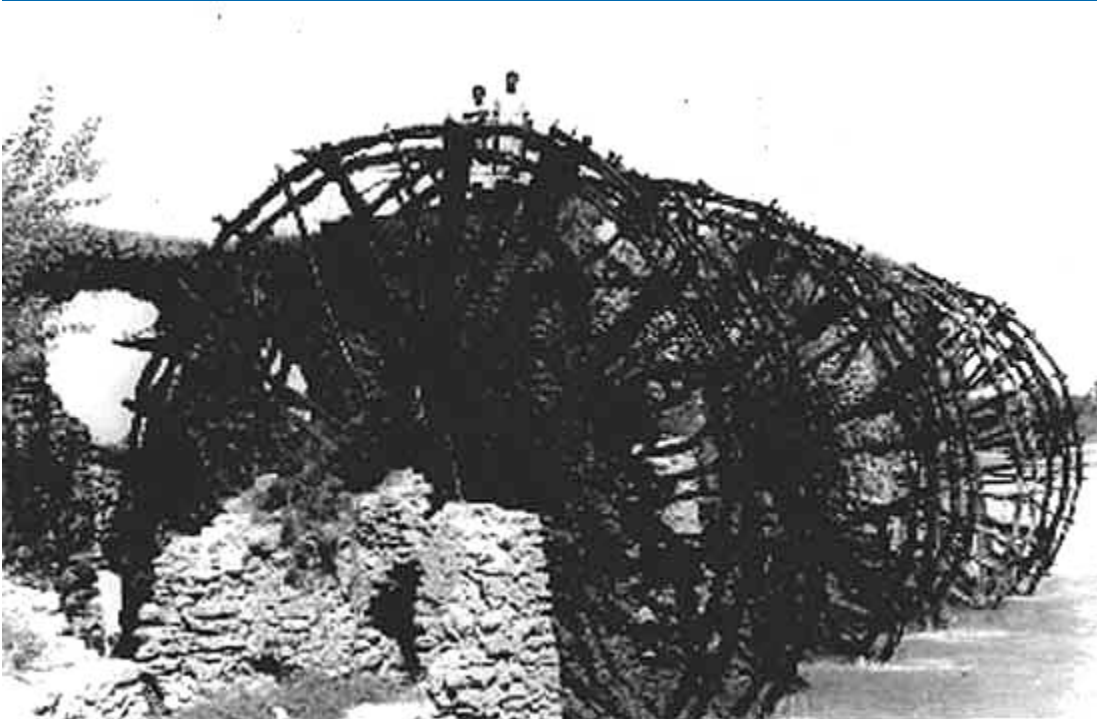
Spain (Cordoba)



Romania

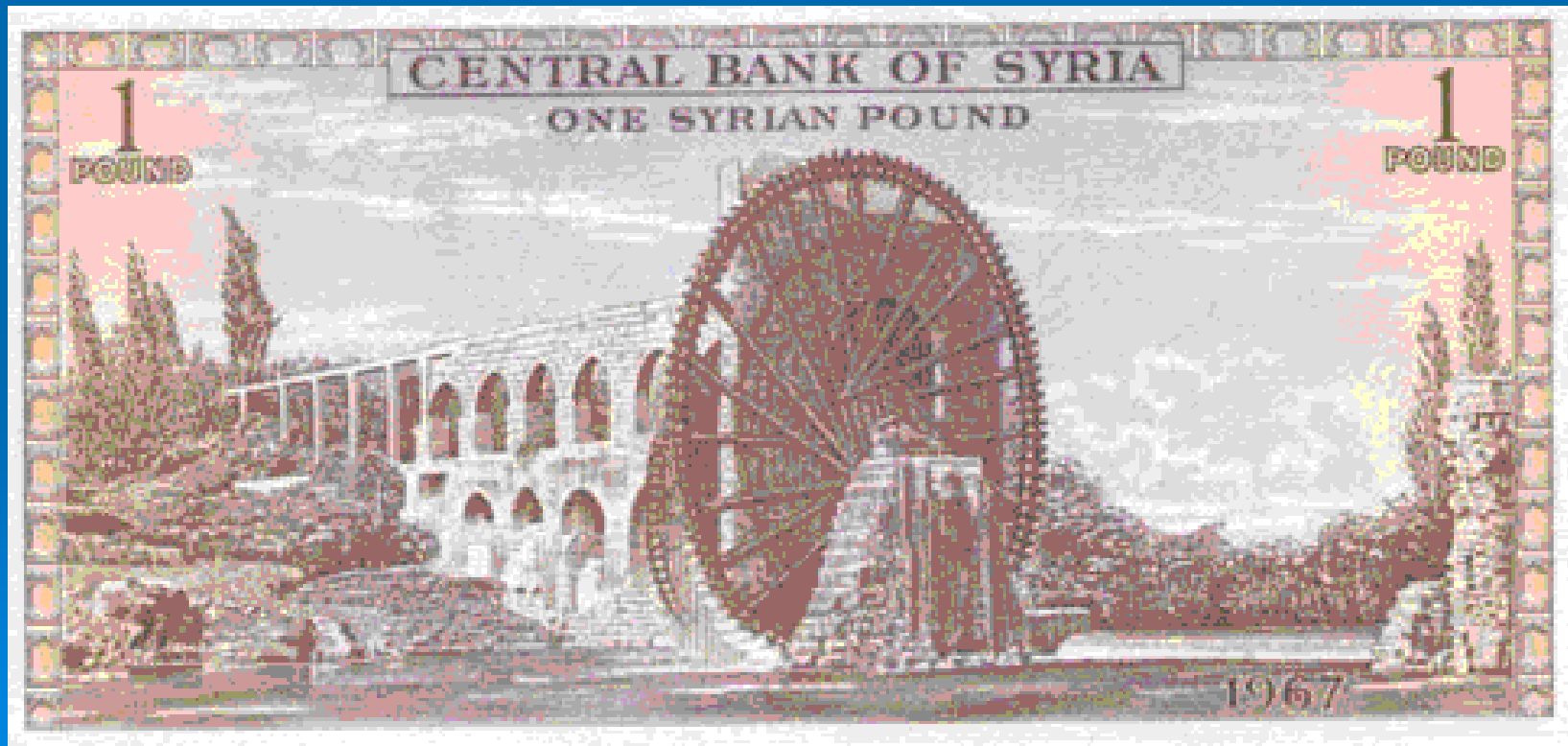


Iraq



Syria

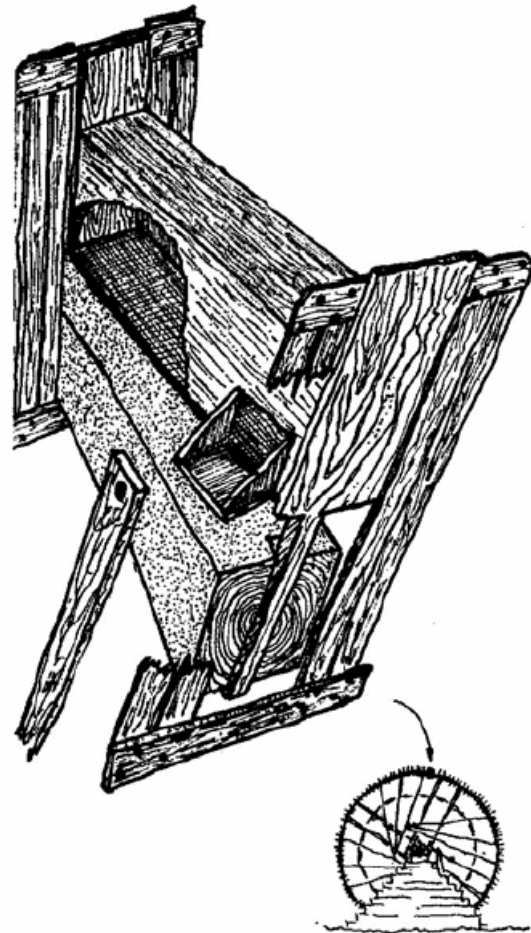
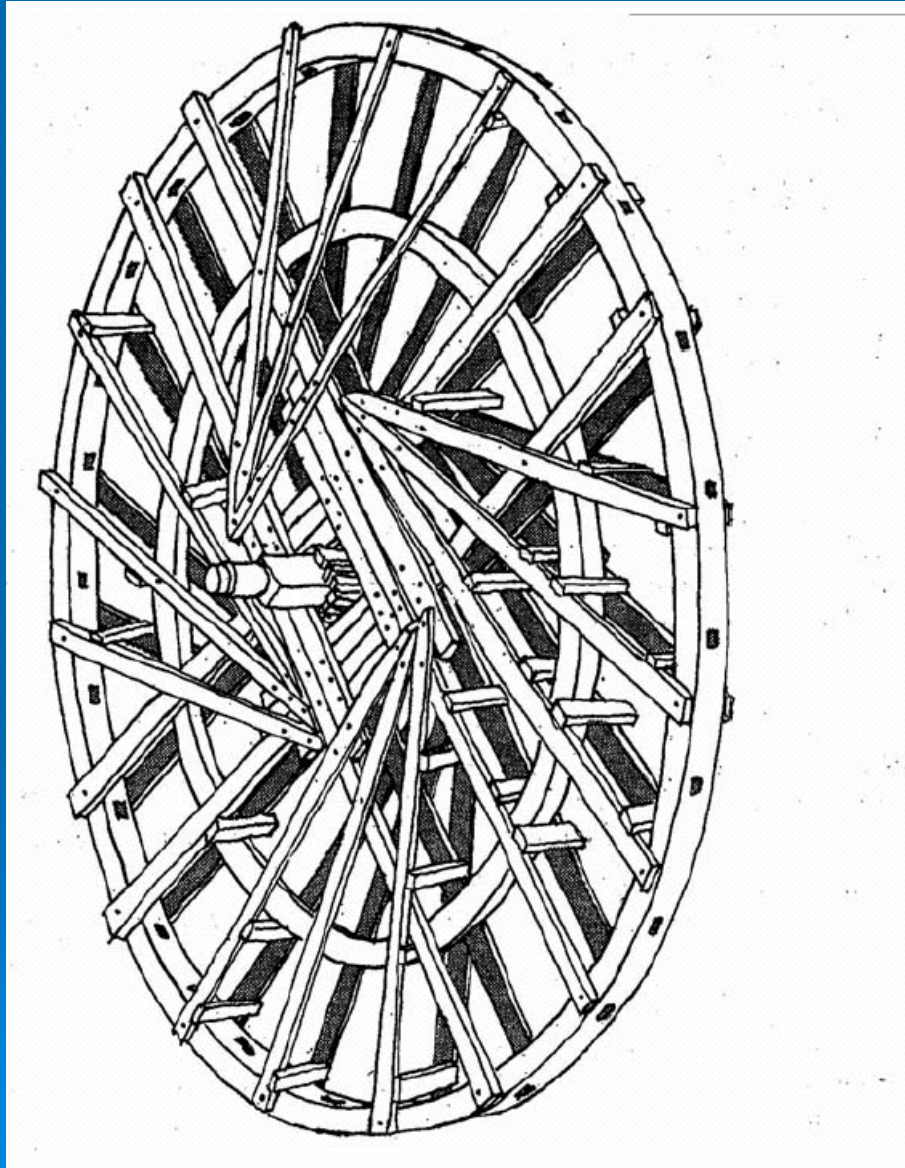
- Likely birthplace of Norias
- Fertile Crescent
- River Orontes



Hama – The City of Norias

- Of the tens of thousands of waterwheels that were built around the world, very few have survived.
- In the city of Hama, seventeen large noria sets continue to operate on the River Orontes as they have for many centuries.
- Often cited as major works of art and treasured remains of an ancient civilization
- These norias irrigate farmland as well as supply drinking water to communities lying next to the river.
- Now, mostly a tourist attraction.

Vertical Undershot Bucket-types



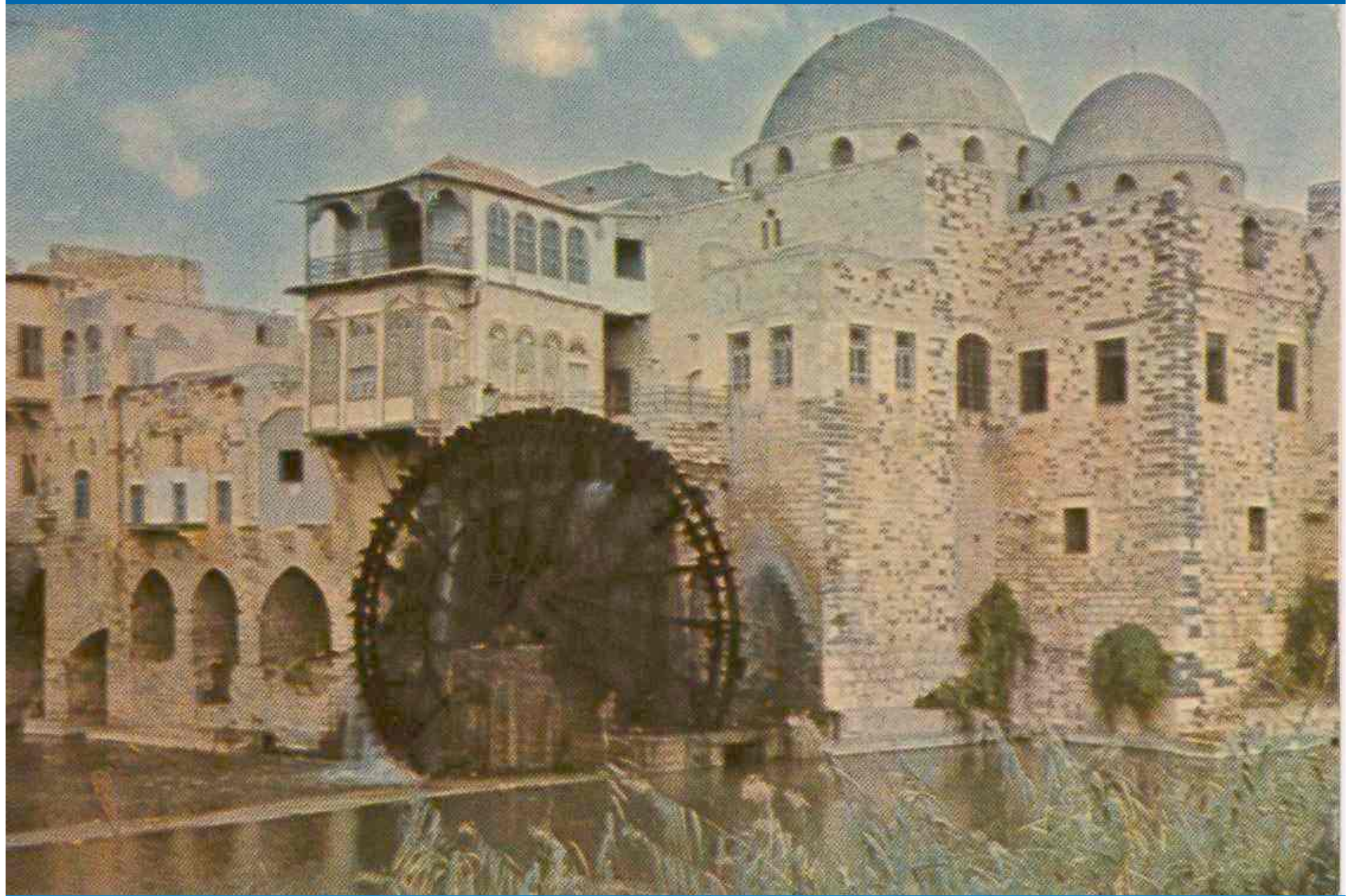


















The Noria Al-Muhammadiyah

- One of the largest ever constructed (65 feet in diameter)
- One of the oldest surviving with a confirmed date of construction (1361 AD)
- Schiöler- Experimentarium (typical):
 - Power: 1,000 Watts (1.34 hydraulic HP)
 - Efficiency: 0.3
 - Water flow: 0.004 m³/second (63 gallons/min)

“This large blessed noria was built in order to take water to the al-A’la mosque during the life of our Honored and Respected Lord, guarantor of the Hamath Kingdom in the year 763.” (1361 AD)

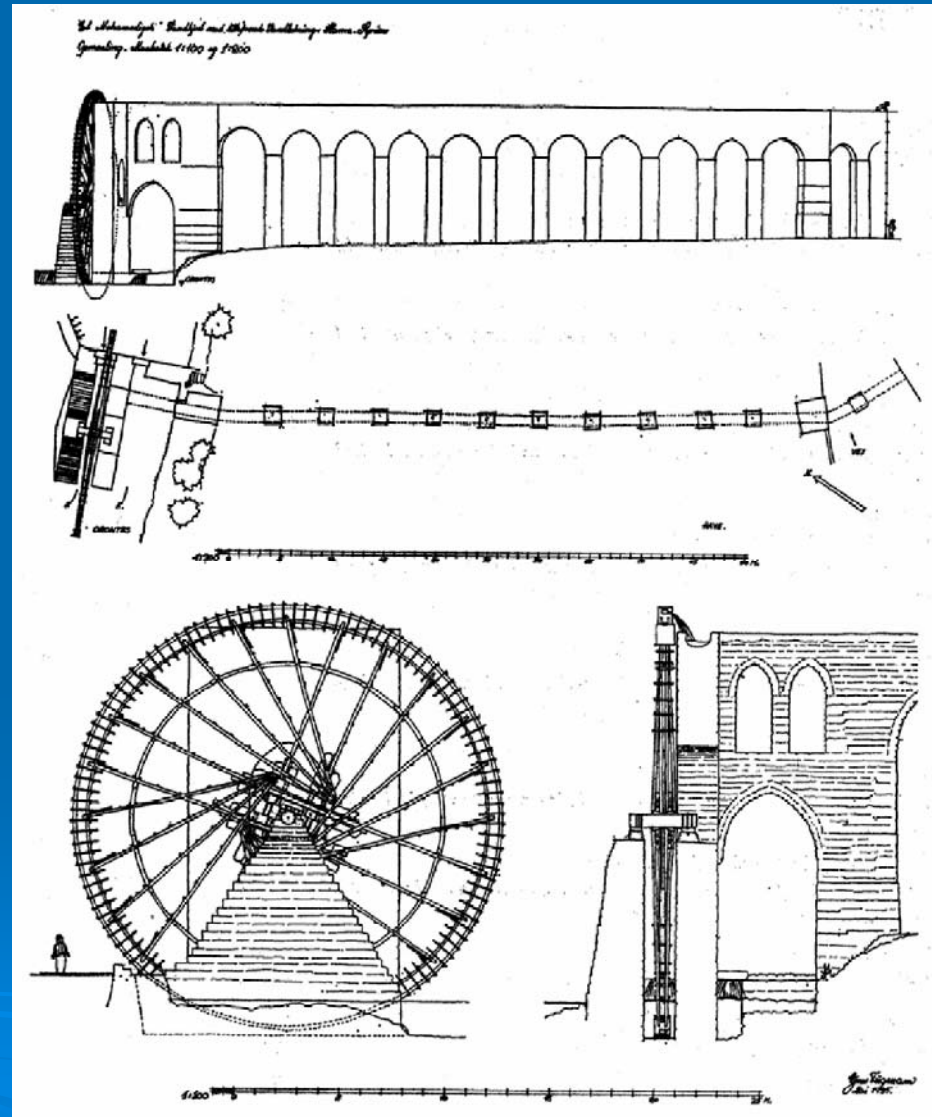
- *An inscription on the eastern face of the column of the thirteenth arcade of the Noria Al-Muhammadiyya.*
- *The founder was twice governor and representative of the Ottoman Empire in Hama until his death (1368-1371 AD).*
- *In addition to supplying the Grand Mosque, this noria provided water to a public bath, to the gardens around the mosque, and to the houses and the fountains of the same neighborhood.*



Drawing

The oldest available
to-scale drawing of
this water wheel
by the Danish
architect Einar
Fugmann in 1935

(Schioler, 1973)



Draft Plaque Wording

HISTORIC MECHANICAL ENGINEERING LANDMARK NORIA AL-MUHAMMADIYYA

763 AH (1361 CE)

FOR THOUSANDS OF YEARS PRIOR TO THE INDUSTRIAL REVOLUTION, THE WATER WHEEL WAS MANKIND'S ONLY MEANS OF HARVESTING AND UTILIZING LARGE QUANTITIES OF ENERGY. IMPORTANT IN THEIR OWN RIGHT, THESE ANCIENT DEVICES ALSO PAVED THE WAY FOR WATER MILLS, WINDMILLS, AND MODERN TURBINES.

THE GIANT WATER WHEELS THAT CONTINUE TO OPERATE ON THE RIVER ORONTES IN HAMA, SYRIA ARE UNIQUE IN BOTH SIZE AND AGE. THE NORIA AL-MUHAMMADIYYA DATES TO 763 AH (1361 CE). WITH A DIAMETER OF 21 METERS (69 FEET), IT IS AMONG THE LARGEST WATER WHEELS EVER CONSTRUCTED. ITS VERY EXISTENCE TODAY SERVES AS A LASTING TESTIMONY TO ENGINEERING INGENUITY IN THE ANCIENT MUSLIM WORLD AND TO THE CENTRAL ROLE OF TECHNOLOGY IN CREATING AND SUSTAINING SUCH SOPHISTICATED CIVILIZATIONS.



THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS - 2006