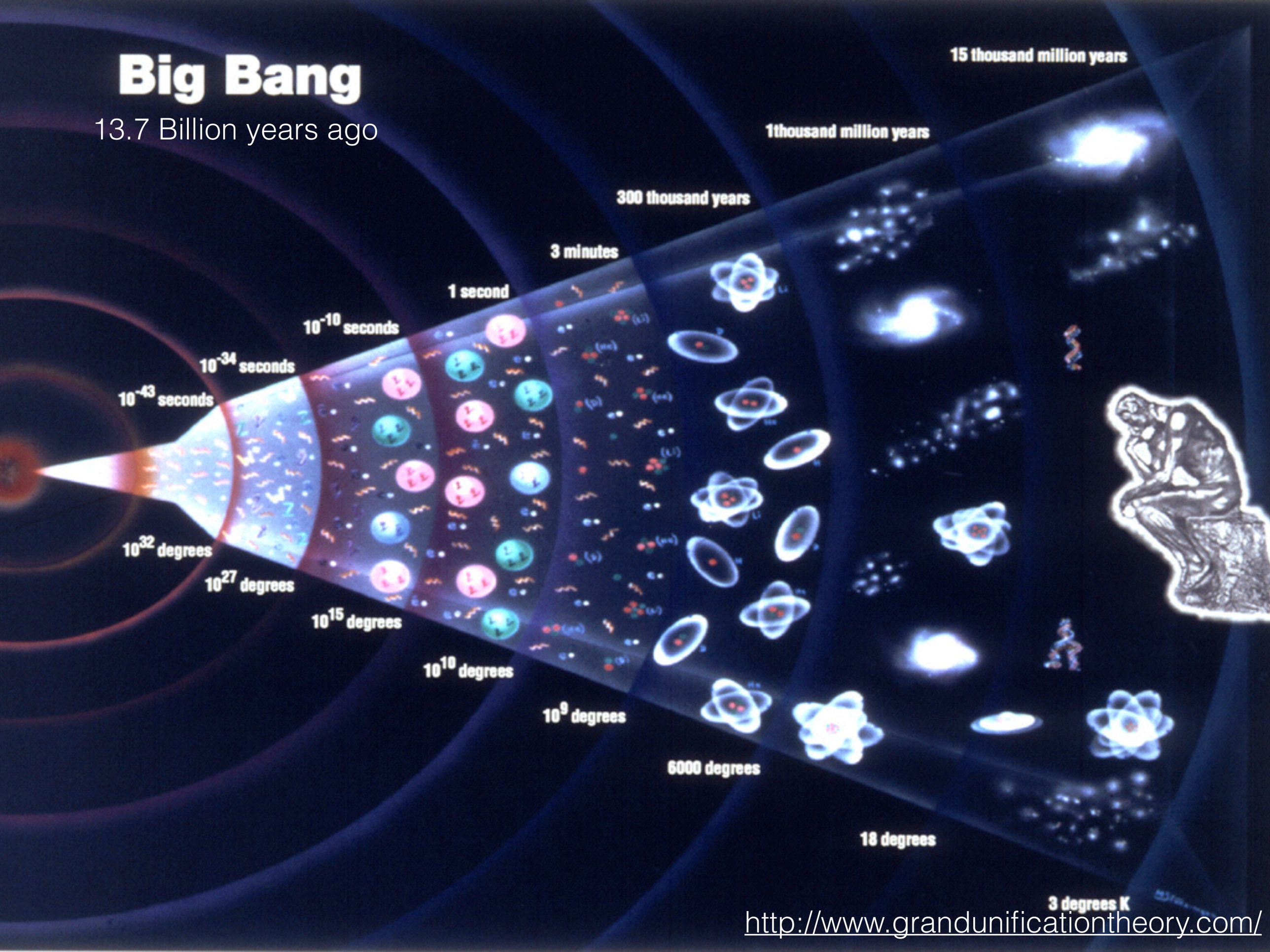
Manoj Bhargava

ITP/NYU/Feddersen

Big Bang

13.7 Billion years ago



http://www.grandunificationtheory.com/

‘Like seeing the face of God’
- Nobel physicist George Smoot

http://lambda.gsfc.nasa.go

http://www.universetoday.com

4.2 billion kg of matter to energy per second

e=mc^2

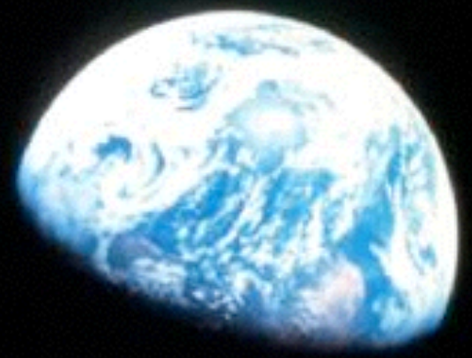
so

3.7 x 10^26 joules / second =

3.7 x 10^26 watts

NASA

4.6 billion years ago



NASA

3.4 billion years ago

http://
arch.ced.berkeley.edu

Organismen gestalten die Umwelt

Protozellen

Archaea

Biofilme

vor ca. 3,8 Mrd. Jahren

Motiloide (Proto-Eukarya)

vor ca. 2 Mrd. Jahren

Eukaryoten: Kerne, Fasern, Mitochondrien, Zillen

Endosymbiosen

Chloroplasten

Pflanzen

Protoctista

Pilze

Einzeller

Trichoplax

Vendozoen

Ctenophoren

Schwämme

Vögel

Säuger

Reptilien

Amphibien

Trogesystem

Fische

Beine

Placodermen

Schädel, Kiefer, Schuppengürtel

Conodonten

Schlundwerkzeuge

Kieferlose Fische

Kopfkapsel

Achsenstab, Längsmuskeln

Branchiostoma

Mundcirren

Tunikaten

Erweiterung des Kiemendarmes

Grabrüssel

Enteropneusten

Tentakelbildung

Graptolithen, Pterobranchia

Tiere

Gallertoide: gallertiges Bindegewebs-Muskelgitter

längliche Formen: Coelomräume

Mundreuse

bewegliche Mundregion

gegliedertes Hydroskelett

Kriechfuß und Radula

Parenchym

Körperschlauch

Tentakelkragen

kompakte Formen: Gallertfasergitter

Zilienplatten

sessile Lebensweise

Kanalvermehrung

Skelett

Abflachung

Stromatoporen

Verdauungsräume

Schlundrohr und Mesenterien

Wechsel Polyp/Meduse

Quallen, Hydrozoen

Sklerite

Parapodien

Einzelpolypen

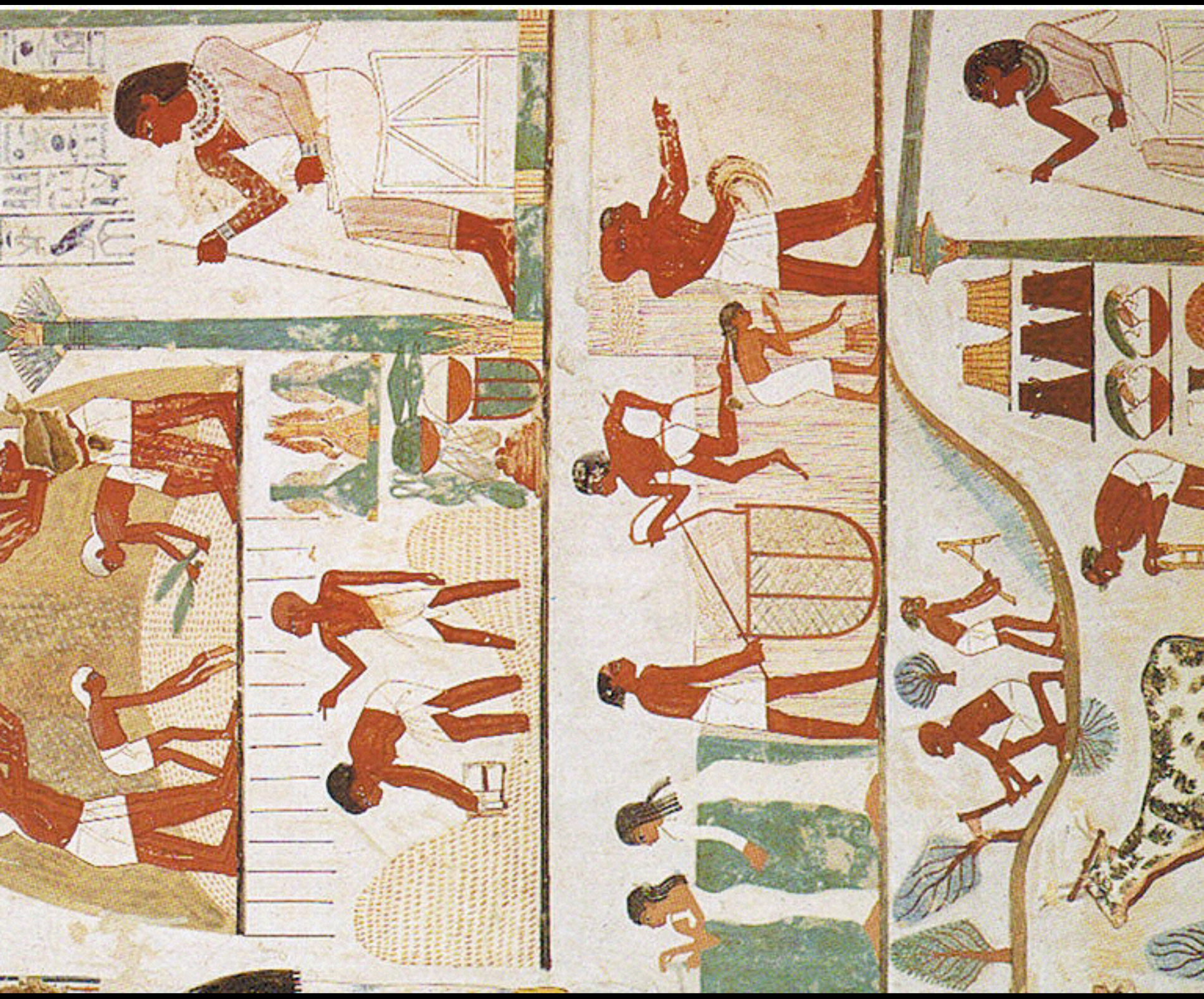
3.4 billion years ago

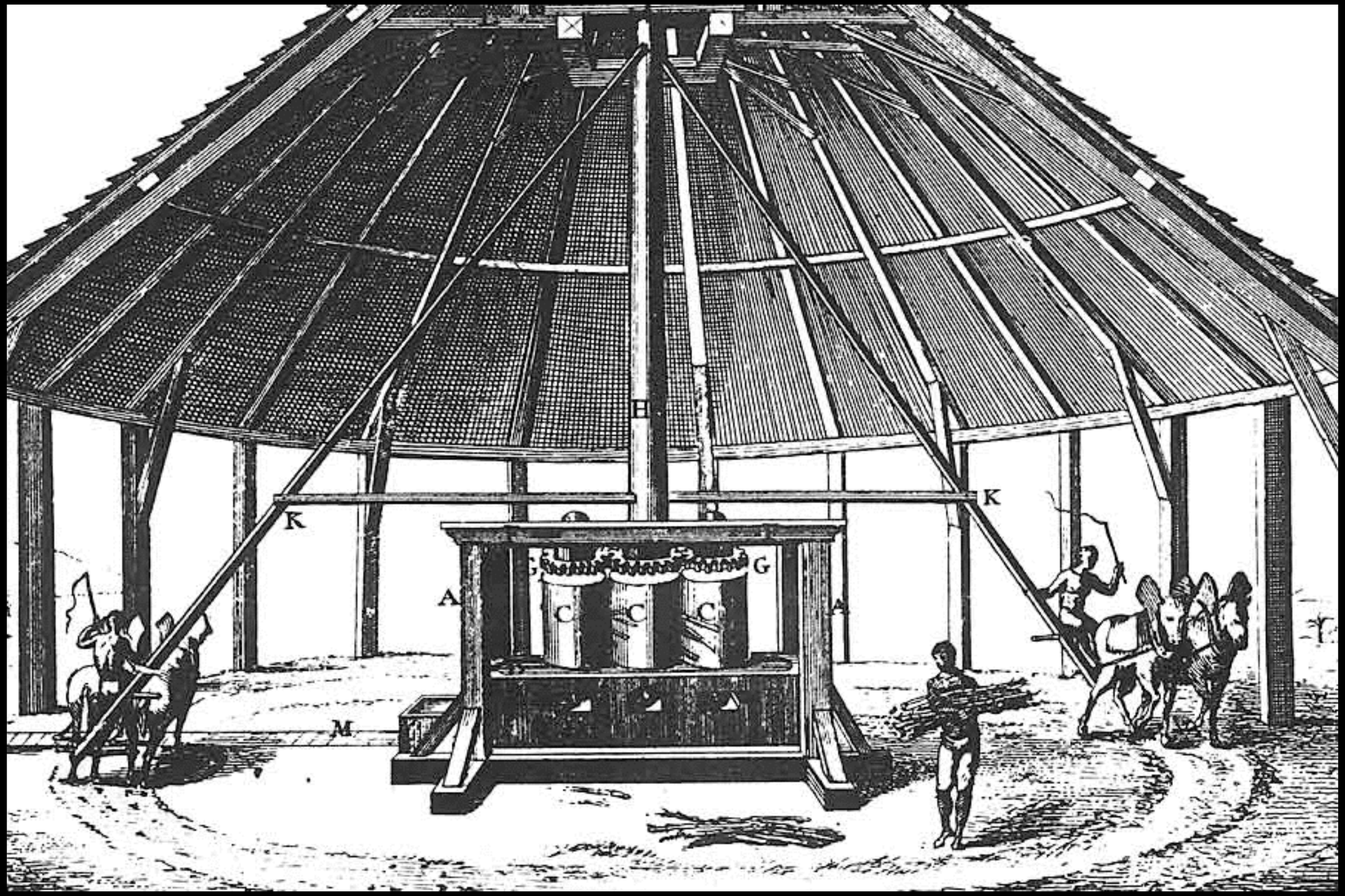
http://www.morphisto.de/

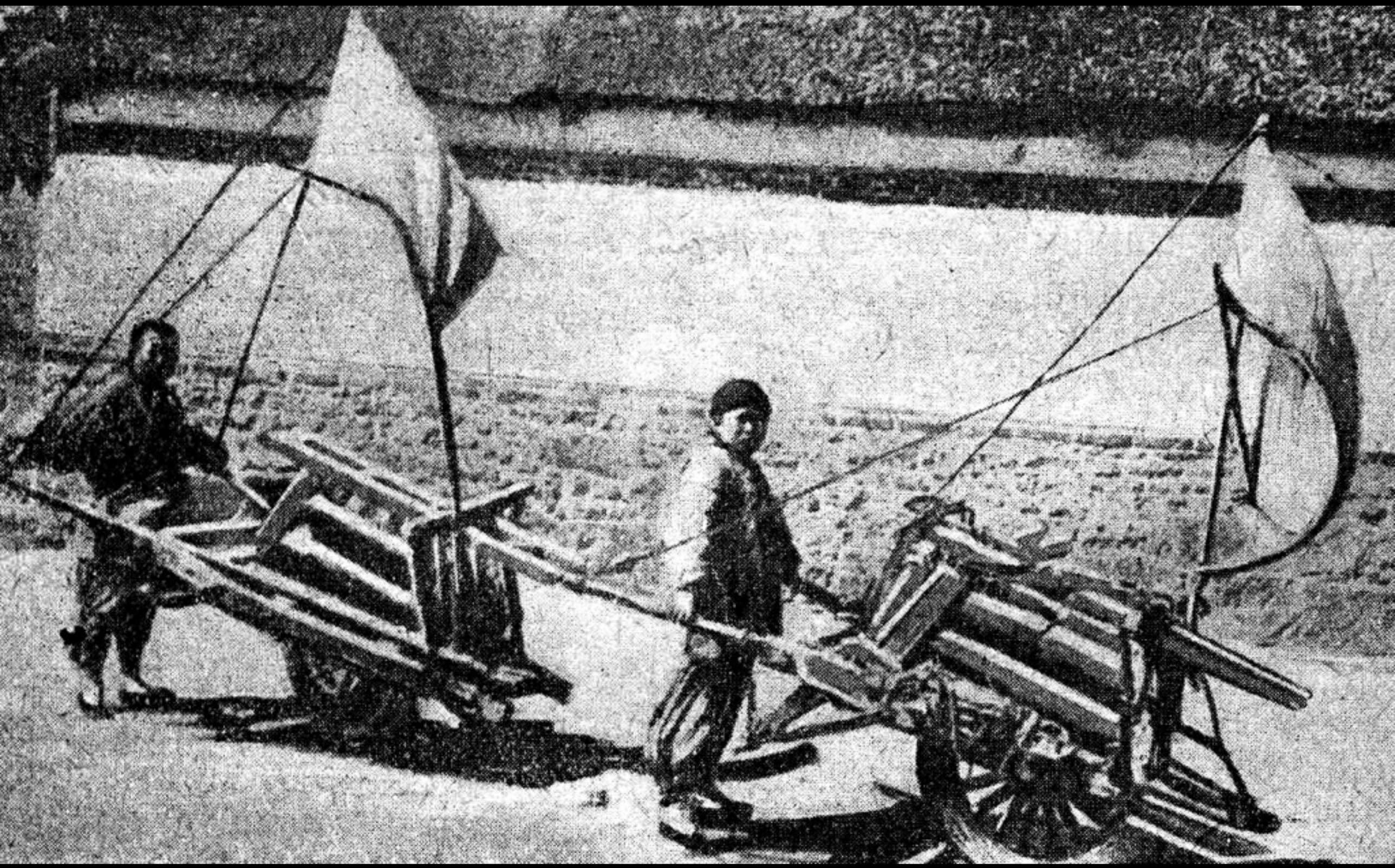
1.7 million - 200,000 years ago

20,000-30,000 years ago

<10,000 years ago



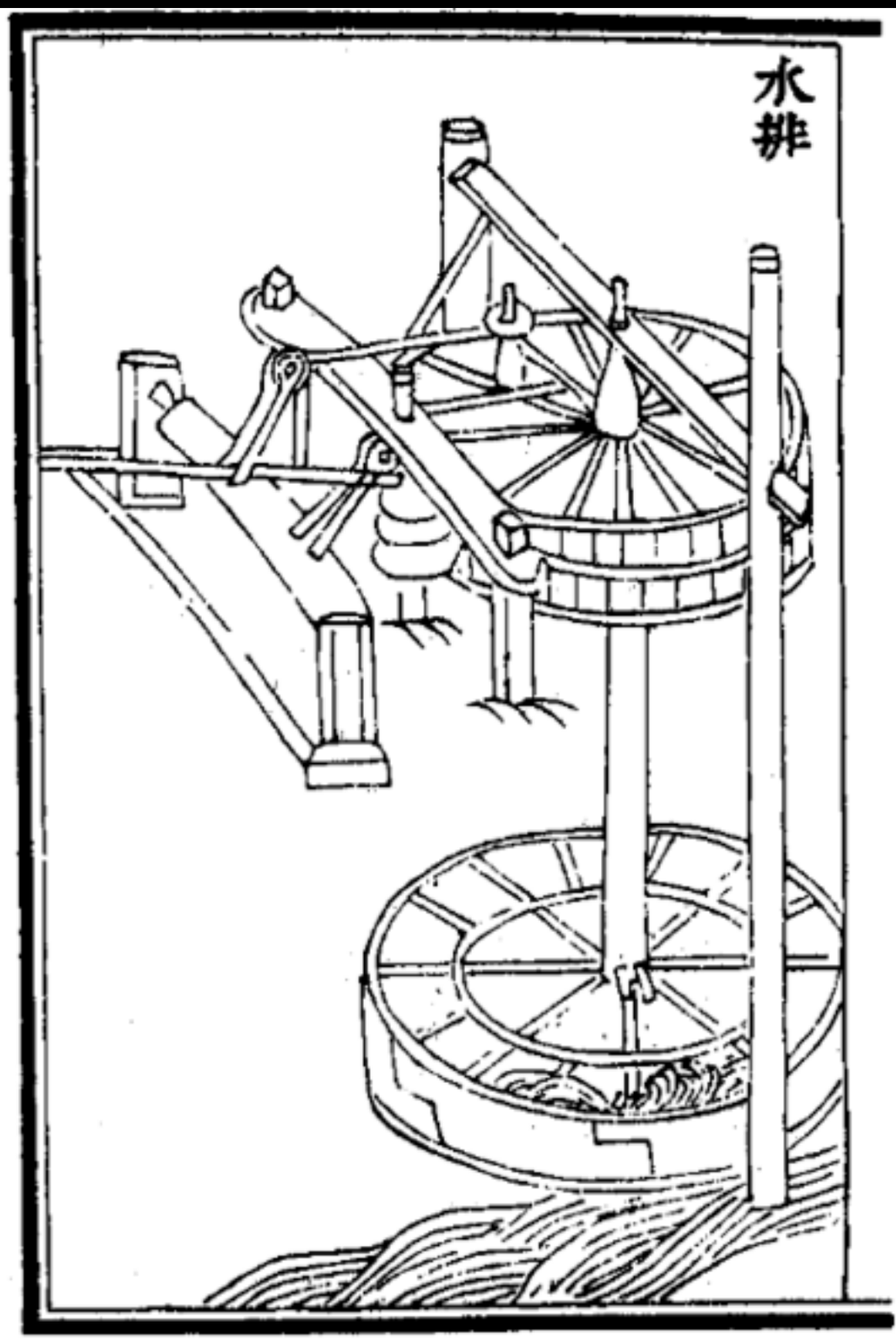

K
K
H
A
A
G
G
C
C
C
M



Stone Age - no fire needed

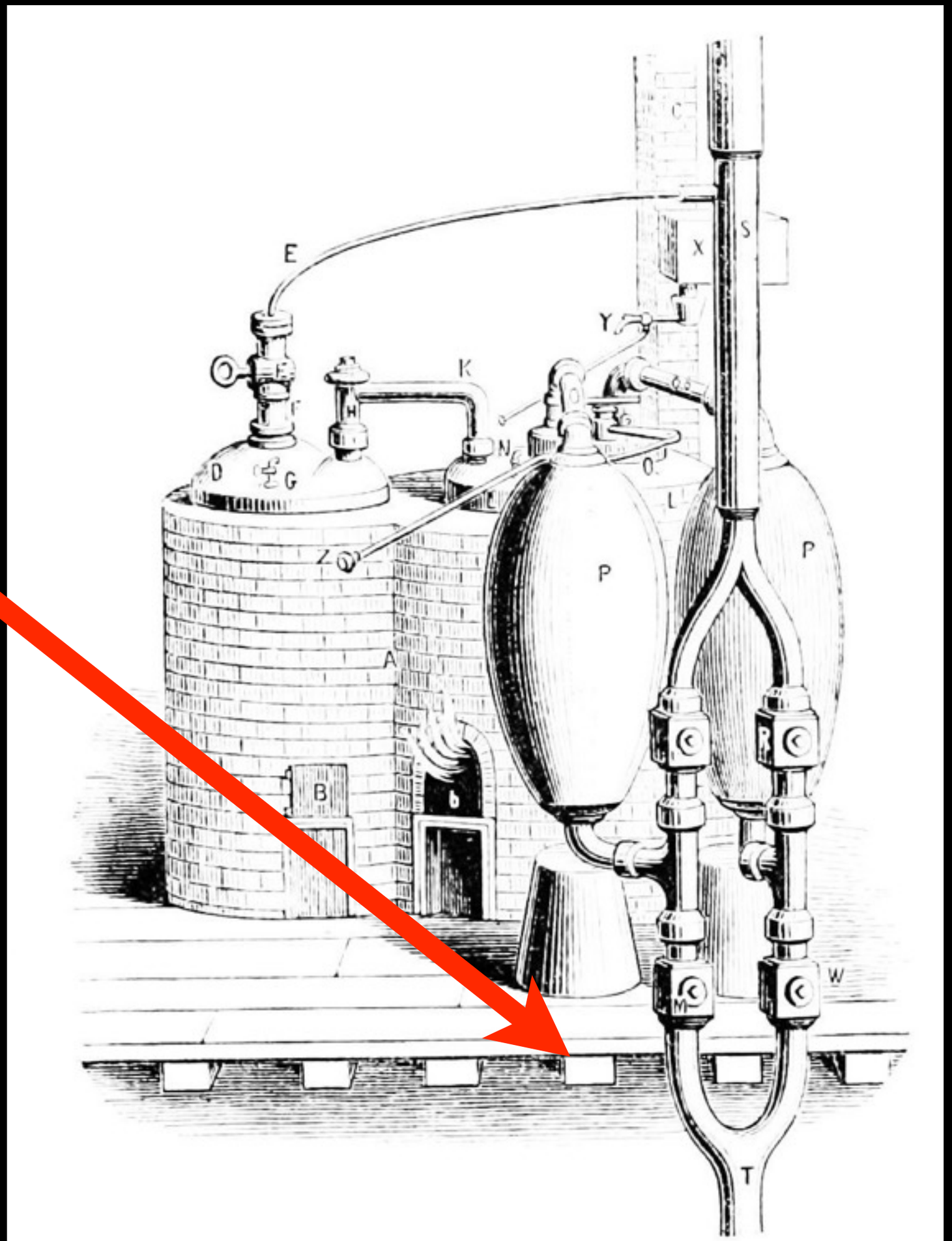
Bronze Age - 950°C

Iron Age -1500°C

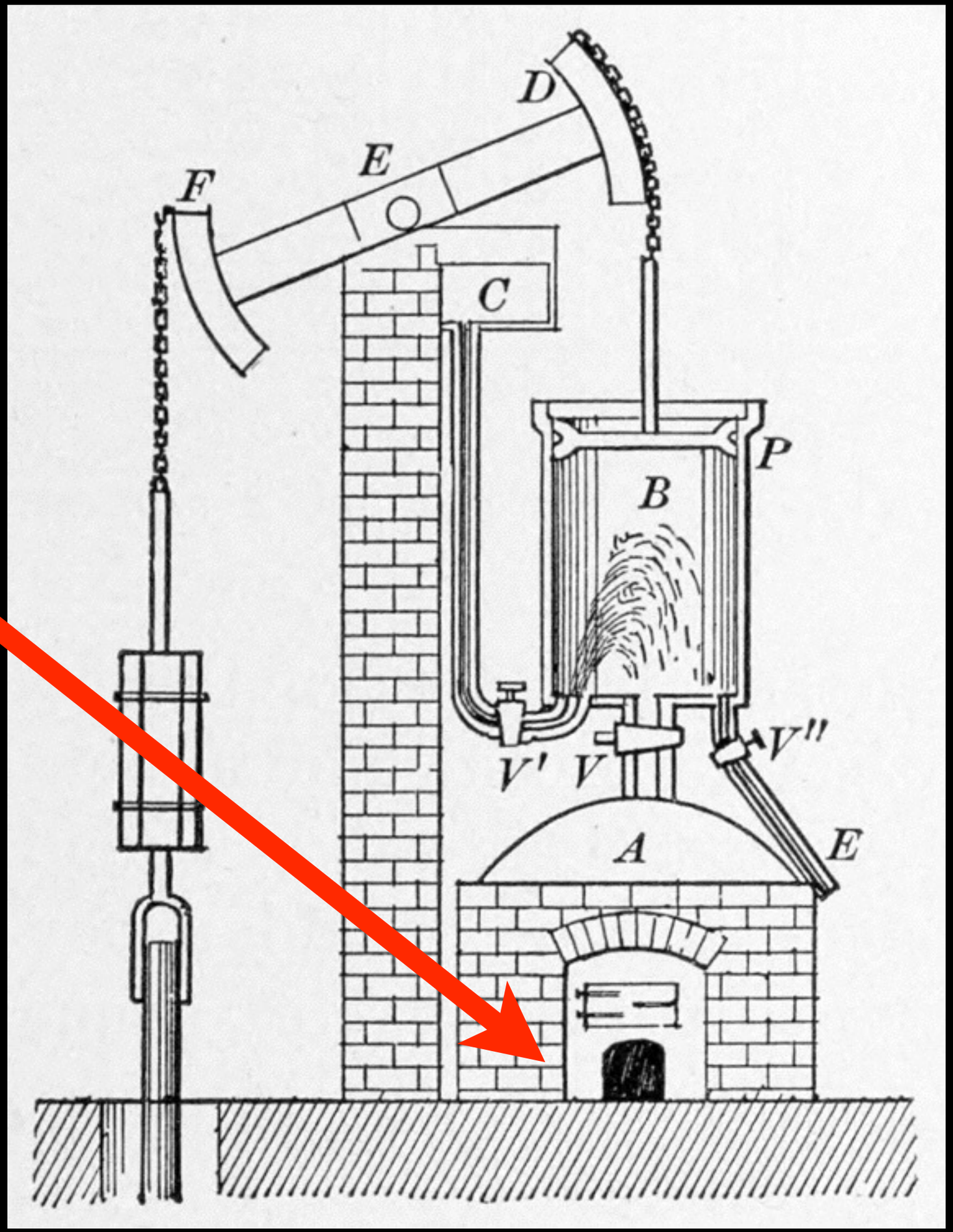


100 BC - Herona (?)

1300s - Huolongjing



1699 - Savery



1712 - Newcomen

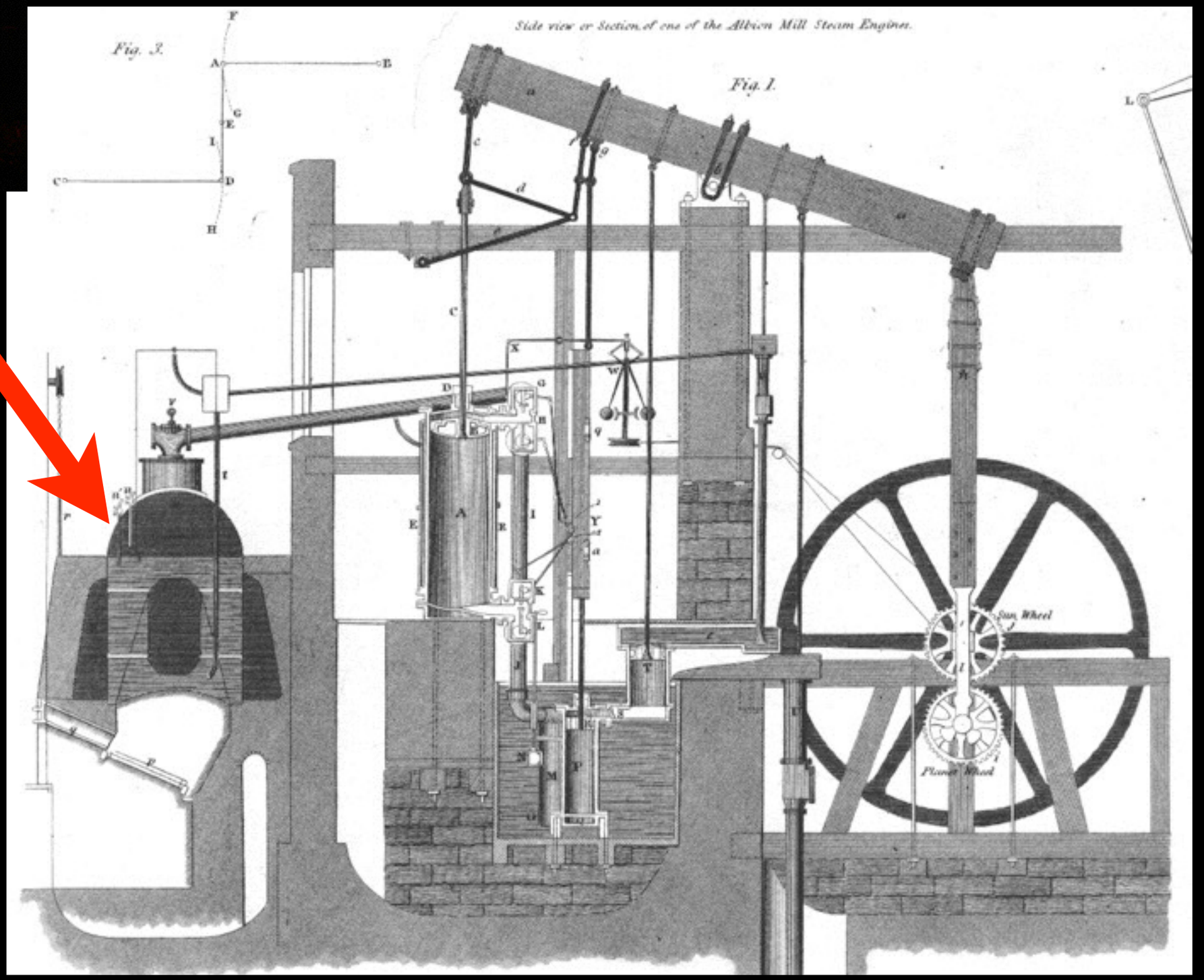
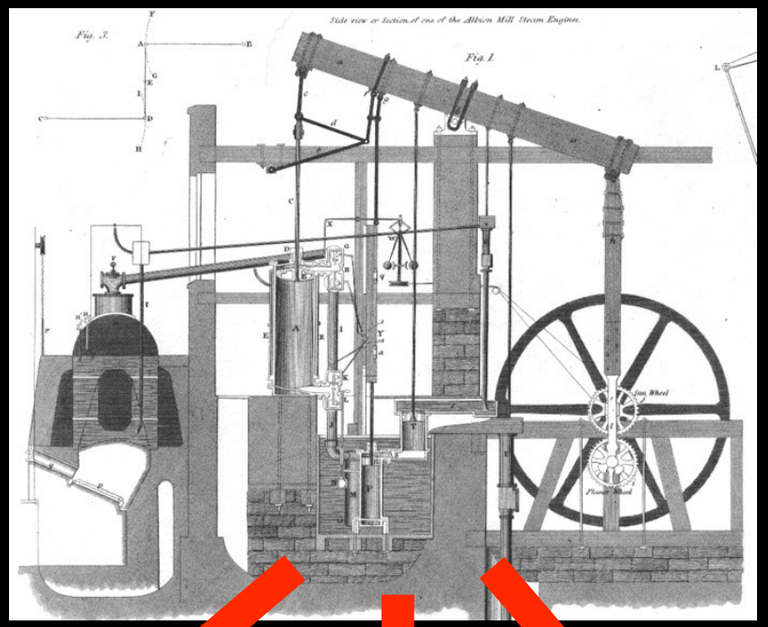
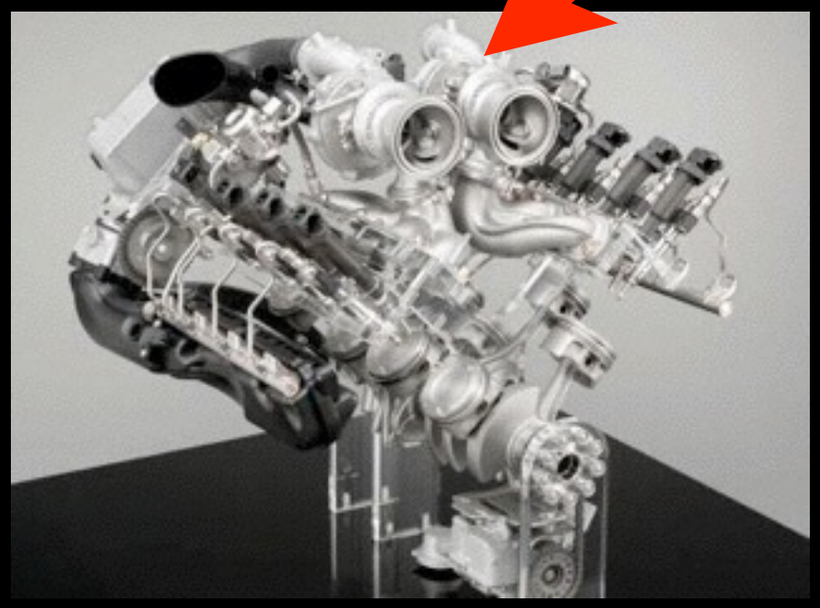


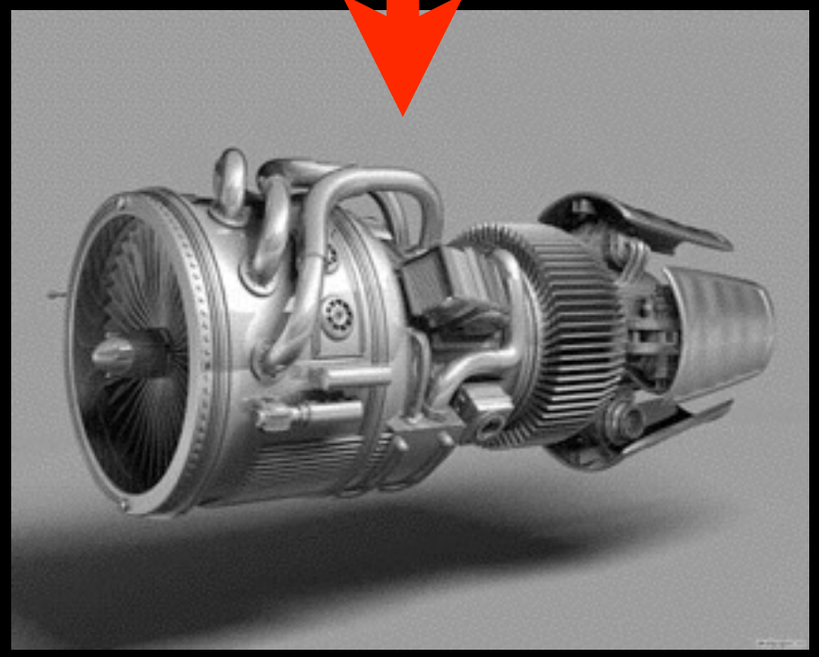
Fig. 3.
Side view or Section of one of the Albion Mill Steam Engines.
Fig. 1.
Sun Wheel
Planet Wheel

1775 - Watt

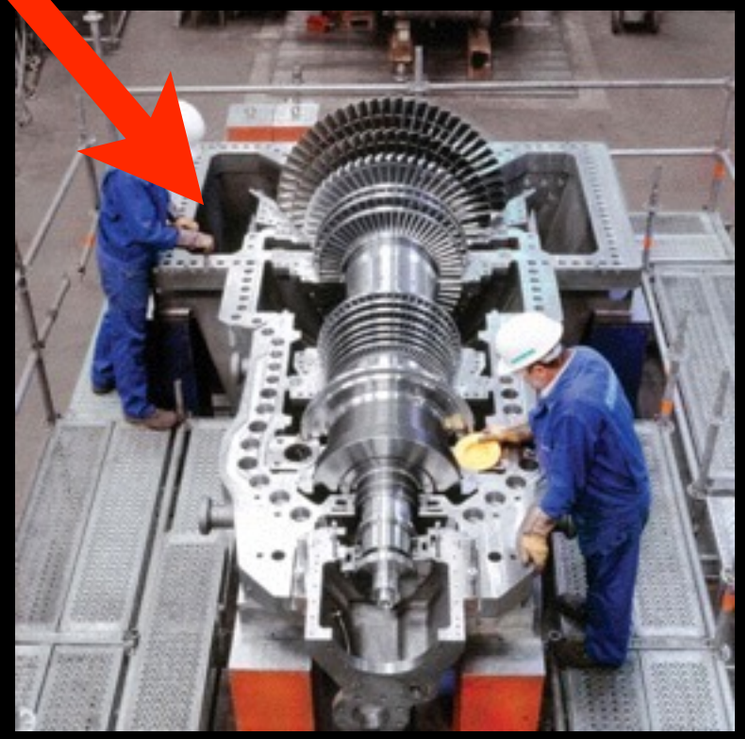




I.C.E.



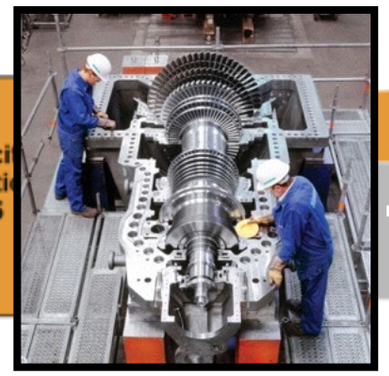
Jet engine

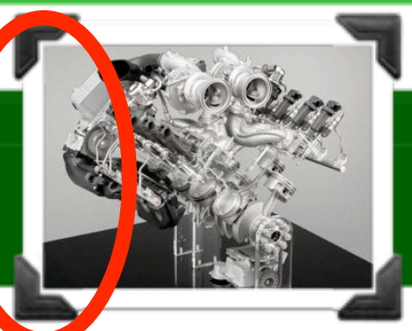


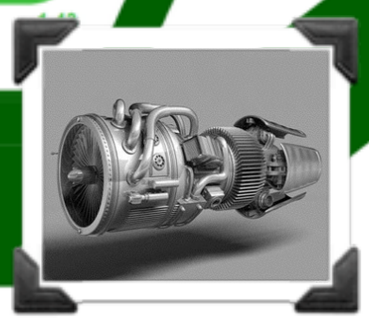
Steam turbine

Estimated U.S. Energy Consumption in 2016: 97.3 Quads

Lawrence Livermore National Laboratory







Source: LLNL March, 2017. Data is based on DOE/EIA MER (2016). If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. This chart was revised in 2017 to reflect changes made in mid-2016 to the Energy Information Administration's analysis methodology and reporting. The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 65% for the residential sector, 65% for the commercial sector, 21% for the transportation sector, and 49% for the industrial sector which was updated in 2017 to reflect DOE's analysis of manufacturing. Totals may not equal sum of components due to independent rounding. LLNL-MI-410527

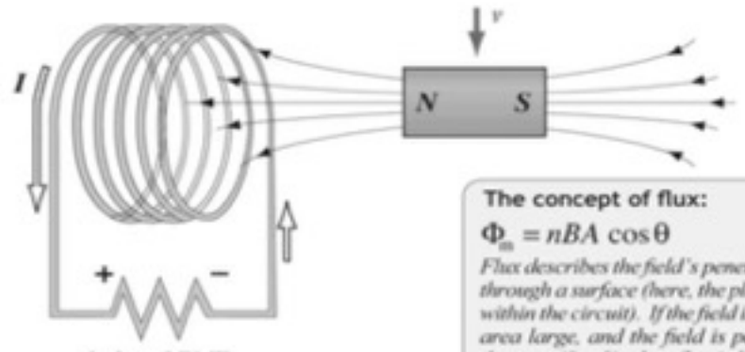
https://flowcharts.llnl.gov/archive.html

FARADAY'S LAW

$$\varepsilon = -\frac{\Delta\Phi_m}{\Delta t}$$

ε = induced emf

$\frac{\Delta\Phi_m}{\Delta t}$ = rate of change of magnetic flux through the circuit



Induced EMF

The concept of flux:

$\Phi_m = nBA\cos\theta$

Flux describes the field's penetration (or flow) through a surface (here, the plane of the loops within the circuit). If the field is strong and the area large, and the field is perpendicular to the area ($\theta = 0$), then flux is high. Each turn in the coil (n) adds more area.

Image Source: http://wikipremed.com/01physicscards600/379a.gif

?

Manoj Bhargava

http://hyperphysics.phy-astr.gsu.edu/hbase/magnetic/indcur.html