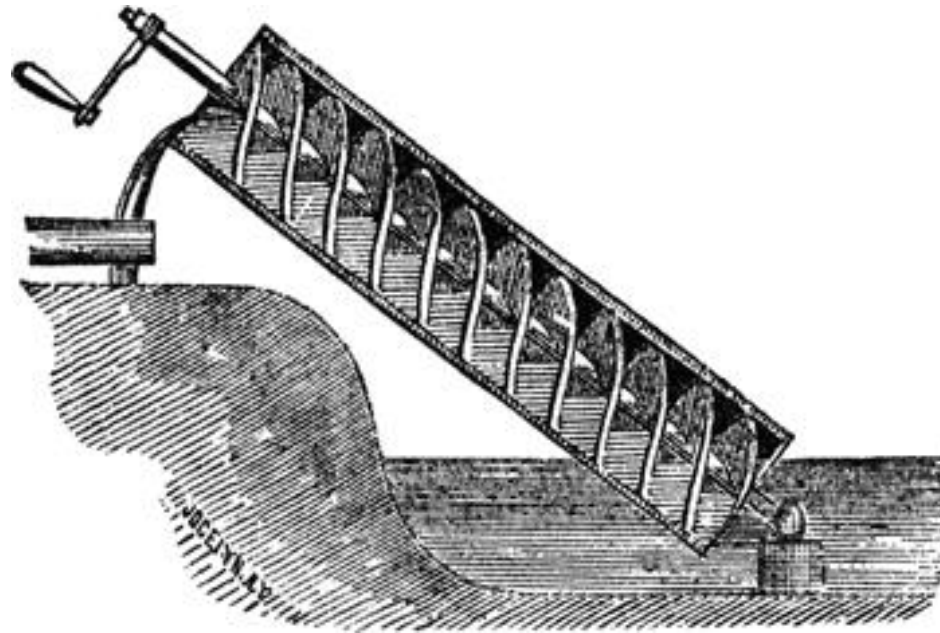


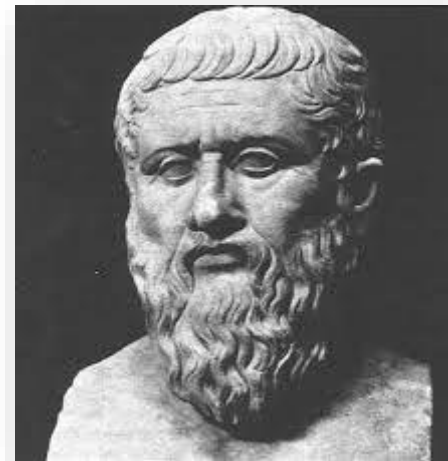
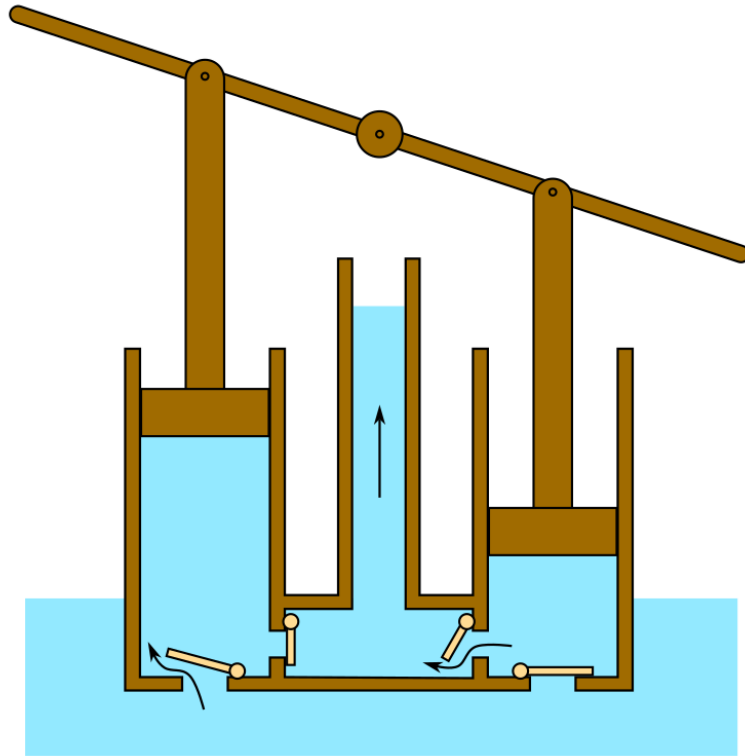


The History and Future of Fluid Power Pumps and Motors

Samuel Kärnell, Linköping University

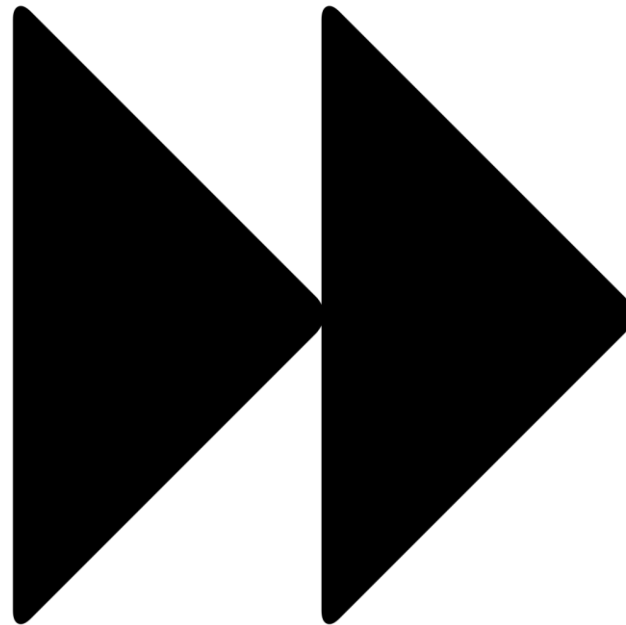


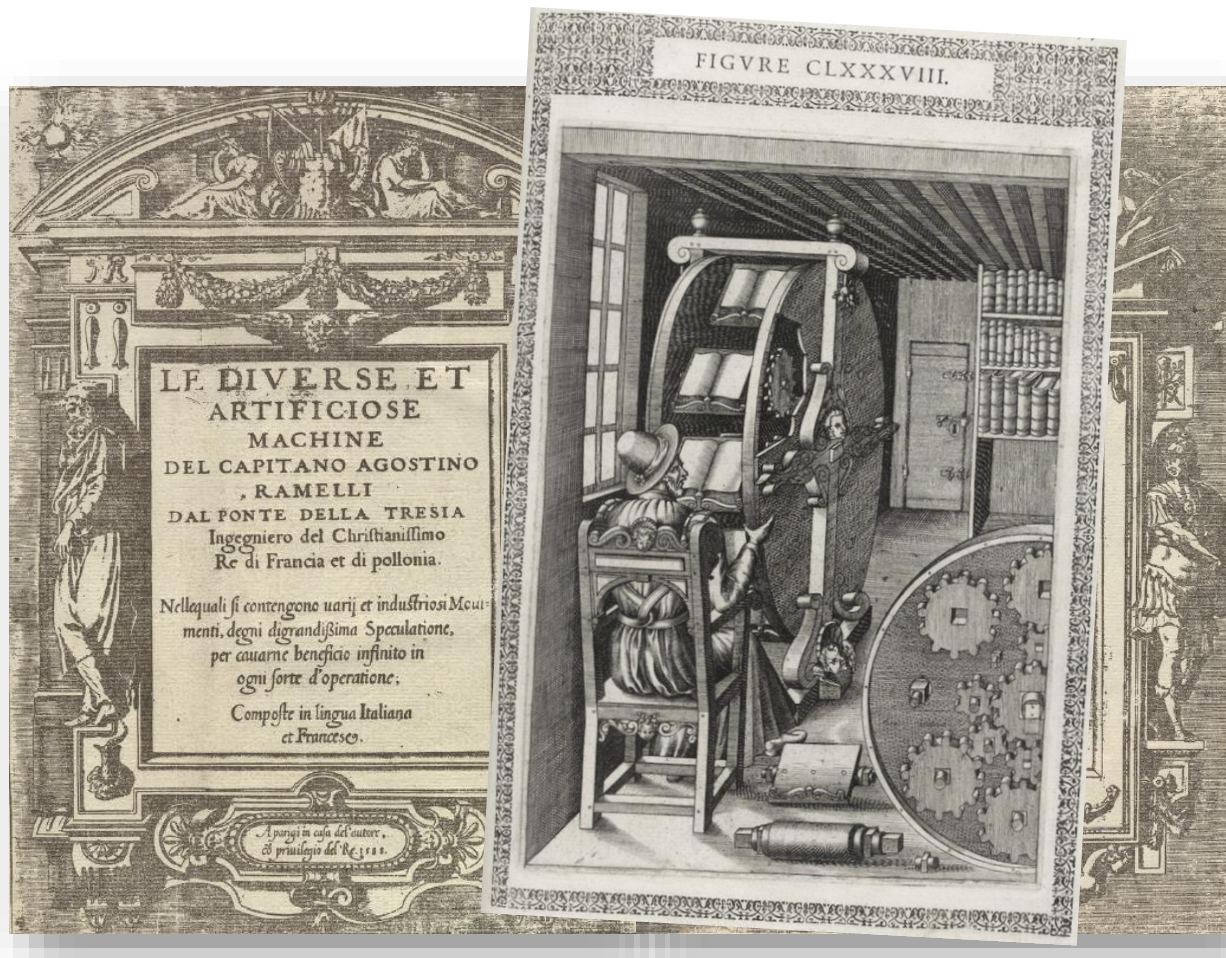
≈ 2000 B.C.



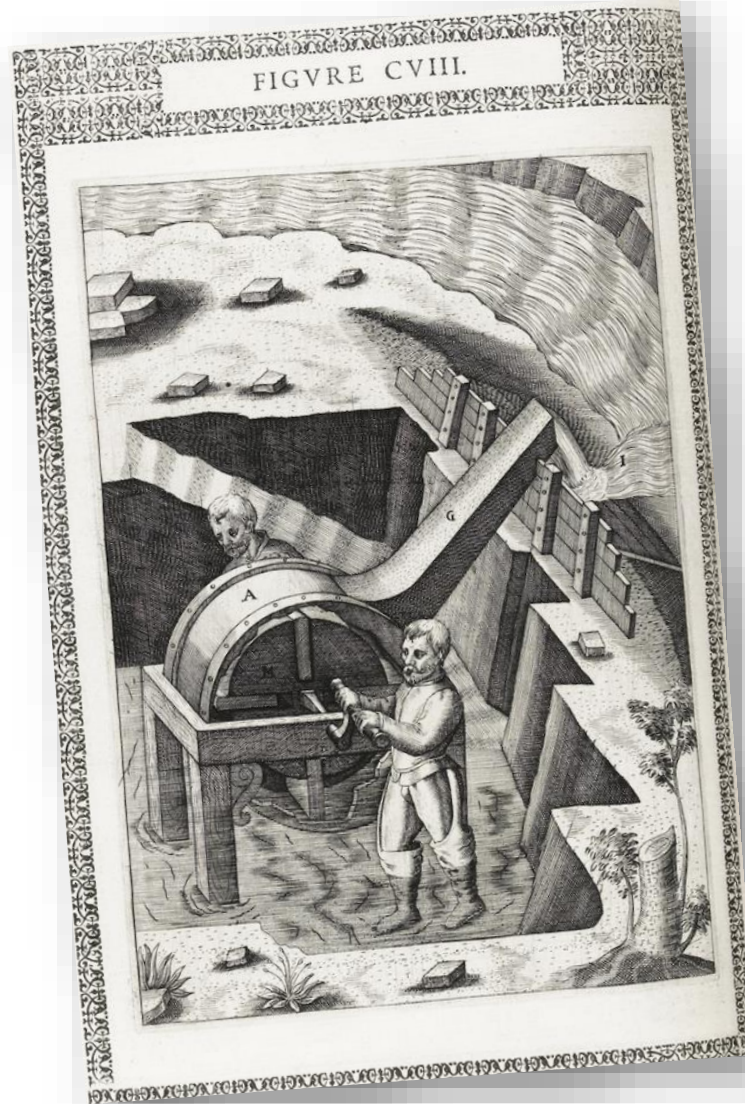
Ctesibius of Alexandria,
≈ 250 B.C.

Fast forward...



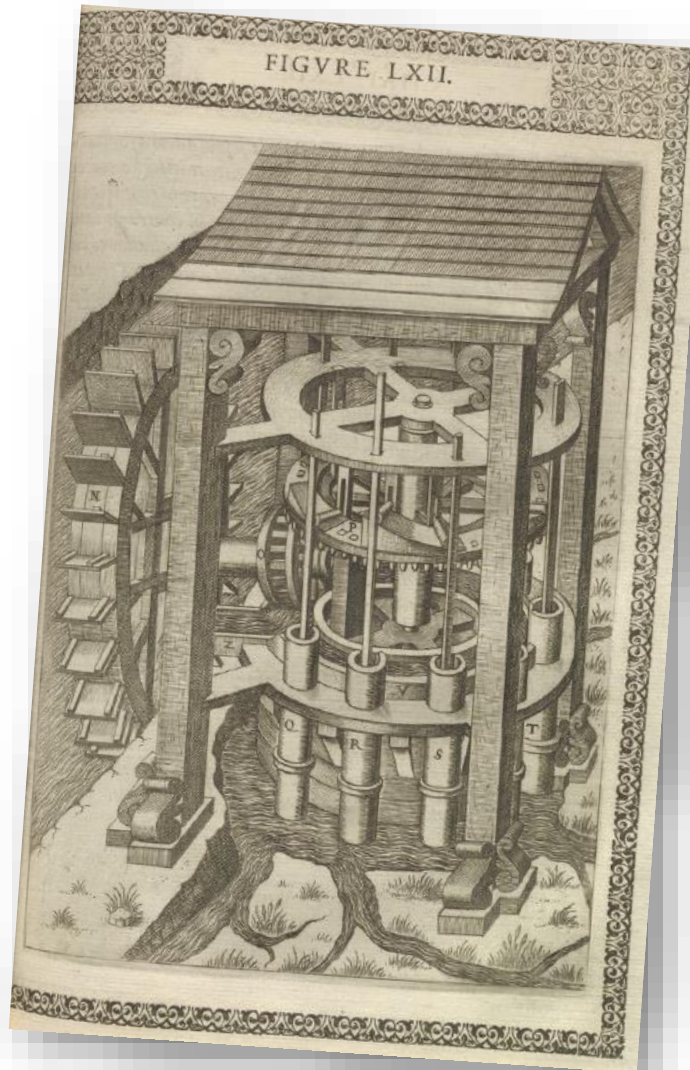


Agostino Ramelli, 1588

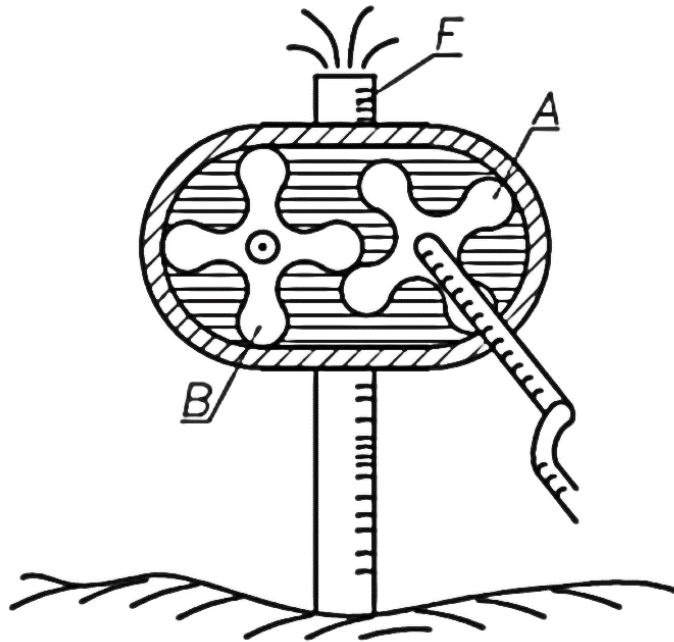


Agostino Ramelli, 1588

Axial piston pumps



Agostino Ramelli, 1588



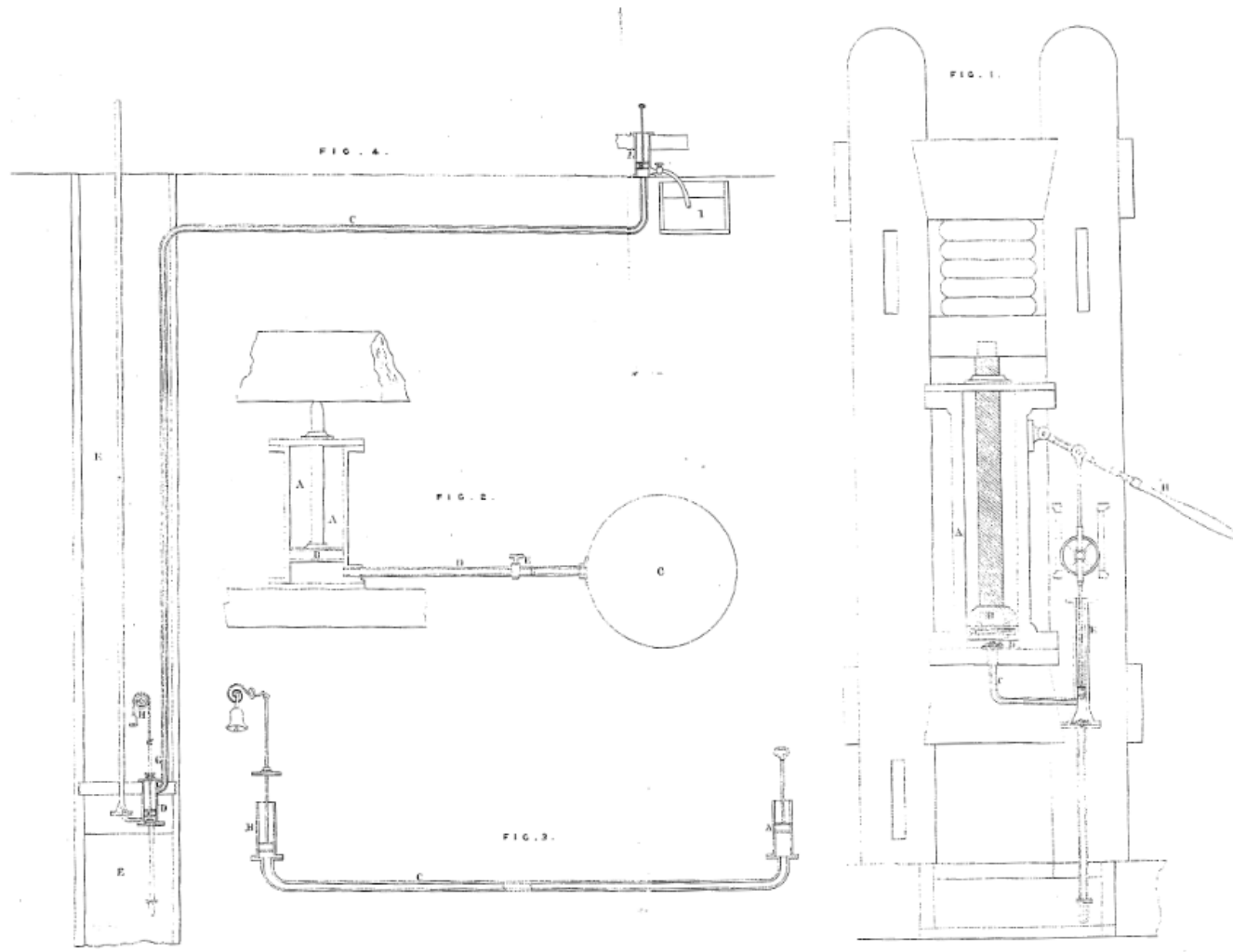
Johannes Kepler, ≈1600



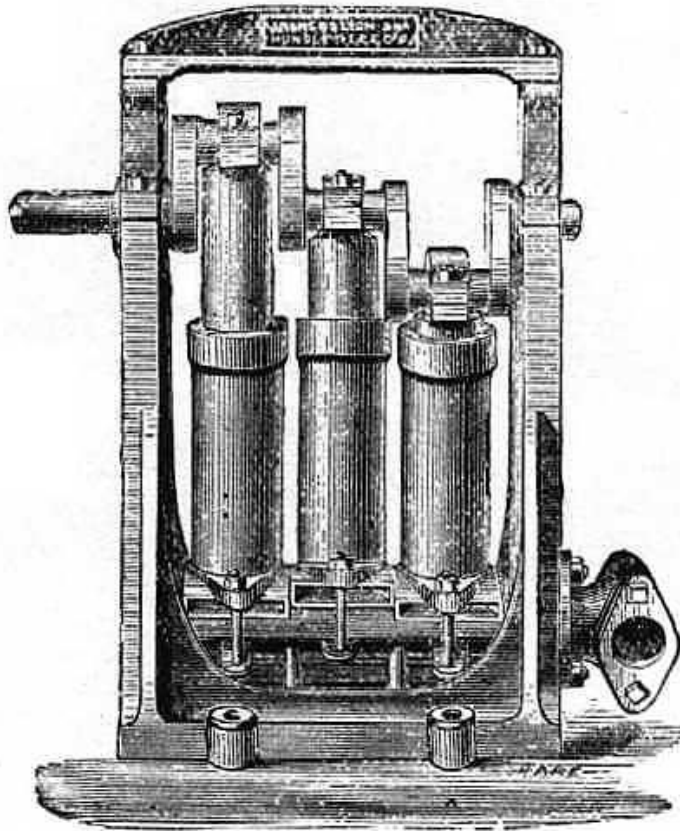
Blaise Pascal,
≈1650



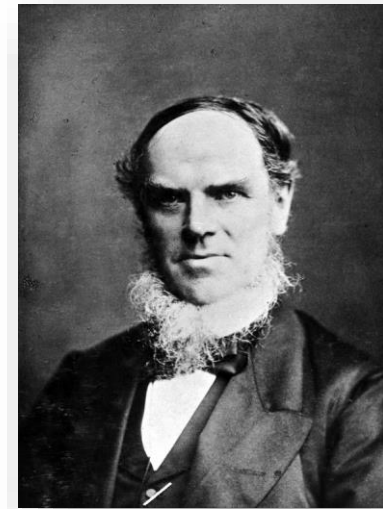
Joseph Bramah, 1795



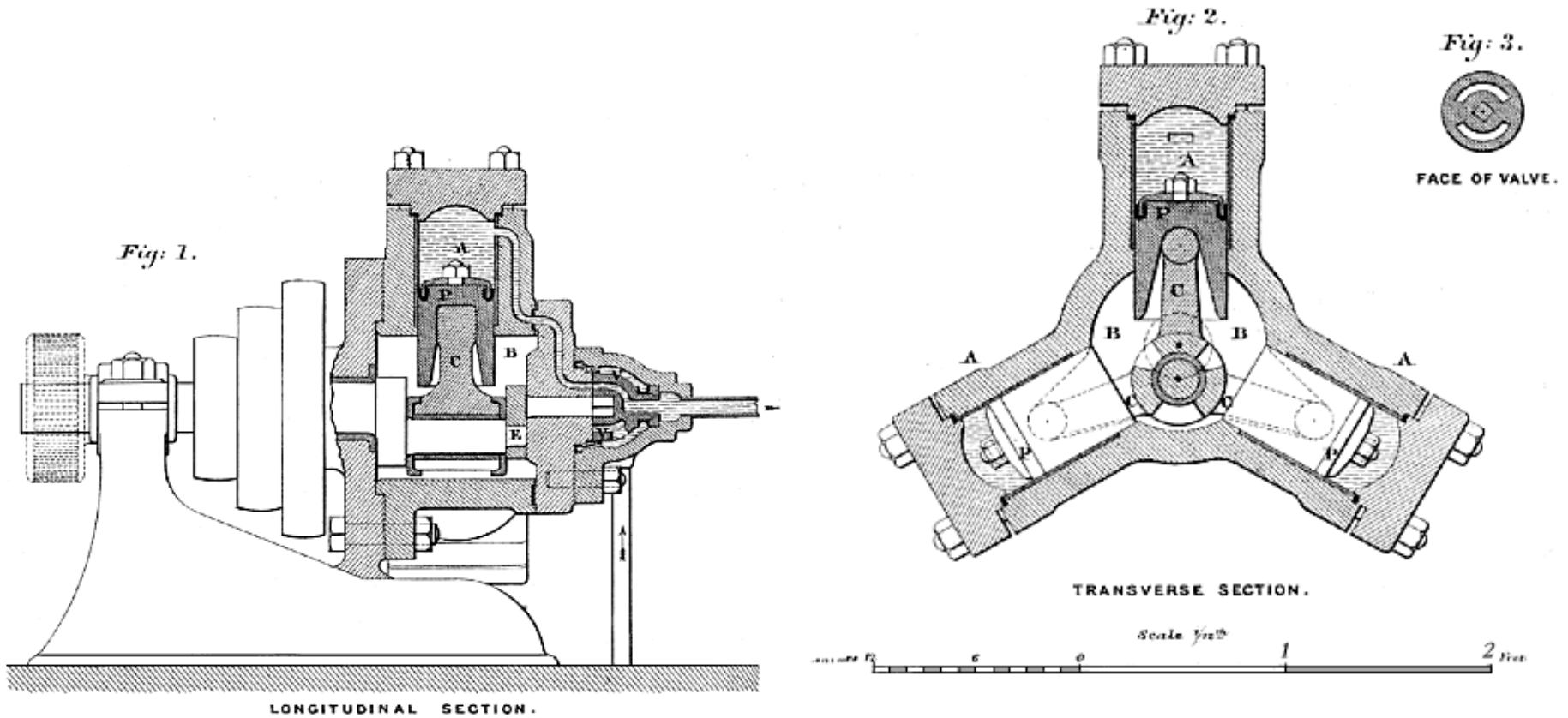
Oscillating piston motor (“water engine”)



From *The Hydraulic Age* by B. Pugh, pub Mechanical Engineering Publications Ltd, 1980

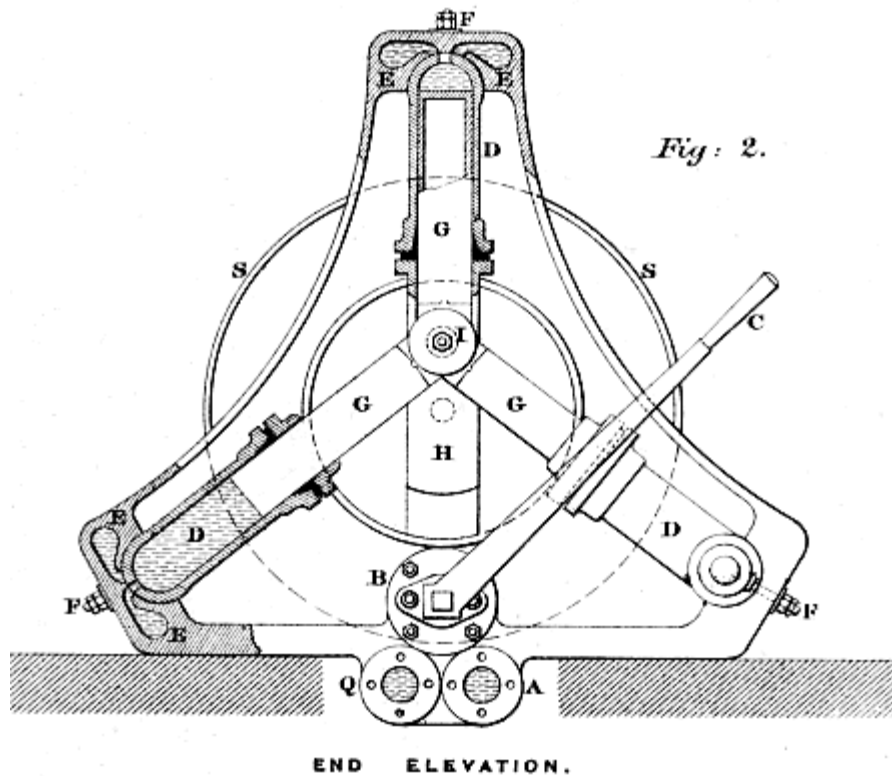


John Ramsbottom, ≈ 1840

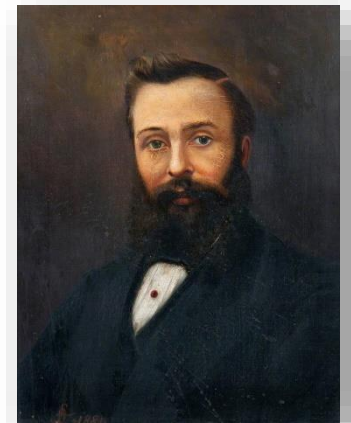


From *Hydraulic Power & Machinery* by Henry Robinson. Pub Charles Griffin & Co, London 1893

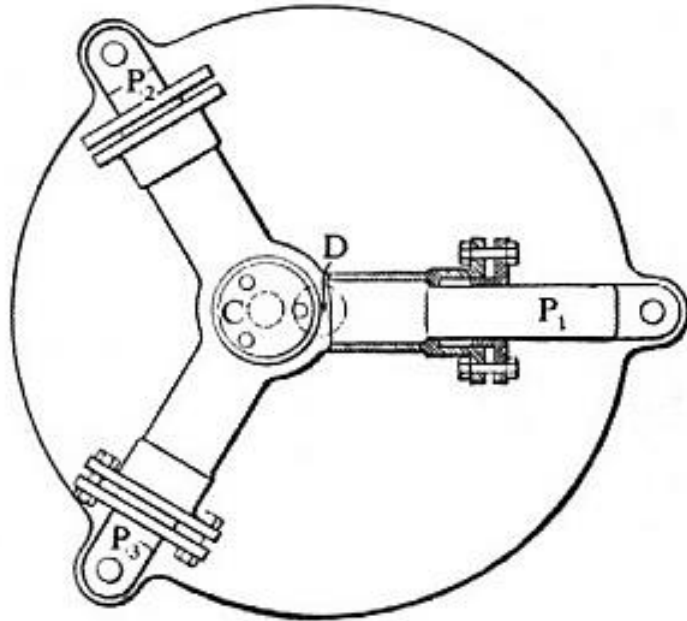
Peter Brotherhood, 1870s



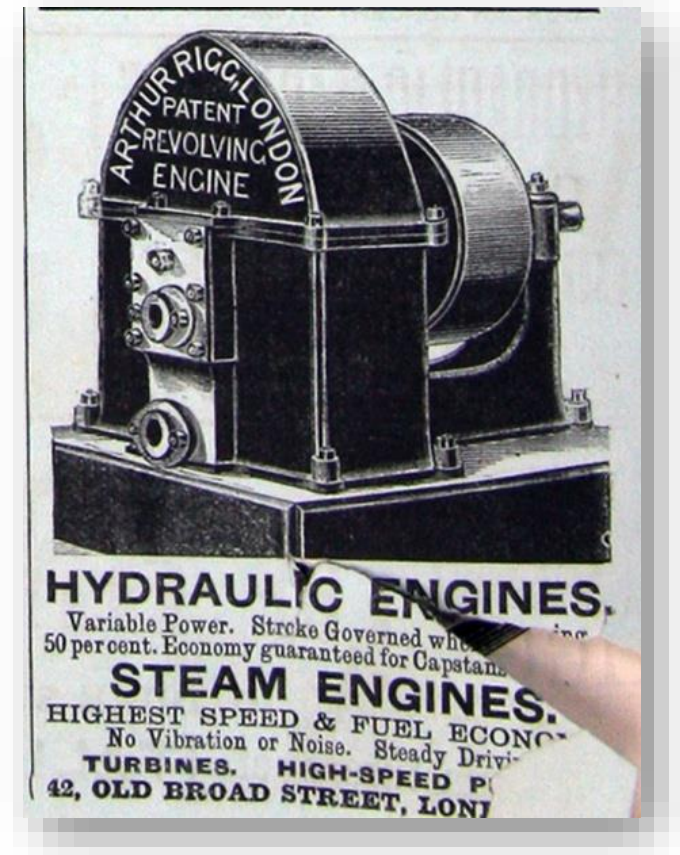
From *Hydraulic Power & Machinery* by Henry Robinson.
Pub Charles Griffin & Co, London 1893



John Hastie, 1870s

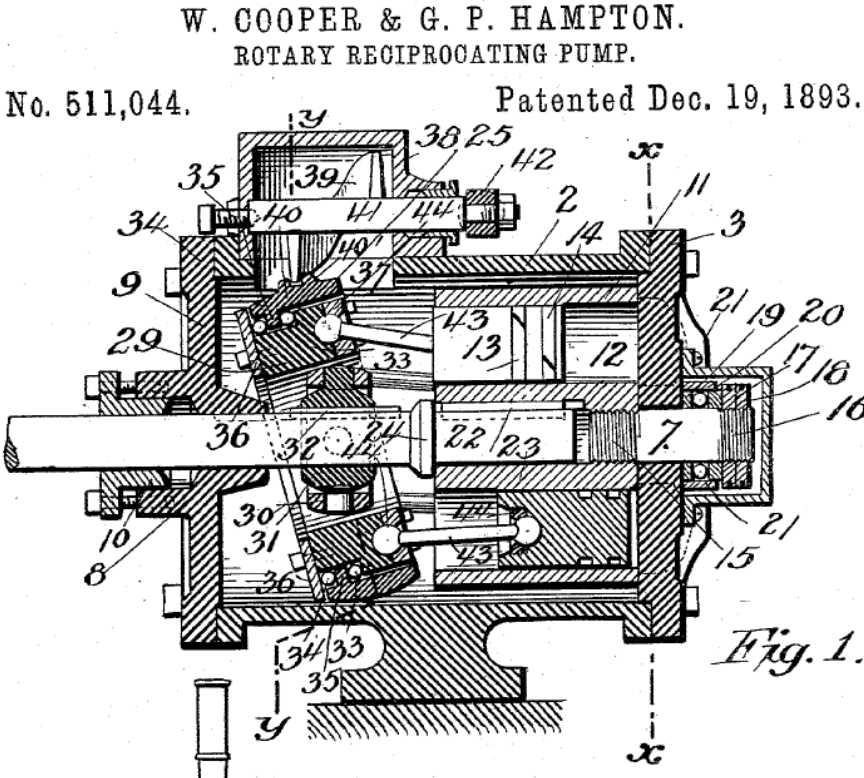


From *Hydraulic Power & Machinery* by Henry Robinson.
Pub Charles Griffin & Co, London 1893

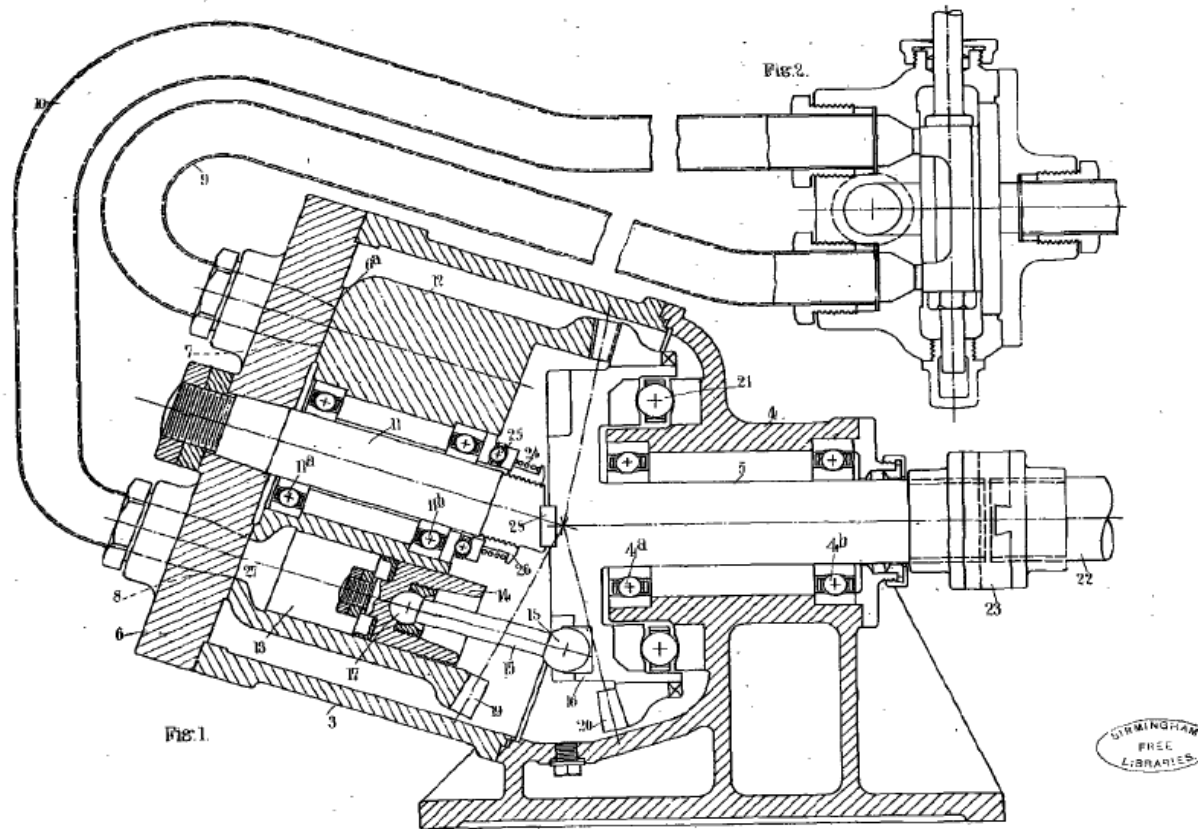


Arthur Rigg, 1880s

“... especially adapted for use with electric motors or other constant rotary power”



William Cooper and George Hampton, 1893



F. H. Clergue, 1908

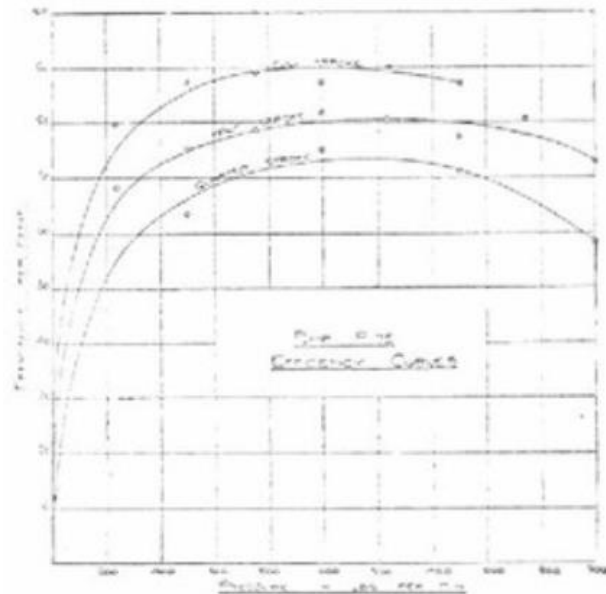
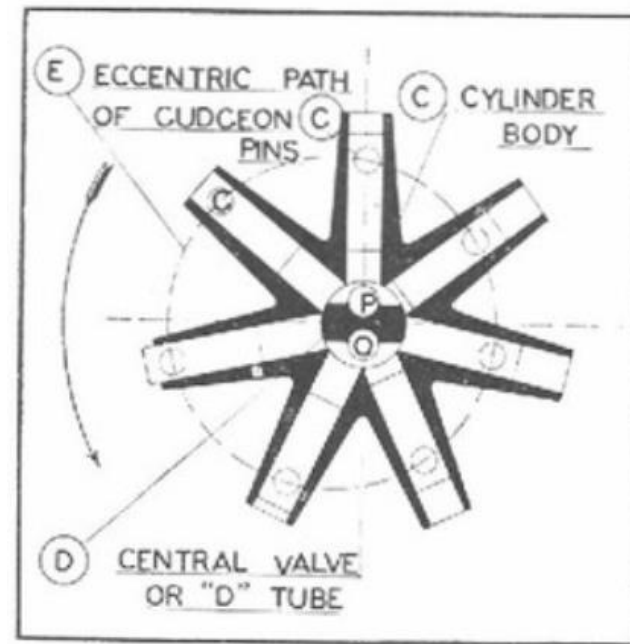
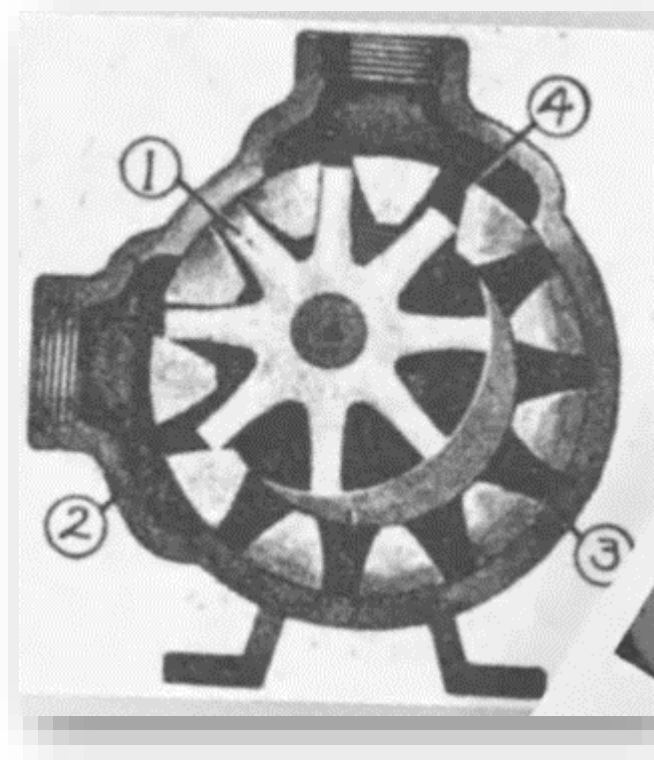


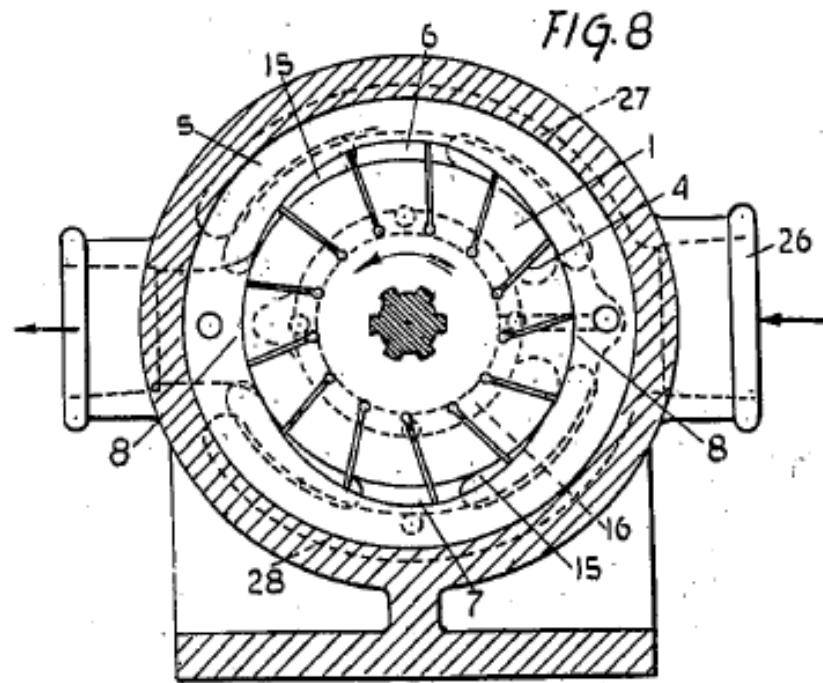
Fig. 5.—Efficiency curves for latest Hele-Shaw pump.



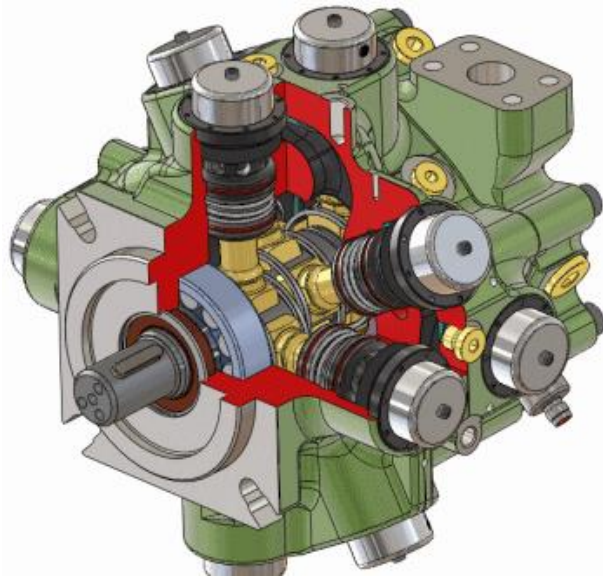
Henry Selby Hele-Shaw, ≈1910



J. Nielsen, ≈1910



H. Vickers, 1920s



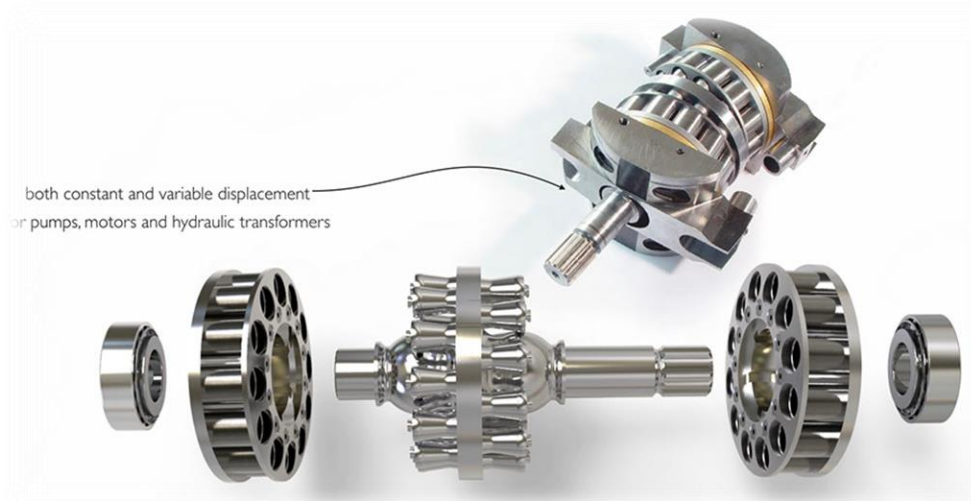
W. Rampen & S. Salter, 1990



Danfoss completes takeover of Scottish firm Artemis Intelligent Power

15 Jan 2021

Danish multi-national Danfoss today [DATE] announced the full purchase of Edinburgh R&D firm Artemis Intelligent Power Ltd – with plans to roll out its innovative Digital Displacement® technology worldwide.



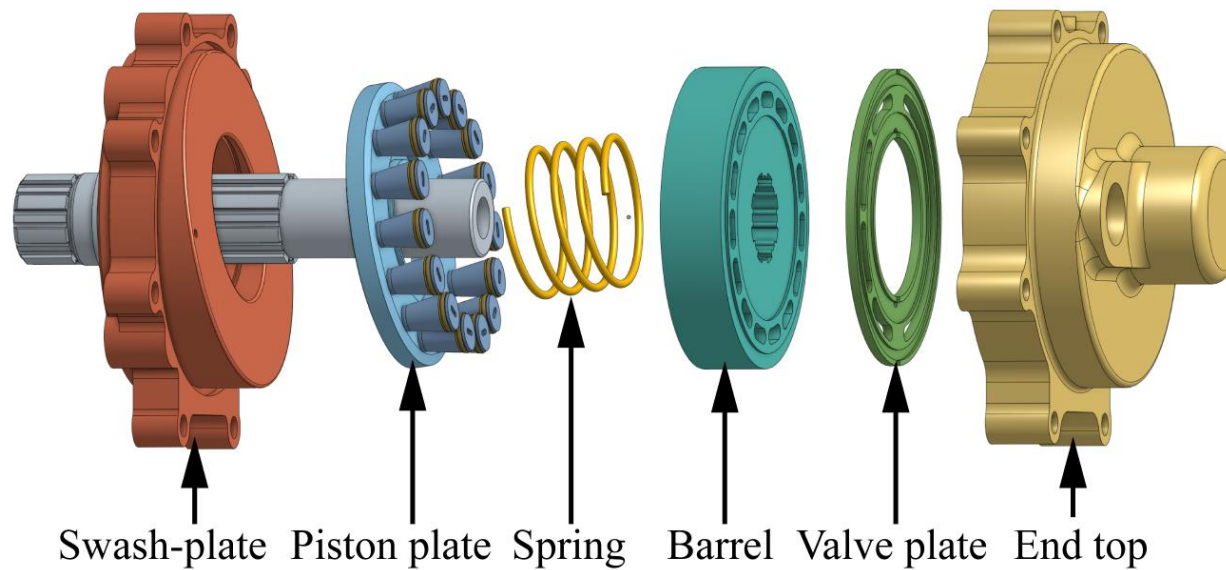
P. Achten, 2000s

BUCHER
hydraulics

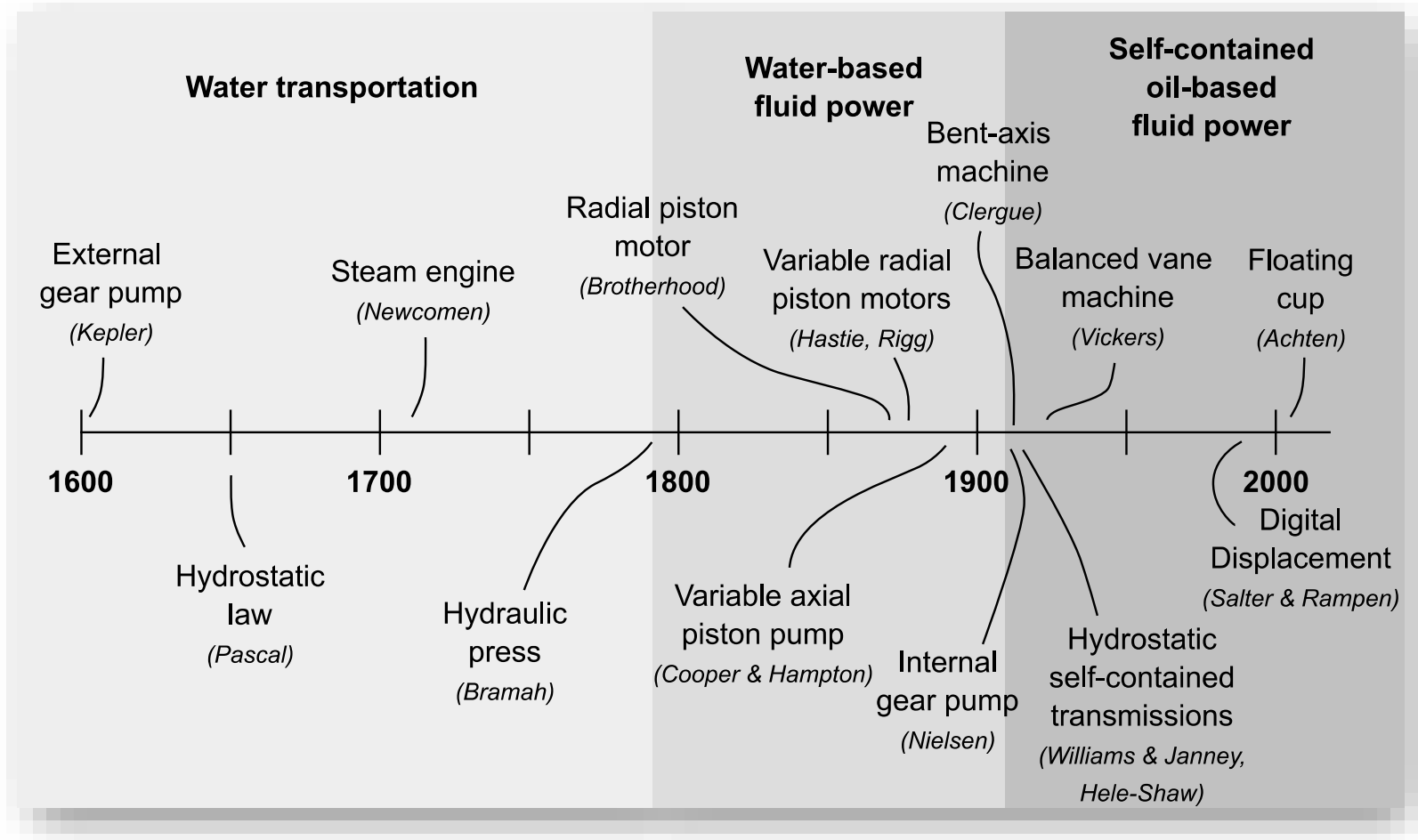
Fixed Displacement Piston Pumps and Motors

AX Series





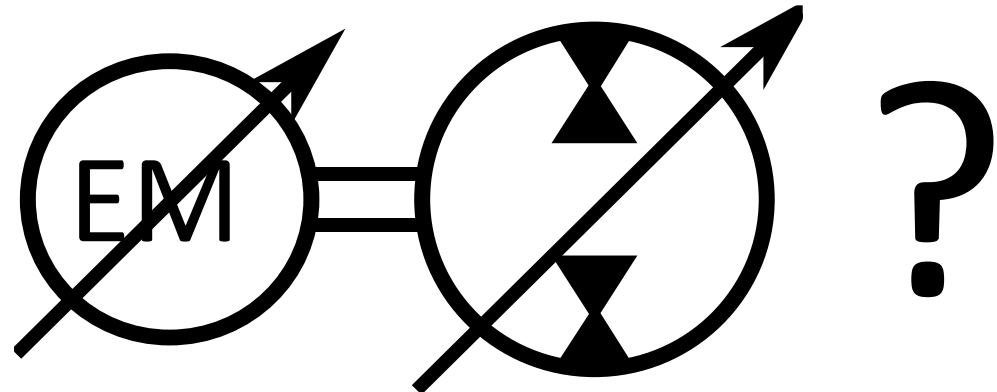
*From A Novel Axial Piston Pump/Motor Principle with Floating Pistons
Design And Testing by Liselott Ericson & Jonas Forssell. 2018*



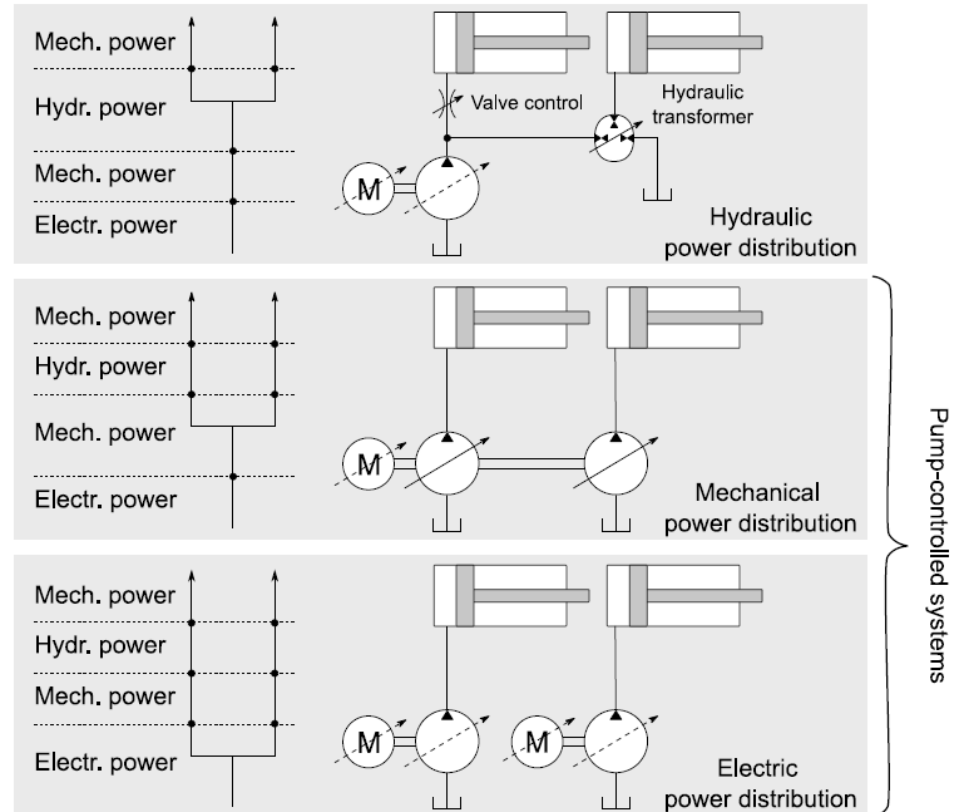
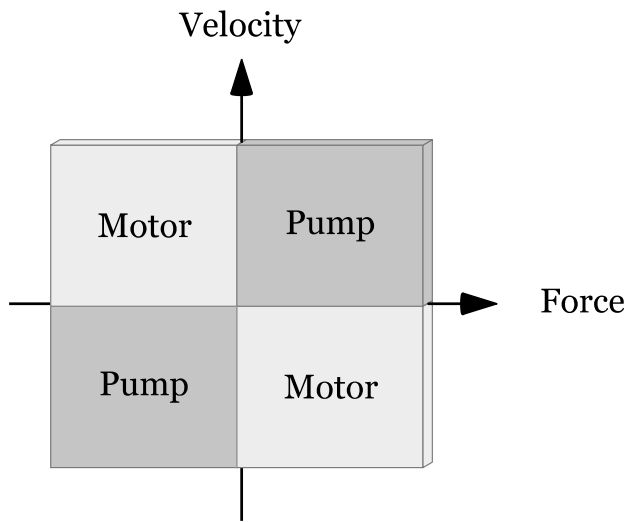
What about the (electrified) future?

Electric machines

- They can run in both directions.
- They can be controlled down to zero speed.
- They can transfer power in both directions.



What about the future?





The History and Future of Fluid Power Pumps and Motors

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