Fig.27. Launching of the ship in the sea, near the Kenchreae harbour, [Tassios et al.].

V. WATER TECHNOLOGY IN ANCIENT GREECE

1. FLOOD CONTROL, LAND-RECLAMATION

1.1. Mycēnaean period

(Pheneos, Tiryns, Thisbē, Kopaïs)

Basic characteristics:

a) Flooding torrent contained in an artificial lake (low rise dams)

[Arcadian Orchomenos, Mantineia)

b) Deviation of torrent outside (large channels), towards

– cesspits or

– the sea

The drainage of Kopaïs lake

(140 sq.km, 13th c. BCE)

- Melas river ➡ artificial lake 12 sq.km
- Kēphissos (Boeotian) river deviated:
  - Impressive channel (earth fill 25 km)

    b = 40,0 m, t = 2,50 m, navigable
- Low hill “Glas”: administration center

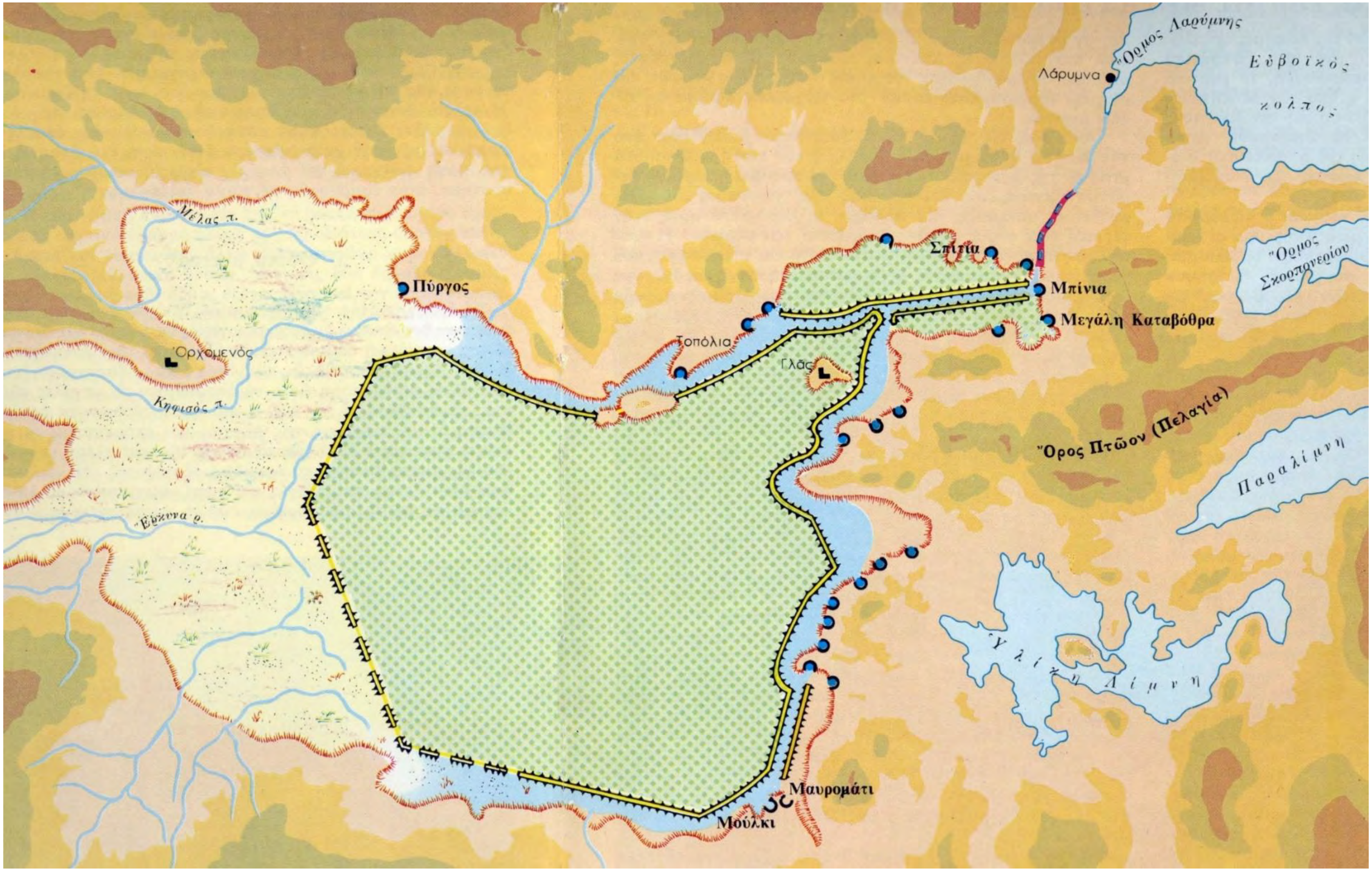

Fig. 1.1. Flood control and land reclamation of Kopais lake (14th century BCE) [Iakovidis][7].

Fig.1.3: Masonry cove
[Author]

Fig. 1.3. Masonry cover of the Mycenaean hill shaping the inner side of the channel

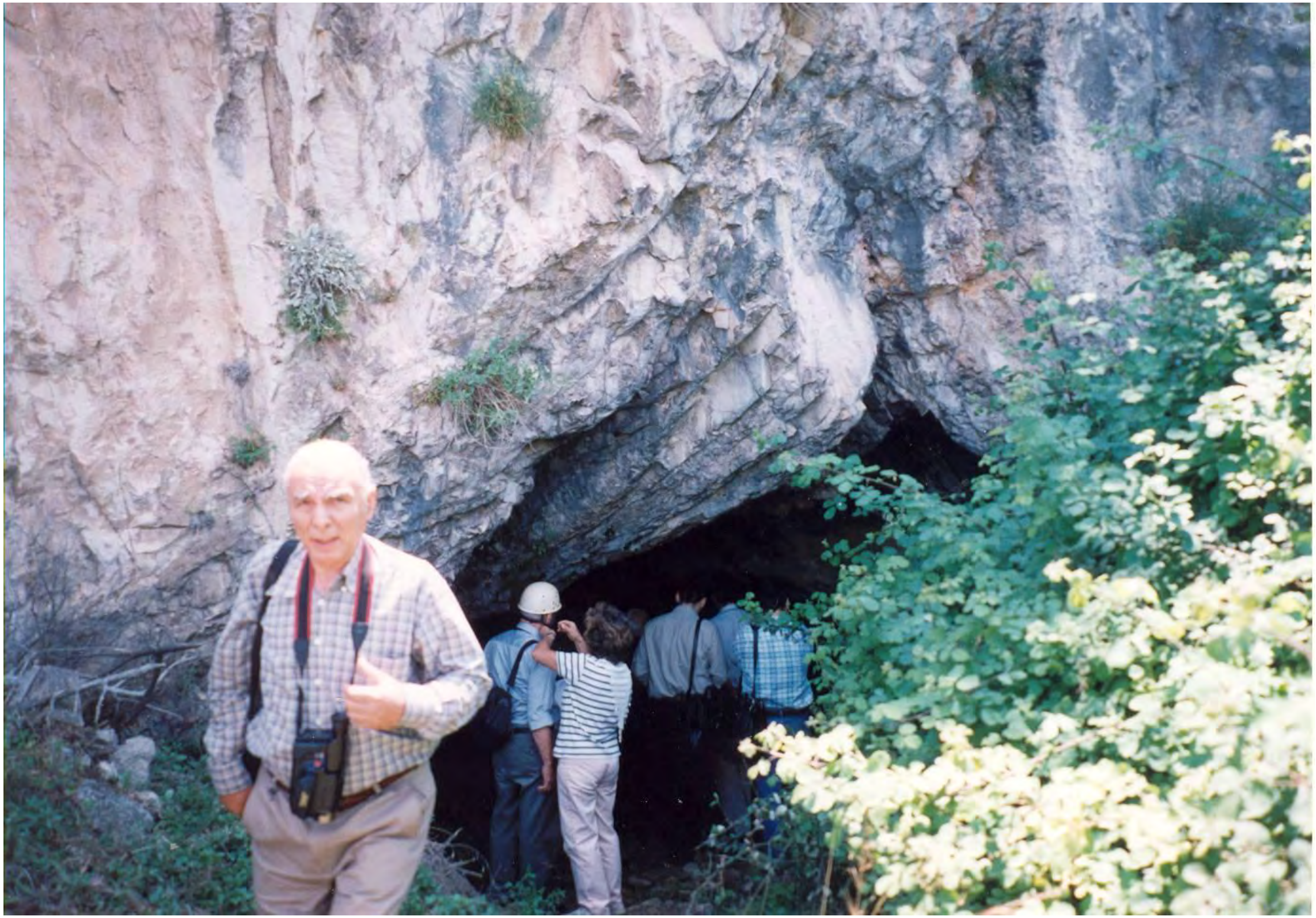

Fig. 1.4: The largest cesspit receiving flood waters [Author]

Fig. 1.4: The largest cesspit receiving flood waters [Author]

1.2. Classical and Hellenistic period

– The drainage of the Ptekhai lake (4^{th} c. BCE)
– The first “Build, Operate, Transfer” (BOT) scheme in the world
– Near Eretria (Euboea), (Fig. 1.7)

(4th c. BCE)

- Joint Venture:
  - Harephanēs (Megara) + partners
- Covenanter:
  - The Parliament of the City of Eretria

Fig. 1.9. The stele where part of the BOT contract is engraved (Athens Museum of Inscriptions)

- Time schedule: 4 years
- Remuneration in kind:
    - 10 years private cultivation
- Environmental conditions
- Detailed technical provisions
- Guaranties and reliability

2. WATER LIFTING DEVICES

"The technology of lifting water, did not become **mechanised** until the Hellenistic period"

Humphrey et al., 1998, p. 309

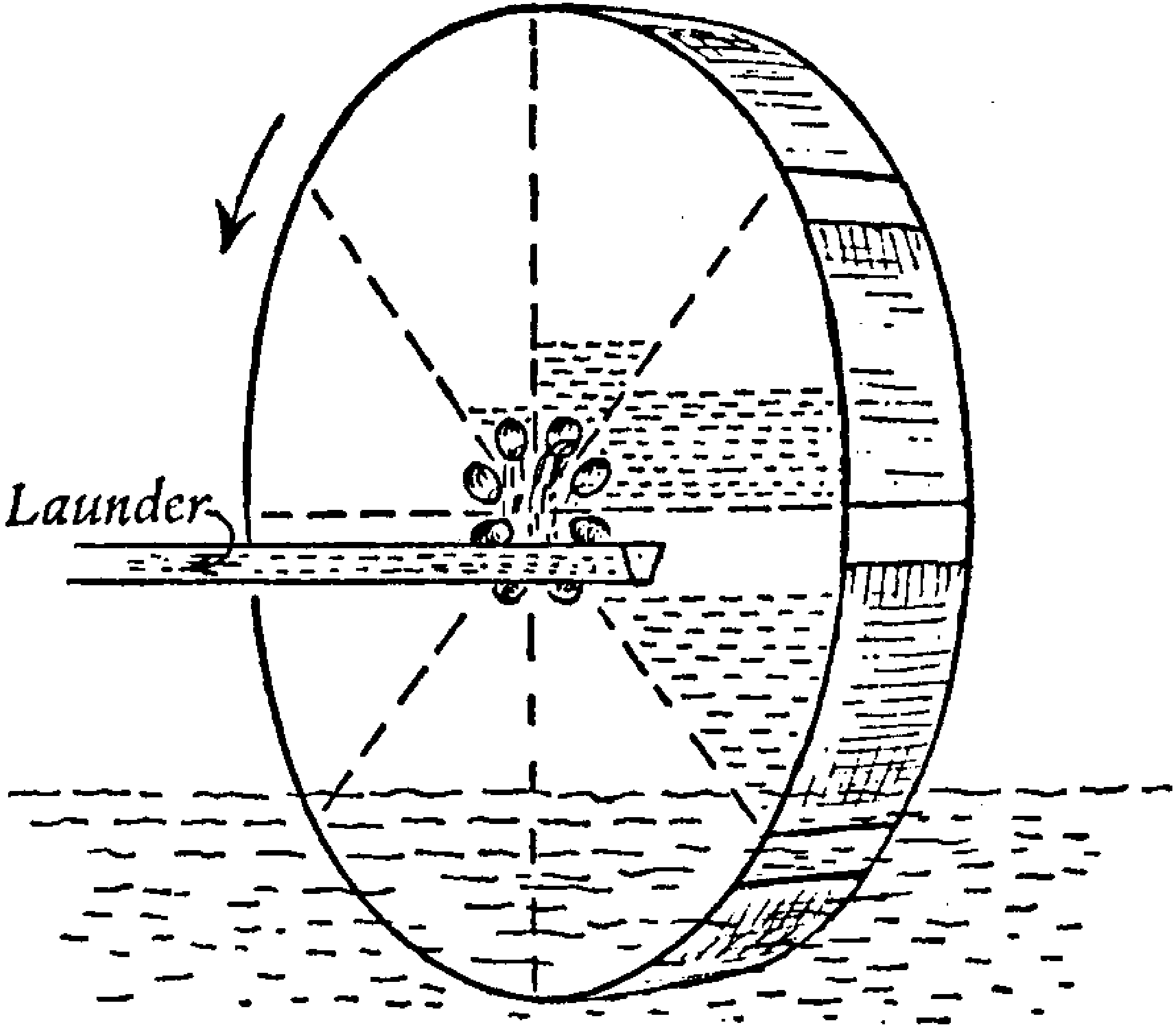

Fig. 2.1. The “Tympanon” (Landels J., Berkeley, 1981)

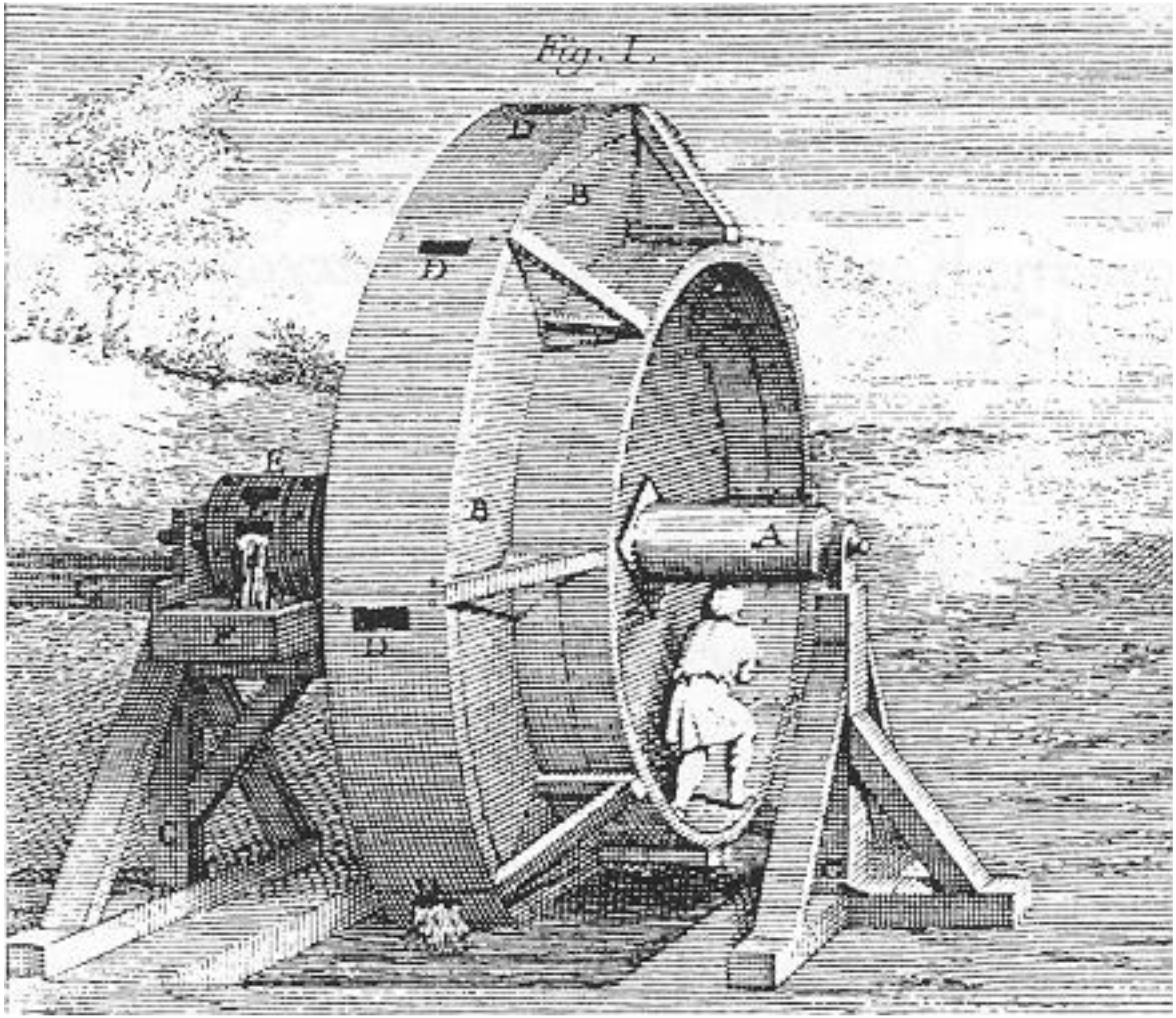

Fig. 2.2. Treading of Tympanon [Perrault M., Bruxelles 1979 (1684)]

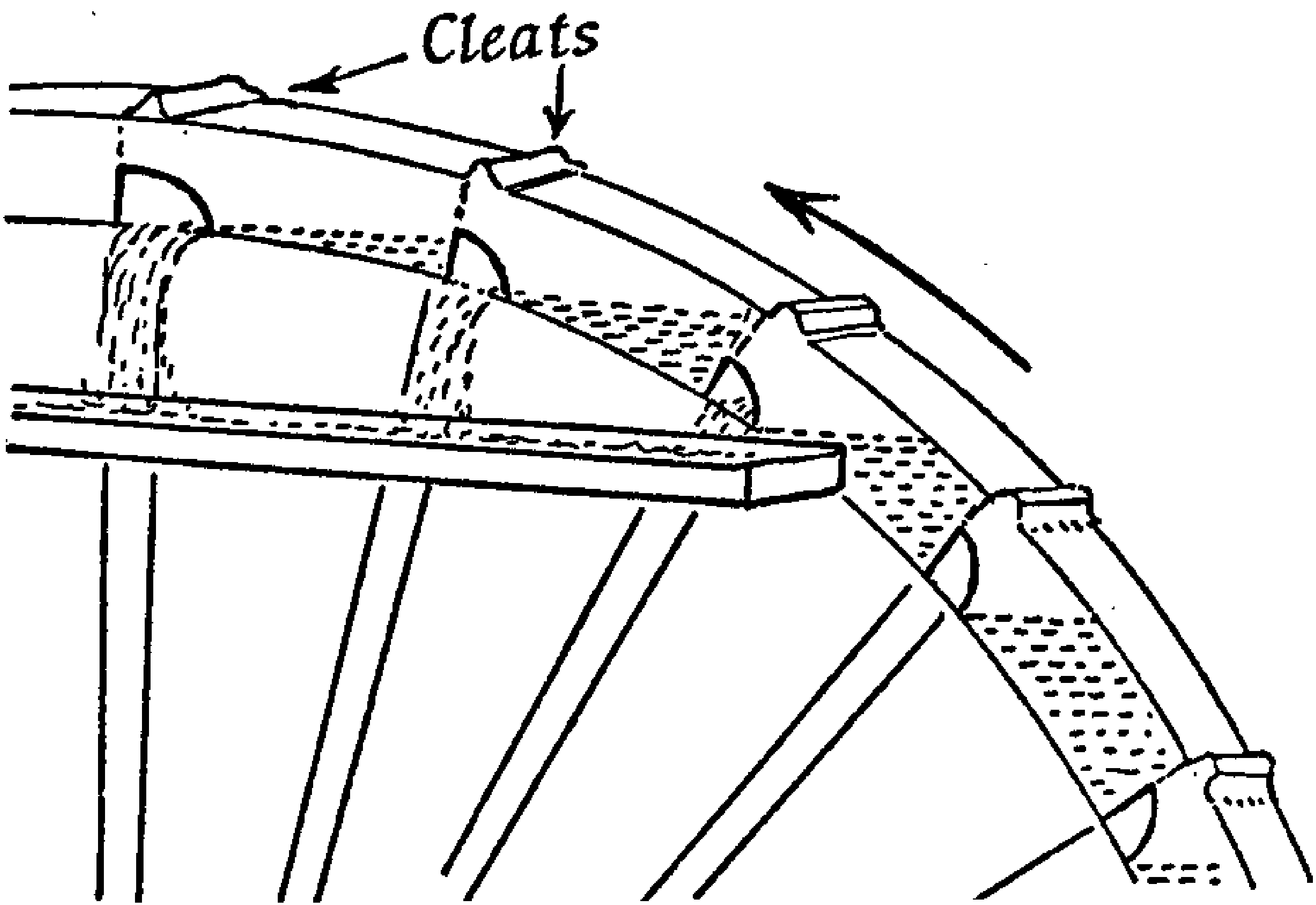

Fig. 2.3. Water compartements of a water wheel (Landels J., Berkeley, 1981)

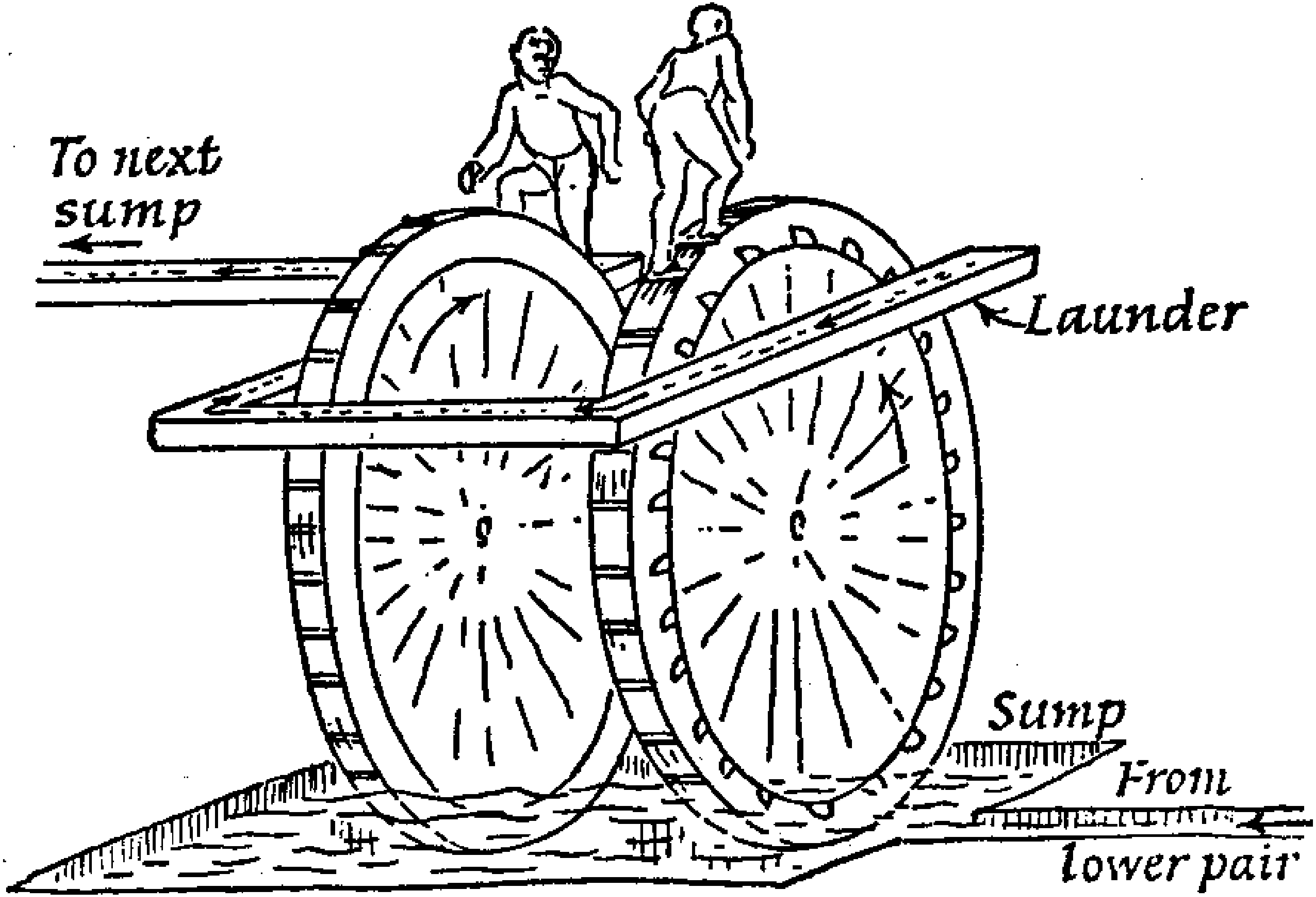

Fig. 2.4. Wheels with “compartements rim”; representation based on archeological finds in Spain (Landels J., Berkeley, 1981)

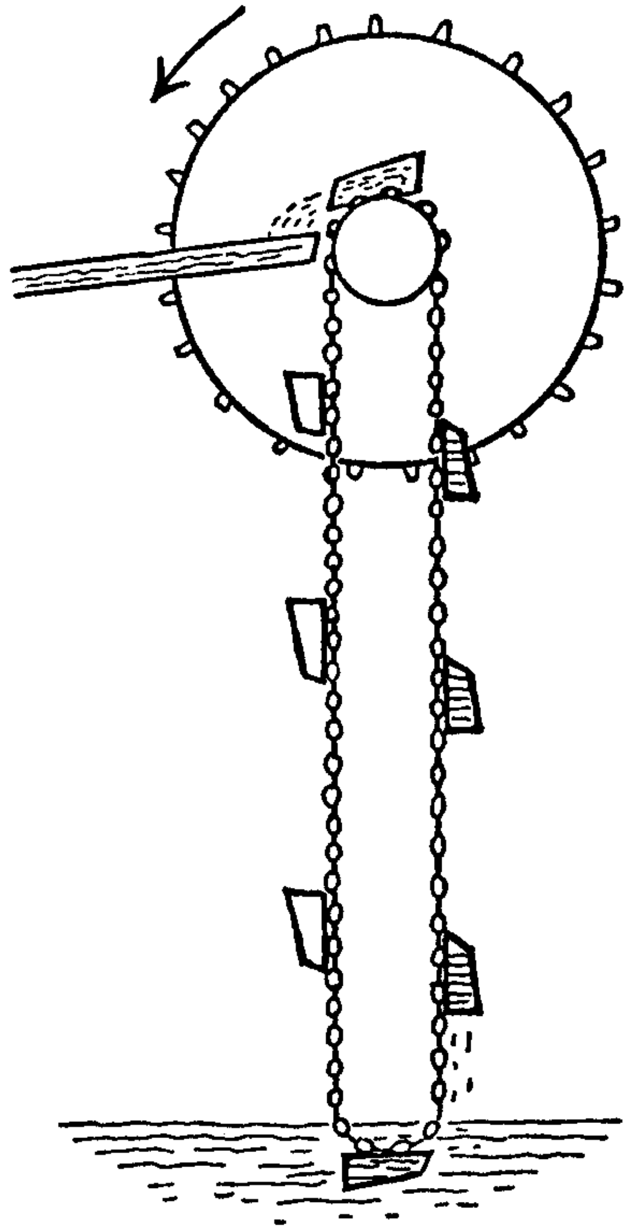

Fig. 2.5. The wheel-driven Backet-Chain (Landels J., Berkeley, 1981)

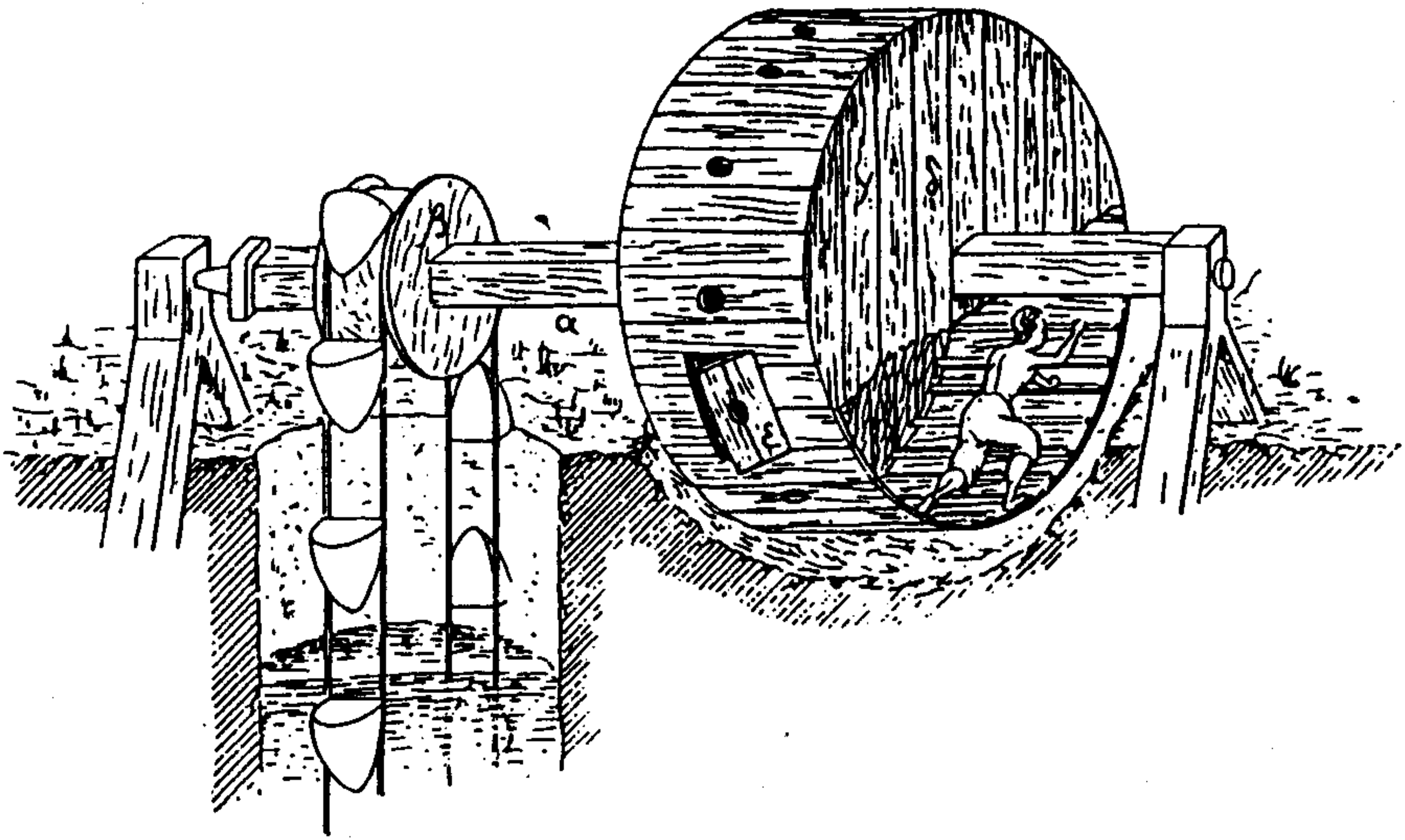

Fig. 2.6. The wheel-driven bucket-chain, following the tradition of Philo (Carra de Vaux representation, in Oleson J., Toronto, 1984)

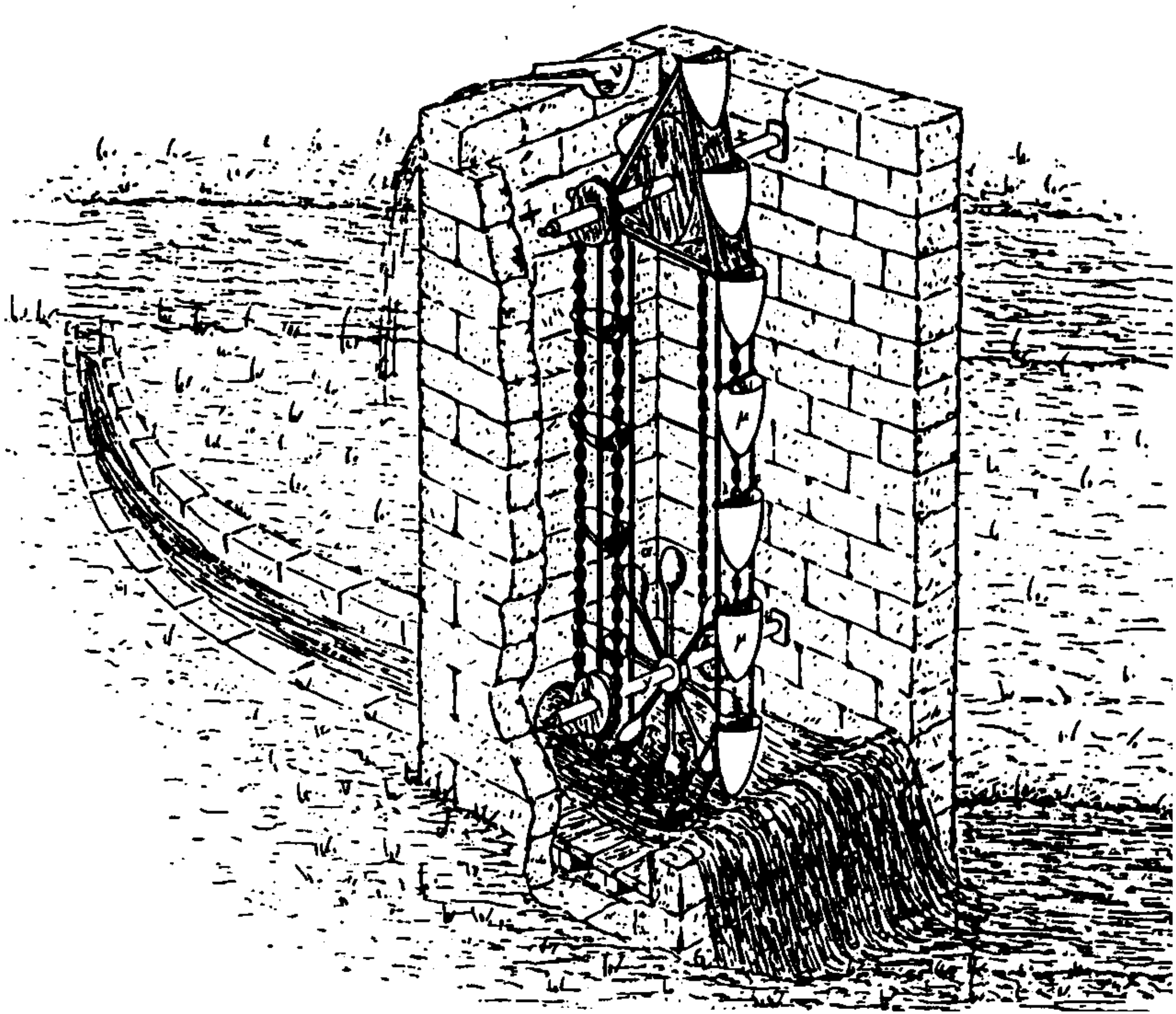

Fig. 2.7. Philo's paddle-wheel driven bucket-chain. Representation by Carra de Vaux, Paris 1908

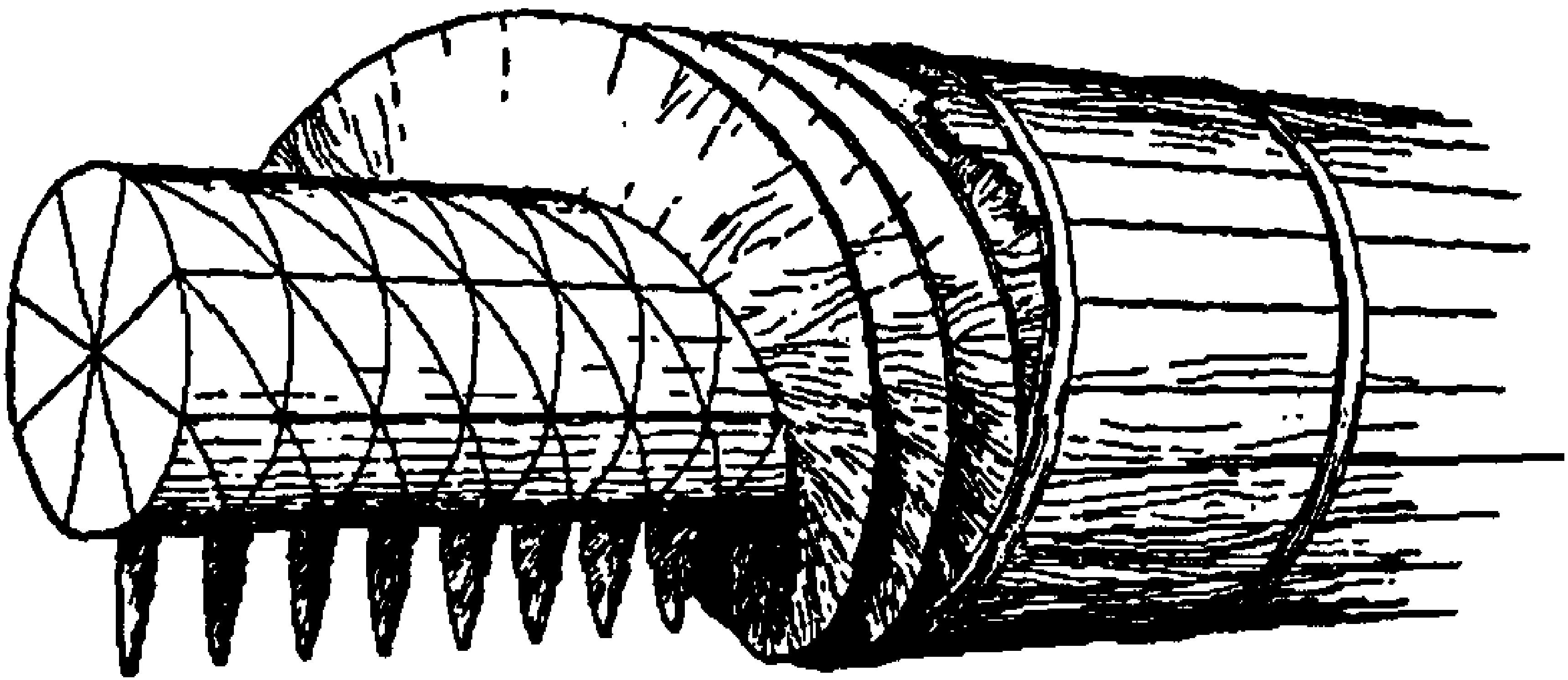

Fig. 2.8. Tracing of spirals and affixed elicoidal strips in an Archimedēs screw pump (Representation by M.H. Morgan, Cambridge, 1946)

The Ctēsibian force-pump
[3rd c. BCE]

- Two pistons, two cylinders
- Appropriate valves
- Feasibility of metal working and tightness
- Philo of Byzantium (Alexandria, ~ 240 BCE):
  "You should not wonder at or doubt that such craftsmanship is possible"
  [Pneumatics, book IV, 77.7]
- Used up to day…

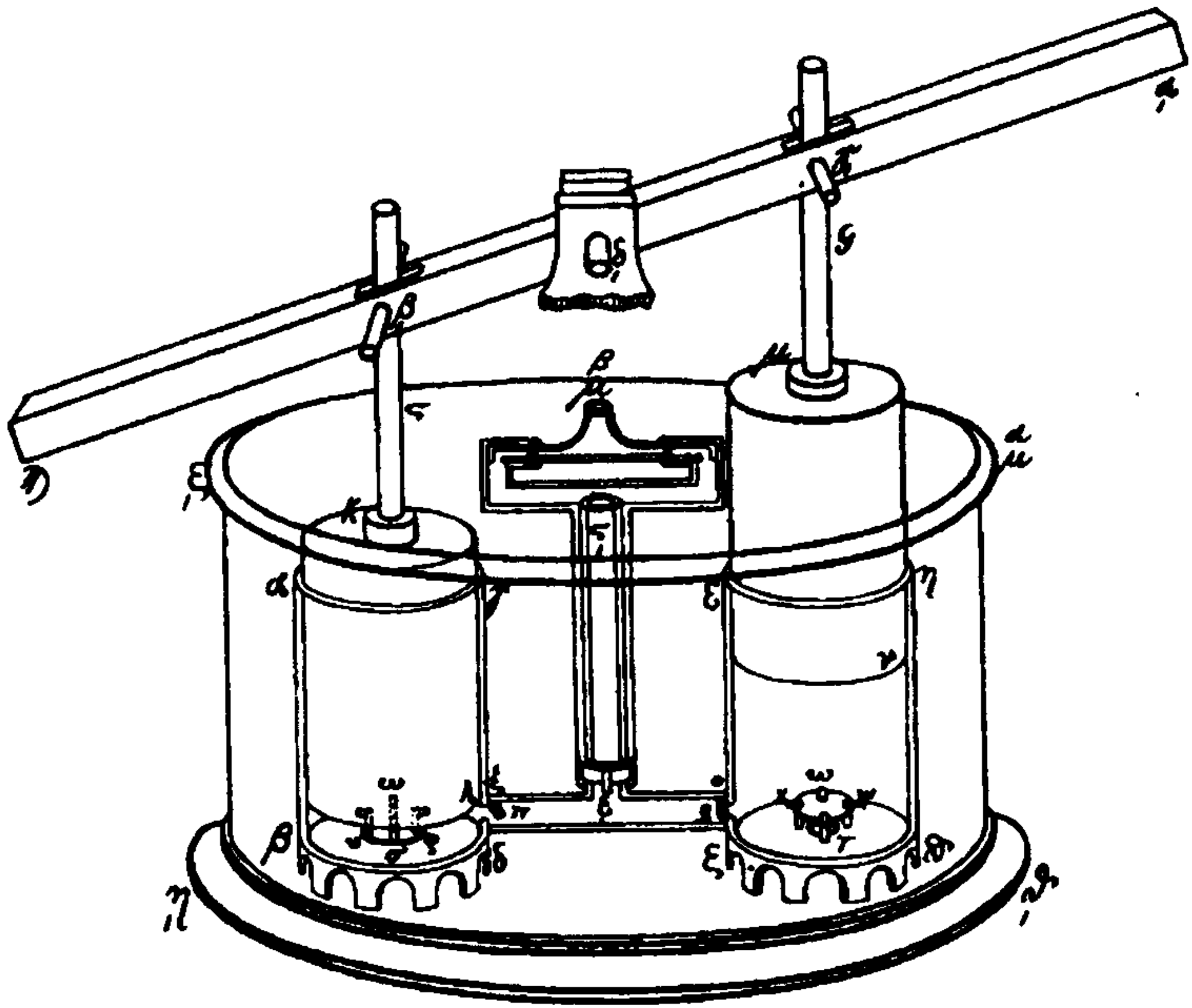

Fig. 2.10. Ctesibius' force pump with swiveling nozzle (Schmidt, W.: "Heron-Druckwerke und Automaten Theatren", Teubner, 1899)

3. WATER SUPPLY

- Mycenaean
- Samos
- Athens
- Megara
- Pergamos

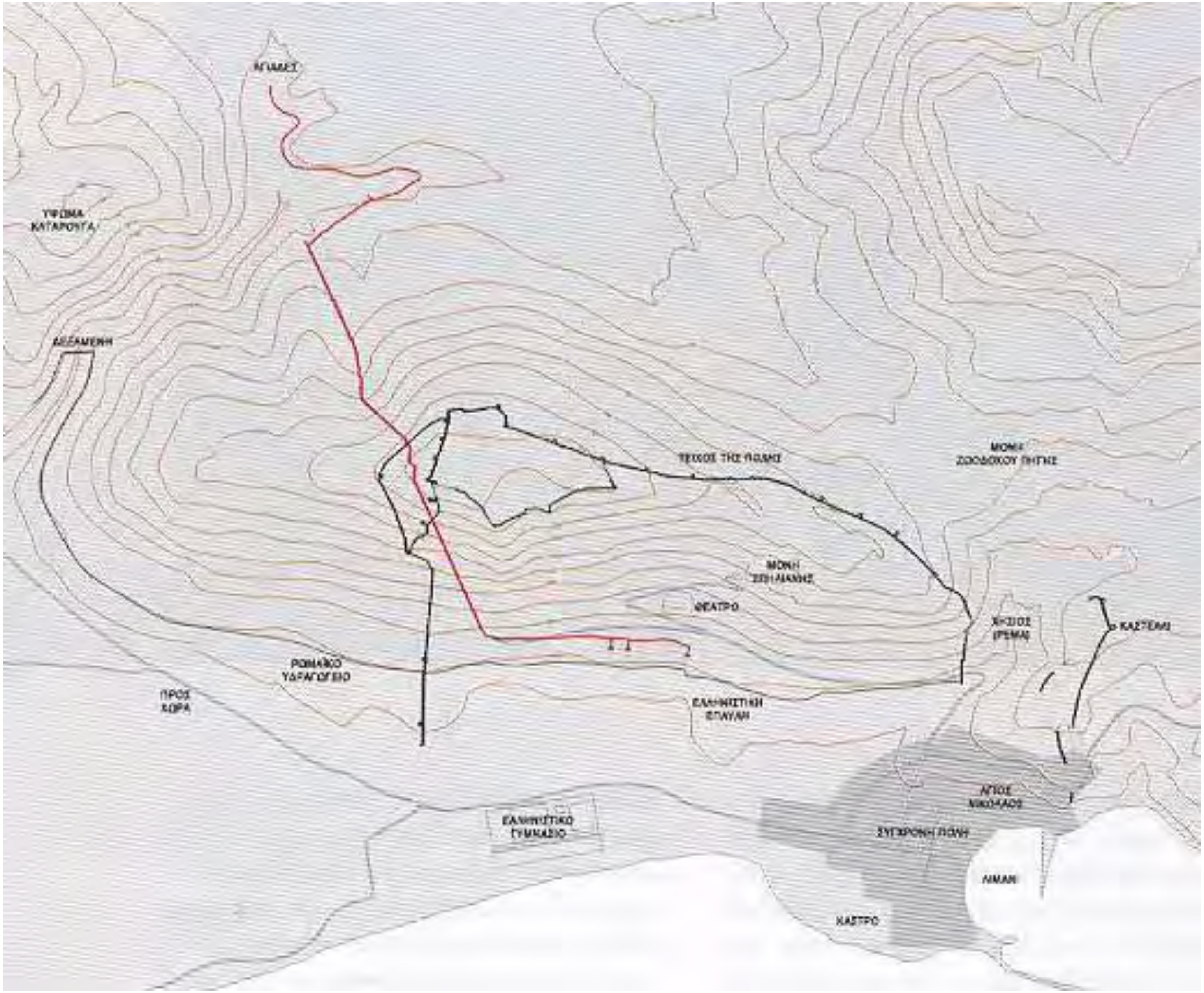

Fig. 3.1. Lay out of the Eupalinian aqueduct in Samos (~550 BCE)(Kienast, H., Die Waserleitung des Eupalinos auf Samos, Deutsches Archäologisches Institut, Samos, Band XIX, 1994)

Fig. 3.2. Typical cross section of the Eupalinos tunnel (Kienast, H., Die Waserleitung des Eupalinos auf Samos, Deutsches Archäologisches Institut, Samos, Band XIX, 1994)

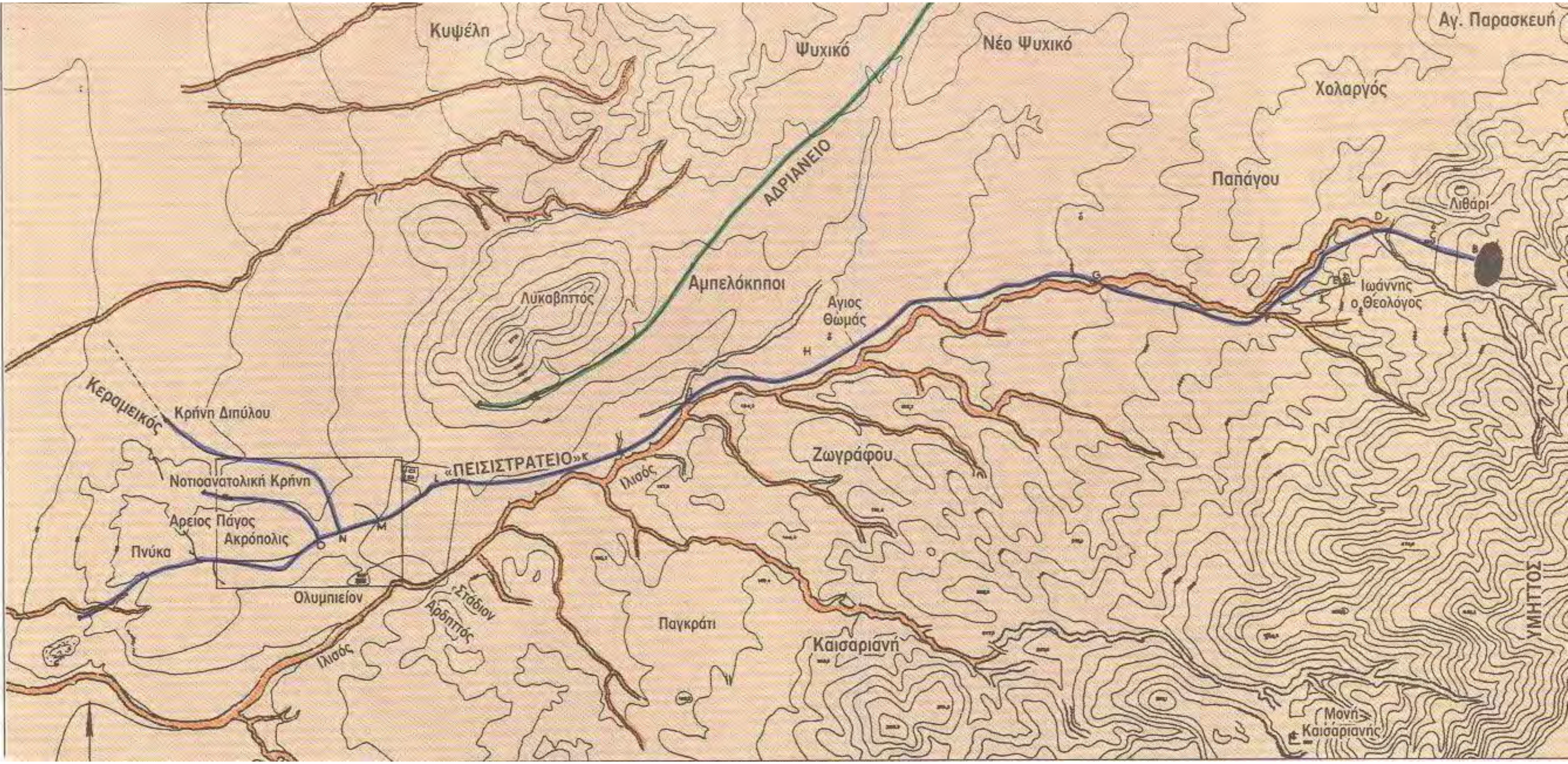

Fig. 3.5. Lay out of the Peisistratos and Hadrian aqueducts in Athens

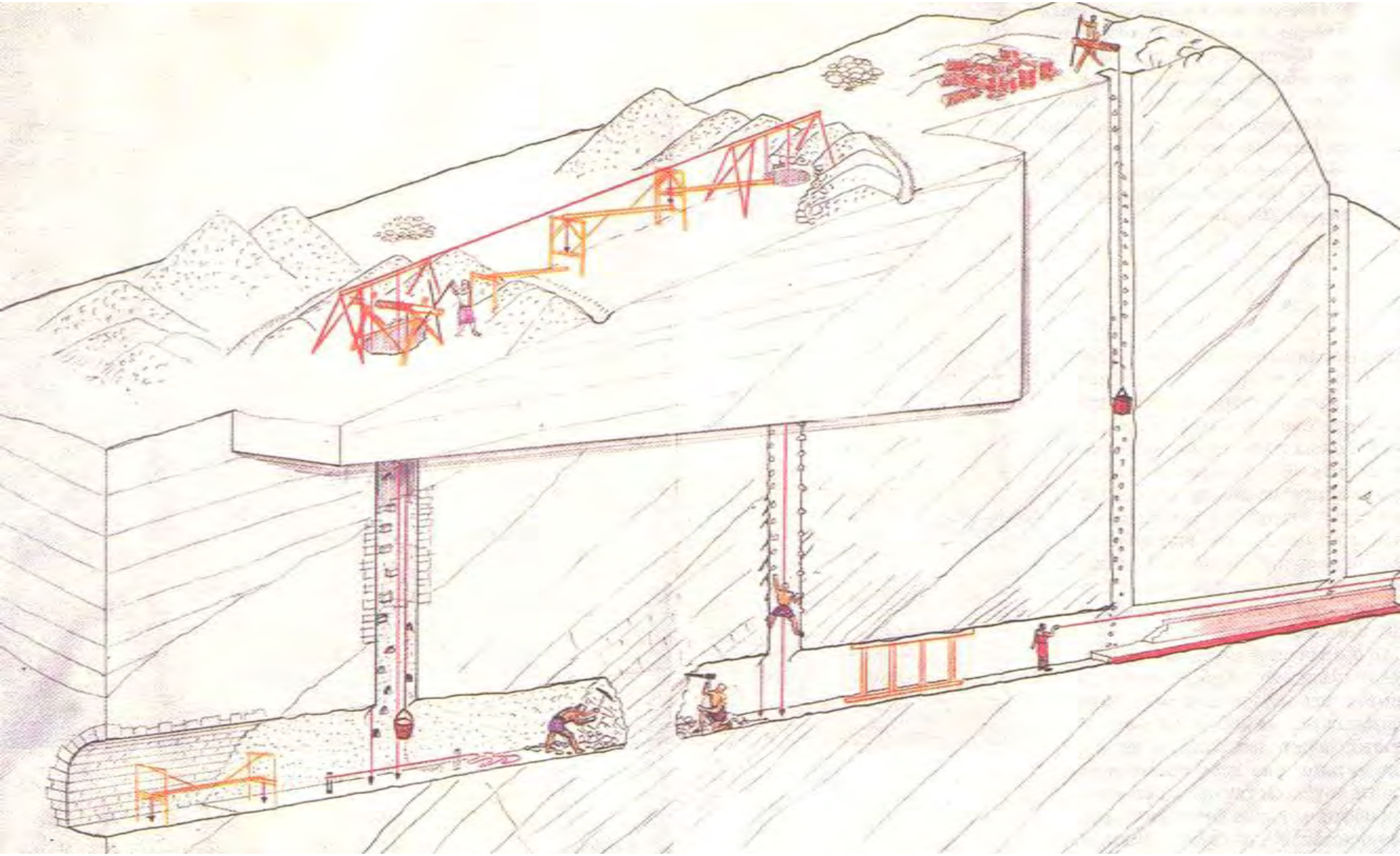

Fig. 3.6. Technical details of the tunnels of Hadrianian aqueduct (M. Korres, 1985)

Megara

- The water-reservoir of Theagenēs, (Fig. 3.10) (~ 500 BCE)
- Roof supported by five rows of columns (Fig. 3.11)
- Area 14 x 19 m divided in two
- Flow regulating bronze valves, (Fig. 3.12)
- Plastering of walls (pozzuolanic mortar)

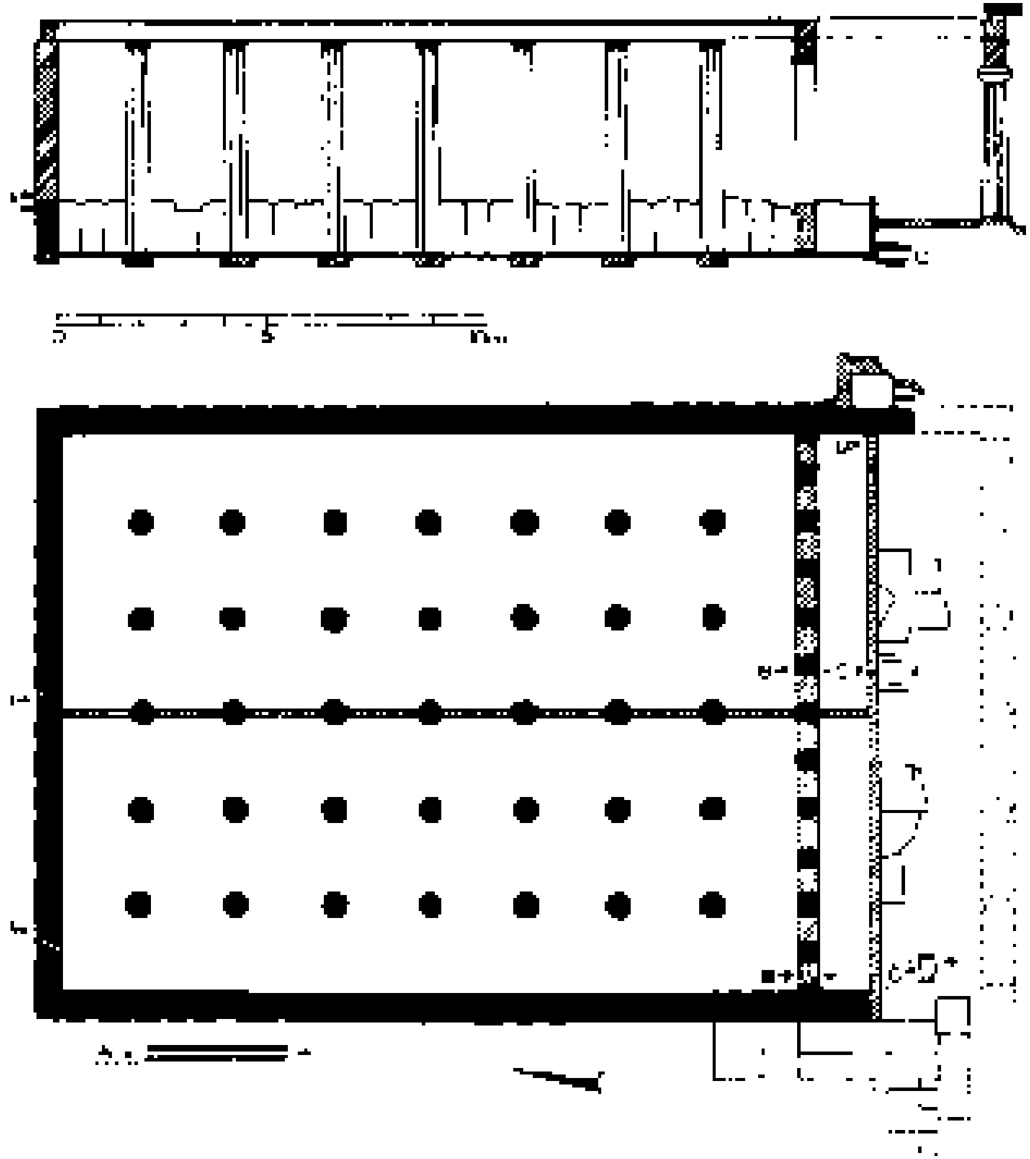

Fig. 3.10. The Theagenēs krēnē, Megara (5th cent BCE) [P. von Zabern, p. 113]

Pergamos (3rd, 2nd c. BCE)

(Capital of the Kingdom of the Successors central coastal Asia Minor)

"It is with the Hellenistic age that the great breakthrough comes [in Hydraulics]"

A. Trevor Hodge, 1992

- Several long (~ 40 km) aqueducts
- Valleys crossed by means of subterranean conducts
- Thus **siphons under pressure** were inevitable
- New materials for pipes:
  - ceramic ➡ –
  - stone ➡ 100 m
  - lead ➡ 200 m

  } pressure of water

Fig. 3.18. Tripartite terracotta aqueduct of the Eumenian aqueduct of Pergamos (P. von Zabern, p. 25)

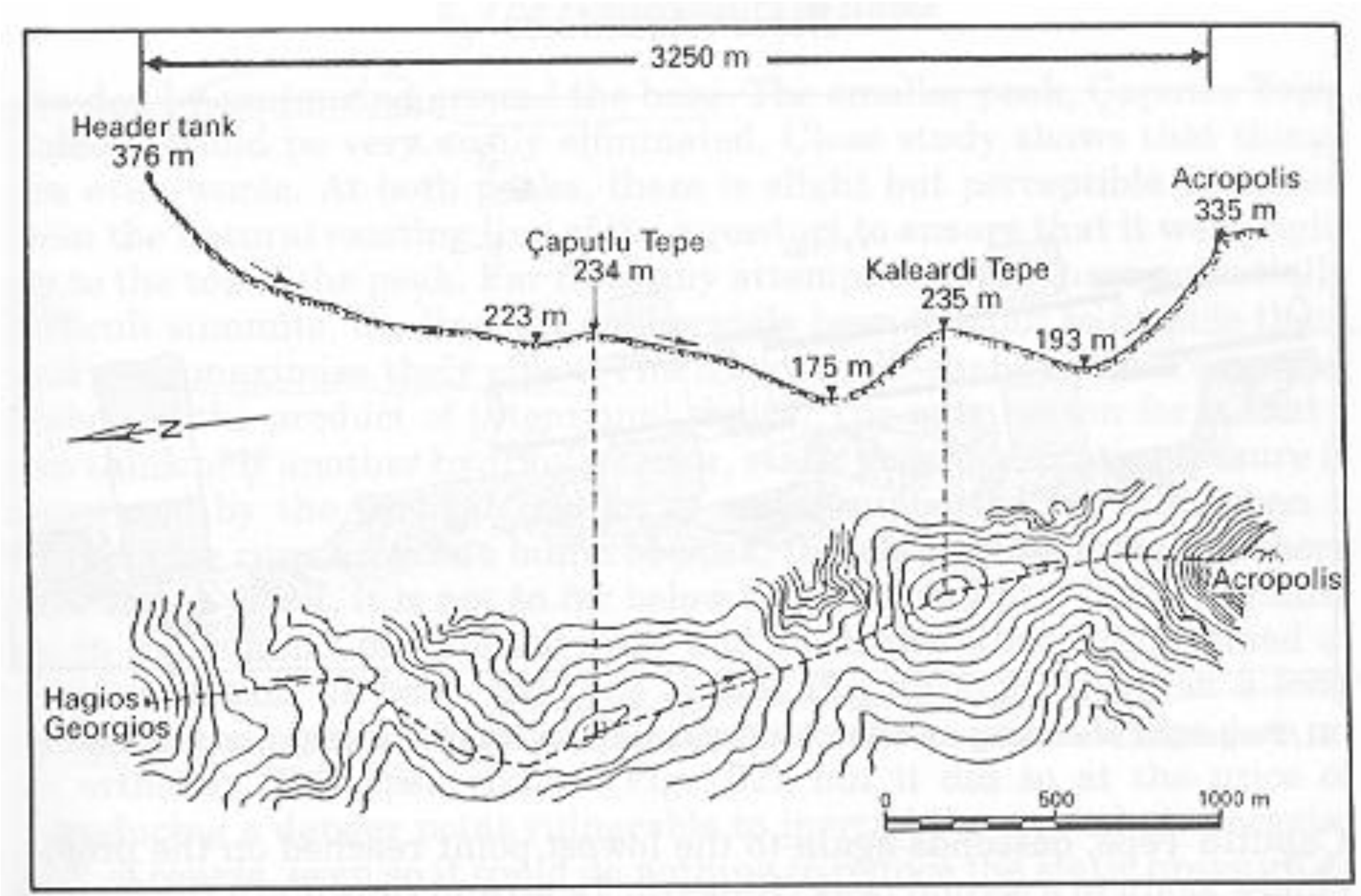

Fig. 3.19. Pergamos: Longitudinal section of the final part of the aqueduct No 2 (from Madradag), under hydraulic pressure up to 200 m of water column. (A. Trevor Hodge, p. 43)

Fig. 3.14. Stone-pipes form in the siphon of the city of Patara (H.Fahlbusch, in Ph. Von Zabern, p. 157)

Fig. 3.22. The archaic hybrid solution of lead-pipes and stone-collars, in the Artemision of Ephesos (P. von Zabern, p.180)

VI. DESIGN and CONSTRUCTION