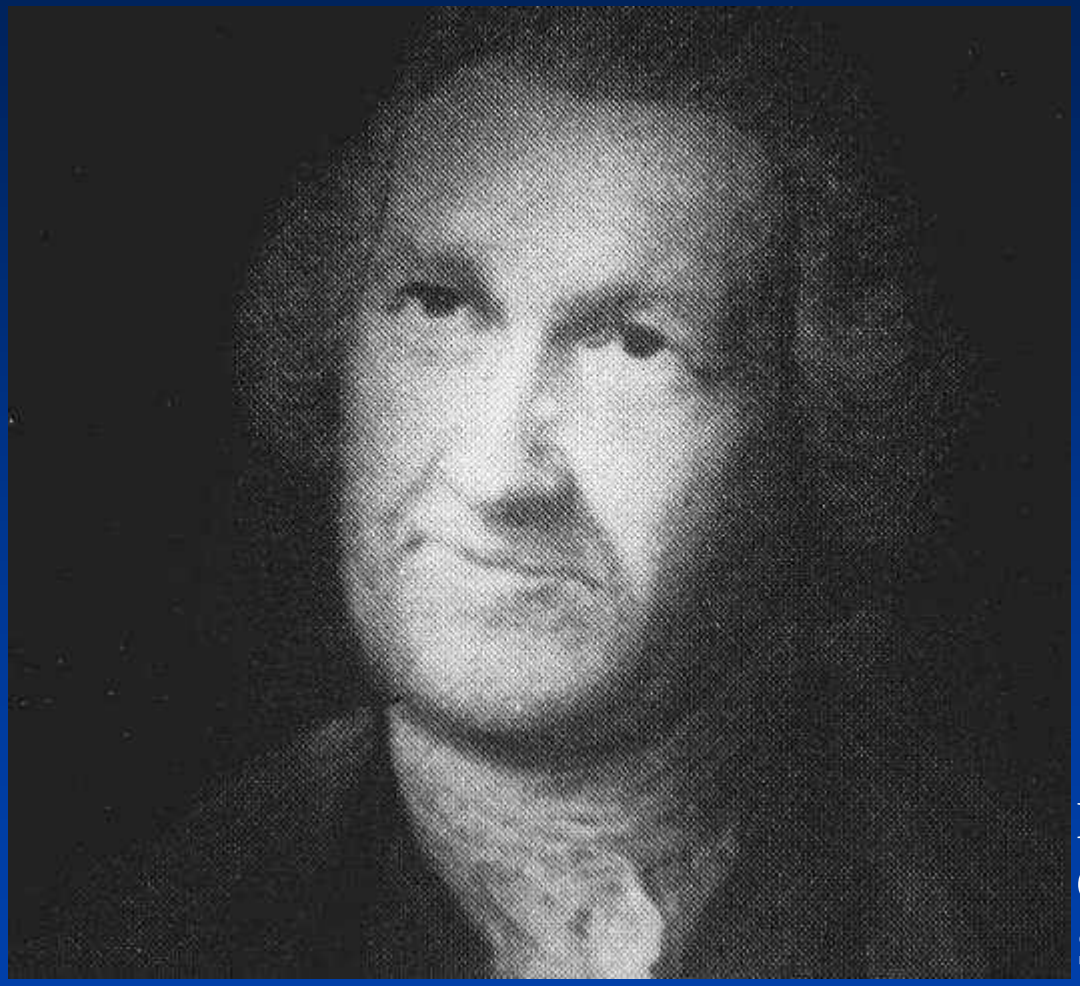
Smeaton: Legacy of an Innovator

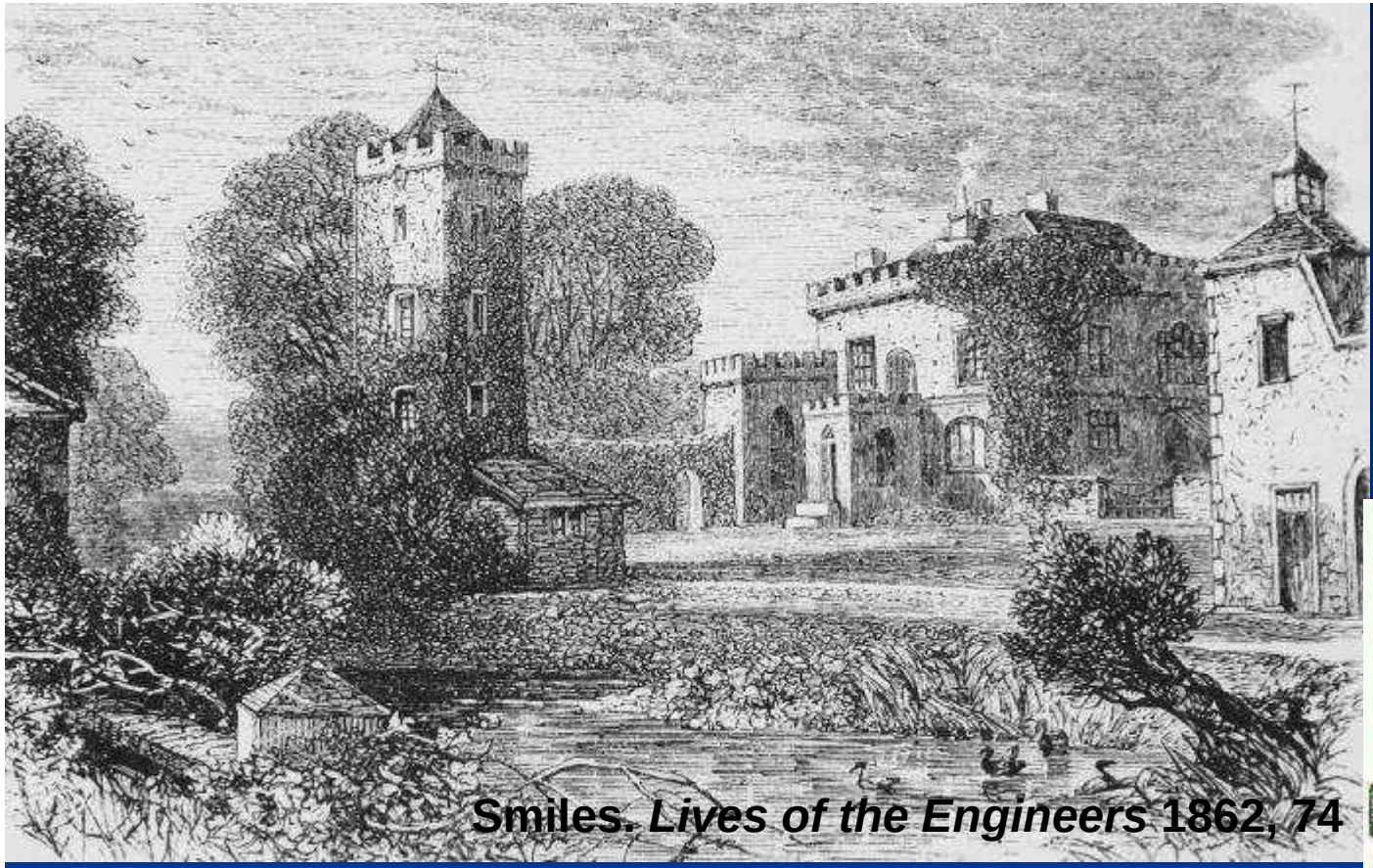
By Prof Roland Paxton MBE FICE FRSE *Em. Member ICE PHEW*



Smeaton's *Designs* Newcomen Society 1950, pl. 4

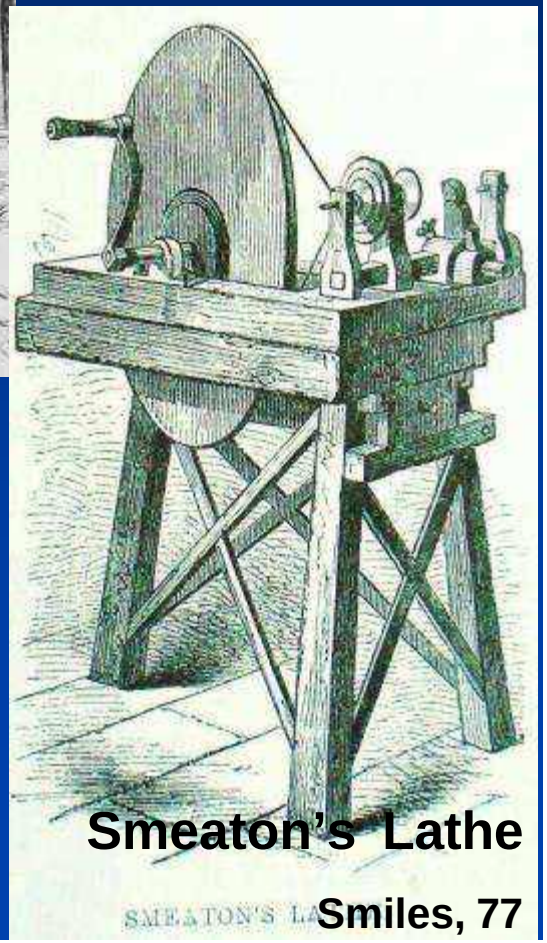
Smeaton at 59 By Gainsborough Commissioned by Samuel Whitbread

John Smeaton International Symposium Innovations in Civil Engineering Heriot-Watt University Edinburgh, UK 4th Sept 2024



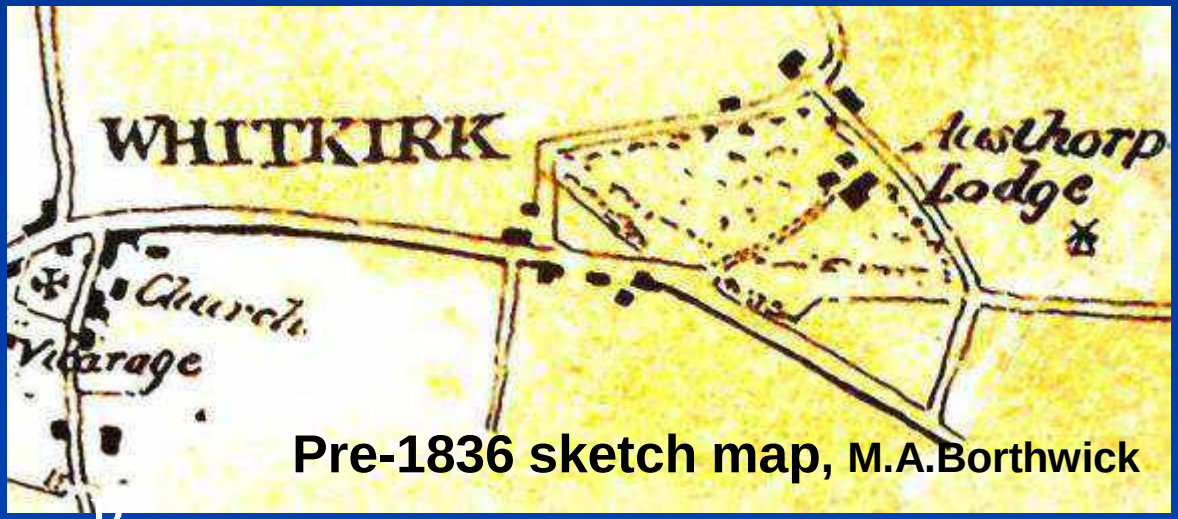
Smiles. *Lives of the Engineers* 1862, 74

Smeaton
b. 28 May
1724
Austhorpe
Lodge
near Leeds



Smeaton's Lathe

Smiles, 77



Pre-1836 sketch map, M.A.Borthwick

P

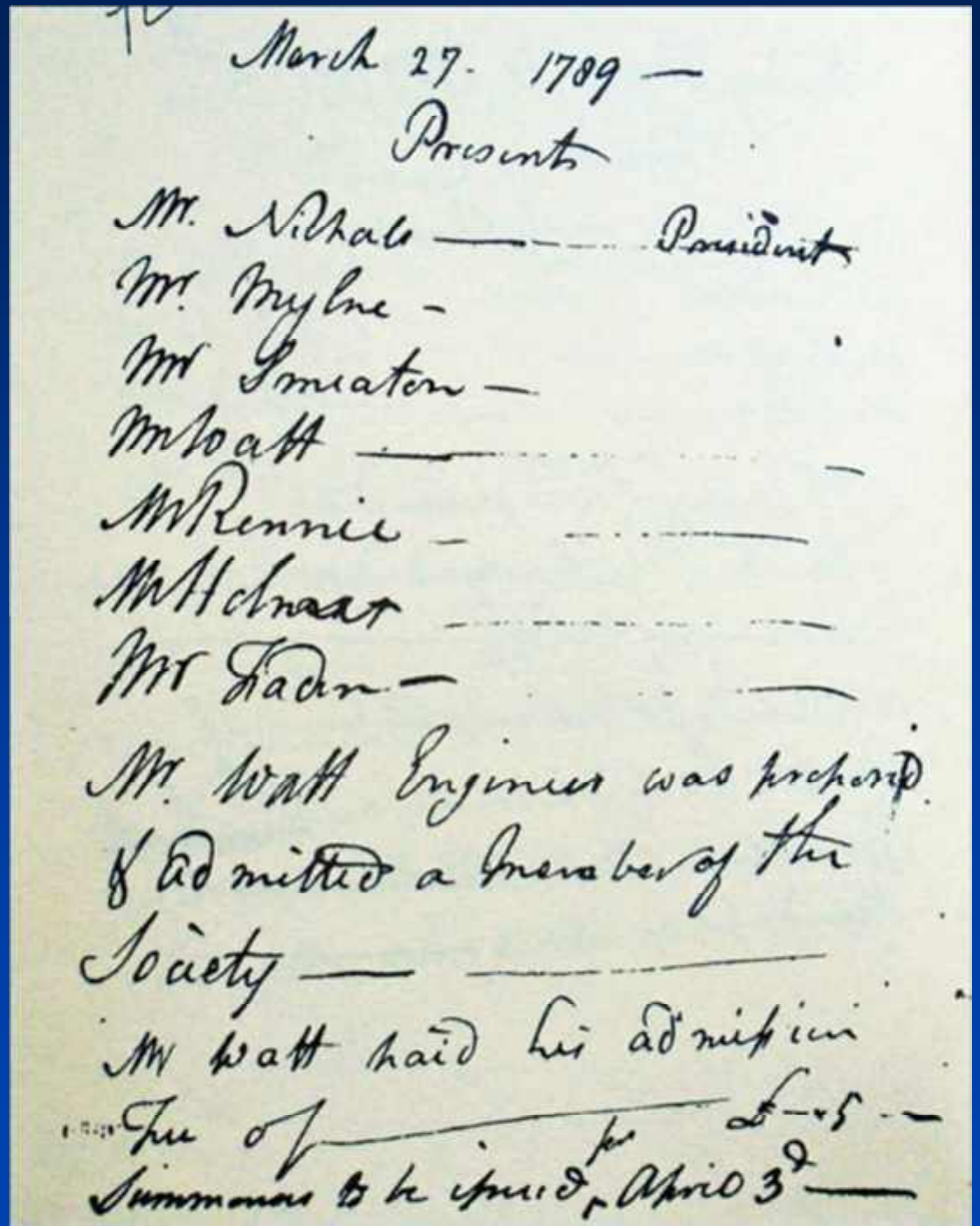
- 1734-40 Leeds Grammar, developing home workshop
- 1742-52 makes tools, models, instruments; becomes a leading engineering scientist
- 1753 FRS, gold medal 1759 for '*Experimental Enquiry into Power'* paper, 1 of 18 read by 1788! **EXHIBITION**
- 1753 Begins career as 'civil engineer', first to be named so in reports of 1754 and 1768
- 1755-85 after examining "Low Countries" works and Thames bridges, engineered Edystone Lighthouse

+100s of projects nationwide; in extraordinary demand;

1200 drawings preserved at Royal Society

- 1783 Gainsborough portrait painted

Society of Engineers *Minute-book 1771-1791*
James Watt admitted 1789



March 27. 1789 —

Present

Mr. Nicholson — President

Mr. Myln —

Mr. Smeaton —

Mr. Watt —

Mr. Rennie —

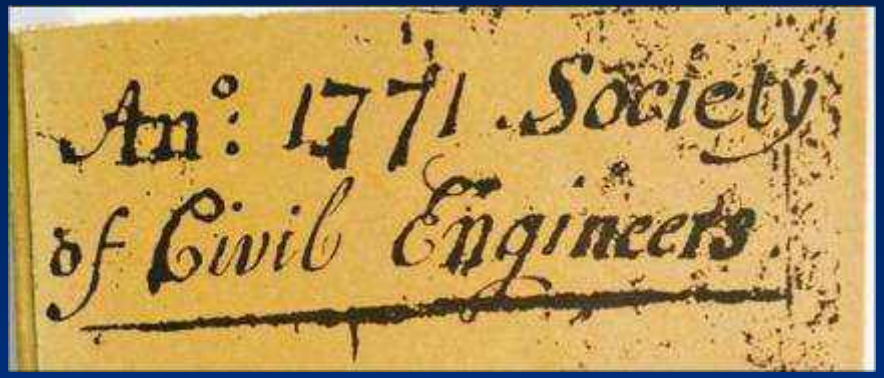
Mr. Hanson —

Mr. Yeates —

Mr. Watt Engineer was proposed & admitted a Member of the Society —

Mr. Watt paid his admission Fee of £—5—

Summons to be issued for April 3d —



Smeaton praised Watt's steam engine improvement, ***"Your idea of condensing in a separate vessel from the cylinder, I took upon as a greater stroke of invention than has appeared since Newcomen's engine in 1712."*** Smeaton also offered to introduce a paper by Watt at the Royal Society on this topic and supported his Fellowship in 1785

Mr Watt Engineer was proposed
& admitted a Member of the
Society ——— ———————

Mr Watt paid his admission
Fee of ——————— £—.5.—
Summons to be issued for April 3d ———

Smeaton’s innovative ’Enquiry’ into water and wind power read to Royal Society 1759, in print till 1862

Experimental ENQUIRY

CONCERNING THE

NATURAL POWERS

OF

WATER and WIND

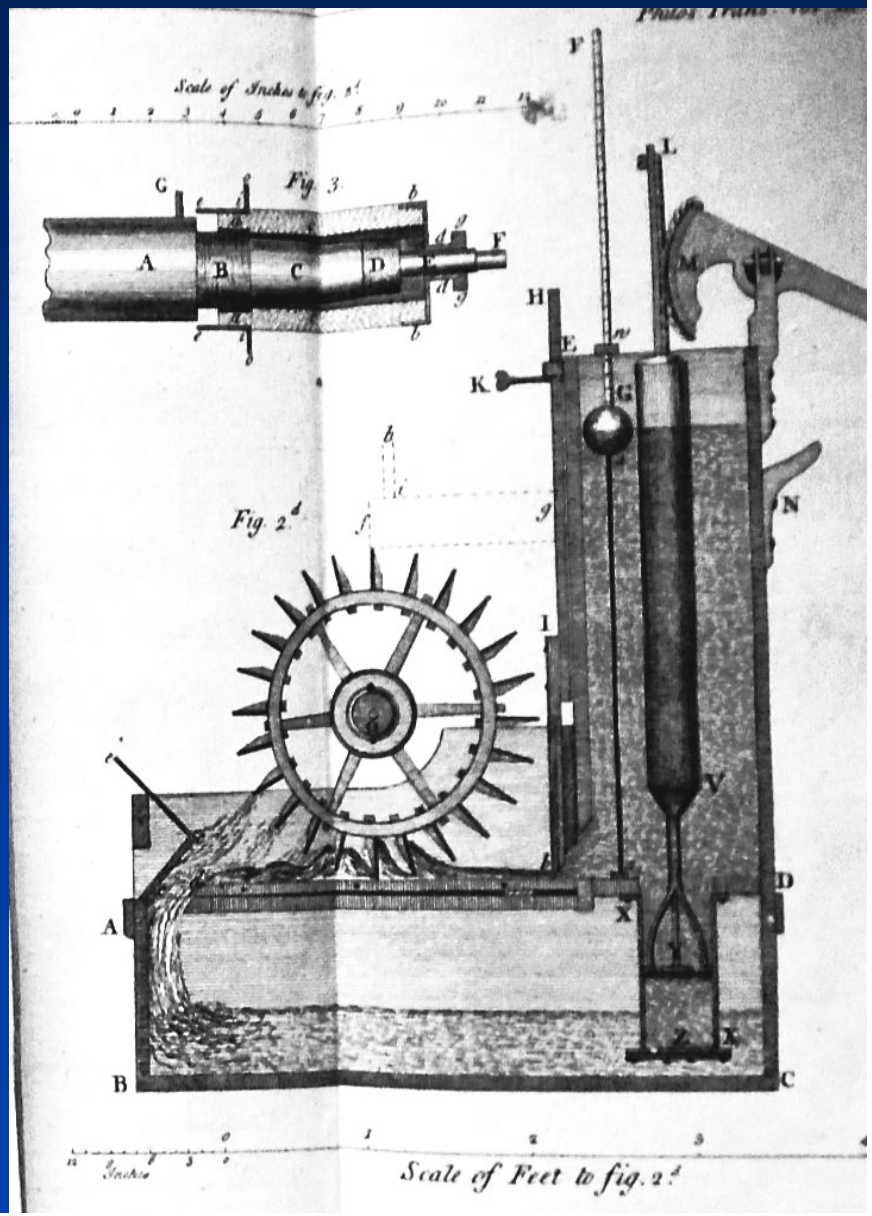
TO

Turn MILLS, and other MACHINES, depending on a circular Motion.

By J. SMEATON, F.R.S.

LONDON:

Printed in the Year M.DCC.LX.



1796 &1810 editions

EXPERIMENTAL ENQUIRY

CONCERNING THE

Natural Powers of Wind and Water

TO TURN

MILLS AND OTHER MACHINES

DEPENDING ON A

CIRCULAR MOTION.

AND AN

EXPERIMENTAL EXAMINATION

OF THE

QUANTITY AND PROPORTION

Of MECHANIC POWER

Neceſſary to be employed in giving different degrees of VELOCITY to HEAVY BODIES from a STATE of REST.

ALSO

NEW FUNDAMENTAL EXPERIMENTS

UPON THE

COLLISION OF BODIES.

WITH FIVE PLATES OF MACHINES.

BY THE LATE MR. JOHN SMEATON, F. R. S.

London, I and J, Taylor 1796 2nd edn.

RECHERCHES EXPÉRIMENTALES

SUR L'EAU ET LE VENT,

CONSIDÉRÉS COMME FORCES MOTRICES,

APPLICABLES AUX MOULINS ET AUTRES MACHINES A MOUVEMENT CIRCULAIRE, etc.;

SUIVIES D'EXPÉRIENCES SUR LA TRANSMISSION DU MOUVEMENT ET LA COLLISION DES CORPS;

PAR M^r J. SMEATON, de la Société Royale de Londres,

Ouvrage traduit de l'anglais, et précédé d'une Introduction;

PAR M. P. S. GIRARD,

Ingénieur en chef des Ponts et Chaussées, Directeur du Canal de l'Ourcq et des Eaux de Paris, Membre de l'Institut d'Egypte, etc.

PARIS,

Chez COURCIER, Imprimeur-Libraire pour les Mathématiques, quai des Augustins, n° 57;

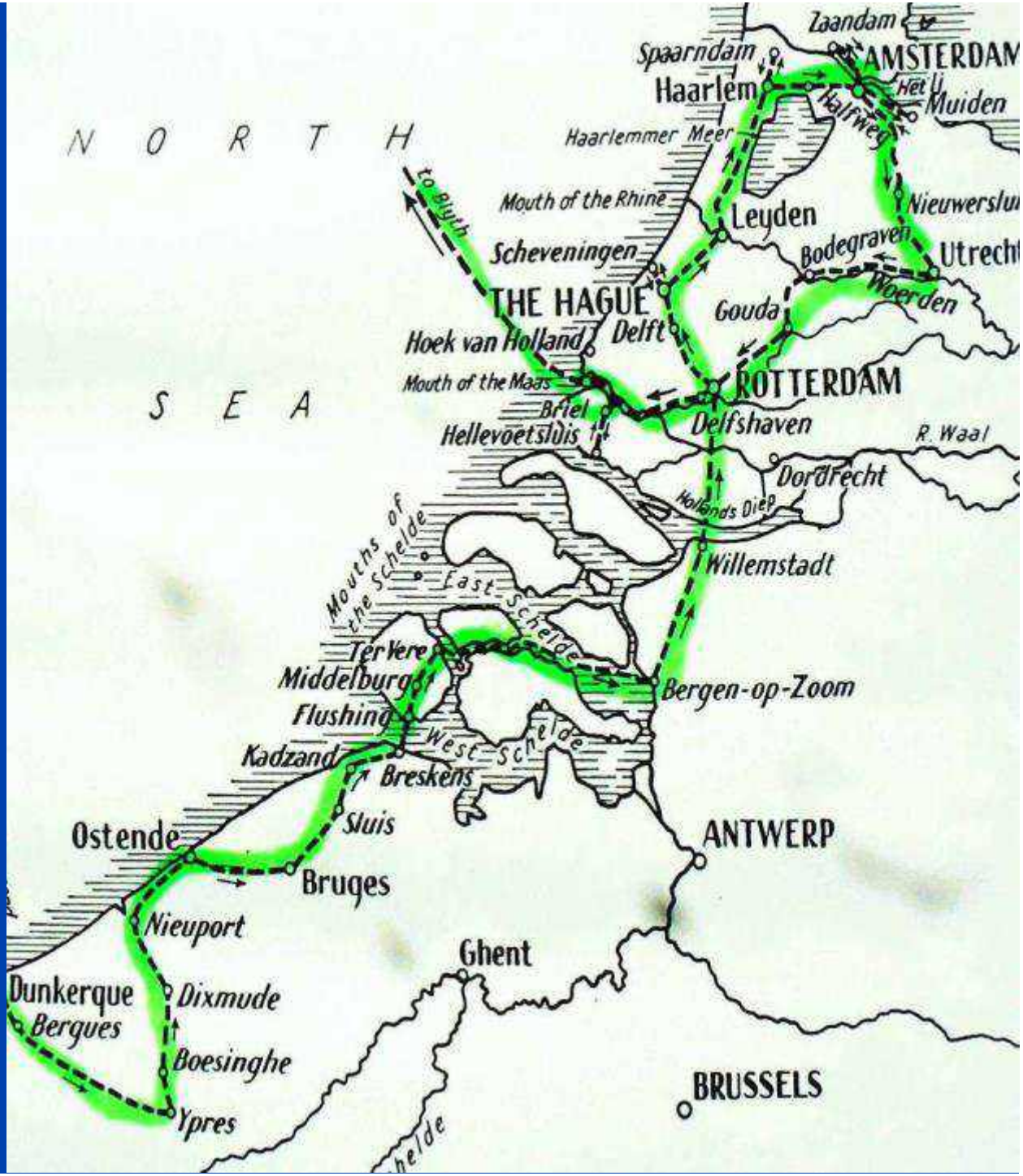
Et à La Haye, chez IMMERZEEL et Compagnie, Libraires.

1810.

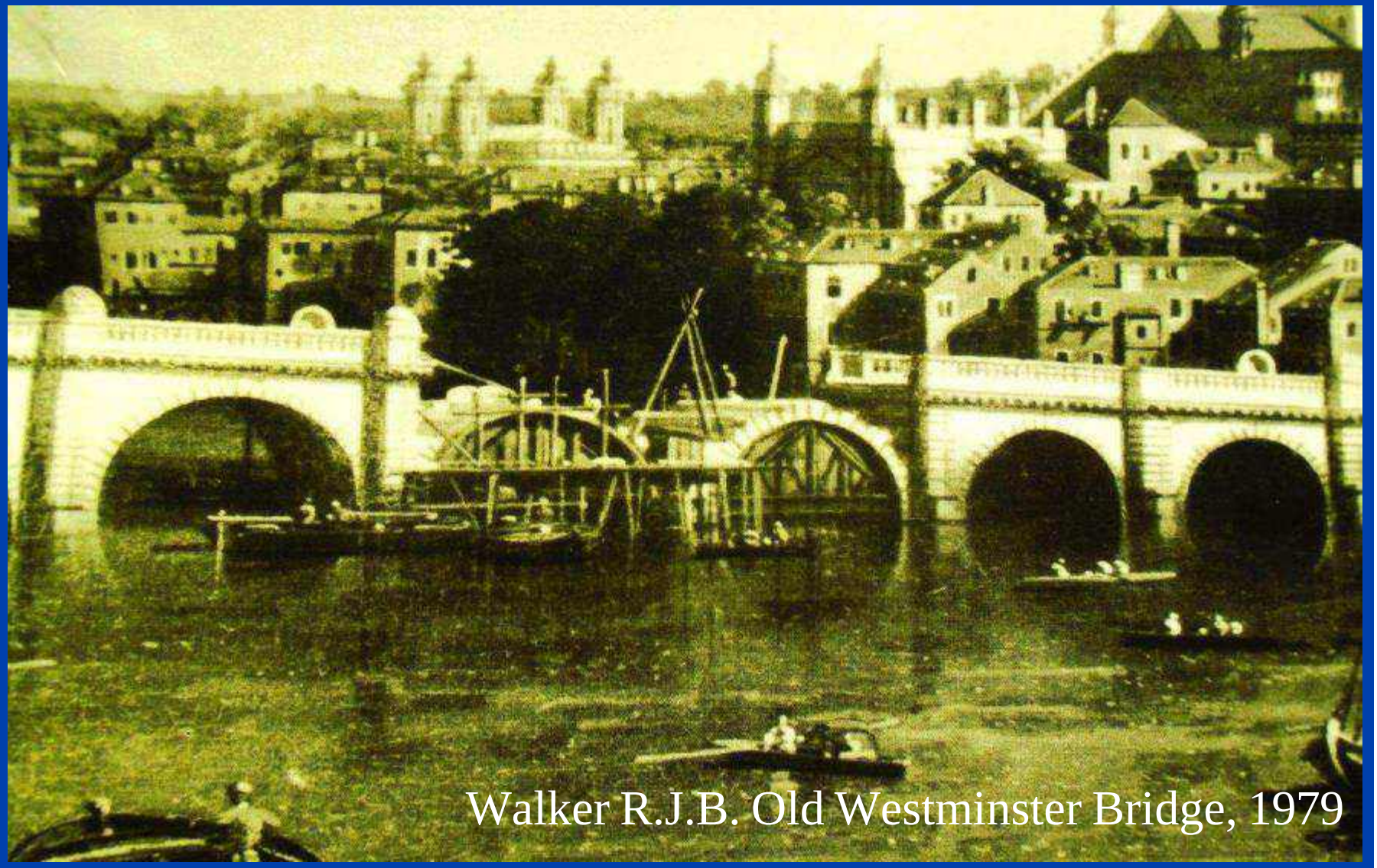
SMEATON'S Netherlands infrastructure exploration tour

15 June - 19 July 1755

Smeaton's *Diary of his Journey to Low Countries.* Newcomen Soc. 1938



Influences on Smeaton's bridge practice:
Westminster, Blackfriars, Old London Bridges 1742-63



Canaletto: Westminster Bridge view c.1746: Note ongoing remedial work

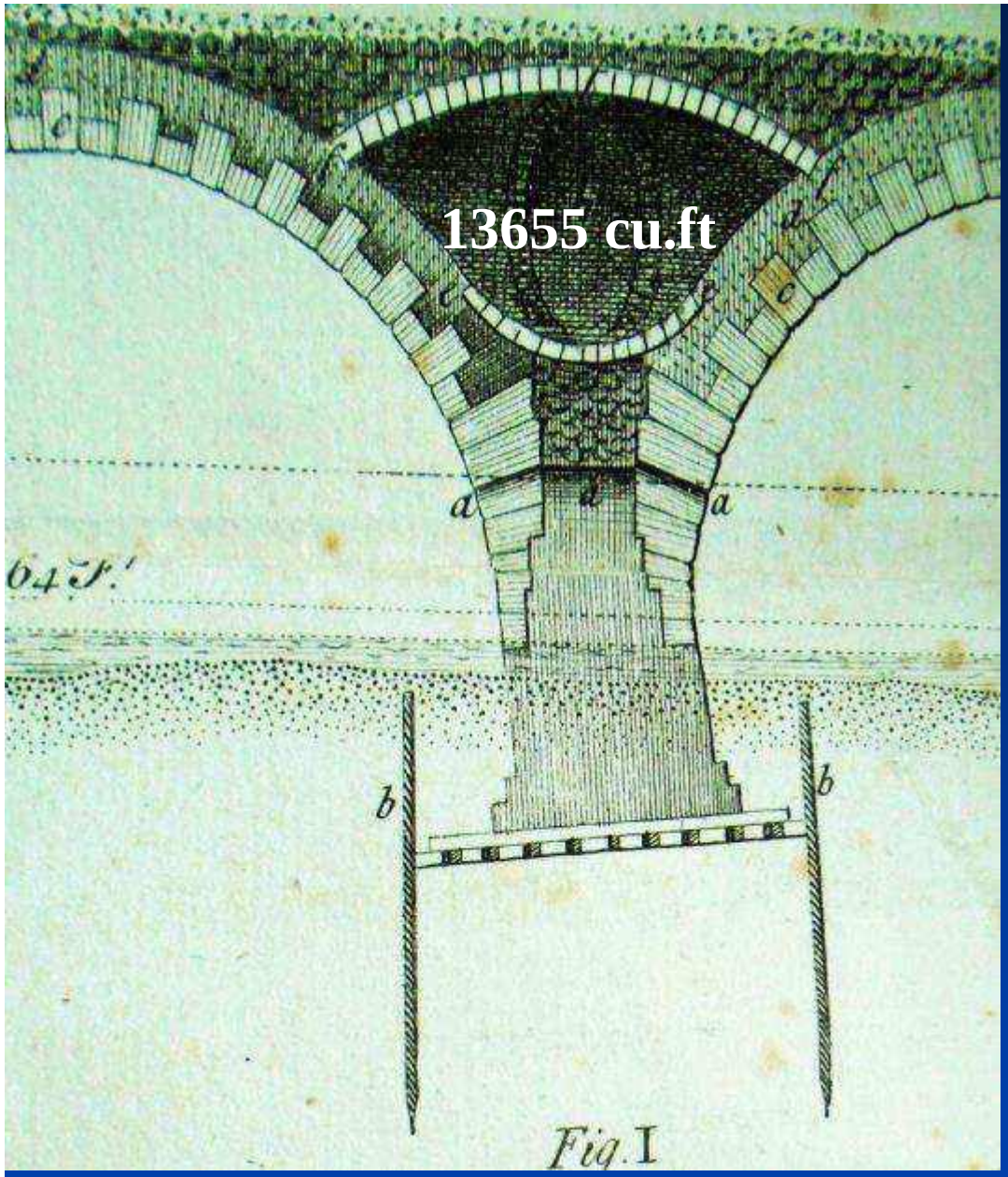


FIG. III. A ſection of the fifth pier from *Weſtminſter* ſhore, and the arches on each ſide of it, ſhewing how that pier has ſunk down, and the manner of rebuilding ſo as to prevent its ſinking any more.

a That part of the pier and arches which was not taken down.

b The dove-tail'd piles drove quite round the pier to keep the gravel or ſand under it from being preſſed out, being in number about 210.

c The *Portland* arches turned as before.

d The *Purbeck* arches, the ſame thickneſs at the key as at the ſpringing, and reſting on a reverſed arch turned with *Portland* ſtone over the pier.

e The reverſed arch.

f A large arch of *Portland* ſtone, turned from the back of one *Purbeck* arch to the back of the other, leaving a large cavity over the pier, containing 13655 cubical feet.

g Two ſmaller arches, from the back of each arch to the adjoining piers, leaving two cavities under them, containing 5652 cubical feet.

h A large oval opening in each front ſpandril wall, behind the octangular turrets, leaving two cavities containing 609 cube feet.

i Spaces filled with chalk laid dry and looſe without mortar.

k The gravel laid a top of the bridge for the road way.

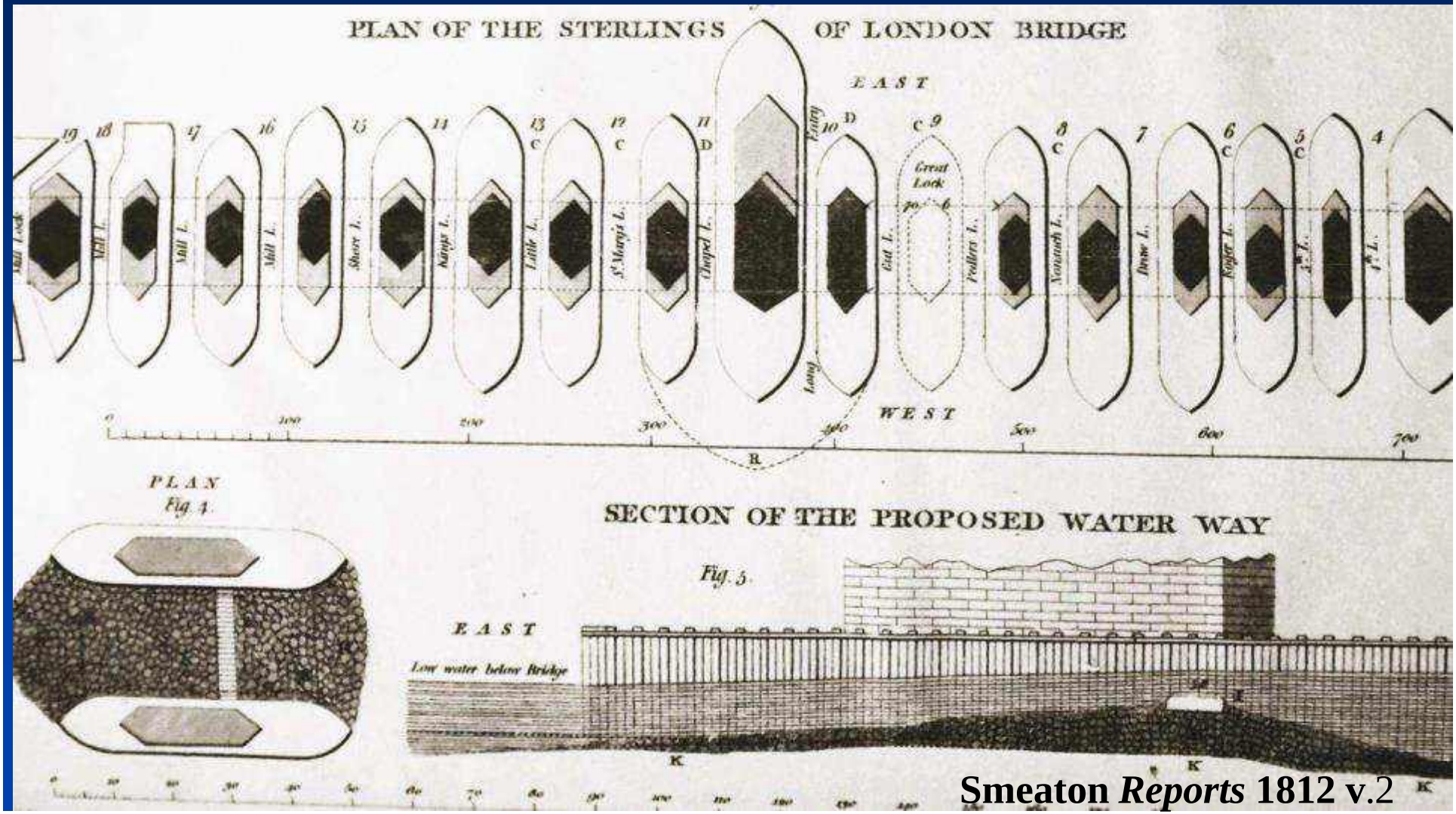
l *Rubble* wall laid in mortar and built in place of the dry rubble croſs walls on the two piers next the failing arches to ſtrengthen the works left ſtanding.

Westminster Bridge sunken pier rebuilt by 1752

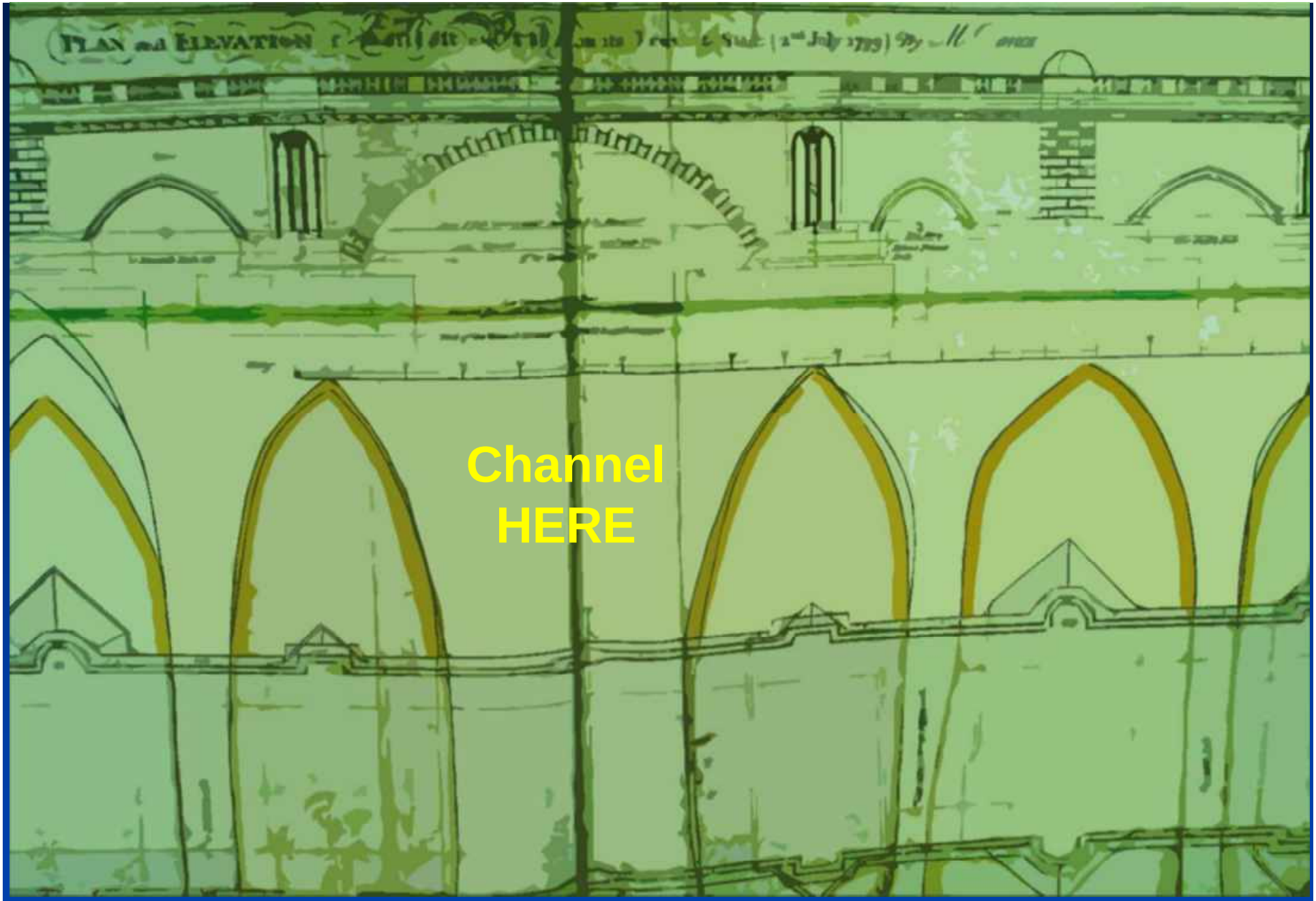
Gentleman's Mag: Supplement, 1752

Smeaton almost certainly saved Old London Bridge from collapse in 1763

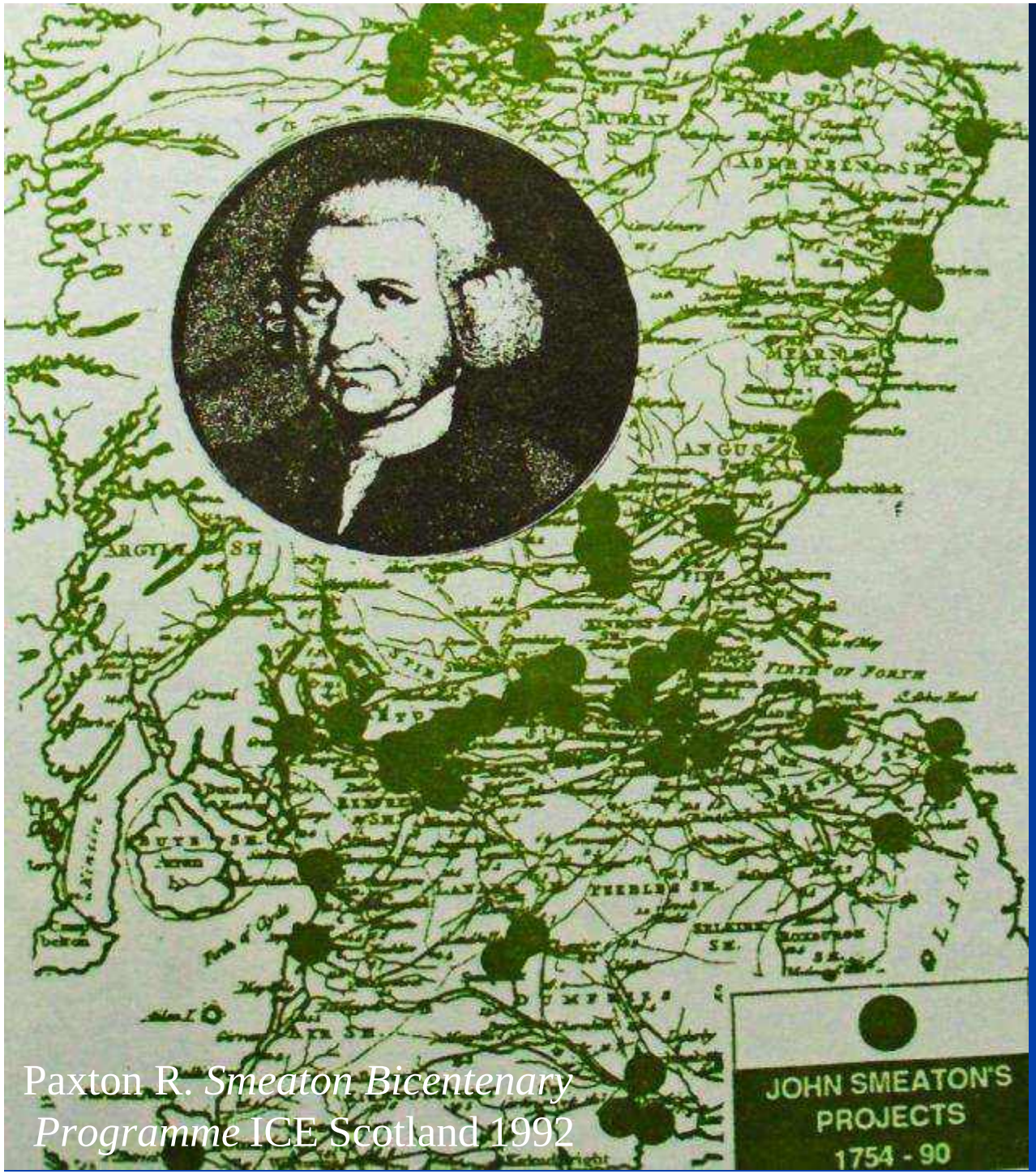
Navigable channel, Old London Bridge 1759.
Smeaton's improvement in 1763 after emergency call-out. The pier 'sterlings' were becoming undermined by scour. Smeaton's prompt action in securing them with salvaged building rubble *"probably saved the bridge."* C. Hutton's *Math. Dict., 1795*



Smeaton *Reports* 1812 v.2



Old London Bridge 36 years after Smeaton’s improvement



Paxton R. *Smeaton Bicentenary Programme* ICE Scotland 1992

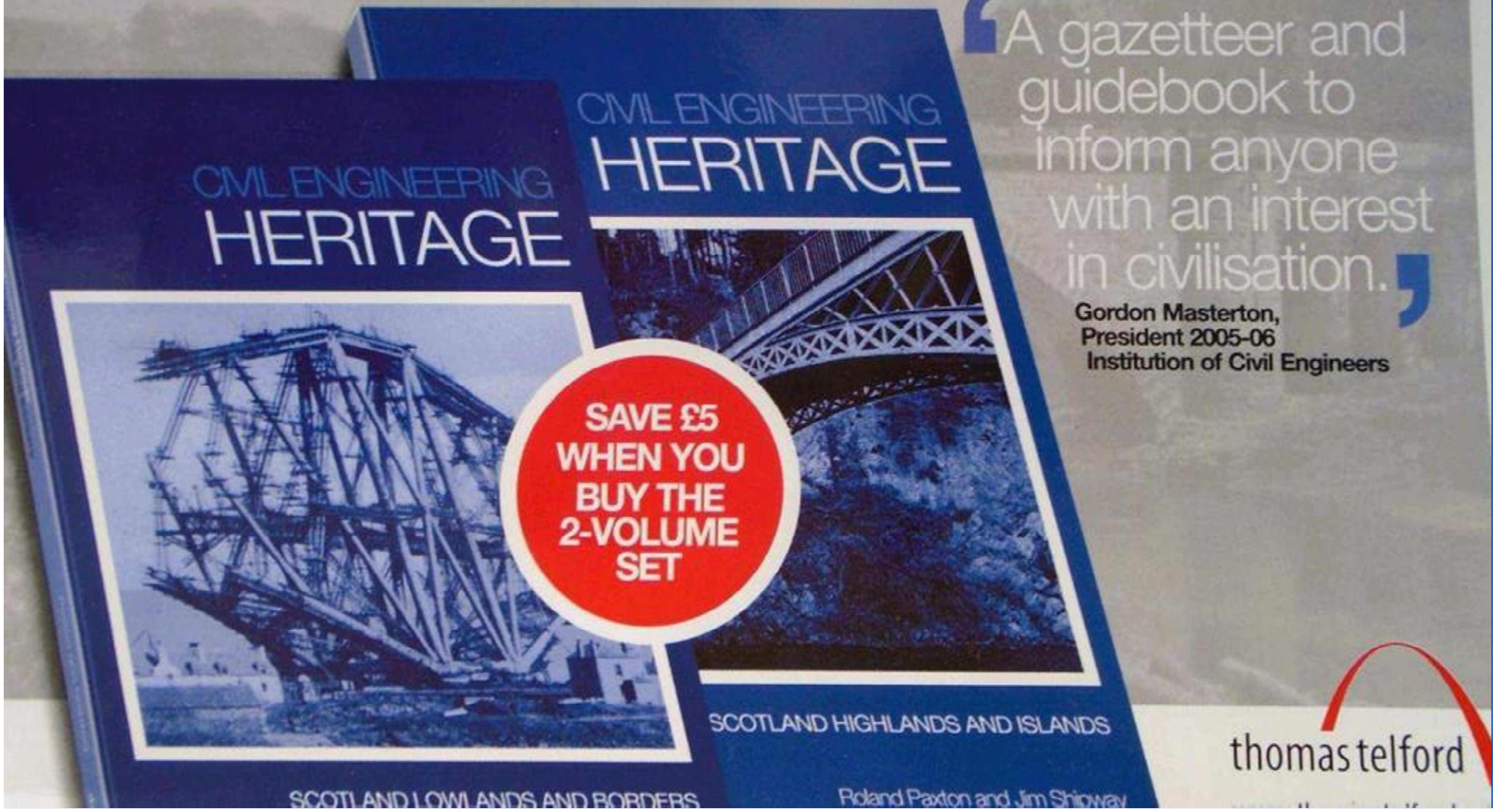
1754 - Smeaton's fundamental contribution to Scotland's transport and power infrastructure

c. 50 projects:

- land drainage
- river navigation
- mills & millwork
- harbours
- canals
- water supply
- lighthouses
- bridges

Civil Engineering Heritage: Scotland

Edited by R. Paxton and J. Shipway



"A gazetteer and guidebook to inform anyone with an interest in civilisation."

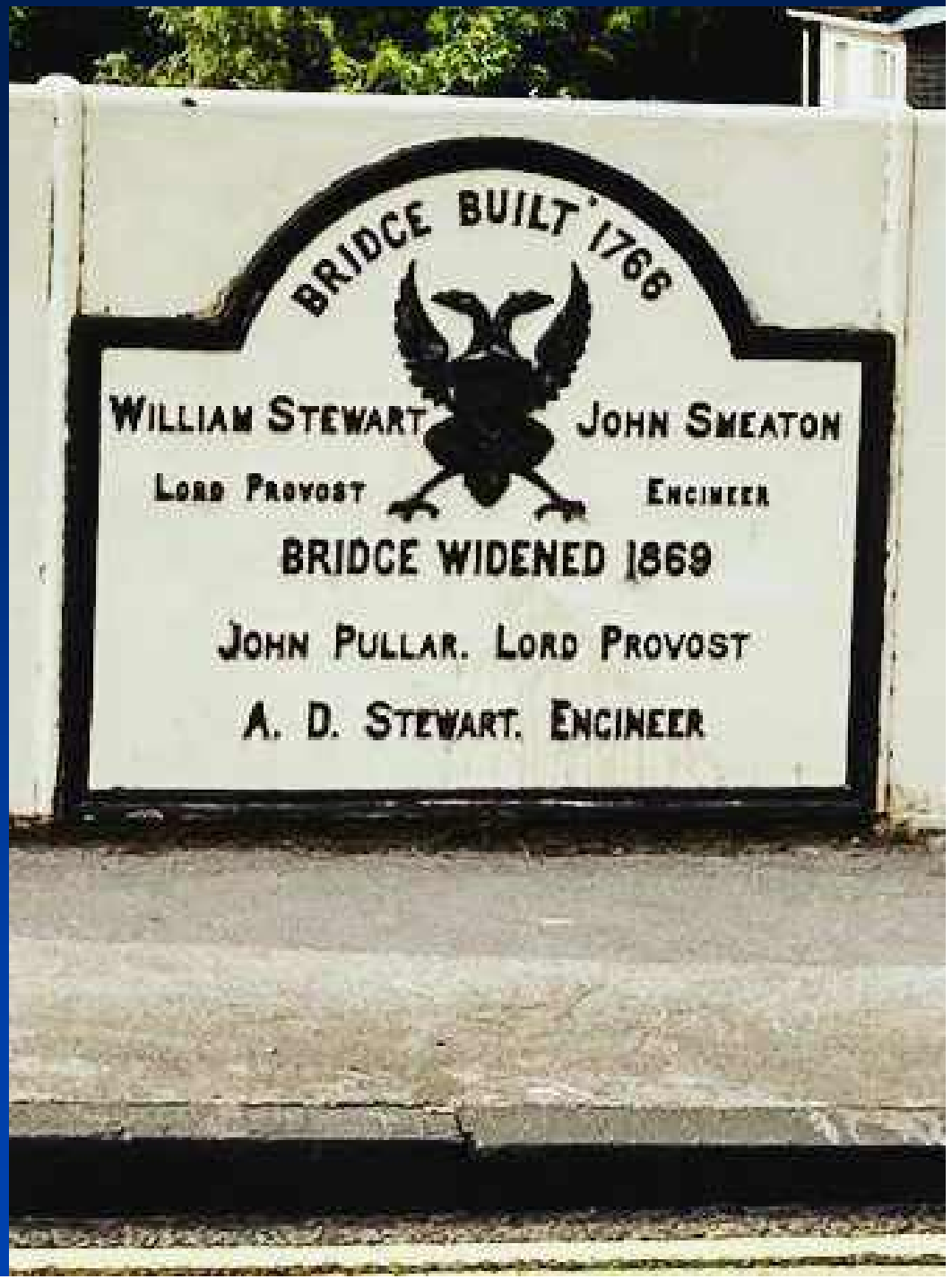
Gordon Masterton,
President 2005-06
Institution of Civil Engineers

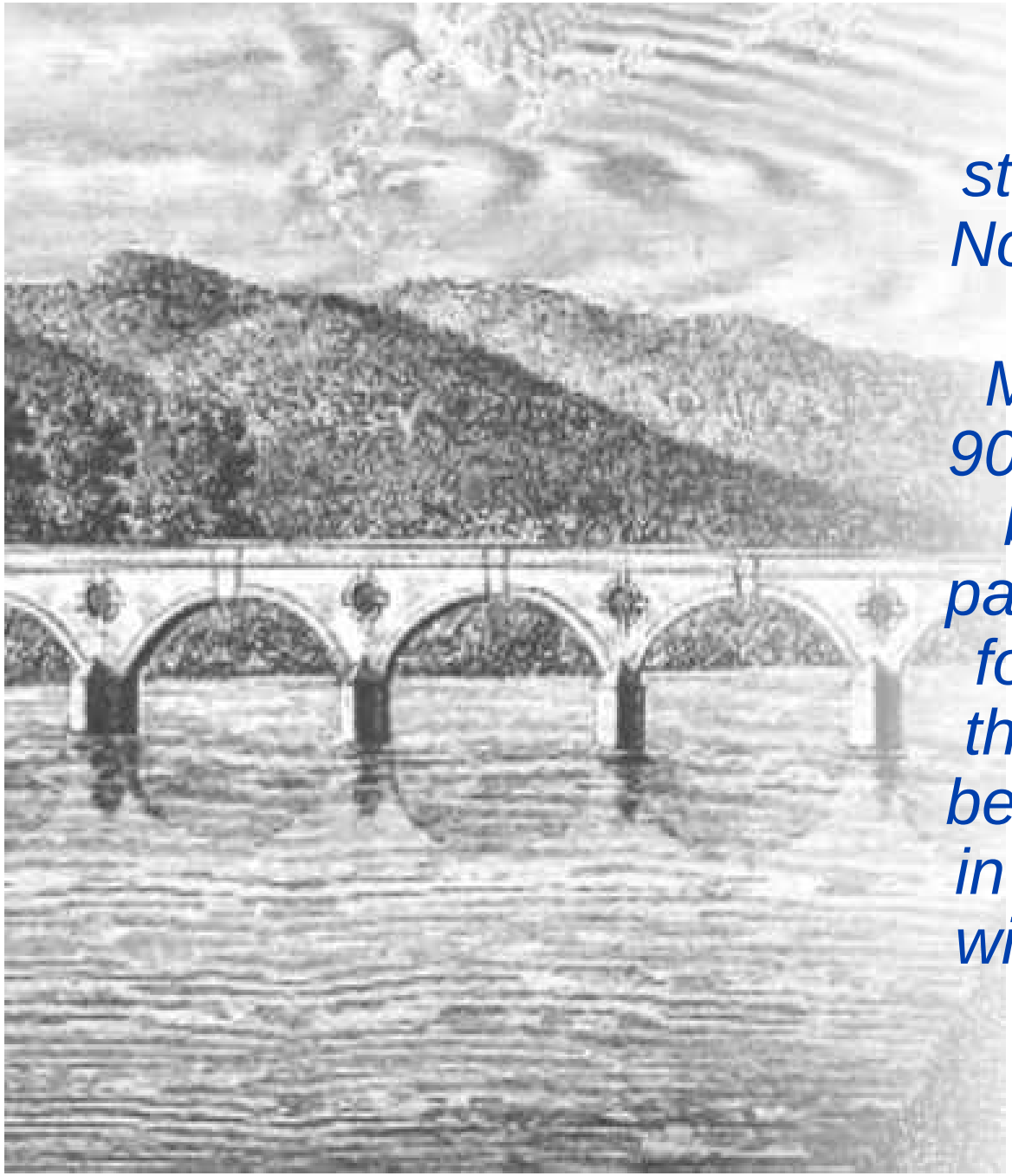
thomas telford

PERTH BRIDGE 1766-71

"Cost £26000
Forfeited Ests.£11000
Perth city £2000
Royal Boroughs £500
private subs. £4756
But it was thanks to the Earl of Kinnoul finding the £7744 balance that work did not meet with a check."

Edinburgh Mag. April 1788





PERTH BRIDGE

"the most beautiful structure of the kind in North-Britain, designed and executed by Mr Smeaton. Length 900ft; breadth (the only blemish) 22ft within parapets. The piers are founded 10ft beneath the river bed on oak & beech piles; stones laid in pozzolana, cramped with iron. 9 arches, the centre 75ft span."

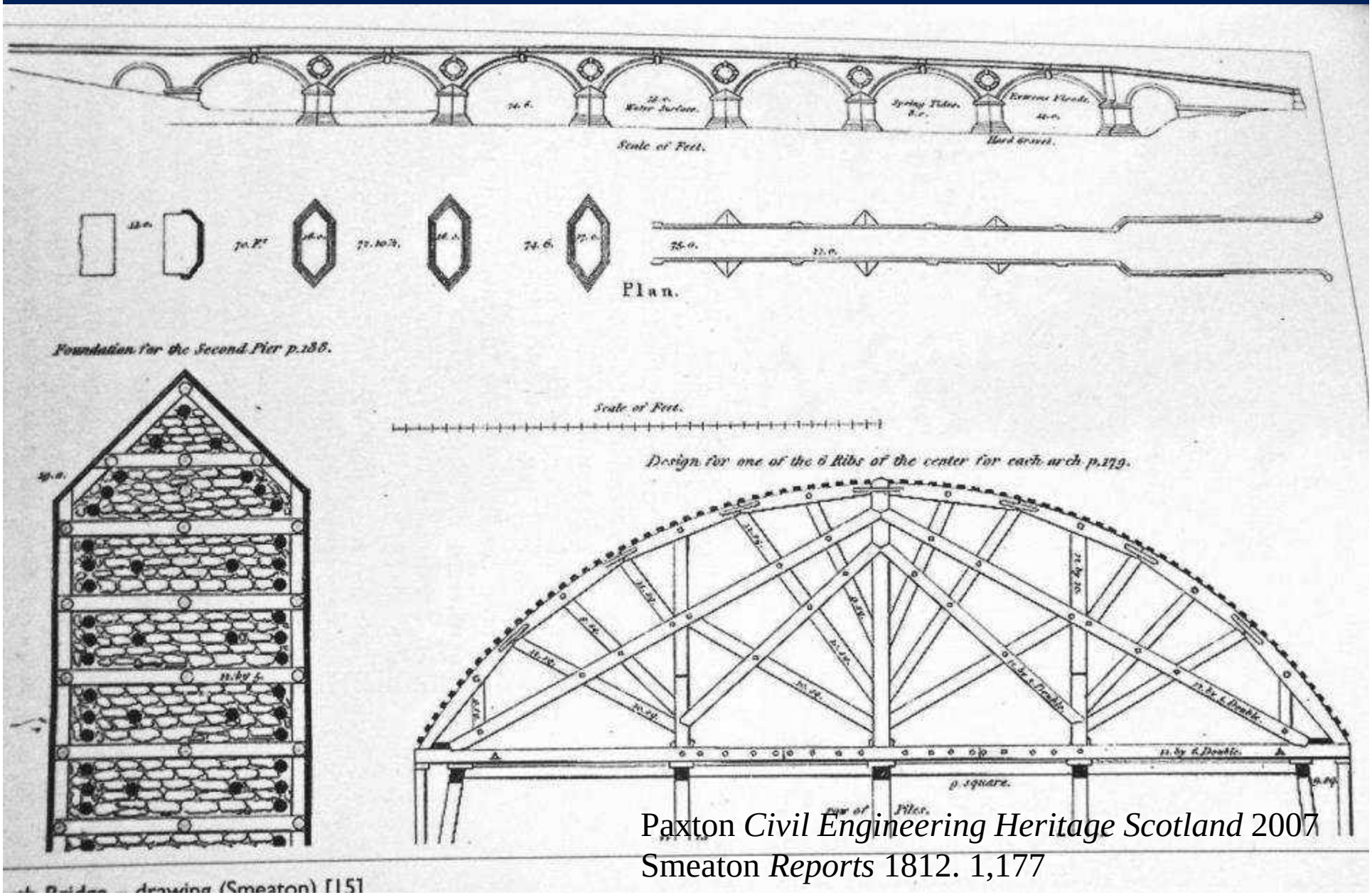
Edinburgh Mag. April 1788

Perth Bridge in 2024 - with Allan Stewart's iron cantilever bracket footways added in 1869

PERTH BRIDGE c.1830

Perthshire Illustrated, Fullarton

PERTH BRIDGE SMEATON's DESIGN 1766



Paxton *Civil Engineering Heritage Scotland* 2007

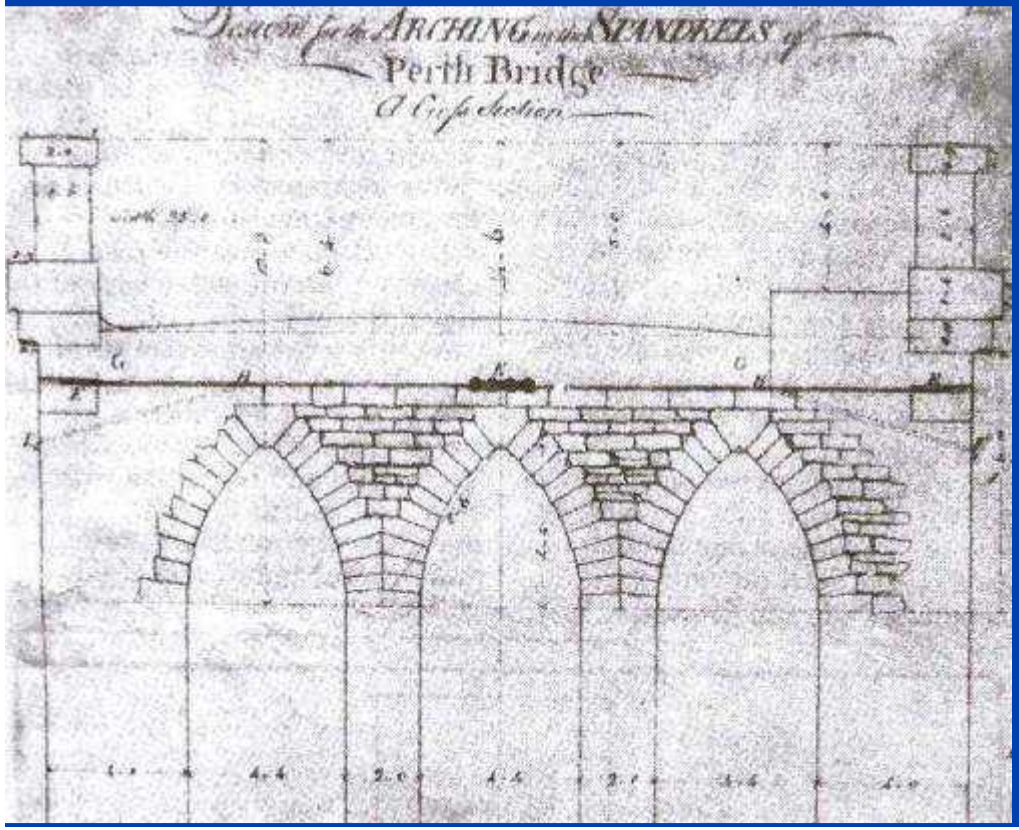
Smeaton *Reports* 1812. 1,177

Perth Bridge ‘sterling’ pier protection

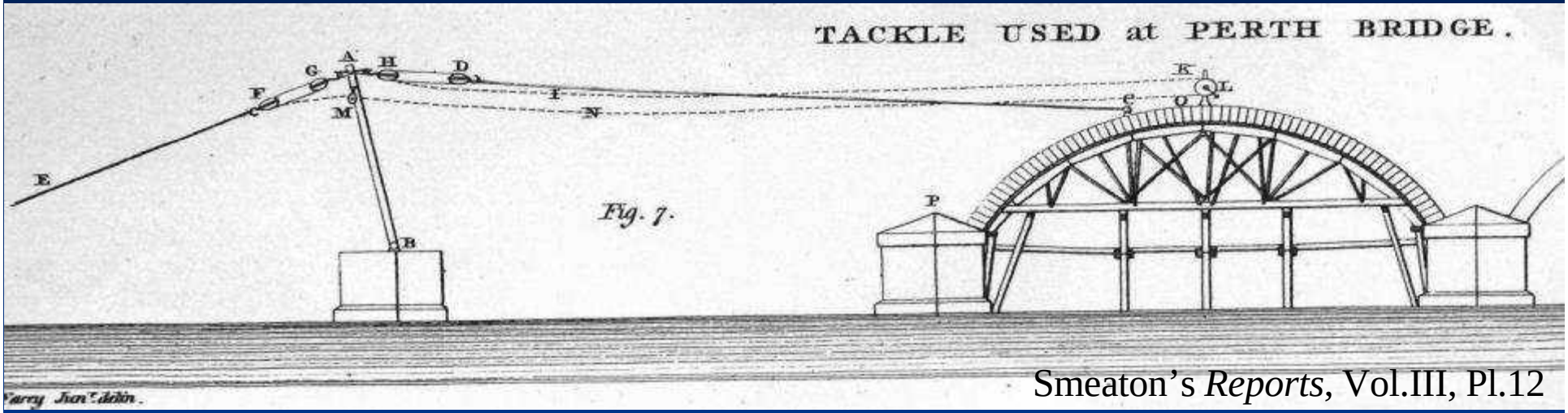
Paxton 1992

Perth Bridge: Smeaton cross-section c.1765 width 22ft. - innovative large scale cavitation

Cavity as in 1992 - 4½ft. wide



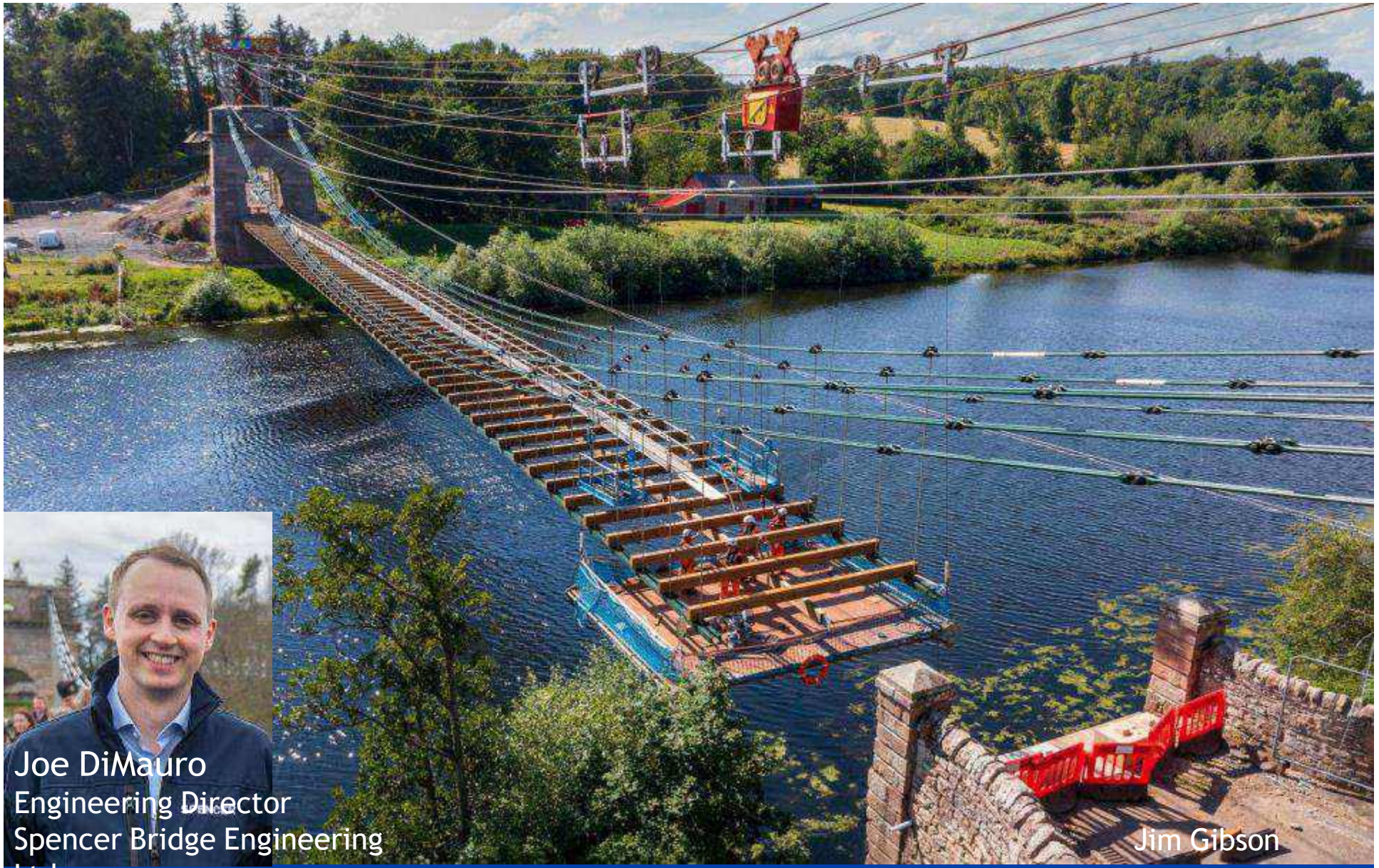
Perth Bridge Lifting Tackle
[A-B shear leg over-set by guide ropes]



Smeaton's *Reports*, Vol.III, Pl.12

See EXHIBITION FOR THE KEY THIS INGENIOUS ARRANGEMENT

A forerunner of that used innovatively recently for lifting ironwork from above during conservation of Union Chain Suspension Bridge over the Tweed. Details sent to Joe Dimauro, Engineering Director, Spencer Bridge Engineering Co. Ltd, Hull, Union Bridge Contractor, who replied *' I have read the extracts you sent of Smeaton's lifting tackle and it is very interesting. There are some clear similarities with the approach we took, we also suspected a similar system may have been used during the original install of the Union Chain Bridge or at least the addition of the 1903 cable as evidenced by the two vertically driven anchor rails on the English embankment above the tower which align with the chains.'*

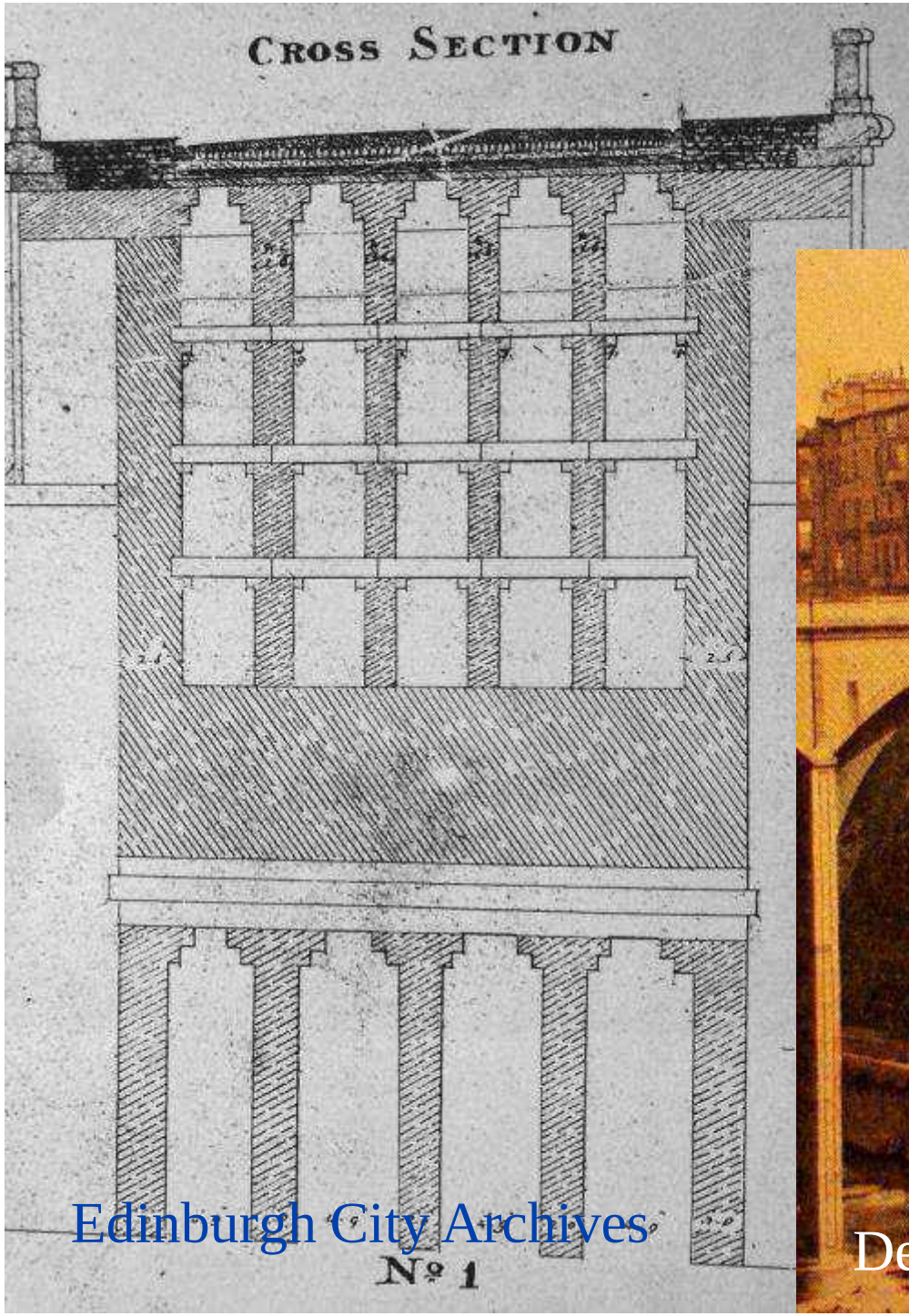


Woodliner crane in operation above the Union Chain Bridge c.2021

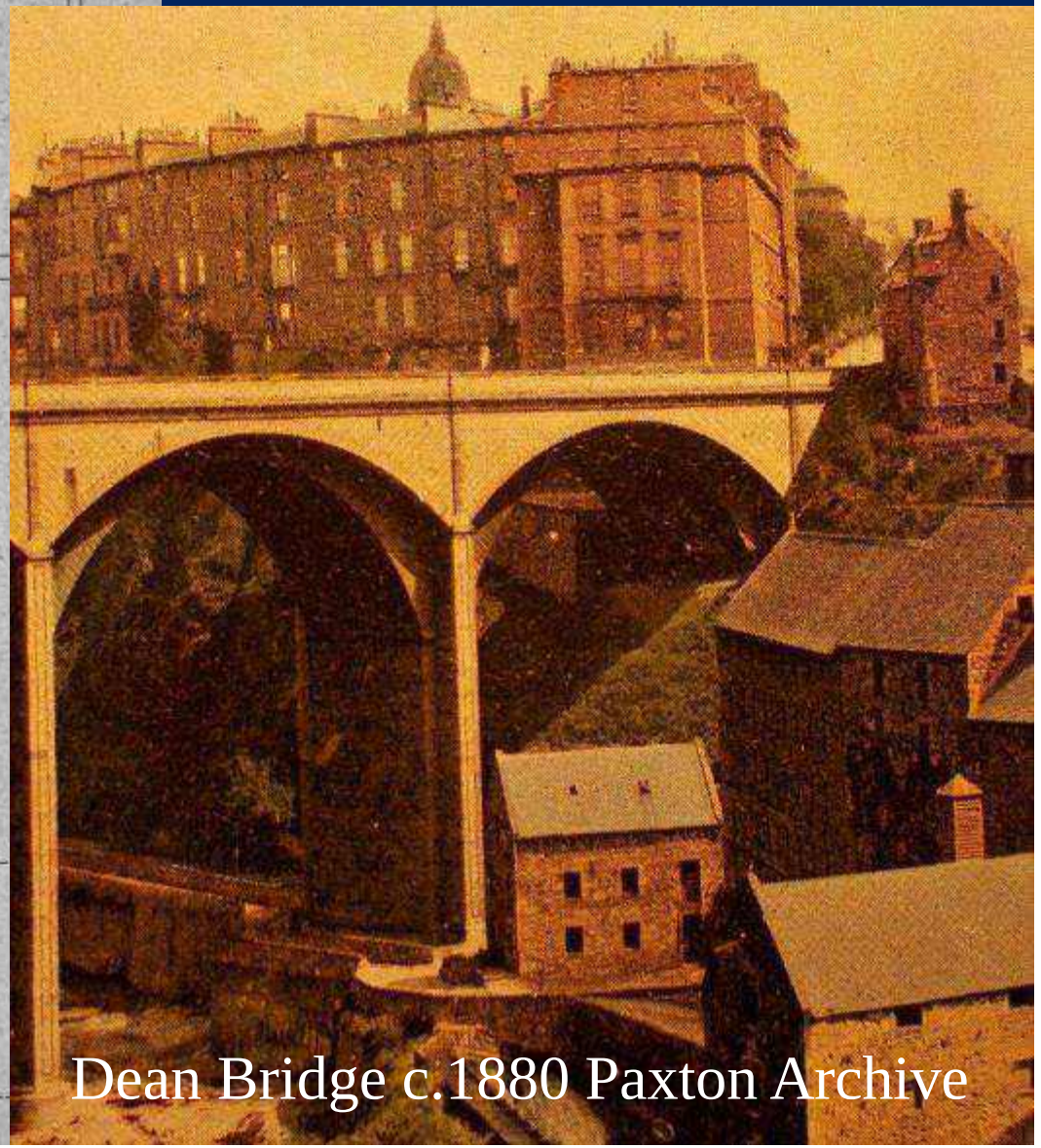
DEAN BRIDGE EDINBURGH

D Telford cross-section 1829

Extensive use of cavities

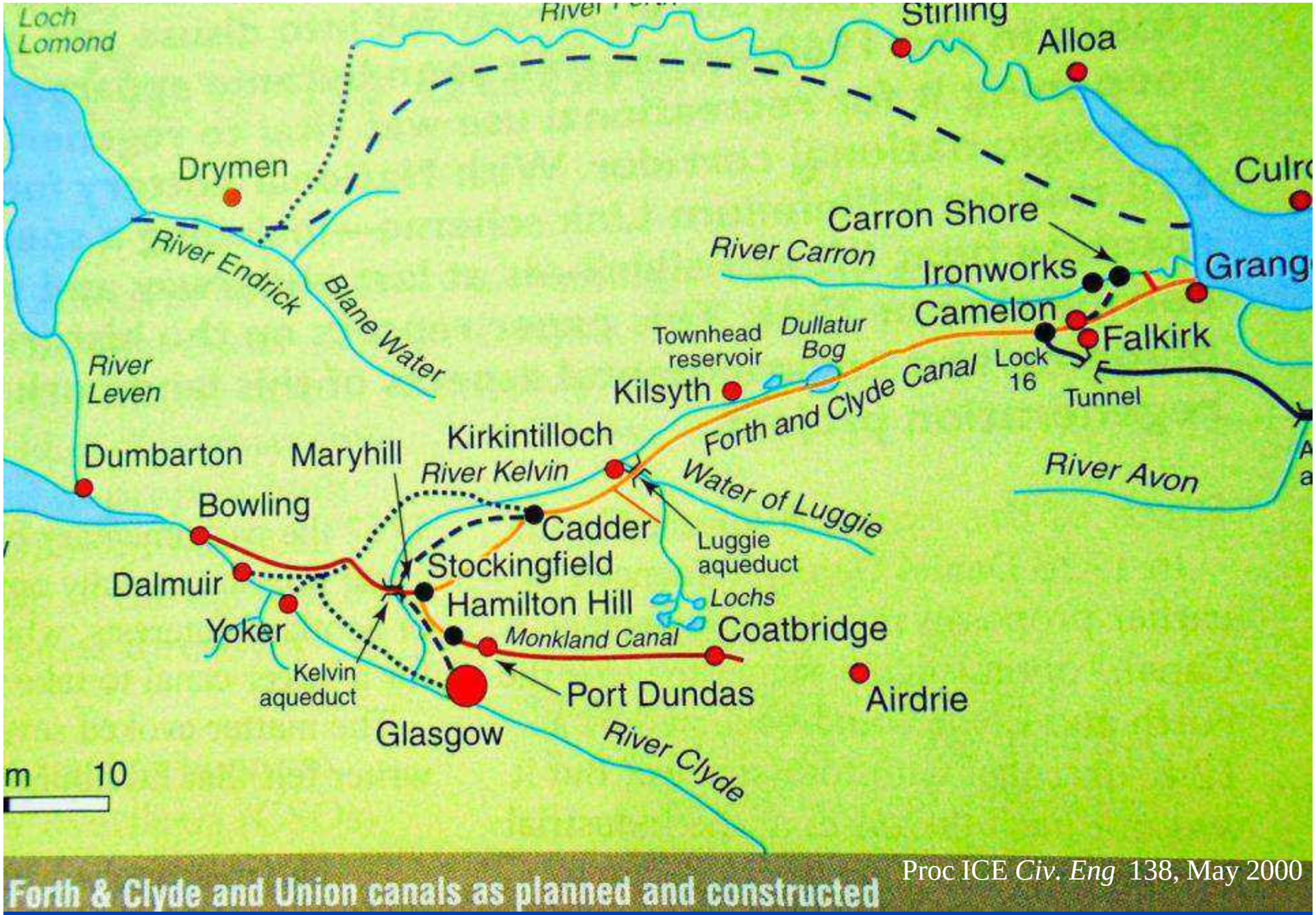


Edinburgh City Archives



Dean Bridge c.1880 Paxton Archive


PERTH BRIDGE at 300th
ANNIVERSARY SMEATON's BIRTH
heavily trafficked at times and without
weight restriction
A.Paxton

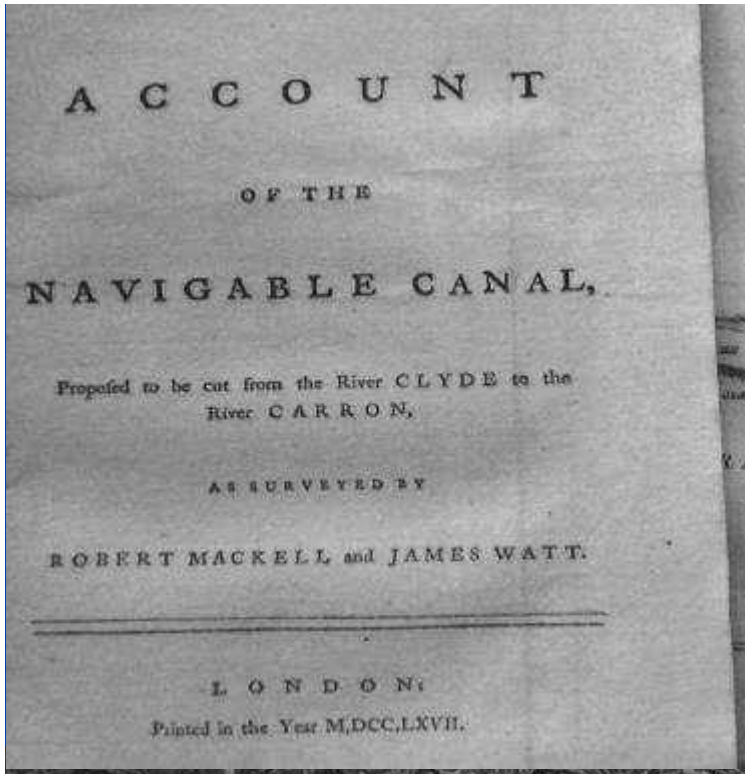


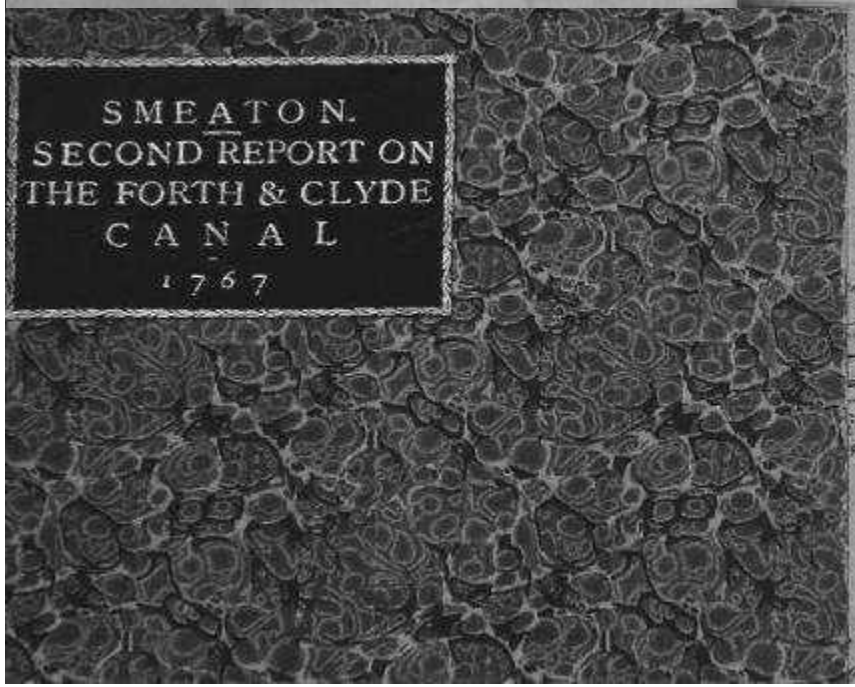
Proc ICE *Civ. Eng* 138, May 2000

Forth & Clyde 35-mile Ship Canal plan

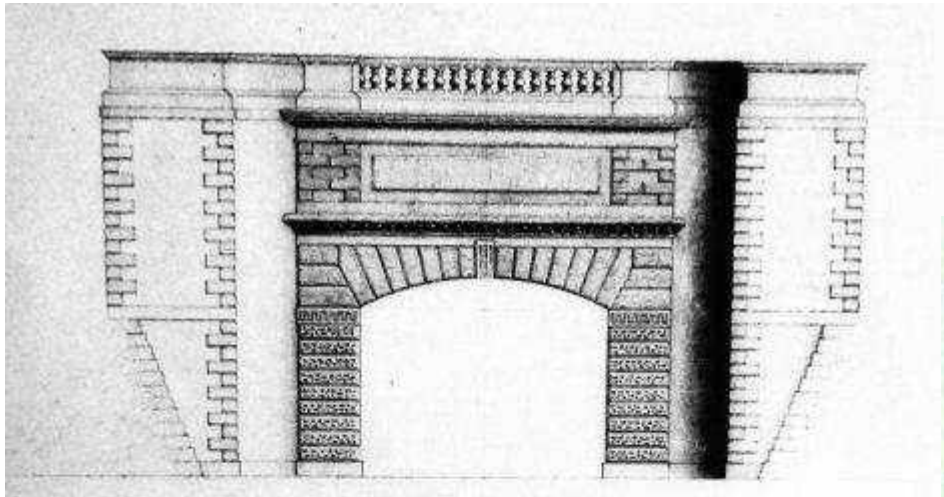
Mackell & Watt's proposed 'small canal' replacement for Smeaton's 'Great Canal' - April 1767

EXHIBITION



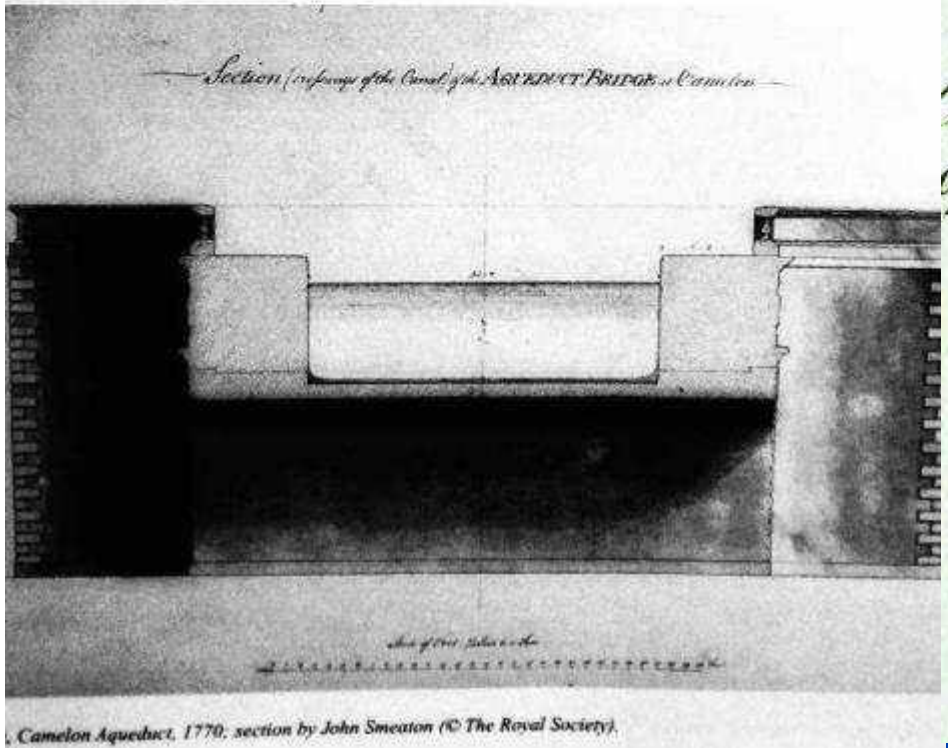


Approved Smeaton Plan 8 Oct 1767



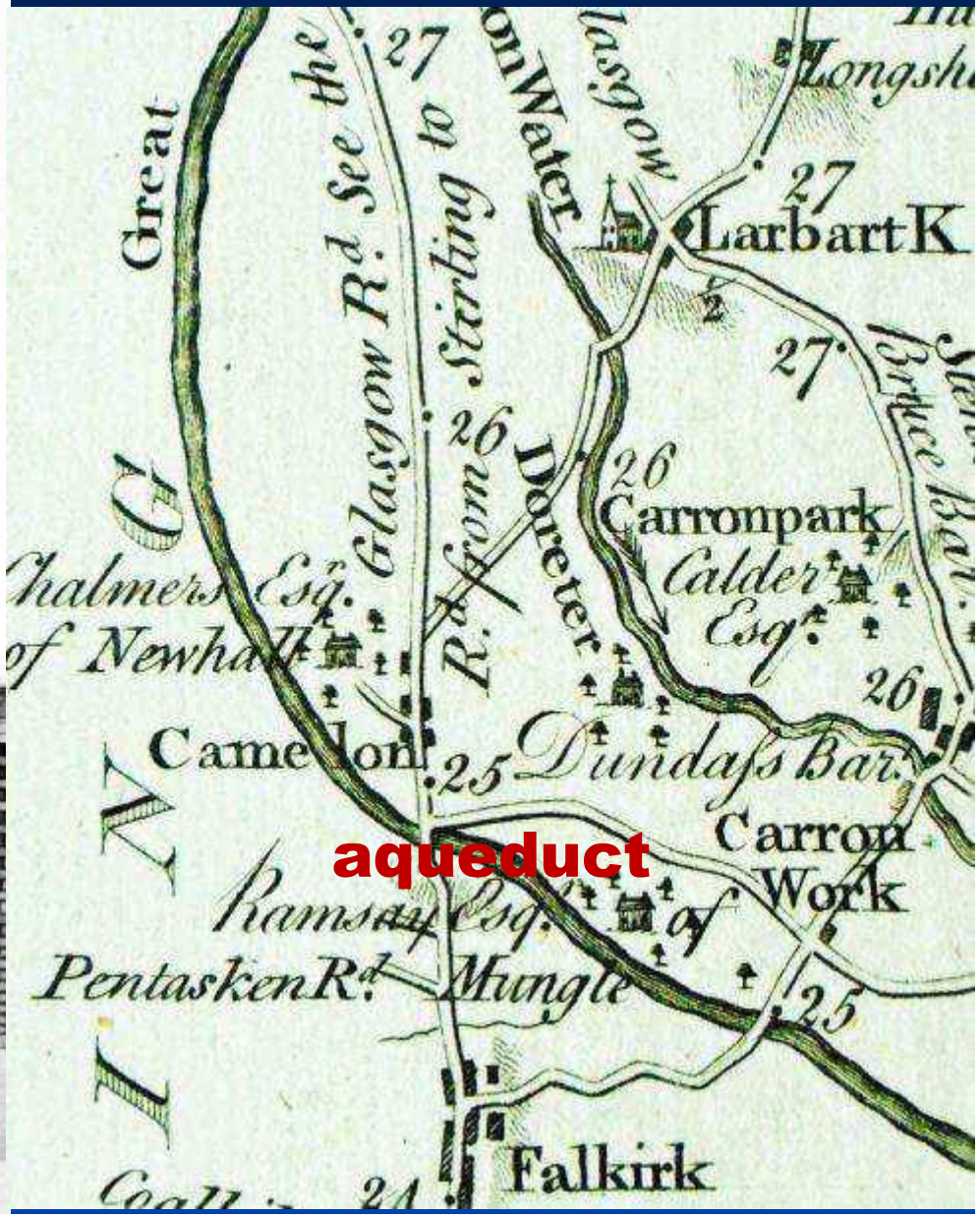
Smeaton drawings c.1769
(at Royal Society)

Camelon Aqueduct, 1770; elevation by John Smeaton (© The Royal Society).

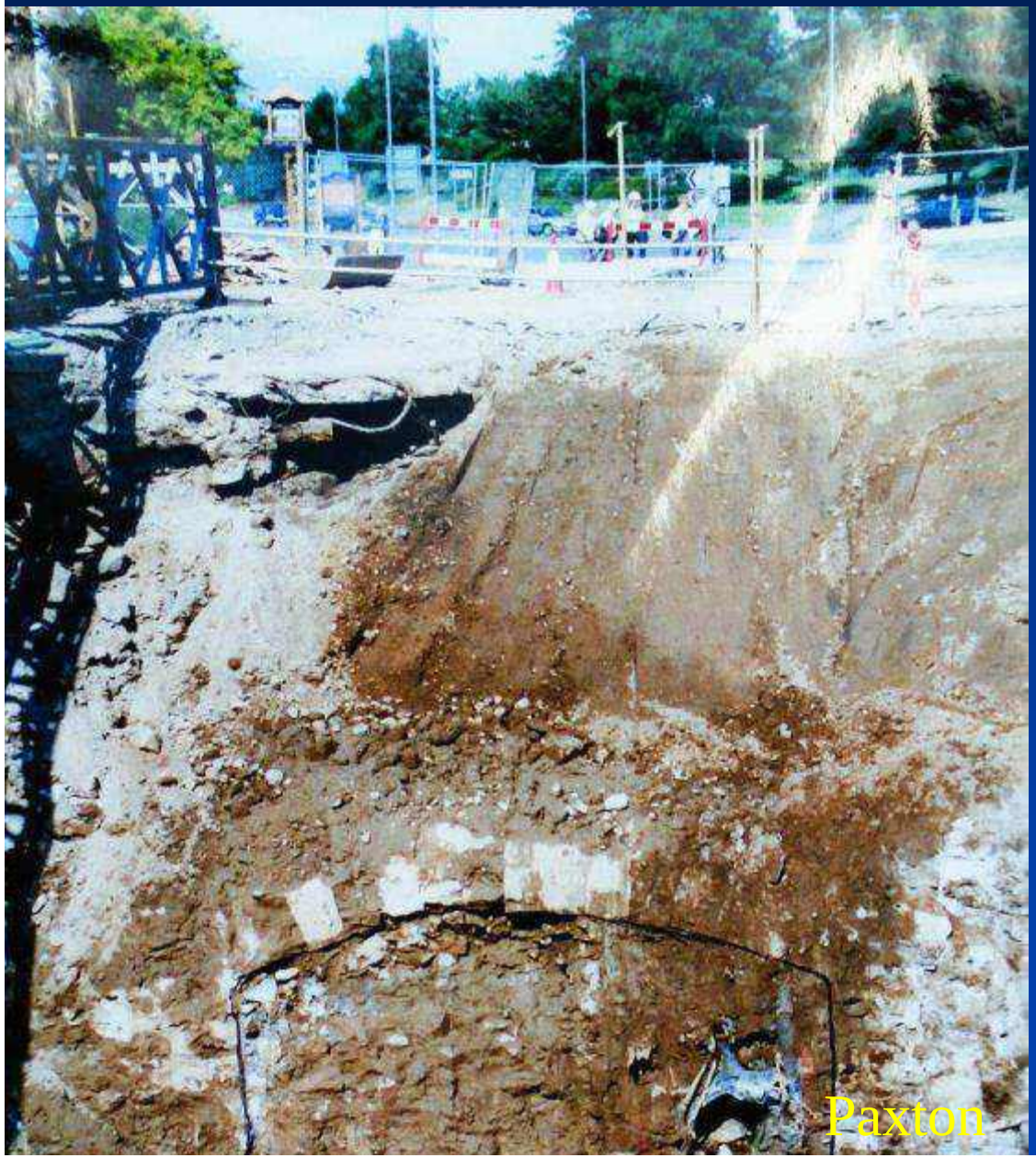


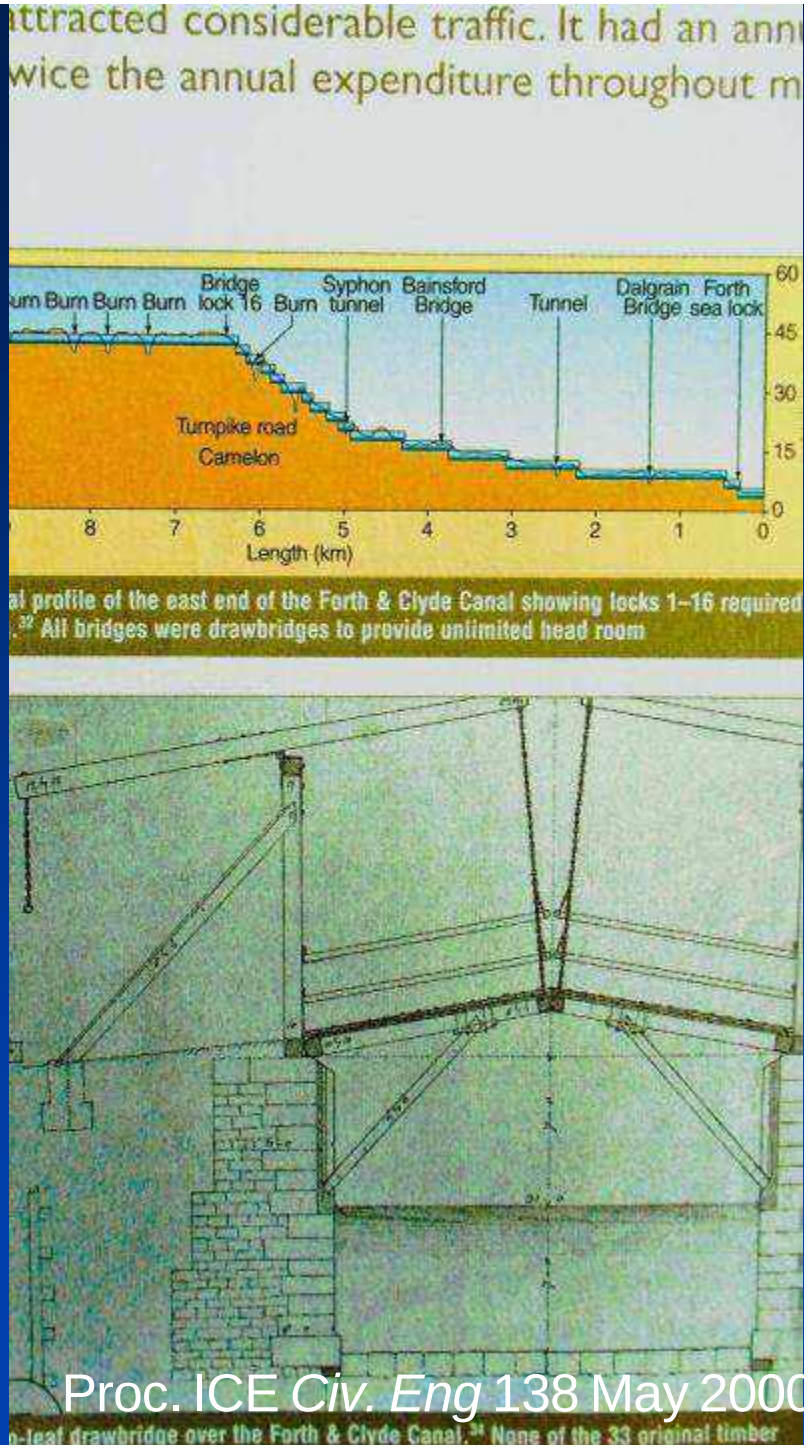
Camelon Aqueduct, 1770; section by John Smeaton (© The Royal Society).

Camelon Aqueduct on Map, Taylor & Skinner 1770

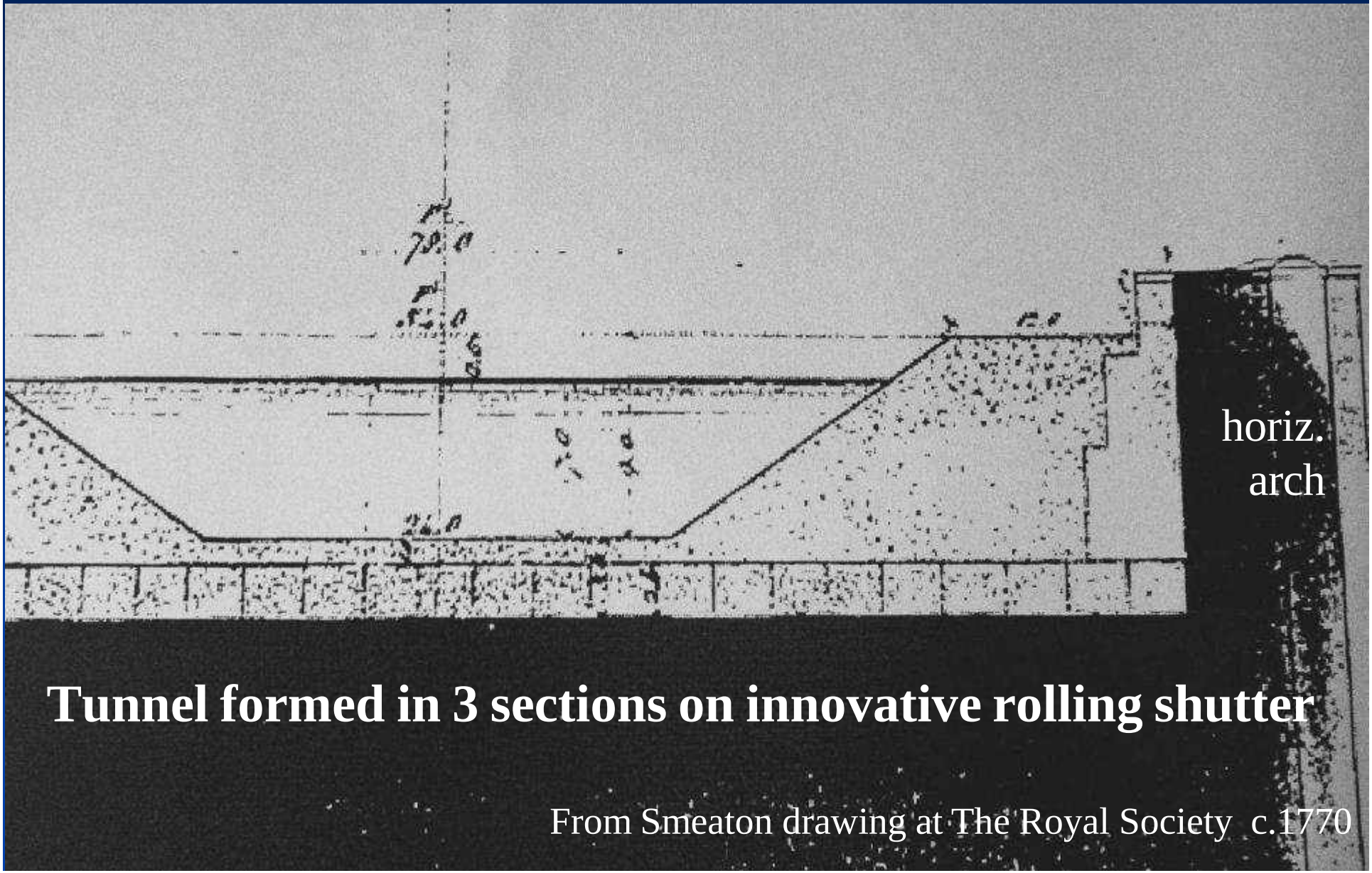


Camelon Aqueduct top July 2000 Locks 1-16; timber bridges [33]





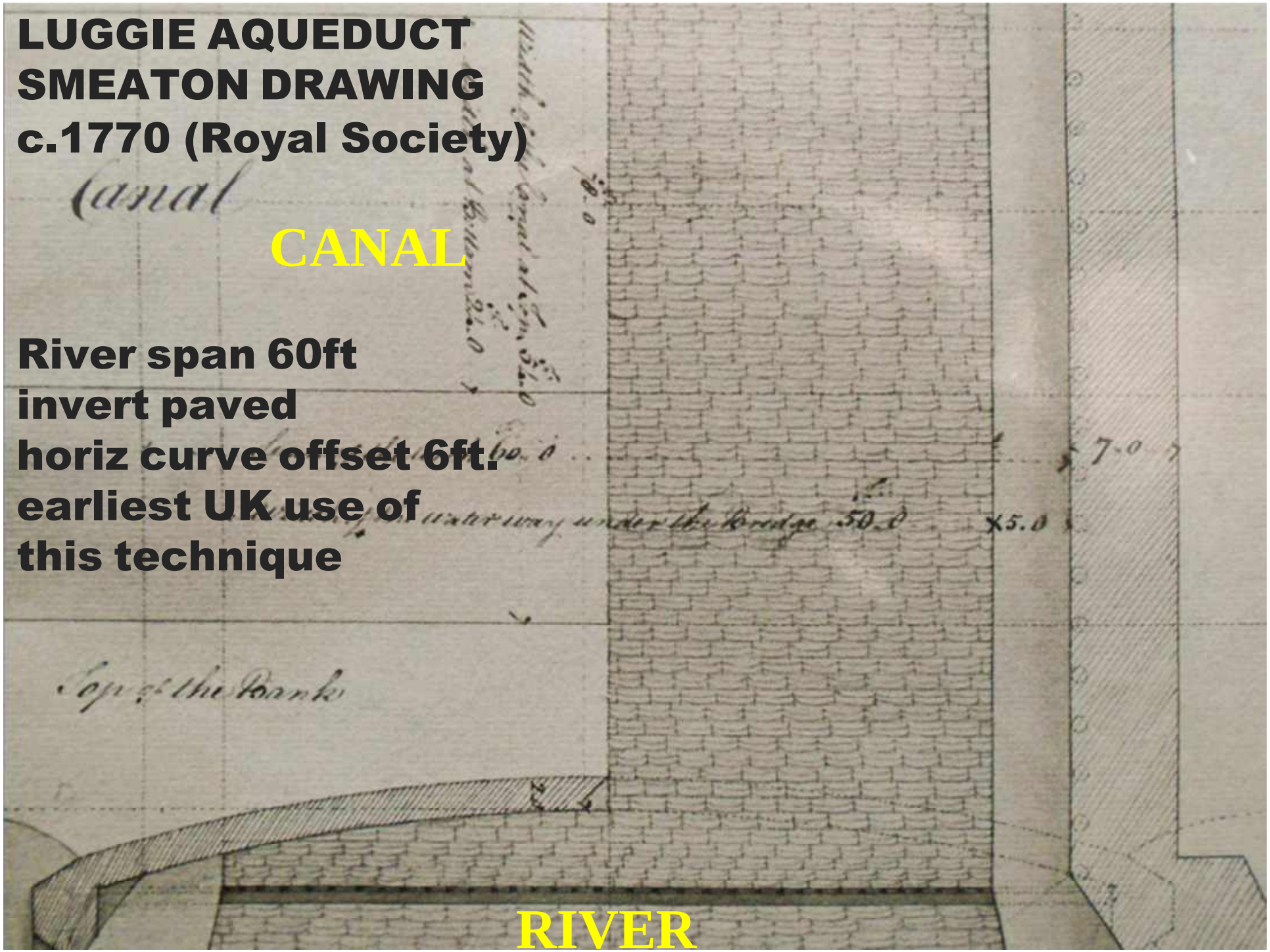
Smeaton: Forth & Clyde Ship Canal 1768-90
Luggie Aqueduct 1774 – ships to19ft. wide, 2-way



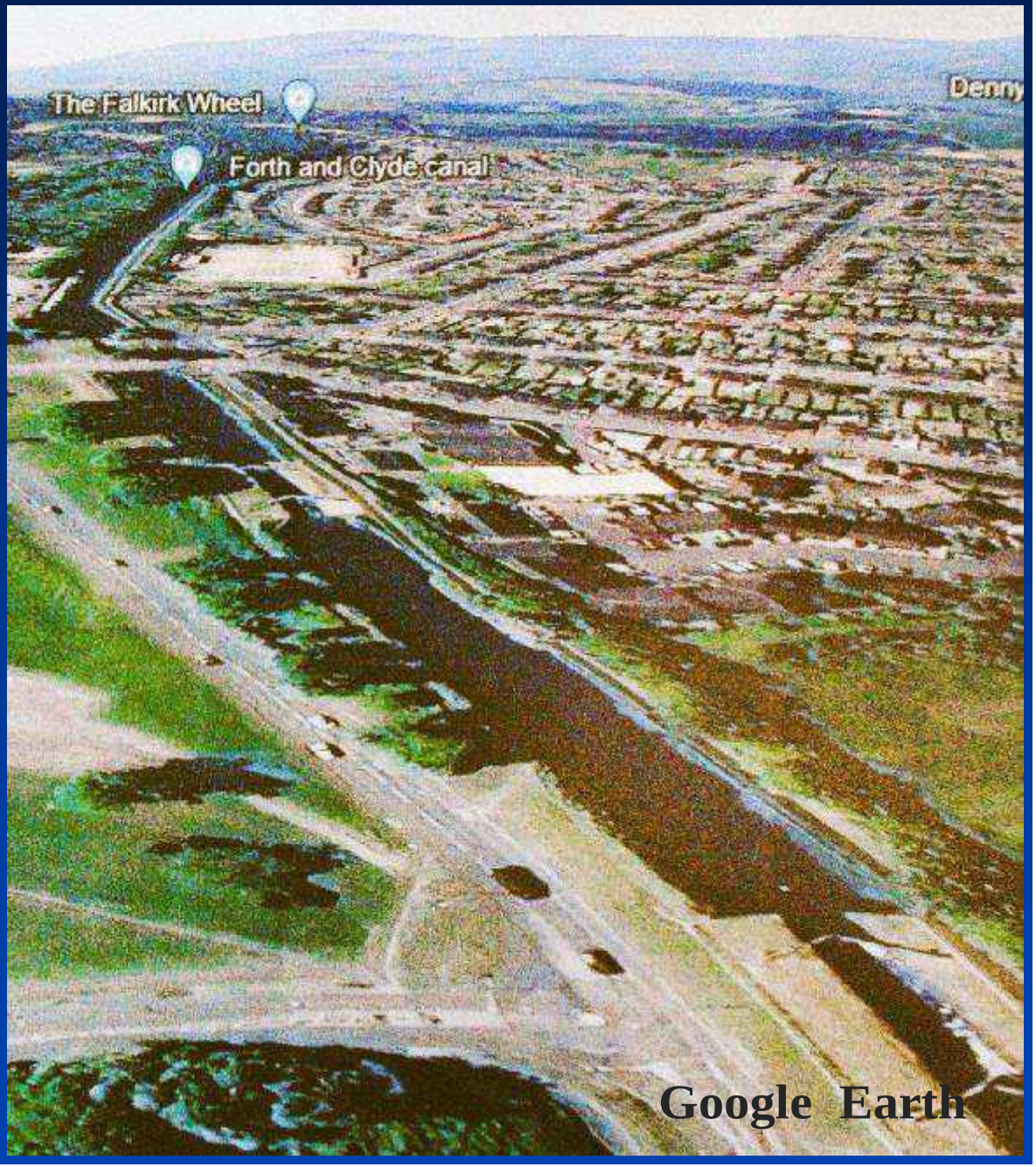
Tunnel formed in 3 sections on innovative rolling shutter

From Smeaton drawing at The Royal Society c.1770

Forth & Clyde Canal. Luggie Aqueduct, Kirkintilloch 1774 (railway innovation 1858!)


LUGGIE AQUEDUCT
SMEATON DRAWING
c.1770 (Royal Society)
CANAL
River span 60ft
invert paved
horiz curve offset 6ft.
earliest UK use of
this technique
RIVER

Forth & Clyde Canal - Locks14 -16 at Falkirk



Boat to Edinburgh
Lock 17 8/6/2024

Smeaton's proposed Management Structure for Forth & Clyde work 1768 - basis of modern practice

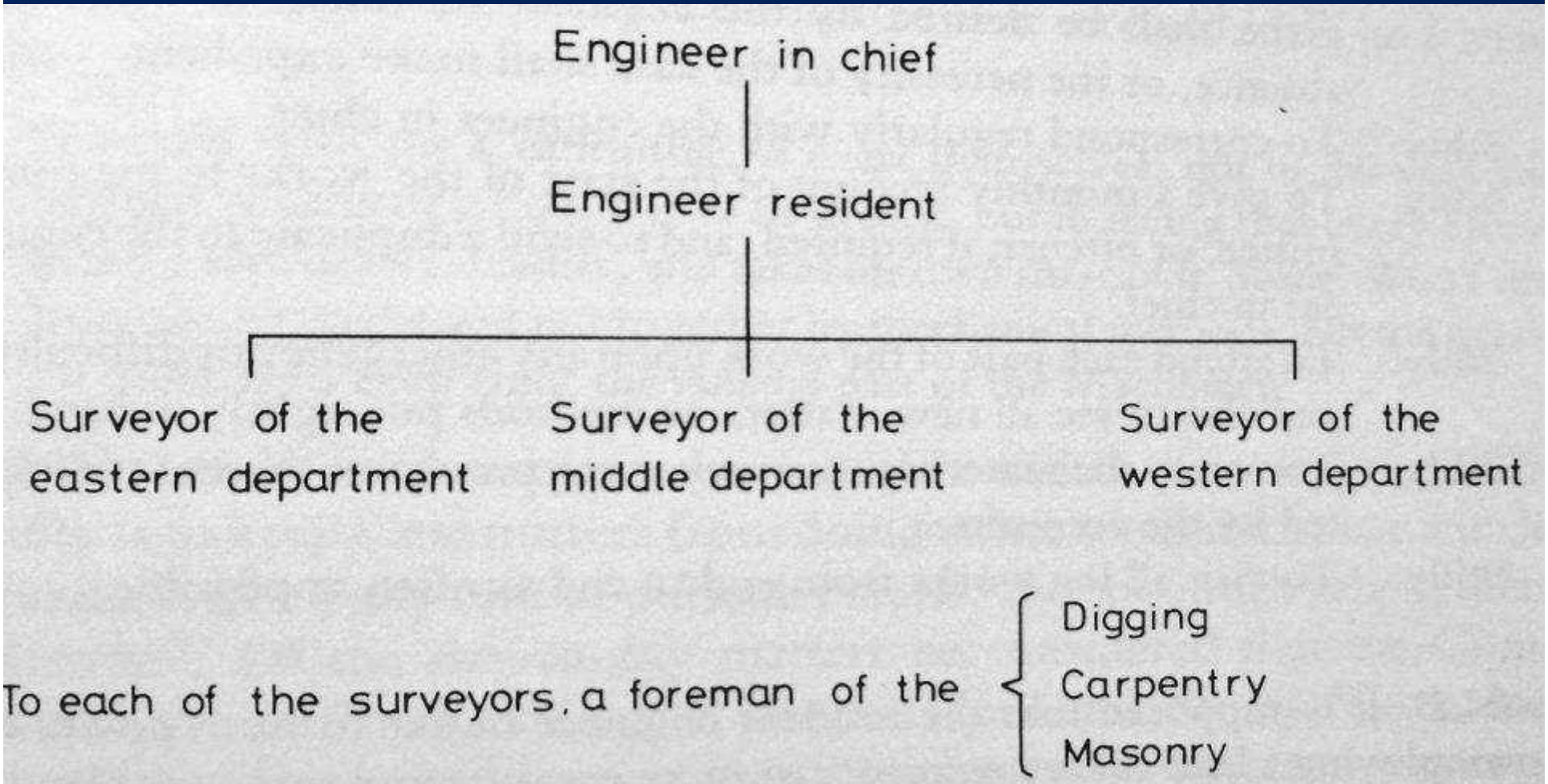
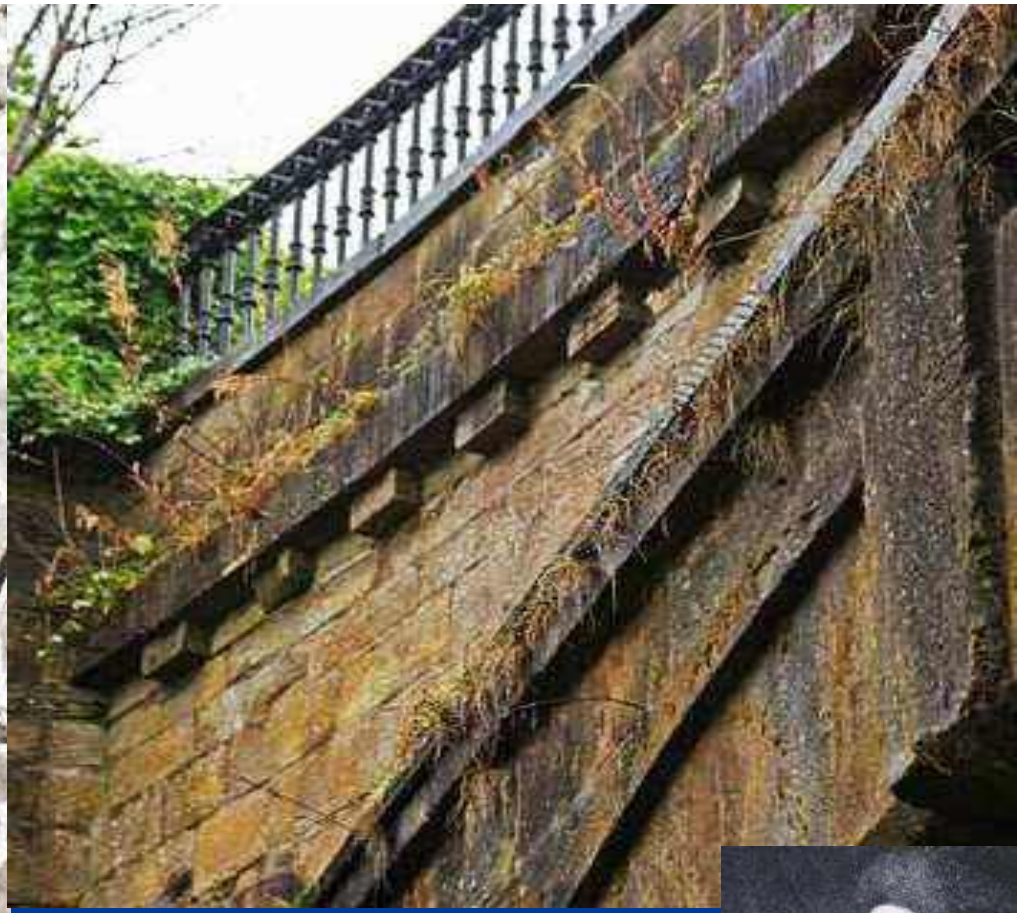


Fig. 52. Management structure for work on the Forth & Clyde Canal

223

Skempton A.W.,
***John Smeaton FRS* 1981**

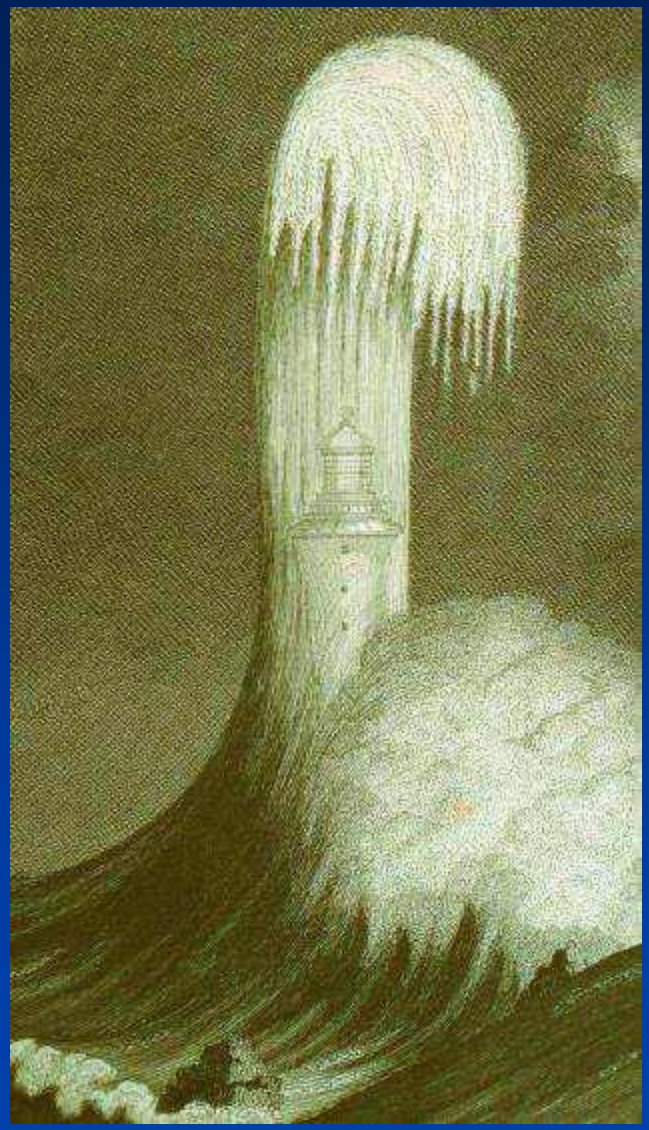
Paxton & Shipway *Civil Engineering Heritage Scotland Lowlands and Borders* 2007, title page



Luggie Aqueduct detail
Maryhill Locks Glasgow
1790.

Completed by R. Whitworth
In consultation with
Smeaton.
Contractor William Gibb

Smeaton's Engineering classic *1791, 1793, 1813*



Vignette by Smeaton's daughter, Mary

A

NARRATIVE OF THE BUILDING

AND

A DESCRIPTION of the CONSTRUCTION

OF THE

EDYSTONE LIGHTHOUSE

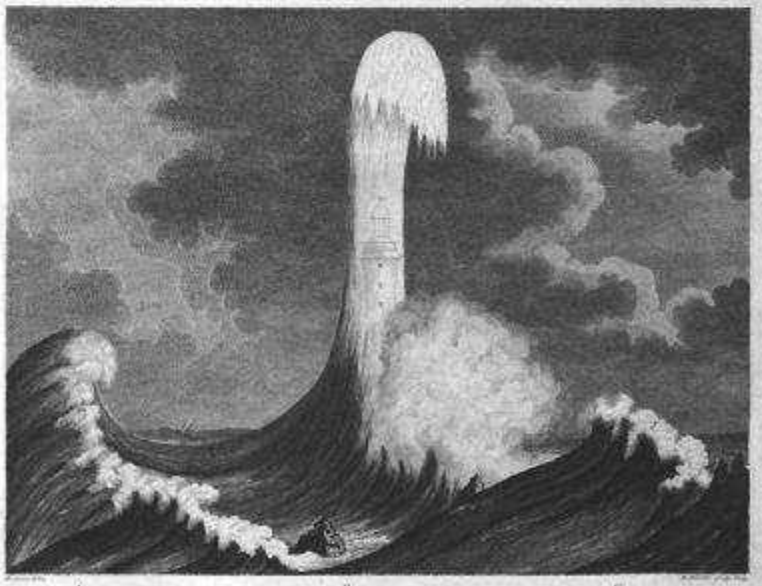
WITH STONE:

TO WHICH IS SUBJOINED,

AN APPENDIX, giving some Account of the LIGHTHOUSE on the SPURN POINT,

BUILT UPON A SAND.

BY JOHN SMEATON, *CIVIL ENGINEER*, F.R.S.



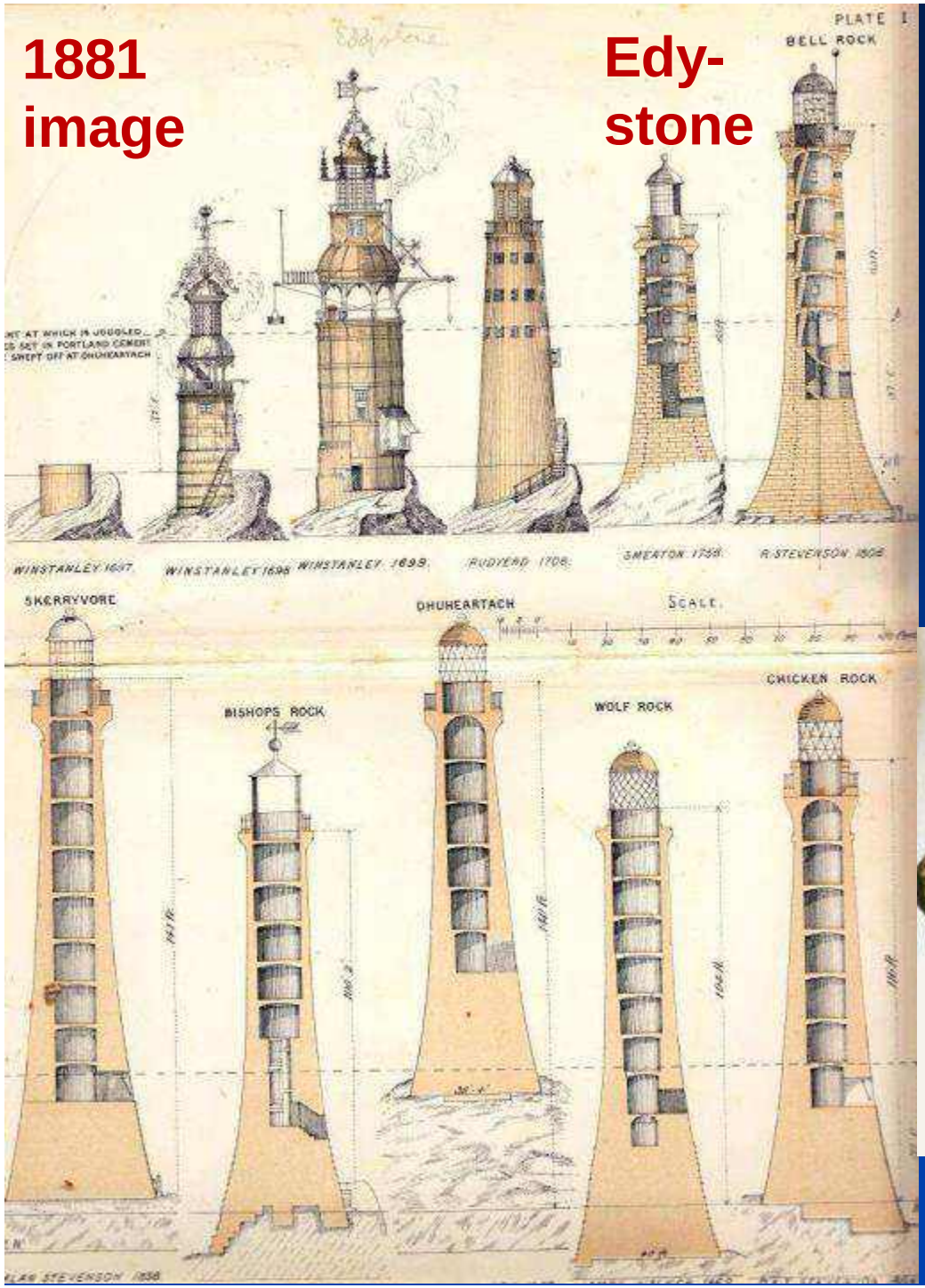
The MORNING after A STORM at S.W.

LONDON:

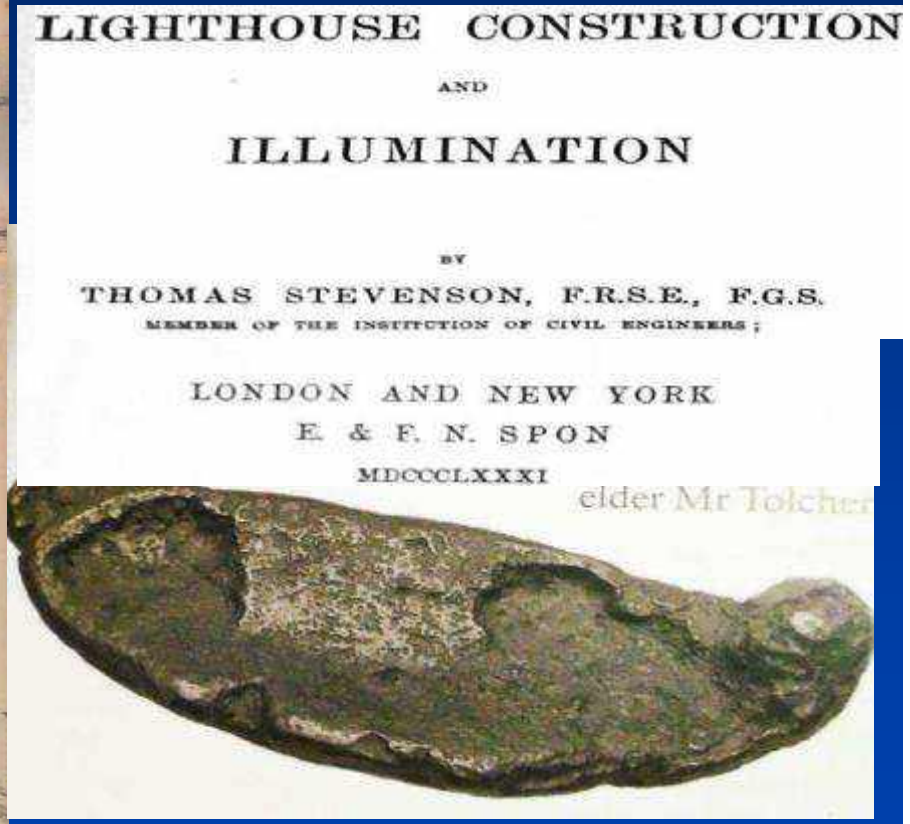
PRINTED FOR THE AUTHOR, BY H. HUGHS:

SOLD BY G. NICOL,

BOOKSELLER TO HIS MAJESTY, PALL-MALL. 1791.



Edystone Lighthouse of 'our greatest maritime engineer' fundamentally influenced lighthouse construction for 150yrs


LIGHTHOUSE CONSTRUCTION

AND

ILLUMINATION

BY

THOMAS STEVENSON, F.R.S.E., F.G.S.

MEMBER OF THE INSTITUTION OF CIVIL ENGINEERS;

LONDON AND NEW YORK

E. & F. N. SPON

MDCCCLXXXI

elder Mr Tolcher

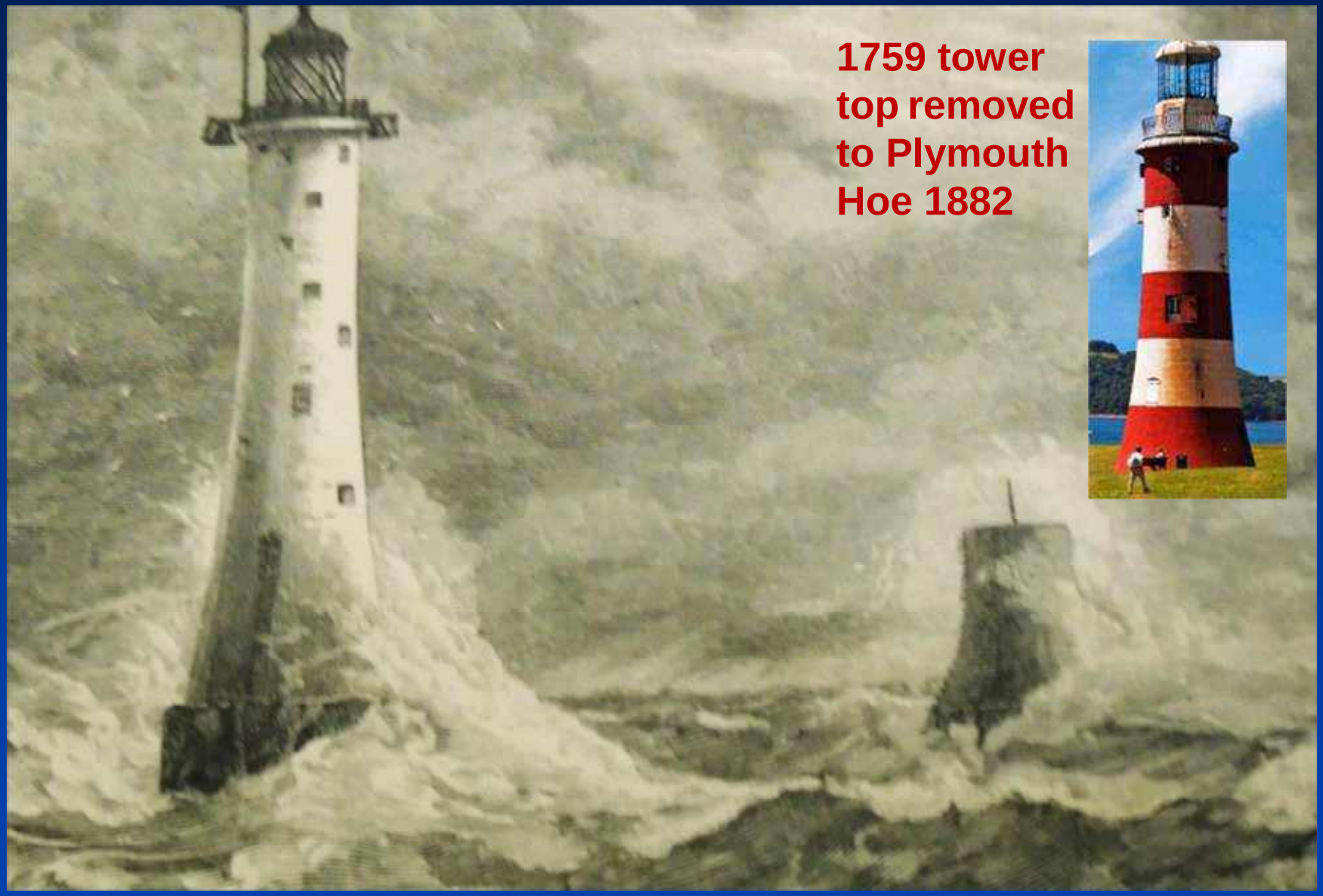
Rudyerd lighthouse fire 1754- Lead swallowed by Henry Hall

Bell Rock LH 1811

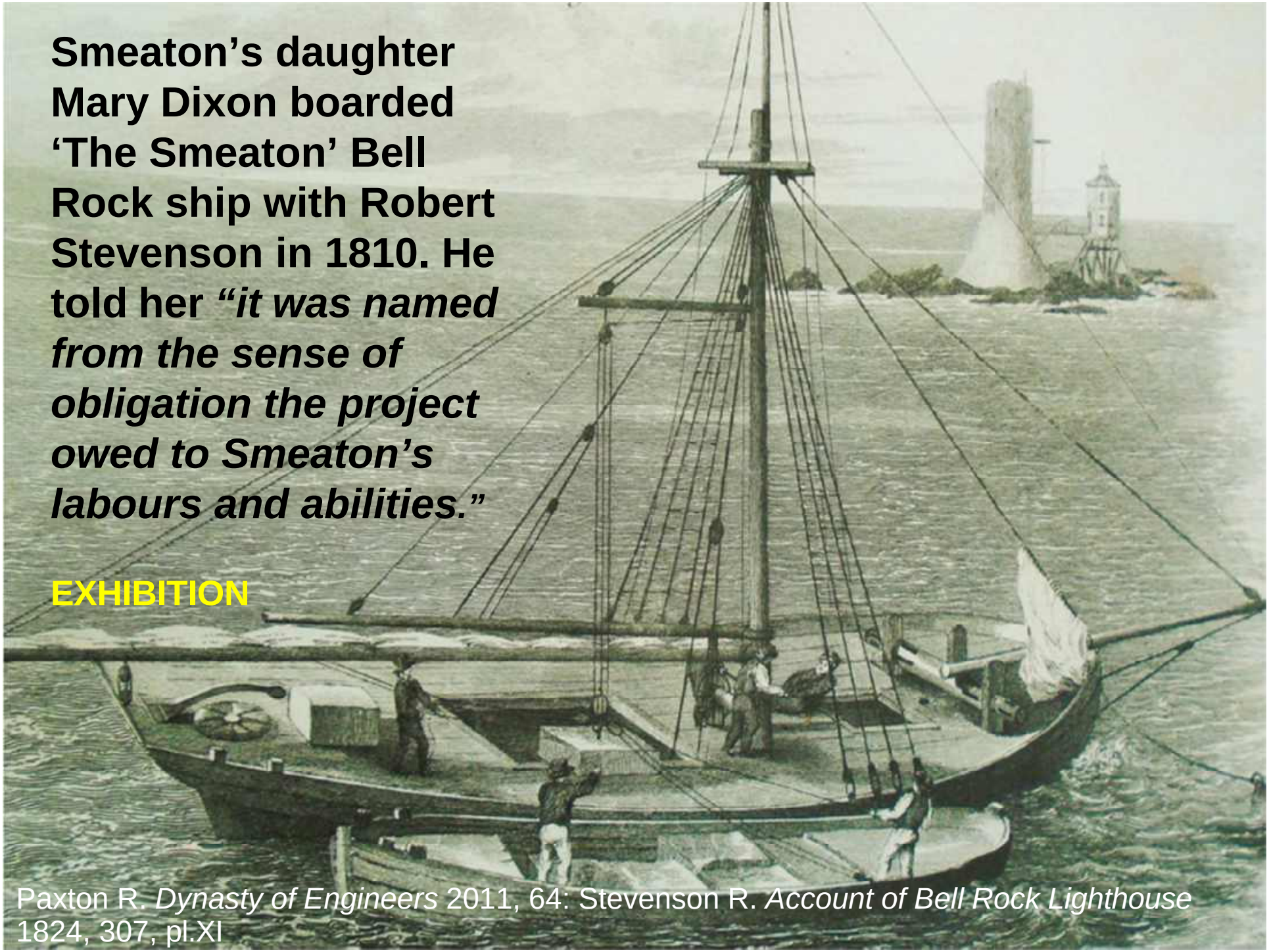
Skerryvore LH 1844

Northern Lighthouse Board Journal 12/21; 12/23

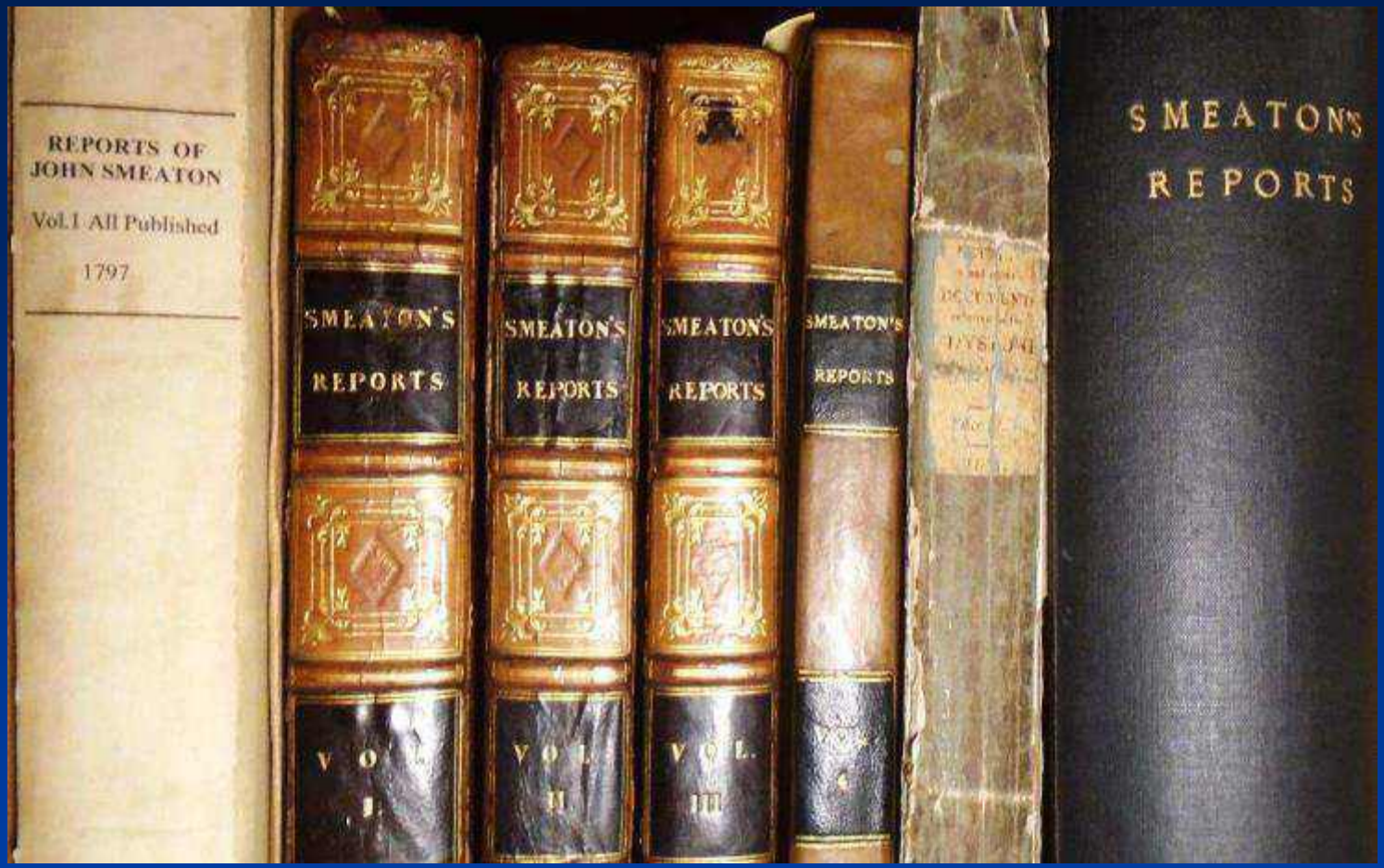
New Eddystone Lighthouse J. Douglas 1882



1759 tower top removed to Plymouth Hoe 1882



Paxton R. *Dynasty of Engineers* 2011, 64: Stevenson R. *Account of Bell Rock Lighthouse* 1824, 307, pl.XI



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