

RSE@Arbroath 2008

The Bellrock Lighthouse and the Stevenson family
'The Engineer and the Author'

By:

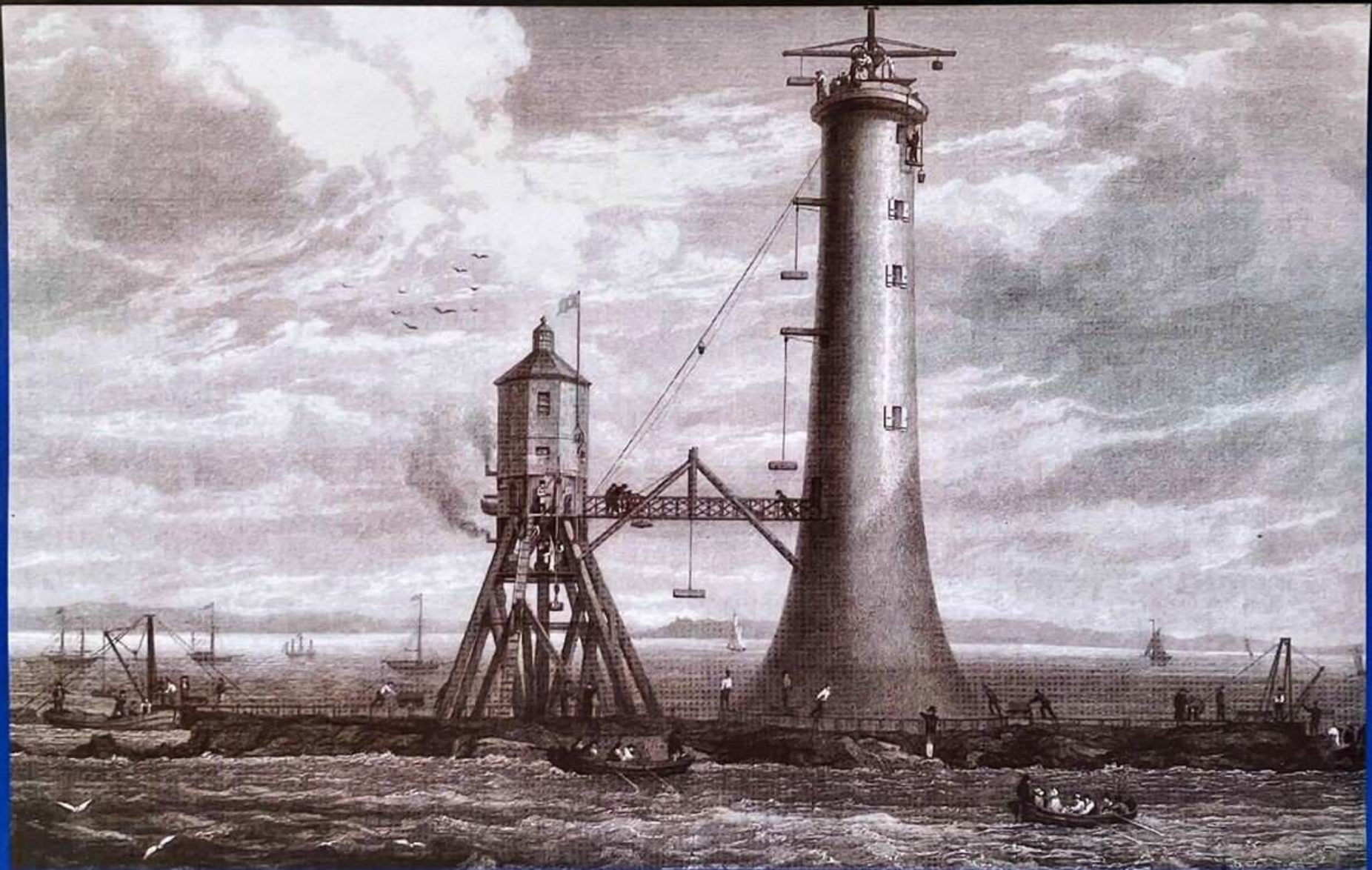
Professor Roland Paxton MBE FRSE

and

Virginia Mayes-Wright

Director of the Museum of Scottish Lighthouses

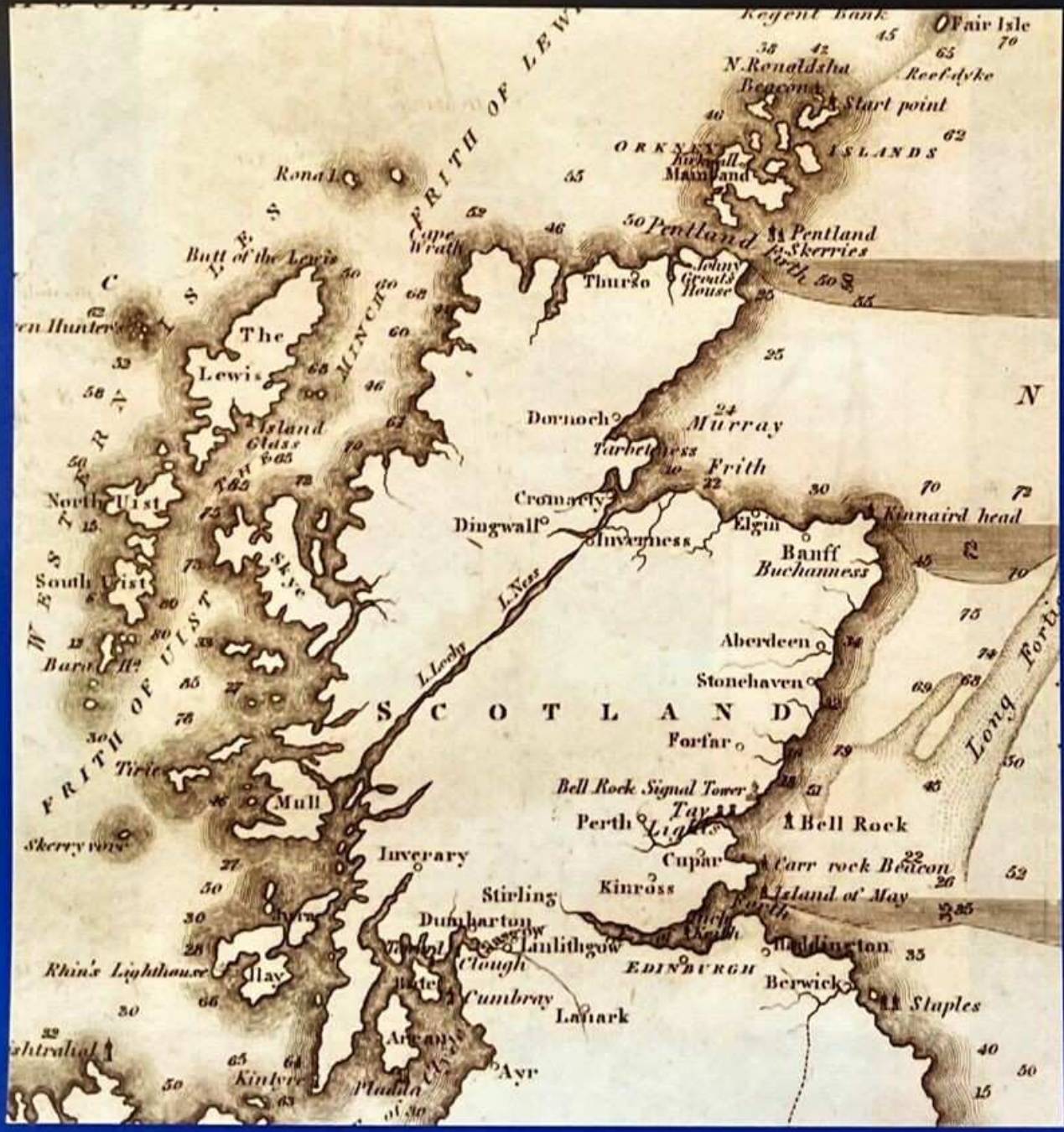
Cross Curricular School Talk



**CREATION OF THE BELL ROCK LIGHTHOUSE 1807-11 –
ONE OF ‘THE SEVEN WONDERS OF THE INDUSTRIAL WORLD’**

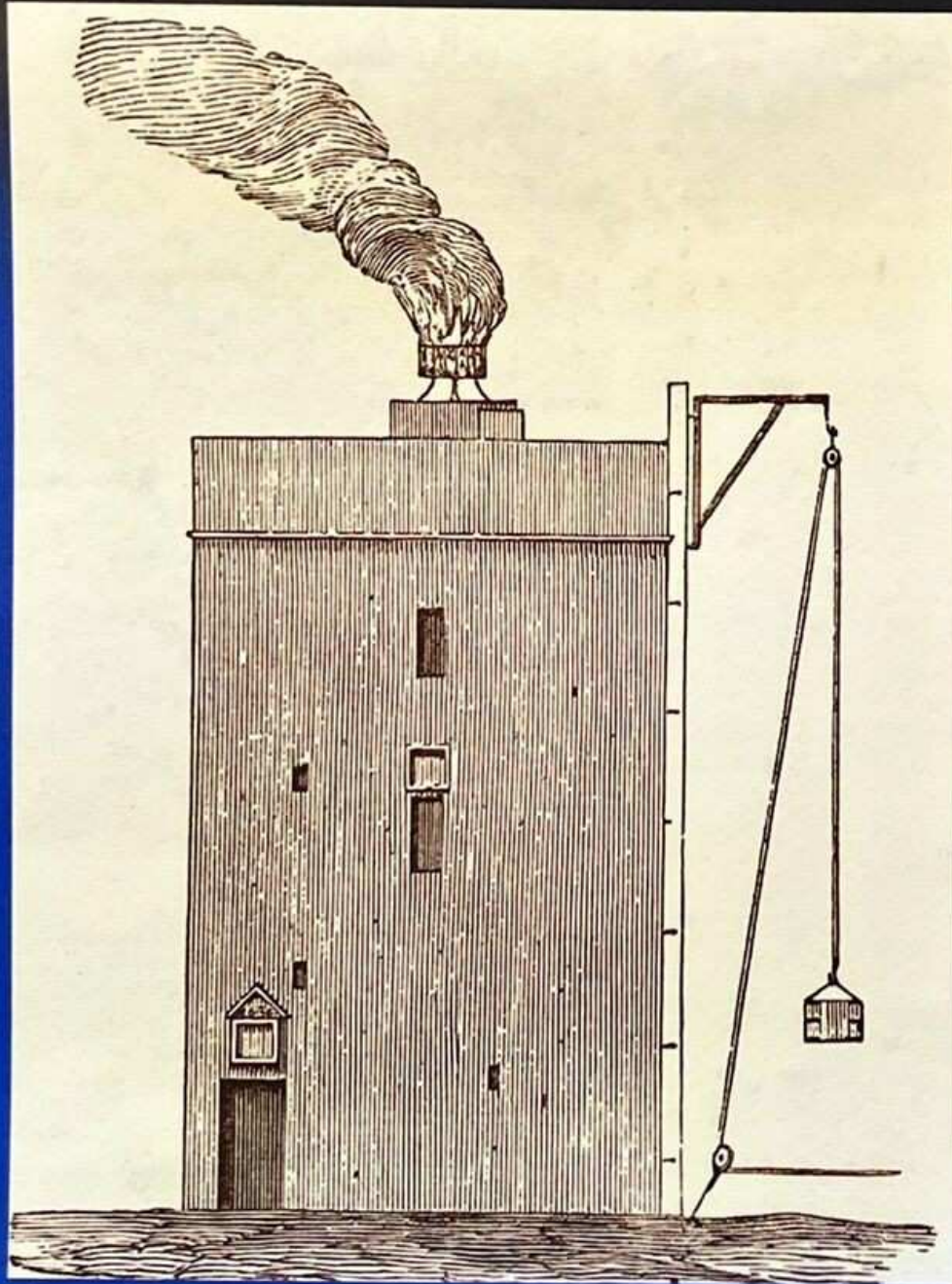
by Professor Roland Paxton MBE FICE FRSE

School of the Built Environment, Heriot-Watt University

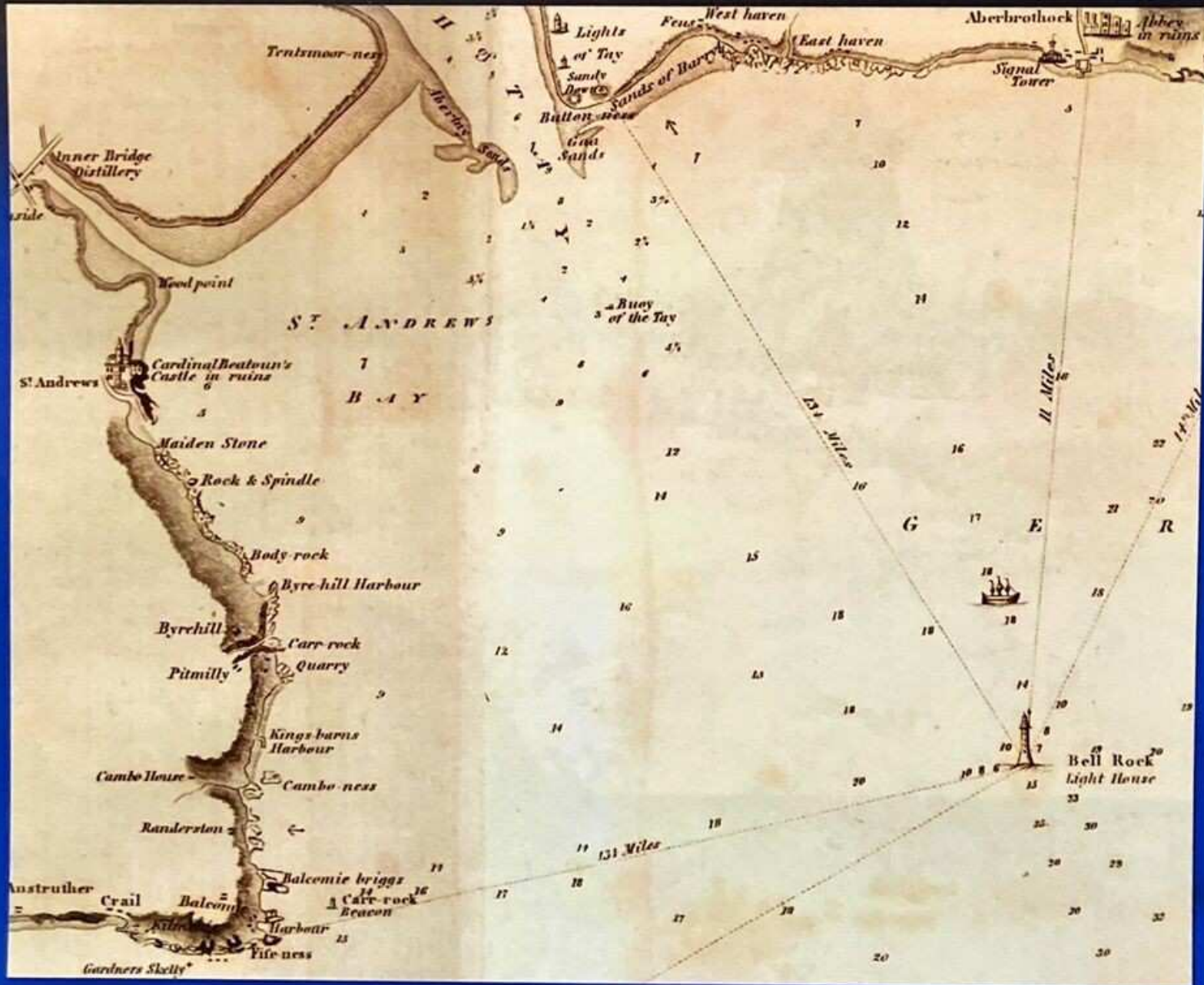


SCOTLAND'S DANGEROUS UNLIT COAST

(Isle of May Lighthouse 1635)
Northern Lighthouse Board [NLB] formed in 1786 to improve maritime safety



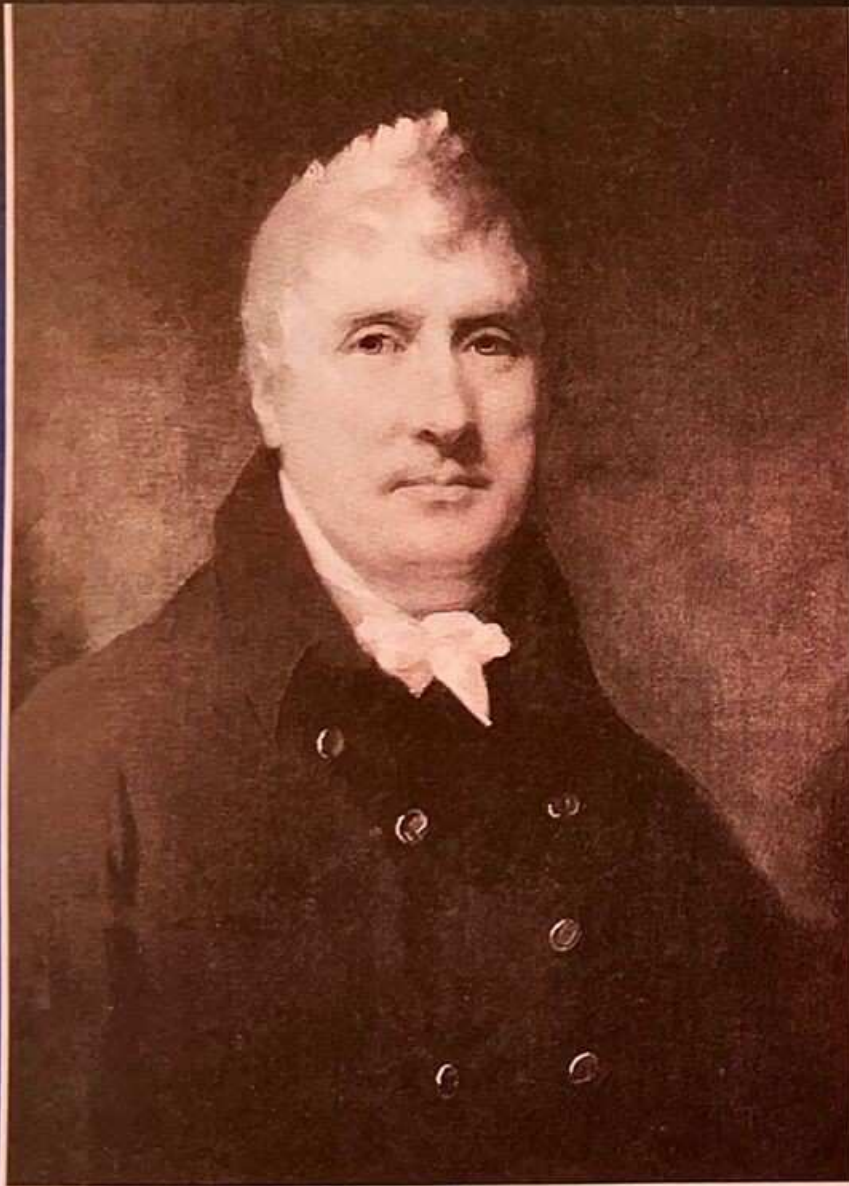
Isle of May coal-fired
lighthouse – in service
1635 -1816



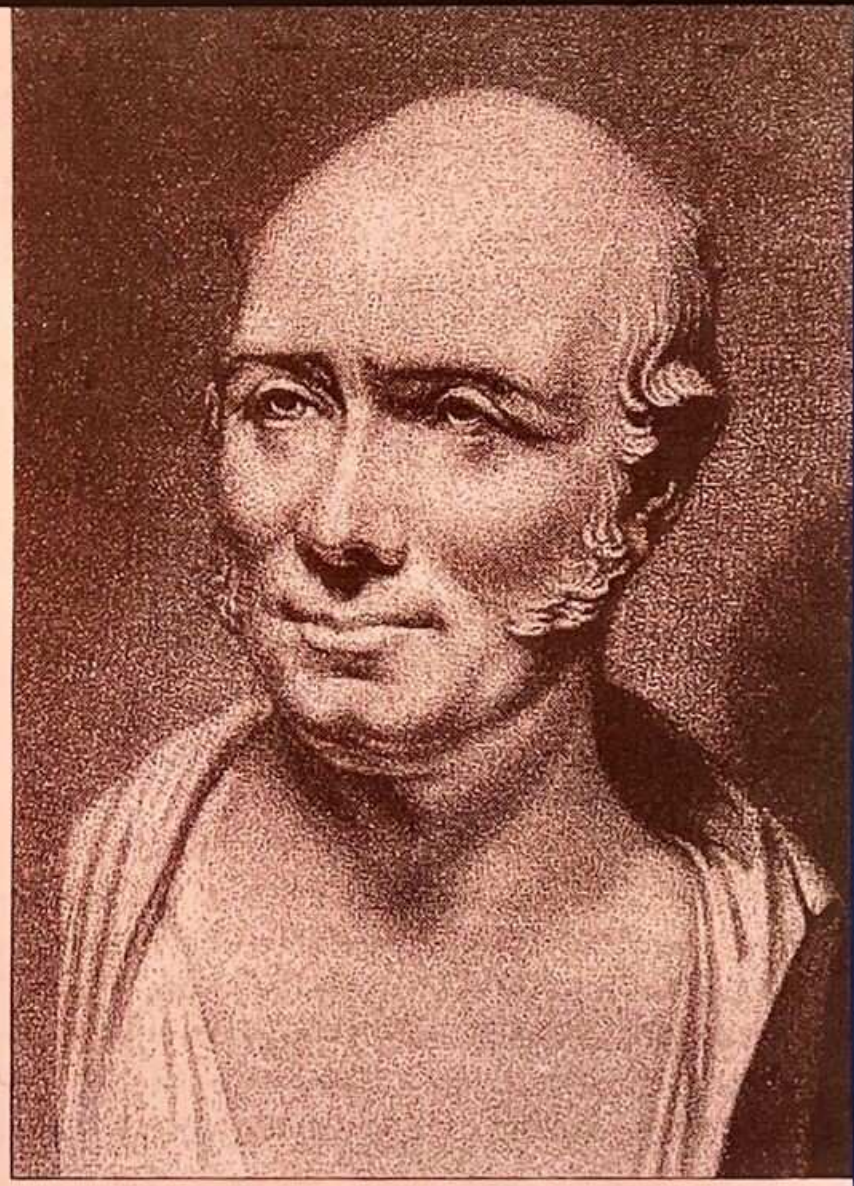
The hazardous Inchcape or Bell Rock 11 miles off Arbroath



The Bell Rock at low tide – submerged up to 4m at high tide. In 1799 70 vessels were stranded or lost on Scotland's coast, many of which would have found a safe haven in the Firth of Forth had there been a lighthouse on Bell Rock - The challenge of creating one by 1811 was met by Rennie & Stevenson based on Smeaton's Eddystone lighthouse of 1759

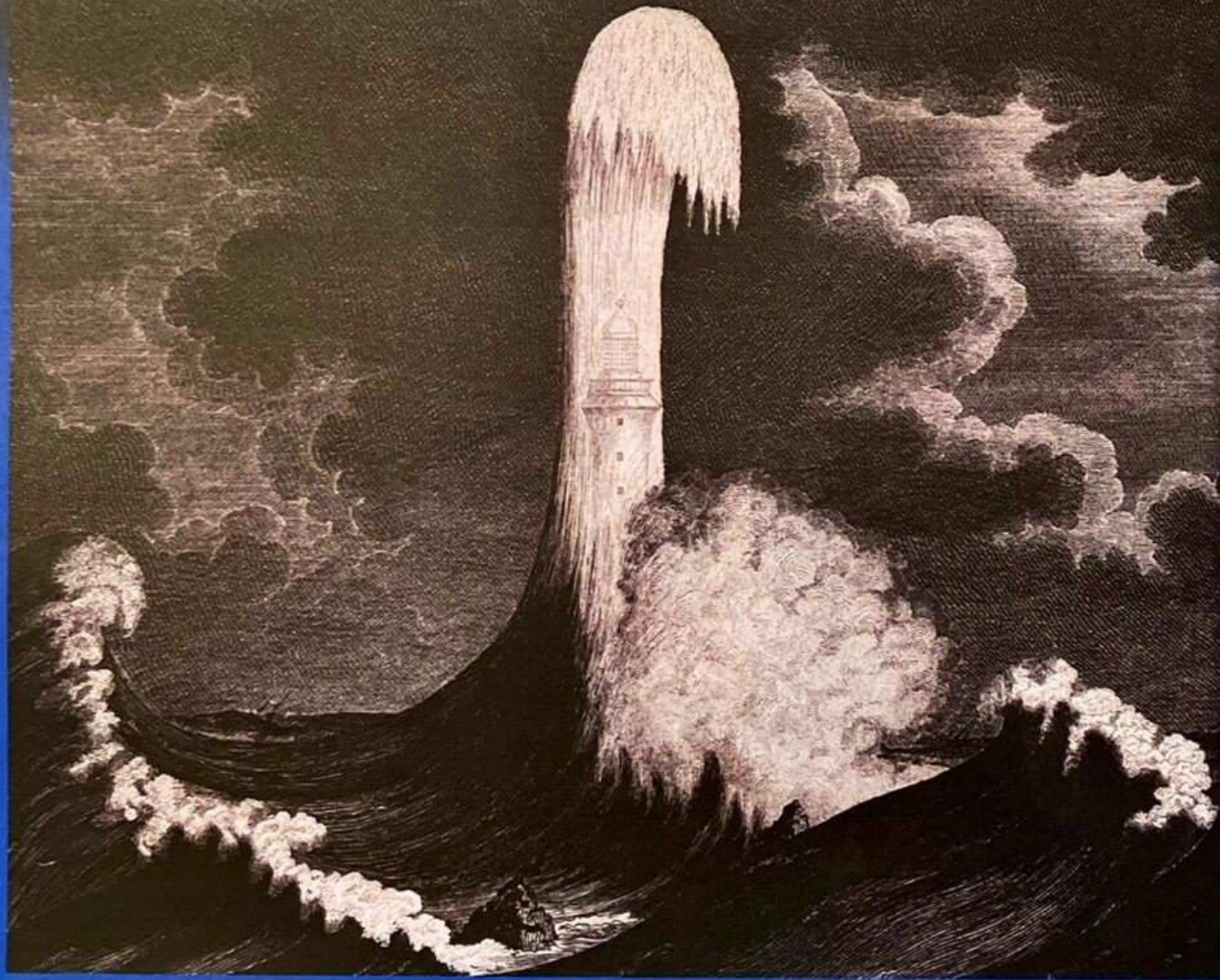


John Rennie FRS, FRSE

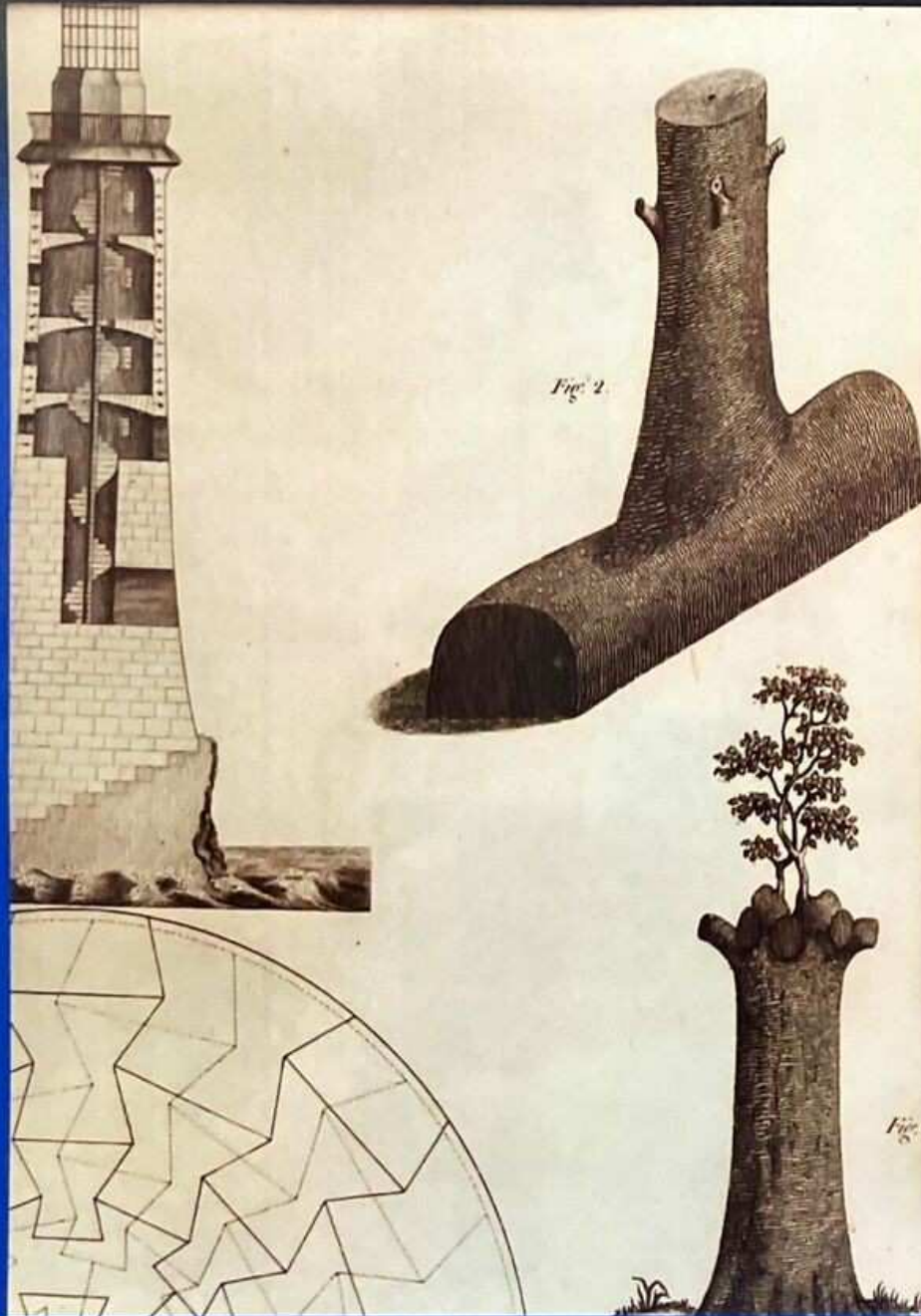


Robert Stevenson FRSE

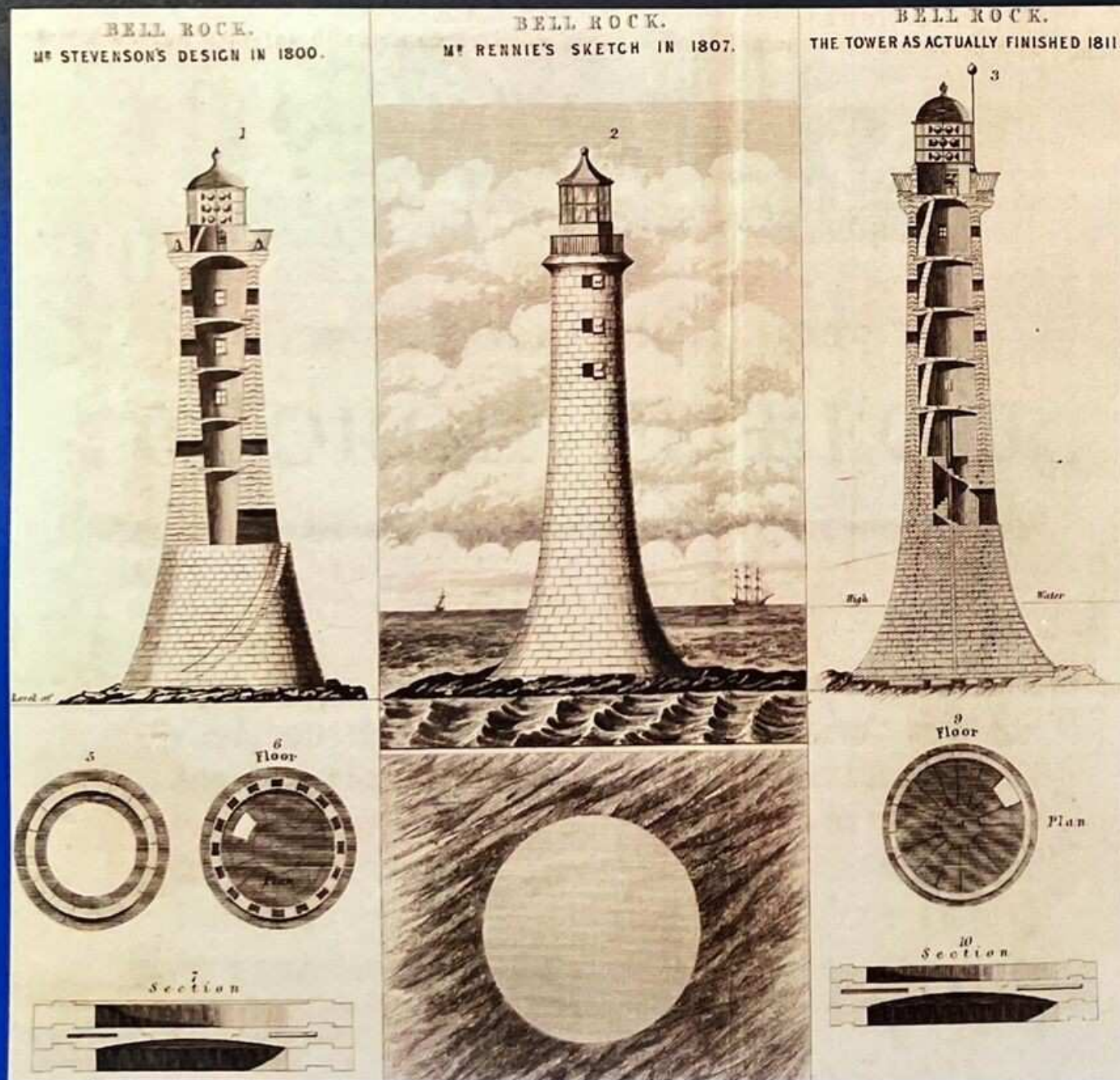
Civil Engineers Rennie (1761-1821) & Stevenson (1772-1850)



Eddystone lighthouse 1757-59 (nr. Plymouth) in a storm in 1759



Smeaton considered his design structurally analagous to an oak tree. He regarded dovetailed masonry as essential.



Bell Rock lighthouse designs 1800-11. Note that in Rennie's and the as built design, the tower curvature at the rock is about 40° to the horizontal to dissipate wave force. As seen, Stevenson proposed about 70° and omitted dovetailing



ANNO QUADRAGESIMO SEXTO

GEORGII III. REGIS.

C A P. CXXXII.

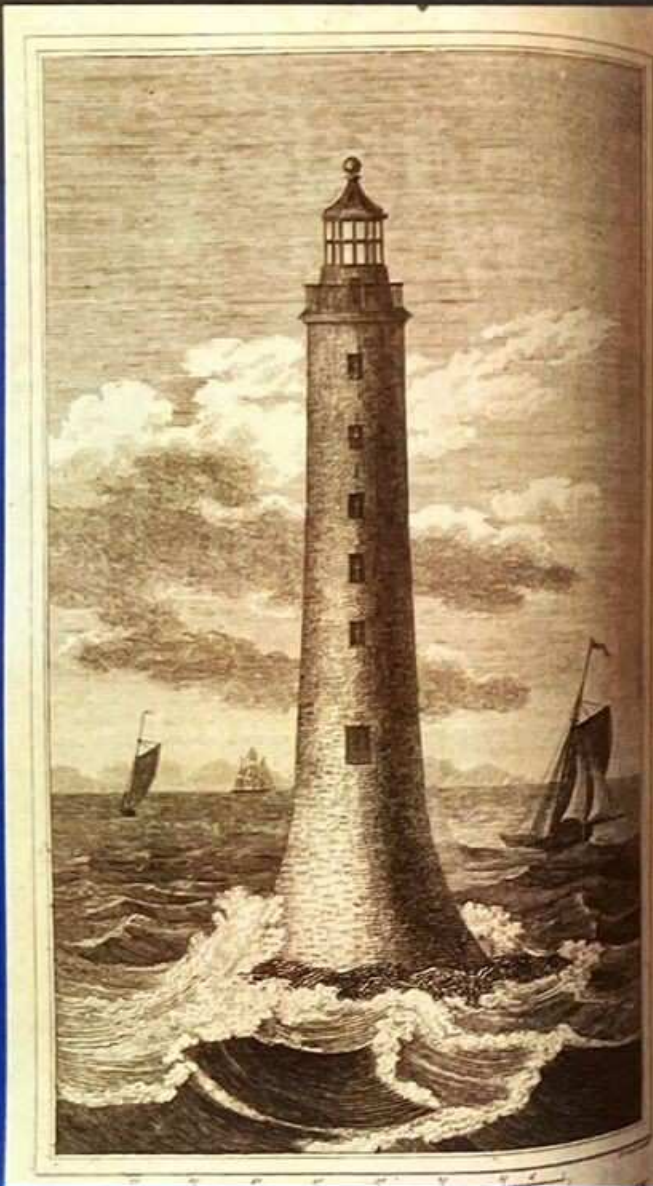
An Act for erecting a Light House on the *Bell* or *Cape Rock*, on the Eastern Coast of *Scotland*, and for enabling the Commissioners of the Treasury to advance a certain Sum of Money out of the Consolidated Fund of *Great Britain*, towards that Purpose. [21st July 1806.]

WHEREAS by an Act, made in the Twenty-sixth Year of His present Majesty's Reign, intituled, *An Act for erecting certain* 16G.3. c.1021

After an unsuccessful attempt in 1803 based on Stevenson's plan an act for the lighthouse was obtained in 1806 with Rennie's Backing. Financed by shipping dues of 3 pence/ton



The NLB Lighthouses from 1787 - Kinnaird Head, North Ronaldsay, Pentland Skerries (2), Eilean Glass, Mull of Kintyre, Pladda, Inchkeith & Start Point (Stone ball sea mark 1802-09). Engineer, lamp-maker Thomas Smith, step-father & father-in-law of Robert Stevenson, his apprentice 1796-1802.



SCOTS MAGAZINE,
AND
Edinburgh Literary Miscellany,

FOR JUNE 1807:

With a Plan and Elevation of Mr RAWLIN'S design of the LIGHT-HOUSE
to be erected on the BELL ROCK.

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Chief engineer Rennie's design for the tower in 1807. Stevenson, the resident engineer, laid the foundation stone 10 July 1808. Two days later he succeeded Thomas Smith as engineer to the NLB.

AN
ACCOUNT
OF THE
BELL ROCK LIGHT-HOUSE,

INCLUDING THE
DETAILS OF THE ERECTION AND PECULIAR STRUCTURE
OF THAT EDIFICE.

TO WHICH IS PREFIXED A
HISTORICAL VIEW OF THE INSTITUTION AND PROGRESS
OF THE
NORTHERN LIGHT-HOUSES.

ILLUSTRATED WITH TWENTY-THREE ENGRAVINGS.

DRAWN UP BY DESIRE OF
THE COMMISSIONERS OF THE NORTHERN LIGHT-HOUSES,

BY
ROBERT STEVENSON,

CIVIL ENGINEER ;

FELLOW OF THE ROYAL SOCIETY OF EDINBURGH ;
MEMBER OF THE SOCIETY OF SCOTISH ANTIQUARIES, OF THE WERNERIAN NATURAL HISTORY SOCIETY,
AND OF THE GEOLOGICAL SOCIETY OF LONDON ;

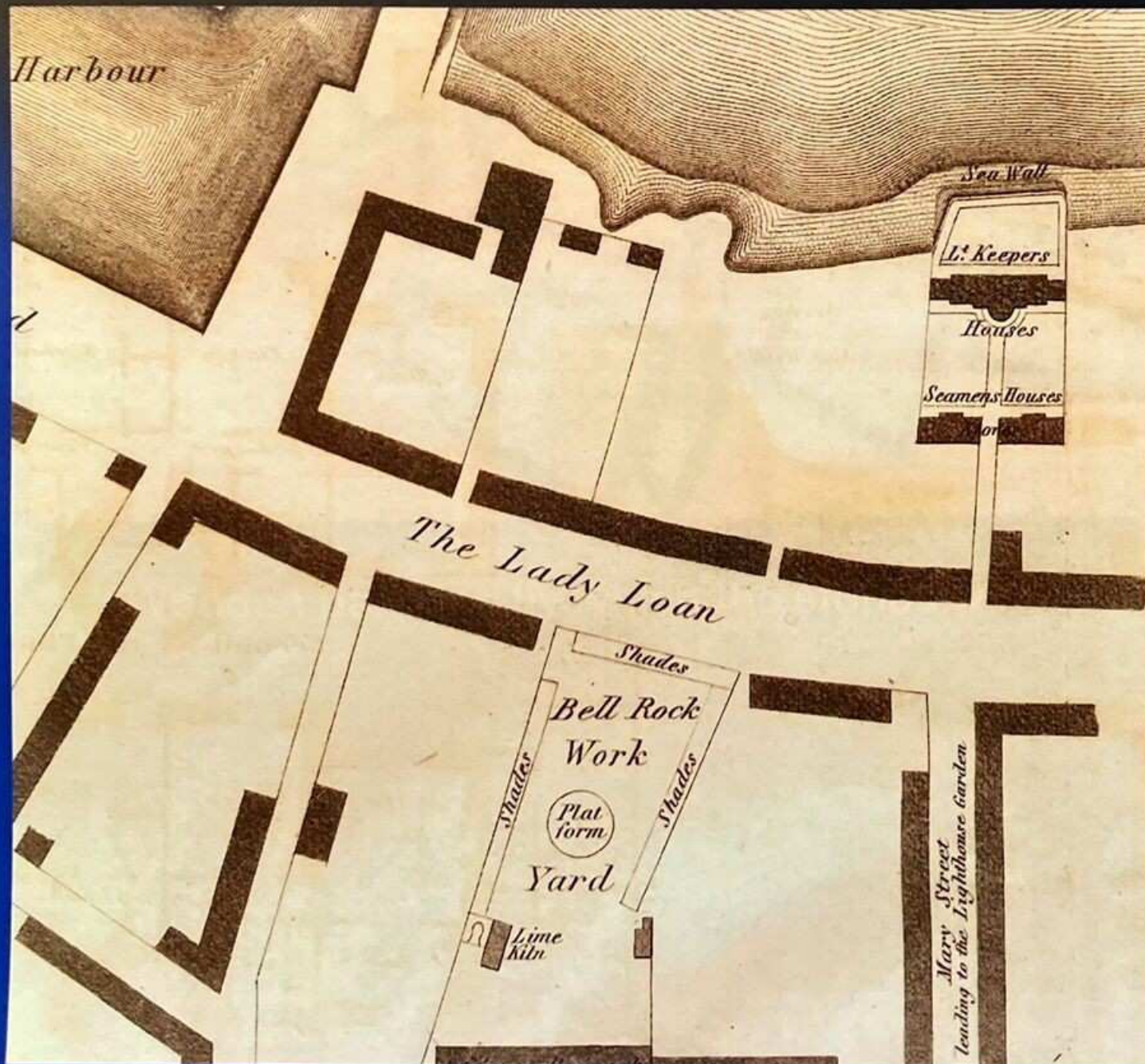
ENGINEER TO THE NORTHERN LIGHT-HOUSE BOARD, AND TO THE CONVENTION
OF ROYAL BOROUGHS OF SCOTLAND.

EDINBURGH :

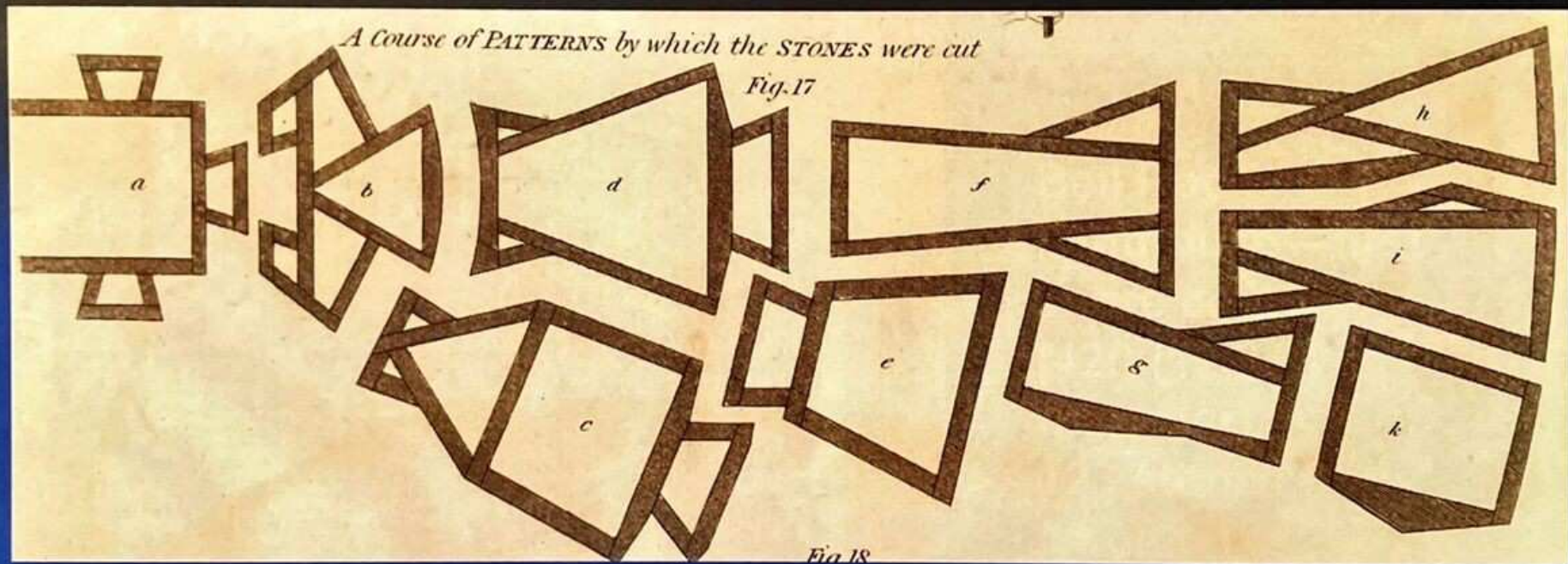
PRINTED FOR ARCHIBALD CONSTABLE & CO. EDINBURGH ;
HURST, ROBINSON & CO. 90. CHEAPSIDE; AND JOSIAH TAYLOR, 59. HIGH HOLBORN,
LONDON.

1824.

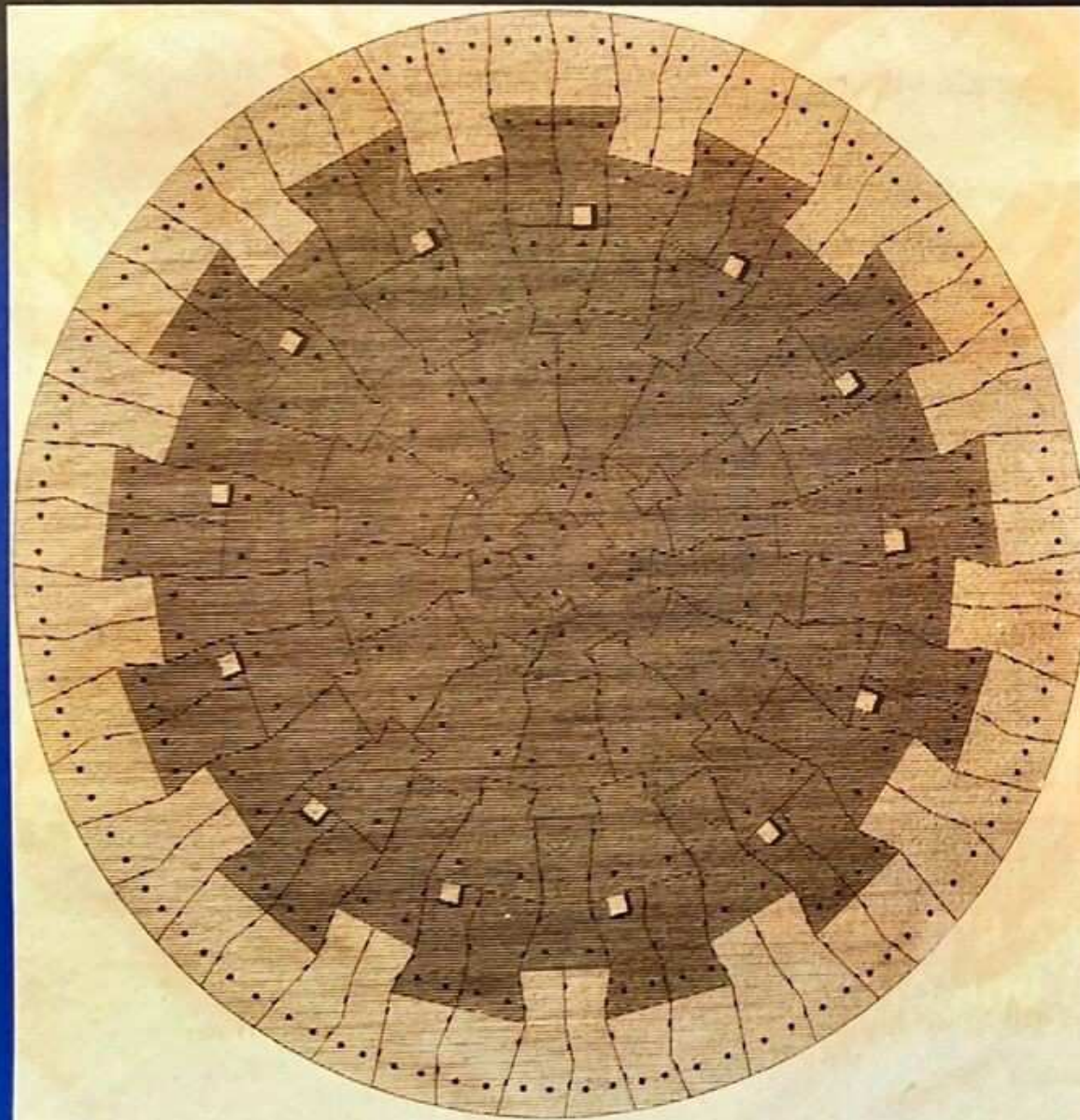
Stevenson's account of building the lighthouse - a classic of civil engineering modelled on Smeaton's Eddystone Lighthouse book 1791



Bell Rock lighthouse workyard at Arbroath – the circular platform carried each course of stone before shipping out to the Rock.



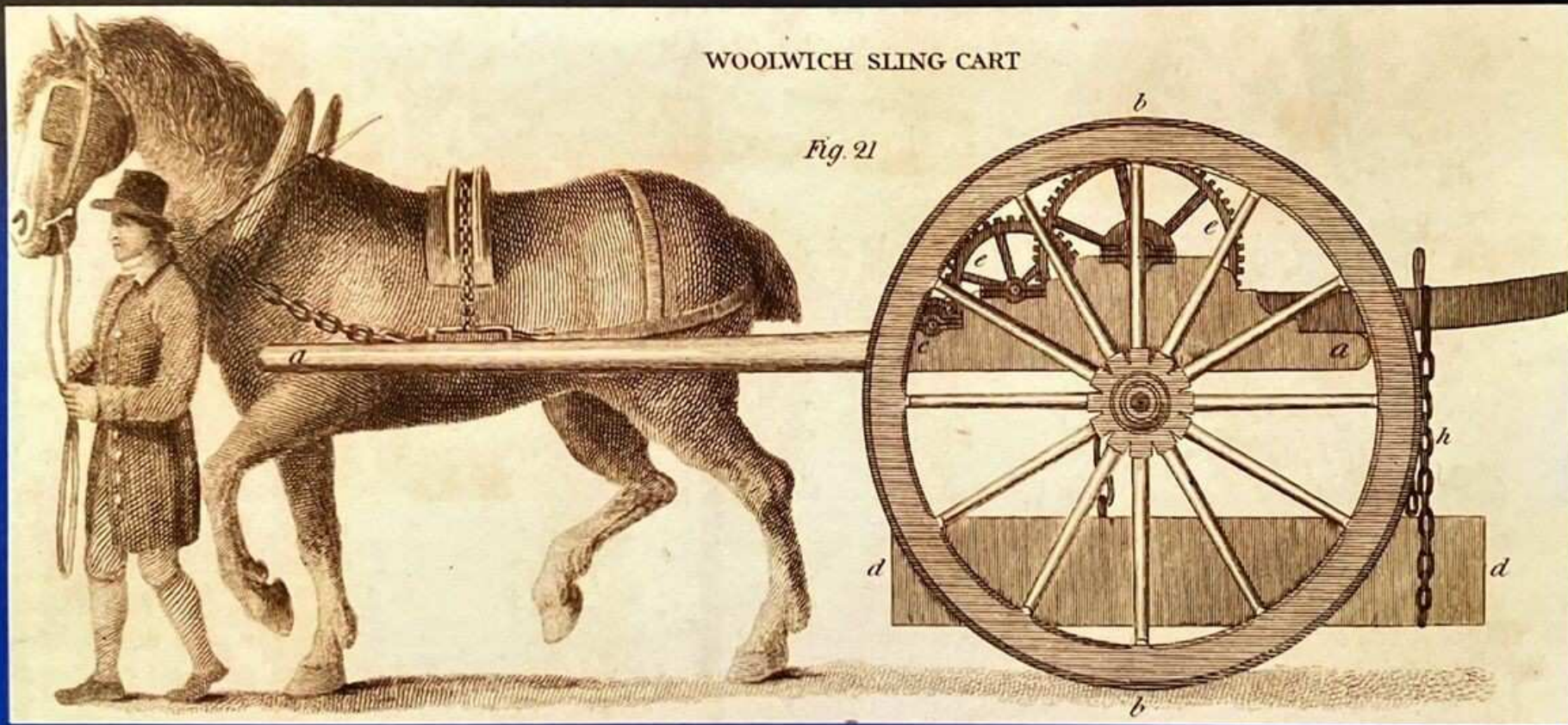
Wooden patterns by which the stones were cut for a course



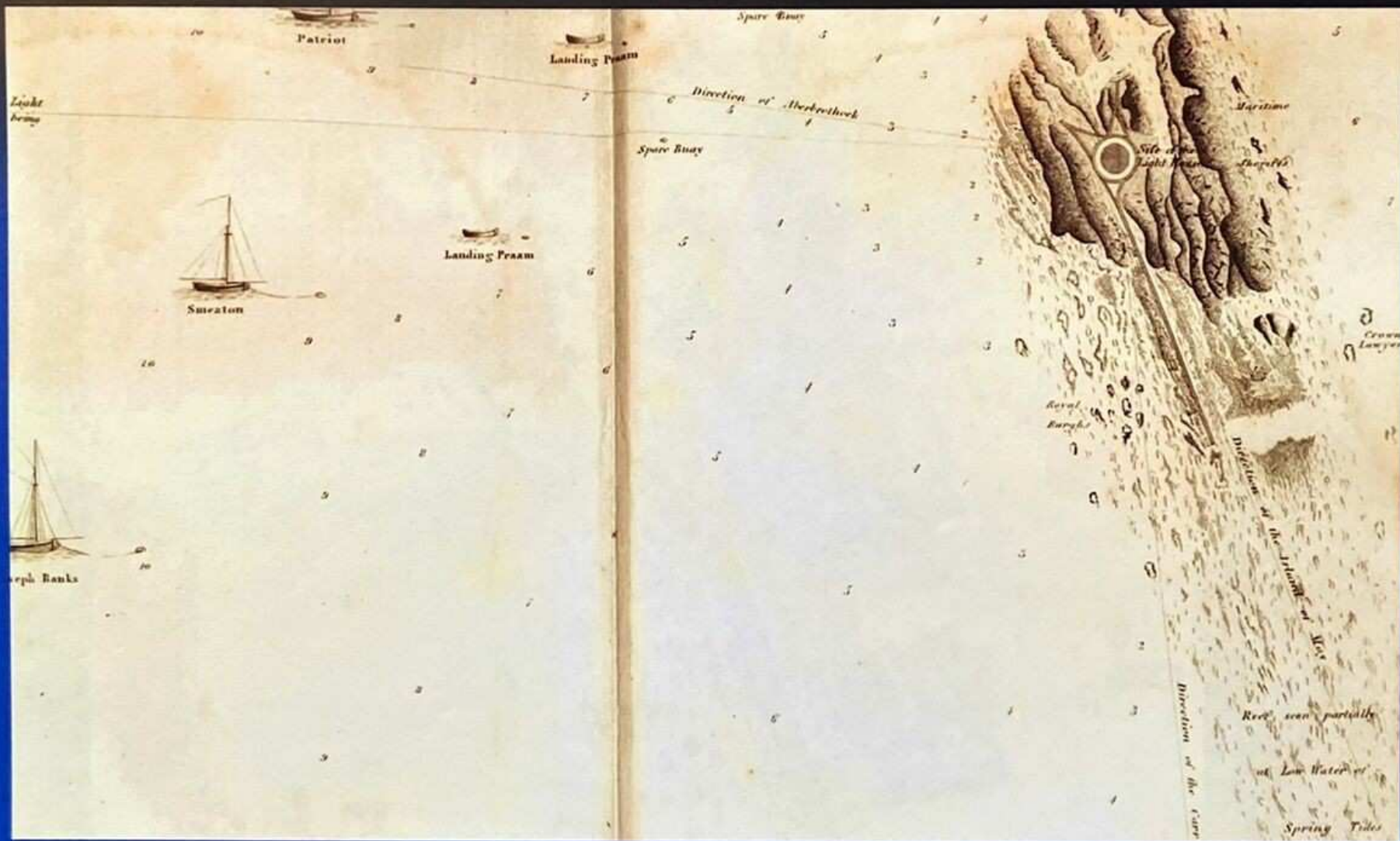
First entire Course

0 5 10 20
Scale of feet

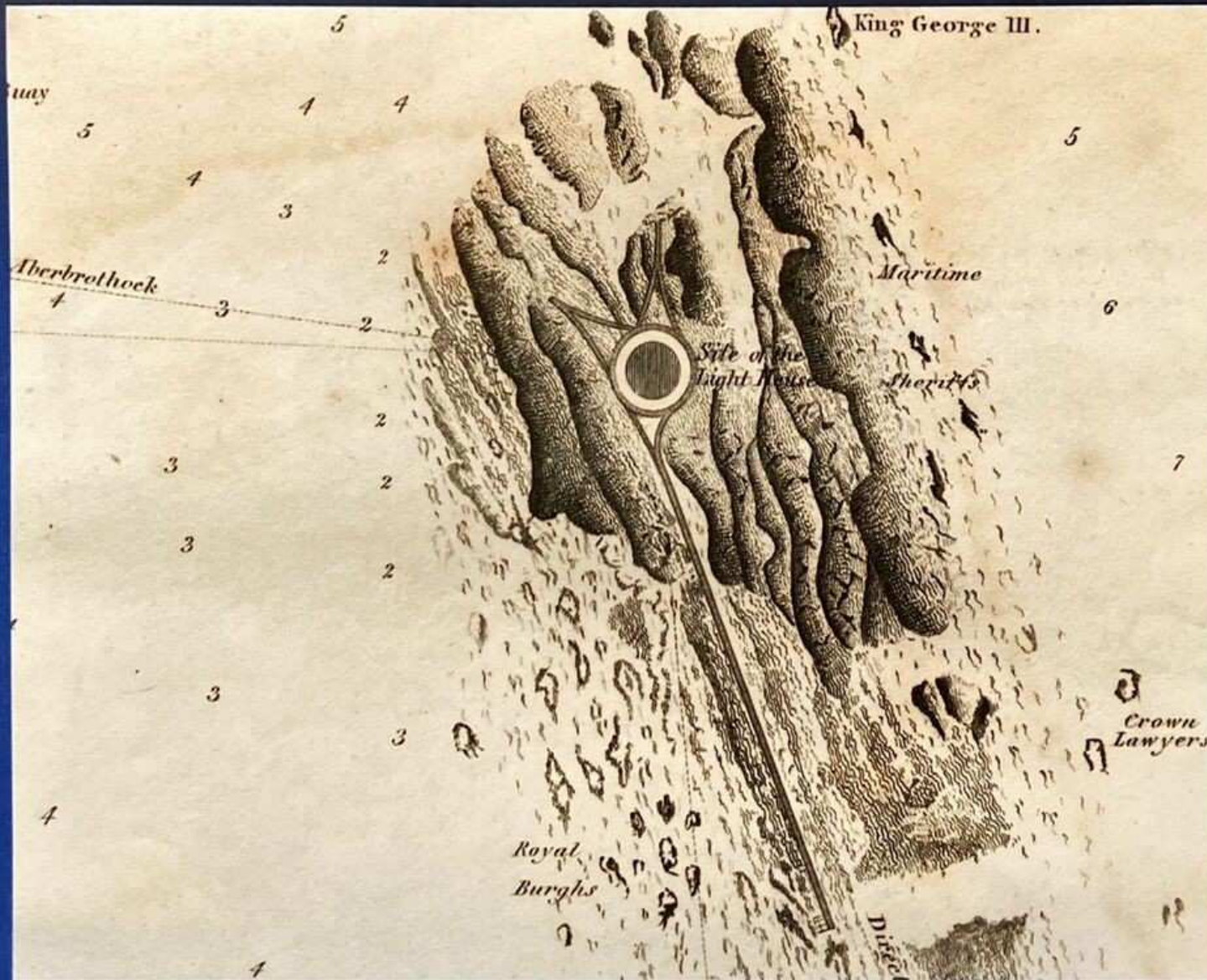
**Bell Rock
lighthouse – first
entire course
[42ft (12.8m)
diameter]
123 stones from
11 patterns?**



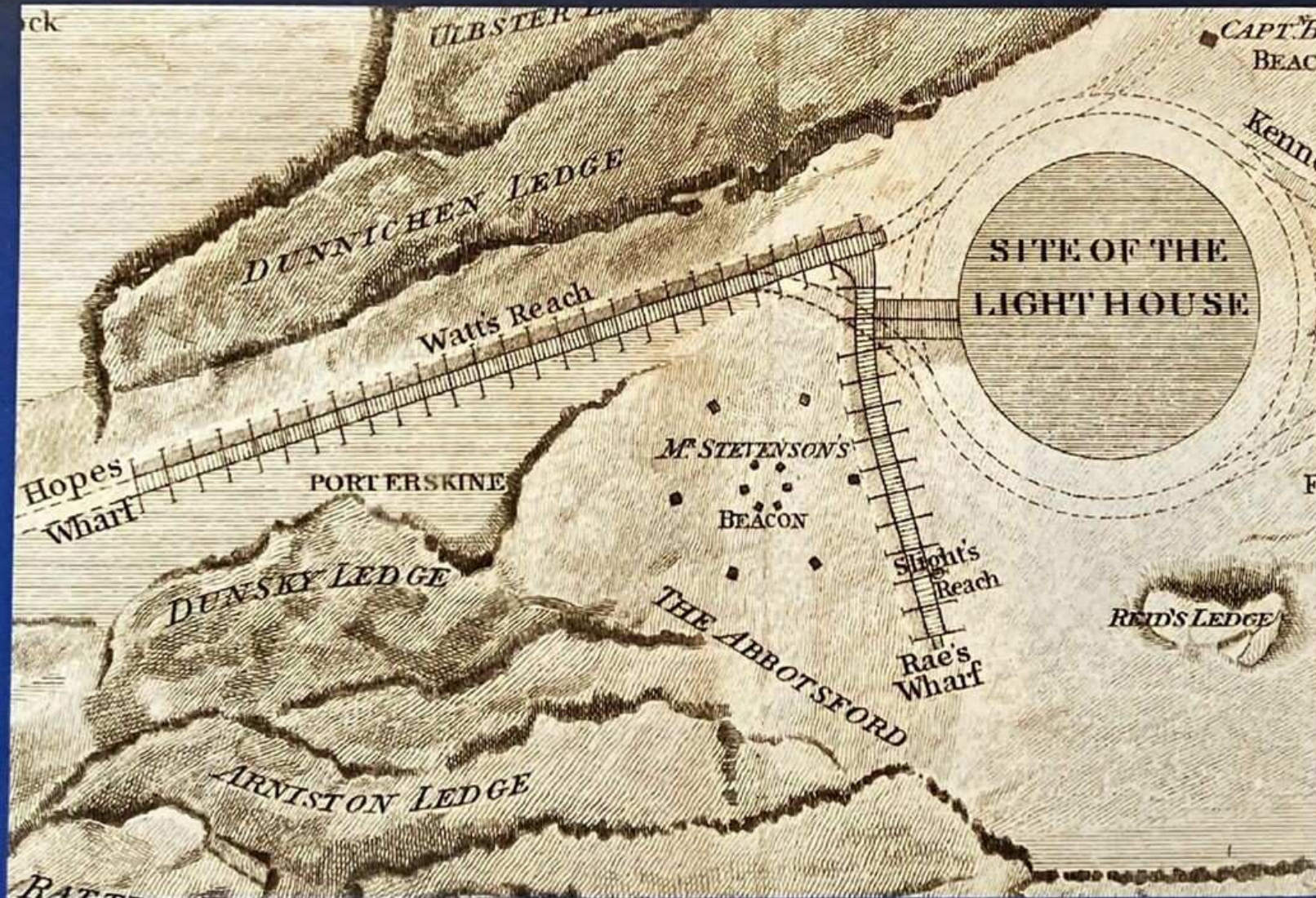
James Craw with 'Bassie' hauling stone in and around the Arbroath workyard and to and from the harbour



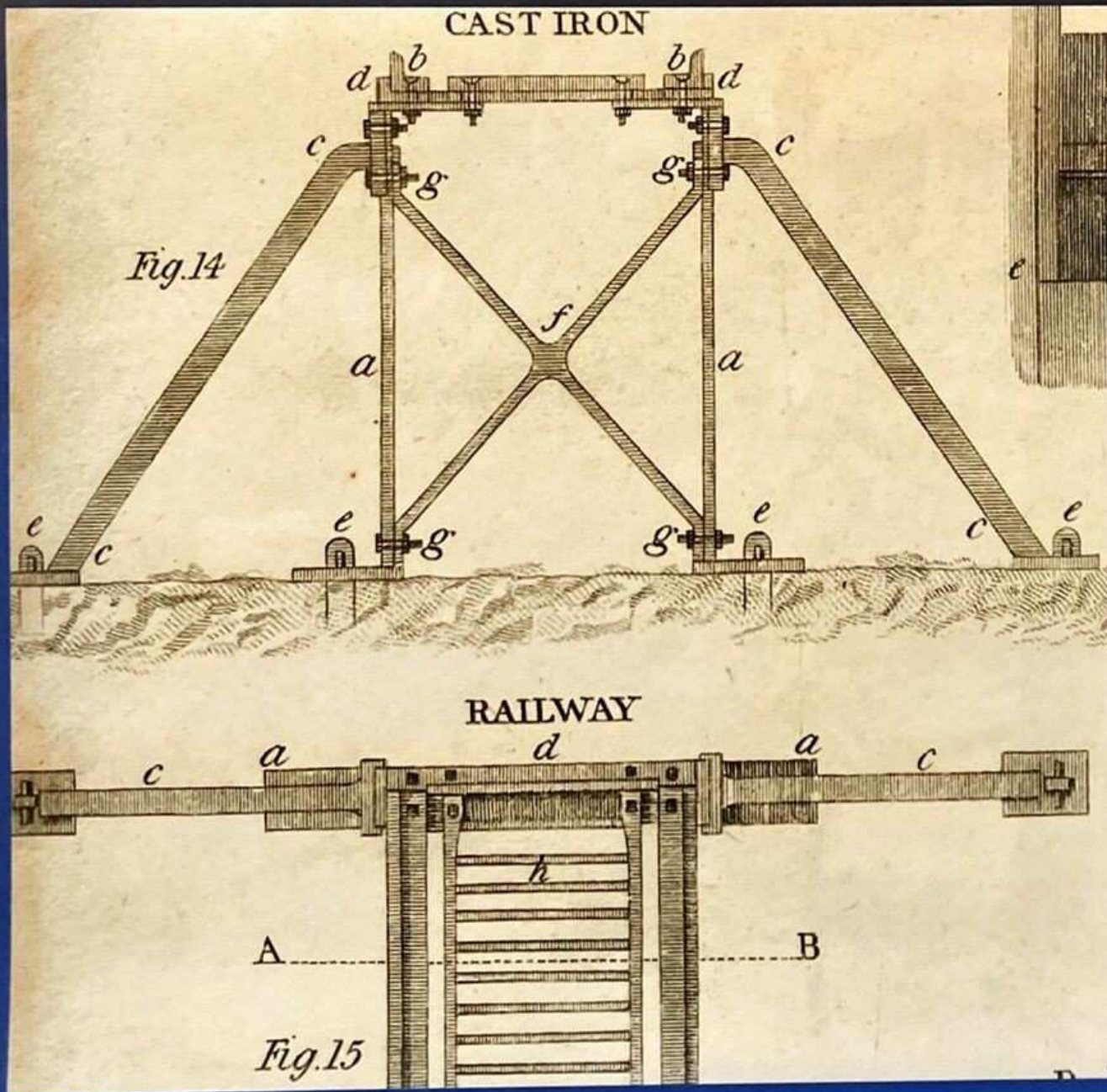
Rock & ships: Sir Joseph Banks – Smeaton – Patriot - praams



Operations at the rock before erection of the beacon -1807



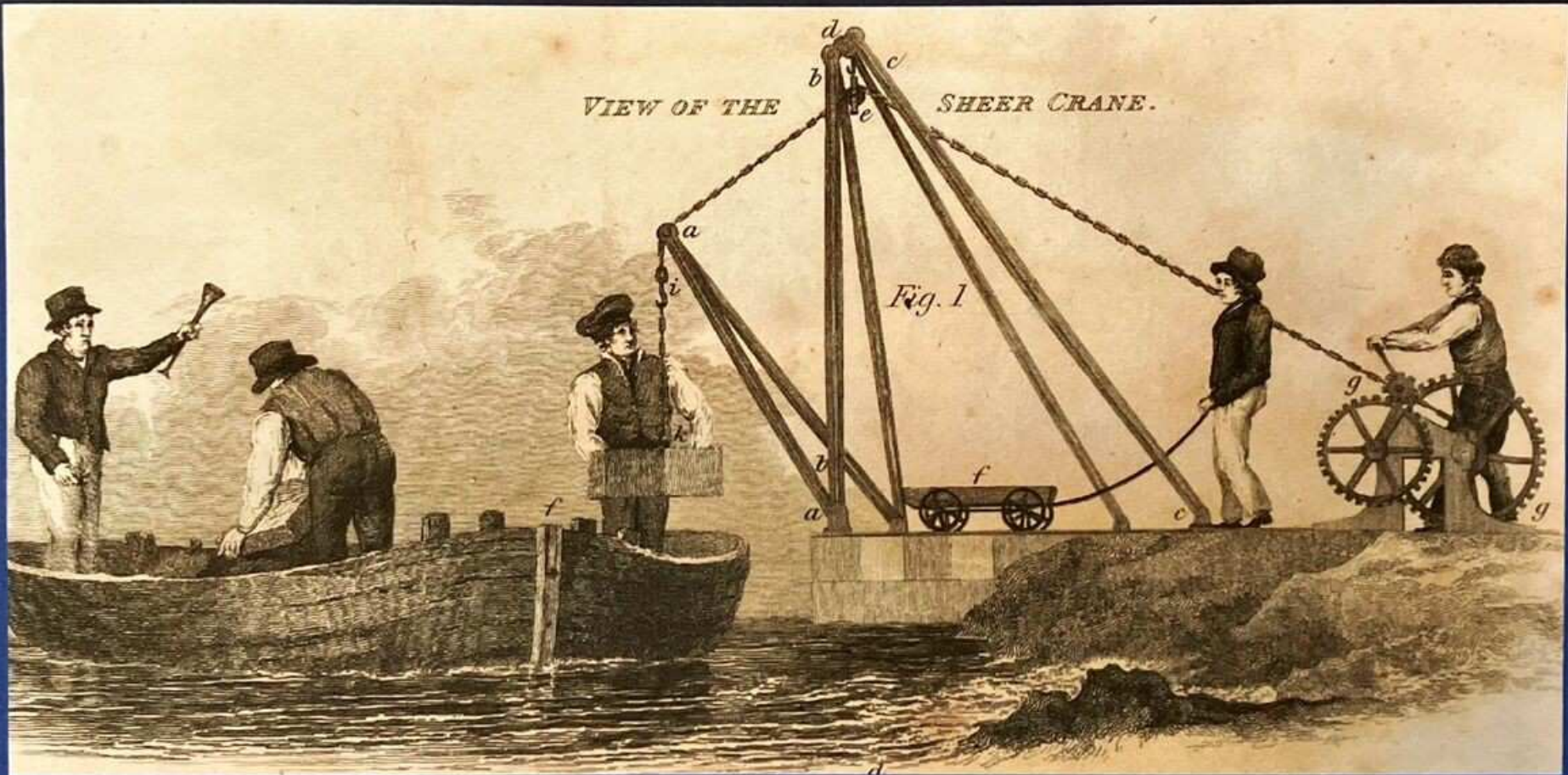
Plan showing railway and temporary beacon position



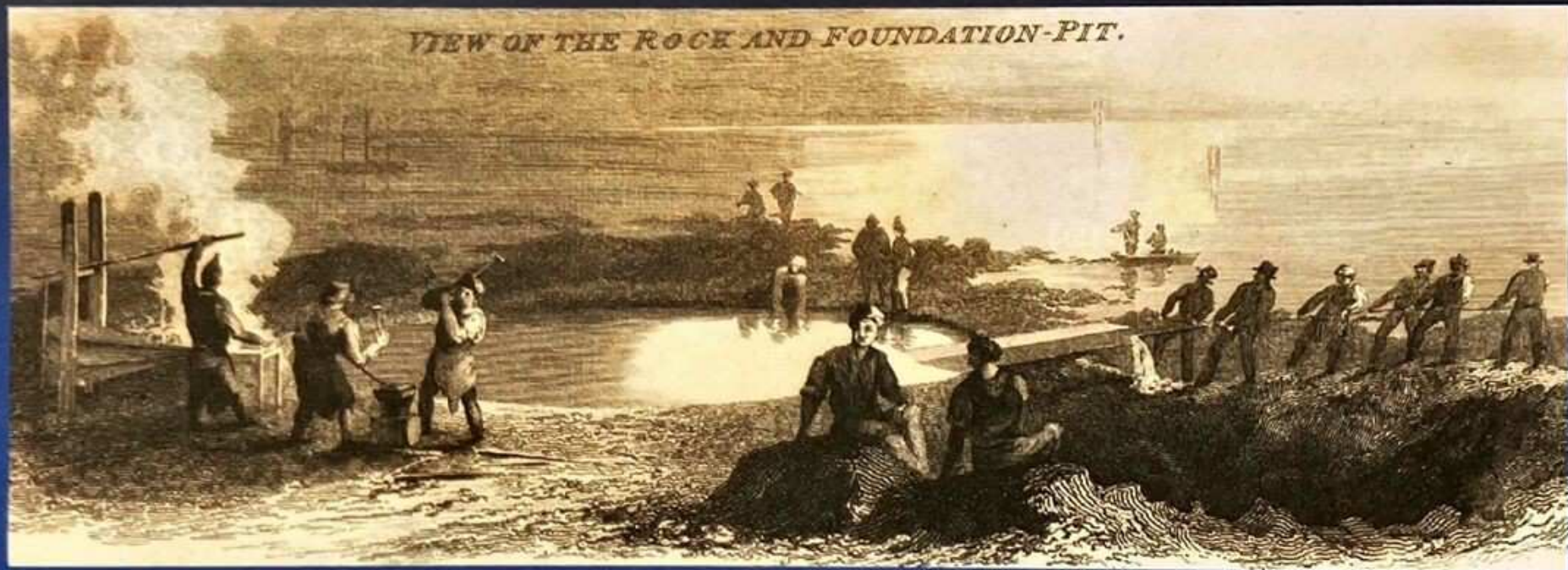
Railway over uneven rock surface – designed by Francis Watt



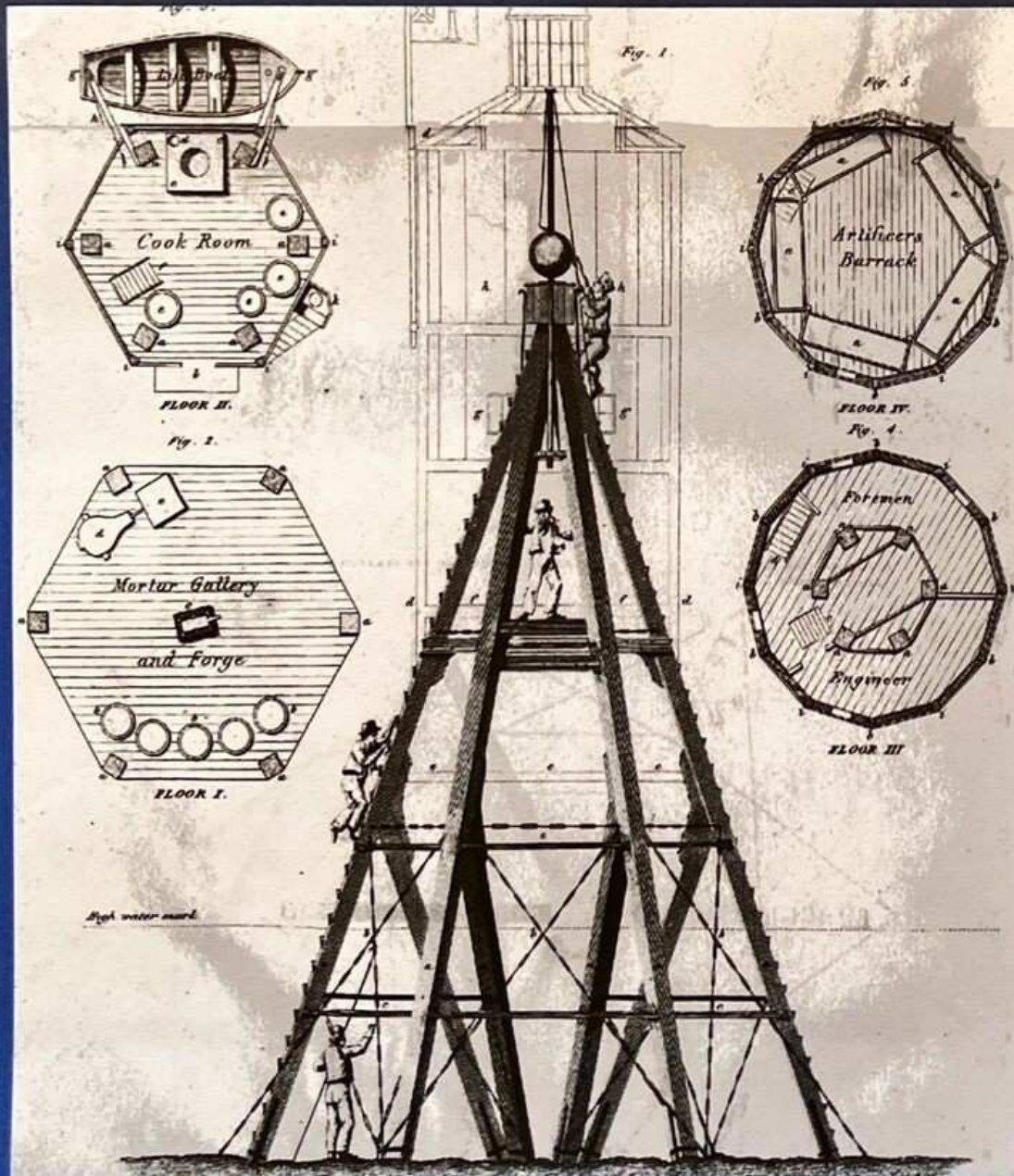
Cast iron railway as photographed by the writer in 1986



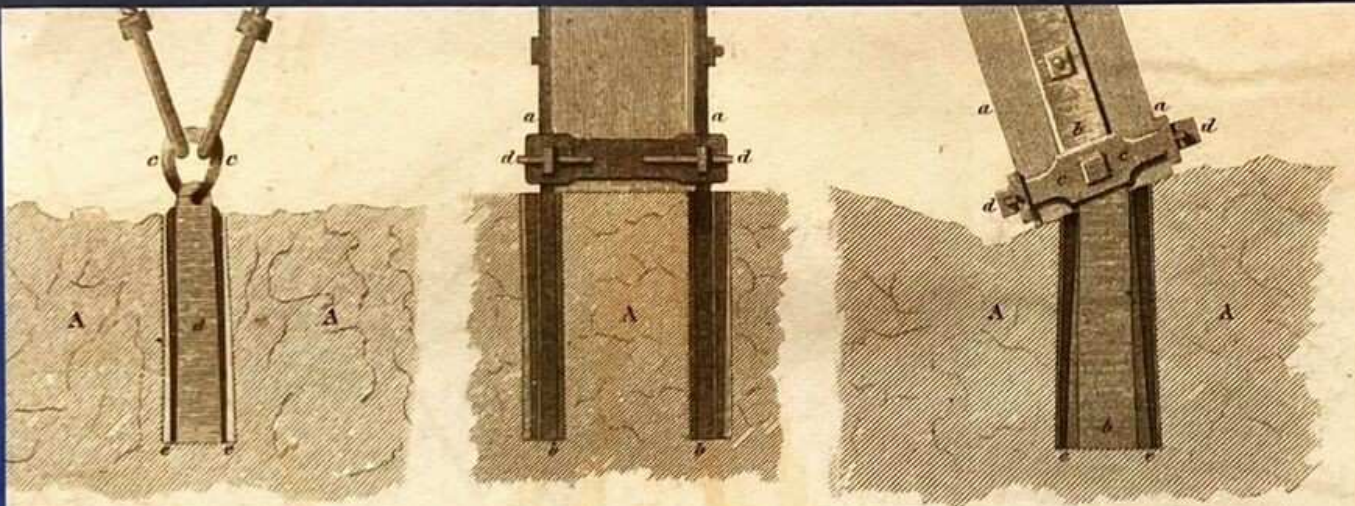
Transferring stone from praaam to railway by sheer crane



View of the foundation pit in 1807 being de-watered by six men and ironwork being forged to anchor beacon to rock. After about 2 hours work the water began to rise



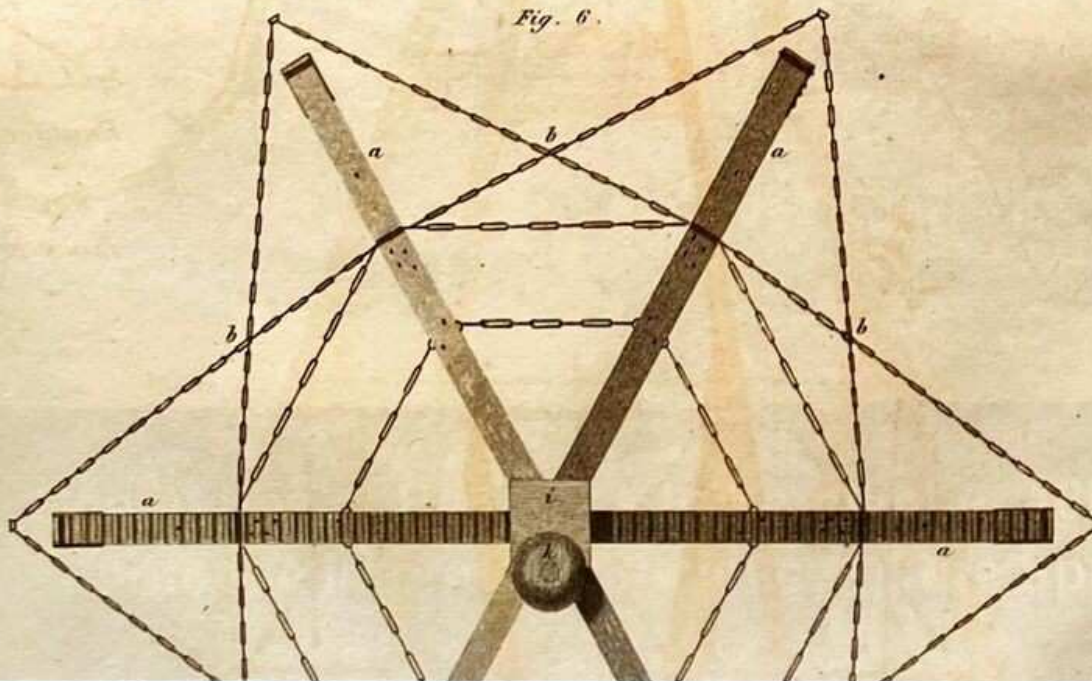
**Bell Rock
temporary
beacon – note
bracing chains
and the four
levels – mortar
gallery, cook
room,
engineer's and
foremens'
quarters and
workmans'
barrack (25
bunks!)**



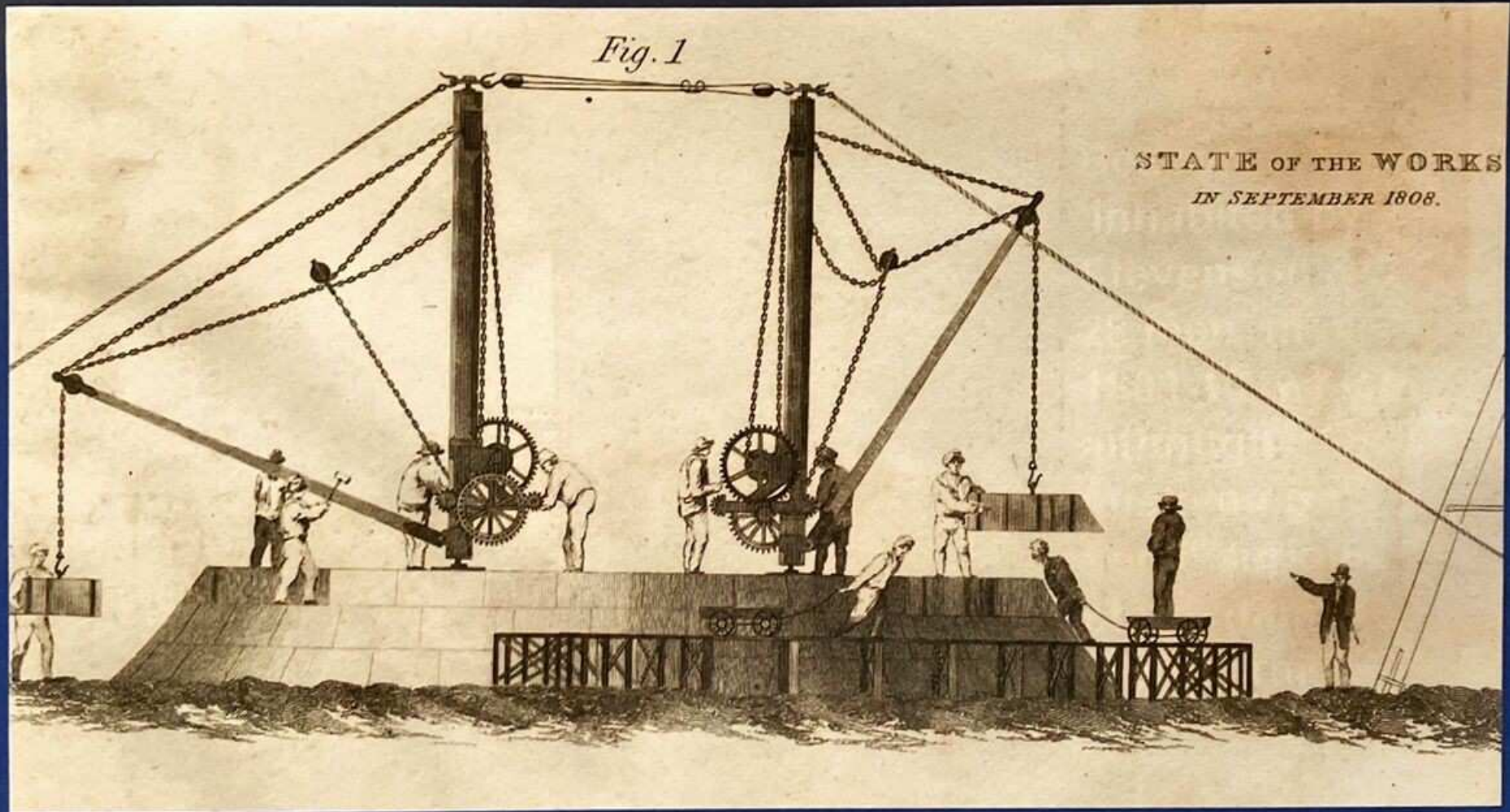
ENLARGED VIEW OF
BRACING CHAINS

ENLARGED VIEW OF THE GREAT STANCHIONS

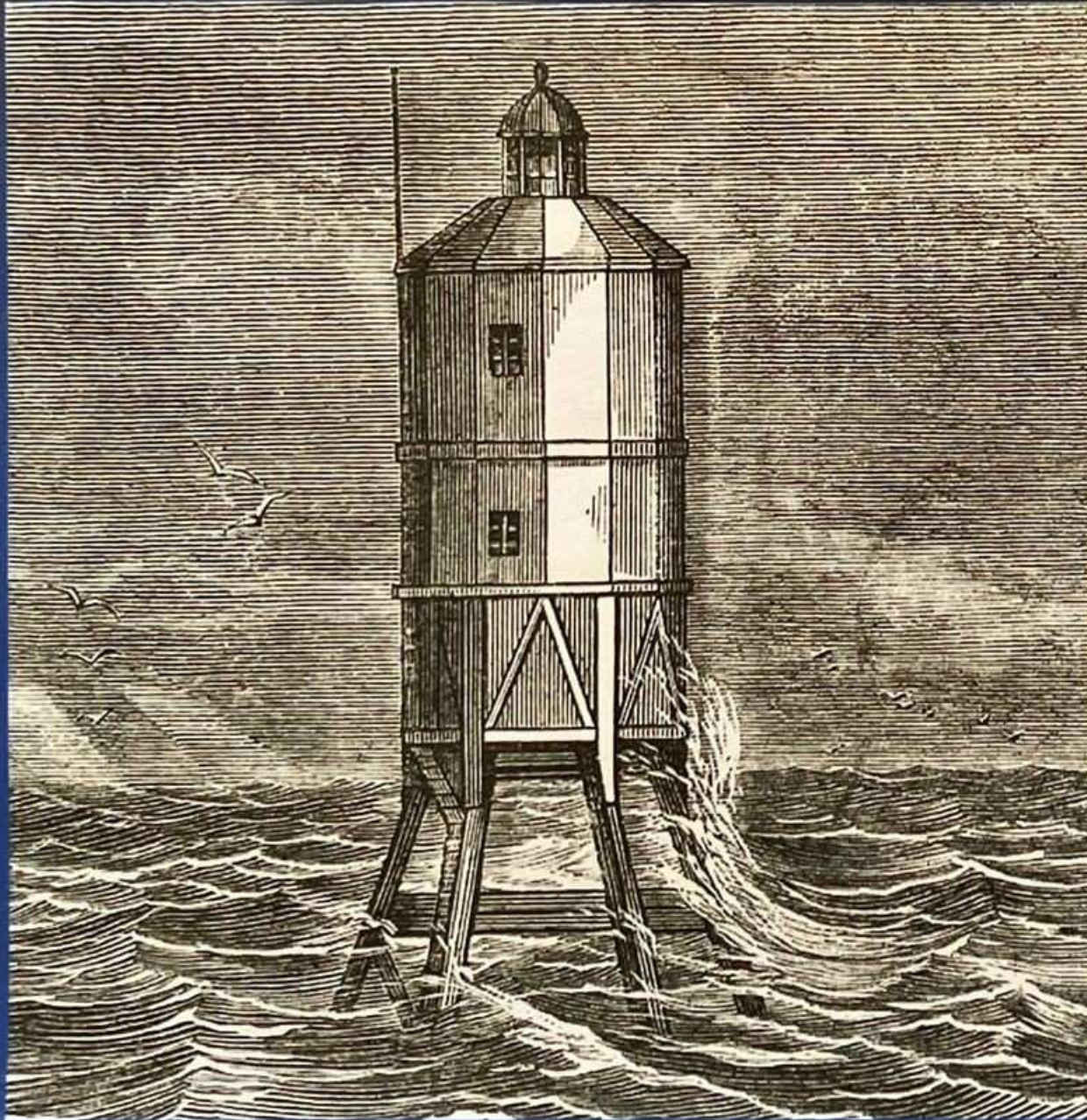
Fig. 6.



Details of
beacon fixing
and bracing



**Operations at Bell Rock in September 1808 – innovative cranes
- note the improved efficiency of the Spanish windlass effect**

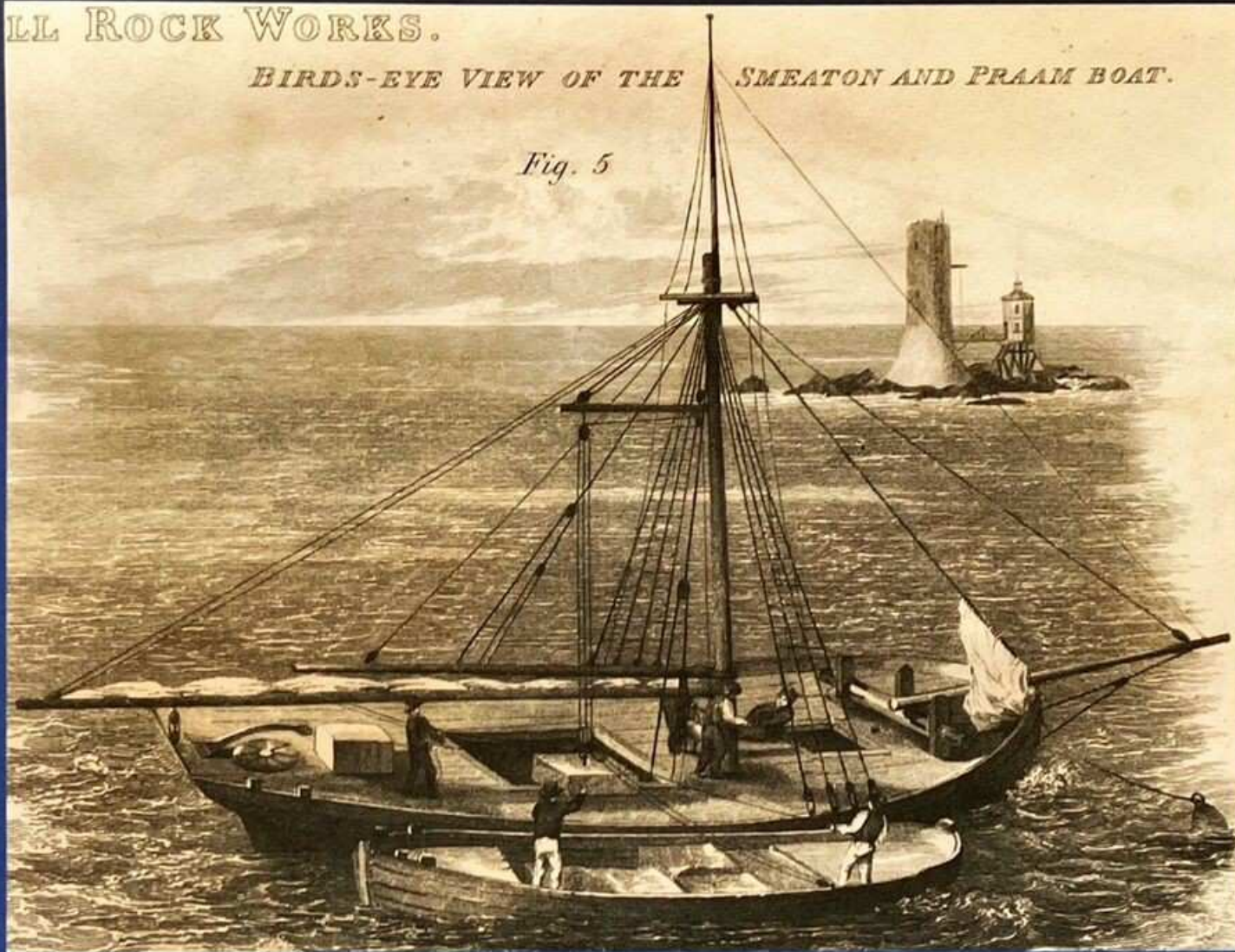


**Beacon
'inhabited by
Stevenson &
28 men' in
1809-10, which
although
sustaining
some serious
storm damage
stood firm**

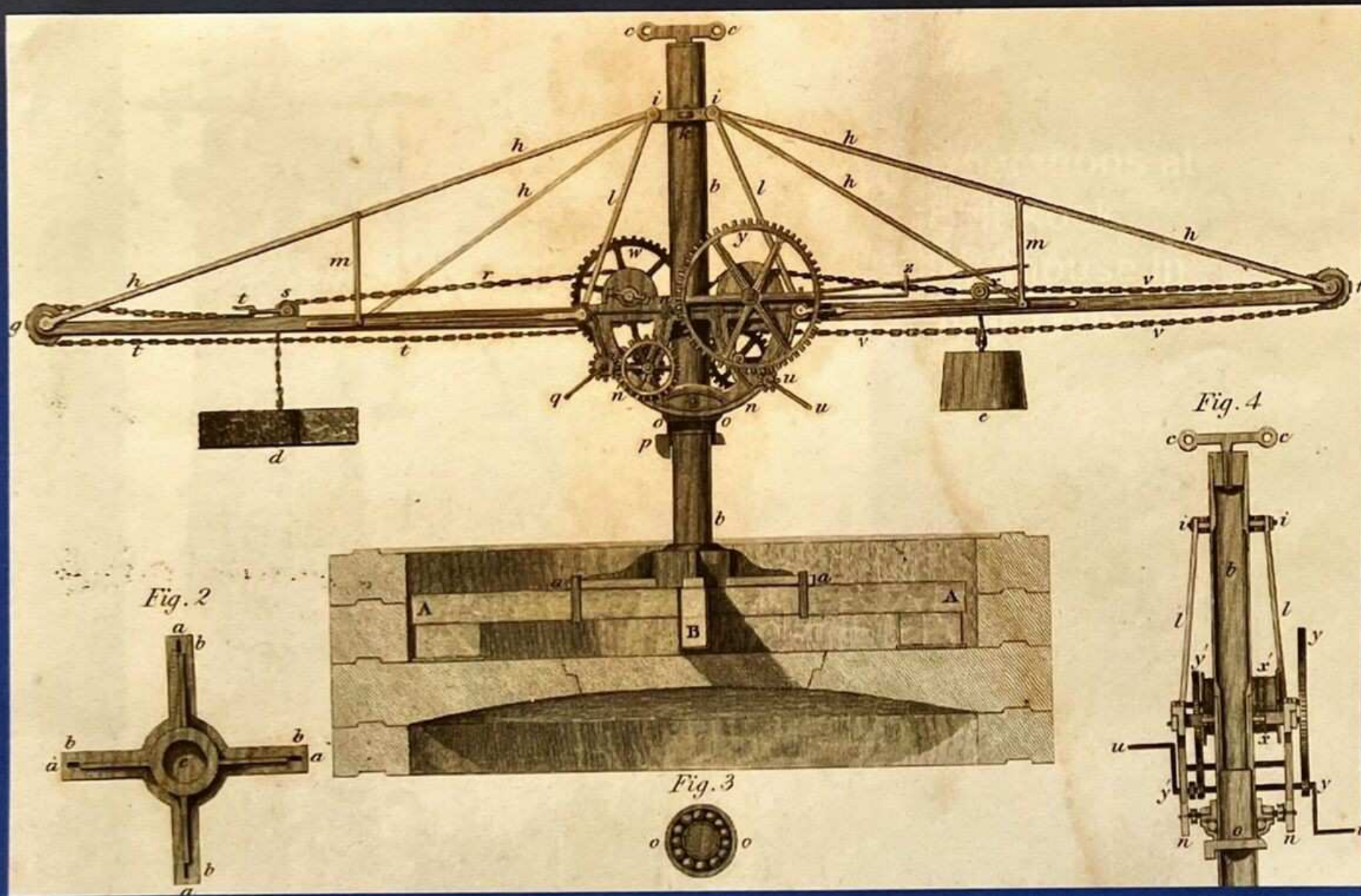
ALL ROCK WORKS.

BIRDS-EYE VIEW OF THE SMEATON AND PRAAM BOAT.

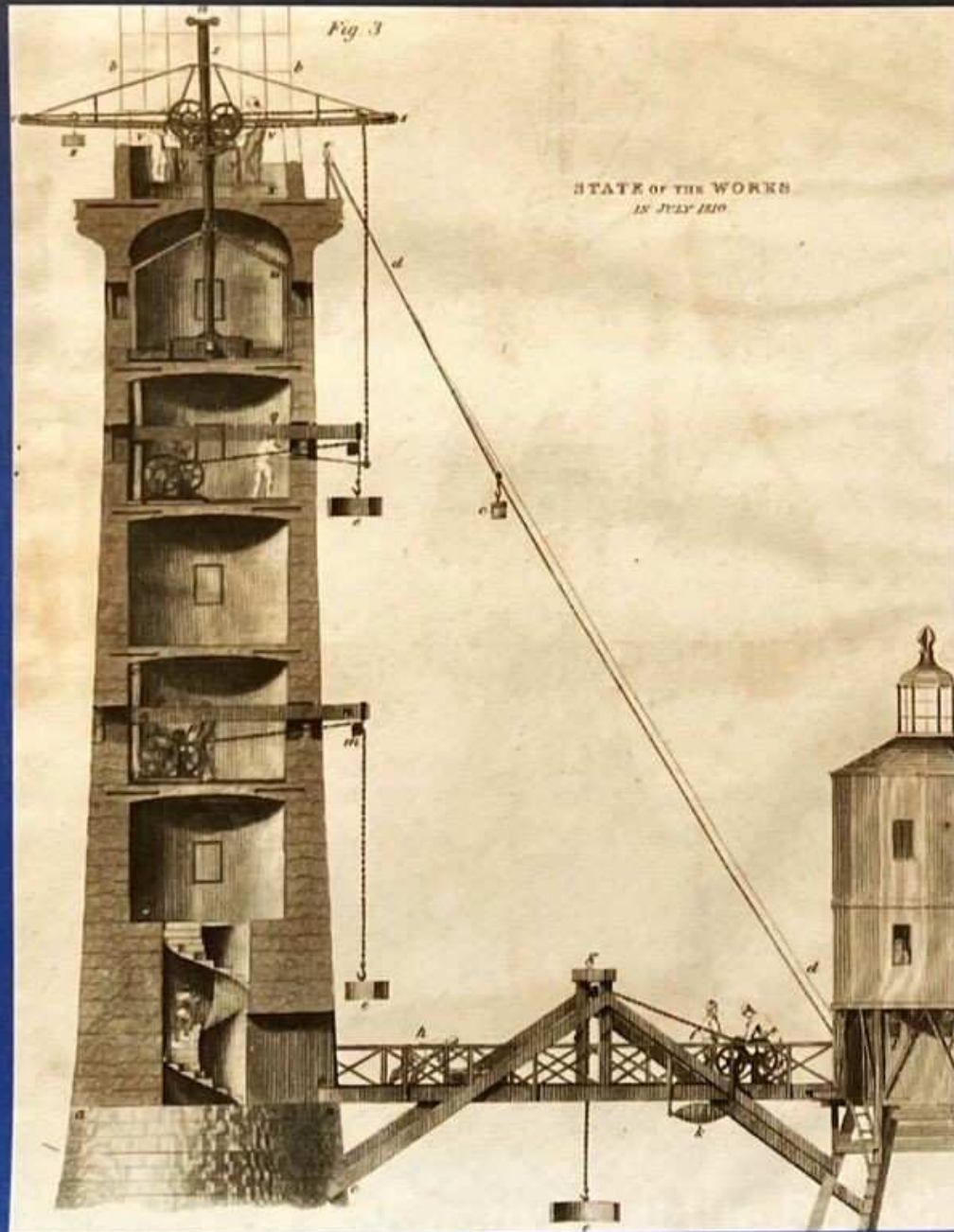
Fig. 5



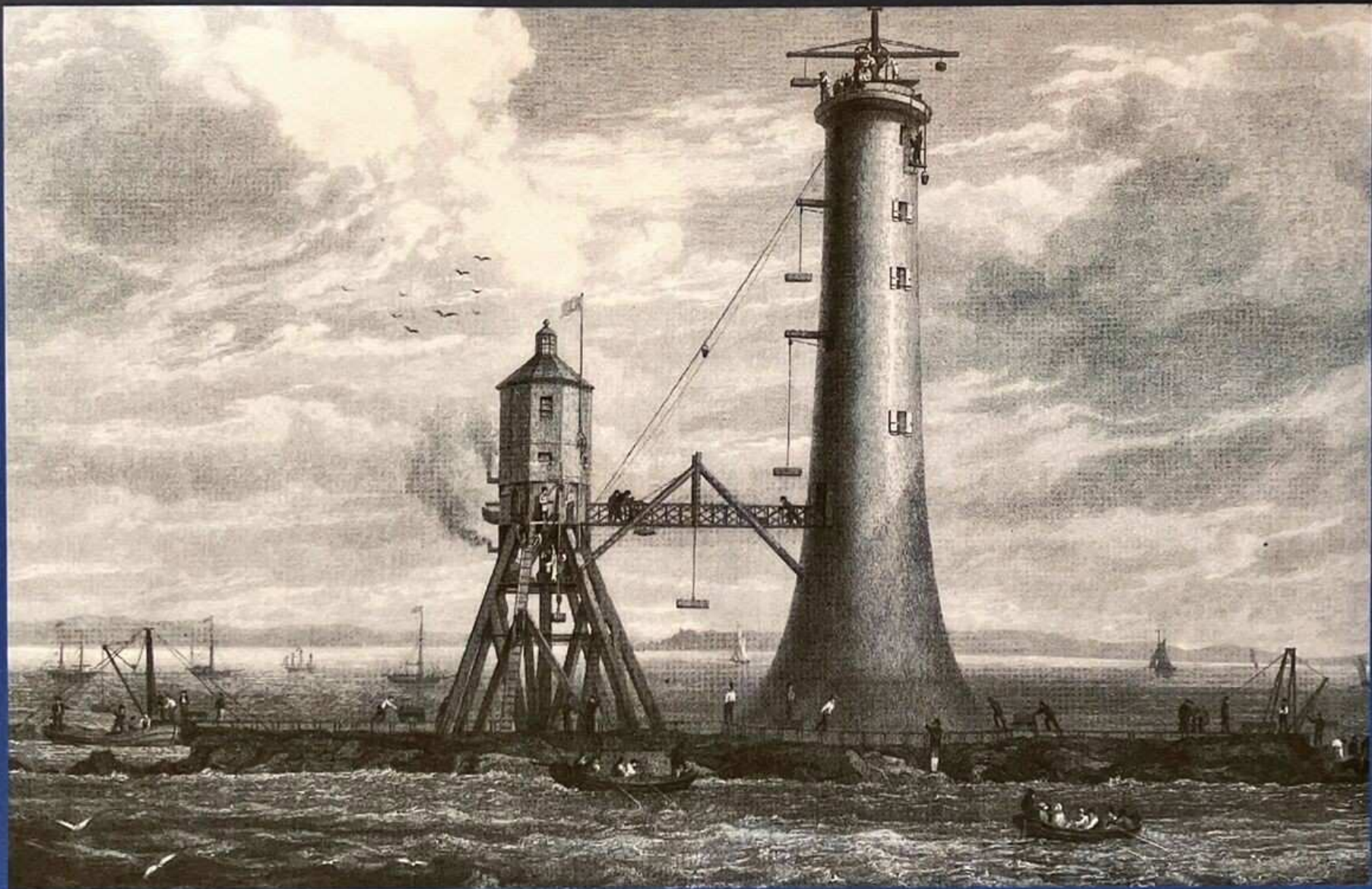
View of the Smeaton and pram boat 1809



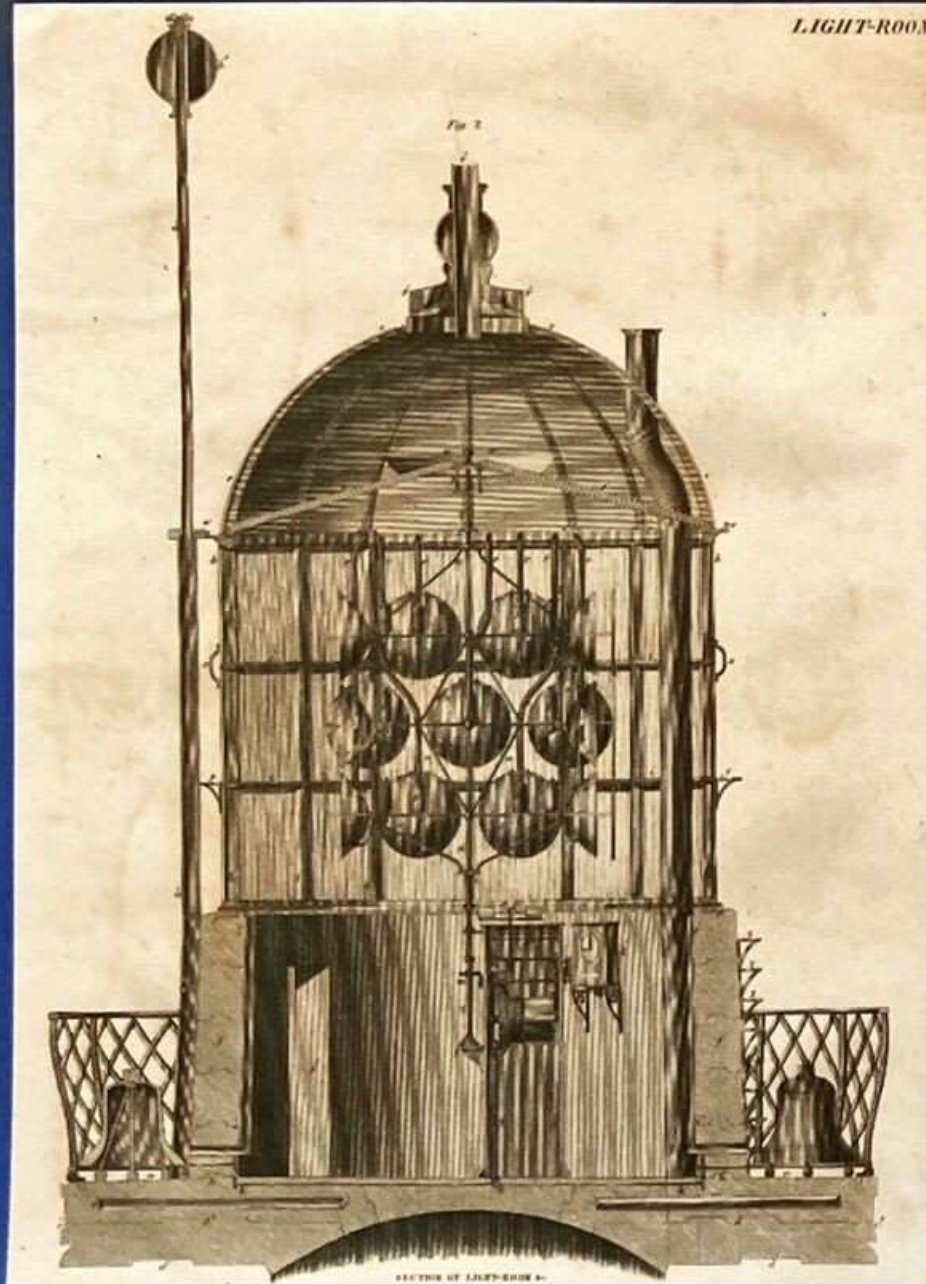
Watt's ingenious balance crane – the world's first iron tower-crane?



Operations at
Bell Rock
lighthouse in
July 1810



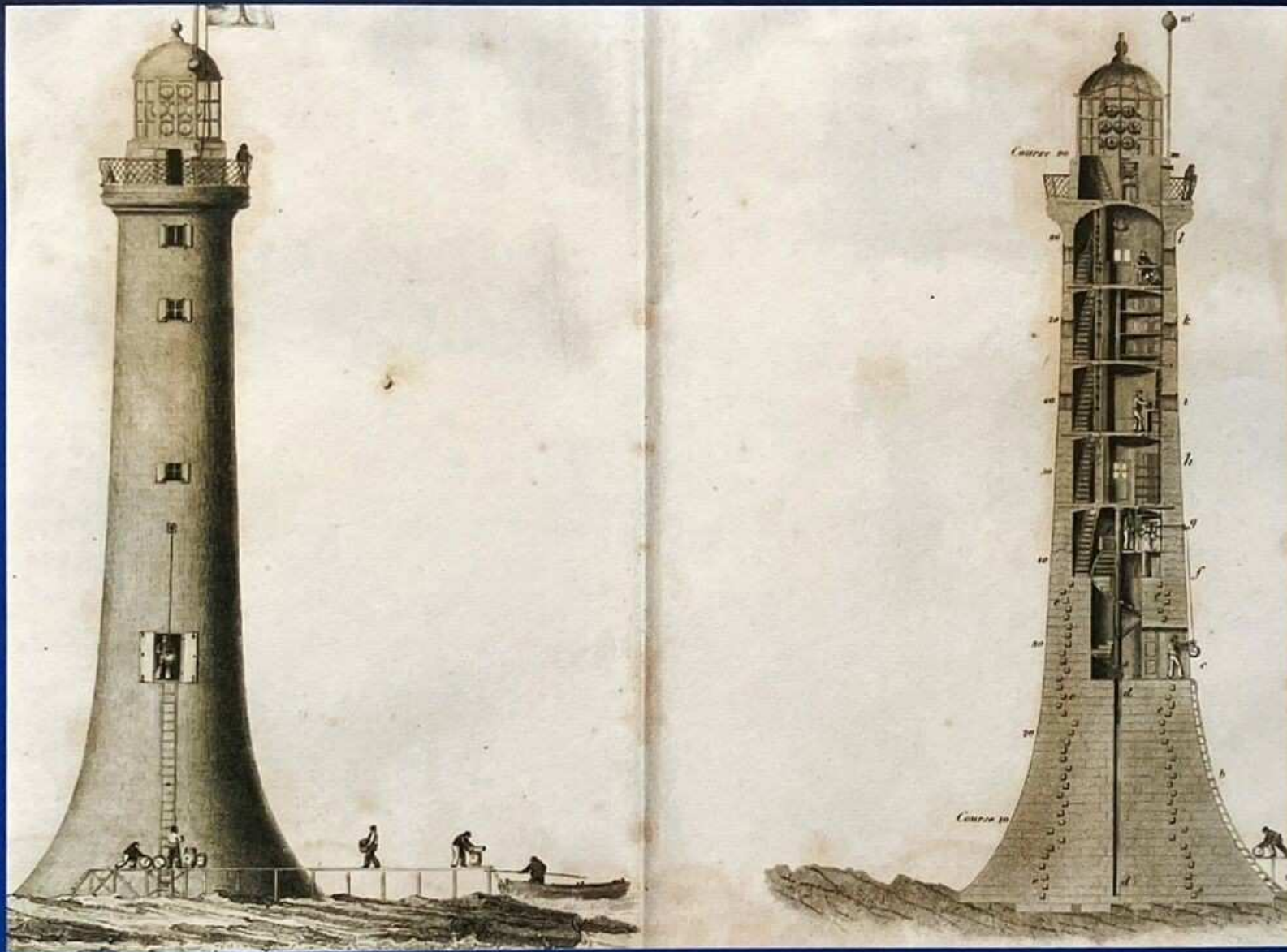
Overall activity at the Rock in July 1810



Lantern with revolving array of silvered-copper reflectors & argand lamps. Note fog bells and chimney from the kitchen



Engraving of painting commissioned by Stevenson from J.M.W. Turner for Bell Rock book – based on sketches of actual conditions by Masson and MacDonald. Spray up to 105 feet



Elevation & section of the completed lighthouse 1811
Cost £61,331.9s2d Contains 28,530 cu.ft and weighs 2,076 tons. Light
first exhibited 1 February 1811