



Stephen K. Jones

*Wales Member ICE Panel for Historical Engineering Works;
Trustee Friends of Union Chain Bridge*

Stephen K Jones was born in Cardiff. His professional experience is in the field of industrial development and economic regeneration, specialising in new technology and innovation adoption at the Welsh Development Agency (WDA). He was seconded to the Institution of Civil Engineers (ICE Wales Cymru), becoming a Companion member of ICE in 2007, and since 2010 has worked as an independent researcher in engineering and technology, *Welsh Achievements in Science, Technology and Engineering* being a recent example. Stephen is Chief Executive of the South Wales Institute of Engineers Educational Trust.

Engineering history, particularly the work of Brunel, has long been an interest and was marked in 2009 with the final volume of

the Brunel in South Wales trilogy. Recent publications include a chapter in the late Gordon Miller's book; *Samuel Brown and Union Chain Bridge* (2017), a chapter in *The Engineering Revolution: How the modern world has been transformed by technology* (ed. R.A. Buchanan, 2019). Exhibitions include *Web of Iron* which can be seen at the Thomas Telford Centre in Menai Bridge and the Chain Bridge Honey Farm Visitor Centre at Horncliffe. A Visiting Research Fellow at Bath University and member of the Newcomen Society since 1983, serving on council and regional committees, he is currently a committee member of ICE Wales Cymru and represents Wales on the national Panel for Historical Engineering Works (PHEW).

3. Union: The Welsh Link

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The Bombardment of Algiers, 27 August 1816, by George Hyde Chambers. In this section of the painting both hempen and chain cable (left and right portholes) can be seen in use on HMS Impregnable, a 98-gun second rate three-decker ship of the line and a near copy of HMS Victory (National Maritime Museum, Wikimedia Commons).

In December 1817 Simon Goodrich (1773–1847) of the Navy Board reported on a visit to a chainworks being built at Pontypridd, then known as Newbridge. Goodrich noted the chain making works and test house of Captain (later Captain Sir) Samuel Brown (1774–1852), his second purpose-built chainworks which would open in 1818. Brown's background was a naval one in which he had worked his way up to acting lieutenant, serving with distinction during the Napoleonic wars. At the end of hostilities, he sought to make improvements to the efficiency of the Navy, in particular improving the rigging and

mooring of ships. Iron chain cables had been tried before, in 1634 a patent by Phillip White, a Northumbrian blacksmith, stressed the importance of consistent iron quality and its preparation, if iron chain was to replace hempen cable. It would take another hundred and seventy-four years, however, before wrought iron chain cable became a practical proposition as far as the Navy was concerned. The delay was in the production of iron in sufficient quality and quantity, iron which needed to be proved in terms of its strength, and only until then could it replace the traditional means of mooring ships, hempen cable. Nelson's flagship HMS

Victory carried as many as eleven hempen cables of up to 20 inches in diameter and which had a short life due to alternate wet and dryness and the cutting action of rocks and ice. Onboard it had to be stored in cable tiers by the most able men on board in order to pay out without jamming.

Brown would develop his ideas in London, getting smiths to forge his first chain cable of twisted wrought iron links. For capital he turned to his cousin, the merchant Samuel Lenox of Billiter Square, London, and Plaistow (co. Essex), and decided to carry out a practical demonstration chartering the 400-ton *Penelope*, fitted out with chain cable for both mooring and rigging cables. The four-month voyage to Martinique and Guadeloupe in the West Indies was a success regarding chain cable and following



*Record Ship's Cable in 1905
3¾ inch cable manufactured by Brown,
Lennox & Co., Pontypridd, for the Quadruple
Screw Turbine Express Steamer, built by
Swan Hunter, and Wigham Richardson,
Limited for the Cunard Company, Limited*

a favourable report to a naval committee four warships were equipped with iron chain cable. By 1811 iron chain cables were in general use with one cable to each ship but it would be several years before hempen cables were completely replaced by the Royal Navy. Brown was promoted to master and commander in recognition of his work, and his patents gave him exclusive rights to supply chain cables to the Navy. With regular naval contracts assured and merchant fleet orders coming

in, Brown looked for a site to establish a purpose-built chain works. A suitable site was found in 1812, at Millwall on the Thames, convenient to Deptford Naval Yard and within easy reach of the India and London docks. Any chain cable supplied to the Navy had to be consistent in strength through testing and the determination of proof stresses to prove chain cable strength for which Brown installed a testing machine based on weigh-



Brown's established his first purpose built chainworks at Millwall on the on the Isle of Dogs alongside the Thames. Here Brown's experimental chain suspension bridge span was erected and tested. Millwall was still manufacturing maritime related products such as buoys when this photograph was taken in 1977, the works closing in the early 1980s. (SKJ photograph)

bridge principles in 1816 at Millwall. By 1823 'Samuel Brown and Company' had become 'Brown, Lenox & Co.'

With the Millwall works fully engaged on maritime chain cables Brown decided to open a second chainworks at Newbridge on the Glamorganshire Canal, used by the ironmasters of Merthyr Tydfil in sending iron down to the port of Cardiff. Brown could therefore rely on bar iron in significant quality and quantity and he was familiar with Merthyr iron, notably Cyfarthfa iron. This may have been the reason for Brown choosing Newbridge or possibly the local knowledge of Philip Thomas (1771-1840) his smith foreman who would go on become Newbridge's first manager and joint patentee with Brown in 1816. Brown's twisted wrought iron links were welded on the ends which proved to be a weakness of the design and the cause of some early cables parting.

However, Brown continued to improve his chain cable design by side welding and adopting stay-pins or studs to maintain the link shape and prevent its collapse. Before Brown introduced these improvements his major competitor; William Brunton, enrolled a patent in 1813 for improvements to chain cables, which included the use of broad-ended studs (Brown's first ideas on the shape of studs had been towards pointed-end pins). Brown and Thomas's 1816 patent covered the manufacture of cable composed of oval-shaped links, side-welded with broad-ended studs, the links being formed on special machinery, also covered by the patent. This form of chain cable shape has remained almost unchanged to the present day and a process of manufacture that continued at Newbridge until the end of wrought iron chain production.

Sometime after the opening of Millwall Brown was considering a new line, that of iron chain suspension bridges. In this field



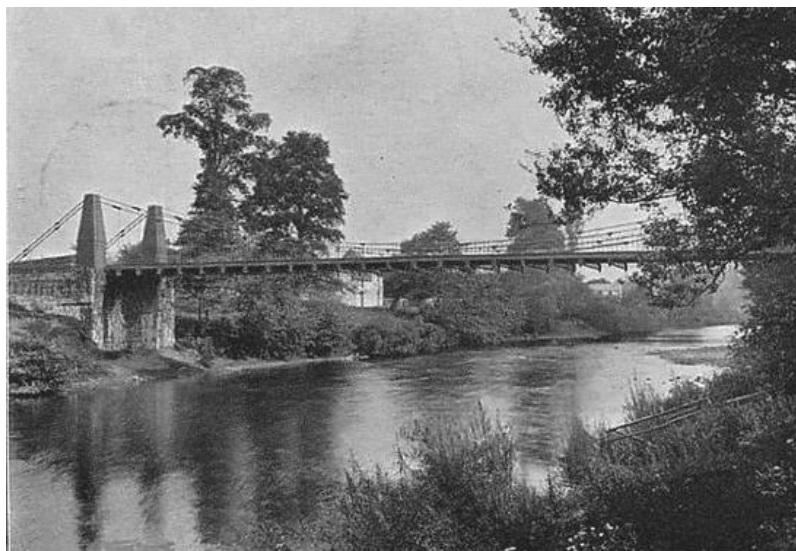
The Newbridge testing house, showing two hydraulic machines with the oldest (1868) machine on the left. Tested chain cable would be lowered through the floor into canal barges in the canal pond below. Photograph taken in the 1980s when specialist chain work including shackles etc. was still demanding the skills of Newbridge smiths. (SKJ photograph)



On the deck of HMS Neptune George V, with Admiral Callaghan, are inspecting the fleet at the Coronation Review of 24 June 1911. Then the largest dreadnaught battleship afloat Neptune served as Callaghan's flagship as C in C of the Home Fleet. Brown Lenox had equipped all the 165 vessels at the Review, a monopoly until 1916 when war demands outstripped production of Newbridge and Millwall. The company's reputation saw merchant fleets of the world ordering chain cable and included Cunard and ships such as the Mauretania in 1905. Many foreign navies, including the Imperial German navy in the pre-first world war period also specified Brown Lenox. (SKJ collection)

Brown was the first in Britain to erect iron suspension bridges with a level road deck, James Finley having erected the first bridge of this type in America in 1801. Brown's innovation was for chains of flat eyebar links and pins, which he patented in 1817, Thomas Telford would adopt a similar concept for his Menai and Conway suspension bridges. Brown's first chainbridge was the Union Suspension Bridge, which united England and Scotland with Welsh iron chain links, made in Newbridge in 1820. As with his chain cable Brown would use round eyebar links using Cyfarthfa iron from the Crawshays' Merthyr ironworks. His Newbridge landlord would go out of his way in 1822 to see this 'hanging bridge', Benjamin Hall noted that 'the appearance of the bridge is very light and neat, and the general opinion is that it is likely to last and is as durable as any other'.

Brown predominately used round eyebar links for his chainbridges, presumably from the same Cyfarthfa round bar iron stock used for chainmaking, he did design some chainbridges with flat eyebars which as far as can be asserted, were not made at his works and it is known that the links of the Wellington Chainbridge at Aberdeen were supplied by another Merthyr ironworks; Thompson, Forman of Penydarren ironworks at Merthyr Tydfil. Two of Brown's suspension bridges were built in Wales, both being erected under the personal supervision of Philip Thomas. One at Llandovery over the Towy and another over the Usk at Kemeys, both now replaced. Tenders were invited in 1829 and that of Brown Lenox & Co., was accepted for a bridge of 150 feet span, 22 feet wide with cast iron towers and wrought iron side railings; '...strong enough to carry fifty-tons with safety for £1800...' Completed in 1830 Kemeys chainbridge was guaranteed for two years, it lasted until 1906.

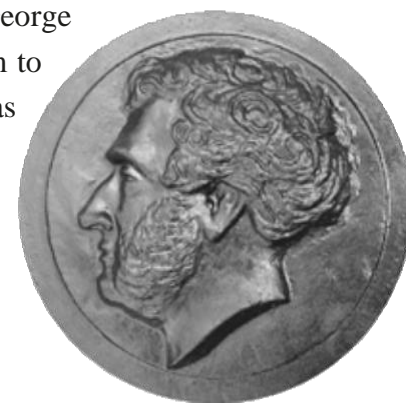


*Kemeys Chainbridge, crossing the Usk on the Usk-Abergavenny road, the two-pinned steel arch bridge that replaced it retains the name of 'Chainbridge'.
(SKJ collection)*



*View of the Newbridge works from Pontypridd common in the 1980s, the derelict Glamorganshire Canal running diagonally from bottom left to right with the testing house just left of centre.
(SKJ photograph)*

Brown Lenox established a reputation as the premier manufacturers of chain cable not just for the Navy but the mercantile fleets of the world. A famous order included Isambard Kingdom Brunel's ill-fated PSS Great Eastern in 1857. Brunel visited Newbridge several times during the manufacture of the chain cables, the largest size of $2\frac{7}{8}$ inch diameter being the largest chains made up to that time. At the shipyard, Brunel asked the then senior partner; George William Lenox, to stand with him to be photographed with the chains as a backdrop; 'I wanted Mr. Lenox to stand with me but he would not, so I alone am hung in chains.'



*The only known image of George William Lenox – no photographs appear to exist!
(SKJ collection)*

