ISSN 0960-7870

BRITISH BRICK SOCIETY

INFORMATION 113

JULY 2010

TALL CHIMNEYS ISSUE

OFFICERS OF THE BRITISH BRICK SOCIETY

Chairman Terence Paul Smith BA, MA, MLitt
Tel: 01582-725138
Flat 6
6 Harthill Drive
LUTON, Bedfordshire LU2 0AX

Honorary Secretary Michael S Oliver
Tel. 020-8954-4976
E-mail: micksheila67@hotmail.com
19 Woodcroft Avenue
STANMORE
Middlesex HA7 3PT

Honorary Treasurer Graeme Perry
Tel: 01889-566107
E-mail: graeme@giperry.co.uk
62 Carter Street
UTTOXETER
Staffordshire ST14 8EU

Enquiries Secretary Michael Hammett ARIBA
and **Liason Officer with the BAA**
Tel: 01494-520299
E-mail: mh36@bulldoghome.co.uk
9 Bailey Close
HIGH WYCOMBE
Buckinghamshire HP13 6QA

Membership Secretary Dr Anthony A. Preston
(Receives all direct subscriptions, £10-00 per annum)*
Tel: 01243-607628
11 Harcourt Way
SELSEY, West Sussex
West Sussex PO20 0PF

Editor of *BBS Information* David H. Kennett BA, MSc
(*Receives all articles and items for* BBS Information)
Tel: 01608-664039
E-mail: davidkennett@stratford.ac.uk (term-time only)
7 Watery Lane
SHIPSTON-ON-STOUR
Warwickshire CV36 4BE

Publications Officer John Tibbles
(*Holds stock of past publications)*
19 Leander Road
Bilton Grange
HULL, East Yorkshire HU11 5QE

Printing and Distribution Secretary Chris Blanchett
Tel: 01903-717648
E-mail: buckland.books@tiscali.co.uk
Holly Tree House, 18 Woodlands Road
LITTLEHAMPTON
West Sussex BN17 5PP

Web Officer Sandra Garside-Neville
Tel: 019-4-521339
E-mail: sgnuk@yahoo.co.uk
63 Wilton Rise
YORK YO24 4BT

The society's **Auditor** is:
Adrian Corder-Birch F.Inst.L.Ex
E-mail: clerk@siblehedinghampc.org.uk
Rustlings, Howe Drive
HALSTEAD, Essex CO9 2QL

* *The annual subscription to the British Brick Society is £10-00 per annum.*
Telephone numbers and e-mail addresses of members would be helpful for contact purposes, but these will **not** *be included in the Membership List.*

British Brick Society web site:

http://www.britishbricksoc.free-online.co.uk/index.htm

Contents

Editorial: Tall Brick Chimneys 2

Building the Tallest Chimney in the World
by Graham Brooks 6

Cornish Tall Chimneys
by John Ferguson 10

Factory Chimney Stacks: some thoughts and some evidence
by Paul W. Sowan 18

Book Notice: London's Sewers
by Terence Paul Smith 23

Brick in Print 25

Brick Query 30

Brick for a Day 31

Cover Illustration:

Houldsworth Mill, Reddish, is visible across the Manchester conurbation. Built in 1865, it was designed by A.H. Stott of Oldham, a specialist mill architect. The engine house is behind the central block of this double mill. There is an octagonal chimney capped by an elaborate top.

Editorial:
Tall Brick Chimneys - an early type

For rather more than a decade beginning in the late 1960s and continuing until he ceased to live in Bedfordshire in 1980, although mostly in discontinuous periods but for about three and a half years in the mid 1970s almost daily, the present writer used to commute from Luton to Bedford by train. Amongst the distant sights from the railway line (now the Midland Mainline) were the now largely demolished chimneys of the brickworks at Stewartby, Marston Moretaine and Kempston Hardwick. For all three works, these same chimneys were more closely visible from the railway line which originally ran from Oxford to Cambridge and now runs only from Oxford to Bedford, a single line still much used to transport bricks.

In 2007, the British Brick Society received a query from one its members, Mr P.A. Earwaker, concerning tall chimneys and their preservation. Mr Earwaker makes the point that many chimneys are round ones and this impression is certainly reinforced by early-nineteenth-century paintings which are panoramas of towns: for example, *Bolton from Queens Park* by Samuel Towers, done in about 1895 [Bolton Art Gallery], or the two early paintings of Manchester from Kersal Moor, Salford, done in 1821 and 1851 respectively [both Salford City Art Gallery].

Other evidence gives the impression of round chimneys as opposed to ones with either a square or an octagonal cross-section is the popular image of the tall brick-built cotton mill with its round chimney, seen in many photographs, architects' impressions and mills surviving in towns like Oldham and Bolton. Actually, this could be more a view from the last generation of steam-powered mills, those built after about 1890 rather than earlier mills. Based mainly on the chimneys of cotton mills in Lancashire, it is possible to suggest a typology of brick chimneys and in particular to isolate the earliest form.

One of the two earliest forms combines the chimney stack with the principal stair in a turret with the chimney rising through the centre of a spiral stair. It is this form which is depicted in drawings of Islington Mill, Salford, after the collapse of the supports of the uppermost of the seven floors in October 1824 (Fig. 1). The floor beams of Islington Mill were initially supported only by a single row of columns but after barely twelve months, a beam at the north end of the eleven bay structure holding up the top floor gave way under the weight of the machinery housed there. The weight of the machinery as it fell caused the floors below to give way with the loss of twenty-one lives.

At Islington Mill, the combined chimney and stair tower is no longer extant. It was originally on the west side of the mill, beside the internal courtyard (Fig. 1). This is actually a very strong structure, with the stone steps linking the chimney shaft and the curving outer wall of stair turret giving stability to the lower stages of the chimney. This early form of mill chimney is found in several early cotton mills in Manchester, including no fewer than at least three in the complex of four mills known as Murray's Mills, in Ancoats beside the Rochdale Canal, begun in 1798 with Old Mill and continuing with further structures of 1802, 1804, and two of *c.*1804-1806. Whilst these can be traced in plan, none is now complete and the chimney is disused even though the stairs may be.

Manchester's oldest surviving mill chimney is at Brownfield Mill, Ancoats, where the combined stair and chimney shaft is situated in the angle between the two wings of the mill. These wings are the same height but the earlier one of *c.*1825 is seven storeys whilst its neighbour with more generous ceiling heights has only six storeys.

These combined stair and chimney towers continued to be built throughout the first three-quarters of the nineteenth century. An addition to Murray's Mills, Manchester, the Doubling Mill

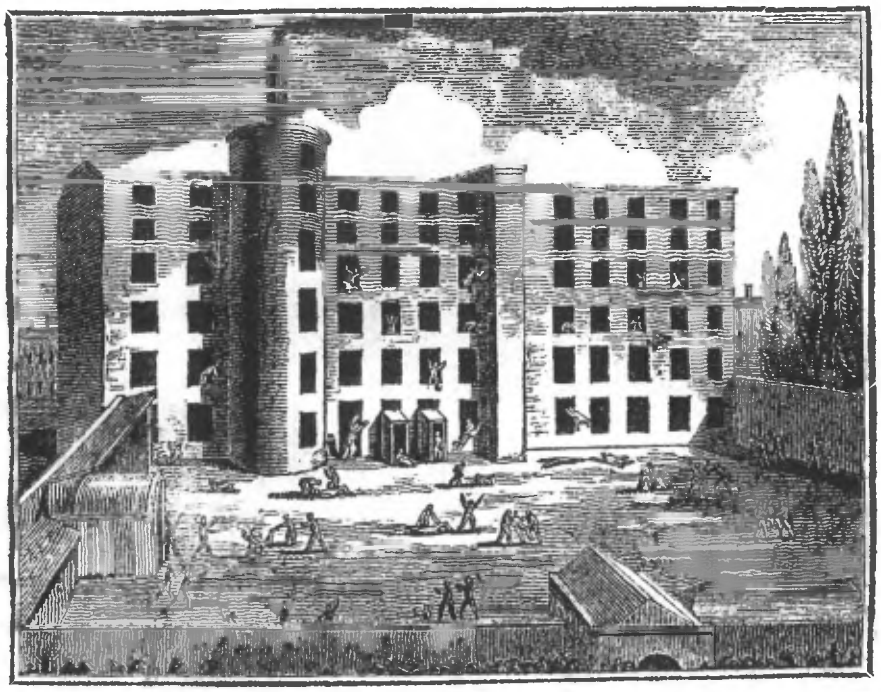


Fig. 1 Islington Mill, Salford, was built in 1823 by the Manchester building contractor David Bellhouse, but due to poor casting techniques used in making the single row of iron pillars which held up the floors, collapse of an upper floor unable to bear the weight of the heavy machinery placed on it caused a general failure of all floors at the north end of the building, to the left of the combined chimney and stair tower, in October 1824. The engraving shows the mill, the now demolished stair tower and chimney and the square projection of the privy tower.

of 1842 has one and even later is the 1872 Bliss Mill, a woollen tweed mill at Chipping Norton, Oxon., designed by the Bolton architect George Woodhouse. Externally of stone, this mill has extensive use of high quality red-brown used for brick lining the external walls, including the stair turret, and providing the fireproofing between the various floors of the five-storey structure. Walls are in English Garden Wall bond with thin mortar joints. William Bliss II (1810-1884) believed in a good quality mill wherein to manufacture his high quality product.

There are square chimneys to some early and mid nineteenth-century mills, such as that at the St Helena Mill, Bolton, beside the River Croal, but their survival is rare. Known from an earlier photograph is the chimney at the Back King Street Factory, Bolton, off Deansgate, one of the town's principal streets. This building now much altered and reduced in scale was where, in a now demolished attic, Samuel Crompton had set up his spinning mules after 1802 and 1815. This too had a large square chimney attached to one of the buildings.

More usual, particularly in the second half of the nineteenth century and beyond to 1926, are octagonal chimneys, usually independently sited and often on a square base and an elaborate top. Dominating the view from St Thomas' churchyard, Salford, across the other side of the Manchester conurbation is Houldsworth's Mill, Reddish, of 1865, where the chimney, at the rear of the mill complex, towers above the centre of this double mill, five storeys in height, designed by A.H. Stott of Oldham.

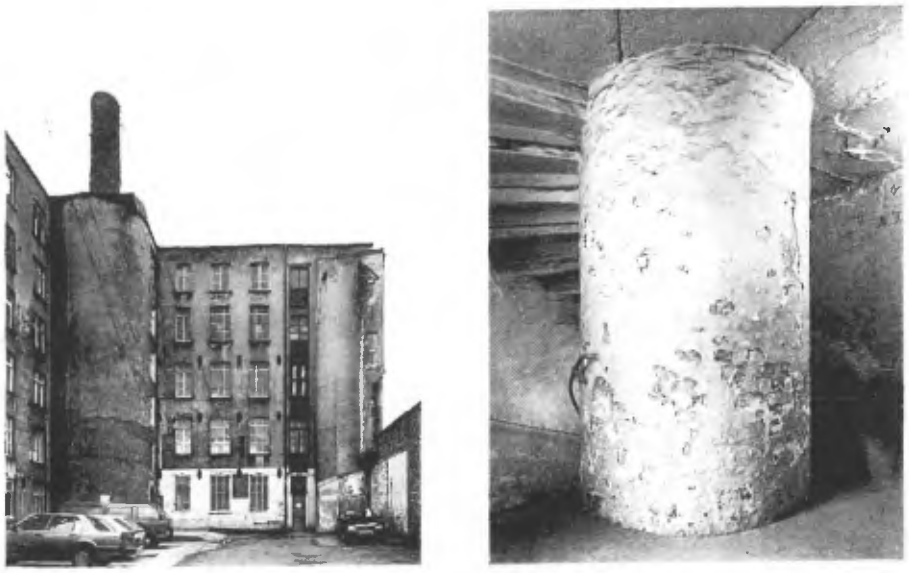


Fig.2 External view (left) and internal view (right) of the extant combined chimney and stair tower at Brownfield Mill, Manchester, built in 1825. Brick of the chimney can be seen beneath the thin, peeling plaster.

A free-standing octagonal chimney often indicates renewal of the engine house in the late nineteenth century. The Wear Mill at Stockport, underneath the viaduct, was originally powered by a water-wheel turning in the River Mersey and later by a steam engine beside a mill building of *circa* 1831. The octagonal chimney appears to be part of the extensive redevelopment of the site in 1884.

There were multiple extensions to Copley Mill, near Stalybridge, which opened for business in about 1827. One of these involved building a new engine house in 1871. A plain tapering octagonal chimney was built in conjunction with the new engine house and served both the new beam engine and the old one.

On the other hand, architects Bradshaw, Gass and Hope of Bolton tended to favour the round chimney. Examples can be seen in the Croal Mill of 1907 east of Bolton and the Barnfield Mills at Tyldesley, near Wigan, built in 1894.

Elsewhere in this issue of *British Brick Society Information,* three different papers attempt to address some of the six concerns Mr Earwaker had in his query in *BBS Information,* **104,** July 2007. The geographical spread of these articles ranges is confined to England from Carlisle in the north to Surrey in the south and Cornwall in the south-west. These follow earlier contributions in *BBS Information,* **106,** February 2008, on tall chimneys in Cornwall, and in *BBS Information,* **107,** June 2008, concerning the building of brickworks chimneys at the Fletton works near Peterborough.

The editor of *British Brick Society Information* invites others whose geographical base or experience is different to his own to produce information about tall chimneys in other areas: from different angles, it would seem that Scotland, the West Riding of Yorkshire, and the London area would all repay study.

Chimneys and brick kilns feature in a remarkable collection of industrial paintings, an aspect of the subject which is not often considered by those researching brick. *Wonders of Work and*

Labor: The Steidle Collection of American Industrial Art, is the catalogue of the paintings in the Earth and Mineral Sciences Museum and Art Gallery at Pennsylvania State University, at University Park, Pennsylvania, USA, includes much that is of interest. The paintings were collected by Dr Edward Steidle (1887-1977), Dean of the College of Mineral Industries at the Pennsylvania State University from 1928 to 1953, and the collection has been augmented since Dr Streidle's retirement.

The catalogue has a relatively small black-and-white reproduction of each of the 153 paintings in the collection with 78 of them shown in colour at a much larger scale. Unfortunately only one of those showing brick production, that by Howard Ellis, is amongst those given a colour plate.

Four of the paintings feature brickworks or, more specifically, brick kilns. Howard Ellis painted *Brick Plant in Winter: Closing Time* in or just before 1935, the year Dr Steidle acquired the painting. It shows a works covered with snow but no kiln. In the city in the background are two tall chimneys. Both Ludwig Henning's *Refractories Plant* of 1935 and *Burning Silica Brick,* an undated painting by Christian Jacob Walter show circular beehive downdraught kilns with square-shaped chimneys, very much in the manner of the disused kiln which members of the society saw on the visit to Eroll Brickworks, in County Angus, Scotland, or is still in use by Peter Minter at his brickworks at Bulmer, Suffolk, England. A more continuous process seems to be implied in the long kilns depicted from above with multiple smokestacks on the long side in *Brick Kiln,* an undated painting done before 1937 by Gustave L. Brust jr.

One of the paintings shows bricks in use. In 1954, George S. Zoretich painted *The Roles of Refractories in Steel.* This is reproduced in the colour plates.

On one of his forthcoming visits to the United States, your editor is hoping to visit the Steidle Collection with the specific purpose of examining the paintings showing brick kilns for an article in a future issue of *British Brick Society Information.* Hopefully, this will have colour reproductions of the paintings and information about their origins..

Most of the industrial paintings in the collection are of steel mills, glass works and coal mines, including chimneys in the first-named and underground scenes in the last. Whereas the brick kilns have square chimneys, the steel mills have round chimneys. There are also paintings of iron ore pits and stone quarries. Robert Valentine painted *Abandoned Limestone Quarry: Armour Gap Quarry at Bellefonte, PA* in 1934 and *White Rock Cement Kiln* a year later. The chimneys on this are square.

Most of the paintings are highly realistic portrayals of their subject whether human or industrial, but an undated work by Christian Jacob Walter, *Train Shed: Union Station* of the demolished station in Pittsburgh with its great single arched roof bears comparison with the series by Claude Monet of the Gare Saint Lazare in Paris, many of which were shown at the Third Impressionist Exhibition in 1877, notably *Interior. View of the Gare Saint-Lazare: the Auteuil Line,* dated 1877 [Paris: Musée d'Orsay]. There is one difference between the station in Paris and that in Pittsburgh: The Gare Saint-Lazare has a multiple ridged roof; the single arched roof of the former Union Station in Pittsburgh can be compared to Barlow's famous trainshed at London St Pancras or the surviving, but re-cycled Union Station in St Louis, Missouri, USA, whose buildings are now a retail mall with an attached hotel, the latter replacing the original hotel at the train station.

DAVID H. KENNETT
Editor, *British Brick Society Information*
Shipston-on-Stour
27 July 2010

Building the Tallest Chimney in the World

Graham Brooks

Further to the comments on tall chimneys in *British Brick Society Information,* **104,** July 2007, **106,** February 2008, and **107,** June 2008,[1] we give details of the building in northern England of what at the time was the world's biggest chimney. When built in 1836, it was claimed that Dixon's chimney in Carlisle at 320 ft (97.6 metres) from foundations to top was the highest in the world. From ground level to the top it measured 300 ft (91.5 metres).[2]

The chimney was built to provide draught for the new Shaddongate Mill being built by the firm of Peter Dixon & Sons for their cotton business. The seven-storey, stone-built cotton spinning mill of twenty-two bays was 215 ft by 58 ft (65.575 metres by 17.69 metres) and had been designed by Richard Tattershall (1802-1844), a Manchester-based architect[3] who also designed the chimney for a fee of £100.[4] Details of the chimney were included in R.M. Bancroft's standard text of 1885 on the construction of tall chimneys.[5]

Building of the chimney started on 11 September 1835 and was carried out by Richard Wright, a local Carlisle builder.[6] The majority of the work was carried out under the supervision of William Ormiston senior, his foreman.[7] The initial foundations consisted of concrete to a depth of 6ft (1.83 metres) covering an area of 35 ft 6 in. (10.8275 metres). The footings are 6 ft high, built up in four courses of 1ft 6in. each, and having an offset each time of 1 ft 6 in. (see fig 2 no. 13). From the top of the flues to the ground level the shaft is circular with a diameter of 19 ft (5.795 metres) with a wall thickness of 5 ft (1.525 metres). The four flues enter the chimney through this circular base (fig. 2 no. 12); each flue is 6 ft 9 in (2.06 metres) high and 2 ft 6 in. (0.77 metres) wide. The flues are lined with 9 inch firebricks.

From ground level the chimney has an octagonal shape initially with an outside diameter of 17 ft 4 in. (5.9 metres) and an internal diameter of 9 ft 6 in. (2.9 metres). The main walls of the chimney are of brick construction with stone quoins at each corner. Originally the chimney had a stone cornice near the top with a thickness of 7 ft (2.135 metres) (fig.2 no. 14) Above this was a blocking course of brick, 8ft 3 in (2.52 metres) high which was surmounted by a one foot thick coping stone. The stone coping had an overhang of 3 ft (0.915 metres) giving a top hat appearance to the top of the chimney. The original chimney has an external diameter at the top of 9 ft (2.75 metres) and an internal diameter of 6ft 8 in (2.03 metres). This gave a batter of 1:72.

As was customary, the finishing of the chimney was celebrated with the usual party and a number of guests were winched to the top, on 29 October 1836, using a wooden box drawn up the inside of the chimney to celebrate. The chimney was first used on 25 November 1836 and was connected to four boilers, which were made by Blake & Sons of Bury; they were brought by steamer from Liverpool and along the Carlisle Canal to near the site of the factory. The chimney was also connected to the Carlisle sewer system to provide ventilation and provided ventilation over a radius of 400 yards (366 metres).

It is not recorded where the bricks for the chimney were made, but by the 1830s bricks were bring made over a large area surrounding Carlisle including the fields surrounding the site of the factory.[8] In 1845, Messrs Peter Dixon & Sons let the casting and making of 1.5 million bricks at Murrel Hill opposite the chimney. This became the first mechanised brickworks in Carlisle started by Mr Thomas Nelson, a local building contractor. He used Mr Beart's patent brick making system[8] and was said to be only the sixth works of its type in England.

A lightening strike in 1931 caused damage to the top of the chimney and the top 15 ft

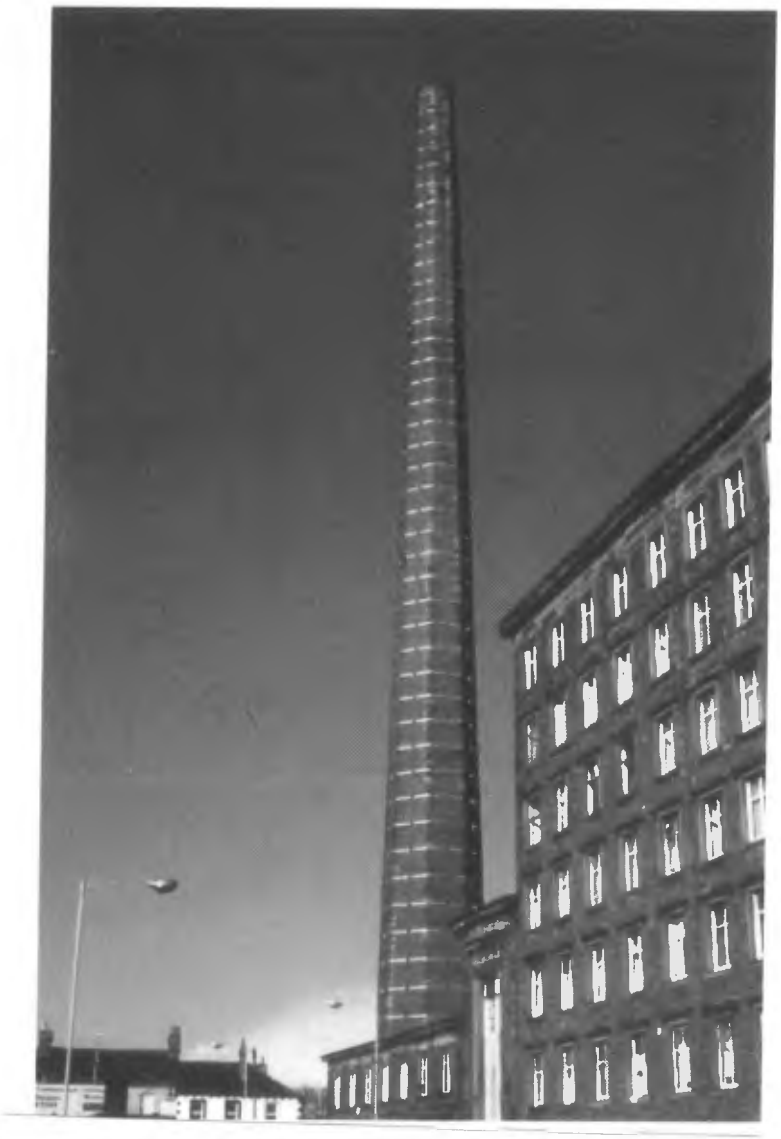
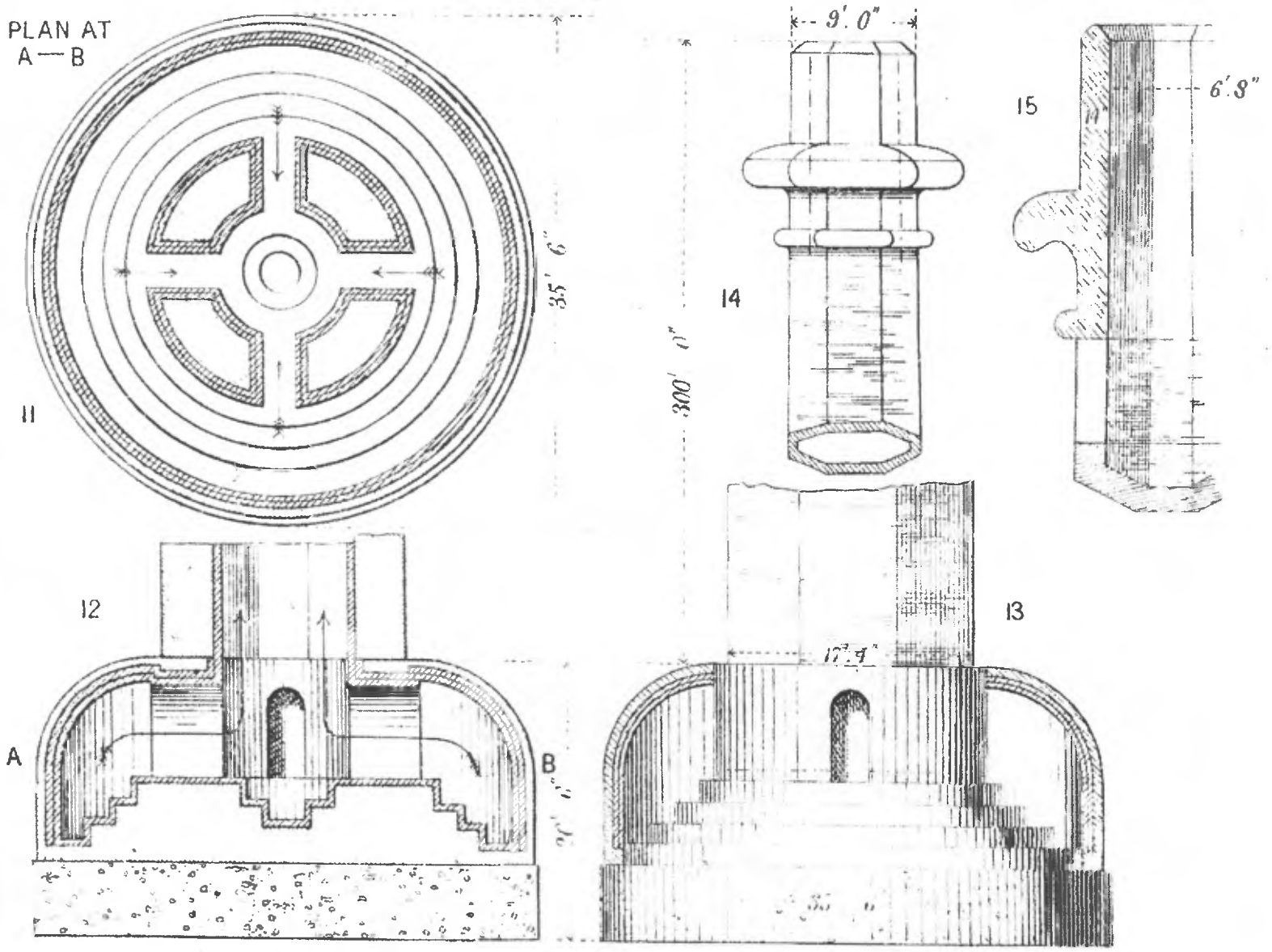


Fig. 1 The chimney of Peter Dixon & Sons' Shaddongate Mill, Carlisle, in its present day condition.
Note the distinctive iron bands at regular intervals.

(4.575 metres) including the stone capping was removed in 1950 due to fears of a partial collapse. Further damage in 1968 lead to a further reduction in 1970. Neglect over the years eventually lead to a call for the demolition of the chimney in the late 1980s. But after being purchased by Carlisle City Council, it was decided to preserve the chimney rather than demolish it. The chimney was consolidated in 1992 with forty metal bands being placed around the chimney (clearly visible on fig. 1) and it being re-pointed. It now stands at 275 ft (83.875 metres) as one of the major landmarks of Carlisle with its neighbouring mill having been converted into flats.[9]



PLAN AND SECTIONS OF DIXON'S CHIMNEY TAKEN FROM BANCROFT'S BOOK

Fig. 2 (opposite) Details of plans and sections of the Shaddongate Mill from R.M. Bancroft, *Tall Chimney Construction,* 1885.

11. Plan at flue level.
12. Cross-section at flue level showing how the gases entered the chimney. Note the concrete base is clearly shown.
13. Stepped construction at flue level.
14. Stone capping: exterior.
15. Stone capping: cross-section.

NOTES AND REFERENCES

1. P.A. Earwaker, 'Tall Chimneys', *BBS Inf.*, **104,** July 2007, p.32; O. Ward and K. Rickard, 'Tall Chimneys: Some Initial Responses', *BBS Inf.*, **106,** February 2008, pp.42-43; G.C.J. Lynch, 'Tall Brick Chimneys', *BBS Inf.*, **107,** June 2008, pp.19-26.

2. N. Pevsner, *The Buildings of England: Cumberland and Westmorland,* Harmondsworth: Penguin Books, 1967, p.103 and pl.63, which shows the chimney with the top intact.

3. For Richard Tattershall see H.M. Colvin, *A Biographical Dictionary of British Architects 1600-1840,* New Haven and London: Yale University Press, 3rd edition, 1995, p.958. Tattershall's first connection with Carlisle was to win the competition for the Cumberland County Infirmary, Carlisle in 1830. This brick building was completed in 1832, see Pevsner, 1967, p.102 and pl.62.

4. Tattershall also designed the 367 ft 6 in. (112.12 metres) high for William Blinkhorn's chemical works in Bolton in 1842. This structure is not listed among Tattershall's works, Colvin 1995, 958.

5. Robert M. Bancroft, Francis J. Bancroft, *Tall Chimney Construction. A Practical Treatise on the Construction of Tall Chimney Shafts containing details of upward of eighty existing mill, engine-house, brick works, cement works and other chimneys in England, America and the Continent, constructed in Brick, Stone, Iron and concrete,* Manchester, 1885. Available at http://www.archive.org/details/tallchimneyconst))banc

6. Richard Wright was also the builder of St Michael's church, Church Street, Stanwix, Carlisle, of 1841 by John Hodgson; for the church see Pevsner, 1967, p.97.

7. William Ormiston was born in Lauder, Scotland, and came to Carlisle in 1828. He worked on Harraby and Warwick Road bridges, Brunstock House of 1827-28, Holme Eden Abbey (the home of one of Peter Dixon's sons), Holme Eden church, and the Wetheral Viaduct of 1830-34 on the Newcastle to Carlisle line.

8. For a list of brickworks in the north of Cumbria see G. Brooks, 'Cumbrian brick and tile works: North Cumbria, *Cumbrian Industrialist,* **3,** 2000, pp.49-59.

9. Paper received January 2010.

Cornish Tall Chimneys

John Ferguson

This contribution on the question of tall chimneys is a delayed response to the query by Mr P.A. Earwaker in *British Brick Society Information*, **104,** July 2007.[1] Kingsley Rickard in response to the same request has contributed some general information on Cornish engine house stacks in *British Brick Society Information*, **106**, February 2008,[2] and it is hoped that this article will provide amplification of Kingsley Rickard's article and extend it to other industrial chimneys in Cornwall.

Throughout the metal mining areas of Cornwall, one of the obvious features of the landscape is the surviving engine houses built mainly in the nineteenth and early twentieth centuries to house Cornish beam engines. These steam engines, were used in pumping water from the mine, bringing men or materials to the surface, or for powering the stamps used to crush the rock so that the mineral fraction could be easily separated. Engine houses are normally dominated by a circular chimney stack which carried the waste gases and smoke from the fires. These stacks, usually built into one corner of the engine house (Fig. 3), are constructed from granite or other readily available country rock and are topped with a lighter brick section (Fig. 1). Due to neglect these brick tops are often much reduced in height or missing altogether.

The height and diameter of these chimneys varies and is dependent on the cylinder size of the engine installed. The following figures taken from *The Engineer* are quoted by R.M. Barton:[3]

Cylinders	24 inch to 70 inch	(61-178 cm)
Stack height	54 feet to 72 feet	(16.46-21.95 metres)
Stack, diameter at base	10 feet to 11 feet	(3.05-3.353 metres)
Flue	3 feet	(91.4 cm)

The earliest chimneys associated with engine houses were square rather than circular and examples can now only be seen in old lithographs and paintings of mining scenes. One particularly fine example illustrated by Carter[4] was Woolf's stack at Dolcoath Mine, built *c.*1815 and demolished in 1940. By the 1830s circular chimneys for mine engine houses were the norm. The earliest of these was built as a series of drums one above the other, decreasing in diameter upwards, giving a series of discrete steps. A well-known example is the Pednandrea Mine stack in Redruth (SW 709425). This structure was built *c.*1820 of stone and topped with brick, originally 140 feet (42.67 metres) high. For safety reasons it has now been considerably reduced in height. Another example of this type was built *c.*1873 at Carn Brea stamps engine house, near Tregajorran (SW666408). The stepped drums of masonry with battered sides are topped with a brick section with parallel sides and a drip ring. The height was approximately 60 feet (18.29 metres) with a basal diameter of 19 feet 6 inches (5.94 metres). The height of the lowest drum is 12 feet (3.66 metres) and the second drum 10 feet (3.05 metres) with a step of 12 inches (30.5 cm.). The flue is 3 feet (91.4 cm.) wide and about 4 feet 6 inches (1.37 metres) in height. Another example of a stepped chimney is at Great Work near Godolphin (SW595609), where the steps are in the upper brick section. The upper brick and lower granite sections are separated by a prominent drip ring.

The bricks used for the top sections of the stacks associated with engine houses are laid in header bond, using wedge-shaped headers in with an outer curved face (Fig. 1). these wedge-shaped stack bricks are typically 9 inches (24.3 mm,) long and 2½ inches (6.75 mm.) thick. The bricks taper from 4 inches (10.8 mm.) on the outer face to 2¼ inches (6.4 mm) on the

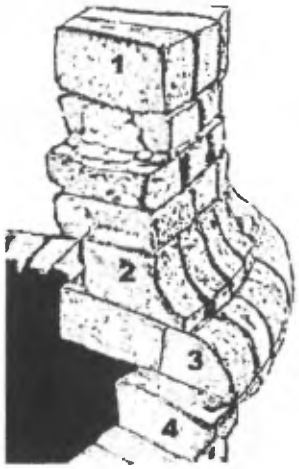


Fig. 1 (left) Drawing of the top of a Cornish Engine House chimney stack showing the brick specials used in the construction of a typical drip course. Based on a photograph of the stack at Hawke's Shaft Engine House, Killifreth Mine, Chasewater, Cornwall, before restoration.

1. Wedge-shaped headers used to construct the main part of the stack.
2. Concave header.
3. Bullnose brick.
4. Plinth header.

After J. Ferguson and C. Thurlow, *Cornish Brick Making and Brick Buildings*, St Austell: Hillside Press, 2005, p.181.

Fig. 2 (right) Two examples of wedge-shaped header bricks used in building Cornish Engine House chimneys.

Top: Example from Levant Mine, Pendeen, Cornwall. Red brick, badly mixed, by an unknown maker, probably local.

Bottom: Example on display in the brick collection housed at Wheal Martin China Clay Museum. Made by T. Nichols & Co., Burthy Brickworks near Summercourt, Cornwall. The brick is creamy pink in colour, a feature of Cornish made bricks, using china clay waste.

inner (Fig. 1. Top). rarely, chimney stacks such as that at Poldice Arsenic Works were built using ordinary bricks laid in header bond, which because of the curvature of the chimney gives rise to thick vertical joints on the outer face.

Stack bricks (wedge-shaped headers) were usually imported from Bridgwater in Somerset,[5] although later in the nineteenth century some Cornish brickmakers, such as the St Day Brick & Fireclay Co., St Day,[6] and T. Nichols & Co., Burthby near Summercourt[7] (Fig. 2 Bottom), made stack bricks, which they advertised in their product lists.

Most stacks are plain or simply banded as at Levant, where the main engine stack has four bands of cream-coloured brick towards the top. The 17 foot (5.2 metres) brick section of the stack at Wheal Metal near Sithney, is exceptional using three different colour bricks in a diamond pattern (Fig. 4, Left). These is normally a simple decorative drip course at the top of these chimneys (Fig. 1), although, as already mentioned, many have now lost this feature. Wheal

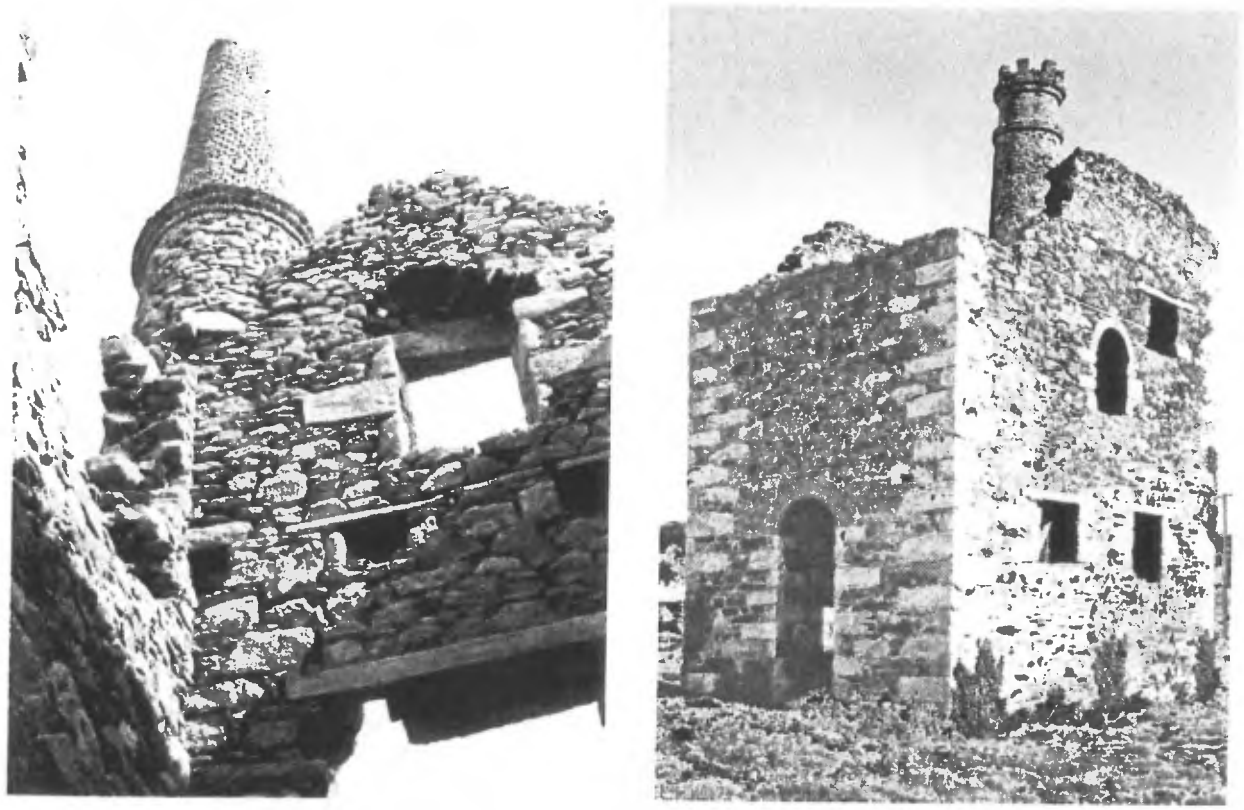


Fig. 3 Chimney stacks incorporated in the corner of the engine house.
Left: Wheal Edward Mine, near Botallock, Cornwall. (SW 703.472)
Right: Wheal Basset Mine, near Porttown, Cornwall. As there is no outcrop of granite in the vicinity, this engine house and the lower part of the chimney are built of local stone, with granite quoins. Note that the brick section of this stack, which is complete, is only abut 10 feet (3 m.) in height.

Bassett engine house chimney (fig. 3, right) is a distinctive exception, having a castellated top.

In certain situations, chimneys associated with mining operations can be freestanding (Fig. 5, Bottom Right). There are several examples where difficulties were encountered in the construction of the engine house which meant that the chimney had to be free-standing, as for example at Crowns, Botallick (SW 361398).

A by-product of separating the ore from the waste rock was a fraction rich in arsenic. When purified, arsenic, (in the form of its oxides) was a valuable by-product which could be sold to paint and insecticide manufacturers. If separated arsenic rich material is heated in a furnace, oxides are driven off which when cooled would give a pure, solid oxide mixture. Condensation was carried out in a series of connecting chambers known as a lambreth, which had a furnace at one end (to drive off the arsenic) and a free-standing chimney at the other.

This traditional Cornish method of chimney stack construction using a granite lower section with a lighter brick section above is not restricted to mine engine house chimneys. This method of construction is also to be found in clay areas around St Austell and elsewhere. Traditionally purified china clay was dried in a clay dry, where hot gases, from a furnace at one end of the dry, were passed through flues beneath a drying floor on which the wet clay was placed, and thence to a free-standing chimney venting to the atmosphere (Fig. 5, Top Row)

Kingsley Rickard in his note commented on the need to build round-section chimneys because of the wind factor.[8] Thus square-section chimneys are comparatively rare in Cornwall

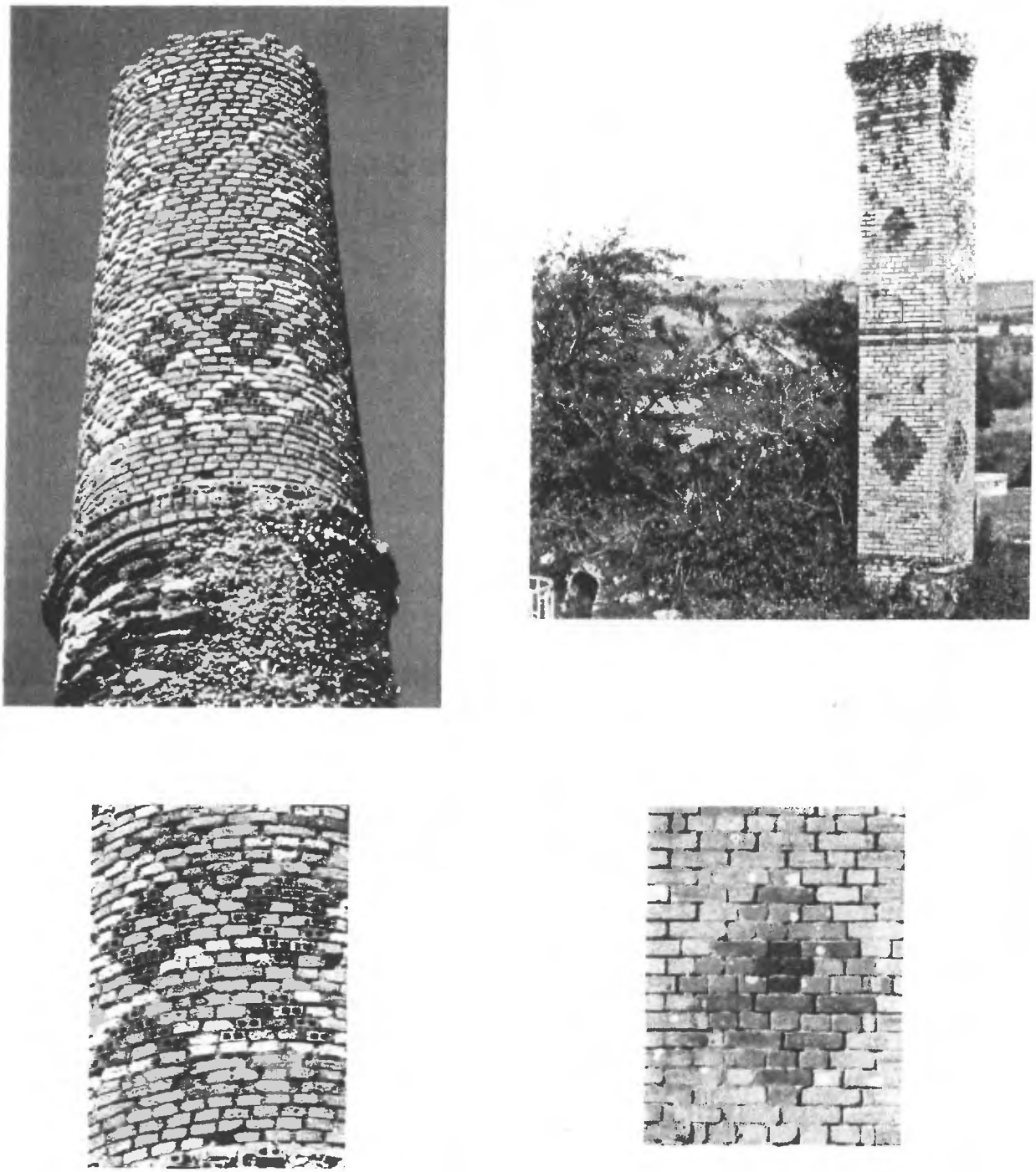


Fig. 4 Ornamented chimney stacks.
Left: Wheal Metal, near Sythney, Cornwall. the ornament is in a combination of red and cream brick with the darker red brick in the diaper.
Right: Carkeet Brickworks, near Jamaica Inn, Bodmin Moor, Cornwall. The stack is built in cream/brown brick with the diaper picked out in the darker shades; these are imported bricks and bear the mark 'COWAN'. One of the fireholes of the brick kiln can be seen bottom left in the top right-hand photograph. Note the lean on the chimney!

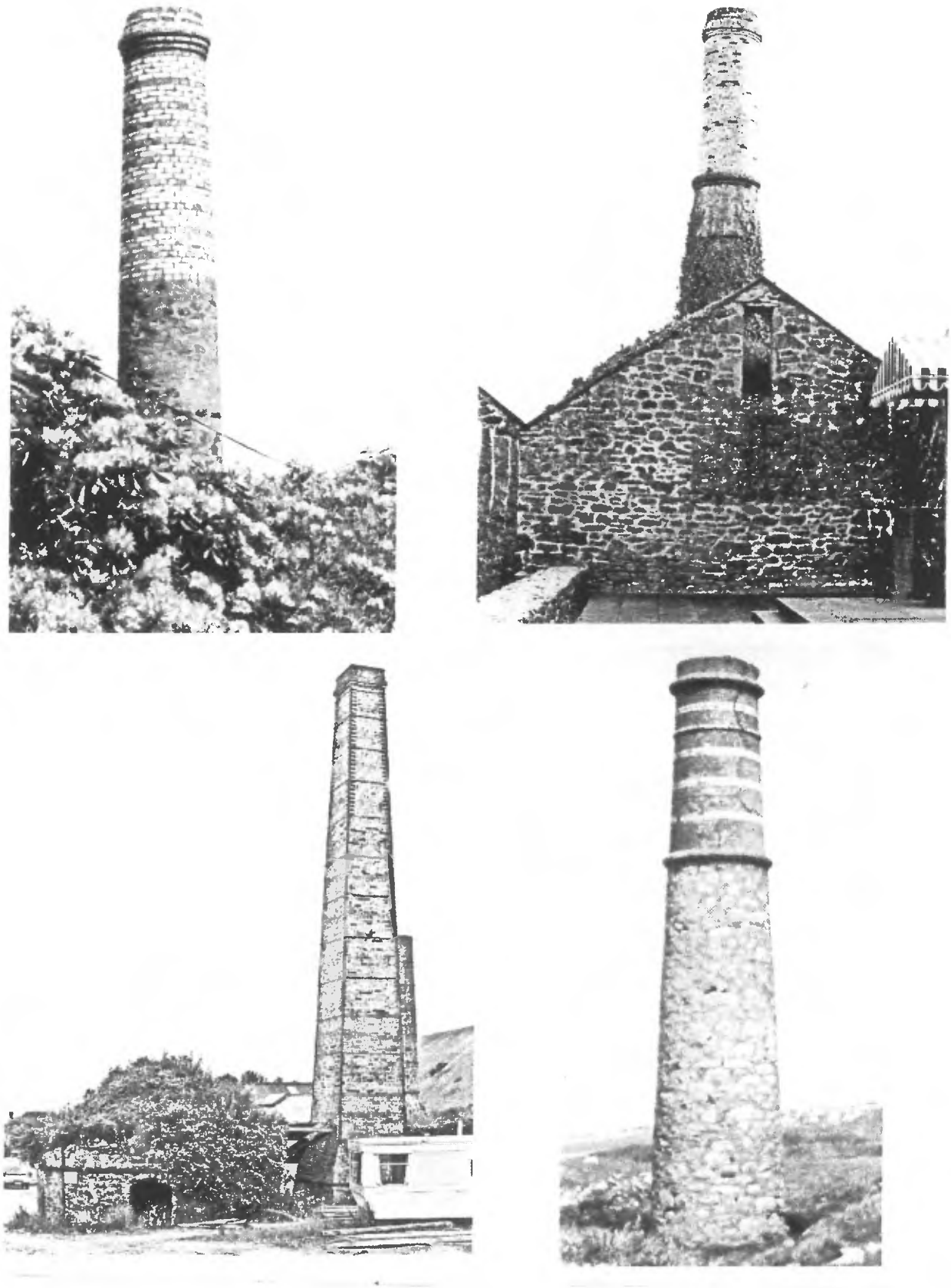


Fig. 5 Free-standing chimney stacks.
Top Row China clay dry chimneys. Georgia near Nancledra.
Wheal Martin, near St Austell.
Bottom Row Carbis Brickworks, near St Austell
Levant Man Engine Chimney, Pendeen

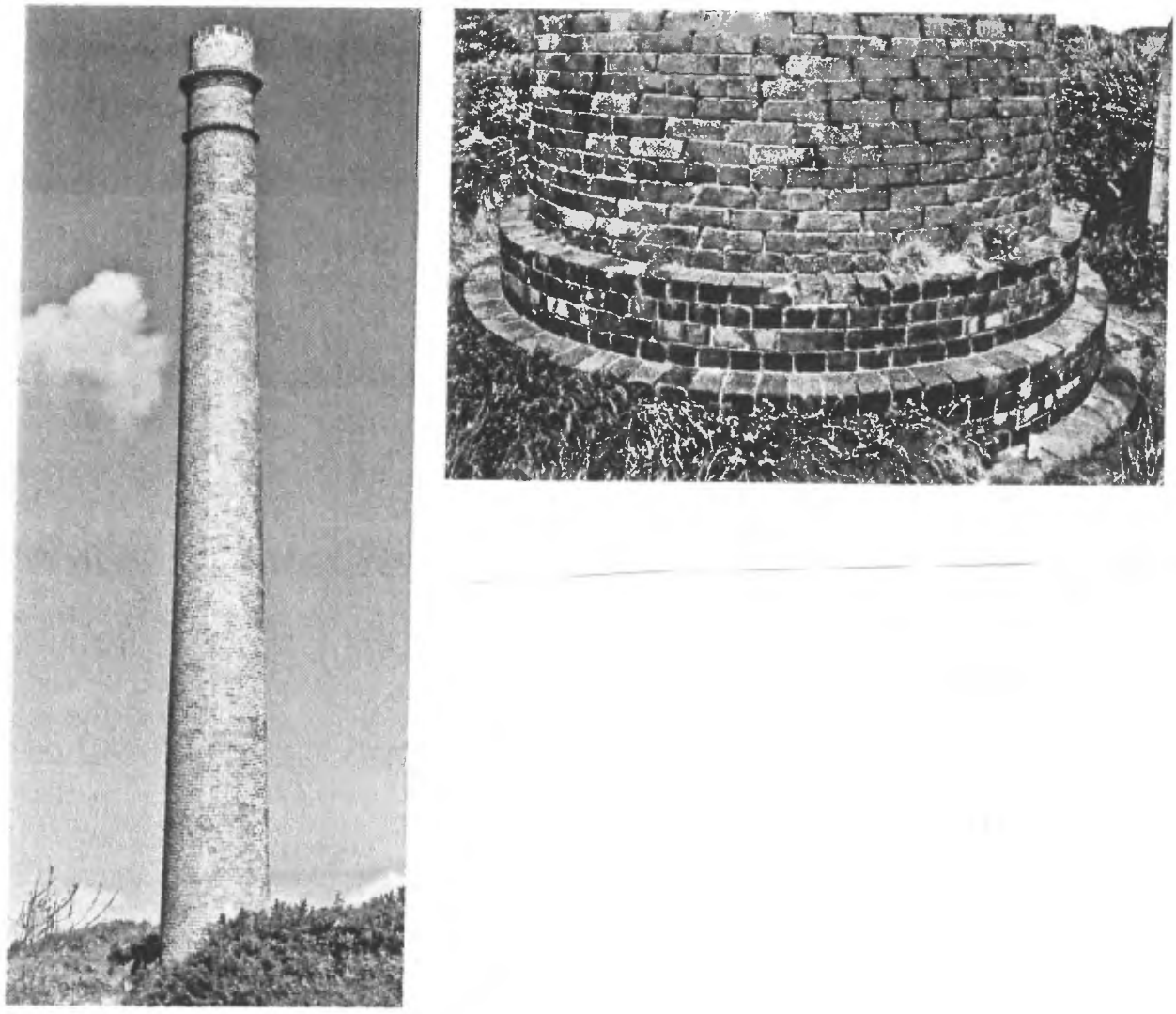


Fig. 6. National Explosive Co. Works, Upton Towans, near Hayle. Steam boiler stack for the nitric acid battery. Free-standing built in dark blue engineering brick, laid in English Garden Wall bond of one row of headers, three rows of stretchers. Both header and stretcher bricks have a convex outer face. Basal diameter (above plinths) 8 ft 6 in. (2.6 metres). Height 85 ft (26 metres).

and only three are known to the author. These are the surviving brickworks chimneys at Carkeet[9] and Carbis[10] (Fig. 4, Right; and Fig. 5, Bottom Left) and a chimney which was part of an arsenic calciner at King Edward Mine, near Camborne (now a museum run by the Trevithick Society). The other surviving brickworks chimney at Wheal Grey, near Penzance, is round, with a lower section built of granite and a cream brick upper section. The dangerous-looking lean on the Carkeet chimney emphasises the need for chimneys with minimum wind resistance.

An example of a chimney built in the classical manner is the surviving 100 foot (30 metres) high circular stack at the National Explosives Company works at Upton Towans, Hayle (Fig. 6). This is built using a mixture of wedged, curved facers and wedge-shaped headers with a curved outer face in engineering brick. The bond is English Garden Wall bond with three rows of stretchers to one row of headers (Fig. 6). the bricks are marked 'GWR' and were probably made in Swindon. A red brick chimney on a square granite base at Porthia Clay Works, near St Ives, is thought to have been built with bricks bought from the National Explosive Company

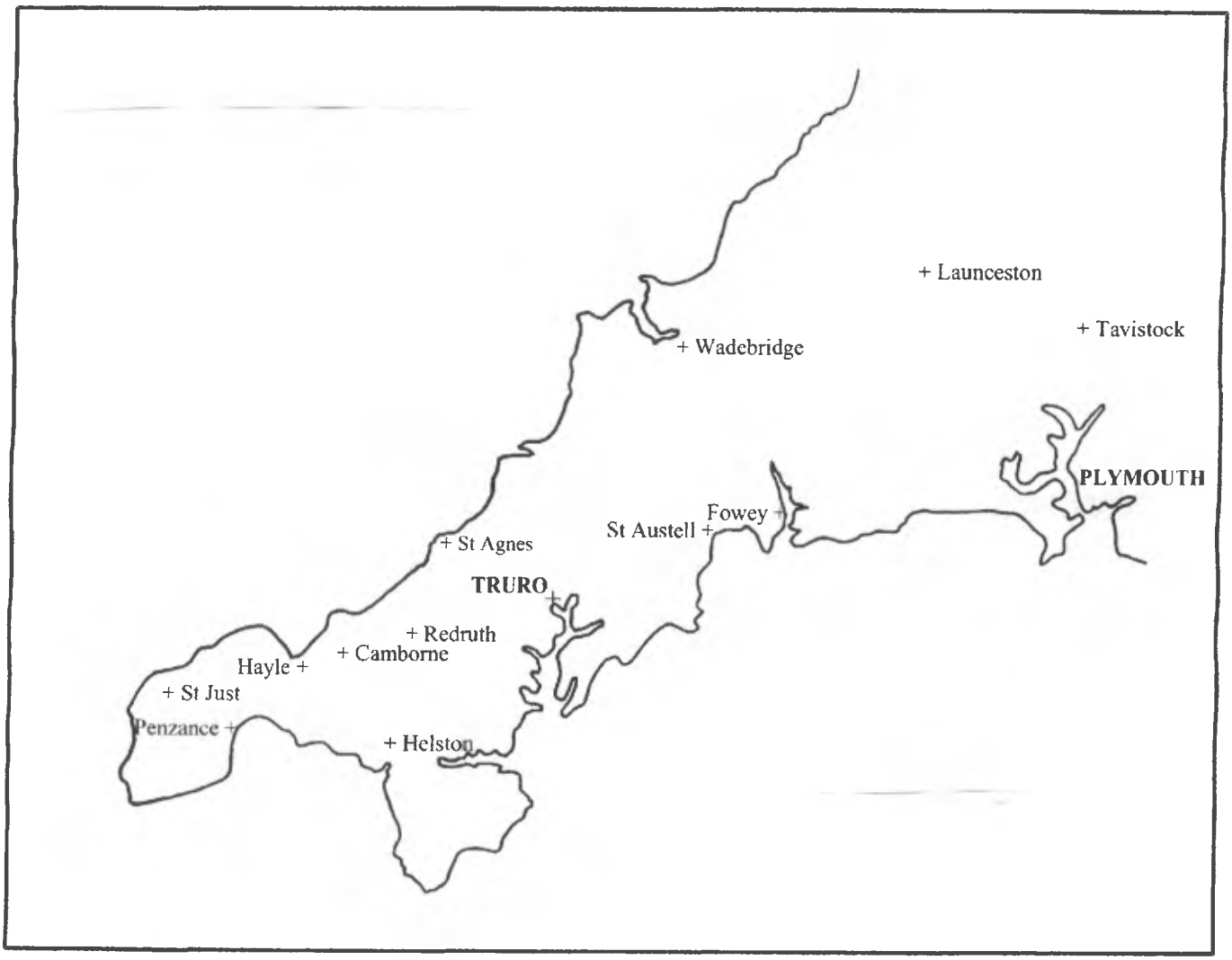


Fig. 7 Cornwall showing places noted in the text and the appendix..

when the works were dismantled and the bricks salvaged in 1921. The chimney also uses English Garden Wall bond.

APPENDIX
CORNISH STACKS

The following list gives some details of other Cornish stacks know to the author and not mentioned in the text. Sadly the data is incomplete, as after embarking on this project in 2008, the author moved away from Cornwall and has not been able to return to carry out fieldwork to fill in the gaps. The grid reference throughout have been taken from the one-inch Ordnance Survey maps and give an approximate location of each chimney.

Carbis Brickworks, near St Austell. SX 009598
Square, all brick with iron reinforcing bands, height 55 ft (16.8 m.)

Carkeet Brickworks, near Jamaica Inn, Bodmin Moor. SX 220733
Square, 4 ft (1.2 m.) base. All brick with diamond pattern decoration, height 30 ft (9.1 m.)

Great Work, near Godolphin. Engine House. SW 595291.
Round, brick section stepped, brick section height 27 ft (8.2 m.), total height unknown.

Levant Arsenic Calciner, Pendeen. SW 370478
Round, granite base, brick top, diameter at base 16 ft (4.9 m.), flue 3 ft (1 m.) Opening to lambreth - 3ft 6 in (1.1 m.) wide, 4 ft 9 in (1.5 m.) high.

Levant Man Engine, Pendeen. SW 369346
Round, granite section 22 ft (6.7 m.), brick section 17 ft (5.2 m.) with four bands of cream brick.

National Explosive Company Works, Upton Towans, near Hayle. SW 579399
Steam boiler stack for the nitric acid battery.
Round, engineering brick in English Garden Wall bond, height 85 ft (26 m.), basal diameter 8 ft 6 in (2.6 m.), flue 3 ft 6 in (1.1 m.).

Poldice Arsenic Calciner. SW 745421
Round, granite base, ordinary bricks laid in header bond. Brick section 20 ft (6.1 m.).

Porthia Clay Dry, St Ives. SW 498378
Round brick stack on square granite base 14 ft (4.3 m.) high, stack *circa* 66 ft (*circa* 20 m.); chimney made of recycled materials.

Roseworthy Arsenic Works Calciner Stack. SW 608401.
Round, granite with brick top, height 100 ft (30.5 m.), basal diameter 15 ft (4.6 m.), flue 3 ft (1 m.).

Taylors Shaft, Pool near Redruth. Engine House SW 670418
Round, granite base, brick top with vertical lettering 'E P A L'.

Wheal Grey Brickworks, near Penzance. SW 595291
Round, granite base, cream brick top section.

Wheal Martin Clay Dry, near St Austell. SX 005.555.
Round, granite base 35 ft 6 in (10.8 m.), cream brick top section 16 ft 6 in (5 m.).

Wheal Metal Engine House, near Sythney. SW 625.295
Round, decorated brick top section 17 ft (5.2 m.).

NOTES AND REFERENCES

1. P.A. Earwaker, 'Brick Query: Tall Chimneys;, *BBS Inf.*, **104,** July 2007, p.32.

2. K. Rickard, 'Tall Chimneys in Cornwall', *BBS Inf.*, **106,** February 2008, pp.42-43.

3. R.M. Barton, *A History of the Cornish China Clay Industry*, Truro: D. Bradford Barton, 1989 edition, p.173.

4. C. Carter, 'Early Engineers around Camborne', *Journal of the Trevithick Society*, **25,** 1998, p. 61.

5. J. Ferguson, 'Brick Imports to Hayle, Cornwall, late eighteenth and nineteenth century', *BBS Inf.*, **62,** June 1994, pp.15-23.

6. J. Ferguson and C. Thurlow, *Cornish Brick Making and Brick Buildings*. St Austell: Cornish Hillside Publications, 2005, pp.102-104.

7. Ferguson and Thurlow, 2005, p. 80.

8. Rickard, 2008, p.43.

9. Ferguson and Thurlow, 2005, pp. 89-91 with further illustration p. 41.

10. Ferguson and Thurlow, 2005, pp.77-79; the chimney is illustrated p. 78 top.

FACTORY CHIMNEY STACKS:
SOME THOUGHTS AND SOME EVIDENCE

Paul W. Sowan

P.A. Earwaker in *British Brick Society Information,* **104,** July 2007, enquired about the means employed in building tall brick factory chimneys, their design and their history.

Tall brick factory chimneys have commonly been of square, octagonal, or circular section, and in all cases the outer faces taper upwards. Photographs of numerous examples of all three kinds have been published in Pickles' book, *Our Grimy Heritage,* (Pickles, 1971). Many factory chimneys are, of course, brick built, but some constructed of brick were faced in stone, for example that at the tweed mill at Chipping Norton, Oxfordshire.

TWO CLASSES OF FACTORY CHIMNEYS

Industrial chimneys may perhaps be divided into two main classes. The first group have much the same purpose as domestic chimneys, and serve to create an updraught to remove the products of combustion (primarily carbon dioxide, steam, and residual atmospheric oxygen and nitrogen) of coal or other fuels from fires for steam engine boilers, forges and the like. The purpose of the chimneys in the second group is to remove more noxious gases (such as the very toxic sulphur dioxide) or particulates (such as arsenic oxide) from chemical processing such as the roasting of metalliferous sulphide ores. As technology advanced, and factory operators either chose or were forced by legislation to exercise a greater degree of environmental friendliness, or indeed simply realised that arsenic and sulphur recovered from flue gases were valuable and saleable products in their own right, ways and means were devised to prevent their escaping up the chimney and to facilitate their recovery for sale. Very tall chimneys were built primarily to discharge smoke and toxic materials so high above ground that they were more effectively dispersed and diluted before coming back to ground level as dust, soot, or gases dissolved in 'acid rain'. This was obviously of particular concern in the new towns of the Industrial Revolution, which were often in valley settings where many factories at first relied on water power. This tended to hinder dispersal.

Taller chimneys, also, would create a stronger draught, provided the cross-sectional area of the flue was commensurately larger. Brees (1852) observes that 'In erecting chimneys [for steam engines] from 70 to 90 feet high, it is a common rule to make them 20 inches square at the top for each horse-power of the boiler .... the draught is not improved by increasing the height much beyond 40 or 50 yards [120 to 150 feet], unless the width be increased on a similar ratio'.

Many very tall chimneys of the first class, associated with brick kilns and (a little later) lime kilns date from the middle of the nineteenth century, when kilns were built to the patent of Friedrich Hoffmann (1818-1900) of Gröningen near Halberstadt, Germany. This patent was widely adopted throughout the UK from the 1860s onwards for both brick and lime kilns of the continuously operating 'ring oven' pattern. A special case is perhaps provided by the 'glass cones' of places such as Bristol, where one survives, and pottery kilns, of which one survives at Coalport, Shropshire.

In more recent times, we have at Croydon a pair of very tall (92 metre) brick chimneys, being all that remains of Croydon 'B' Power Station. These were built shortly before World War two and are all that remains of the former power station.

THE SPECIAL CASE OF THE DIETZSCH AND SMIDTH LIME KILNS

A third group of very tall structures might also be classed as chimneys, comprising continuously operated vertical shaft lime kilns where the 'chimney' is more or less an integral part of the processing furnace. If , as especially in lime kilns, the lower part of the structure was intended to become very hot (over 1000°C), and to contain a moving charge of material being processed, wear-resistant refractory brick linings, renewed from time-to-time, were essential. These lining bricks had to be of very precisely moulded or cut to shapes and sizes and laid with extremely thin mortared joints. Re-lining was a skilled and time-consuming business. The upper parts of such shaft or running kilns, in cheaper brick, accommodated feedstock being dried and pre-heated by flue gases, utilising what would otherwise be wasted heat, and thus wasted fuel. There are two such shafts each accommodating a pair of Dietzsch kilns for limeburning surviving at the former Dorking Greystone Lime Co. Ltd's works at Betchworth, built in 1887 and 1897. Carl Dietzsch. of Malstatt, an industrial suburb of Saarbrücken, patented his first kilns for cement manufacture in or about 1883 but they were later, as with Hoffmann kilns, adapted for lime-burning.

Also at Betchworth, there is another related structure, a very tall Smidth-type lime kiln dating from the first years of the twentieth century but abandoned before construction was completed and so never fired. Although described by the lime company as a 'modified Dietzsch kiln', the design has clearly been influenced by the patents of Carl Schneider of Hamburg and Verner Frederick Lessöe Smidth of Copenhagen; and of Verner Smidth and Emil Risager, of 1898. The lime company at Betchworth was notable for examples of 'technology transfer', importing German and Danish designs and adapting brick or cement kilns for burning lime. All three of these imposing brick towers at Betchworth are Scheduled Ancient Monuments (SAM 22781).

THE FIRST TALL CHIMNEYS

The earliest tall industrial chimneys, I suspect, were associated with the earliest steam engines, which were first employed for pumping water from deep mines, whether for coal or metalliferous ores. Thomas Savery (*c.* 1650-1715) patented an engine for this purpose in 1698, which was subsequently improved upon by Thomas Newcomen (1663-1729) in a patent issued in 1705. Further improvements were later made by James Watt (1736-1829). Hard on the heels of coal-fired steam pumping engines came the associated ore-roasting and smelting furnaces, in which the main ores of copper, lead and zinc – all being sulphides – led to the release of quantities of poisonous sulphur dioxide into the air.

Of, course, once steam engines had been mounted on wheels and put to work pulling trains, from the 1820s onwards, industrial towns and cities were smoke-blackened in no time! Tall chimneys on trains were precluded by tunnels and overbridges; and trains delivered coal to homes for domestic heating, with obvious consequences of the same kind.

The taller the chimney, the greater the loading on the lowest parts. Thus the unconfined compressive strength of bricks or stone used in the foundations and the plinth was an important question.

The most comprehensive survey of tall chimneys, *Our Grimy Heritage* (Pickles, 1971) is devoted primarily to the aesthetic and architectural aspects of chimney design, but also contains a short note on their construction. He suggests – to my mind, surprisingly if not erroneously – that most such chimneys are double-walled, the space between the inner and outer walls being 'either filled with rubble or left empty, in which case there are connecting stones or bricks at intervals'. Such a rubble filling would add to the weight , but not to the compressive

strength of the structure. Samuel Brees, in his *Illustrated glossary of practical architecture and civil engineering,* depicts a tall factory chimney in cross-section, suggesting solid masonry throughout, with no interior space, rubble-filled or empty (Brees, 1852).

Standard rectangular bricks were, of course, quite suitable for square-sectioned chimneys. Octagonal chimneys called for 'dog-leg' bricks at the corners. Circular chimneys called for radial bricks, with a different splay being needed according to diameter, which made for complications as the diameter decreases upwards.

A FIRST-HAND ACCOUNT OF CHIMNEY-BUILDING AT RUNCORN IN 1834

There is an interesting account of the construction of a very tall chimney in 1834. In Sir George Head's *Home Tour through the Manufacturing Districts of England,* we read:

> In the outskirts of the town [Runcorn], on the premises of a soap and soda manufactory, one of those stately circular chimneys, which are becoming every day more general in the country, has lately been built for the purpose of carrying off, by means of flues communicating far and wide among the buildings, all noxious *effluvia* from the works. These noble specimens of modern brick-work answer the object for which they are intended to perfection: and, certainly, in populous cities, might, by collecting the smoke from numerous and different points, and disemboguing the whole in a body high in mid air, be applied to general domestic purposes. At first sight, as regards danger, the extreme height seems a startling objection, though, in fact, the consideration is but triffling; for a small walled space would insure public security, and enclose a space sufficient to receive, even if the building were to fall, the whole of the materials.

Disemboguement is an antique word developed from the notion of an outflow, as of water into the sea, for example.

> The chimney in question is, I believe, the highest in England – that is to say, ninety-two yards [nearly 85 metres], or two hundred and seventy-six feet to the top of the coping, just seventy-four feet higher than the Monument in London.

The Monument in London, designed by Sir Christopher Wren and built to commemorate the Great Fire of 1666, was at the time it was built, in 1671-77 of Portland stone, the tallest isolated stone column int the world. It is 202 feet high (a little over 62 metres). It is hollow inside, like a chimney, but has a spiral staircase which the public may ascend to the external viewing platform at the top.

Resuming Sir George Head's account of the chimney at Runcorn, we read:

> It is an arduous service, in raising such a structure to such a giddy height, to those whose lot is constant exposure to the fury of the four winds, increased to an appalling degree by the altitude; nevertheless, the work was chiefly performed by two men, who never left the job from beginning to end. At times, as was related to me, they were assisted by others; but the higher the building proceeded, the more fastidious the latter became and discontented, generally contriving, in default of other causes of complaint, to quarrel with their companions. But all were invariably silent as to the true reason of these capricious antipathies – simply, the fear of falling. The diameter of the chimney at the bottom, from outside to outside, is thirty feet – the slant an inch and a half in the yard at each side. The thickness of the wall at the bottom is nine bricks in length, diminishing to a brick and a half at the top.
>
> I happened to be present, in the summer of 1834, while this building was in progress. the operation was curiously performed without scaffolding, by means of a platform of boards at the top, which was gradually raised higher and higher as the work proceeded. The bricks and all the other materials were hauled up the inside of the building by a horse, the bricks especially being

> dextrously bound together, in parcels of about a wheelbarrow load each. The horse walked outwards away from the building, in a straight line, a bell always sounding when each load was ready – with this signal the animal was fully acquainted. As the length of the rope was the same as the height of the building, I had no difficulty, by pacing the extent of the horse's walk, to ascertain the elevation: which at that time was one hundred and fifty feet. (Head, 1836, pp.6-8)

Presumably the men, as well as the materials, ascended or descended by way of the inside of the chimney, perhaps using temporary internal platforms, ladders and/or ropes, or perhaps, as was common in mines and in well-sinking, in a large bucket. Of course, this would only be possible where a sufficiently generous internal diameter was available at the top. Hauling loads up on the outside would be tricky as, on account of the batter of the structure, it would be difficult to keep the load clear of the brickwork.

CONSTRUCTION METHODS IN COMMON WITH LINED MINE SHAFTS AND WELLS

Wells and deep mine-shafts have been sunk, and wholly or in part brick- or stone-lined, to depths of hundred and sometimes thousands of feet. For several reasons, this is a more challenging task than building chimneys. At the top of a chimney, the workman enjoys, perhaps, too much fresh air! At the bottom of the well, the risk is of too little, and poisoning by your own carbon dioxide. But the working space is constricted in both cases, as is the risk of falling, *from* the workplace at the top of the chimney, or to it at the bottom of the well. Peculiar to well- and shaft-sinking, however, is the ever-present danger posed by falling bricks or baskets full of excavated rock.

Before the introduction of forced ventilation of mines driven by powered fans, many deep mines, and even some coal mines, were ventilated by making a shaft which served as the chimney to the furnace at the bottom. This induced a flow of air through the mine. The grate and base of a furnace shaft can be seen during public underground tours at the Hopewell Colliery Museum in the Forest of Dean, Glos.

The longer canal and railway tunnels were liberally provided with that are often called 'air shafts'. These, constructed in the same way as wells and mine shafts, were in fact primarily made as tunnel-miners' access and spoil extraction routes. Most such tunnels were dug in sections from the shaft bottoms, not simply from each end. How shaft-sinking was done for railway tunnels is described in great detail by Frederick Walter Simms in his work, *Practical Tunnelling*, the first edition of which was published in 1844 (Simms, 1844).

REFERENCES

Brees, Samuel Charles, 1852
The Illustrated Glossary of Practical Architecture and Civil Engineering: comprising the theory and modern practice, with the subjects of office & field work, the steam engine, mechanical engineering, surveying levelling & use of instruments, mining and quarrying, manufacture of iron, bricks, lime and cements, carpentry, joinery, bricklaying and masonry, slating, painting and glazing, building etc., London: Publisher not stated, fp + vi + 7490 + (2) pp.

Earwaker, P.A., 2007
'Brick Query: Tall Chimneys', *BBS Information*, **104,** July 2007, p.32.

Head, George, 1836/1968
A home Tour through the Manufacturing Districts of England in the Summer of 1835, London: John Murray: xi + (1) + 434 pp. [reprinted with introduction by W.H. Challoner, London: Frank Cass & Co. Ltd, 1968.]

Pickles, Walter, 1971,
Our Grimy Heritage, Fontwell: Centuar Press Ltd, 64 pp + 125 plates.

Simms, Frederick Walter, 1844
Practical Tunnelling Explaining in detail, the setting

out of the works: shaft-sinking, and heading driving; ranging the lines, and levelling underground, sub-excavating, timbering; and the construction of the brickwork of tunnels: with the amount of labour required for, and the cost of the various portions of the work: as exemplified by the particulars and the Bletchingley and Saltwood tunnels London: Troughton and Simms, xii + 174 pp + fp + 12 pls.

Sowan, Paul W., 2004,
Scheduled Ancient Monument 22781. Betchworth Lime Works: lime kilns at Betchworth Quarry [annotated copy of English Heritage description.] Author: 7 pages.

Death of a Large Brick Structure: Meadowside Granaries, Glasgow

Once, they towered above the Clyde. Initially built between 1911 and 1913 to the designs of a structural engineer, William Alston, the Meadowside Granaries on Castlebank Street, Partick, were extended at both ends in 1936 and 1937. West of the extended structures, two further granaries were built in 1960 and 1967. As structures closed in 1988, they reminded those who drove west out of Glasgow along the north bank of the river Clyde that the life of the river depended on trade, both imports and exports.

Built by the Clyde Navigation Trust, the original granary was thirteen bays and thirteen storeys. With the second of the 1930s extensions, it became thirty-four bays long. Each bay was 12 feet (3.66 metres) in length. External walls were in buttressed brickwork, which as it rose through the building was reduced in depth. As with the Monadnock in Chicago of 1892, the base of the brickwork in the Meadowside Granaries was no less than 6 feet (1.83 metres) in depth.

In building the Meadowside Granaries, no fewer than five million bricks were used. It has been claimed as Europe's largest brick structure.

Half of the building had floors of ferro-concrete, itself a new material in 1911-13, supported internally by cast iron pillars and resting on the external brickwork. In the other half of the building, were great ferro-concrete drums acting as silos for the imports of American grain. Grain sacks were unloaded from trans-Atlantic freighters, both steam-powered and sailing ships, on to a conveyer belt to the building's sixth floor. Some went directly down sack shoots into waiting lorries and train trucks; some was carried by conveyor up to the top floor for distribution into storage.

Frank Arneil Walker, in *Phiadon Architectural Guide: Glasgow,* 1992, 104, mentions plans affoot almost two decades ago to convert the granaries into flats. Sadly nothing came of the proposal and in 2009, they were progressively demolished.

DHK

Book Notice: London's Sewers

Paul Dobraszczyk's book results from the author's doctoral research in the Department of History of Art and Architecture at the University of Reading. It covers 'the years when London's new system of sewers was first planned (1848-58) and then constructed in its first and most important phase (1858-68)' (p.9).

After a Preface and Introduction, Section I ('Planning') begins with Chapter 1, which considers the mapping of pre-1850s London, above and below ground, as a preliminary to the new sewer system. The statement that 'the view from below [that is, from the existing sewers] positively *revelled* in the dirt and chaos of subterranean spaces' (p. 33 my italics) seems at variance with the primary sources quoted, which record criticism and repugnance rather than any coprological fascination; the existing sewers were '"dilapidated", "decayed", "dangerous", "defective", "frightful", "crushed", and "rotten" (p. 34). Chapter 2 discuses the planning of the system with all its potential difficulties. The initial scheme envisaged by Edwin Chadwick (1800-1890) proposed the use of human excrement as manure on the fields around London, very much as horse manure was used to fertilize the soil of the Middlesex hay meadows; but this was superseded under Sir Joseph Bazalgette (1819-1891) by a system which disposed of the sewage as waste in the Lower Thames.

Section II ('Construction') begins with Chapter 3, which examines contracts and construction, including the preparation of drawings and specifications, tenders, and the award of contracts – mostly to larger firms who did not always present the lowest tenders; unfortunately there is no adequate discussion of why such choices were made. Construction is only briefly considered, although it is noted that there were some stoppages, such as 'the 1859-60 labourers' strike over working hours, continuous problems with heavy summer rains, hard winter frosts, and difficulties [in] obtaining brick and stone', though these 'did not prevent progress remaining "decidedly satisfactory"' (p.81). Chapter 4 applies to the sewers the eighteenth-century concept of the 'Sublime' as defined by Edmund Burke (1729-1797): 'a strong emotional response – .... a mixture of awe and terror – to vast or overwhelming natural or man-made objects' (p.85). In the present short notice it is impossible adequately to summarise this thoughtful and intelligent discussion of how, through texts and illustrations in the press, the construction work on the sewers and the destruction caused by accidents were viewed at the time. One may mention, incidentally, that there are several references to bricklayers and bricklaying and that at p.90 it is noted that the main sewers employed 318 million bricks (repeated at p.173).

Section III ('Architecture') begins with Chapter 5 – by far the longest in the book – on 'Engineering and Art' (pp.115-166), which is likely to be of greatest interest to those concerned with bricks and other building materials and their uses. It is important for its assessment of the work, in brick, tile, stone, and cast iron, of the hitherto largely neglected Victorian architect and engineer Charles Driver (1832-1900). London-based, he became an Associate (1867) and then a Fellow (1872) of the Royal Institute of British Architects and was elected to the Institution of Civil Engineers in the year of his death. His work included not just the pumping stations for the sewerage system – the above ground and therefore publicly visible elements of the scheme – but also bridges, seaside piers, railway stations, and other buildings in Britain and abroad. Although Driver is named in the relevant muniments concerning the pumping stations, he is not credited with their design, and his responsibility for them has to be established by comparison with his known works. This involves stylistic analysis. The argument is, so I believe, entirely convincing. It is, moreover, an important contribution to the study of Victorian architecture and in particular to that of the relationship between 'art' architecture and engineering, aesthetics and utility.

Chapter 6 examines the often ambivalent perceptions of the system and thus 'brings [the] book full circle: from the uneasy conjunction of old and new in the first stages of planning .... to just such a conjunction in its reception some 20 years later' (p.189).

There is a brief Postscript (examining the metaphorical use of sewers in film and literature), a section of endnotes, a list of 'Newspaper articles and engravings consulted', a bibliography, and an index.

The early chapters of the book struck me as somewhat heavy-going – perhaps due to their origin in an academic thesis but possibly also to the fact that the *minutiae* of sewerage systems do not greatly exercise my imagination. Otherwise, there is much of value, especially for those with an interest in Victorian architecture and building materials. At £35-95 it is expensive, but it is well and attractively produced.

T.P. SMITH

This is a notice of:

Paul Dobraszczyk,
Into the Belly of the Beast: Exploring London's Victorian Sewers,
Reading: Spire Books, 2009,
236 pp., numerous illustrations in black-and-white and colour
ISBN 978-1-904965-24-4, price £34-95, hardback

Another general account of the building of London's sewers is to be found in

Stephen Halliday,
The Great Stink of London Sir Joseph Bazalgette and the Cleansing of the Victorian Metrŏpolis,
Stroud: Sutton Publishing, 1999,
xiv + 210 pages, numerous black-and-white illustrations, 8 colour plates,
ISBN 0-7509-1975-2, price £19-99.

See also

The Crossness Engines Trust,
The Crossness Engines,
London: the Crossness Engines Trust, n.d.
28 pages, numerous illustrations in black-and-white and colour,
No ISBN, price £3-50

also web site: www.crossness.org.uk

BRICK IN PRINT

Between November 2009 and June 2010, the Editor of the British Brick Society received notice of a number of publications of interest to members of the society. This is a now regular feature of *BBS Information*, with surveys usually two or three times a year. Members who are involved in publication and members who come across books and articles of interest are invited to submit notice of them to the editor of *BBS Information*. Web sites are also included. Unsigned contributions in this section are by the editor.

DAVID H. KENNETT

1. David Gillard, Sir Richard Best, Ed Bacon and Tony Crowther,
Bricks & Water 100 Years of Social History in Clapham & Patching Villages.
Clapham, West Sussex: The Friends of Clapham & Patching Churches, 2000
278 pages, numerous black and white illustrations.
ISBN 0-9539742-0-0, price £12-50.

The brickworks at Clapham were noted in the gazetteer for West Sussex by BBS member Molly Beswick in *Brickmaking in Sussex, History and Gazetteer,* 2nd edition, 2001, page 188. This well-illustrated local history was in preparation at about the same time. One of the two photographs on the cover is of Em Fields and George Ruff, two of the kilnmen, standing beside one of the three circular downdraught kilns.

The four authors devote pages 79 to 88 to a brief history and several reminiscences by former workers of their working lives at the brickworks in the 1930s and again in the 1950s. In the 1960s, the brickworks was gutted by fire but although the authors include an illustration of the local newspaper account of the fire, they do not give a precise date. Re-establishment of the works gave it another decade or so of manufacture of high quality red bricks until 1978.

Photographs with their captions also cover transport, employees and a works outing. An interesting contrast is that in the late 1920s almost every employee is wearing a cloth cap whilst a similar photograph of the 1950s shows few of the men with any headgear whatsoever.

2. Mike Kingman, 'The Adoption of Brick in Urban Staffordshire: The Experience of Newcastle-under-Lyme, 1665-1760',
Midland History, **35, 1,** Spring 2010, pp.89-106
M.J. Kingman, 'Civic Improvement and Use of Brick: A Case Study of Tamworth, 1572-1760',
Transactions of the Staffordshire Archaeological and Historical Society, **42,** 2008, pp.68-80.

These two papers, contrasting in their conclusions about two very different Staffordshire towns, arise from the author's Keele University Ph.D thesis on 'Brickmaking and Brick Building in Staffordshire, 1500-1760', other studies derived from which have appeared in issues of *British Brick Society Information.* One point BBS member Mike Kingman makes in the Newcastle paper is that urban brick was rare in Staffordshire before 1660: the author cites only six brick buildings around the cathedral and in the close at Lichfield plus two almshouses elsewhere in the city, the Great Hall at Wolverhampton, a house in Tamworth, and a 'Brick House' in Burton-on-Trent as being brick buildings in a town. None, for example, is recorded in either the Five Towns or in the county town of Stafford.

Fig. 1 Tamworth Town Hall was built by Thomas Guy in 1701.

The Newcastle study considers those practical factors which may have affected the personal and community decisions to build in brick in the seventeenth and eighteenth centuries. Before 1760, provincial brick production was traditional in operation, severely hindered by transport costs and serving a market which was too small to act as a spur to capital investment. How would-be builders could obtain bricks in a community which did not possess a resident brickmaker was met in Newcastle-under-Lyme by the financing of a municipal brick kiln. Yet paradoxically, this civic enterprise, together with the corporation's policy of restrictive housing leases and the lack of involvement by the town's other major landowner, Lord Gower, provided a disincentive to the employment of brick and these coincided to restrict the construction of fashionable brick buildings to a small minority of independent townsfolk. In Newcastle-under-Lyme, the transformation from timber-framed vernacular styles to a more uniform and brick-built style was a slow and hesitant process.

In contrast in Tamworth, the corporation there recognised the commercial and financial benefits which arose from a deliberate policy of physical improvement. This helped to create a new and fashionable townscape in which the promotion and encouragement of brick was a significant feature.

AUTHOR (adapted and extended)

3. Rosemary Lamont, 'Aspiring to Versailles: Goldsborough Hall, Yorkshire',
Country Life, 30 June 2010, pages 94-97

Goldsborough Hall is a red brick house with sandstone dressings built in the early seventeenth century. The house was remodelled by John Carr for Daniel Lascelles when the two outer rectangular bays of the original east or garden front were extended into half-octagonal bays, still using the original materials.

The gardens underwent a remarkable transformation in the last decade of the seventeenth century and the article records four drawings made for the new layout, probably in 1692. The drawings include a plan of the proposed new layout, which as a survey drawing of 1738 shows was largely acomplished. On the 1692 drawing, there is a block plan of the house before Carr's alterations with the adjacent stables and parish church. The bird's eye view of the garden in 1738 also shows the house in its original form. Both reproductions show the extensive kitchen garden, complete with the brick wall surrounding it.

The story of how a French garden was transported to Yorkshire is detailed in the article.

4. Jo Moore and Christina Sinclair, 'Tube Stations',
C20: The Magazine of the Twentieth Century Society, Winter 2009/10, pp.4-5.

Of 257 London 'Underground' stations (many, of course not *underground* at all) only 57 are listed buildings. Recently, the Twentieth Century Society, concerned about the threat resulting from changes to the management and running of the system, has undertaken a survey of several of the unlisted stations, much of the work carried out by Christina Sinclair, an architecture student at Edinburgh University. Drawing on that work, this article briefly describes three of the stations.

Brent Cross (formerly Brent, 1923) by Stanley Arthur Heaps (1880-1962) is in a 'neo-Georgian' style using thin red Dorking bricks with a Portland stone colonnade with simplified entablature. Croxley (formerly Croxley Green, 1925) by Charles Clark (1885-1972) is in an Arts and Crafts domestic style using red brick and slate hanging with a front canopy supported by cast iron columns. Perivale (1947) by Brian Lewis (1906-1991) has, above a sinuous canopy, a large concave window of glass and concrete (here called 'glascrete'); otherwise, the building is of red bricks, those of the tall parapet being in Stack Bond (here, not quite accurately, described as 'courses of soldier bricks'). The platform has metal canopies 'incorporating a single-storey brick unit with glazed waiting room'; there is also an island platform with a brick enclosure and attached glazed waiting room. Throughout, surviving fittings and signage are mentioned.

There is a photograph of Croxley and photographs of two stations not discussed: Hanger Lane (1947) by Brian Lewis and the partly brick-built Moor Park (here dated to the 1950s but completed in 1961 according to L. Menear, *London's Underground Stations: a Social and Architectural Study*, Tunbridge Wells: Midas Books, 1983, p.112).

It is a pity that the article is limited to a mere two pages and three buildings, not least because by no means all the stations are included in the six volumes of *The Buildings of England: London*. Those who wish to know more should consult Menear, 1983, or D. Lawrence, *Underground Architecture*, Harrow: Capital Transport Publishing, 1994. So far as the brick-built stations are concerned, there is scope for further contributions to these pages.

T.P. SMITH

5. Alan Powers, 'Modernist Mews',
Country Life, 17 March 2010, pages 94-95

Edward Cullinan, the Royal Institute of British Architects Gold Medallist in 2008, is one of the

leading architects to work with brick: for example the new chapter house for the cathedral at St Albans Abbey. Alan Powers examines his self-built house, taking the weekends of three years to construct in the early 1960s. A mews house facing south, it has the bedrooms on the lower floor and an open-plan living/dining/kitchen space on the first floor. The materials are stained timber and re-used London stock bricks. These are left raw; plaster was not used, as the photographs of the interior make plain.

6. Christine Slessor, 'Diakone Church and Nursing Home, Düsseldorf, Germany', *Architectural Review*, **1359,** May 2010, pp.64-67.

In 2004, the Austrian architectural partnership Baumshlager Eberle won the competition for this project in a residential district of Düsseldorf. Diakone is a social welfare arm of the Protestant Church, and the brief was for a church and a nursing home — open to those of any faith or none. Both buildings are of brick in Stretcher Bond. The bricks are variegated rust and violet, giving a 'delicately flecked, almost tweedy countenance'; they are of a 'long, thin, almost Roman' format.

The nursing home has a square 'footprint' set parallel to the surrounding streets and comprises three ranges around a rectangular courtyard open to one side. It is an unassuming building with plain façades punctuated by regularly disposed vertical rectangular windows. At ground level are a shop and café giving on to an open space, intended to 'dissipate the depressingly familiar feeling of being marooned in an anonymous institution'. This admirable approach is reflected in the thoughtful internal arrangements, allowing residents to 'choose how to live their lives'. One criticism is that one might wish for more prominent mullions and transoms to the windows, thus avoiding the somewhat blank-faced appearance of the building.

The church is a square structure set diagonally to the street-line and thus also to the nursing home. Its purpose is suggested by regular, widely-spaced Greek crosses of projecting vertical and horizontal bricks, each arm two bricks long. There is also a large Latin cross fixed to one face. Yet inside, and consonant with Diakonie's tolerant approach, there is 'the bare minimum of Christian iconography'. This space is lighted by high-set horizontal clerestory windows. To the rear are five storeys of offices and meeting rooms. On the flat roof is a metal bell-frame. At ground level on the street side a long horizontal opening giving on to a parvis or open area unites church and outer (secular) space.

This reticent and attractive project is refreshingly unsullied by any self-promotion on the part of its architects. The article is illustrated by plans and sections and by some excellent colour photographs by Eduard Hueber.

T.P. SMITH

7. Tim Tatton-Brown, 'A Tudor Survival Lambeth Palace London SE1', *Country Life*, 11 November 2009, pages 58-63

Today, the Archbishop of Canterbury is the only Anglican prelate other than the Bishop of London to retain a London residence, and even the latter makes do with a flat near St Paul's. In 1486, John Morton (*c.*1425-1500), a long-standing supporter of the new king. Henry VII, became the first Tudor Archbishop of Canterbury. Morton had a reputation for building in brick: Hatfield Palace, of which only one wing survives, was his work, done when he was Bishop of Ely.

As archbishop, Morton had a large staff who had to be accommodated at the palace. He built upwards: additional floors to an existing tower at the opposite end of the palace to his more often cited five-storey great gatehouse. The gatehouse contained ten sets of chambers, each of two rooms of which the outer one contained a fireplace and the inner one was sleeping quarters.

Each floor had a latrine. Above the gate itself is a large room, used until 1857 for the Prerogative Court of Canterbury, the principal probate court in England and Wales. The room is still lined with wills. Two floors were added to Chichele's 1434-35 tower; Chichele had faced his tower in Kentish Ragstone from Maidstone, where the archbishop had property. Morton built in brick but continued the use of his predecessor's facing material. However, the staircase and latrine tower beyond is externally of brick.

The article is illustrated with six good coloured photographs and a reproduction of an eighteenth-century painting of the great gatehouse.

Pages 64-65 of the same issue of *Country Life* cover the life of the Scots architect Charles Rennie Mackintosh (1868-1928) in the series on 'Great British Architects'. One of the illustrations is the interior of 78 Derngate, Northampton, a brick house he transformed in 1916 for the newly-married W.J. Basset-Lowke.

8. Stephen Turnbull, *Chinese Walled Cities 221 BC-AD 1644,*
Oxford: Osprey Publishing, Fortress 84, 2009,
64 pages, numerous unnumbered illustrations,
ISBN 978-1-84606-381-0, price £11-99.

Following *The Great Wall of China 221 BC -AD 1644,* in the same series in 2007, Stephen Turnbull has examined the brick-faced walls of a number of Chinese cities, some of which are hardly on the regular tourist trail for western visitors to the imperial kingdom. Beijing, Xi'an and Shanghai are well-known but despite a decade teaching students from throughout the various provinces of China this writer was unaware of cities like Datong, Kaifeng, and Pingyao or the fortified village of Zhang Bi, a rarity among smaller settlements. But in 1644, nó fewer than 4,478 places in China had walls. If this reviewer were to add China to the stamps on his passport, Pingyao with its well-preserved brick walls, towers and gates would certainly be a place he would wish to visit.

The earliest city walls were of rammed earth. Those at Zhengzhou, Henan province, were constructed in the Shang dynasty period (*c.*1520-1030 BC). Another city with rammed earth walls is Kaifeng, also in Henan province. Both these cities are on the Yellow River. Rammed earth could be built up to a considerable height. Those in Datong, on the northern edge of Shanxi province, tower over the single- and two-story houses beside them (p.6). The Datong walls have brick cladding on the inner and outer faces, now much robbed so that we can see they were six or eight bricks thick (p.16). Unfired brick was used from the Zhou dynasty onwards: the Zhou succeeded the Shang in 1030 BC but were symbolic rulers only after 771 BC. Only when the Tang dynasty held the mandate of heaven, AD 618 to 906, was fired brick used for city walls. The material became universal when the Ming dynasty was in power, AD 1368-1644. As with the great wall, a frontier wall, the bricks for town walls were large — four times the size of a house brick. Lime mortar was used, and within the mortar was a glutinous rice paste, increasing the strength of the bond. These city walls are absolutely massive. The Ming dynasty walls of Xi'an totally dwarf the cars parked at their base and an army could ride six abreast along the top (photograph on p.8). Where locally available, materials other than brick and rammed earth were used including sandstone blocks at the foot of the walls of Nanjing and dressed blocks of the local grey-coloured stone at the port city of Penglai

After an Introduction and a Chronology, chapters cover Design and Development (pp. 14-21); the Principles of Defence (pp.21-23); the Great Fortified Cities of China (pp.24-40); the Living Sites (pp.40-47); the Sites at War (pp.47-58); and the Sites Today (pp.58-62). There is a short bibliography, a useful glossary and an adequate index. The illustrations are by Stephen Noon.

Brick Query

From time to time, the British Brick Society receives enquiries about bricks, brickmaking, other ceramic building materials, and brick buildings. These are printed when space is available in *British Brick Society Information.* Responses are also included when these are forthcoming.

DHK

A BRICK FROM WEST HARTLEPOOL BRICK COMPANY

Hartlepool Museums have a small collection of bricks, only one of which is marked with the name of a Hartlepool manufacturer (fig. 1). Within the square frog, it reads:

WESTHARTLEPOOL
PATENT
BRICK COMPANY L^{D}

The lettering is of good quality. There is no space between the 't' of West and the 'H' of Hartlepool as there is on the bottom row.

Fig. 1 The brick made by the West Hartlepool Patent Brick Company Ltd, now in Hartlepool Museums.

Hartlepool Museums and Heritage have no information about a West Hartlepool Patent Brick Company Limited. but apparently it is not in the collection of brickworks ephemera they were given by a local historian Robert Wood.

Robert Wood collected paper materials such as business cards, invoices, receipts and company labels from brickworks in Billingham, Wingate, Seaton Carew, Shotton, Hart and West Hartlepool. Jean-Philippe Stienne, the Collections access Officers of Hartlepool Museums and Heritage, informs us that the paper records are mostly of the 1830s to 1860s. They can be viewed by appointment at Sir William Grey House, Clarence Road, Hartlepool.

If any member of the British Brick Society has information about the brickworks or can throw light on the use of the word 'patent' in the company title, I would be grateful to know.

MIKE CHAPMAN
8 Pinfold Close, Woodborough, Nottingham
e-mail: pinfold@freenetname.co.uk

Brick for a Day

The British Brick Society held two meetings in the late summer and autumn of 2009. These were a tour of Rugby School in August and a walking tour of Finsbury from the Angel to Farringdon in September. Due to considerations of available space and because of the need to check recently published information about Clerkenwell, in Finsbury, reports on these visits were held over from recent issues of *British Brick Society Information.* An account of Rugby School appears below. The buildings seen in Clerkenwell will be the subject of an article in *BBS Information,* **115,** November 2010, which issue is to be devoted to brick in London.

The British Brick Society has held two meetings in early summer 2010. The Annual General Meeting was held in Reading on Saturday 12 June 2010 and was followed by a walking tour of the town. A visit to W.H. Collier's brickworks at Marks Tey took place on Saturday 17 July 2010, where members saw the new kiln. Thanks are due to the society's honorary secretary, Mick Oliver, for organising the meeting in Reading and to BBS member Adam Sowan for his excellent and enlightening tour of the town's brick buildings. Mike Chapman organised the visit to the Marks Tey brickworks and the society must thank him for finding a brickworks to visit and for the organisation on the day. Reports on each of these are in progress and it is hoped that they will appear in a subsequent issue of *British Brick Society Information.*

DHK

RUGBY SCHOOL

In the early 1880s, two of the new boys met on the platform of Rugby Station. It was the first day of term for both at Rugby School. They were William Temple, later Archbishop of Canterbury, and Richard Henry Tawney, for many years Professor of Economic History at the London School of Economics. In terms of its buildings, the school they encountered, on the eastern edge of the small Warwickshire town was a very different to the one to that known to its most famous headmaster, Thomas Arnold — in post from 1828 to 1842 — whose time there was described from the schoolboy's perspective in *Tom Brown's Schooldays* (1866) by the barrister, Thomas Hughes.

Rugby School has two building periods in the nineteenth century. The earlier, lasting

from 1809 to about 1820, was the work of Henry Hakewill (1771-1830). Hakewill used a yellow, stock brick for the Old Buildings of 1809-13 and the headmaster's house of *c.* 1830. For these he used a castellated neo-Tudor style. These plus Hakewill's chapel of 1818-21 and a library of 1842, both built using similar materials and in a similar style, were the set of buildings inherited by William Temple's father, Dr Frederick Temple, when he became headmaster in 1857. Hakewill's buildings are the prominent ones from the field on which in 1823 William Webb Ellis picked up the ball and ran with it.

In Temple's twelve year incumbency — he became a bishop in 1869 — a new architect, the forty-five year-old William Butterfield (1814-1900), was commissioned in 1859 to do minor works. It led to a thirty year association with the school and it Butterfield's use of polychrome brickwork which is most often associated with the school. Red brick was used with yellow brick and black brick. Major buildings by Butterfield are the new quad, begun in 1867 but not finished until 1884, a western extension of Hakewill's work to provide more classrooms. Pupil numbers doubled in the middle four decades of the nineteenth century. The quad is closed on the south side by the chapel, externally a restrained use of red brick with bands of yellow brick, black brick, and grey stone, the whole capped by a great tower which moves from square to octagonal and finally to a pyramid roof above long gargoyles: the last designed to take surplus rainwater far away from the building below.

Butterfield also worked elsewhere. Alongside the playing field and facing Dunchurch Road are the former swimming bath of 1876 and the gymnasium of 1872, which is still used by the boys. Across the street is his new big school of 1885, less flamboyant than his earlier work, with plain red brick not polychrome brickwork. This followed his eight-year rebuilding of St Andrew's parish church in the town centre, between 1877 and 1885. Further away is the reading room and museum of 1878, the school's first memorial to Dr Temple. A second memorial is T.G. Jackson's very different speech room of 1908-09.

In 1567, Lawrence Sheriff, a native of the town who had made a fortune in mid-Tudor London, founded a free school in his home town for the education of boys from Rugby and the neighbouring parish of Brownsover. Rugby School still does that, now for girls as well as boys, along with fee-paying pupils of both genders from across the world, and, through the Arnold Foundation, seeks to enhance the chances of boys and girls whose current circumstances are preventing them from achieving their full potential and who are likely to benefit from a boarding education. If the built environment is a major factor in inspiring young people — as the present writer is convinced it is — the buildings of Rugby School would do that far better than many institutions.

DHK

The Bristol Industrial Archaeological Society Brunel Prize

The Brunel Prize is offered by the Bristol Industrial Archaeological Society in alternate years for an original study of any facet of local industry, preferably within an archaeological context. The area covered by the Bristol Industrial Archaeological Society is Bath, Bristol and the country towns and villages round about them.

The closing date is 31 August 2010 and further details are available from either Mike Chapman, 51 Newton Road, Bath BA2 1RW or Owen Ward, 77 Hansford Square, Bath BA2 5LJ. After this year, the prize will next be offered in 2012.

BRITISH BRICK SOCIETY
MEETINGS IN 2010 and 2011

Saturday 9 October 2010
London Autumn Meeting
A walk downhill from Canonbury to Moorgate
To include Canonbury Tower, Canonbury Square, Essex Road underground station, Moorfields Eye Hospital, the former Leysian Mission, Wesley Church, the barracks at Armoury House.

A Saturday in early Spring 2011
London Spring Meeting
Hampstead Garden Suburb

Either Saturday 11 June 2011 or Saturday 18 June 2011
Annual General Meeting
Nottingham area with afternoon visit to Holme Pierrepoint Hall.

A Weekday in August 2011
Late Summer Meeting
We hope also to arrange a visit to either the Blist's Hill Brickworks in Ironbridge, Shropshire, or the brick-built lime kilns in the quarry at Llanymynech Rocks on the Anglo-Welsh border between Shropshire and Monntgomeryshire.

Projected future visits include:
1. Early brick houses in West Norfolk
   To include some of East Barsham Manor, Oxburgh Hall, Great Gressingham Priory and Methwold Vicarage (these are all on or near the A1065 road from Fakenham to Mildenhall)
2. The Tilbury Forts

Details of theLondon Autumn Meeting are included in this mailing.
Details of meetings in the early part of 2011 will be included in the November 2010 mailing

The British Brick Society is always looking for new ideas for future meetings.
Suggestions of brickworks to visit are particularly welcome.
Offers to organise a meeting are equally welcome.
Suggestions please to Terence Paul Smith, Michael Oliver or David Kennett.

Changes of Address

If you move house, please inform the society through its Membership Secretary, Dr Anthony A. Preston at 11 Harcourt Way, Selsey, West Sussex PO20 0PF.

The society has recently been embarrassed by material being returned to various officers from the house of someone who has moved but not told the society of his/her new addess.