# The Strange History of Paper Roofs

*by*

MALCOLM AIRS

*Sheets of tarred paper nailed onto boarded roofs were in common use as a practical roofing material throughout England, Scotland and the colonies from about 1770 until the mid-nineteenth century. They appealed to improving landlords and emerging industrialists on the grounds of economy and to devotees of the picturesque for aesthetic reasons. A few examples still survive and it is hoped that the publication of this account will lead to the identification of further examples.*[1]

## INTRODUCTION

The scientific curiosity and spirit of invention which characterised the eighteenth and nineteenth centuries greatly expanded the range of materials available to the adventurous builder or the creative architect or engineer. Some, such as iron or steel, concrete and glass, have proved of lasting worth to the construction industry. Many others, such as the India rubber roofs patented by William Brockedon, gentleman of Devonshire Street, London, in January 1845, were never more than a passing curiosity of no practical value.[2] Somewhere in between was the practice of using sheets of tarred paper as a roofing material which was once widespread in parts of England and Scotland but the knowledge of which had all but disappeared from public view until the discovery of a group of surviving examples in the vicinity of Oxford in the 1980s.

## LITERATURE

The most comprehensive account of the technique involved in making a water-proof covering from this unlikely material is provided by a pamphlet published in 1811 by John Claudius Loudon, the agricultural reformer, gardener, inventor and prolific publicist, entitled *An Account of the Paper Roofs Used at Tew Lodge, Oxon.*[3] Born in Lanarkshire in 1783, Loudon had moved to London in 1803 and in 1807 had taken over the tenancy of Wood Hall Farm, Pinner, close to Kenton Farm, Harrow, where his father was established as the tenant.[4] In 1808 Loudon's pioneering farming methods, publicised in his pamphlet on *An Immediate and Effectual Mode of*

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*Raising the Rental of the Landed Property of England...*[5], brought him to the attention of General George Stratton who invited him to manage his estate of 1,500 acres at Tew Park in Oxfordshire. In return, Loudon was offered part of the estate at a nominal rent where he was able to establish one of the earliest agricultural colleges in England.[6] Under the terms of the agreement, Stratton provided Loudon with a new farmhouse (Fig.1) which his landlord described in a letter of 12th March 1810 as standing 'on the brow of a hill, commanding a beautiful valley, and a view

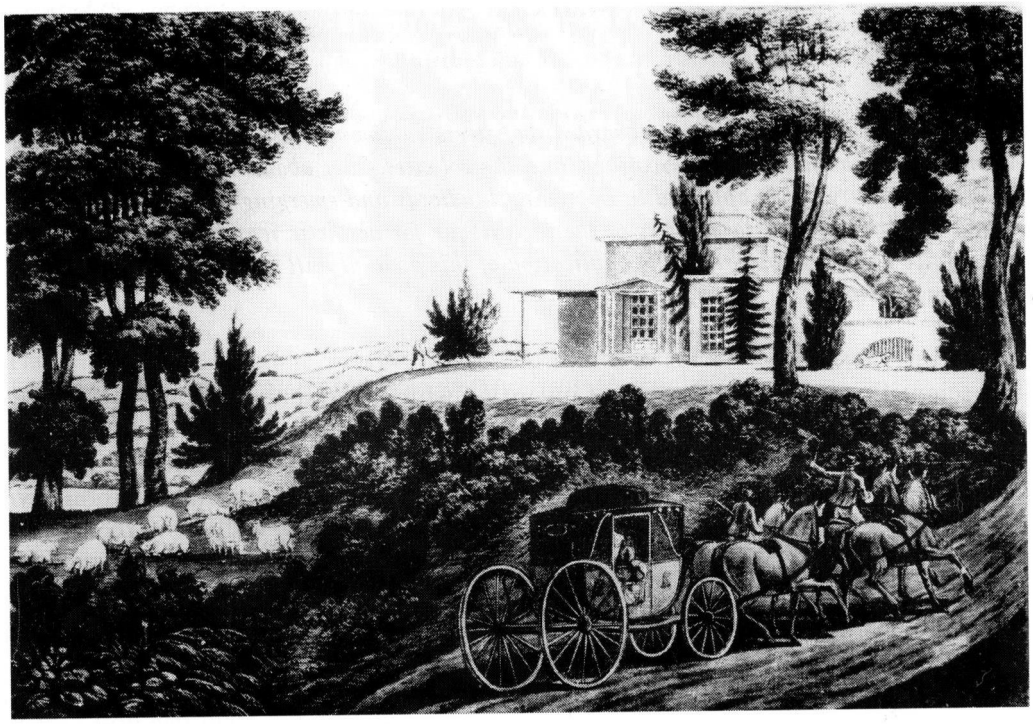

Fig. 1
The Farmhouse at Great Tew, Oxfordshire
From *Observations on Laying out Farms in the Scotch Style...* (1812)

of a great part of the farm (Fig.2). 'It is also', he went on, 'a very ornamental object. Its roof, and that of all the farm buildings, is paper, dipped in tar, &c.which, from the enormous price of pitch and tar, did not cost much less than slate or tiles, but is much more picturesque than either'.[7]

The design of the farmhouse, built in 1809, was almost certainly by Loudon himself, strongly influenced by the picturesque designs of Joseph Gandy published a few years earlier.[8] It no longer exists, having been replaced by the Boulton family soon after they bought the Tew estate in 1816[9] but the roofs of the house and the associated farm buildings were described by Loudon in his pamphlet in fine detail (Fig. 3). The pitch of all the roofs was very flat with a rise of only two-and-a-half

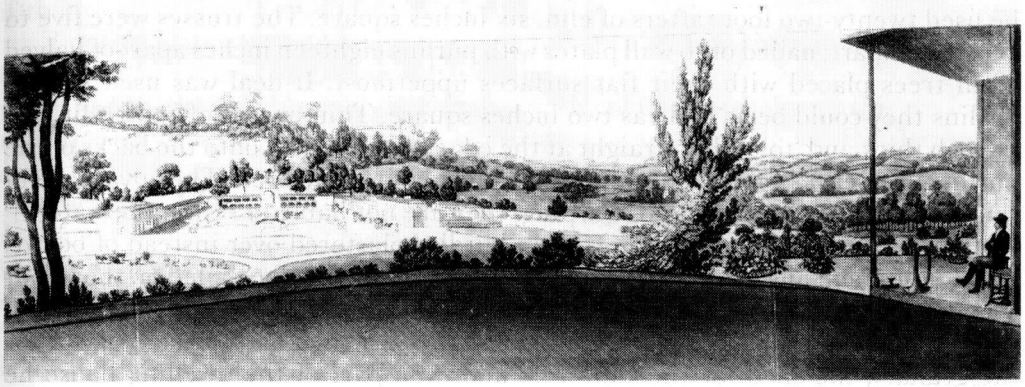

Fig. 2
The Farmery at Great Tew, Oxfordshire
Viewed from the farmhouse with J.C.Loudon seated on the verandah
From *Observations on Laying out Farms in the Scotch Style...* (1812)

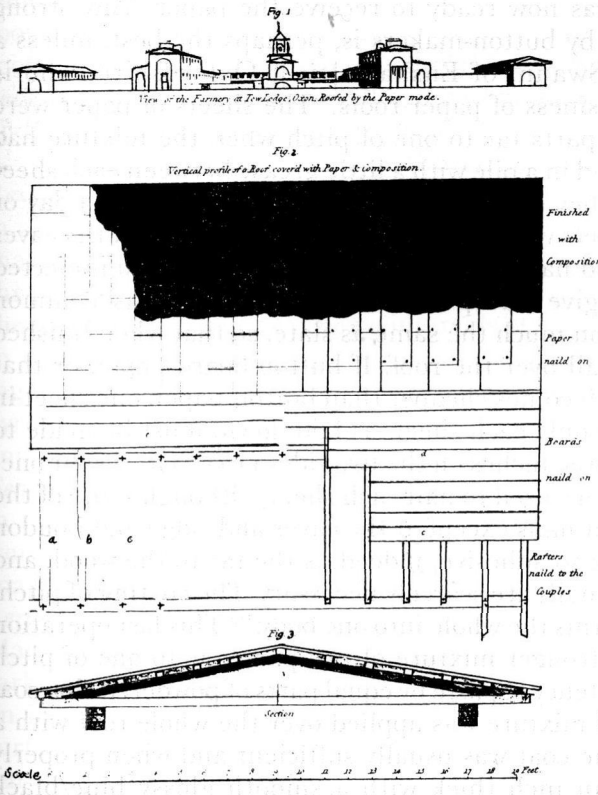


Fig. 3
The Farmery at Great Tew, Oxfordshire, with plan and section of paper roof
From *An Account of the Paper Roofs used at Tew Lodge, Oxon.* (1811)

inches in each foot. The scantling of the rafters depended on the type of timber used and the width of the particular building. With twenty foot rafters of deal they should be one-and-a-half inches deep and three inches wide but on the farmhouse he used twenty-two foot rafters of elm, six inches square. The trusses were five to eight feet apart, nailed onto wall plates with purlins eighteen inches apart of halved larch trees placed with their flat surfaces uppermost. If deal was used for the purlins they could be as little as two inches square. Thin boards of Scotch fir half an inch thick and 'tolerably straight at the edges' were nailed onto the backs of the purlins from eaves to ridge rather than in the plane of the roof. 'The advantage of this mode is, that in the case of warping, they are not liable to retain the water'.[10] Loudon also experimented with wooden hurdles plastered over instead of boards and 'found them answer tolerably well. The paper could not be nailed on them, but was made fast by strips [of wood], running from the eaves to the ridge, as in verandah roofs'.[11] He used this technique on the cart shed and the stables but for the granary, the shed for the winterers and even part of the dwelling house he substituted plasterers' laths to which the paper could be nailed and he found this the cheapest method when the roof was not to be walked on or in danger of being pierced by a pointed instrument from below. Deal boards a quarter to five-eighths of an inch thick could also be used.

The structure of the roof was now ready to receive the paper: 'Any strong coarse paper will do. That used by button-makers is, perhaps the best, unless a sort made on purpose by Mr Swann, of Ensham [*sic.*], Oxfordshire, who is thoroughly conversant in the business of paper roofs.' The sheets of paper were dipped into a cauldron of three parts tar to one of pitch when the mixture had reached boiling point and then laid in a pile with a little grease between each sheet to prevent them sticking while they dried. This operation was repeated a day or two later before the prepared sheets were nailed onto the roof starting at the eaves with three inches turned over and nailed underneath the boards which projected beyond the plane of the walls to give a deep overhang. If the paper was 'common coarse wrapping paper, it is laid on much the same as slate, so that when finished it will remain double thickness all over the roof. If button-board paper, or that manufactured by Mr Swann which comes cheaper than button-paper, one sheet in thickness will frequently suffice; only each sheet, as laid down, must be made to overlap the one previously laid three inches on the two sides next to it'.[12] Four one-inch nails with half-inch heads were used to nail each sheet, although some of the roofs at Tew were covered without nails except at the eaves and ridge and Loudon 'found them answer equally well; so adhesive, indeed, is the tar to the wood, and one tarred sheet to another, that nails are scarcely necessary. The coating of pitch, in the manner to be described, forms the whole into one body.'[13] This last operation was carried out with a slightly stronger mixture of two parts tar to one of pitch which was thickened to the consistency of paste by equal parts of powdered charcoal and whiting or lime. The heated mixture was applied over the whole roof with a hempen mop and left to dry. One coat was usually sufficient and when properly laid was about one eighth of an inch thick with a smooth glossy blue/black

appearance. Extra protection could be achieved by 'strewing sand, forge dust, or smithy ashes over the pitch as soon as laid on, by a large dredge box.' This formed a thicker coating 'and renders it less liable to melt with sun and run off, or to blaze if the building should catch fire.'[14]

Loudon elaborated on some of the details of the Tew roofs in a subsequent book on *Observations on Laying out Farms in the Scotch Style, Adapted to England*, published in 1812 and lavishly illustrated with colour plates. From this we learn that the paper was specially made by Messrs. Swann and Co. at Eynsham and came in sheets measuring two feet by twenty inches.[15]

Although Loudon's description is by far the most detailed account of paper-roofing, it was not the first technical specification to appear in print. Three years before his pamphlet, Charles Vancouver had reported to the Board of Agriculture on the state of farming in Devon where he described the paper roofs which were 'getting very much into use' in the area around Exeter 'notwithstanding that slate is by no means difficult to be procured in almost every part of the district.'[16] The paper used was described as sheathing paper which was a kind of pasteboard that had been developed for protecting the hulls of ships from woodworm and which would have been freely available in maritime locations. The composition for covering the paper included bone-ashes and sand as well as whiting and pounded charcoal which was added to a boiling mixture of tar and black rosin and spread over the roof more thickly than in Loudon's recipe.[17] Although it was commonly used on roofs elsewhere in the kingdom, sheathing paper was criticised by other writers because of its propensity to fall apart when handled[18] or because it was too thick and pulpy,[19] and they generally advocated brown packing paper.

In 1808, the same year that Vancouver published his account of Devon, the Reverend John Graham of Fintry described some of the practices used in Scotland in a communication to the *Farmer's Magazine*. The basic technique was similar to that advocated by Loudon with minor variations in the temperature of the tar at the time of dipping the paper and a stress on the necessity of planing the edges of the boards 'that there may be no intervals at the joinings.'[20] He also drew attention to the improved composition discovered by William Ramsay of Glasgow: 'This ingenious chemist uses the tar extracted from wood in the formation of the pyrolignous acid, and, by a peculiar composition, makes it assume as close a texture, and as bright a polish, as the finest marble.' Sir John Sinclair in his *Appendix to the General Report of the Agricultural State and Political Circumstances of Scotland*, published in 1814, generally followed Graham with the added refinement that the boards were covered with boiled tar before the paper was attached and the final overall coating was finished by gentle pressure from a roller.[21] In the *General View of the Agriculture of the County of Dumbarton* by the Reverend Andrew Whyte and Duncan Macfarlan, published in 1811, they described the boarding of the roof 'with thin sarking deals pared off at the edge, so as that the upper one may cover about half an inch of that immediately under, without disturbing the smoothness of the surface.' These boards presumably were laid horizontally in the plane of the roof, but they went on to describe 'a still more economical mode of construction' which

had been lately introduced where the sarking-boards were fixed 'in a perpendicular position. In this way they need very little dressing, and it is not considered of any consequence, that they should join exactly at the edges.'[22] The manufacture of pyrolignous acid was carried on in the county and they commended the tar that was created in the process because it was considerably cheaper than common tar without throwing any light on the details of the 'peculiar preparation', presumably that discovered by Ramsay, which rendered it hard and durable.

In describing the paper roofs of the county of Stirling published in 1812 as part of the *General View of the Agriculture of Stirlingshire*, the Reverend Patrick Graham drew heavily on the technical account of his fellow minister John Graham as already set out in *The Farmer's Magazine* and offered no new information. As far as English publications are concerned, J.B.Papworth gave a short description of the process of paper roofing 'for small out-houses, and such alone' in his *Rural Residences* of 1818 and Nicholas Carlisle reproduced verbatim parts of Loudon's pamphlet in his *Hints on Rural Residences* of 1825.[23] All the published accounts are in broad conformity in describing the basic techniques even though the details may vary. A very shallow roof pitch of the order of ten to twelve degrees with slender rafters supported boards which were generally aligned from eaves to ridge, and which were covered by sheets of prepared paper nailed down like slates and finished by an overall coat of tar composition. An initial preference for sheathing paper was replaced by a general enthusiasm for coarse brown paper. However, Loudon makes it clear that there were other 'modes of applying paper and composition which have proved unsuccessful, and nearly as expensive as the best slate roofs.'[24]

One of the alternative methods was proposed by the architect Henry Holland for Doltons Farm, Bedfordshire, on the Woburn Estate in 1791 and the manuscript specification survives in the Bedfordshire County Record Office.[25] This technique involved a double layer of both boards and paper on a roof with 'very little falling or the Pitch will be liable to run with the heat of the sun.' Half-inch deal boards were laid on joists and covered with thick brown paper. Similar boards were then laid over the paper and coated with hot pitch onto which another layer of paper was applied with a finishing coat of pitch and a top coat of tar dressed with sifted chalk. Robert Salmon, the clerk of the works to the Duke of Bedford, experimented with a number of novel building materials at Woburn, including the first use of *pisé de terre* in England, and it is possible that he did not proceed with Holland's instructions. The original endorsement on the specification of 'Method of covering Roofs with pitch & paper' has been altered in pencil to substitute 'Tarr & chalk' for the last two words, probably as a result of an attached quotation dated 4th October 1791 from William Lee at the Eight Bells, Fulham, to undertake 'tarr covering' at a cost of 3s.6d. a day for himself and 3s. for his man.

Lee proposed a much simpler process with tongued and grooved boarding covered with a mixture of tar and chalk without any paper at all. His proposal is clearly related to the composition for flat roofs invented by the 3rd Earl Stanhope and another lengthy manuscript dated 1798 amongst Salmon's papers describes

'Earl Stanhopes method of covering Buildings copied from original in possession of Mr Wm. Smith.'[26] Stanhope experimented with his composition on his country seat at Chevening House, Kent, and the consequences were described by the 5th Earl in August 1856:

> ... my grandfather also improved the main house by changing its garrets into attics ... altering the old tiled and sloping roof with a uniform and nearly flat surface. This and the roof of the two larger wings he covered with a composition or cement invented by himself (1776-7) but although the cement enjoyed at one time considerable fame and although several great buildings elsewhere - Buckingham Palace for instance - were covered with it... the invention did not thrive in the house of the inventor. Though patched and soldered and mended again and again and again it still let in rain in various places to the great damage of the ceilings and discomfort of the inmates below. At length between 1850 and 1856 it was wholly removed and the roof covered with Patent Asphalted Felt.[27]

The composition roofs at Buckingham Palace by Nash also failed and by July 1838 it was recommended that they should be replaced in copper or lead.[28] A similar composition was successfully introduced by Lord Minto into Roxburghshire, Scotland, around the turn of the century[29] and may have been inspired by the artificial slates manufactured by Sir James Wright at his factory in Essex between 1776 and 1803 and described by Papworth as being 'in great request in our West Indian Colonies as a substitute for shingle' during the American war.[30]

ORIGINS AND DISTRIBUTION

Both Stanhope and Minto failed to patent their inventions and a similar oversight by the inventors of the various techniques of paper roofing described in the publications of the early years of the nineteenth century means that we remain ignorant of when paper was used first in this way and who discovered its potential. Despite the enthusiasm of improving landlords and clergymen in Scotland, John Graham was adamant that the practice was introduced from England[31] and there is some documentary evidence to support this contention. In 1778 the eminent architect John Carr of York submitted a design for a grandstand to be built on the race course at Kelso, Roxburghshire, with masonry walls and a paper roof and in his covering letter he wrote that 'if the workmen are unacquainted with the covering of the Roof with pitch paper and Gravel, I will send a person to cover it.'[32] The implication that Carr had used the technique on previous occasions makes it a matter of considerable regret that no details survive of the roofs of his demolished grandstands at the race courses of York (1755), Nottingham (1777) and Doncaster (1777-81). However, it was noted that 'house covering paper' was one of the products of the paper mills at Thornton le Dale in the North Riding in 1775[33] and Loudon saw 'numerous manufactories' roofed with paper in Yorkshire on a visit in 1811,[34] so it can be accepted that the practice had been established in the county before the last quarter of the eighteenth century.

In Wales, paper had been used as a temporary covering to protect the decaying stone roof of the medieval chapter house at Margam Abbey in Glamorgan at the same time that Carr specified it for Kelso. Henry Wyndham saw it on a tour in the

summer of 1777 when he described it as 'thick oiled paper, which by no means prevented the rains from penetrating and phyltering through the stonework.'[35] It was still in place when E.D.Clarke visited Margam in 1791 and grieved to see the 'absurd method' used to protect the stonework which had greatly deteriorated over the last fifteen years.[36]

Apart from its possible use at Kelso and a later reference by Loudon to a church in Dunfermline erected '40 years ago' (i.e. *c.*1770), it was widely believed by contemporary observers that paper roofs were first introduced to Scotland by a ship-builder called Wood who used the technique when he built a public warehouse on the harbour at Greenock in about 1780 and which remained in 'perfect preservation' for more than twenty years without the need for any repairs.[37] His example, 'long gazed upon in stupid silence', was followed by 'frequent imitations... executed in the vicinity of Glasgow.' The largest group of paper-roofed buildings ever carried out in a single development took place a few years later in 1807 at Campsie in Stirlingshire when Messrs. Macintosh, Knox & Co. erected a factory for the manufacture of alum, copperas and Prussian blue and built fifty cottages for their workforce, all covered with sheathing paper. The cottages were built in blocks of four and a detailed description together with sample costs, plans and elevations was published seven years later (Fig.4).[38] By 1812 it was reported that paper roofs had 'been adopted in Stirlingshire upon a considerable scale',[39] no doubt inspired by the example of Campsie and an unidentified country house roofed in the same manner by Mr. Spiers of Culcreuch before 1808.[40] At about the same time the technique had been adopted in Dumbarton for a wide variety of buildings including dwelling

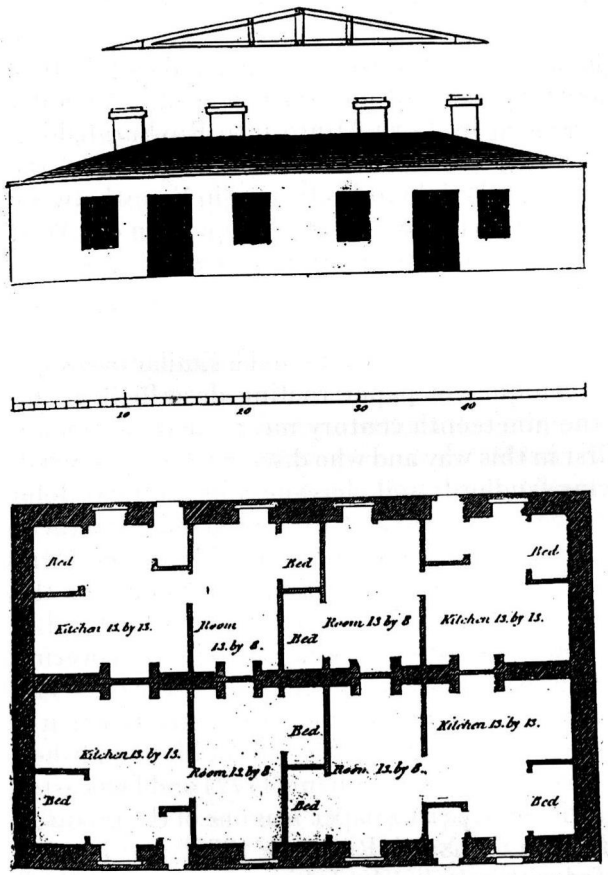


Fig. 4
Campsie, Stirlingshire
Plan, elevation and roof section of typical block of four cottages
From *Appendix to the General Report of the Agricultural State, and Political Circumstances of Scotland* (1814)

houses, store houses, factories, 'sheds attached to bleachfields' and cart sheds and pig-styes. 'But it is generally thought that it will not answer for barns, from excluding the air too much, nor for cow-houses and cattle-sheds, as the breath of the cattle must melt the pitch and corrode the paper.'[41] Further north at Gordon Castle, Moray, paper was used to roof the gatekeeper's lodge in the summer of 1809 and as the craftsmen came from Inverness it was presumably in use in that county, too.[42]

By far the most entertaining account of a Scottish paper roof is the description by his son of the improvements made by the Hon. Henry Erskine, Lord Buchan, to his country estate at Ammondell, Linlithgow, after his retirement from the legal profession in 1812:

> but whatever taste my father had in laying out grounds he certainly had the oddest ideas possible of building a house. He made his residence at Ammondell consist at last of two houses, connected by an inconvenient sort of gallery; the access to the best rooms was through a long narrow passage. He hollowed away the ground to make offices under the old house, so that it cracked all the way up one side; he made those under the new house dark and damp; the roof would not keep out the water, the foundations would not let it get away; his ice house had a southern aspect; his coal cellars had trap doors under the front windows; Lady Minto persuaded him to adopt a new sort of roofing just invented, paper covered with pitch; whenever any flaw occurred, which was as often as there came extreme heat or frost, or heavy rain, the laundrymaid had to be sent up with a hot iron, to iron the peccant places in the roof, which was then supposed to be as good as ever. Perhaps it was but it was never very good.[43]

Lady Minto's enthusiasm for paper was no doubt a refinement of her late husband's experiments with composition roofs and explains the survival of Carr's letter amongst the family papers. Clearly, paper roofs were comparatively common in parts of Scotland even though they were not always so widely welcomed by the heirs of those who had first promoted them.

Similarly, the geographical distribution of known paper roofs in England is very wide. In addition to Yorkshire and Devon already mentioned, Loudon published a design for a paper-roofed farmstead at Kenton Lane Farm, Harrow (Fig.5), as a cheaper alternative to the brick and tile complex that he actually built for his father in 1808[44] and he noted paper roofs on several warehouses at Deal, Dover and Canterbury and on factories in Hertfordshire where paper-making was an important industry.[45] The accuracy of his observations can be confirmed by both surviving examples and other documentary sources. In Canterbury, the Woolstore in Pound Lane, built shortly after 1825 as a warehouse, was almost certainly originally covered with paper as was a similar building in Best Lane off the High Street.[46] Elsewhere in Kent, Crabble Mill and the adjacent row of cottages, just to the north of Dover, built in 1812 in response to the demand for flour to feed the large number of troops stationed along the south coast during the Napoleonic wars, had a tarred paper roof which survived *in situ* until it was replaced in the 1990s with stainless steel (Fig.6).[47] The mill is on the River Dour and the paper was no doubt provided by one of the six paper mills that stretched along the river in the nineteenth century. Another corn mill near Lime Kiln Street in Dover had already

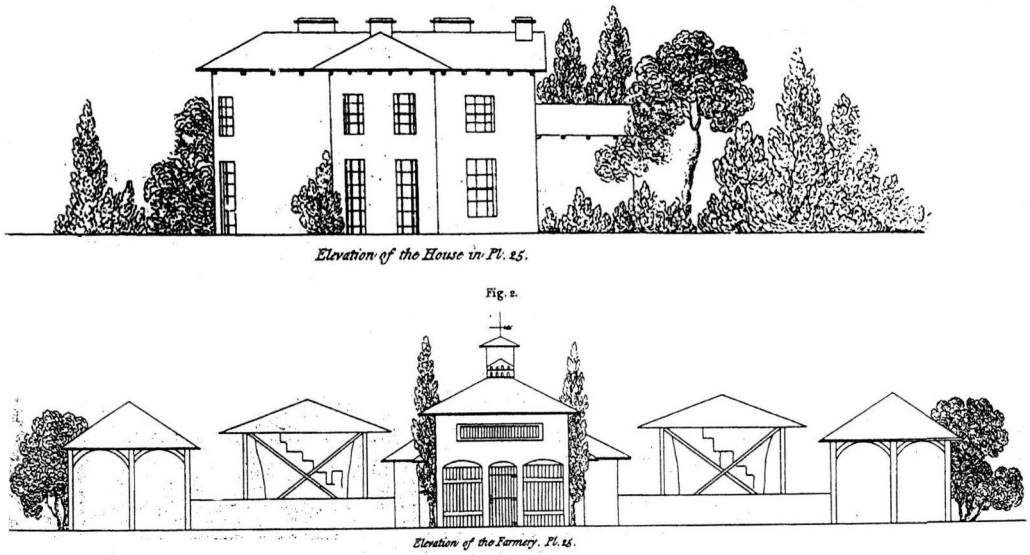


Fig. 5
Kenton Lane Farm, Middlesex
Alternative designs for the farmhouse and farmery with paper roofs
From *Observations on Laying out Farms in the Scotch Style...* (1812)

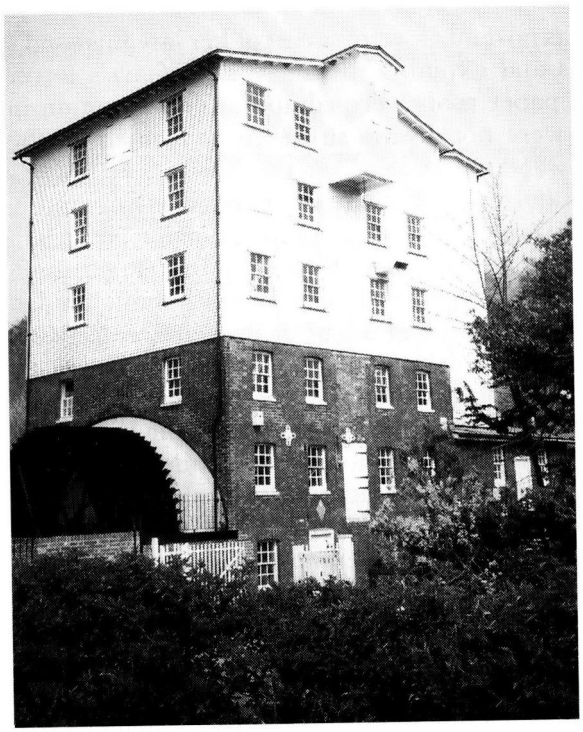

Fig. 6
Crabble Mill, Dover, Kent
After restoration

been built with a tarred paper roof for Peter Pecker in 1809[48] and later in 1822, Stephen Witherden insured his tenanted house covered with paper on the Ropewalk, Dover, valued at £100.[49] In the same year further round the coast at Margate in the same county, John Smith, hosier and haberdasher took out an insurance policy on the stock in his dwelling house and shop at 155 High Street, built of brick and timber and covered with tarred paper.[50] It has only been possible to sample a random number of Sun Fire Insurance policy books but it is clear that the company agents saw nothing unusual in the roof material and were prepared to underwrite the risk at a premium comparable to that for thatched roofs. Other policies noted include a substantial dwelling house owned by the Reverend James Gill at Sun Hill, West Cowes on the Isle of Wight, built of brick and 'covered with thick brown paper with a composition of Rosin, Sand & Oil', insured on 19th July 1800[51] and a further contribution to the distribution pattern in Scotland with a tenement in Houston, Renfrewshire, insured by John Houston, thread manufacturer, in March 1810.[52]

The lightness of paper roofs made them highly suitable for covering the immense spans of the enormous timber roofs adopted by the Royal Navy from about 1814 when they began the practice of building fighting ships under cover in an attempt to prevent the dry rot which frequently took hold during the long periods that it took to build a ship on an open slip. Between that date and the early 1840s 'timber roofs with main spans of up to 30m were built over almost every shipbuilding slip and many of the docks in all Britain's naval dockyards.'[53] The development of the timber-framing technology which made such huge structures possible has been fully explored by James Sutherland but the waterproof covering of the roof presented an equal challenge. Copper in thin sheets was the preferred solution but this was so expensive as to account for almost half the total cost of the roof and tarred paper as well as tarred canvas was used on a number of examples as a cheaper alternative.[54] From the available records it is not possible to be certain how many slips were covered with the cheaper materials but the best surviving example of the period, No.3 Slip at Chatham Dockyard, built as late as 1837, was originally covered with tarred paper over boards laid horizontally due to the enormous span of the roof (Fig.7).

Chatham is in Kent, a county which has a large number of known examples of paper roofs. In addition to the buildings already noted, Loudon mentioned warehouses at Deal and some of the boat sheds at Whitstable might have been roofed with paper.[55] However, by far the greatest concentration is in the vicinity of Oxford where paper-making was a significant regional industry in the eighteenth and nineteenth centuries. Loudon's experiments at Great Tew were not the first use of the material for roofing in the county. John Swann carried out major improvements to his paper mill at Wolvercote in 1799 which included roofing part of the structure in tarred paper.[56] In 1804 he bought Eynsham Mill and again used paper to roof the extensive new buildings for the expanded enterprise which were designed and executed by Daniel Harris of Oxford.[57] Swann died in 1806 and the business was continued by his brother James who supplied Loudon with the paper

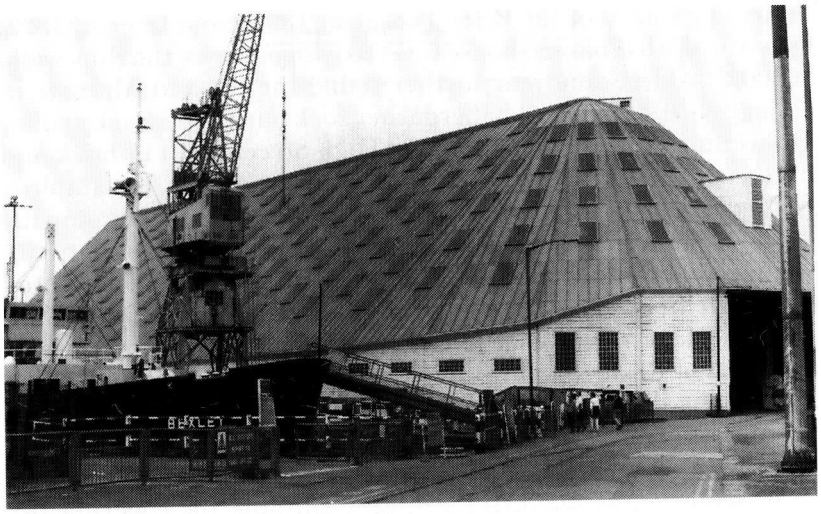

Fig. 7
No.3 Slip,
Chatham
Dockyard, Kent
With later roof
covering

for Great Tew. This was the Mr Swann described as being 'thoroughly conversant in the business of paper roofs.' Sometime later, in about 1820, James built a malthouse with a low cambered roof and an attached row of cottages in Newland Street a short distance away from the mill at Eynsham and their paper roofs still survive beneath a modern layer of felt (Fig.8). In 1823 he bought the corn mill at Sandford on Thames to the south east of Oxford and converted it to the manufacture of wrapping paper.[58] His new buildings on the site included a range of drying lofts with a brick built ground floor to accommodate the manufacturing process and a timber-framed upper storey where the paper was hung over ropes to dry, assisted by shutters to control the air flow. Drawings of the mill made by Buckler on 25th July 1826 show that the complex was very similar to the mills at Wolvercote and

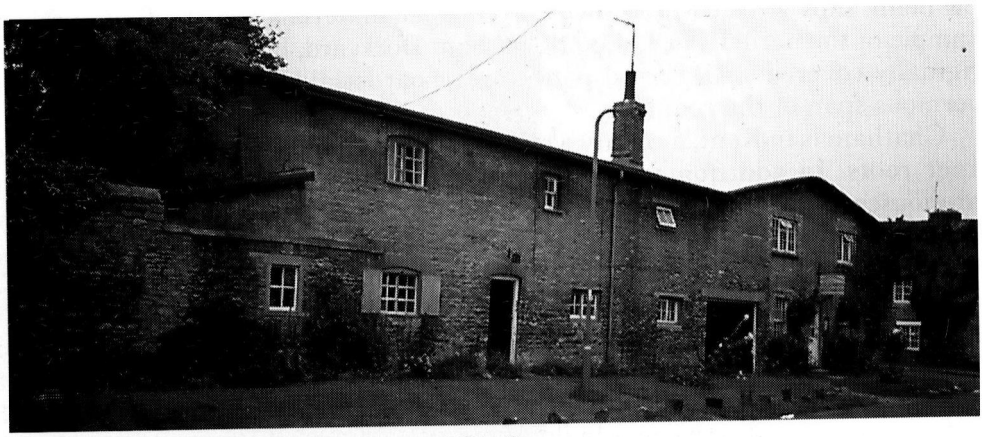

Fig. 8
Newland Street, Eynsham, Oxfordshire
Cottages and malthouse (right) built for James Swann

Eynsham and, like them, it was covered with a shallow-pitched paper roof.[59] The roof only survived until 3rd December 1836 when *Jackson's Oxford Journal* reported that it was blown off during a great gale and deposited some hundreds of yards away.

In introducing paper making to the village, Swann had to import skilled labour and he built a terrace of six houses called Mill Row on a bank a short distance to the north of the mill in the period between 1823 when the mill was purchased and July 1826 when it came into operation in its new role. Apart from the pitch of its roof, the terrace is of conventional appearance with brick walls and original soft-wood fenestration (Fig.9). The houses remained in the ownership of the mill and

Fig. 9
Mill Row, Sandford on Thames, Oxfordshire
Front elevation after restoration.

in the occupation of mill workers until paper-making ceased in 1981. At that date when they were about to be sold to the sitting tenants, they were in an unaltered condition. During the subsequent rehabilitation of the terrace it was revealed at a late stage that the original paper roof survived virtually intact beneath the later covering of corrugated iron, although its condition was too delicate to permit retention and it was removed in its entirety after it had been recorded (Fig.10).[60] It has been replaced by a proprietary material which gives the blue/black appearance described by Loudon. The roof structure itself has been retained and consists of boards of random width running from ridge to eaves and nailed onto the top of horizontal battens (Fig.11). The eaves project from the face of the building and are protected by a fascia board. It is not known when the roof was first covered with a more modern material, but the paper showed evidence of several coatings of pitch together with numerous rows of nails and had been repaired on a number of occasions during its lifetime as a primary roofing material, including, presumably, in the aftermath of the great gale of December 1836 (Fig.12).

The Swann business went bankrupt in 1848 and the assets were sold,[61] but other paper makers in the Oxford area had already followed their example in

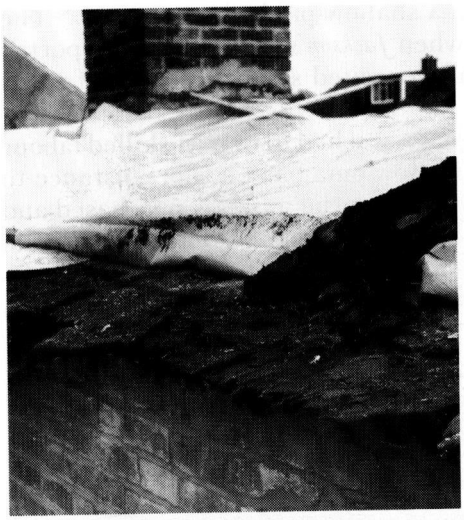

Fig. 10
Mill Row, Sandford on Thames, Oxfordshire
Detail of projecting eaves and paper covering

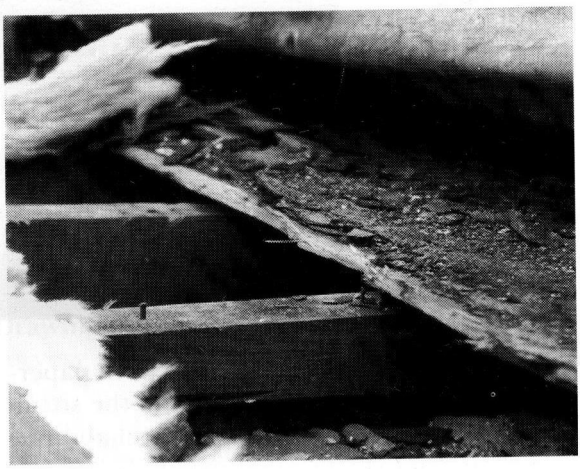

Fig.11
Mill Row, Sandford on Thames, Oxfordshire
Detail of boards and purlins

Fig. 12
Mill Row, Sandford on Thames, Oxfordshire
Detail of tarred paper showing evidence of successive coverings

Fig. 13
Weirs Lane, Oxford
Semi-detached cottages photographed in June 1923 shortly before their demolition
*The Bodleian Library, University of Oxford*
*M. S. Top. Oxon. d. 493, fol. 59r bottom*

using their own products on their buildings. Weirs Mill on the Thames close to where Donnington Bridge now crosses the river was converted *c.*1824 from corn to paper manufacturing and judging by a photograph of *c.*1870 at least two of the buildings on the site had a paper roof.[62] The mill also owned a group of three pairs of semi-detached workers' cottages fronting onto Weirs Lane and these, too, were roofed with paper (Fig.13).[63] Sometime before 1885 Weirs Mill was bought by John Towle who owned the nearby Hinksey Mill and was converted to manufacture cardboard.[64]

Towle was one of the most extraordinary characters in nineteenth-century Oxford. Described in 1870 as 'the eccentric Wesleyan', he had held a Chartist meeting in 1842 and in 1853 was elected as one of the first nonconformist aldermen of the city (Fig.14). In 1856 he was elected Mayor and created a scandal by refusing to take the oath of loyalty to the Vice-Chancellor of the University.[65] Towle had been making cardboard at Hinksey Mill since 1825 and in 1843 he took full advantage of its location when the Great Western Railway Company was constructing the long-delayed branch line into Oxford. In the words of the official history:

> The whole branch, 9 miles 57 chains in length, was completed early in June, and on the 10th Major-General Pasley, with Brunel and several Directors, came down to inspect it. The only fault the General had to find was the insecure state of the bridge


Fig. 14
Political lampoon on John Towle
*Centre for Oxfordshire Studies, Oxfordshire County Council*

carrying the Oxford-Abingdon turnpike road over the line. This brick arch with the road embankments approaching it had been left to the last moment for the curious reason given in General Pasley's report:

> 'Mr. Brunel explained to me that the haste with which this arch was built was caused by the conduct of an individual in possession of part of the ground over which the embankment was carried, who after the site of the bridge was decided on, erected what he called a 'house', which I saw but should never have guessed the use of, being a small hut of timber framework covered with *brown paper* with a fireplace in it, for the purpose of claiming compensation from the Railway Company for having diminished the value of his property; and the work was delayed as this person's unexpected claim could not be settled until near the period of the entire completion of all other parts of the railway.' [66]

Towle emphasised his spirited attitude towards authority by naming the building Paisley House, presumably as a lightly disguised reference to the Chief Engineer of the GWR and, despite its opportunistic origins, it survived as part of a greatly

Fig. 15
Paisley House, Oxford
Front elevation immediately prior to demolition
*Oxford Archaeological Unit*

extended structure until the whole complex was demolished in the summer of 1996 (Fig.15). From its original two-up two-down form the building was expanded until it had become a substantial five-bedroom villa with a sequence of extensions over the next thirty years. During this period Rob Kinchin-Smith of the Oxford Archaeological Unit has distinguished nine distinct structural phases, all of them marked by experiments with different techniques (Fig.16). The earliest roof was flat with large overlapping sheets of cardboard laid on elm boards and a covering coat of composition. Later roofs had a shallow curved profile of deal boards with overlapping sheets of coarse paper and a thinner covering coat. In places some of the sheets were held down by tarred card or galvanised iron strips in the manner specified by Loudon for verandah roofs. Some of the curved roofs had an insulating layer of sawdust, a technique which was also used in the construction of some of the walls (Fig.17).[67]

As much as anything else, it is the construction of the walls that sets Paisley House apart from all the other buildings discussed so far. Paper walls did not feature in the literature promoting the use of paper as a building material although there are two incidental references in a couple of unlikely sources. The first is in a poem published as early as 1573 by Edward de Vere, Earl of Oxford, called *The*

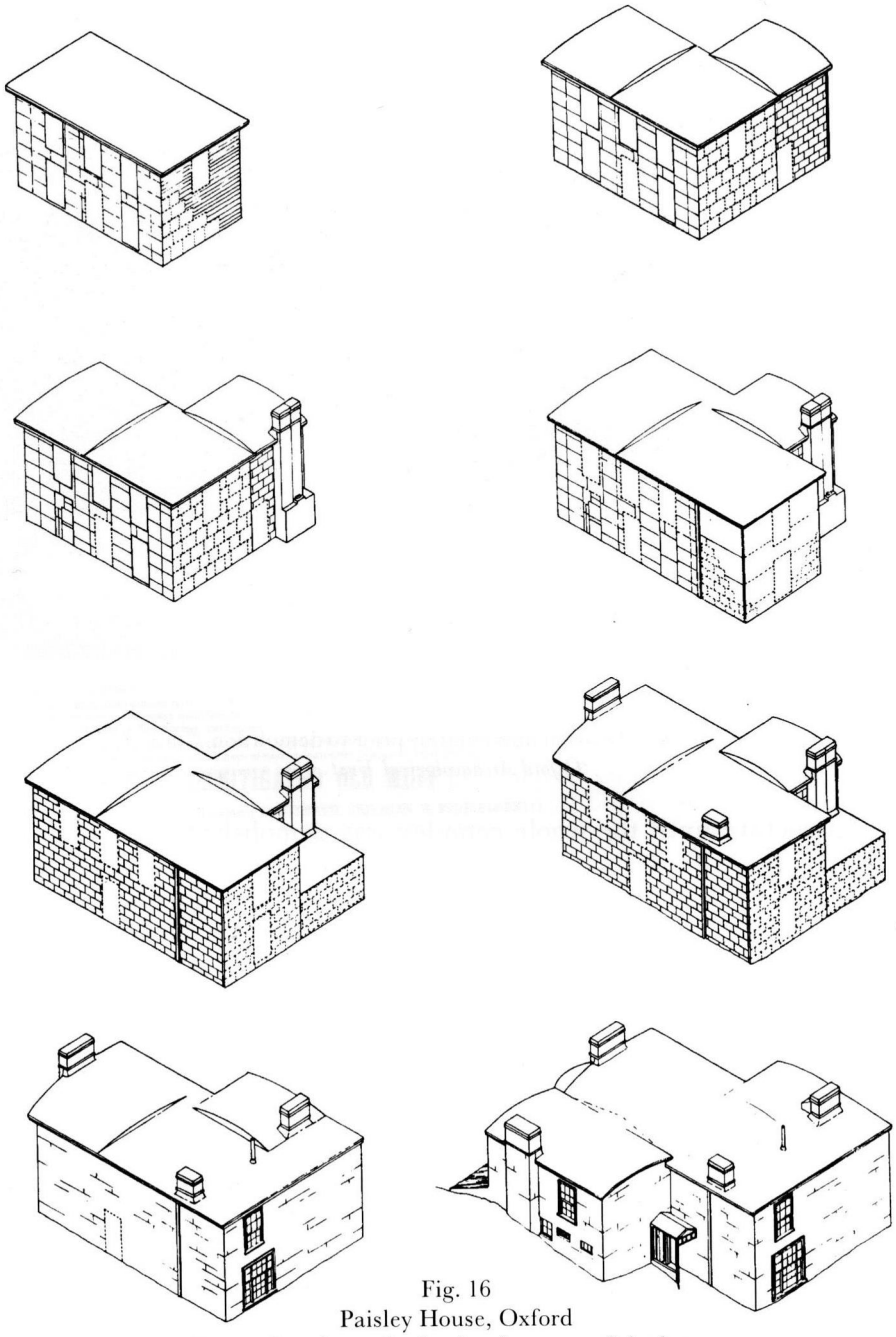

Fig. 16
Paisley House, Oxford
Successive phases in the development of the house
*Oxford Archaeological Unit*

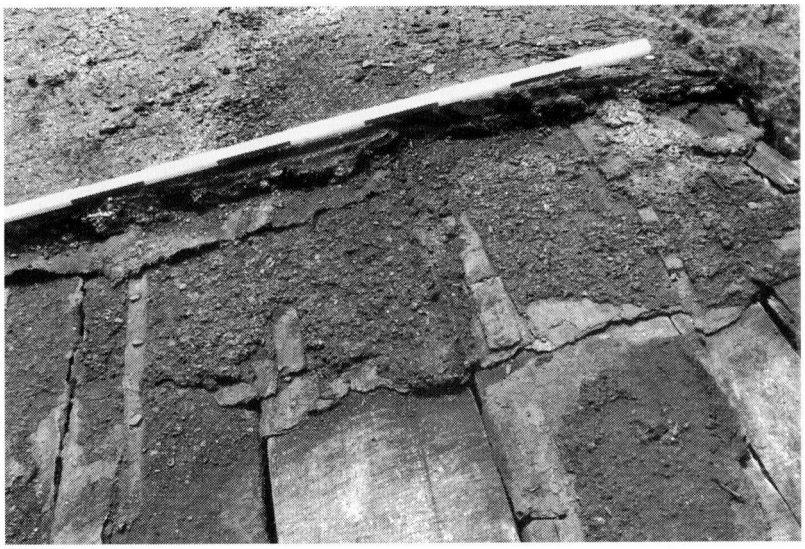

Fig. 17
Paisley House, Oxford
Detail of roof showing boards, paper, card fixing strips and composition coat.
*Oxford Archaeological Unit*

*Labouring Man That Tills The Fertile Soil,* where he describes:

> The mason poor, that builds the lordly halls,
> Dwells not in them; they are for high degree,
> His cottage is compact in paper walls,
> And not with brick or stone as others be.[68]

As paper was a luxury item in sixteenth-century England, this must be a poetic metaphor for the thinness of the walls rather than a factual description. The other reference also comes from fiction and is found in *Letters From England* published by Robert Southey in 1807 where he expostulates:

> Nothing is too absurd to be believed by the people in this country. Some time ago there was a woman who went about showing herself for money, with a story that she had been pregnant three years. There was something extraordinary concerning this impostor; for the house in which she lived, which stood upon the shore in the province, or shire as it is called of 'Sussex' had no other walls or roof than laths and brown paper pitched over. It had stood three years without injury, when the person who related this to me saw it.[69]

This is more likely to be based on personal observation but the surviving evidence from standing buildings is very sparse. No.4 Church Lane, Ufford in Suffolk is described in the statutory list of buildings of special architectural and historic interest as being clad in tarred paper but the present rendered appearance makes it impossible to confirm this.[70] It is just possible that the rendered finish on the buildings in Weirs Lane, Oxford, disguised a paper covering, but all the other known paper-roofed buildings had walls of traditional construction.

At Paisley House five phases of experimenting with different techniques to clad the timber stud walls have been identified (Fig.18). They range from butted fibreboard panels through overlapping sheets of tarred card to large sheets of tarred

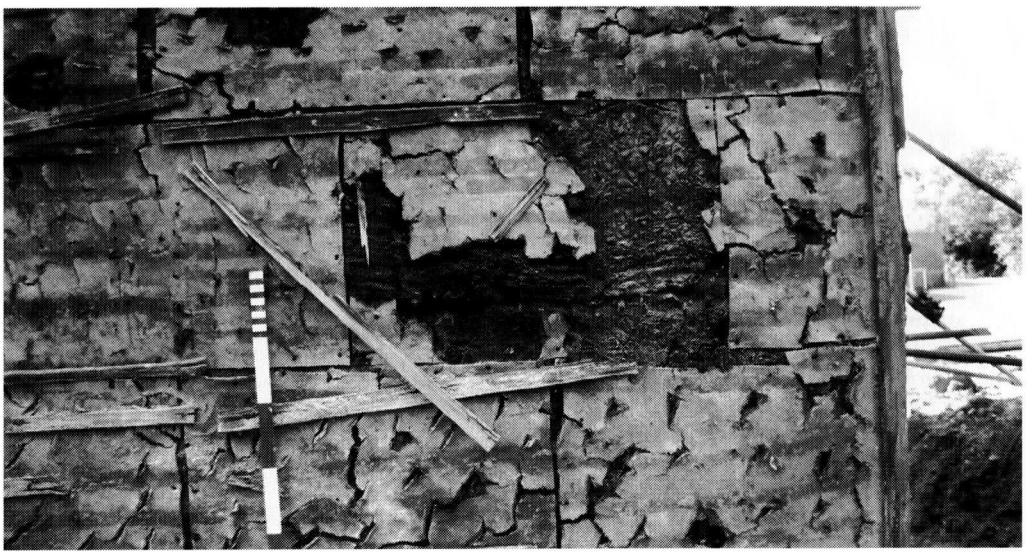

Fig. 18
Paisley House, Oxford
Detail of walling showing butted fireboard panels over tarred paper.
The panels have been keyed to take a later render.
*Oxford Archaeological Unit*

paper. In most of the phases a layer of sawdust sandwiched in the cavity between the inner and outer walls was used to provide insulation. A full analysis of the technical aspects of the house will be published in due course, but it is evident that in its later phases of expansion the use of paper for the walls was abandoned in favour of a more conventional approach using laths and render.

The fibreboard panels which were employed on the original building have a close affinity with the papier mâché building panels patented by Charles Frederick Bielefeld in 1851.[71] Papier mâché had been used for external architectural ornament before 1760 for the Turkish Tent in the gardens at Painshill, Surrey[72] and on the garden elevation at No.13 Berners Street, London, by Sir William Chambers.[73] It had also been used for the internal finish of some intricate roofs such as the vaulting of the transepts at Ripon Cathedral in about 1840[74] and the technically-advanced dome of the Reading Room at the British Museum built between 1854 and 1857. In 1892 the enlarged dome of the Meridian Building at the Royal Observatory, Greenwich, was covered in papier mâché which was only removed during the air raids of World War II.[75] But it was Bielefeld who successfully promoted the material for complete buildings and received extensive publicity for the portable village of ten houses and a large storehouse which he erected at his factory at Hale Mills near Staines railway station in the summer of 1853 before packing it into cases for transportation to Australia (Fig.19).[76] The village had been commissioned by a Mr Seymour who was emigrating to Australia and it was

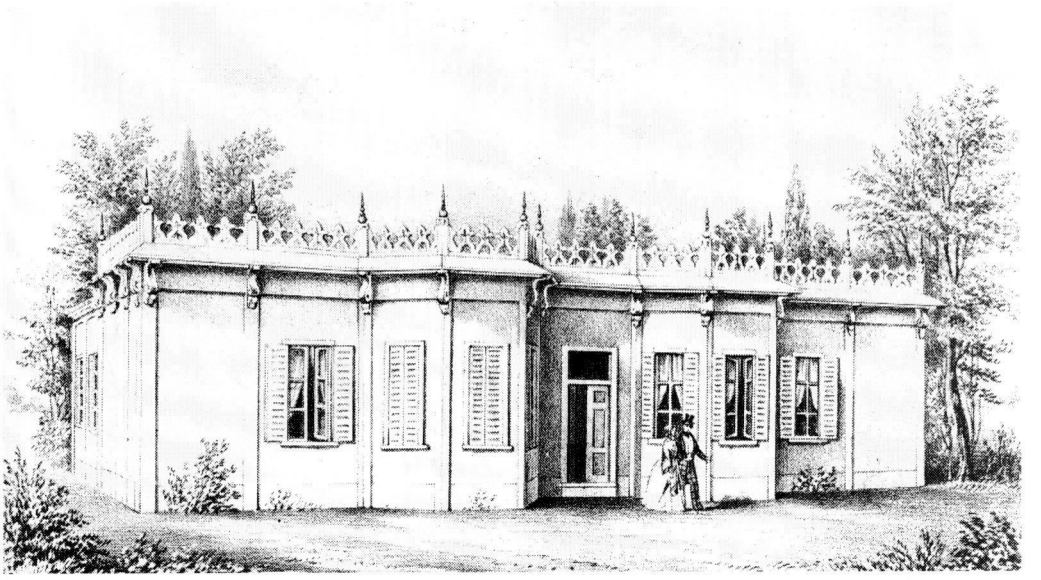

Fig. 19
Papier mâché villa, destined for Australia.
From *Portable Buildings designed by Charles F. Bielefeld, Patentee* (1853)
*Miles Lewis*

almost certainly destined for Melbourne.[77] The papier mâché panels were set into grooves in the timber framework with an air space between the internal and external surfaces rather than nailed as at Paisley House, but otherwise the system would seem to have been identical.

Two other examples of tarred paper roofs remain to be considered in the Oxford region. At Mapledurham, the hidden valley in the otherwise conventional roof of the former vicarage built by Lewis Wyatt in 1831-2 for Lord Augustus Fitz-Clarance, the natural son of King William IV, has a covering of cardboard sandwiched between two layers of tar despite the requirement for lead in the original specification[78] and just across the historic county boundary in Abingdon two of the buildings in what was Stevens Boatyard originally were covered in paper (Fig. 20).[79]

Although all the evidence indicates that paper roofing was an English invention which was taken up with enthusiasm by progressive Scots, it also appealed to the pioneers in the colonies and elsewhere abroad. In 1821 the roof of the Commercial Hall in Cape Town was covered with tarred sheathing paper and 'repairs to Sheathing' were mentioned for outbuildings to Government House in 1827 at Cape Colony where the previous year the same material had been used to cover part of a house on Robben Island.[80] In 1835, George Gilbert built a fortified farmhouse with paper roofs at Sephton Manor near Fort Beaufort, Cape of Good Hope, and published the designs in *The Graham's Town Journal* for 10th September. In Europe a flax spinning mill was built with a paper roof at Myslakowice, Poland, in 1844 to

Fig. 20
Stevens Boatyard, Abingdon, Oxfordshire
Prior to demolition in 1995

the designs of Frederic Kaselowsky, who had spent time in England studying the construction of textile mills,[81] and in the U.S.A., tarred paper roofs have been noted at the Eastern State Penitentiary, Philadelphia, designed by John Haviland and opened in 1829.[82]

DISCUSSION

The fundamental attraction of paper roofs was, of course, economy although this was not simply a result of the cheapness of the basic materials themselves. Indeed, General Stratton in complaining about 'the enormous price of pitch and tar' used at Great Tew stated that his roofs 'did not cost much less than slate or tiles'.[83] However, the tar produced in the distillation of pyrolignous acid was apparently 'considerably cheaper than common tar.'[84] Another advocate in 1812 suggested that the 'expense, even of a paper roof, is *now* much increased by the high duty which has been lately laid on paper of all kinds.'[85] The real saving came from the structure of the roof itself. Not only were fewer timbers of a lighter scantling needed to support such a lightweight covering[86] but, due to the low pitch, the area of the roof to be covered could be as much as thirty per cent less than a conventional roof. Consequently it was variously claimed that the cost of paper roofs could offer savings of up to half the cost of a slate roof[87] although a more realistic ratio is provided by the actual costs for the cottages at Campsie of 8s. per square yard as

opposed to 10s. for slate roofs.[88]

Maintenance was another factor that needed to be considered by a prudent landlord and some impressive claims were made in this respect by the supporters of paper roofs. Sir John Sinclair stated that 'the roofs will require a slight repair in about a year after they are finished, and afterwards may last for ten or twelve years without requiring any further repair.'[89] He contrasted this with tile-roofing, which initially was cheaper than either paper or slate 'but requires to be repaired every year, and at last comes to be the most expensive.' The perception that tiled roofs were inherently fragile, at least in Scotland, was underlined in an essay written by George Smith which was awarded a prize by the Highland Society of Scotland in 1833 and published in the following year. 'Tiled roofs', he wrote, 'although the cheapest in the first outlay, are always the dearest in the end, by constantly requiring repair to keep them wind and water tight.'[90] Loudon, in promoting the durability of paper, cited a church at Dunfermline which had stood for forty years without repair and went on to relate how Mr Swann had told him that the paper roof at Wolvercote had lasted thirteen years without repair while the adjacent blue-slated roof had been such a 'continual plague' that he proposed to replace it with paper.[91]

But it was not just long-term economy that commended paper to improving landlords as preferable to tile. A taste for the picturesque meant that buildings should ideally blend with their surroundings. As Edmund Bartell wrote in his *Hints for Picturesque Improvements in Ornamented Cottages* published in 1804:

> Upon this ground, every material of a strong harsh colour should be rejected: the fierce red brick, or the perfect white of a wash of lime are equally disgusting. The characteristic mark of a cottage is humility, as if, conscious of its inferiority, it should appear to retire beneath the shelter of its friendly woods; which it would not do, were it fabricated of glowing colours and costly materials.[92]

In expanding this argument, he went on 'there is the same objection to the use of tiles, particularly the red sort, that there is to brick walls; a cottage with such a covering no longer retains its quiet colour...'[93] This view was echoed by Richard Elsam in his polemic for the picturesque published in 1816 as *Hints for Improving the Condition of the Peasantry in all Parts of the United Kingdom, by Promoting Comfort in their Habitations...*:

> ... we cannot conceive what apology can be offered for the introduction of either tiles or slates of any sort, which, though excellent materials for covering habitations almost of every description, are quite out of character and perfectly inconsistent upon the peasant's humble cot, particularly red tiles of any quality, which produce nearly the same disagreeable effect as scarlet houses or cottages built with red bricks, the obtrusive and unpleasant appearance of which never fail to destroy the harmony of the most tranquil and beautiful scenery.[94]

In a later passage, Elsam described how tiles were

> sometimes coloured with quick-lime, sharp sand, and soot mixed together with water. This composition produces a grey colour not unpleasant to the eye; but for picturesque cottages intended to harmonize with rural scenery, we should prefer something in imitation of brown thatch a few years old.[95]

Thatch, of course, appealed to many of the proponents of the picturesque but the advanced farming community took a strongly contrary view, arguing that straw was one of the most valuable agricultural products and should be reserved exclusively for the production of manure.[96] As Charles Waistell put it in his *Designs for Agricultural Buildings* ... , published in 1827:

> ... straw for thatch should never be used when other covering can be obtained. If much of it be used for thatching buildings, the farm will be robbed of its manure, and, consequently, its improvement retarded. When straw thatch begins to decay, it must occasion a faint, unpleasant, and perhaps unwholesome smell. Where the water which falls upon the roof is to be collected, thatched buildings of any sort are improper, and when they get old, they are a great harbour for vermin; indeed, where other materials can be had, thatch of any sort, particularly for dwelling houses, should be avoided.[97]

In this climate of debate, the advantages of tarred paper must have appealed to many progressive land owners. It was just the right dark colour to satisfy contemporary taste. The prominent projection at the eaves which was a characteristic feature of its construction met with another consideration expressed by writers like Bartell who pointed out that 'unless the eaves project a considerable way over every part, the building will have a mean appearance, and lose that depth of shadow for which reed covering is so eminently conspicuous ... '[98]

The picturesque element is never far from the surface in all the literature published on paper roofs. In 1825 Nicholas Carlisle published verbatim Loudon's account of the paper roofs at Tew in a book of essays otherwise devoted to the writings of such propagandists for the picturesque as Papworth, Robinson, Price, Repton and Malton[99] and Loudon's own pamphlet is sub-titled '... in point of Economy, Durability and Elegance.' In expanding on that final quality, he wrote:

> The flatness of those roofs being greater than that of slate, their resemblance to that material in colour, their projection at the eaves, communicate ideas of lightness and Doric simplicity, unfelt in viewing any other species of roof.[100]

He went on to state that he was anxious to promote these roofs to improve the effect of agricultural buildings 'among rural scenery' and his client at Tew was less impressed with the economics of the experiment than with his obvious pleasure that the farmhouse was 'a very ornamental object' with a roof that was 'much more picturesque' than slate or tiles.

## DECLINE

The use of tarred paper as a popular roof covering had virtually ceased in Britain by the middle of the nineteenth century. The reason can hardly be due to doubts about its durability. The surviving examples alone demonstrate an extraordinary longevity provided regular maintenance was carried out. The development of new materials from the 1840s onwards, such as felt, corrugated iron and the chemically-treated Willesden paper must have played a part.[101] However, it is notable that these new cheap materials, with a few exceptions, were invariably confined to utilitarian structures of little architectural ambition and it must be concluded that

it was a decline in interest in the qualities of the picturesque rather than any inherent flaw which sounded the true death-knell for what was once seen by many sensible builders as an eminently sustainable and attractive roofing material.

NOTES AND REFERENCES

1. My research into this arcane subject was inspired by R. Crickmay in 1981 when he identified the significance of the terrace at Sandford on Thames and drew my attention to Loudon's pamphlet. Since then many people have been tolerant of my growing obsession and generous with the information that they have passed on. Miles Lewis, in particular, has provided me with a number of important references and has kindly eliminated some embarrassing errors in early drafts of the text. Frank Kelsall, as always, has suggested a number of fruitful lines of enquiry as well as offering specific references, as did Malcolm Graham. Anne Riches tracked down an elusive text for me and John Eaton, Mark Barnard and Sally Stradling visited individual buildings on my behalf in pursuit of unsubstantiated rumours. Anna Eavis cheerfully helped me through the resources of the National Monuments Record. Carol Rosier, Paul Calvocoressi, Edward Peters, Robert Taylor, Sir Howard Colvin, Dan Miles, John Ashdown and Julian Munby periodically remembered my project and gave me helpful information. Other references were kindly suggested by Ivan Hall, Ian Bristow, Derek Church, Julia King, Dave Stenning, Kim Sankey, Charlotte Bradbeer, Clare Tilbury, Elizabeth Beaton, Linda Monckton and Charles Morris. Rob Kinchin-Smith generously shared his meticulous deconstruction of Paisley House with me and I am grateful to John Bold both for his reference to Chevening and for his tactful editing of the final text. I owe a special debt to the University of Oxford and to the President and Fellows of Kellogg College for granting me a sabbatical term to complete my research.
2. National Reference Library of Science and Invention, Patent No. 10,270. 24th January 1845.
3. The copy of the pamphlet in the Bodleian Library is the 2nd edn. dated 1811. I have been unable to trace any copies of the 1st edn. but, as Loudon did not complete the farmhouse at Tew until late 1809 or early 1810, it is unlikely to have been published before 1810 and may well have been published shortly before the 'new edition' of 1811.
4. Simo, M. L., *Loudon and the Landscape,* (New Haven and London, 1988), 3 & 7.
5. London, 1808.
6. Gloag, John, *Mr Loudon's England,* (Newcastle upon Tyne, 1970), 32 & 37.
7. Sinclair, Sir John, *An Account of the Systems of Husbandry Adopted in the More Improved Districts of Scotland...,* (Edinburgh, 1812), Appendix III, 28.
8. Gandy, Joseph, *Designs for Cottages, Cottage Farms, and other Rural Buildings...,* (London, 1805) and *The Rural Architect...,* (London, 1806).
9. *Victoria County History of Oxfordshire,* XI, (London, 1983), 228.
10. Loudon, J.C., *An Account of the Paper Roofs Used at Tew Lodge, Oxon,* (2nd edn., London 1811), 4.
11. *ibid,* 5.
12. *ibid,* 6.
13. Loudon, J.C., *Observations on Laying out Farms in the Scotch Style, Adapted to England,* (London, 1812), 45.
14. *idem.,...Paper Roofs...,* 7-8.
15. *op. cit.,* 44.
16. Vancouver, Charles, *General View of the Agriculture of the County of Devon,* (London, 1808), 90-1. I owe this reference to Dr Edward Peters.
17. Three-quarters of an inch.
18. Graham, John, 'On Farm Buildings, With an account of a New Species of Roof', *The Farmer's Magazine,* vol. ix (1808), 75.; Whyte, Andrew, & Macfarlan, Duncan, *General View of the Agriculture of the County of Dumbarton...,* (Glasgow, 1811), 75.
19. Sinclair, Sir John, *Appendix to the General Report of the Agricultural State and Political Circumstances of Scotland,* vol. 1, (Edinburgh, 1814), 266.
20. Graham, J., *op. cit.,* 74.

21. Sinclair, *Appendix...*, 266.
22. Whyte & Macfarlan, *op. cit.*, 35.
23. Papworth, J.B., *Rural Residences...*, (London, 1818), 36. Carlisle, Nicholas, *Hints on Rural Residences*, (London, 1825), 66-9.
24. Loudon, *Paper Roofs*, 11.
25. Beds. C.R.O., R4/608/27/2.
26. *idem.*, R4/608/27/22.
27. Kent C.R.O., U1590 699/1. I am grateful to Dr John Bold for drawing my attention to this reference and for supplying a transcript.
28. Colvin, H.M., (ed.), *The History of the King's Works*, vol. vi 1782-1851 (London, 1973), 275 & 277.
29. Sinclair, *Appendix...*, 266-7.
30. Papworth, *op. cit.*, 36. Wright was not the inventor, but refined the patent taken out by Henry Cook on 16th March 1778. I am grateful to Julia King for the information on Wright.
31. Graham, John, *op. cit.*, 73.
32. The letter is in the Minto papers in the National Library of Scotland and I am grateful to Dr Ivan Hall for drawing my attention to this important reference and sending me a copy of the document.
33. *York Courant*, 18th July 1775, quoted in Shorter, A.H., *Paper Mills and Paper-makers in England, 1495-1800*, (Hilversum, 1957), 61.
34. Loudon, *...Paper Roofs...*, 12.
35. Wyndham, Henry Penruddocke, *A Tour Through Monmouthshire and Wales...*, (2nd. edn., Salisbury, 1781), 34.
36. Clarke, E.D., *A Tour Through the South of England, Wales and Part of Ireland Made During the Summer of 1791*, (London, 1793), 191-2. I am grateful to Carol Rosier for drawing my attention to Margam.
37. Graham, John, *op. cit.*, 74-5.
38. Sinclair, *Appendix...*, 279-80 and plate XV.
39. Graham, Patrick, *op. cit.*, 75.
40. Graham, John, *op. cit.*, 75.
41. Whyte & Macfarlan, *op. cit.*, 36.
42. Beaton, Elizabeth, 'Paper Roofs', *Vernacular Building*, xiii (1989), 62-3. I am grateful to Elizabeth Beaton for this reference and for sending me a copy of her paper.
43. Small, John, *The Castles & Mansions of the Lothians*, (Edinburgh), 1883. I am grateful to Anne Riches for transcribing this passage for me.
44. Loudon, *Observations...*, 82-3.
45. *idem*, *...Paper Roofs...*, 9 & 12.
46. The original shallow roof pitches of both buildings make any other covering unlikely. I am grateful to Kim Sankey of the Conservation Practice for drawing my attention to the Woolstore and allowing me to inspect it during restoration work in 1992.
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49. *idem.*, Policy 988979 (19th Feb. 1822).
50. *idem.*, Policy 990323 (13th March 1822).
51. Policy 705452.
52. Policy 842819.
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54. Knowles, John, *An Inquiry into the Means which have been taken to Preserve the British Navy, from the Earliest Period to the Present Time Particularly from the Species of Decay now Denominated Dry-Rot*, (London, 1821), 78.
55. Pers. comm. Oliver Chapman, Canterbury City Council. In other parts of England, Dave Stenning of Essex County Council, has identified an agricultural building at Burtonwood Farm,

Great Chesterford, with a roof boarded vertically which might well have carried a paper roof and the late Alban Caroe suggested to me that the roof over the nave at the church of St Nicholas, Stanford on Avon, Northants, might have been covered in paper.

56. Carter, H., *Wolvercote Mill, A Study in Paper-making at Oxford,* (Oxford, 1974), 26. The buildings were drawn by John Buckler on 29th July 1826 (BL, Add, MS 36, 377, f. 175). They were demolished in 1855.
57. Drawn by Buckler on 3rd August 1824 (BL, Add. MS 36, 373, f. 38).
58. Carter, *op. cit.,* 29.
59. BL, Add. MS 36, 377, ff. 29-30. The site was redeveloped for housing in the late 1980s.
60. The significance of the roof was first discovered by R.J. Crickmay to whom I owe a great debt of gratitude for inspiring the research which has led to this paper.
61. *VCH Oxon,* II, (London, 1907), 240.
62. Bodleian Library, Minn Coll., Neg 13/32.
63. They were demolished in the summer of 1923 but were recorded by photographs taken at the time, *idem.,* 31/2/12a and 61/1/10a. I am grateful to Dr Malcolm Graham for drawing my attention to these buildings and for much other assistance with this project.
64. *VCH Oxon.,* II, (London, 1907), 242.
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66. MacDermot, E.T., *History of the Great Western Railway. Vol. I: 1833-1863,* (London, 1927), 178-9.
67. A full analysis of the structure was made during controlled demolition by the Oxford Archaeological Unit and I am grateful to Rob Kinchin-Smith for a copy of his preliminary report and for many useful discussions on site.
68. I owe this reference to the kindness of Sir Howard Colvin. John McCann made the helpful suggestion about its meaning.
69. I am extremely grateful to Frank Kelsall for giving me this reference and for suggesting many other lines of enquiry.
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76. *The Illustrated London News,* 6th August 1853, 80.
77. I am greatly indebted to Dr Miles Lewis of Melbourne University for corresponding with me on this subject and sending me extracts from his own copies of Bielefeld's rare catalogue *Portable Buildings, designed by Charles F. Bielefeld, Patentee* (1853) and his article 'Those Elusive Paper Houses', *This Australia* (no date), 36-9.
78. I am grateful to Dan Miles for this discovery made during repairs in 1997.
79. I am grateful to Clare Tilbury for first drawing my attention to this example. The buildings were destroyed by fire in 1995 but they seem to have been built at a late date in the nineteenth century and had comparatively steeply pitched roofs with horizontal boards.
80. Lewcock, Ronald, *Early Nineteenth Century Architecture in South Africa,* (Cape Town, 1963), 385.
81. Gerber, Piotr, 'The Flax Spinning Mill in Myslakowice near Jelenia Gora, Poland ', *Industrial Archaeology Review,* xiii, No. 2, (Spring, 1991), 142-51.
82. Pers. comm. Carol Rosier.
83. Sinclair, 1812, *op. cit.*
84. Whyte and Macfarlan, *op. cit.,* 36.
85. Patrick Graham, *op. cit.,* 82.
86. Loudon calculated that '1 rafter necessary for each stone flat roof would make 3 for a paper one', ...*Paper Roofs*..., 8.
87. Graham, John, *op. cit.,* 73; Graham, Patrick, *op. cit.,* 82.

88. Sinclair, *Appendix...*, 279.
89. *idem.*
90. Smith, George, *Essay on the Construction of Cottages Suited for the Dwellings of the Labouring Classes,* (Glasgow, 1834), 19.
91. *...Paper Roofs...*, 9.
92. *ibid,* 10-11.
93. *ibid.,* 18.
94. *ibid.,* 18.
95. *ibid.,* 37.
96. This argument is repeated time and again in the *Reports to the Board of Agriculture* for the various counties published at the turn of the century.
97. Waistell, Charles, *Designs for Agricultural Buildings...*, (London, 1827), 78.
98. Bartell, *op. cit.,* 19.
99. Carlisle, Nicholas, *Hints on Rural Residences,* (London, 1825).
100. *...Paper Roofs...*, 10.
101. Willesden paper was named after the north London suburb where it was manufactured. It came in rolls rather than individual sheets and was principally used as an under-covering for tiled or slate roofs but could also be employed as an external covering in its own right as long as it was protected by a coating of oil paint. It continued to be specified well into the present century and deserves a separate study of its own.