The Ewbank Nail

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ABSTRACT: A productive liaison between an American mill engineer and an English merchant, led to the production in Newport, Monmouthshire of one the first effective machine made nails suitable for hardwoods. It had a remarkable run of over one hundred years in use in Australia, where for a long time it was ubiquitous. Subtle changes to the nail profile are particularly useful in establishing a series of threshold dates for various buildings constructed there during the pioneer period and hence assists in estimating their construction dates. The "Starhead", or "Ewbank" nail, as it was often known, was also exported to China, Chile, India, New Zealand, and other parts of the British Empire, during the latter half of the of nineteenth century , as well as being widely used within Britain.

GENERAL

Introduction

The series of wrought iron nail types produced by Dos Works in Newport, Monmouthshire, in Wales, and known generally as "Ewbank" nails, was one of the most successful British exports during the Victorian era, and they were in use in Australia through to 1939 (Ponting, pers.comm., Varman, 1993 p159).
The machine wrought nail, which after 1869 had a star trademark on its head, and hence sometimes known in England as "Starheads", is an important type which has been little understood. It was made in Britain, and widely used there, but it figures predominantly in the overseas market. It was especially used in Australia because it could cope with the hard eucalypt timber. It is often mistaken by investigators, including even professional archaeologists, for a hand wrought nail. Precisely why it is known as the Ewbank is one of the questions raised in this paper.

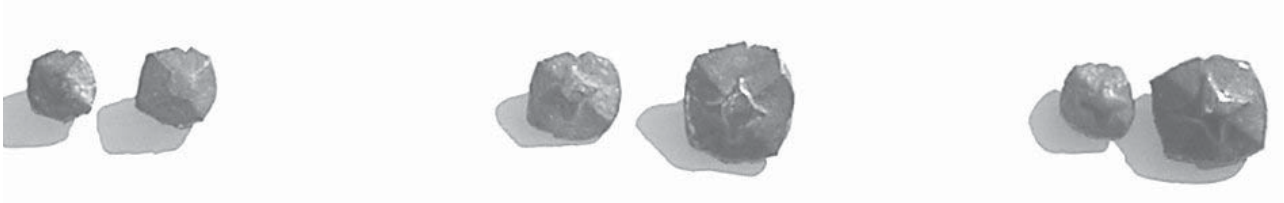

Figure 1: The three main stages of patent in pairs, 1834 facetted head with no trademark, 1869 star head-trademark, and the 1881 square grip to under-head, with more regular head form

The importance of the Ewbank nail is that it was made by machinery in such a way as to replicate more cheaply the fibrous and resilient quality of the wrought nail, and that it could be driven into hard timber without splitting the timber or fracturing the nail. Qualities due in part to the replication of the shank shape and the spade shaped point, which enabled positive crushing of timber fibres needed as a first step to initiating penetration. It was made by J J Cordes & Co of the Dos Works in Newport, Monmouthshire, a business which started

as a partnership between James Jamieson Cordes, an American, and his brother-in-law Henry Ewbank (Johnson, unpub.).

Research in two hemispheres

In Britain a partial history of the Dos Works had been written by Malcolm Johnson, and the Ewbank family history has been researched by Canon Robin Ewbank, Rector of Hartley Wintney in Hampshire, England. In Wales, Richard Jones of Caerphilly, a keen nail collector living a few miles from the original factory, had contact with former employees, had collected some of the nails and begun to research the patents. The Head Carpenter at the Weald & Downland Museum of Buildings in Singleton, Roger Champion, had searched out redundant stock of the Ewbank nails from local and London sources to meet the Museum's needs. After a fire at a London warehouse he was able to obtain the best of the water damaged stock for the Museum. Unused nails, which have not had the details of the head damaged as a result of being struck by inconsiderate carpenters, are particularly important in the study of nail typology, and examination of those in the Museum's bins greatly assisted in sorting out the several varieties.

The present paper arises from the coming together of two Australian parties. Miles Lewis had been collecting samples of the nails sporadically and had done some documentary research on their availability and sale in Australia. He has located Ewbank nails as far back as 1837. Chris How was studying at the Weald & Downland Museum early in 2005, and having brought some samples of Ewbank nails found in Australia, was able to compare these with those in the Museum's bins. His Australian nails were earlier in date and lacked the star, as did a few samples at the Museum. Subsequently, in the process of researching timber framed buildings, How has been able to assemble a typology of nails from dated structures, to demonstrate the three main forms they took over time, and to correlate this with documentary information, so that they have become a useful tool for dating structures (How, 2006 pp48-50).

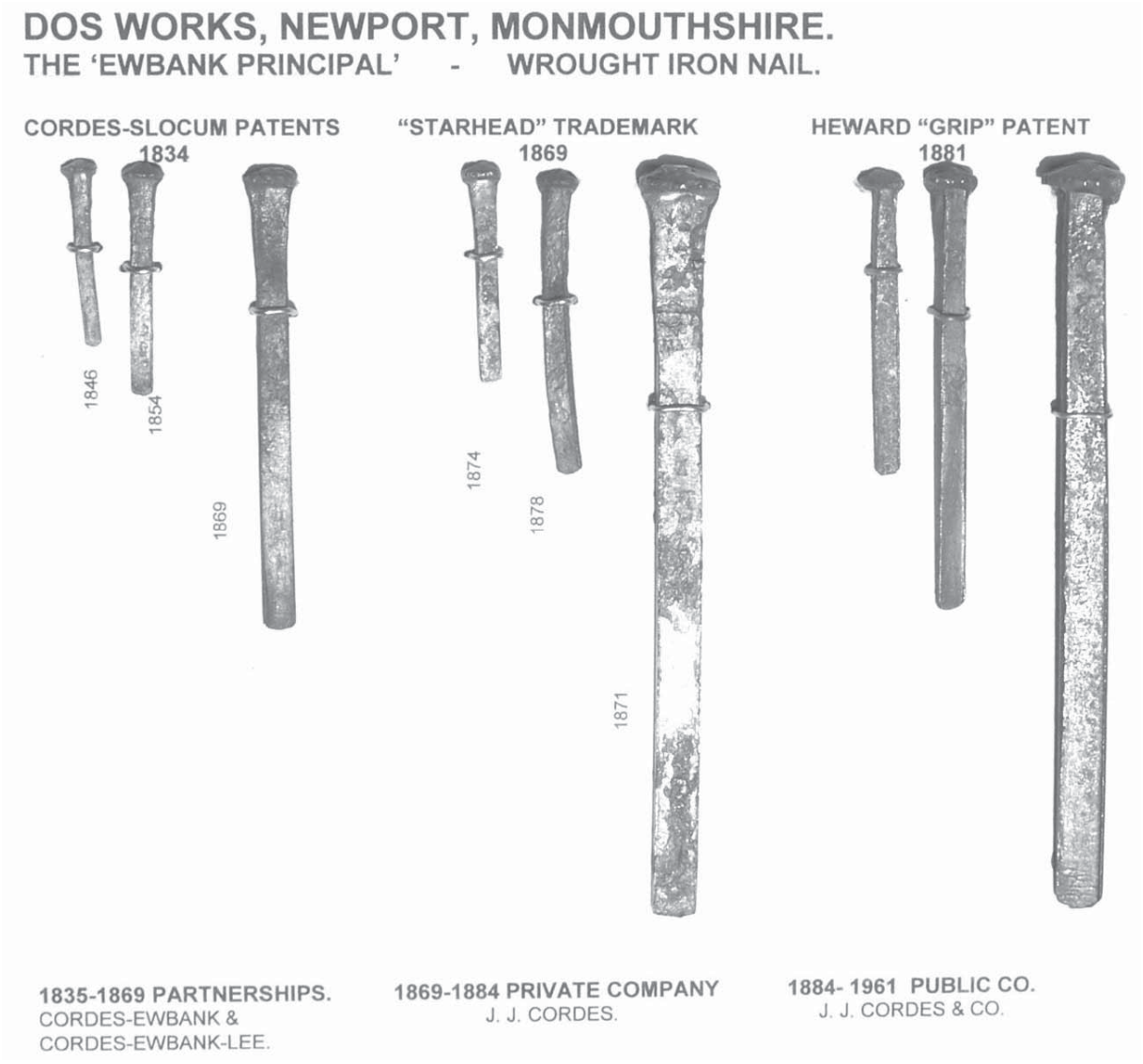

Figure 2: The three main patent types based on the "Ewbank principal"

The family connections

The first record of an association of Henry Ewbank with James Cordes goes back to 1820 and they, together with their future father-in-law, Jonathon Lucas are mentioned by the English mechanical engineer, John Galloway, when engaged in preparing gearing for rice mills run by all three in Charleston (Chaloner, 1990 p.101). They were collectively described by him as being "very wealthy and owning around a thousand slaves". Galloway's company also made mining equipment and pumps for a Mexican mining venture Henry and James were involved in during the early 1820s.
The charging and hanging of one of Lucas's slaves in the Denmark Vesey slave revolt in South Carolina prompted Jonathon Lucas to pass on his plantation holdings to his eldest son and to transfer the base of his international business concerns to London (MLH, 2008). He was the son of an English millwright, originally from Cumberland, who had married into a wealthy Carolina family of Huguenot descent. (Johnson, unpub.). Henry Ewbank, an English merchant, whose family also originated in Cumberland, had completed an apprenticeship in Newcastle, England, in 1808 and it appears he afterwards traveled widely in North America. Henry Ewbank subsequently married Lucas' daughter, Lydia in 1827 (Ewbank, pers. Comm.).
Another daughter, Mary, married James Cordes, a Yale college educated engineer, also of Huguenot descent. James Cordes and Jonathon Lucas with his family, arrived in London in 1823, and in the same year Lucas was listed in the London Commercial Directory under Lucas & Ewbank, rice millers, at Idol Lane near to Tower Close. The partnership of Lucas & Ewbank also had extensive riverside milling and warehouse facilities at Rotherhithe, on the south bank of the Thames. An article in the *Times* of 26 September 1836 describes how the mill complex was burnt down, a few years after Lucas had died, leaving only the fire damaged granary warehouse.

THE NAIL FACTORY

Dos Works and the hidden bequest

In 1832 Jonathon Lucas died, and James Cordes formed a partnership with his brother-in-law, Henry Ewbank, to develop a wrought iron nail-making machine, for which they had acquired the patent rights. This machine would replicate the stages by which nails were then made by hand using nail rods, simulating the drawing out of the point by use of converging rollers. In this it was so successful that the nails are frequently mistaken for the hand made article, even by professionals such as archaeologists. A British patent, no 6686, was taken out by James Cordes in 1834, and the partnership set up a factory for its manufacture the following year in Newport, Wales. Henry Ewbank's specific connection with the nail is something of a mystery. He was eleven years older than his brother-in-law, and they already had significant joint foreign experience behind them (Chaloner, 1996). Ewbank had obtained a patent for dressing rice in 1819 and another, jointly with Lucas, in 1827. He and James Cordes were in the rice and export business together and were registered as Ewbank and Cordes of Idol Lane. Ewbank, was forty seven years of age, his brother-in-law eleven years younger, and the patent was entered in his Cordes's name. The first use of the term "Ewbank nails" appearing in England was in 1853 but earlier in several Australian newspapers: the *Perth Gazette* in July 1841, *The Courier* in Hobart February 1844, the *Maitland Mercury* of August 1844 and so on through to the 1850s.
James Cordes made three patent applications in 1834, each one a "communication from a foreigner residing abroad", so it seems that he acquired a package of patent rights, much as Nettlefolds were later to do on a grander scale for screw-making machinery. Two of these applications were for improvements in machinery for making rivets, screw blanks and bolts, and are not directly relevant here except for the fact that the first lapsed for the want of the specification being enrolled, and the second, which seems to be its revival, reveals that between the lodgement of 8 October 1834 and the enrolment of 8 April 1835, news of the foreigner's death has reached England. If the same foreigner was the source of the nail patent, as seems probable, this may be a clue to his identity.

The ladder of patents

The patent which Cordes obtained in 1834, on the basis of the foreign communication, may be the origin of the Ewbank nail, as it was not for a new machine but for an improvement, and this improvement consisted in the use in combination of four elements, each of which seems to have been separately known already - compressing rollers, stretching holders, holding bars and guiding slides. New or not, the process, and especially the stretching rollers, doubtless improved the resilience of the nail. The Ewbank nail is recognised by the raised ridges to top and bottom edges of the parallel sided, tapering shank, and the patent specification seems to indicate that these distinctive ridges were caused by eccentric rollers on the machine squeezing and elongating the heated nail rod into a new cross-sectional form.

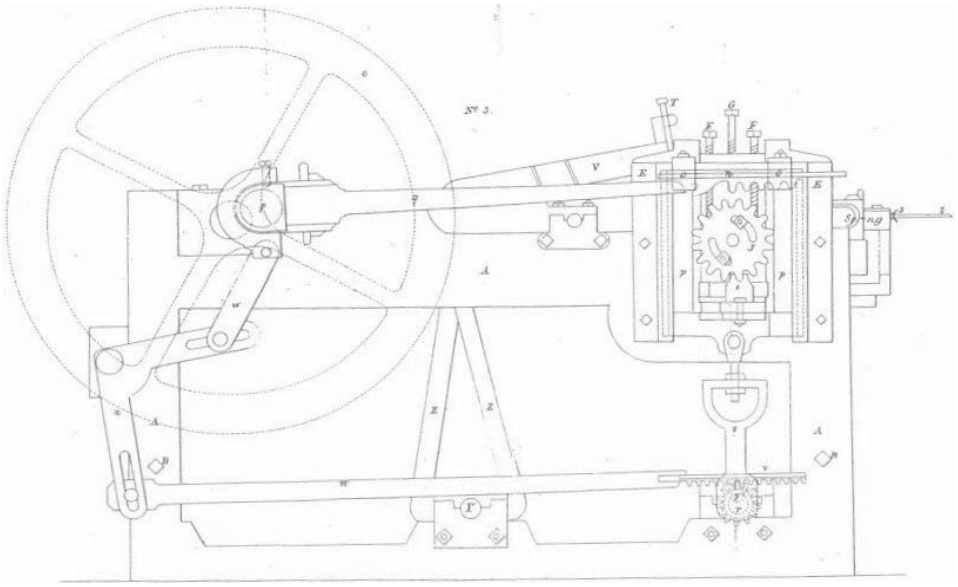

Figure 3: Side view of the machine patented in 1834; (British Patent Office)

The operation of the machine was achieved by shaping, heading and cutting in one revolution of the large fly wheel. This drove a con rod on each side of the machine via a crank, thereby activating the cog wheels. The nail rod feed was on the centre line, and adjusting screws were provided on top of the turret arrangement
A further patent, no 1835, shows that that a mechanic was engaged for a consideration of £500 to insert gearing into the original design, such that the converging rollers traveled proportionally together, thereby avoiding problems of curvature of the nail shank, and a connected patent was granted to a Samuel Slocum of Rotherhithe in August 1835, "in connection with J. Cordes patent of 8 October 1834". A subsequent patent to a Samuel Slocum shows an address at St Pancras, but it is almost certain that the Slocum referred to is the Samuel Slocum of Ploughkeepsie in New York State, and that he was then in England working on the development of machinery to make pins, for which he obtained British Patent 6578 in March 1834. He subsequently appears in US patents, and is sometimes incorrectly credited with the invention in 1841of the stapling machine on account of his developing a machine to stick pins into paper (Today in Science History.).
What is certain is that without the gearing insertion into the nail machine, it would not have worked satisfactorily, and so the "Ewbank" machine was from its outset, the product of several inventive minds. Years later, the Manager of Dos Work, Frank Raikes, was to comment on the "Ewbank principle" (Johnson,unpub.). This could only be the concept of using eccentrically mounted rollers to both shape and stretch out the iron fibres into the remarkably tough nail shank.
A weekly advertisement in the *Times* first appeared in March 1853 advising that Higgs and George of 82 Cannon Street were appointed agents for, "Patent Wrought Nails. Manufactured by JJ Cordes and Co, frequently known as Ewbank's nails---." This advertisement continued until December 1866, some seven years after Henry Ewbank's death. Canon Ewbank has unsuccessfully researched the possibility of a further family connection between the principals and the agents, since this would be typical of Victorian business practice. His research is on going.

The private company

Henry Ewbank resigned his position in 1853 to continue in the export and rice business from the same London address. He did not entirely sever his association with Cordes and Co, since one of his main items of export was to become nails exported in specially prepared canisters. In 1869 the partnership of J.J. Cordes became the private company, J.J.Cordes & Co. In the same year the company advertised the adoption of a star or cross trademark for the patent wrought iron nails known as "Ewbank" nails. This symbol indeed appears on the head of the nails, although it is often difficult to discern due to the effect of hammer blows, fig. 1.
James Cordes bought out Henry Ewbank's share of the partnership in 1869, and thereafter, the new JJ Cordes trademark, a four pointed star, was struck on the top of each nail head, giving rise to the common name of "Star-heads". Henry Ewbank continued as a merchant and nail exporter. Whereas bulk orders of nails were normally supplied in stout sacks, he exported the nails in sealed iron bin, in order that they would arrive in first class condition (*Australasian Ironmonger*, 1887). This may be one of several reasons why Ewbank's name persists for so long in Australia, even until today, and at least one relative went to Australia as part of the trading business. The nails were a big success in Australia and found to be the only ones capable of penetrating the tough eucalypt timber, especially in their larger sizes. The American Trader, G.F.Train wrote from Melbourne in 1855;

"Our American cut nails are not suited to the wood of this country, or it is of so close a grain that it breaks in being driven. Britain supplies a much better article. Ewbank's pressed nail is much used and well liked" (Train 1970.).
There is some irony in this, since Samuel Slocum, the mechanic who inserted the gearing into the machine, was an American and should have the credit for ensuring the machine worked properly. James Cordes had only recently surrendered his American citizenship. (Johnson, unpub.). He did not become a British subject until 1853 when his naturalisation document was signed by Viscount Palmerston, Queen Victoria's Secretary of State.

Competition, changes and public company

By 1870 the American cut nail was being widely sold and affecting Cordes's traditional markets (Johnson, 2008). It looked nicer than the British product and the lighter range was elegant in appearance and easy to use in softwood fittings. A New Zealand auction announcement of flood damaged goods in the *Daily Southern Cross* of 3 April 1866 shows four varieties of construction nails including 129 kegs of Ewbank nails and 17 kegs of American cut nails. The largest American cut nail was 3 inch (75mm), and the smallest Ewbank nail was 1½ inch (38mm). There were also 49 kegs of cut floor brads and 13 kegs of wire nails. A similar span of time versus size of product has been observed in Victoria and starting around 1865 it is mostly American cut nails which are found in softwood second fixings; door frames, skirting, quad, and shelving. Ewbanks in the smaller size range are hard to find after this date in softwoods. Significantly, Ewbank nails continued to be used in the smaller size range when used for fixing hardwood shingles.
Perhaps as a result of American pressure, an employee of JJ Cordes and Co, James Heward, lodged a series of patent applications aimed at improving production. In 1881 he developed a new four sided grip to hold the shank prior to the header moving forward to form the head with its patterned trademark. The top die of the grip was retained in place as the top and side dies moved away to let the finished nail fall out. With practice this four sided grip pattern to the underside of head can be easily recognised together with the slight narrowing due to the compression applied under the formed head, thereby establishing another threshold date based on this nail type. This improvement increased production, but the number of earlier pattern nails found in field studies of post 1881 structures suggests that the older machines were kept in production alongside the improved model. The four sided grip nail has shown up occasionally in Victoria, but How found large numbers of this variation in the Lord cottage, dating from the mid 1880s, in Second Valley, near Cape Jervis in South Australia.
Heward also developed a cut nail facsimile of the Ewbank nail based on a pre-profiled sheet, cut into shank sized billets, which whilst hot were subjected to face compression prior to heading. The effect of the face compression caused the sheared sides to become cuspate with no evident shear marks. The head was struck in an accurate form of the earlier head, also with star trademark, but with an entirely regular appearance. It appears that the method used is that shown in the Heward patent of October 1870, no 2711. Although these nails appear superior to the earlier wrought version, they allegedly did not prove so strong in practice. These were introduced to suit those persons requiring a cheaper nail, and were called the T-patent (*The Australasian Ironmonger* , 1887).
In 1889 the Private Company structure became a Public one which may have been a reflection of changes necessary to compete efficiently, and the range of products then extended well beyond just nails, spikes and rivets. In America, the same process was occurring to their cut nail producers as their cut nails came under continuing pressure from the newly introduced steel wire nail which was much cheaper to produce (Lovejoy, 1983).

The foreigner resident abroad

As the patent specification referred to the invention as a communication from a foreigner resident abroad, neither Cordes nor Ewbank was the inventor of the improvements patented in 1834. Since the American efforts from the 1790s on had been directed to perfecting cut nails, with an absence of references to any form of wrought nail machine, or indeed any such material evidence of this type of nail, then the overwhelming probability is that he was European rather than North American. The two brothers-in-law had ample opportunity to meet all types of mechanically minded persons as a result of their Mexican experience, and as a result of their international trade prior to 1834. The generic form of the nail follows more the pattern which was engrained in Britain rather than the Continental patterns so far found. The principle of using rollers to create a part straight, and part tapered shank, after the pattern of English nails, may have come out of their own deliberations. The side guides and adjustable slides were not new developments and may have come from any source since Lucas had business interests both in Germany and Belgium (MLH, 2008). He could not have been Slocum as some American sources seem to suggest, as Slocum was resident at the time in London, neither was he deceased, as was the certain foreigner by October 1835.
The American commitment to the cut nail as a mechanical system was just about absolute and none of the American nail experts mention machine wrought nails and there are no illustrations of any American machine wrought type. Prior to 1820 a lack of infrastructure had limited their industrial development and had stopped access to the inland ore and coalfields. A cheap simple cut nail was quite adequate for softwoods and moreover, the demand for simple nails was such that the various machine inventors could sell these simple ma-

chines in the northern states to farmers, small factories and prisons; in the southern states they were sold to plantation owners, including Thomas Jefferson, using slave labour (Loveday, 1983 p25; Ryzewski, 2008).
A feature of the Ewbank nail is the way the grip is applied to face and rear of the nail shank. This was the reverse of the early American cut nails which until 1830 or so were relatively crude, and Americans themselves commented on the non-functional heading device (Edwards, 1993). By the time the patent was obtained the Americans were already in the throes of changing away from the deleterious side grip system which impaired the head strength (Lovejoy 1983 p17). They changed their gripping system from side to face grip thereby avoiding crimping the layers caused by rolling and turned their technology away from facetted heads to a simpler flush head or "raised bump".

Competitors and experiments

The almost complete absence of any serious rival to the Ewbank nail in south east Australia, suggests that competition was never very serious and only three alternative types of wrought nail have shown up. One of these is a T-head lining nail found in Port Fairy and Yankalilla, as well as the Weald & Downland Museum's bins and in south Wales. The other two are inferior copies of the Ewbank nail which used a rolling technique on a straighter shank and which had quite different heads.
Dos works apparently spent some time involved in lawsuits against "imitators" (Johnson, unpub.). One of the wrought nails found in Portland locations as well as Port Fairy, is based on a tack shape and hence is unlikely to qualify as an imitator, but the other type has passing similarity with the Ewbank shank but with a different head form, suggesting that at least one imitator reached Australia.
Several types of nail cut from pre-profiled sheet show up in buildings in Victoria's Western District built around 1850. The nail shanks are cut from across the shaped sheet and then separately headed, following the usage of American separate heading common in America until the 1830s (Lovejoy 1983 p.17.). Since this was the principle of the later Cordes and Co T-patent nail, it is possible that they were already attempting to develop a more cheaply produced cut nail, like the Americans, but with a shank strong enough for use in hardwoods.
The Americans were not without success in their bid to sell their cut nail machines into Britain, and several of their early machines were introduced, but the only cut nail to meet long term general approval was the cut brad used in softwood flooring (Lovejoy 1983 p.24). This appears in England earlier than America and hence may not be of American origin (How 2009 p.82). Other machines sold to the British may have been modified to create a uniquely identifiable British cut nail. This was generally sturdier and generically similar to the forms produced by hand, but more expensive to produce, as was the Ewbank wrought nail. The other main exemption to this rule is the production of cut tacks which vary so little between British and American types as to be indistinguishable.

Problems with quality control

One of the first issues confronting the Cordes and Ewbank partnership was the unreliable quality of iron nail rod coming from suppliers. A brief account of the steps taken by the factory to overcome difficulties with their initial suppliers of nail rod, was used to advance their sales reputation in Australia. Its states that great difficulty was experienced in getting rods perfectly uniform in quality and finish. To overcome this, a rod mill was added to the factory, with a forge, enabling the factory to keep the process from pig iron to finished nails in their own hands. It shows that in 1887 the factory was producing 200 tonnes of finished nails each week. This was an increase of production from 80 tonnes of nails per week in 1853. The raised ridge, which appears on each side of the unaltered length of nail shank, could be as a result of the factory addressing both quality and tolerance problems within its own slitting mills.

THE NAIL VARIATIONS

Identification of the marks

A set of very distinctive marks and indentations are left by the machine rolling and stretching process, and taking into account minor changes which manifest themselves in any decade, and which presumably come from variables in production such as the temperature of the heated rod, small differences in iron quality, and small differences in machine setting, do not change between 1834 and 1881. The exception to this is shown in fig. 1, which is the star trademark adopted in 1869.

Nail rod used in the original and Heward patents

Nail rod was normally prepared with plain sides direct from the slitting mill, a method little changed from the patent granted in 1588 to Bevis Bulmer (Jenkins, 1971). Detailed pictures by Diderot and by Genin indicate plain side shear rolls, consistent with nail shanks found all over Europe (Diderot,1987pl. 99; Baklanov, 1935 p.107). The sides of the Ewbank nails, however, show a central raised bulge which takes up the middle third of the unaltered section of nail shank, whose purpose can only be to provide extra tolerance to the heated rod when being inserted into the nail making machine. In many cases it is very distinct and can be measured. In other cases, it almost disappears. In common with much of the British nail rod from the eighteenth and nineteenth centuries, the rod is not square sectioned but rectangular, with the depth about 80% of the nail width. It seems highly improbable that the rods were re-rolled after slitting and so it is likely that some variation in the slit-

ting disc edges was adopted to incorporate this distinctive feature. The ridges are gradually ironed out by pressure from the side restraining plates as the rollers proceed to the shank end of the hot nail rod.

Machine marks on the nail shank, 1834 – 1881

These comprise six unique features:
- Side ridges on either side of the nail shank left by the rollers, which are thinner than the the shank to allow free movement. These occur to both top and bottom surfaces of the nail shank.
- Proportional and even tapering of the shank for the bottom three-quarters of its length.
- Opposing, slightly cuspate, but essentially flat surfaces, form the vice compression imprint. These are set at a slight convergence towards the underside of the head and finish with a small 45 degree bevel. The flat surfaces occupy around 20% of the shank length below the head, and the pressed width varies from nail to nail.
- Two non-intersecting shear cuts to the shank end with a fracture join between, creating a spade shaped end.
- One to three transverse, half round indentations across the shank towards the head end, which are the ejection finger marks. These vary in position, and are frequently very faint.
- Rounded haunches on each side under the head, which are rarely equal in size as the head is struck off centre more often than not. Nails made around 1880 are more likely to be symmetrical than the earlier versions.

These marks are shown in figure 4 below.

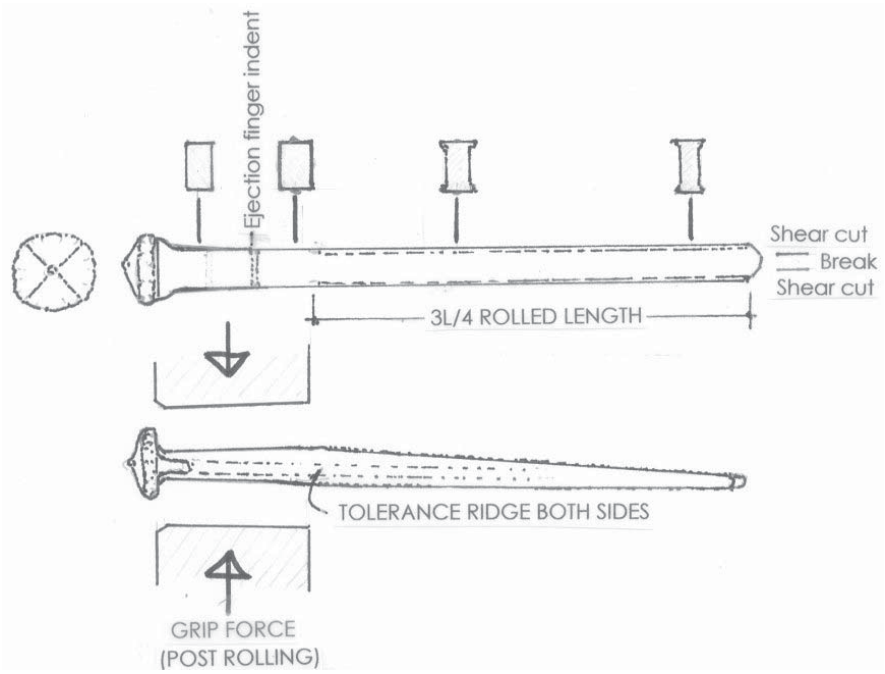

Figure 4: Ewbank nail features in the first two patents

Head features

These comprise the trademark four pointed star, similar to a NATO star for all versions made after 1869, and on very rare occasions it is possible to identify a small pimple at the intersection of the four facets to the head in the version made prior to the trademark adoption, although this is normally obliterated. Other features are:
The head was rarely struck on the nail centreline and so usually appears lop-sided, irregular edges and tiny breaks to the head perimeter show that the spread of metal under impact from the heading device was outside the normal elastic limit and into the plastic zone.

The "Heward" grip, 1881 patent

A square cross-section is created to the haunch by compression of the rectangular sectioned nail rod, described as four die portions moving together to create the grip. There is an odd visual effect caused by the transition in shape of the otherwise normal shank, which appears to have a minor twist under the head. Each corner of the square has a small gusset or haunch, but these are not equal in size. On one diagonal there is a major gusset, and on the opposing diagonal a minor gusset. The length of the grip is much less than before and only occupies about 15% of the shank length. The head is often still off-centre as with the earlier versions.

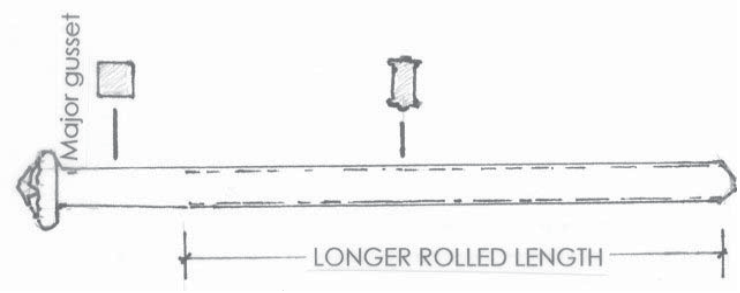

Figure 5: Features of the 1881 square-grip patent

The T-patent

There is no clear date as to the start of production of this cut-nail facsimile but a reference to it in the *Australasian Ironmonger* suggests it would have occurred about 1875. Unlike the above three versions it is not made from rod but from blanks sheared off a profile rolled strip. Distinctive shear marks suggest that the shearing was done with cold strip, and under great pressure. The blanks were then heated and dropped into moulds formed by two cuspate faces, and then compressed. The essential features are:
- Both top and bottom edges on both sides curve down, and no shear burr is visible.
- The two sides are both cuspate.
- The top and bottom are both slightly convex.
- The cross-section is not symmetrical but slightly trapezoidal.
- The head is very regular with no signs of edge break-out as seen in the rod versions.
- The haunches are modeled on the earlier versions but appear symmetrical and regular.
- There is a pronounced absence of burrs and rough edges.

Figure 6: T-patent circa 1893 with chisel point

CONCLUSION

Proper identity of the three versions of the Cordes and Co wrought nails and of the cut-nail facsimile can establish useful threshold dates for construction or phases of construction in the various countries to which the nail was exported. An understanding of the manufacturing process of both wrought and cut nails in the Cordes range will avoid confusion with hand wrought nails of the period.

REFERENCES

Australasian Ironmonger. 1887. April 1st Trade Notes. Sydney.
Baklanov, H.B., 1935: *Metalurgical Techniques in the XVIII Century Urals*. Moscow. Ogisch.
Chaloner, W.H.,ed.Farnies,D.A. &Henderson,W.H.,1990:*Industry and Innovation*. London. Routledge.
Diderot, D, ed, 1751-1780: *L'Encyclopedie*. 35 vols, Paris. Denis Diderot.
Edwards, J.D. and Wells, T., 1993: *Historic Louisiana Nails*. Baton Rouge. Geoscience Publications.
How, C.I.,2009: *The American Cut Nail*, in Lewis, M. ed. *The Pacific Connection*. Proceedings of a seminar at the University of Melbourne. Melbourne.
Jenkins, R. 1971: *Links in the History of Engineering & Technology from Tudor Times.* Cambridge. Ayer.
Lovejoy, A.J. 1983: *The Rise & Decline of the American Cut Nail Industry*. Westport (Connecticut). Greenwood.
MLH. 2008: History of Middleburg Plantation.http://bellsouthpwp.net/r/_/r_timmon/middleburg-MLH.htm
Ryzewski, K. & Gordon, R. 2008: *Historic nail-making techniques used revealed in metal structure*. Historic Metallurgy. Vol 42 part 1. Historical Metallurgy Society. Wakefield Yorks.
Train, G.F., ed. Potts, E.D.& A., 1970: A Yankee Merchant in Gold Rush Australia: Letters of 1853-1855. London.
Today in Science History, 2009. http://www.todayinsci.co/3/3_04.htm

Unpublished references

Bournemouth University. How, C.I., 2006: *Framing Evidences as an aid to dating Pioneer Buildings*. MSc thesis.. Typescript unpublished.
Newport Library. Johnson, M. undated c 2005: *A Place in Time*.. Typescript unpublished.
Newport Library. Johnson, M. 2008: *JJ Cordes & Co., Nail Manufacturer 1835-1961*. Typescript unpublished.
University of Sydney. Varman, R.V.J. 1993: *Bricks and Nails. PhD thesis*. Typescript unpublished.