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The Art of Ornamental Turning

On a day in June 1978 the Liverpool firm of John O'Keeffe & Son, die sinkers and engravers, received a letter from Mr. Warren G. Ogden Jr. of Massachusetts, U.S.A. The letter contained a request for information about a second hand rose engine lathe which had been purchased for £150 by John O'Keeffe on March 28th 1816 from the London firm of Holtzapffel & Co.

This study is an account of my enquiries and researches arising out of this communication, in the course of which I have discovered much of interest about the craft of ornamental turning as well as some local history, the history of the lathe, and also something about the history of my family.

My connection with the firm of John O'Keeffe & Son began in 1956 when I was apprenticed as a die sinker and engraver, and ended when I relinquished my partnership to begin my training as a teacher of craft and design.

It is much to my regret that during the years I spent with the family firm I did not take time to investigate its history. Of the antiquity of the business there was never any doubt, an old letter heading which must have been in use before the last war bore the legend 'Established over a Century'.

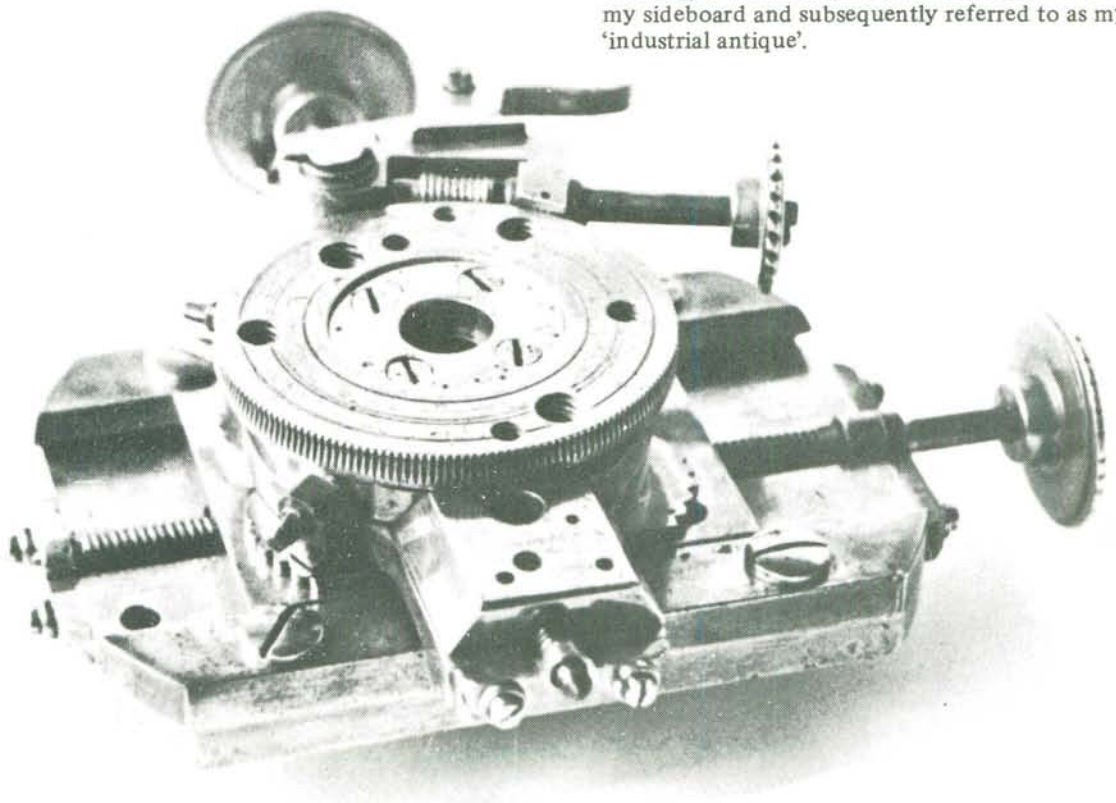
The letter from America contained a copy of a letter from the Liverpool Record Office to Mr. Ogden, which detailed all the references to the family firm in the Liverpool directories. The earliest entry is in the directory for 1818 where John O'Keeffe is described as an engine turner. In 1835 the entry O'Keeffe John, rose engine turner and beer shop appears, and in 1867 his trade is described as rose engine turner and engraver.

In the directory for the year 1868 the following entry appears, O'Keeffe J. and Son die sinkers and stamp cutters, 11 Clare Street. This address remained the home of the firm until 1937.

Mr. Ogden's letter also contained copies of two pages from the ledger of Holtzapffel & Co. which showed the entry of John O'Keeffe's purchase. A list of some of Holtzapffel's customers showing the serial numbers of rose engines they had bought was also enclosed together with a small photograph of a Holtzapffel rose engine lathe owned by Mr. Warren G. Ogden.

Mr. Ogden is engaged in trying to trace the present whereabouts of as many of Holtzapffel's lathes as possible. His purpose in writing to John O'Keeffe & Son was to find out if anyone remembered the machine bought in 1816. According to Mr. Ogden, Holtzapffel & Co. made over two thousand five hundred lathes, and only six complete working examples of their rose engine lathes are known to exist to-day.

Some years ago, in the workshops of John O'Keeffe & Son I discovered the piece of equipment illustrated. After dismantling and cleaning, it was brought home and displayed on my sideboard and subsequently referred to as my 'industrial antique'.



The device consists of two slides and a worn wheel and tangent screw mounted on a brass bed, having a boss on the back. The boss has a tapered thread presumably to allow for fixing to some kind of mandrel. The worn wheel has 180 teeth and the screws on each of the two slides have 14 teeth per inch. The worn wheel also has a number of tapped holes to allow for the fixing of some kind of face plate or work piece.

Nothing was ever found which related to this machine or which might have given some indication as to its function. It bears no marker's name or reference number of any kind, and my father was unable to enlighten me as to its origin.

A number of intriguing questions arise out of the foregoing which seem to warrant further investigation. To begin with there is the question of the rose engine lathe itself. From the photograph in Ogden's letter it appears to be a 'beautiful piece of machinery', to quote Ogden's own words. There is obviously little chance of tracing the rose engine lathe which John O'Keeffe acquired but perhaps it would be possible to examine one like it. It would certainly be interesting to find out how it worked and what kind of things were made on it.

The name Holtzapffel & Co. is unfamiliar to me and perhaps it would be interesting to find out more about them. From the dates mentioned by Ogden it would appear that this company was operating in the same city and at the same time as Henry Maudslay and other pioneers of machine tool development. Perhaps there was some connection between them.

Another intriguing point which emerges from Ogden's letter concerns the list of names he encloses. Of the fourteen names appearing on this list four of them are titled. Could it be that Holtzapffel's lathes were bought mainly by wealthy amateurs? One of Tolstoy's characters in 'War and Peace', Prince Bolkonski, had a passion for wood turning. Perhaps like many fictional characters he was typical of his time.

I am forced, reluctantly, to admit the unlikelihood of John O'Keeffe being a wealthy upper class diletantti, so the question remains why should he spend the enormous sum of £150 on this machine? Although the value of the pound has fallen, due to the long struggle with France. The battle of Waterloo was fought only nine months before. £150 must have represented a substantial investment. Average wages at this time were scarcely more than £1 per week.

It would appear that in 1816 John O'Keeffe was running a fairly prosperous business, but what kind of business was it? What did an engine turner produce? and what were working conditions like in the Liverpool of 1816?

The question of whether there is any connection between my industrial antique and the Holtzapffel rose engine lathe is perhaps the most interesting one of all. The possibility of dating by means of chemical analysis such as carbon dating may be worth exploring. A comparison with a Holtzapffel machine might be a possibility and photographs could be sent to Warren G. Odgen in America.

Although there appears to be a distinct possibility of resolving the question of the authenticity of this relic the question of what happened to John O'Keeffe's Holtzapffel rose engine lathe will probably never be resolved.

My father was the youngest of nine children all of whom have long since died. The family business had been his exclusive concern since the death of his brother and sole partner in the early thirties. The obvious, indeed the only person to consult was my father but at the time the letter arrived from America he was in his ninetieth year with only a few more days of life left to him.

He had suffered a stroke a few months before and when the letter was read to him he was too weak to speak. He was however able to gesticulate with his hand with which he described the action of turning a handwheel of the kind shown in Ogden's photograph. When asked if he remembered the machine he appeared to nod his assent.

To our great regret and evidently to his, he was unable to say anything about the machine or what happened to it. The distinct impression was gained by those present however that he knew of it and furthermore may even have seen it in operation.

The firm of Holtzapffel & Co.

Johann Heinrich Moritz Poppe, in his 'Geschichte der Technologie', 1810, wrote, '... In England the art of turning was highly cultivated, particularly by Germans. The most highly skilled turner in London to-day is still a German by the name of John Jacob Holtzapffel'.[1]

John Jacob Holtzapffel was an Alsation mechanic, born in 1768, who settled in London around the year 1787. He founded the firm of Holtzapffel & Co. who between 1795 and 1914 completed 2557 lathes of all descriptions. These machines included centre lathes for plain turning, rose engine lathes, lathes for ornamental turning, some of which were so complex that they were sometimes described as carving machines, and machines for the printing of bank notes.

Apart from the reference by Poppe, very little has been written about John Jacob Holtzapffel, the work of his son Charles however is much better documented. Charles Holtzapffel was born in 1806, the Dictionary of National Biography says of him, 'In addition to careful training in the workshop he received a good English education, and by assiduous study and practise became a skilled mechanician'. He was the partner and successor to his father who died in 1835. Charles Holtzapffel was a member of the Council of the Institute of Civil Engineers and Chairman of the Committee of Mechanics of the Society of Arts, London.

Holtzapffel was a prolific writer on mechanics, in 1838 he publisehd his, 'New system of Scales of Equal Parts applicable to various purposes of Engineering, Architecture and General Science', followed by a 'List of Scales of Equal Parts' suitable to his new method. This work was concerned with the decimal sub-division of the standard inch, and arose out of his fastidiousness respecting the accuracy

of his work.[2] He designed a number of measuring instruments and indicators one of which was exhibited to The Institute of Civil Engineers in 1842.[3]

Holtzapffel's 'Turning and Mechanical Manipulation' is probably his most important work, part of which was completed by his son, John Jacob the second. This extensive work comprises five volumes, a sixth was intended but never published, and more than 3000 pages, and covers the manufacture of almost everything mechanical which then existed, as well as the workshop practice of the time. The processes described include the maufacture of files, 135 pages on saws, the tempering of metals, the turning of everything, from egg shells to jewels and every kind of cutting and grinding process known at the time.

The fifth volume is the definitive work in English on ornamental turning and has become the bible of the ornamental turner, Pinto asserts that it was this volume which really made ornamental turning into a popular hobby.[4] The last two volumes contain more than a thousand wood cuts all made by John Jacob the second. The Institute of Civil Engineers said of the work, 'These volumes have been received in the most favourable manner, not only by amateur mechanics, but by professional mechanics and engineers, who find in them stores of information, which they perhaps scarcely know where else to seek for'.[5]

Holtzapffel & Co. at various times employed a number of eminent mechanics and craftsmen including J.H. Evans, author of 'Ornamental Turning', 1887, and Joseph Whitworth who also worked for Henry Maudslay and Joseph Clement before starting his own firm in Manchester in 1835.

In the Official Illustrated and Descriptive Catalogue for the Great Exhibition of 1851, there appears the entry, No. 232 of Holtzapffel & Co., 64 Charing Cross Road. The firm exhibited eighteen items including a five inch centre lathe for amateur turners, a compound slide rest with screw cutting attachment and specimens of plain and ornamental turning by amateurs in wood, ivory and cannel coal etc.

Charles Holtzapffel died in 1847 at the age of 41. An obituary notice observed of him:

'Mr. Holtzapffel probably never put his hand to a machine which he did not improve, and his practice in the construction of machines has been more miscellaneous probably than that of any other mechanist, his workmanship more accurate, and his general mechanical arrangements more refined ... he habitually lent such aid to inventors in working out their devices, as sufficed to render hopeless schemes successful ...[6]

Ornamental turning

Ornamental turning should be defined as the use of specialist machine tools incorporating cams, templets or other devices to produce intricate motions, either imparted to the workpiece or the cutting tool. The turning of complex work between centres using hand tools should not be confused with ornamental turning which is the subject of this work.

One of the earliest references to ornamental turning is in the letters of Martin Luther, 1483-1546, who practiced the art as one means of his livelihood.[7] Whether Luther's work was produced by the use of machine or hand tools is impossible to say. The earliest illustration of an ornamental turning lathe is dated 1578. This machine, which is driven by a bow, is the work of Jacques Besson.

An elliptical cross section of the work is obtained through the use of cams located on extensions to the lathe spindle which bear on a guide bar with a templet slot cut in it. Forked hand tools are used with one end having the cutting edge and the other designed to slide in the templet slot. Considerable skill must have been required to operate this machine as well as the strength to turn the workpiece and at the same time lift the heavy guide bar. It must be doubted whether this crude lathe was ever used with success.[8]

Besson was Leonardo da Vinci's successor as engineer to the French court, and he was himself succeeded by Salomon de Caus. In 1615 de Caus perfected a lathe similar to Besson's in which for the first time the workpiece and spindle are pulled against the guide by weighted cords. A continuous drive was used with a flywheel operated by an assistant.[9]

Although the development of ornamental turning took place mainly on the continent, there are some references to the craft in England. In Moxon's 'Treatise on Turning', published in 1680 a Mr. Thomas Oldfield is mentioned as '... an excellent maker of oval engines and swash engines', showing that these machines were then in some demand.[10] Swash turning is the means by which the ornamental balusters on staircases were made using the traversing mandrel or a system of cams like those on the Besson lathe.

Throughout the seventeenth and early eighteenth centuries continental engineers like de Caus depended on Royal and aristocratic patronage. Such patronage was seldom inspired by a desire to improve the lot of the common man by the advancement of science. Any new developments attracted a sophisticated and jaded minority ever searching for excitement and novelty. Hence a great deal of ingenuity and craftsmanship was dissipated in developing mechanical devices for the amusement of wealthy dilettanti.[11]

The demands of this aristocratic clientele led to some of the ornamental turning lathes becoming ornaments in themselves. In order to satisfy the fastidious taste of the amateur turner many lathes were decorated with ornate Rococo scrollwork. When designed with restraint the ornamental turning lathe was often a superb example of refined and complex craftsmanship.

In the early years of the eighteenth century Peter the Great , Tzar of Russia was a devotee of ornamental turning. A workshop was set up next to his reception rooms at the Winter Palace where his personal turner was obliged to be always

Tomlinson's Cyclopaedia of Useful Arts 1868.

Rose-engine turning requires a particular adjustment of the lathe in addition to special chucks for the production of those patterns of curved lines called by the French *rosettes*, from the slight resemblance which they bear to a full-blown rose, and hence the term *rose-engine*. The rose-engine lathe differs from the common lathe in this, that the centre of the circle in which the work revolves is not a fixed point, but is made to oscillate with a slight motion while the work is revolving upon it, the tool being all the time stationary, and hence the figure will be "out of round," as the turners call it, or will deviate from the circular figure as much, and as often, as the motion is given to the centre. See Fig. 2216.

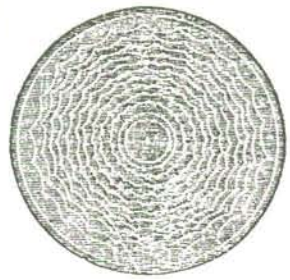


Fig. 2216. THE ROSE.

All work which is to be figure-turned must be held in a chuck screwed on to the end of the mandrel T, Figs. 2217, 2218, which being movable, gives those deviations from the circular form required to form the figured work. For this purpose, the two standards G H, which support the mandrel, are not firmly fixed to the bed A, as in other lathes, but they descend between the cheeks or cast-iron bed almost as low as the bottom of the mahogany bed A, where they are united by an axis P, which is parallel to the mandrel, and supported on pivots at its ends, which pivots being received in pieces of cast-iron descending from the cheeks, and strengthened by an iron bar Q extended between them. The two standards G H are formed of one piece, and have a strong bracing of iron between them.

The work is fixed in a chuck at the extremity of the mandrel, and the tool is held by a slide-rest and adjusts it to the radius of the rose or figure intended to be cut. The oscillating motion is given to the mandrel by means of metal rosettes or wheels fixed upon the mandrel, each having its edge or periphery indented and curved with a waving line, as shown in Fig. 2218. The rosettes are acted on by a small roller at the end of the piece *n*, which is supported by a triangular bar *m* fixed parallel to the mandrel upon the upper end of curved arms. When the mandrel revolves, the eminences and depressions of the rosette applying themselves to the roller, which moves on a stationary axis, will cause a vibratory or oscillating motion of the mandrel and of the frame G H, Fig. 2217, which contains it. Within the cavity of the bed A is a strong spring, applied to the frame of the mandrel, to restore the latter to a central or vertical position when disturbed therefrom by an indentation in the rose. The mandrel M contains 17 rosettes of different patterns. Several are scolloped out like Fig. 2218, but the number of waves or scollops differs from 12, as in the figure, to 144. The socket for the piece *n* can be fixed by its clamp-screw upon any part of the triangular bar *m* in order to bring it opposite any one of the rosettes which it is required to use. Other

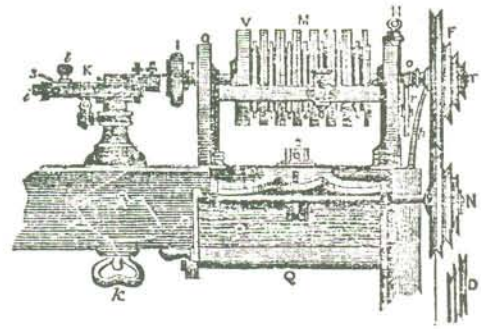


Fig. 2217. ROSE-ENGINE LATHE.

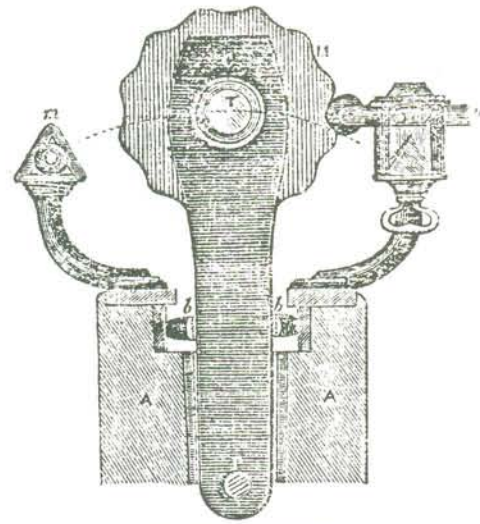


Fig. 2218. ROSE-ENGINE.

rosettes are furnished with convex protuberances. In either case, if the pattern be fine, the wheel on *n* is not used, but the opposite end of *n*, which is rounded, hardened, and polished, to diminish as much as possible the friction of the revolving rosette. The engine is not moved with the foot, but by means of a hand-winch, O, Fig. 2217, fixed upon the end of a spindle, which at the other end carries a small wheel N, communicating by a band with the great wheel. The spindle is supported in a frame attached to the lathe-frame by a centre or joint on which it can be raised up and fixed by a toothed sector to tighten the band when required.

By means of a *straight-line* chuck, the patterns of the rose-engine are made to follow a straight instead of a circular direction.

Art of Ornamental Turning;" and also "Tables by which are exhibited at one view all the divisions of each circle of the dividing plate." The *Mechanic's Magazine* also contains a number of valuable articles on turning.

present.[12] In the Paris Conservatoire there is one of the oldest traversing mandrel lathes known; it was presented to the Paris Institute by Peter the Great in 1717.

In England George the third was well known for his interest in turning. A contemporary working turner is said to have claimed that he could with average industry have earned between 40 and 50 shillings a week as a hardwood and ivory turner.[13] No mention is made of the kind of machine he used but it seems unlikely that he would have used a pole lathe.

During George's reign the industrial revolution was beginning its transformation of his country. By the 1780's Boulton and Watt and their contemporaries had already perfected many of their practical inventions. In the courts of Europe however, the engineers, although quite as clever as their English counterparts, lavished their mechanical brilliance on making toys and automata for rich and royal patrons.[14] It is not surprising therefore, that nearly all the ornamental turning lathes in the London Science Museum are French.

One of these machines, a combined rose engine and medallion lathe is thought to have been the property of Louis the sixteenth, who because of his mechanical proclivities was nicknamed the 'Locksmith'. With the French revolution and the death of Louis and many of his nobles the art of ornamental turning in France declined. No doubt many of the French emigres who settled in England continued to practice the art and this would have been to the great advantage of Holtzapffel & Co.

Holtzapffel delivered his first lathe in June 1795, by the following year he was building his first rose engine lathe, serial no. 16, which was delivered on 17th September 1797. It is possible to be precise about delivery dates because of Holtzapffel's practice of numbering his lathes and recording them in a register of lathes which is now in the Guildhall Library in London.

From this document a very accurate picture of the social status of the art of ornamental turning in the nineteenth century is emerging. In a list compiled by Ogden of lady turners who had bought lathes from Holtzapffel & Co., well over a third were from the nobility, from Marchioness Townsend in 1798, to Lady Ferner Hesketh in 1895.

J.H. Evans in his 'Ornamental Turning' makes numerous references to his aristocratic clients, one of whom, the 4th Earl of Sefton he describes as an expereinced amateur turner. Lady Gertrude Crawford, daughter of the 4th Earl was also an accomplished turner who obtained the highest awards at the competitions of the Worshipful Company of Turners.[15]

It is not difficult to see why the craft of ornamental turning has been associated with the rich and famous. In the first place the cost of the machines rendered them out of reach of all but the very wealthy. Ogden's machine was originally sold for the princely sum of £330. It is interesting to compare this with the simple pole lathe used almost universally by the working turner, which was probably made for just a few pounds.

This comparison with the pole lathe brings me to another reason for the popularity of ornamental turning among wealthy amateurs. Whilst it cannot be said that the operation of these lathes required little skill, it could be claimed that the skill required was of the order of the workmanship of certainty rather than the workmanship of risk.

Of all the traditional crafts none can be mastered without the kind of dedicated application which would rule out all but the most talented amateur. The skill needed to operate a pole lathe could never be acquired during a few hours a week between social engagements. Part of the service provided by Holtzapffel & Co. were lessons on the operation of the lathes and the supply of pre-turned blanks in a variety of exotic woods and ivory.

In his 'Panarama of Science and Art', 1815 James Smith included a section on ornamental turning, which must have been directed at the many amateur practitioners of the art. The following passage from this work seems a fitting summary of its appeal.

'Turning is an Art universally admired, the simplicity of the operation, the facility with which precision in performing it is attained, the agreeable exercise it affords to the mind, the beauty and utility of its products, have drawn, for the amusement of a leisure hour, as well as for objects of real importance, men of all ranks into the number of its practisers'.

The practical and commercial application of ornament turning

Although there is little evidence that the ornamental turning lathe had any direct influence on the general development of machine tools, it is nevertheless true that the rose engine lathe and machines related to it, were in use long before shaping and planing machines were invented. These machines were the first lathes of any kind to do anything more than revolve the work between centres, they could be claimed to be the earliest examples of building the skill into the machine.[16]

Samuel Smiles makes the point that the seemingly frivolous occupation with automata and other devices in the early eighteenth century must have had the effect of introducing workmen to the habits of nice and accurate workmanship which was put to practical effect later, in the making of the self acting lathes, spinning mules and the accurate parts for steam engines.[17]

The rose engine lathe, with its reciprocating and sliding mandrel has one serious defect, its lack of rigidity, this is one of the essential requirements of an industrial metal cutting machine. A rigidly mounted tool positively controlled is essential to achieve true accuracy under heavy loads. The early machine tools of

Maudslay, Clements, Whitworth and others, all have the one common feature, their heavy and rigid construction.

The only feature of the ornamental turning lathe which directly influenced industrial practice was the method of generating screw threads. A series of master threads was cut upon the lathe spindle, which was free to slide through its bearings unless restrained by a catch and groove. With the catch released, one of a series of fixed followers could be engaged with the master thread required. The lathe spindle and workpiece would then begin to traverse longitudinally, enabling the turner to cut the thread on the work using a hand tool and steadying rest. This became the standard method of mechanical screw cutting until the end of the eighteenth century.[18]

From a sliding spindle controlled by a master thread to a sliding rest controlled by a master thread would seem to be a short step. Antoine Thiout, a French instrument maker is credited with this development in 1741 when he perfected a fusée engine.[19] A fusée is a device for regulating clock springs by means of a truncated cone carrying a spiral groove.

This technique was used by Jesse Ramsden in the development of his dividing engine. Ramsden is acknowledged to have produced the first really accurate screw thread and his work may well have influenced Henry Maudslay, with whom lies the credit for the true synthesis of the industrial lathe.[20]

Another use for the rose engine lathe was in the manufacture of pottery. Josiah Wedgwood is said to have got the idea for the use of the rose engine from Plumier's 'L'Art de Tourner', 1701, which is considered the definitive work on the subject, unfortunately there is no English translation. Wedgwood had a number of chapters translated for his own use. Smiles relates an incident in London when the owner of a rose engine lathe refused Wedgwood entry to his workshop without the payment of five guineas.

Later, in 1763, Wedgwood had one made in Birmingham and also found a worker familiar with its operation. The machine was used on his red porcelain and he later applied it in the decoration of his Queen Ware. Obviously Wedgwood was enthusiastic about its use for in 1764 he writes to a friend, 'I have sent you a sample of our hobby horse. This branch has cost me a great deal of time and thought and will cost me more'.[21]

One of Wedgwood's fellow members of the Lunar Scoiety, James Watt, also found a use for the ornamental turning lathe. In 1809 he writes 'There is a machine of the nature of a turning lathe which copies medals and other things in bas-relief: it is called in France tour à medailles, in England the likeness lathe. I have thought of some improvements on it which somewhat extend its uses'[22]

The machines that Watt developed from the medallion lathe, as it is called to-day, were three dimensional copying lathes, capable of reproducing full sized or reduced sized copies of busts and other small sculptures. These machines are now in the Science Museum, together with the rest of his garret workshop where Watt spent many hours during his retirement.

The extremely elaborate patterns generated by the rose engine lathe were used in the making of printing plates for bank notes, as one means of preventing forgeries. The practice was first developed around 1810 by an American, Asa Spencer.[23] Holtzapffel & Co. are known to have made machines used in the printing of bank notes. The process was also applied to stamps, the pattern of fine white lines behind the head of the monarch on the penny black is generated by the rose engine lathe.

The main commercial use for the rose engine lathe was probably in the decoration of gold and silver watch cases. Engine turning for this purpose is said to have been introduced into this country by Francis Guerint of Geneva around 1770.[24] The earliest specimens were cut very deep and therefore only the heavy cases were so treated. Later the divisions became finer and shallower and it is in this form of engine turning, also known as guilloché which is most common.

An early writer on South Lancashire, 1795, refers to the area between Prescott and Liverpool as, '... the centre of the manufacture of watch tools and movements'. He goes on to describe the various parts manufactured, which included watch cases. Another writer also in 1795 indicates quite clearly the state of the watch trade at that time. 'In the year 1792 it is supposed there were made up in Liverpool and its neighbourhood not less a number than five thousand watches some of which were very valuable'.[25]

During the first half of the nineteenth century America became the main market for Liverpool watches. An article in the 'Liverpool Review' refers to Liverpool's strong maritime links with America and the fact that, 'A good Liverpool watch was prized above all others in the U.S.A.' This market was served by some two thousand watch makers working in the old and inefficient cottage industry system'.[26]

The decline of the South Lancashire watch trade is attributed to two factors, both connected with America. From the mid nineteenth century onwards America began producing her own watches using modern methods based on interchangeable parts and the use of machines within a factory system. The competition from this quarter was felt in all sections of the watch trade but nowhere more so than in Liverpool.[27]

The American civil war, 1861-1865 was also disastrous for the Liverpool watch trade, just as it was for the cotton trade. The blockade of the southern ports, as well as the difficulties of doing business in a country in turmoil, lead to the flow of Liverpool watches into America dwindling to a trickle.[28]

Although I have found no direct evidence to connect John O'Keeffe's purchase of a rose engine

lathe with the watch trade, it seems a reasonable assumption, in view of its location, that his business as an engine turner was concerned primarily with the decoration of watch cases.

On the birth certificate of my paternal grandfather, who was born in 1841, his father John O'Keeffe is described as a tornographer. Tornographic seals were made by the family firm in the early years of this century, whether on the rose engine lathe or on some other machine we have no way of knowing. It may be that the decline in the demand for engine turned watch cases led John O'Keeffe or his son to dispose of the rose engine lathe in the latter part of the nineteenth century.

During the grim years of economic stagnation in the nineteen thirties the family firm was moved by my father, from a large but dilapidated building to new premises which were very much smaller. The old building, which the firm had occupied for more than seventy years was condemned as unsafe, and collapsed shortly after being evacuated.

My father often used to relate how he was forced, with great regret, to abandon large quantities of machinery and equipment, much of it old and out of date, because he could find no room for it in the new workshop. The awful possibility must be considered that Holtzapffel's rose engine lathe, by then possibly thought to be of no further use, was abandoned with the rest of the machines to be shortly buried in the ruins of the old building.

Editor's Note: This account is part of a student dissertation, also for Liverpool College of Higher Education, arising from an investigation of the author's family business founded in the early 19th century.

References

1. Eckhart, 464.
2. Austin, p.viii.
3. I.C.E. minutes of proceedings vol. 7 1848, p.14.
4. Pinto, p.385.
5. I.C.E. minutes of proceedings vol. 7 1848, p.14.
6. Austin, p.viii.
7. Mallett, p.293.
8. Rolt, p.33, Woodbury, p.58.
9. Rolt, p.32, Woodbury, p.60.
10. Smiles, 1867, p.208, Eckhardt, p.464.
11. Rolt, p.33.
12. Britkin.
13. Smiles, 1867, p.210.
14. Bronowski, p.265.
15. Abell, p.14.
16. Rolt, p.33, Twiddle, p.6.
17. Smiles, 1867, p.210.
18. Rolt, p.35.
19. Rolt, p.37, Burke, p.145.
20. Rolt, p.39.
21. Smiles, 1894, pp.55, 69.
22. Dickinson, p.192.
23. Mackenzie, p.34.
24. Britten, p.226.
25. Smith, pp.12, 13.
26. Liverpool Review, 24.8.1892.
27. Smith, p.14, Liverpool Review.
28. Liverpool Review.

Bibliography

Abell, S.G., Leggat, J. & Ogden, W.G. Jr. A Bibliography of the Art of Turning and Machine Tool History. S.O.T. (1950).
Beigbeder, O. Ivory. Weidenfeld & Nicolson (1965).
Britkin, A.S. & Vidonor, S.S. A.K. Nartor, an outstanding Machine Builder of the Eighteenth Century. Israel program for Scientific Translations (1964).
Britten, F.J. Old Clocks and Watches and their Makers. S.R. Publications (1932).
Bronowski, J. The Ascent of Man. B.B.C. Publications (1973).
Bryant, A. The Years of Endurance. Book Club Assoc. (1975).
Burke, J. Connections. Macmillan (1978).
Camerer Cuss, T.P. Antique Watches. Antique Collectors Club (1976).
Dickinson, H.W. James Watt. Cambridge Univ. Press (1936).
Doane, G.H. Searching for your Ancestors. Oxford Univ. Press (1960).
Eckhardt, G.H. The Art of Turning. The National Assoc. of Watch & Clock Collectors Inc. U.S.A. (1957).
Evans, J.H. Ornamental Turning. Published by the Author (1887).
Holtzapffel, J.J. Turning and Mechanical Manipulation, vol. V with introduction by Austin, R. Dover (1973).
Mackenzie, A.D. The Bank of England Note. Cambridge Univ. Press (1953).
Mallet, R. Record of the Great Exhibition of 1862.
The Official Descriptive and Illustrated Catalogue of the 1851 Exhibition vol. III.
The Crystal Palace Exhibition Illustrated Catalogue (The Art Journal). Dover (1970).
Pinto, E.H. Treen & other wooden bygones. G. Bell & Sons (1969).
Roe, J.W. English and American Tool Builders. Oxford Univ. Press (1916).
Rolt, L.T.C. Tools for the Job. B.T. Batsford (1965).
Smiles, S. Industrial Biography. David & Charles (1867).
Smiles, S. Josiah Wedgwood, F.R.S., His Personal History. John Murray (1894).
Smith, A. The Lancashire Watch Co. 1889-1910, part 1. Roberts Pub. Co.
Smith, J. Panarama of Science & Art vol. 1. Nuttal Fisher (1815).
Tweddle, N. The Rose Engine Lathe. S.O.T. (1956).
Woodbury, R.S. Studies in the History of Machine Tools. M.I.T. Press.