Gravure Stamp Cylinders: Part 3

by Glenn H Morgan FRPSL

With Part One having recorded traditional cylinder making processes and Part Two detailing modern methods up to the metal deposition stage, Glenn now completes the story.

Surface profiling The cylinder is next treated by machines such as a Polish Master or a CFM (think 'lathe'), Swiss made machines that create a surface profile that is intentionally not a 100% mirrored and flat finish. If the cylinder was to be perfectly parallel when rotating on the press, the doctor blade and cylinder would be touching (i.e. metal-on-metal).

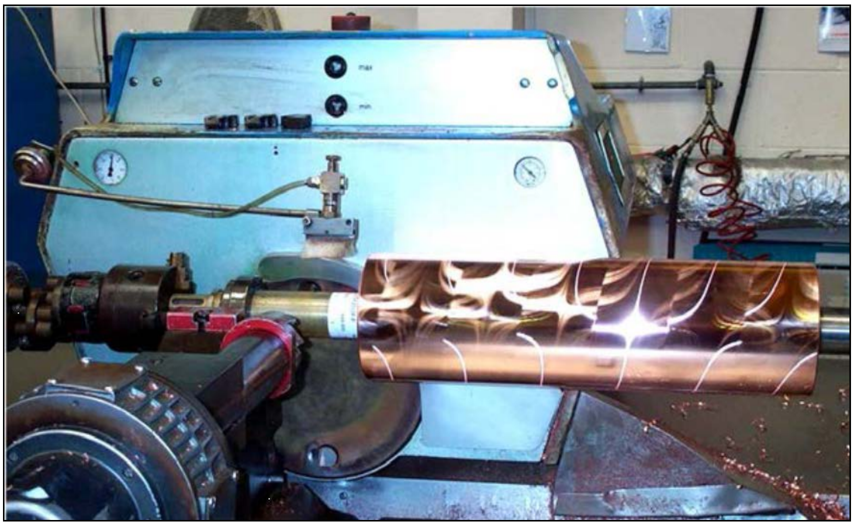


Fig 1 The wave effect being created on a cylinder. *Image © Saueressig Ltd.*

Fig 2 A series of spiral waves, each 70mm wide. *Image © Saueressig Ltd.*

There would therefore be no lubrication between the metals and so the Polish Master *(Fig 1)* creates a one or two micron surface profile known as a 'spiral wave' *(Fig 2)* across the cylinder that gives the doctor blade a series of peaks to 'sit on', with gaps in-between enabling a small amount of ink to be between the two pieces of metal providing just enough lubrication. The life of the cylinder is prolonged as a result and problems with ink printing on non-image areas of a stamp is prevented.

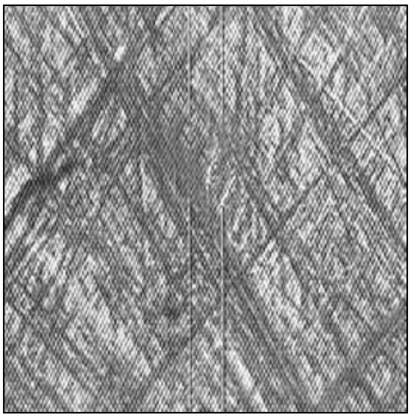


Fig 3 The effect of scratching the surface under high magnification. *Image © Saueressig Ltd.*

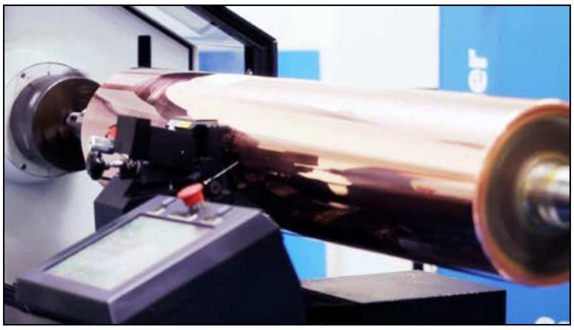


Fig 4 The Hommel Tester taking measurements of the intentionally scratched cylinder. *Image © Saueressig Ltd.*

A rough surface The cylinder surface is also given a slightly rough texture *(Fig 3)* using a polishing stone or paper. The roughness required for a particular cylinder adheres to a written specification and this is measured by a piece of equipment known as a Hommel Tester T1000 *(Fig 4)* that sits on the cylinder and uses its in-built probe across the entire cylinder width to measure any deviations from the specification. A consistency between all peaks and troughs on the trace is required because, in rare instances, these roughness scratches if too deep could act like a long gravure cell, hold ink and end-up printing on a stamp.

The scratches, along with the wave, will help provide a clean print effect, giving the printer the best possible opportunity to produce a stamp that is free of any imperfections. The cylinder maker cannot, of course, do anything about the environmental conditions at the printer, such as any dust in the air, heat or temperature issues.

DLE Cylinder preparation

Cylinder preparation methods for DLE machines are similar to EME, i.e. a steel base followed by a nickel then copper coating, but the process then differs in that, until recent developments, it was further over-coated with an epoxy resin or zinc before laser engraving could commence. This extra top coating was applied because the copper surface was so highly reflective of the laser light when engraving. However, advances in laser technology means that the laser beam is now so fine and the power of the laser light so high that the cells for the ink are able to be created by directly melting away the surface of the copper (known as 'ablation') without the need for resin or zinc.

The laser burns the surface at the rate of around 70,000 cells per second and can take as little as a few minutes to fully engrave each cylinder, which is then coated with chromium for longevity, as with other systems. This direct laser engraving technique is especially useful for the reproduction of soft vignettes and, according to Hell, is 'rapidly becoming a high quality alternative to EME'.

Cylinder engraving

The systems From day one, Apex used the Ohio engraving system and currently has four traditional EME engravers in use. This number is down from five as the latest models offer faster output and quality and so four modern machines can produce a greater cylinder output than five older models, freeing-up valuable floor space.

Fig 5 Managing Director of Saueressig UK, John Gilmour *(left)* and Technical Director Allan Bendall with their latest Ohio 'Hybrid' engraver.
Image © Saueressig Ltd.

In 2012, Apex acquired its first Ohio Hybrid Engraving System *(Fig 5)*, stating at the time: *"The Ohio Technologies Spectrum engraving machine is a new piece of kit that has the latest Hybrid Engraving system, which is more productive than the established technology, saving time and money. The new Hybrid system engraves the complete tone scale, using a conventional diamond-engraved cell shape for the most efficient ink transfer."*

Cylinder engraving
a) EME *(left)*, **b) Hybrid EME** *(right)*.

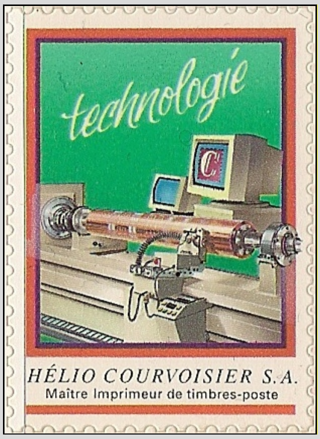
Four point
© symbol

Printed result
c) EME *(left)*, **d) Hybrid EME** *(right)*.

Figs 6a-d Cylinder engraving and printed result of a four point © symbol
enlarged here to an image height of 100 point to reveal the detail now achievable.
Imagery courtesy of Kent Seibel, Ohio Gravure Technologies Inc, USA.

These hybrid engravers are of special interest for security work, as banknotes and stamps often incorporate high volumes of ink and extremely fine-line features, such as the copyright symbol shown here *(Figs 6a-d)*, and is what Ohio 'Hybrid' engraving (or the equivalent Hell 'Xtreme') excels at, eliminating the broken-up appearance of the earlier electronic engravers. It achieves this by thinking on the fly and inserting extra random odd-shaped cells to fill-in what would otherwise be saw-tooth (jagged) edges to text and imagery.

Engraving Whether the cylinder maker uses an Ohio, Hell or Daetwyler electronic engraver, the blank cylinder is loaded and its cells are created, each one being less than a single grain of sand in size. The aim is to cut these minute cells to the desired depth (generally between zero and 70 microns) to enable the intended density, or tonal range, of the image to be consistently transferred to the substrate when printing, producing a solid area of colour.



In 1991, Hélio Courvoisier s.a. of Switzerland became the first stamp printer in the world to print postage stamps from cylinders engraved by an Ohio electronic engraver that incorporated a vacuum system used for extracting the copper debris.

Shown here is a dummy stamp depicting the electronic engraving of a stamp cylinder at Courvoisier.

With an Ohio engraver, cells are cut by a 'diamond stylus' tool that consists of a triangular cross-section capable of engraving an upturned pyramid. The digitised image data gets converted to an electronic vibration that produces a mechanical motion in the stylus, producing cells at the rate of around 8,000 per second.

It can take between 15 minutes and almost a day to engrave a complete stamp cylinder, depending on the design complexity and intended sheet size. The use of a fine screen and Ohio's 2008 innovation, tranScribe with AccuEdge (which allows fine detail to be more precisely engraved, thus printing with better results) will take far longer than straightforward engraving.

The darker the desired image area, the deeper the cuts into the cylinder (i.e. closer to 70 microns in depth) and, conversely, the lighter the desired image, the shallower the cuts (nearer to zero microns). The depth achieved is controlled by the amount of voltage that is applied to each cell being cut into the copper.

The diamonds used in the Ohio engravers may comprise the hardest naturally occurring mineral, topping 'Mohs' Scale of Hardness' with a relative hardness value of 10, but if they chip when in use then not only is there the cost of replacement of the stylus, but the cylinder engraving will need to start over. Some cylinders can take up to 18 hours of continuous operation to engrave, as with the recent Amethyst Purple Machin head stamp, and had the diamond failed towards the end of this job it could soon have put the entire factory behind schedule. Fortunately, this is a rare occurrence.

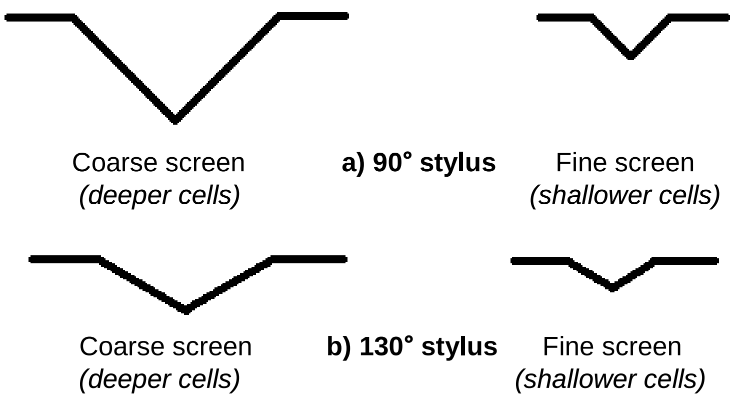
There is always a separate cylinder created for each colour, which often comprises the four colour process (CMYK) plus, potentially, extra 'spot' (Pantone) colours and phosphor tagging. A Royal Mail stamp product, such as a booklet (which is printed on both sides of the substrate), could therefore require eight or more cylinders to be produced.

The stylus cuts away the copper in much the same way as the use of a burin (a sharp pointed engraving tool) by an intaglio engraver. The copper debris created by this engraving process is collected through a scraper affixed to the engraving head in conjunction with a vacuum system so that the metal may be recycled. This operation is known as 'deburring' the copper surface.

<u>Screen types, stylus angles and screen angles</u> There are an infinitely variable amount of cell shapes, stylus angles and screen angles that can be created by the diamond stylus (EME) method and is one reason why Saueressig UK use Ohio, as DLE engravers use static shapes, sizes and screen angles.

Coarse and fine screens Coarse screens (with their deeper cells) enable a heavy amount of ink to be applied to the substrate in a given area, which is useful for, say, a solid background. The flip side is that coarse screens create large 'saw-tooth' edges that will be visible. Fine screens (with their shallower cells) have smaller cells and so these jagged edges are noticeably reduced, as with the small background text found on the gravure printed 'Post and Go' labels.

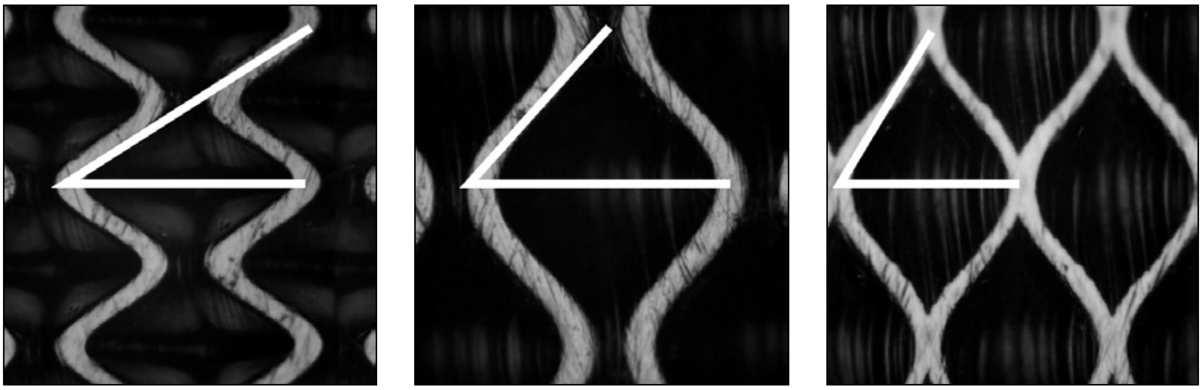
Stylus angles Along with the variation in screens, there is the ink capacity of each cell. The angle of the stylus *(Figs 7a-b)* will impact on this, so anything between a 90° stylus through to around 130° will be used. The topographic view from above the cylinder will be the same, the only difference will be the volume of ink that can be carried in the cell.



Figs 7a-b The chosen screen and stylus angle is important for ink release.

The shallower the angle of the stylus (as with 130°**)**, the more opportunity there is for fluid dynamics to play their part in extracting the ink, but some steep angles (say, 90° stylus angle) will not be as receptive to letting the ink out of the cell through capillary action with as much as 50% of the ink remaining in a cell. A shallower cell angle may allow 60/70% ink release, which assists the printer by making it easier and more efficient for presses to extract the ink.

Screen angles The final element relates to the angle of the cell *(Figs 8a-c)* and this is most critical when using the four colour process, or screens that need to match to each other. If there is not a compressed or elongated cell structure you will end-up with a moiré pattern or screen-clash / cross hatching.



a) 30° Compressed cell **b) 45° Normal cell** **c) 60° Elongated cell**

Figs 8a-c Different screen angles provided different ink release characteristics.
Images © Saueressig Ltd.

A 30° angle gives the perfect screen match with a precise rosette pattern, but the faster the engraver is working the less it copes with engraving that particular screen angle, which is why 32° or 34° is used at Saueressig, as it gives that bit more flexibility.

DLE machines use 37° maximum compression and you will always see some form of screen-clash on the printed product because it cannot accurately create the perfect rosette pattern required to achieve ideal print appearance.

Knowledge of what works best is not a mathematical art, but the result of much experience and liaison between Saueressig, the ink supplier and the stamp printer over many years.

Retouching cylinders The retouching of cylinders was consigned to history at Saueressig Bristol when carbon tissue ceased to be used to transfer images to a cylinder. Today, with the use of high-speed lasers or styli, it is quicker to simply de-chrome and skim-off the top engraved copper face, giving a smooth surface on which to start again and re-engrave corrected imagery instead of laboriously amending the cell structure manually cell-by-cell.

A cylinder can be re-coppered and re-engraved many times and is why there are seldom differences between stamp images on sheets and why 'constant varieties' are rare today.

Warts and all....
It should be noted that the laser or stylus will always engrave what the computer file contains, including mistakes, so any desired amendments, including colour value corrections or adjustments, must be made as a part of the pre-press stage.

The missing currency symbol stamp (left stamp), which occurred once in every 400 stamps.

Where there is an undetected problem with the master computer file, then it is inevitable that the error will be sold across a Post Office counter. An example that 'escaped' is the missing currency symbol found once per sheet on Royal Mail's £2 definitive stamp from 2003, where a print run of 35,000 sheets containing the omission was printed by De La Rue. Subsequently withdrawn from sale, it is unclear how many examples may have been saved in collections; some say around 5,000 copies.

Chroming

With cylinder engraving completed, 8 to 10 microns of industrial strength chrome is applied to the surface by electrolysis *(Fig 9)*. A cylinder becomes four to five times harder wearing than the copper surface once coated than if left untreated. Indeed, an unchromed cylinder would only last a few thousand metres before degradation occurred, with proofing always undertaken on chromed cylinders, unlike in the acid-etching days when Harrison used unchromed cylinders.

Chrome takes on the surface qualities of the copper, i.e. it follows its contours. It has been proved by Daetwyler research that the chrome *always* follows the shape of the copper under it and does not fill the cell with the chrome as might be expected.

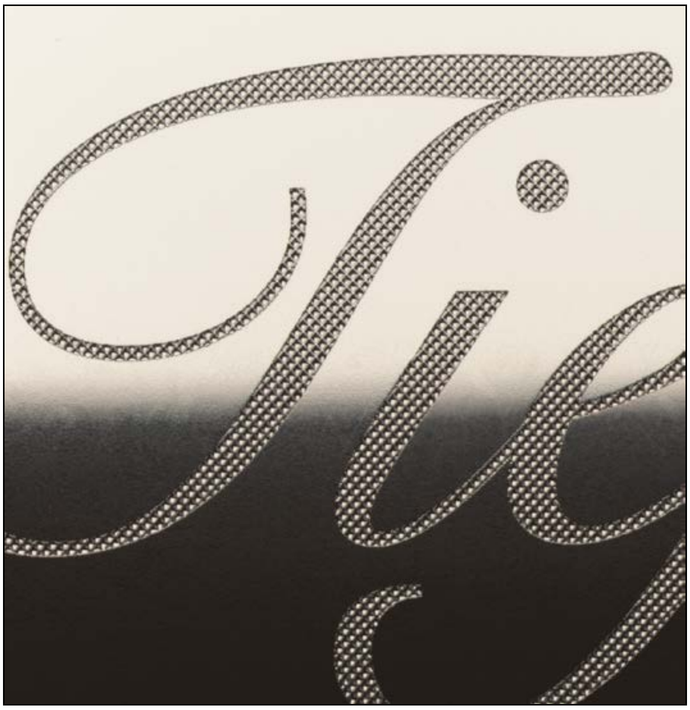


Fig 9 Detail from a Saueressig gravure cylinder that has been chromed.

DLE is a single-use process and so cylinders cannot be re-chromed, whereas EME cylinders can be de-chromed, refurbished, re-chromed and re-used, often being put back on press to complete a print run at a later date, although the security printing industry does not do this, preferring instead to use a newly engraved cylinder and avoid the risk that the refurbished cylinder may have become slightly less effective.

Wet proofing

Once the cylinder has passed inspection, each image-carrier passes through the proofing department, where the cylinders are printed from and tested, often using the exact ink and substrate to be used for the live job to monitor accuracy and printing behaviour. When actual materials are not available, house supplies are used that closely match the intended ink and substrate, but these proofs can then only be used for checking content, not the colour.

Fig 10 The single colour Heaford proofing press.
Image © Saueressig Ltd.

The single colour wet proofing press *(Fig 10)*, made by J M Heaford Ltd. of Altrincham, comprises a barrel to which is applied up to three metres of substrate. The first cylinder is then mounted, but not before a cross has been placed in the identical place on each cylinder to assist with registration between colours. The cylinder is then locked into position and ink is applied between the doctor blade and image carrier and is dammed into place with cotton wool balls. It is is then revolved, picking up the ink and creating a print on the substrate.

Once the entire sheet is printed with all of its colours, each cylinder is then printed again in a cyan (blue) ink only and on a standard (constant) material to act as a control sample. This enables variances across the web to be detected, such as colour density, and ensures that cylinder A matches cylinder B, etc. If a stamp printer subsequently came back claiming an inconsistency across the web, the first thing would be to get them to turn the cylinder around as a fault-finding device. The initial cyan colour progressives would then be shown to prove that the problem must lie elsewhere and Saueressig would work with the printer to resolve the issue.

Incidentally, cyan is chosen as the ink colour for the second round of proofing as it does not have to be mixed with anything else and is very good at spotting imperfections. Green or black ink has been used in the past, but the latter is full of imperfections, so would not give such a pure and clean rendering as cyan does. Also, paper blemishes tend to be black or grey, but never cyan!

Saueressig works to a 100% proofing policy with nothing leaving the factory until fully approved internally.

There were no postage stamp cylinders passing through the factory on the day of my visit, so I show here a proof-pull of the top panel from a Royal Mail 2nd class Business Sheet *(Fig 11)* and enlarged stamp from it *(Fig 12),* as produced at another cylinder maker a short while prior to its demise some years ago.

Fig 11Top panel of Royal Mail business sheet proof.

Fig 12 Enlarged 2nd class stamp proof.

The proof is incomplete as the coloured Royal Mail cruciform logo is absent and note how it bears an overprint in blue of the intended phosphor band layout, which is there to check for correct registration. Collectors of modern GB material will realise that the proof stamps are in a colour that was not adopted for the second class definitive.

Inspection and despatch

Understandably, inspection is of prime concern when producing a cylinder for printing stamps and there are checks and quality procedures in place throughout the entire manufacturing process.

The cylinders are first examined by the QA department and checked against the original written specifications for the job prior to proofing. Microscopes are used to examine the cell structure of each cylinder to ensure that they are within the pre-agreed tolerances. The cylinder is then polished in readiness for the proofing process described above.

Just like a keen stamp collector, the Saueressig team then look for cylinder flaws when carrying out their checks, but with a view to eradicating them before they reach a Post Office.

After all checks have been made, a QA Report is produced on every cylinder confirming that all aspects are accurate, including details of the cells under a microscope, screen used, depth of the cells, angle of the stylus, channel between cells, surface roughness, etc. Nothing is left to chance and if a problem is highlighted, instructions will be issued for a re-make of the cylinder if it does not reach the high-standards expected by Saueressig and its clients.

Once the proofing exercise and QA aspects are deemed accurate, the cylinder is securely wrapped, crated and shipped ready for use by current Royal Mail printers De La Rue or ISP.

Future advances

Advances in laser technology, including Pico Laser for micro-print and text-in-text *(Fig 13)* features, are set to take security printing to the next level.

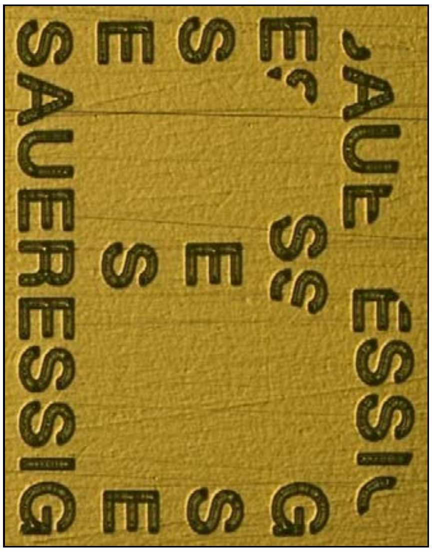


Fig 13 Amazingly, the repeat word SAUERESSIG forming the letter 'B' is a mere 100µm in height, while the entire letter 'B' is just one millimetre tall. *Image © Saueressig Ltd.*

These technologies have yet to be used on postage stamps, but may well be a common element of stamp production one day in order to offer the latest security protection and to remain one step ahead of the counterfeiter.

A final word

With the falling use of stamps and ever-smaller print runs, gravure and its stranglehold on British, indeed worldwide, stamp production has been broken by the offset process. A combination of sheet-fed and web-fed gravure printing had been the mainstream process for British definitive stamp production since 1934, but offset is now increasingly used, especially for the printing of commemorative stamps. This change is due to the improved quality now achievable by offset and the lower cost of printing by that process.

Looking through recent stamp new issue pages of *GSM*, it becomes clear that very few countries now utilise gravure for stamp printing, with PRC, Italy, Japan, South Korea and USA being some of the major countries outside of the UK who still regularly use this method. Only time will tell the extent to which gravure will continue to be used by Royal Mail.

While intaglio and letterpress are employed far less frequently these days, they *are* both still periodically in use and I suspect that gravure will also continue to be utilised for stamp production for many years to come and, if so, then no company is more capable of meeting printing cylinder needs better than Saueressig. Indeed, Royal Mail is clearly impressed with its cylinder maker, as the Artwork Manager, Stamps and Collectibles, stated on the pre-Saueressig website: *"Apex Cylinders has always provided us with an outstanding service, both in terms of the quality demanded and the very tight deadlines involved. We have been very impressed with them indeed, to say the least, as the work itself is quite demanding, particularly due to the security requirements of working with stamps."*

Saueressig UK is not reliant on offering its studio and its cylinder making facilities to Royal Mail as a means of remaining viable as a company thanks to the diverse categories of client that it works with. That said, the prestige attached to producing such crucial components of the stamp production process cannot be underestimated. When talking to staff throughout the factory, it was apparent that they were all extremely proud of their involvement with helping to create British postage stamps.

Further reading

There are innumerable articles and books on the subject covered in this article. A selection that proved especially useful as background reading are recorded here.

Blaney, Henry R. *Photogravure.*
Book. Published by The Scovill and Adams Co [USA], 1895. Non-philatelic.

Cartwright, H Mills. *Notes on the rotary photogravure process.*
Book. Published by The Autotype Co Ltd [GB], undated but probably 1940. Non-philatelic.

Conlon, James A. *Growth of gravure in postage stamps - parts one and two.*
Article. *Philateli-Graphics* [USA]. October 1982 and January 1983.

Ellis, Howard. *Printing processes: photogravure*.
Article. *Stamp and Coin Mart* [GB], December 1990.

Harrison & Sons. *Harrison & Sons Limited, postage stamps / photogravure.*
Brochure. Published by Harrison, c1967.

Harrison & Sons. *Harrison + Sons Limited, postage stamps.*
Leaflet. Published by Harrison, c1967.

Harrison & Sons. *How photogravure stamps are made.*
Article. *Printing World* [GB], then reprinted in *Stamp Collecting* [GB], 3 February 1967.

Harrison & Sons. *Harrison & Sons Limited, security printers for the world.*
Brochure. Published by Harrison, c1981.

Jessop, Philip. *A new look at the Elizabethan specials*.
Article. *Gibbons Stamp Monthly* [GB], September 1974.

Lilien, Otto M. *History of industrial gravure printing up to 1920.*
Book. Published by Lund Humphries [GB], 1972.

Mackay, James. *The introduction of photogravure.*
Article. *Gibbons Stamp Monthly* [GB], September 1993.

Mackay, James. *The introduction of photogravure.*
Article. *British Philatelic Bulletin* [GB], August 2004.

Mackay, James. *The first photogravure issues.*
Article. *British Philatelic Bulletin* [GB], September 2004.

Melville, Fred. J. *The photogravure process - parts one and two*.
Article. *Gibbons' Stamp Monthly* [GB], May and June 1935.

Morgan, Glenn H. *75 years of British stamps by photogravure*.
Article. *British Philatelic Bulletin* [GB], August 2009.

Morgan, Glenn H. *Stamp production: gravure*.
Web article. Royal Mail Stamps and Collectables, 2007.

Ray, Leslie R and Rogers-Tillstone, B. *Background to philately: an anthology*.
Includes article by Sir B Guy Harrison from 1932 entitled *The photogravure process as applied to postage stamp printing*. Book. Published by Blandford Press [GB], 1953.

Robinson, Barry. *How stamps are printed by the photogravure method.*
Article. *British Philatelic Bulletin* [GB], January 1989.

Rosenblum, Larry. *Great Britain celebrates 75 years of multicolor photogravure stamps.*
Article. *Scott Stamp Monthly* [USA], February 2010.

Williams, LN&M. *Gravure printing methods.*
Article. *Stamp Weekly* [GB], 4 January 1968.

Acknowledgements

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