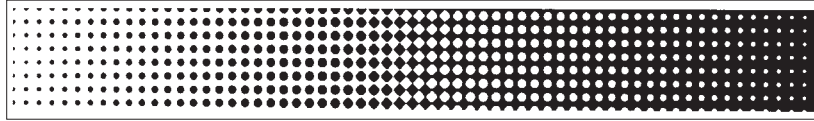


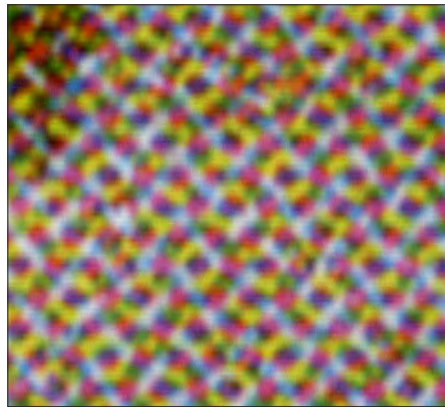
Tone and Colour



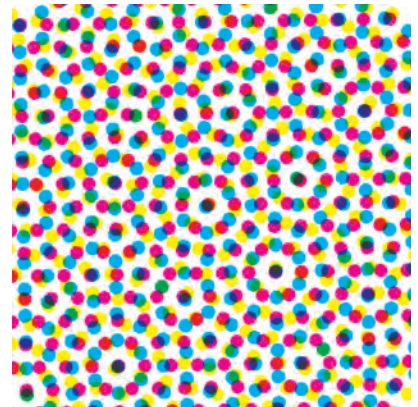
Exaggerated example of halftone screen of grey wedge



Simulated with black included

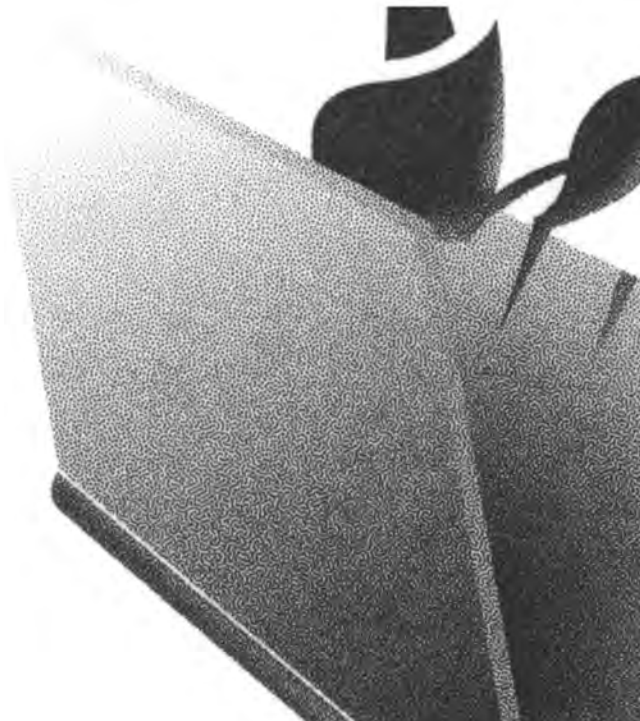


Printed sample



Simulated with black omitted

Halftone colour screens



Stochastic screening

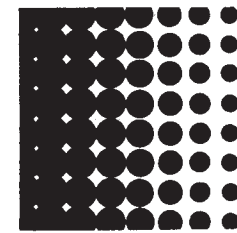
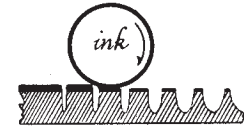
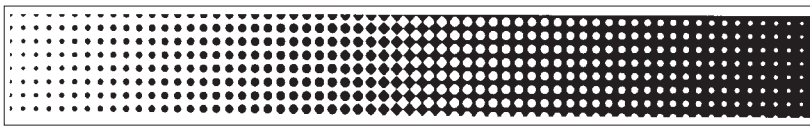
Producing Variation of Tone in a Printed Image

Halftone – Letterpress and Lithography

Below is a wedge where the *colour* changes from white through darkening shades of grey to black. No printing press, or computer printer, can reproduce different tones, they can only print shapes in one solid colour at a time. To produce different tones – densities of colour – the image is broken down into a series



of small dots not discernible to the unaided eye. The larger the dot the darker the colour. The process of breaking a grey image into small dots is

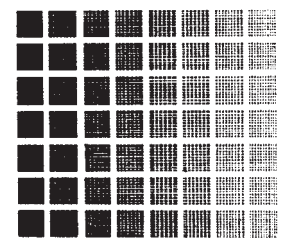
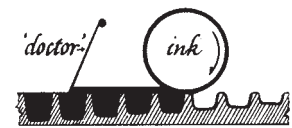


called halftoning. This is done by photographing it through a rectangular ruled screen of between 150-300 lines to the inch and in some *experiments* as high as 800. The screen is at 45° to the horizontal to give better reproduction of horizontal and vertical lines. The second image is an exaggerated version of the first using a very coarse screen. Halftone images are used in both letterpress and lithographic printing.

Gravure

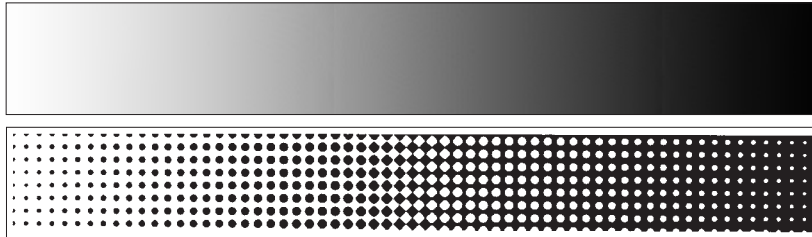
Variation of tone is produced by breaking the image into fine cells all the same size but of differing depths. The deeper the cell more ink is transferred to the paper producing a darker image. Until recently the cells were produced by a photographic process for laying down the design followed by etching. Modern techniques use mechanical *etching*.

The printing process is essentially intaglio. The cylinder is flooded with ink and the excess scraped off the surface by a doctor blade leaving ink in the etched cells. The ink is drawn out of the cells onto the paper under high pressure from the impression cylinder. The paper web passes through a dryer before printing the next colour.



Full Colour Printing – Halftone & CMYK

So called full colour printing is done with the three complementary colours Cyan, Magenta and Yellow with the addition of black (CMYK) since the three complementary colours when combined do not give a strong black. It uses halftone to get gradation of tone. To prevent any undesirable Moiré patterns the screens are set at an angle to each other. In normal commercial printing the screen frequency is of the order of 150 lpi. In stamp printing screen frequencies up to 800 lpi have been used. This is the process used today for lithographed British stamps in full colour. The perception of continuous tone and a full colour picture takes place in the eye which merges the dots and colours.



A grey-scale wedge and an exaggerated representation of how it would be reproduced in halftone.



An enlarged representation of the four colour screen pattern.

There is no restriction in the number of colours used when printing, the CMYK scheme is the minimum for *full colour*.



Printed by Gravure with the process colours CMY and grey substituted for black and the addition of gold.



Printed using the standard CMYK process colours. The numbers in the colour patches give the sequence of printing.

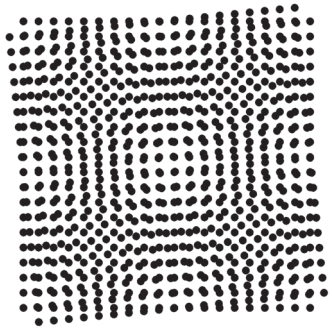


Printed in gravure using the colours, bright green, greenish yellow, magenta, new blue, black and gold.

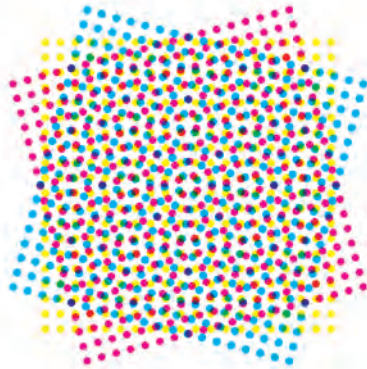
Colour Screens and Screen Angles

Colour printing uses four colours Cyan, Yellow, Magenta and Black. The black is added to strengthen the *black* created by the mixing of CYM which often is a rather muddy black/brown. A different screen angle is used for each colour giving a pattern of rosettes. This separates the dots allowing colour mixing in the brain when the image is viewed at a distance where the screen is not discernible. The screen angles are chosen to prevent undesirable visible Moiré patterns.

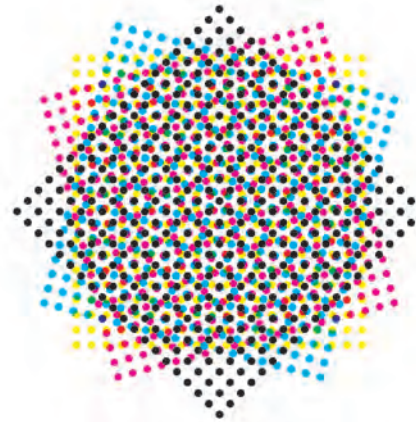
The top row of computer generated images shows a screen typically used for lithographic printing. The top left is an undesirable Moiré pattern, produced with two black screens to emphasise the problem. There are two approaches for aligning the black; dot in centre of rose or empty centre.



Undesirable Moiré pattern



The alignment of the CYM screens



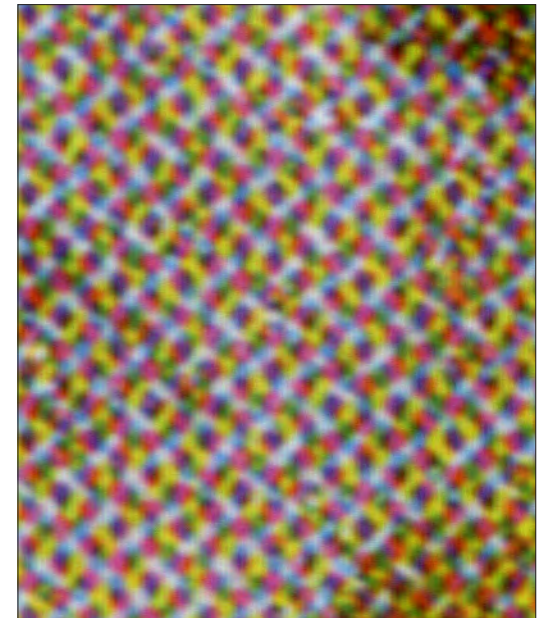
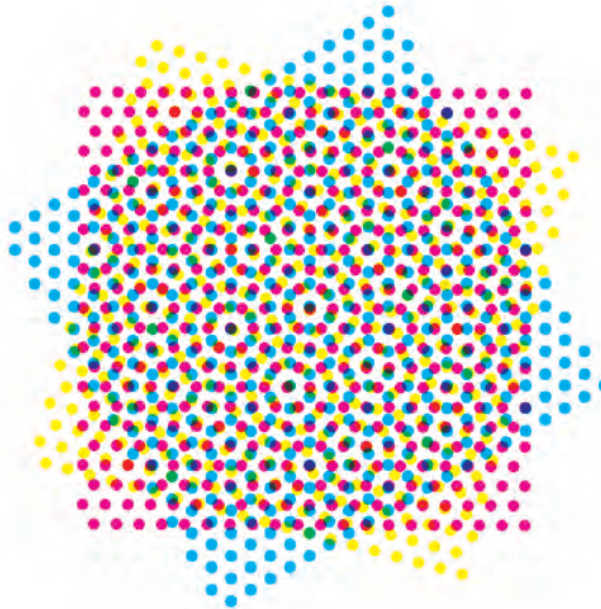
Black in centre of rosette



Centre of rosette left empty

The screen pattern often used for gravure printing. The separation of the rows and the alternating horizontal row positions creates a regular hexagon, with a centre dot, for 7 nearest neighbours.

Black has been omitted for clarity of comparison with the scan of a region of a gravure printed stamp.



Colour Printing – Progressive CMYK



Printed using the standard Cyan, Magenta, Yellow and Black process colours. The centre column shows each colour separately and how they build up in combination. The numbers indicate the printing sequence.

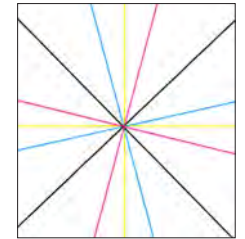
GRAVURE IS AN INTAGLIO PRINTING PROCESS. Printing is usually in four colours (cyan, yellow, magenta and black). The printing forme is a cylinder for each colour, with the image *engraved* as small cells which contain the ink. Variation in tone density is obtained by having cells of different depths. The greater the depth more ink is transferred to the paper. To prevent undesirable Moiré patterns the screen dot patterns are at different angles. The result is a rosette pattern with the colours separated in lithography but less so in gravure printing. The full range of colours is perceived with the dot patterns merging in the eye with the result that the four colours are perceived to mix to give the required colour. A much more fluid ink is used in gravure, this together with variation in ink density gives colour mixing by some overlaying in the printing. The two effects can be seen in the detail below. There is a rosette in the blue area and overlaying for the green.



+



↓



Colour screen angles

These images are computer generated in Photoshop from scans of the original.



+



↓



Detail of gravure screen



+



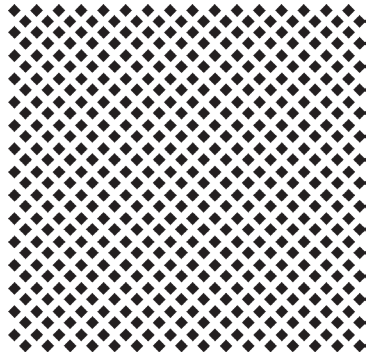
↓



인쇄수령 100매

Electro-Mechanically Engraved Screen

Electro-mechanically engraved gravure cylinders were first used for the Machin definitives for the 18p stamp printed by Enschedé in 1991. The 45° gravure screen is clearly seen. The depth of gravure determines how much ink is put on the paper and so the darkness of the image. There is always some dot gain due to the ink spreading. This is most noticeable in very dark areas where the dots nearly join. The use of square dots rotated through 45° has the effect of producing a 45° screen angle for a rectangular pattern of cells.



A computationally created 45 degree screen at the same scale as the stamp



Part of the Queen's head on the first class Diamond Jubilee Machin.

Electro-Mechanically Engraved Gravure Cylinders

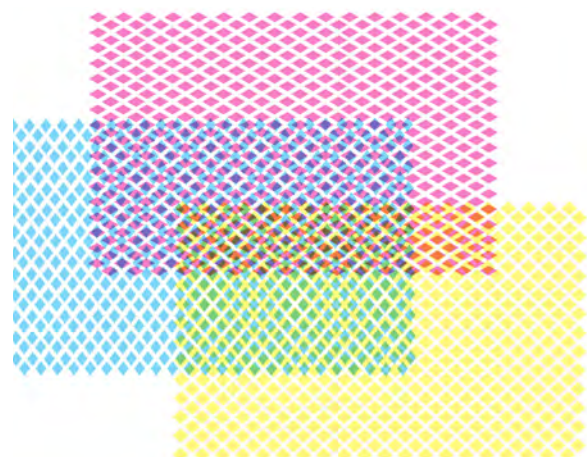
Four colour CMYK printing from mechanically or possibly laser engraved cylinders. This is a good example with regions of a single colour enabling the details of the screen to be seen.



Samples of areas of single colour scanned at 6400dpi to show the screen details. There is some smearing of the ink into the interstices of the cells. This has been slightly cleaned computationally to reveal the cells shown in the left composite below. To produce the different screen angles the ratio of the cell diagonals and the vertical spacing of the cell rows are changed. The measured screen angles are C 53°, Y 41°, M 30°.



Slightly cleaned scans revealing the cell structure. Overlaid to demonstrate the rosette.

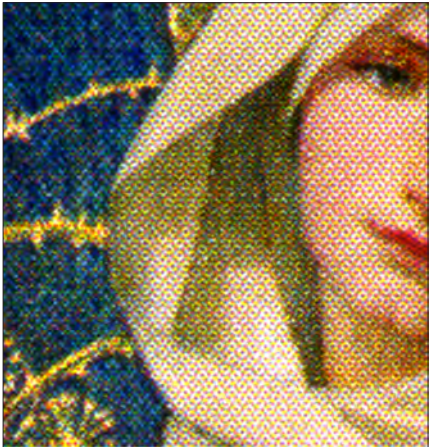


Computer simulation based on the measured cell sizes and screen angles.

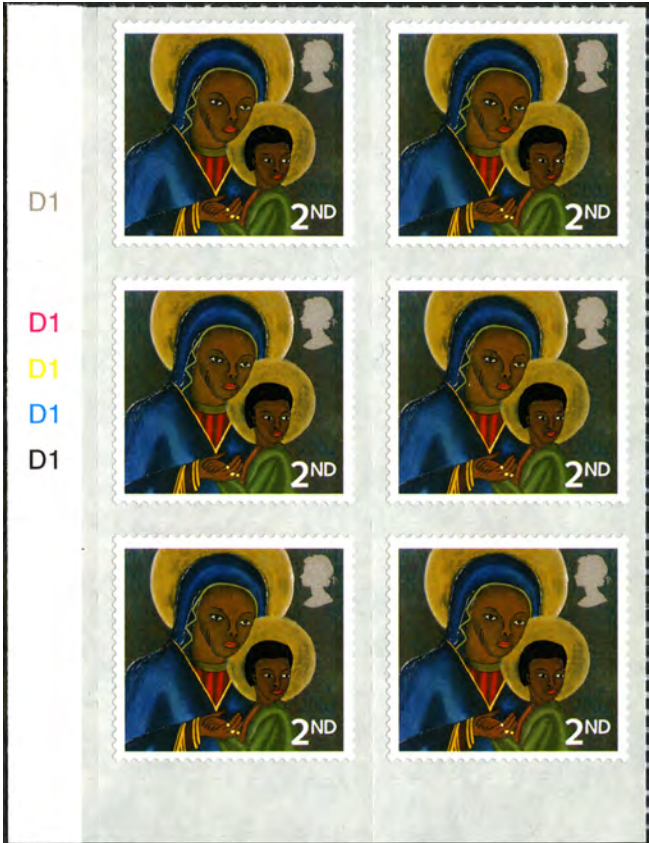
Gravure – Multicolour

2005 Christmas – De La Rue

Gravure using the four process colours CMYK – Cyan, Magenta, Yellow and black.

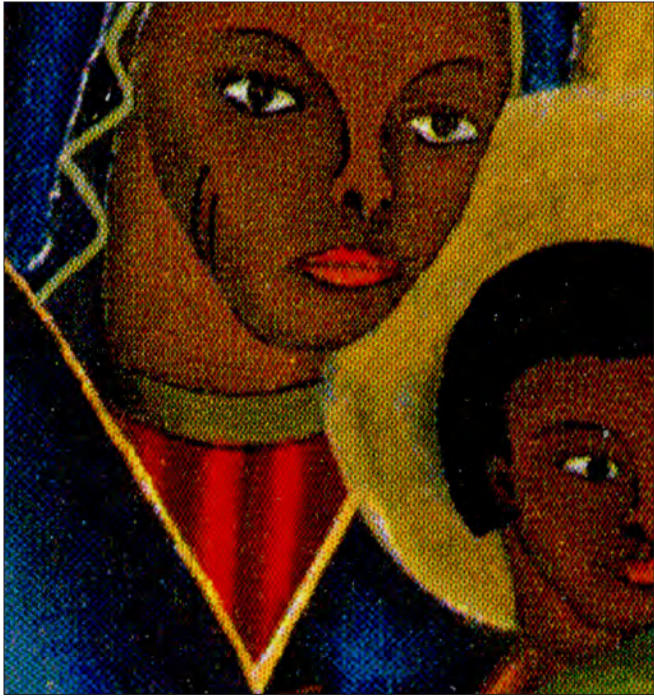


Detail from the 1st class stamp.

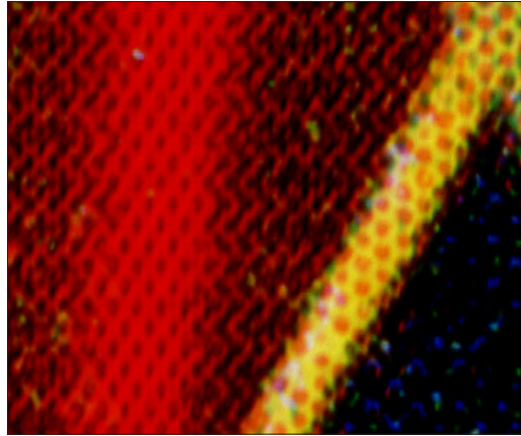


Two Gravure Printings of the Same Stamp

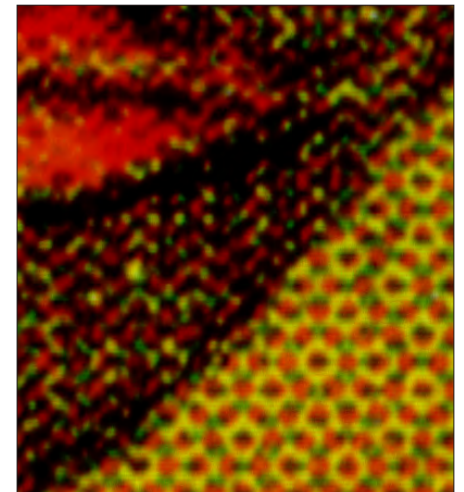
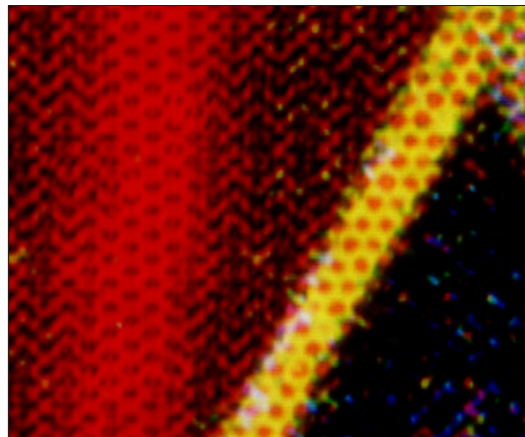
These stamps were produced as both gummed counter sheets and part of a gummed miniature sheet. The most striking difference is that the screens are at right angles. This is most clearly seen for the diamond cells of the black on the red background. There is also a marked difference in the shape and separation of the cells for the other colours.



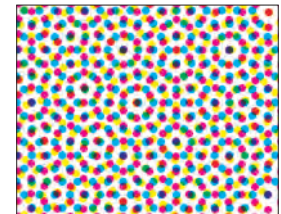
Counter sheet



Mini sheet



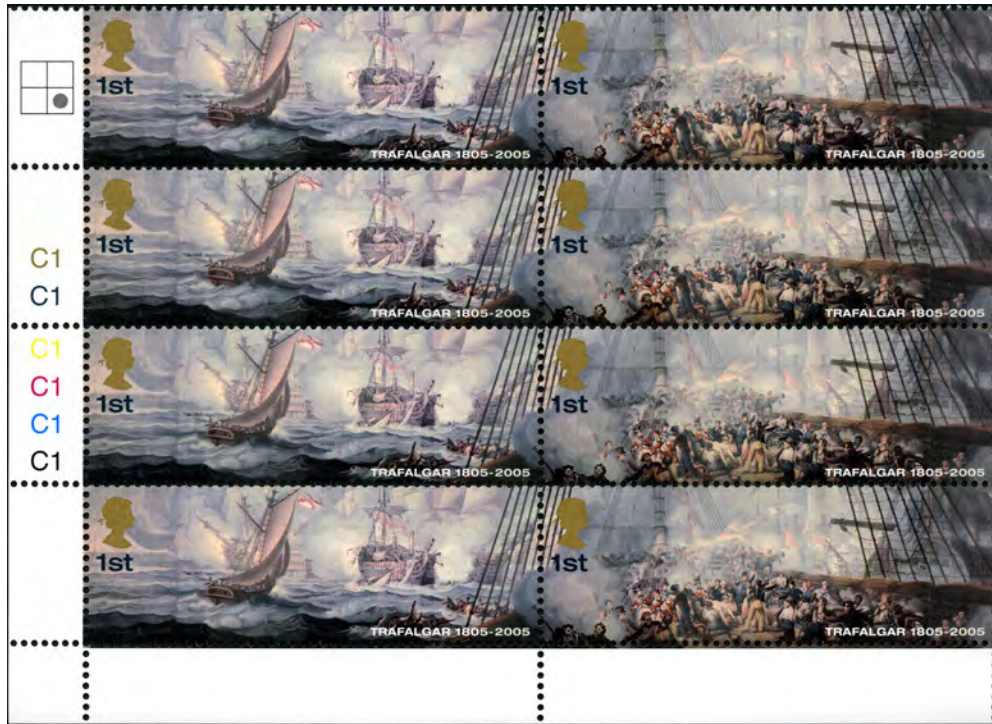
Computer generated screen



Full Colour Lithography with Additional Colours

Additional colours are often added to stamps, essentially printed with the CMYK process colours, to enhance certain features. The most common is to print The Queen's head in silver or gold.

Battle of Trafalgar 200th Anniversary October 2005 – Lithographed by Cartor.



Printed in the four process colours with the addition of a deep blue and gold.

Screen 600 lpi

January 1997 – Lithographed by Walsall



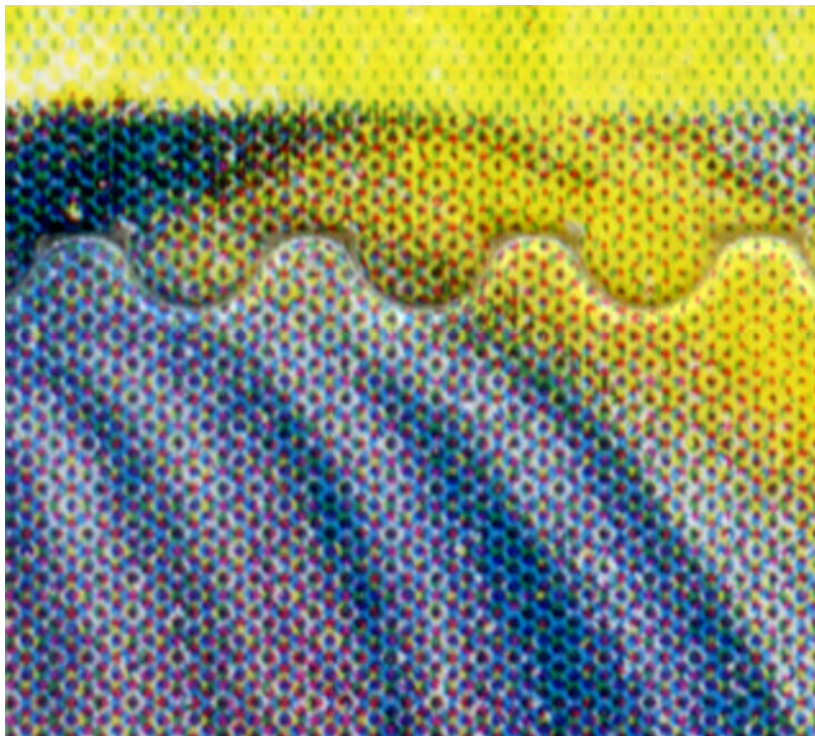
The colours used for printing each stamp are the same; greenish yellow, new blue, magenta, black, blue-green & gold

A Comparison of the Lithograph and Gravure Screens of Printings of the Same Stamp

Printed by gravure with EME cylinders. At the top the diamond 60° screen is clearly seen. The rosette pattern is that created with a screen with alternate rows displaced by half the screen frequency. Overall the image appears sharper than the lithographed one. The weak visual strength of yellow is overcome by laying down more ink giving solid colour in many areas.



Gravure



Lithographically printed. The magenta at the top clearly shows the rectangular lithograph screen with increasing dot size as the image gets darker. Eventually the dots merge giving solid colour.



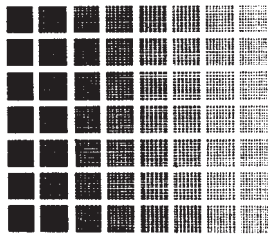
Lithography



Full Colour Printing — Gravure

Fujeira – 1967 Airmail

Printed in Gravure in four colours, CMYK plus Gold, by Fournier



The process by which tone is generated in gravure by different cell depths.

The progression when printing in colour

The sequence of printing in four colour CMYK with the addition of Gold for highlights.

GRAVURE GENERATES VARIATION OF IMAGE TONE by having the image consisting of fine cells all the same size but of differing depths. The deeper the cell more ink is transferred to the paper producing a darker image. Until recently the cells were produced by a photographic process for laying down the design followed by etching. Modern techniques use mechanical *etching* and variable cell sizes

The printing process is essentially intaglio. The plate is flooded with ink and the excess scraped off the surface by a doctor blade leaving ink in the etched cells. The ink is drawn out of the cells onto the paper under high pressure from the impression cylinder. The paper web passes through a dryer before printing the next colour.

As with lithography, the printing is usually done using four colours CMYK, with additional colours added e.g. for special highlights. In the case of the present stamps *gold*.

The cell structure is based on a screen, as in colour lithography, but the different colours are not in the same rigid pattern as they are for lithography. The $\times 8$ magnified detail shows no obvious cell pattern. There is much more colour mixing taking place on the paper, not due to one ink being wet when the second colour is printed, but more due to using inks that are more transparent. This can be seen easily in the green area of the detail.



Full Colour – Superlitho

Lithographed British stamps usually have a screen frequency between 300 and 400 lpi. In 1998 The House of Questa first used *Superlitho* with a screen frequency of 800 lpi.



Lithographed by Cartor October 2005.

Screen ~400 lpi

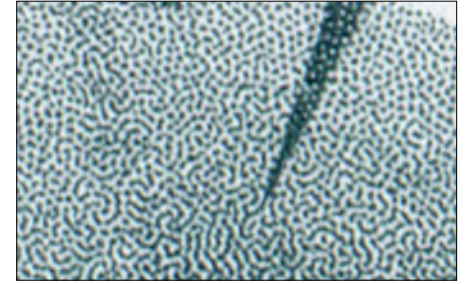
Superlithography by The House of Questa. Process colours not used. Printed in black, new blue, magenta, greenish yellow, deep blue and pale lavender-grey.

Screen 800 lpi



Stochastic Screening

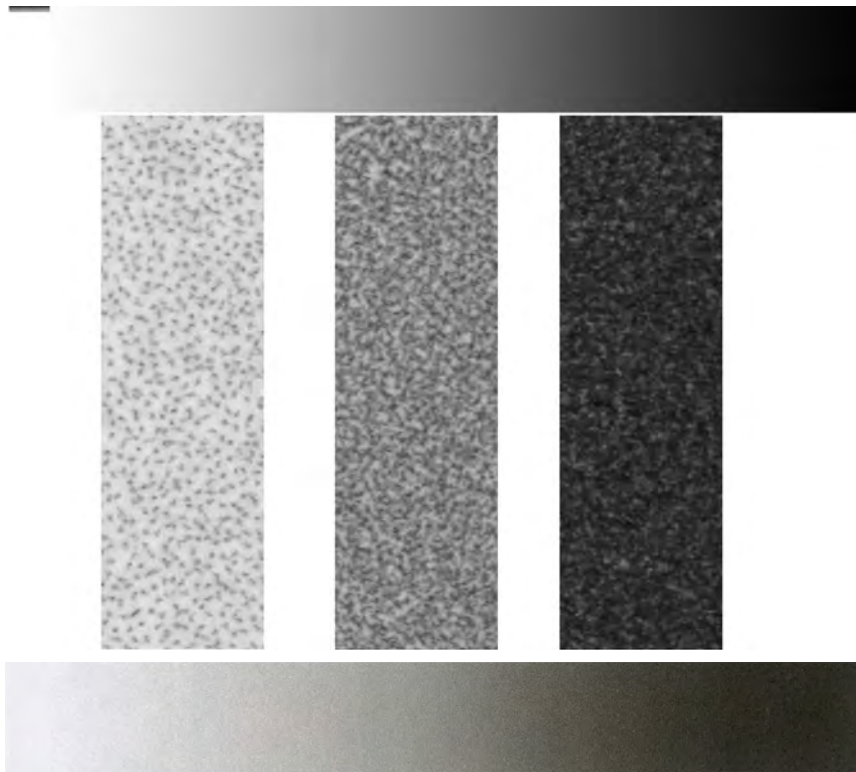
Half tone screens are a regular array of dots. In lithography the dots increase in size as the original image gets darker. Gravure cells are all of the same size increasing in darkness to match the original image. In stochastic screening the dots are all the same size and ink density with tonal gradation being obtained by increasing the number of dots per unit area. The dots are distributed randomly. There are different approaches to generating the random patterns. Some can give rise to semi-random artefacts (see adjacent picture) in the dot pattern.



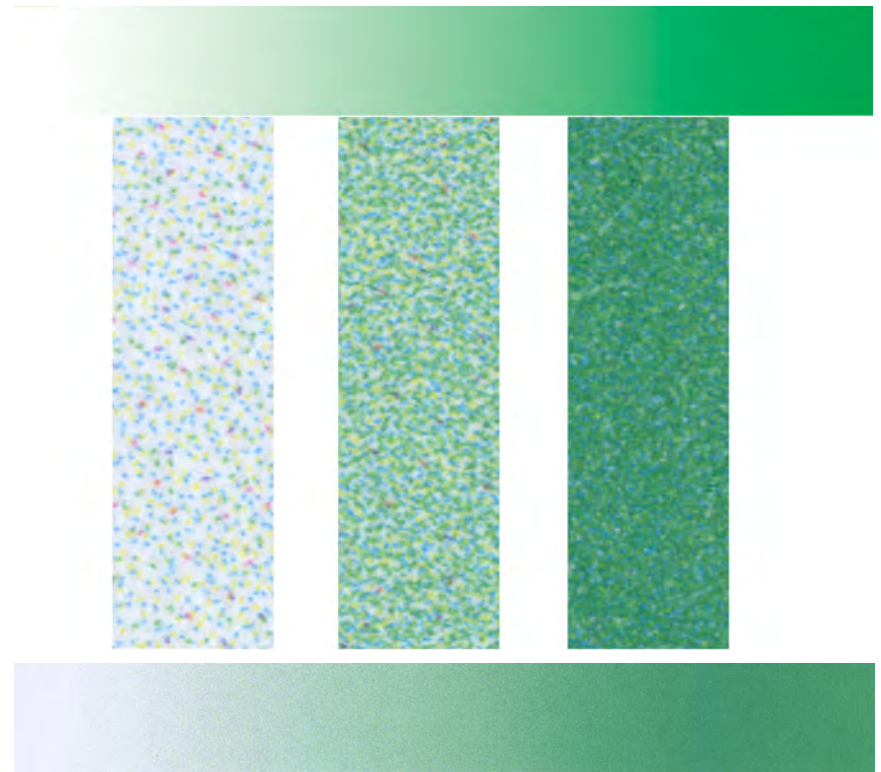
Computer generated examples of stochastic screening

Many ink-jet printers use stochastic screening. An Epson WF-6090 has been used to produce these examples. The horizontal gradients were produced at 600dpi and printed on the ink-jet printer. The resulting images were scanned at 6400 dpi. The details are a 2mm wide slice across the detail's centre. These samples were enlarged 10.66 times. The green is 100% yellow and cyan. The colour separation is clearly seen in the details. The odd flecks of magenta are probably from the paper on which the print was made.

Continuous grey wedge.



Continuous green CY wedge.

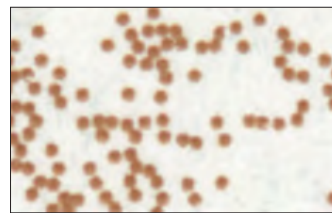


Scans at 6400 dpi of Epson WP-6090 printouts of the continuous wedges

Stochastic Stamp Image

The actual image of the Queen has been generated stochastically.
The image has not been screened for printing, but the text has.

All the dots are the same size. The tonal density is varied by changing the spacing of the dots. In a conventional half-tone image the image tone is changed by varying the dot size keeping the spacing of the dots constant.



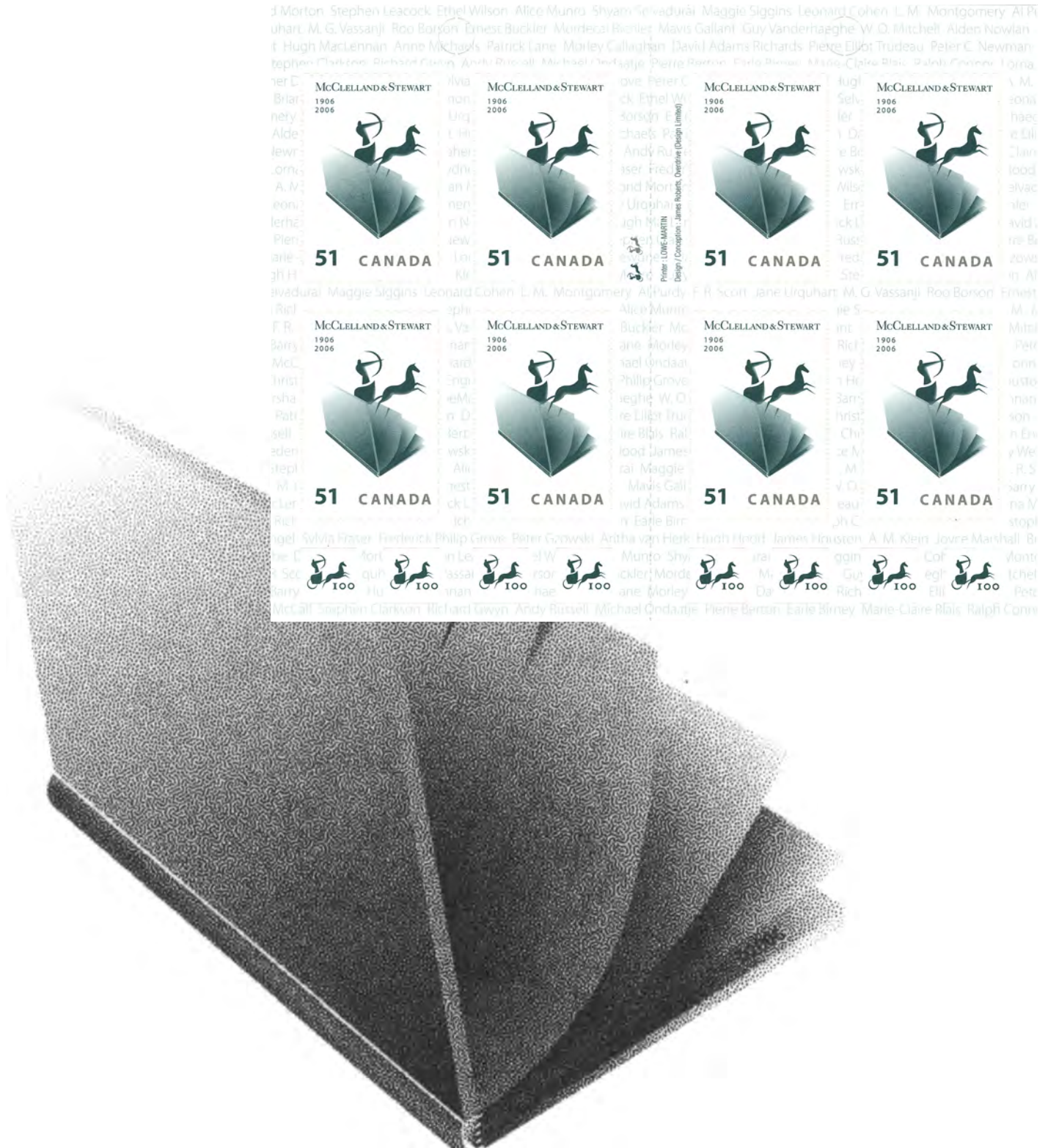
Out of context, and at a larger scale, it is difficult to recognise this detail. The brain supplies a lot of missing information when the whole picture is viewed.

Stochastic Screening - Monochrome Image

A monochrome example of stochastic screening. It is much easier to see the stochastic process with a single colour. The appearance is of a series of random worm-like lines built from dots of a single size. For darker areas the worms are closer packed whereas in very light areas there are single randomly placed dots. The printed results in a softer and smoother gradation of tone than in half-tone screening and is comparable to that of gravure printing.

Celebrating 100 years of the McClelland & Stewart Publishing House

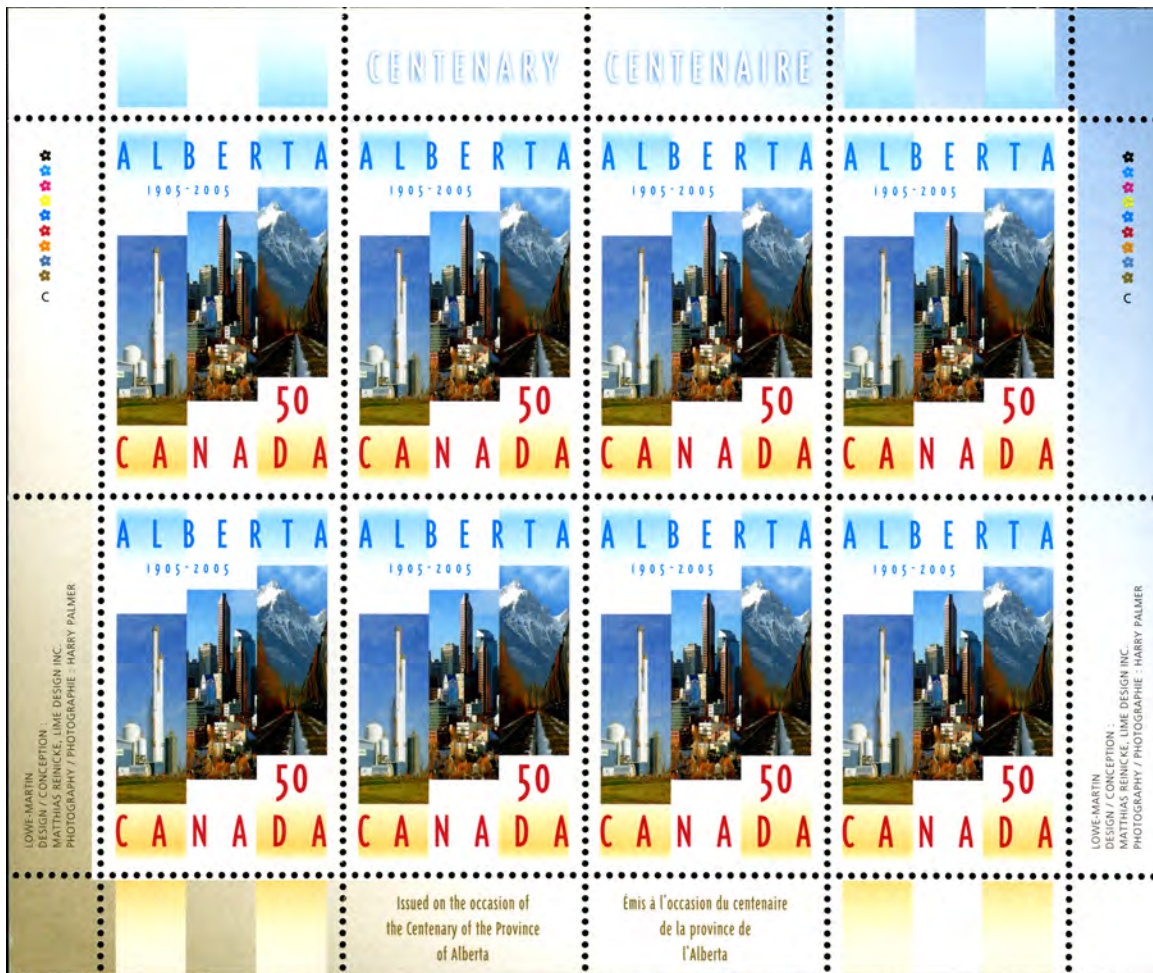
Printed by Lowe-Martin in Offset Lithography with stochastic screening.



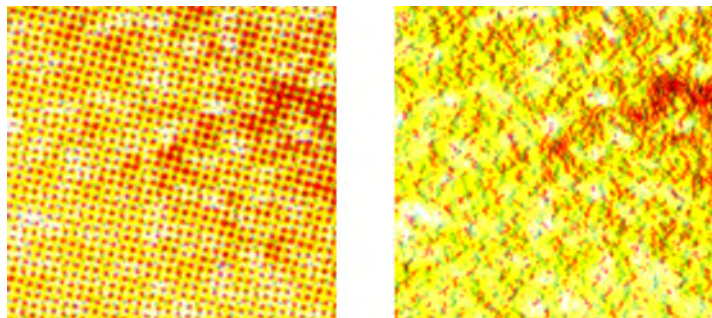
Stochastic Screening

Canada has, for several years, been producing very high quality lithographed stamps printed with in as many as nine colours using stochastic screening rather than the more usual halftone screen.

2005 Centenary of Alberta – Lowe-Martin in nine colour Offset Lithography with stochastic screening.



Lithographed by Lowe-Martin in nine colours using stochastic screening.



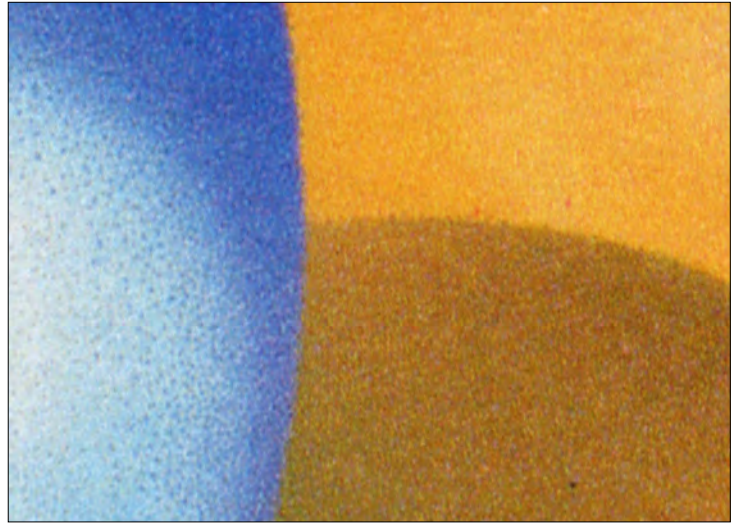
A comparison of Stochastic (right) and Halftone (left) screening. Only a very small sample of the original is shown. The stochastic screen gives a much higher quality.

Stochastic Screening



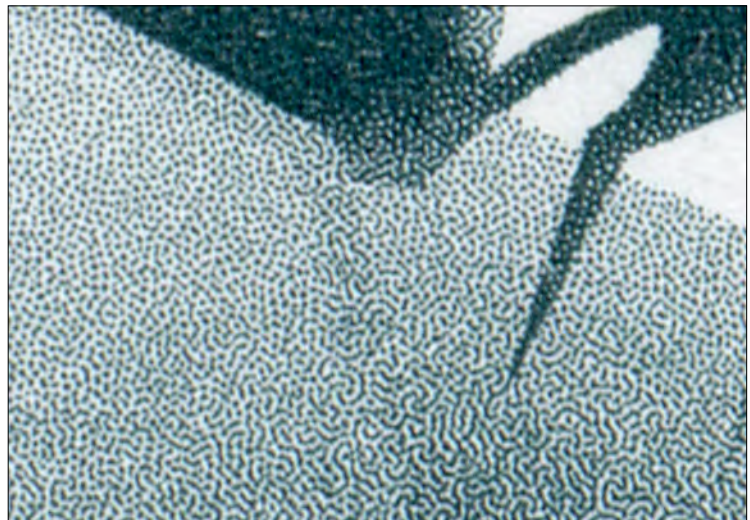
Printed by Lowe-Martin 2006.

Printed in seven colour offset lithography with 10 micron stochastic screening, a very much higher screen frequency than that of the comparison image below.



Printed by Lowe-Martin in Offset Lithography with stochastic screening.

The structure of the stochastic screening and how it changes with the density of the original continuous tone image is clearly visible.



Lithography with Stochastic Screening

Trooping the Colour June 2005

Printed by Walsall in four process colour lithography with silver for the Queen's head.

Probably the first British stamps to use stochastic screening.

Careful examination of the stamps at $\times 16$ magnification shows that stochastic screening has been used.



Detail showing the stochastic screening

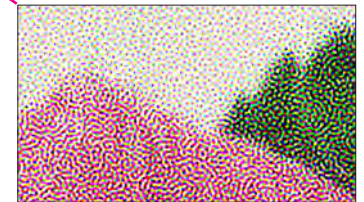
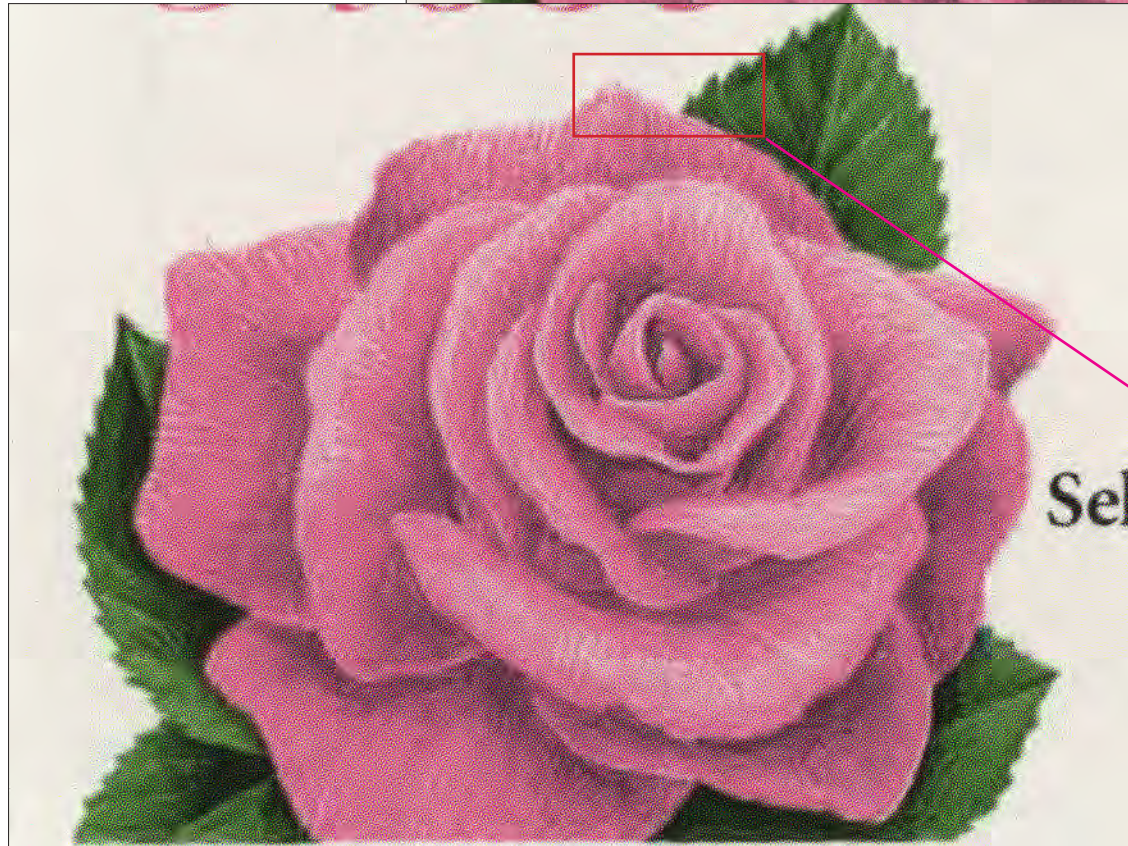
A Comparison of Half Tone and Stochastic Screening

An example of the difference in quality of a printed image produced using half tone and stochastic screening.

The stochastic image has been defaced to prevent commercial use.



Half Tone Screen

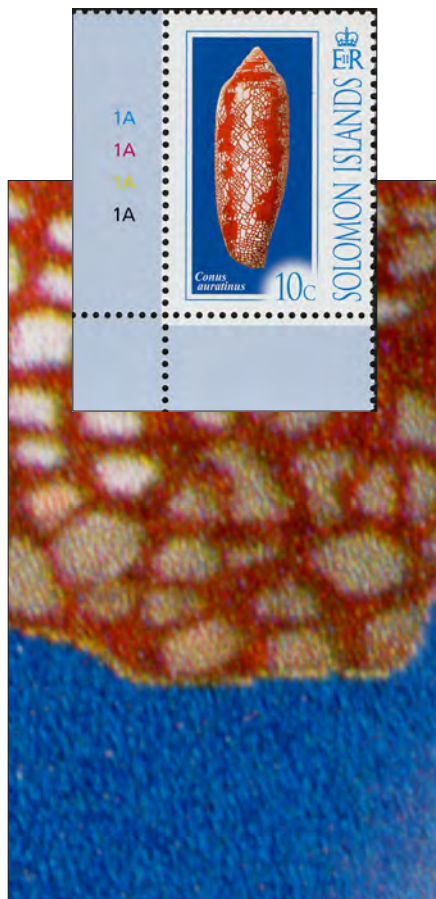


Stochastic Screen.



Stochastic Screening

Examples of Stochastic screening

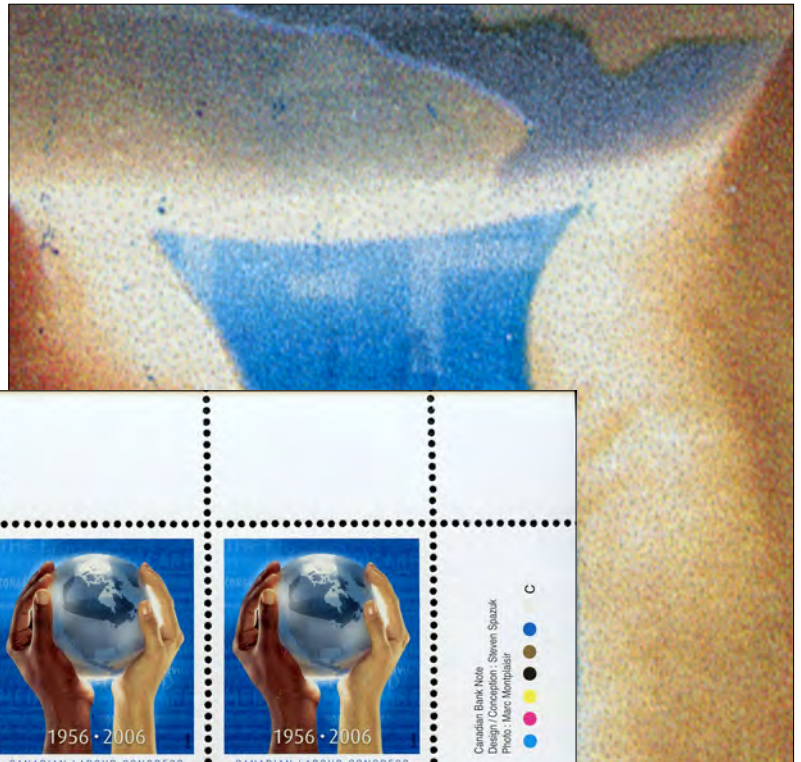


Stochastic Screening – Seven Colours

Canada Labour Congress – 2006
 Printed by the Canadian Bank Note Co.
 Stochastically screened in seven colours.

Canadian Bank Note
 Design / Conception : Steven Spazuk
 Photo : Marc Montplaisir

● ● ● ● ● ● ● C



50 years CANADIAN LABOUR CONGRESS / 50 ans CONGRÈS DU TRAVAIL DU CANADA

1956 • 2006

CANADIAN LABOUR CONGRESS / CONGRÈS DU TRAVAIL DU CANADA

CANADA 51

0 63497 103554 1 8

Canadian Bank Note
 Design / Conception : Steven Spazuk
 Photo : Marc Montplaisir

● ● ● ● ● ● ● C

×12

Dorothy Knowles

“She condenses the huge panoramic arc of the prairie landscape onto a flat surface and yet still conveys the breath-taking immensity of the scene.”

Canadian Art

« Elle condense l'imposant paysage de la prairie sur une surface plane, tout en parvenant à transmettre la saisissante immensité du panorama. »

Canadian Art

The Field of Rape
1971
(80.6 cm x 57.2 cm)
Mackenzie Art Gallery, Regina



The Field of Rape
1971
Dorothy Knowles



The Field of Rape
1971
Dorothy Knowles



The Field of Rape
1971
Dorothy Knowles



The Field of Rape
1971
Dorothy Knowles



The Field of Rape
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Dorothy Knowles



The Field of Rape
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Dorothy Knowles



The Field of Rape
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Dorothy Knowles



The Field of Rape
1971
Dorothy Knowles



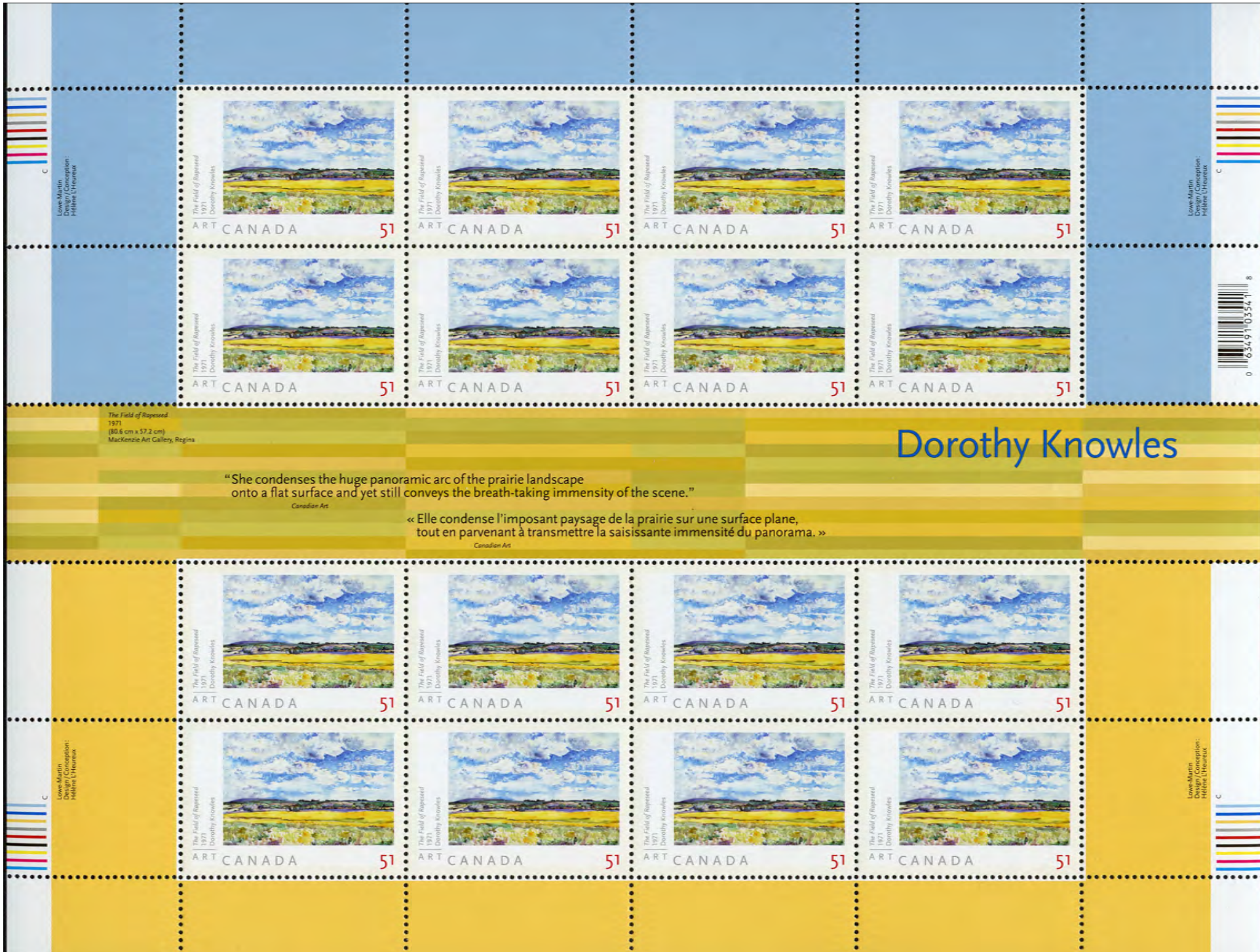
The Field of Rape
1971
Dorothy Knowles



The Field of Rape
1971
Dorothy Knowles

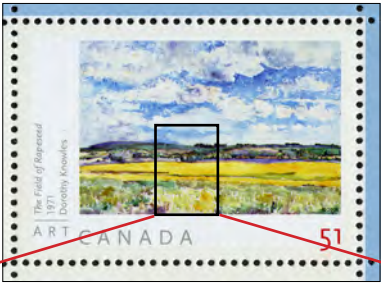


The Field of Rape
1971
Dorothy Knowles



Stochastic Screening – Nine Colours Detail

Printed by Lowe-Martin lithographically in nine colours, stochastically screened with 10 micron dot size.



×16



Gravure – Two Colour Printing

These four issues are the only Machin definitives to be printed by gravure in two colours. The 1/9d was the first two colour definitive for over 50 years. It is now 22 years since the last printing of the 10p.

They were all printed by Harrison.



5 June 1967. Orange & olive brown.



Turquoise & garter blue



September 1975. Orange & black

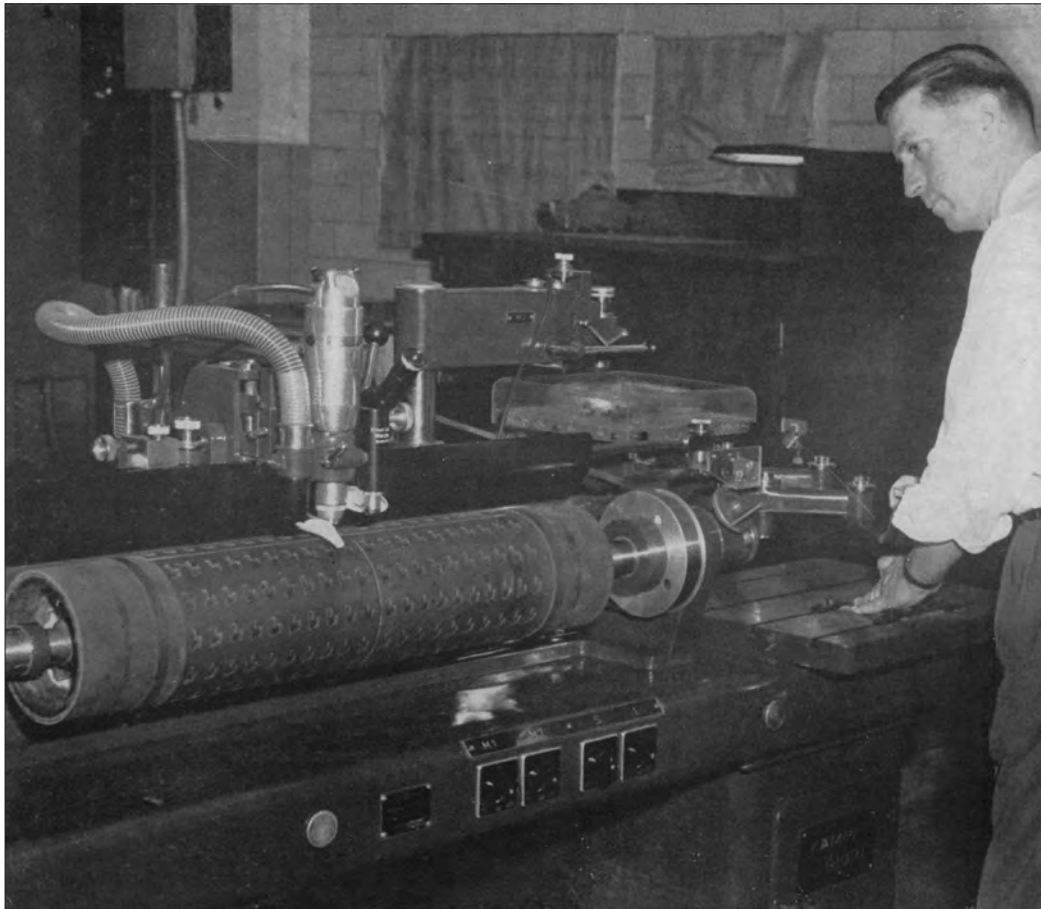


February 1974. Terracotta & orange-brown

Intaglio Colour Printing – The Giori Press 1

Printing two or more colours from different plates requires careful alignment of the two plates and accurate feeding of the paper. Otherwise the two parts of the stamp image may be differently aligned on different sheets or in different printings.

This problem of alignment was overcome by the Koebau-Giori press. It can print two or three colours from a single cylinder in a single pass through the press. Not all designs with three colours could be printed in one pass. Some images were incompatible with the process. The single pass printing was achieved by having inking rollers that applied ink only to the area of the design to be printed in that colour. This was achieved by cutting from the inking roller that part of each subject not to be inked in that colour.



Machining the inking roller used to print the flag issue below.

USA 1957 – Printed in two colours on the Giori press



Detail showing errors in the machining of the red inking roller. There is red ink on the right edge of the blue background to the stars and on the halliard.

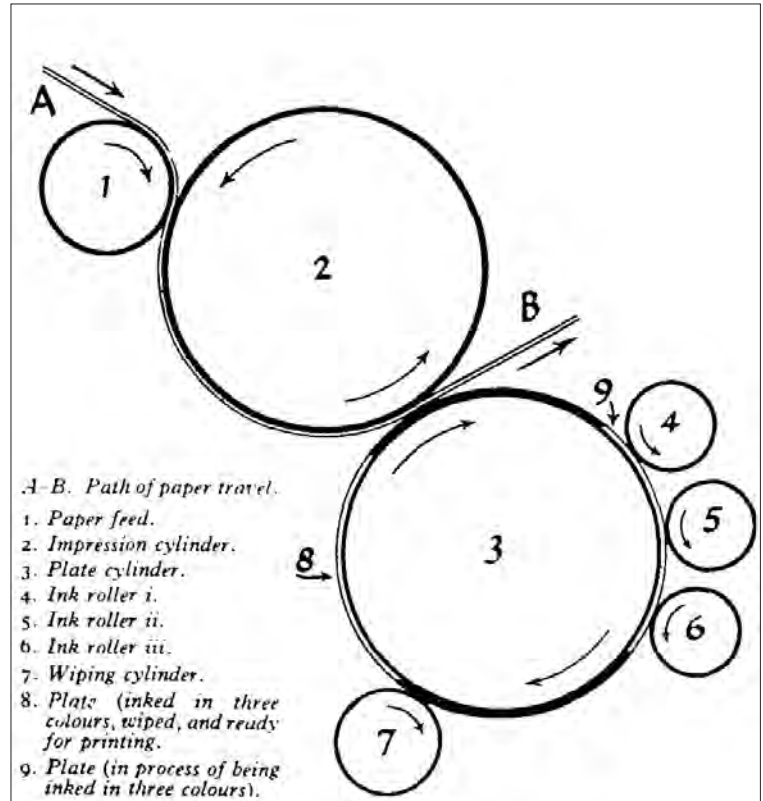
Intaglio Colour Printing – The Giori Press 2

Three colour printing could be done on the Giori press but only if the image was suitable. Unsuitable images required two pass printing.

USA 1957 – Wildlife conservation

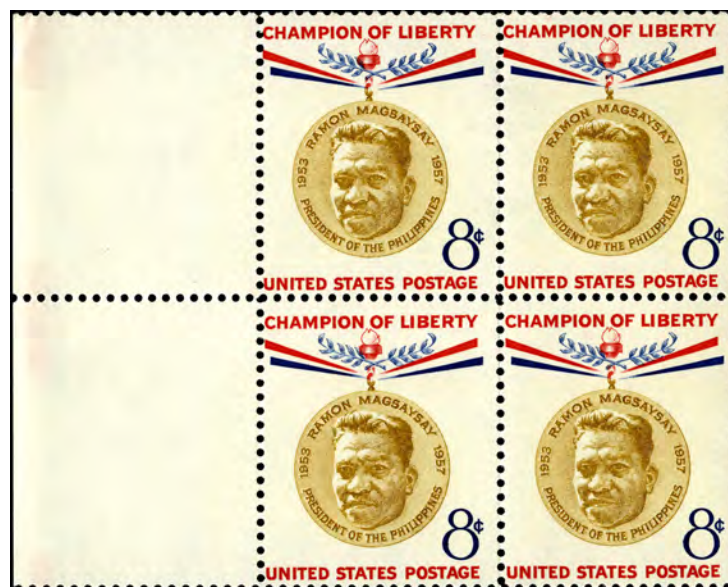


Three colours printed in a single pass



Paper path and inking of Giori press.

USA 1957 – Champion of Liberty



Three colours requiring two passes.

The Giori Press combined with Lithography

USA 1971 – Wildlife Conservation

The black line image was printed Intaglio on the Giori press. The colour is lithographed without the use of halftone. Tone gradation is obtained by using the same size dot at different densities. There is no underlying pattern to the dots. In other places the variation in tone is obtained by changing the density of lines and using cross hatching. Some colour is applied solid. The lithography was done first with the intaglio image printed on top in a very glossy ink.

How the lithograph plates were made is unknown.

This is a most interesting example of stamp printing.

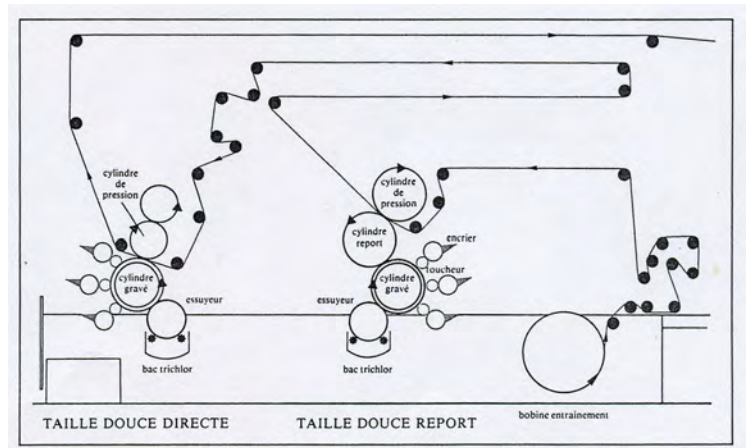


The Six Colour Serge Beaume Press

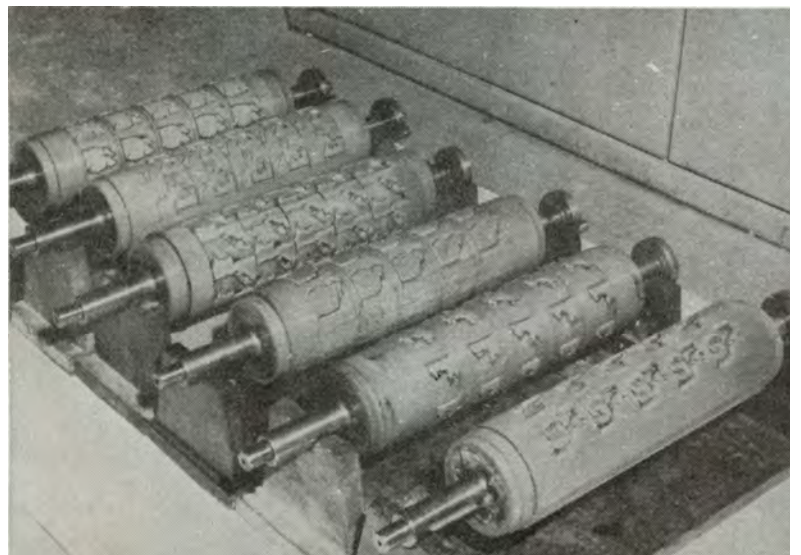
THE SERGE BEAUME PRESS prints up to six colours by intaglio in two stages each of three colours. Two intaglio printing cylinders are required the former on one being a mirror image of the other. A transfer roller is made from the engraved die of the stamp image. This is used to produce the printing cylinder for the direct intaglio printing. The second printing is by offset intaglio where the intaglio image is transferred to an intermediate cylinder, covered in synthetic rubber, which then transfers it to the paper. The intermediate cylinder creates a mirror image. Therefore the printing cylinder must be a mirror image of the direct intaglio cylinder. When making the cylinder the image reversal is probably obtained by transferring the image from the first transfer roller to a second roller that is used to make this printing cylinder, so reversing it.

The inking method is very close to that of the Giori press. The inking rollers are engraved with the stamp design that is to print in a colour by cutting away the rest of the roller surface leaving the inking surface raised. Ink is therefore selectively applied to the printing cylinder. The wiping away of excess ink is done by a cylinder with a plastic surface. The excess ink is removed from this cylinder by rotating brushes dipped in a solvent.

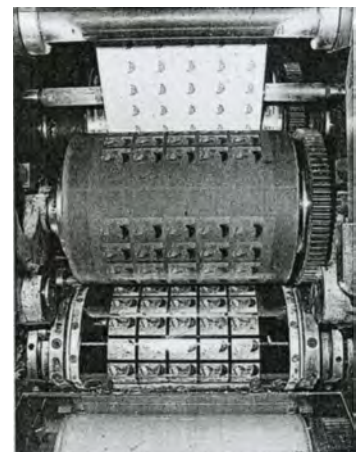
The first stage prints the offset intaglio impression and the second the direct intaglio. Between the two stages the paper passes through a drying tunnel heated to 90°C. This stage besides drying the ink would remove any moisture in the paper causing shrinkage. To prevent this the paper passes through the drying tunnel before the first printing thus preshrinking it and after printing to dry the ink. After the second printing the paper again passes through the dryer.



The printing stages and paper path through the press



A set of six inking rollers



The Offset printing unit. At the bottom is the intaglio cylinder in the middle the offset cylinder and above it the printed paper

Six Colour Printing of French Stamps

SERGE BEAUME DEVELOPED A PRESS FOR PRINTING SIX COLOURS BY INTAGLIO IN TWO STAGES. It uses an inking method very close to that of the Giori press. The inking rollers are engraved with the stamp design that is to print in a colour with the rest of the roller surface cut away. Ink is therefore selectively applied to the printing cylinder. The wiping away of excess ink was done by a cylinder with a plastic covered surface rotating in contact with the printing cylinder. The excess ink was removed from the wiping cylinder by rotating brushes dipped in a solvent. The first stage printed three colours by what was described as “offset taille-douce” or offset intaglio. The image on the intaglio plate being offset onto an intermediate cylinder with a rubber surface. The second stage prints three colours from a single intaglio cylinder directly onto the paper. Between the two stages the continuous paper web passes through a heated tunnel to dry the ink.

The reason for the first stage being offset is not clear. It makes the process more complex since the image on the printing forme has to be a mirror image of that in the second stage.

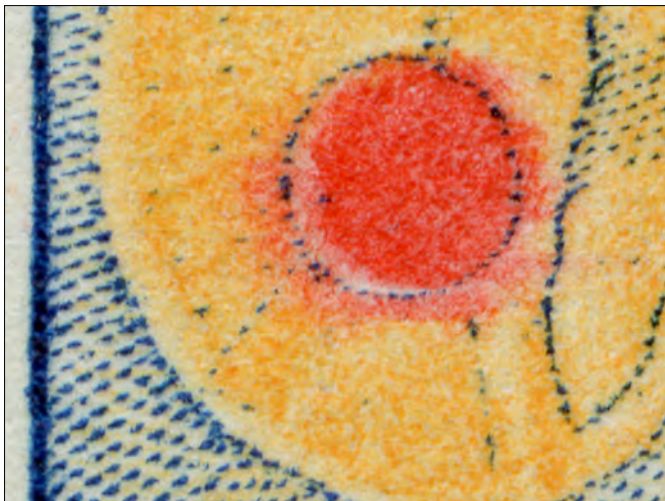
The example below would indicate that the blue black and possibly magenta were printed by direct intaglio. The blue and black have the raised feel typical of direct intaglio. The other colours were offset printed. The smooth texture of the red-pink and orange resembles lithographic printing with continuous areas of colour. However, the offset process may result in spreading the ink in areas of dense colour.

France 1963

Painting by Mark Chagall depicting him and his wife on their wedding day, with the Eiffel Tower in the background with other strange objects.



Note: the continuous colour tones of the red-pink and orange are more like a lithographic image. There is no indication of engraved lines. It is very difficult to wipe an intaglio printing forme with such large areas of continuous colour and not remove the ink from the engraving. The ink spread may be due to it being offset.



Six Colour Printing of French Stamps

Examples of the multicolour art stamps printed on the Beaume press. In places the image on the inking roller is not an accurate match with the rest of the image.



1963 The Wonderful Fisherman.
Church of St. Foy Conches



1968 The Danse. Sculpture
by Antoine Bourdelle



1964 John the Good, King
of France 1319-1364



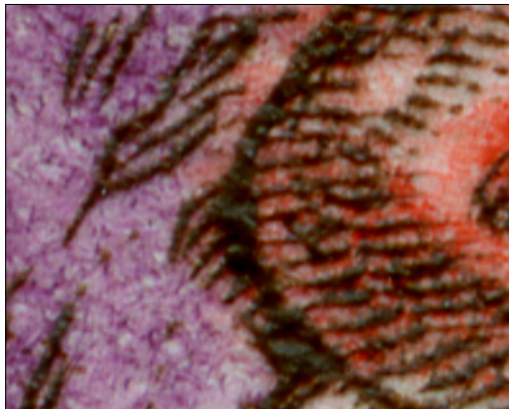
×8



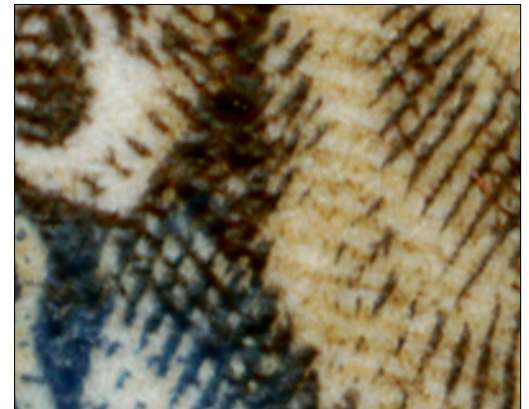
×8



×8



×21



×21

1963 Jakob fighting with an angel by
E Delacroix. Detail from a screen



×8

Gravure – Colours selected for the subject

Each of these stamps is printed in different colours most suited to the subject.

Christmas 1978 – Photogravure



Bright green, greenish yellow, magenta, new blue, black and gold.



Sage-green, greenish yellow, magenta, new blue, black and gold.

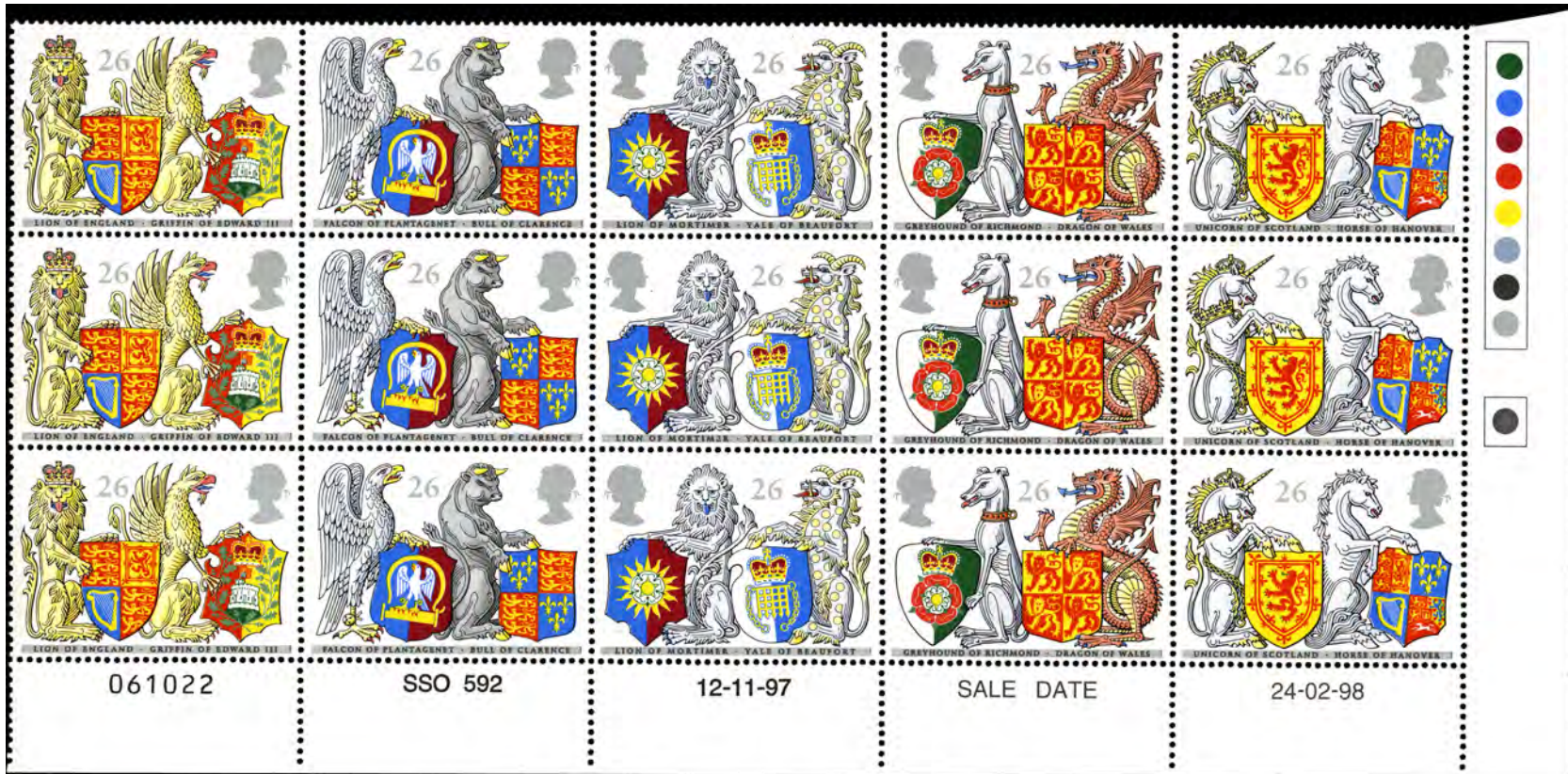


Yellow-Brown, greenish yellow, magenta, new blue, black and gold.



Salmon-pink, greenish yellow, magenta, new blue, black and gold.

Multi-process Printing – Lithograph & Intaglio



The black line of the heraldic beasts are printed intaglio.

Heraldic colours are strong and well defined. It is therefore appropriate to choose the colours separately for each stamp.

Silver, green, bright blue, carmine-red, vermilion, lemon, grey-black and black.

Silver, bright blue, carmine-red, vermilion, lemon, grey, grey-black and black.

Silver, green, bright blue, carmine-red, vermilion, lemon, grey, grey-black and black.

Silver, green, bright blue, carmine-red, vermilion, lemon, grey, grey-black and black.

Silver, green, bright blue, vermilion, lemon, grey, grey-black and black.

Multi-process Printing – Gravure & Intaglio

A combination of printing processes is usually used because some features on the stamp are poorly reproduced by one of the processes. In both sets of examples below Intaglio printing has been chosen for the fine line drawings of the naval vessels and the detail on the rigging and sails of the yachts.

1975 Sailing – Harrison, Intaglio and Gravure



1982 Maritime Heritage – Harrison, Intaglio and Gravure

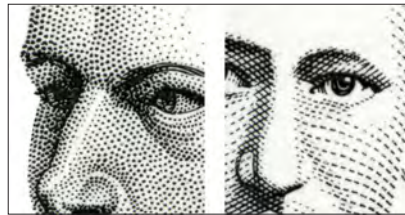


Multi-process Printing – Intaglio & Lithography

The portraits are printed Intaglio and the background is lithographed. The lithographed colours have been chosen to match the subject being different on each stamp.

1995 Pioneers of Communication – Harrison.

The intaglio image predominates with lithography providing a background.



The two styles of shading are a fine example of the genius of Slania.

