Problems with the Differentiation of Rubber Stamp Ink Signature Impressions and Written Signatures

Paul D. Westwood[1] and Robert W. Radley[2]

[1]Forensic Document Services, P.O. Box 543, Queanbeyan, NSW 2620, Australia, and [2]Robert W. Radley, 220 Elgar Road South, Reading, Berkshire, RG2 ODG. England

In most cases, the forensic document examiner has little difficulty in recognising a signature impression created by use of an inked rubber (or plastic) embossed stamping device and distinguishing it from a signature written with a liquid ink pen. When such signatures appear on paper bearing a fine complex printed background (such as security printing) the distinguishing features can be less clear cut and in some cases ambiguous. This paper lists the features which may serve to distinguish "rubber" stamp signature impressions from written signatures and discusses how complications such as a printed background can affect the distinguishing features.

This work originated in a case involving the comparative examination of three questioned signatures in the same name on an American Express Bank cheque and a large number of collected and request signatures written by the account holder. The purpose of the examination was to determine whether the three questioned signatures were written by the writer of the known signatures. Mr. Westwood was engaged by lawyers acting on behalf of the bank and Mr. Radley was engaged by lawyers acting on behalf of the account holder. Mr. Radley was of the opinion that a rubber stamp had been used to produce the principal signature on the questioned cheque. Mr. Westwood was of the opinion that the signature had probably been written on the cheque with a liquid ink pen by the account holder.

In 1991, an American Express Bank cheque was encashed in the sum of HK$1.3 million. The cheque was originally made out to cash in the sum of HK$3.3 million and signed in the usual place to produce what will be referred to as the principal signature on the cheque. The cheque was subsequently altered in two places in order to decrease the value of the cheque to HK$1.3 million. Each of these alterations was accompanied by an adjacent "authorising" signature. One related to the deletion of the word "THREE" and the insertion of the word "ONE," and the other to the deletion of the numeral "3" and the insertion of the numeral "1" to effect the decrease in the value of the cheque. The cheque is reproduced in Figure 1.

The account holder claimed that the principal signature and the two signatures authorising the alterations were forgeries and suggested the reason that the cheque amount had been altered was that on 29th September 1991, the day before the presentation of the cheque, HK$2 million had been withdrawn from his account which would have meant that a cheque for HK$3.3 million would have overdrawn the account.

Methods and Materials

Both examiners readily observed that the two signatures relating to the alterations on the cheque bore a marked degree of similarity to one another in terms of shape and size (Figure 2) as well as clear evidence of a pencil drawn guide line in each signature. The presence of a guide line was even more apparent when examined under the Video Spectral Comparator (VSC-1) using both reflected infrared and infrared luminescence (Figure 3). The two signatures "authorising" the alterations were tracings based on guide lines which were traced from a common model.

Whilst no design or structural fault could be found within the principal signature, an issue arose as to whether the signature was an original from a porous tip, fibre tip or fountain pen, or whether it could have been produced from a rubber stamp. It was this issue that gave rise to this paper.

It was common ground between both examiners that this signature conformed with the known signatures with respect to construction, relative proportions, line quality and apparent variation of pen pressure as evidenced by variations in line widths and that it did not exhibit any evidence of being the product of tracing or freehand simulation. Examples of the genuine cheque signatures are reproduced in Figure 4.

Results

Interaction of printing ink and signature ink

There was an interaction of the security printing ink (a light green lithographic ink) and the black ink of the principal signature on the cheque. Whilst the security

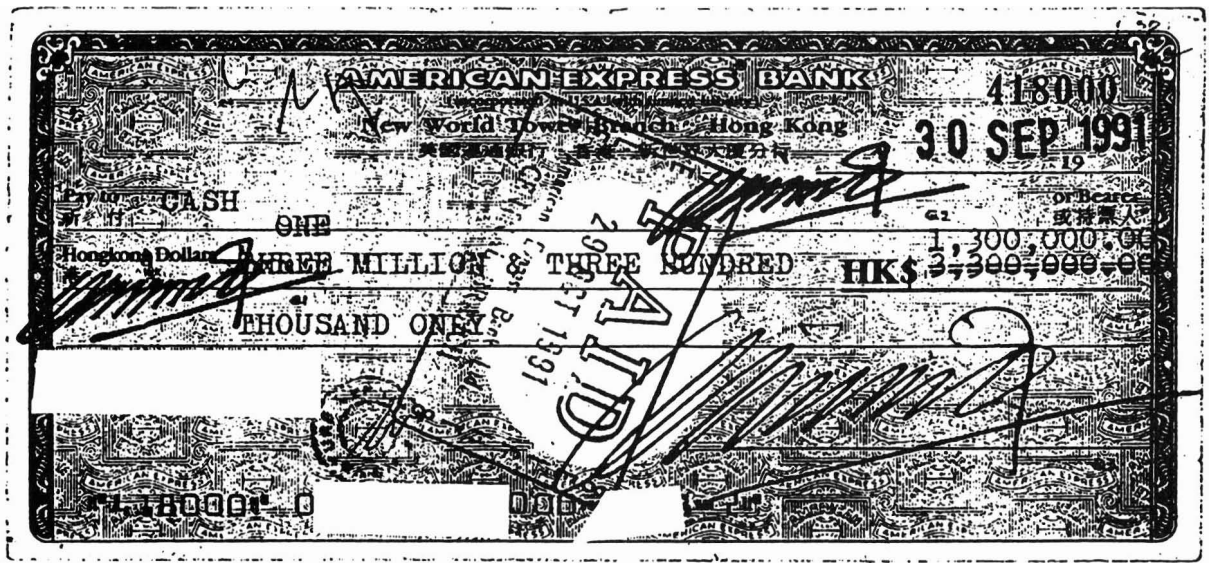


Figure 1. Reproduction of original questioned cheque.

printing ink was a non-fugitive ink, the nature of the ink used to produce the signature became a major issue. It was clearly an aqueous based ink, or partially aqueous based ink, which appeared to have an oleophobic effect when in contact with the green security printing. This lead to irregularities in the apparent structure of the signature due to the signature ink being rejected to varying degrees at those points where it crossed the green background security printing. It will be observed in Figure 5 that the signature ink has been more readily absorbed into the cheque in those areas which do not bear the security printing. This observation is consistent with what one expects when a water based (oleophobic) ink intersects an oil based ink. This effect is illustrated in Figures 6 and 7 where a roller ball pen and a rubber stamp have respectively been used to apply ink over lithographic printing.

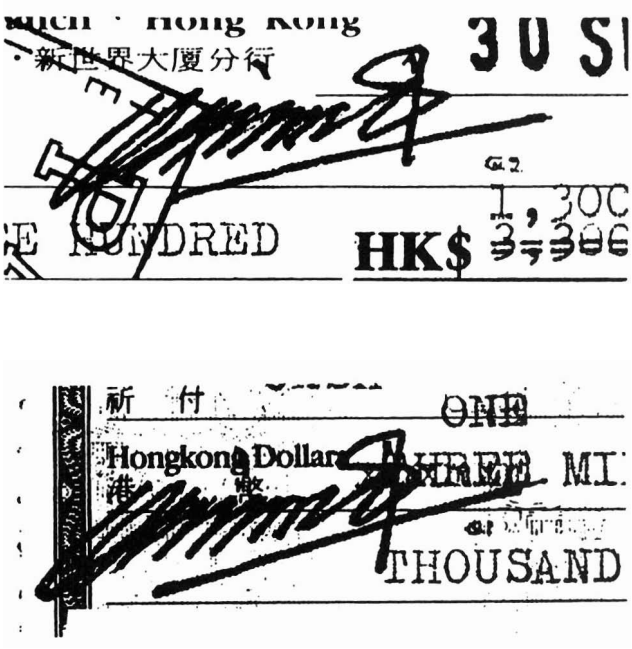


Figure 2. Reproductions of signatures authorising alterations. Note similarities in size and shape of both signatures.

Characteristics of rubber/polymer stamp impressions

Rubber/polymer stamp impressions are frequently characterised by a combination of some of the following features.

1. Poor edge detail which cannot be accounted for as being due to microscopic depressions in the surface of the paper, some contamination of the paper's surface, or ink repellent print on the paper surface.
2. The absence of an impression in the ink line.
3. Protrusions along the ink line (lumps or nodules) due to defects in the manufacturing of the stamp or contamination of the stamp with dust and/or fibres.
4. Bridging of close adjacent lines caused by fibres, hair or similar contamination of the stamp.
5. Ink filling in sharp angles and points of intersections between lines.
6. Rounded or bulbous line beginnings and endings.
7. Breaks in the continuity of the line.
8. Dark parallel edges of the image bordering a slightly less dark inner deposit of ink. The process of pressing the inked rubber/polymer stamp onto the surface of a document causes the ink to squash and squeeze out to the edge of the ink line. This feature is more difficult to see in heavily inked impressions (Figure 16).
9. Evidence of the stamp backing contacting the paper and leaving an extraneous mark.

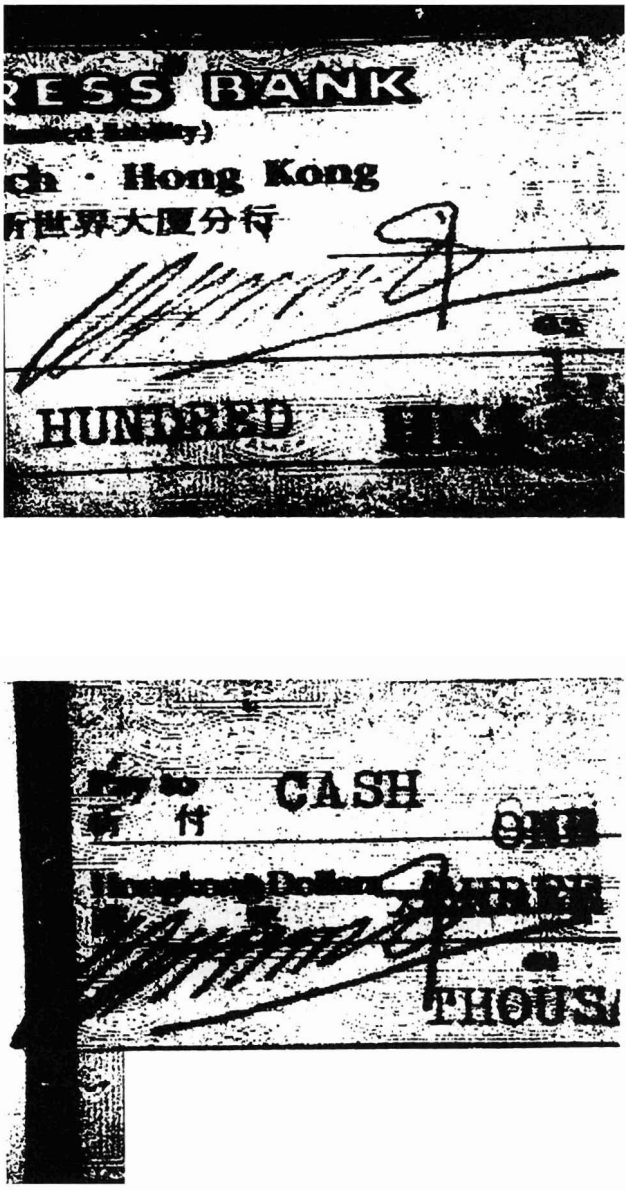


Figure 3. Infra red reflectance video prints of signatures revealing pencil written guidelines.

10. Non-uniform heavy pressure causing distortion in one area of the impression.
11. Blurring/smudging caused by slight movement of the stamp at the time of impact with the paper.
12. Ink splatter.

Initial observations of the questioned signature's appearance

1. As already noted, the signature was characterised by its broken appearance due to the rejection of the signature ink from the surface of the background security printing (Figure 5).
2. There was no impression in the paper surface consistent with the use of a writing instrument.
3. Nodules of ink protruded from the ink line yet the ink line appeared to have been made with speed (Figure 8).
4. Two closely adjacent lines were "bridged" by ink (Figure 9).
5. A number of sharp angles between lines were filled in by ink (Figure 10).
6. Apparent filling in of "corners" occurred at two intersecting strokes at near right angles to one another (Figure 11).
7. The signature appeared relatively "flat."
8. The signature ink exhibited little bleeding of the ink into the paper fibres.

Features 2 through 8 suggested the use of a hand held stamp to produce the signature. The issue to be determined was therefore whether the principal signature was an original signature written with a porous tip, fibre tip or fountain pen or whether it had been produced by a hand stamp.

The microscopic examination of the signature in question did not allow any firm opinion to be offered as to the type of instrument used to produce the signature. Considerable difficulties can be experienced in trying to differentiate between certain types of writing instruments used to write a signature, especially differentiation between fibre tip pens, porous tip pens and, if written on a hard surface, some roller ball pens or even fountain pens. Some of these writing instruments may leave minimal impressions in the paper. In this case the examination of the signature was further complicated by the "movement" or "migration" of the ink as it was being rejected from the surface of the background security printing and the consequential apparent break up of the signature ink. Figure 12 illustrates how ink from a porous tip pen used to produce a full stop moves and changes shape as it interacts with the background printing and the paper stock of a sample cheque.

The possibility of solvent identification was not considered feasible in this case as the cheque was submitted for examination some three years after it was written.

Stamp production

It is a relatively simple task to produce a rubber or polymer stamp of a genuine signature provided that the signature was written on plain paper. A rubber or polymer stereo can be rapidly and relatively cheaply produced (Herkt, 1985 and Casey, 1978). Probably the most popular method would be the production of a plastic stereo from a photopolymer. This incorporates the use of a photosensitive solvent soluble plastic or resin which, when exposed to ultraviolet light, polymerises and becomes insoluble. The image of the signature to be copied is prepared as a photographic negative and placed in contact with a light sensitive polymer resin which is often merely spread onto the negative's surface. Ultraviolet light is then shone through the clear (image) areas of the negative and causes the exposed area to harden. The unexposed (non image) areas of the resin remain soluble and can be washed away leaving the hardened image of

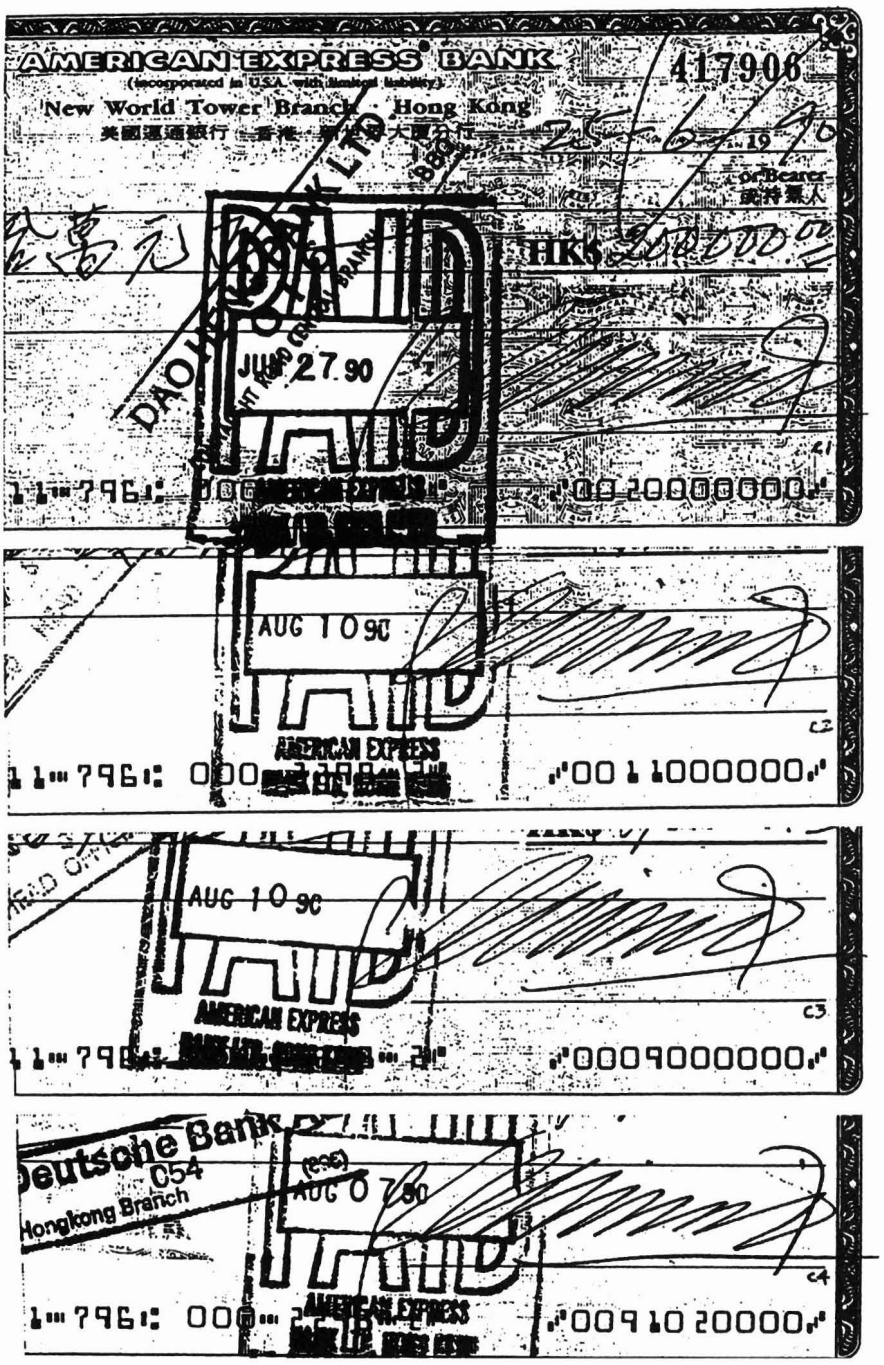


Figure 4. Examples of genuine cheque signatures of account holder.

the signature which requires no further treatment other than adhering it to the stamp mount.

Experimental observations on signature stamp impressions

Utilising a suitable specimen signature from the account holder, Mr. Radley had a polymer hand stamp manufactured. Mr. Westwood simulated the loops, curves and angular pen movements characteristic of the signature of the account holder and used two of these simulations for the production of rubber and polymer stamps. Numerous signature stamp impressions were made by both examiners on plain paper as well as on sample American Express Bank cheques similar to the cheque in question. A variety of new and used stamp pads were used for inking the stamps. It was noted that some pads were impregnated with ink which undoubtedly showed a tendency for rejection of the stamp pad ink by the background security printing on the American Express Bank cheques

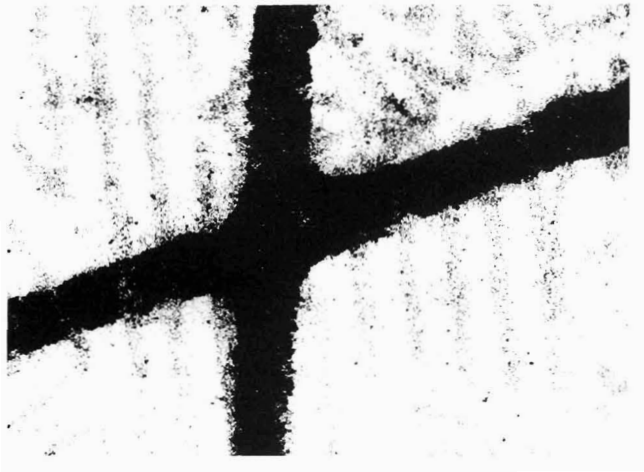


Figure 5. The ink line of the questioned signature has a broken appearance caused by the rejection of the signature ink from the security printing.

Figure 6. Illustration of how water based liquid ink writing is repelled from the surface of oil based lithographic printing within approximately three seconds.

whilst others did not. No chemical analysis of the solvents of the respective stamp pads was made.

Using these stamps the following observations were noted.

1. On many occasions, nodules were observed on the ink lines and may well have been the result of inked dirt particles being transferred from the stamp ink pad onto the hand stamp and subsequently onto the paper (Figure 13). Mr. Westwood raised the possibility of the nodules being formed as a result of the signature having been written with a liquid ink pen and the ink migrating from the surface of the security printing to nearby absorbent areas (Figure 13a).
2. "Bridges" between close ink strokes were observed on occasion (Figure 14). These "bridges" may well have been produced as the result of small hairs or fibres from the stamp pad being transferred onto the face of the hand stamp or by a build-up of debris on the face of the stamp. These inked fibres or debris produced "bridges" when stamped onto the paper. It was noted that the appearance of these "bridges" was quite different to the effect of ink running along an individual fibre in the paper. Mr. Westwood also observed a similar bridging effect in test writings made on sample

Figure 7. Example of stamp pad ink being broken up due to the repulsion of the water based ink from the surface of the oil based lithographic printing.

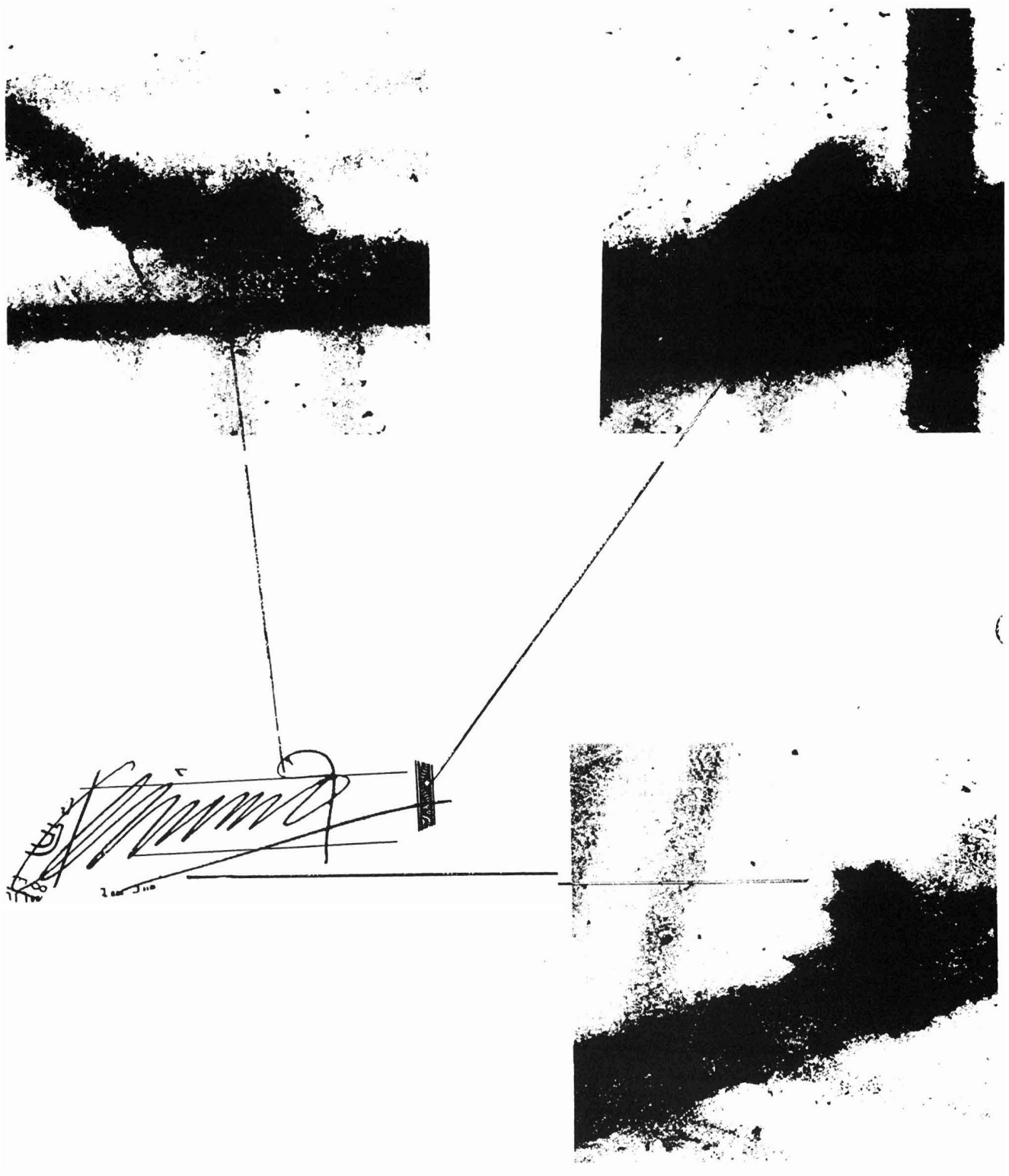


Figure 8. Nodules protruding from the line of questioned signature.

cheques using fountain pen and fibre/porous pens (Figure 9a and "Examination of Test Writings" below)

3. The filling in between sharply intersecting lines was also observed, especially after the stamps had been subjected to considerable use. The filling in was caused by heavy inking of the stamp and/or the presence of a build-up of foreign material in the structure of the stamp (Figure 15).

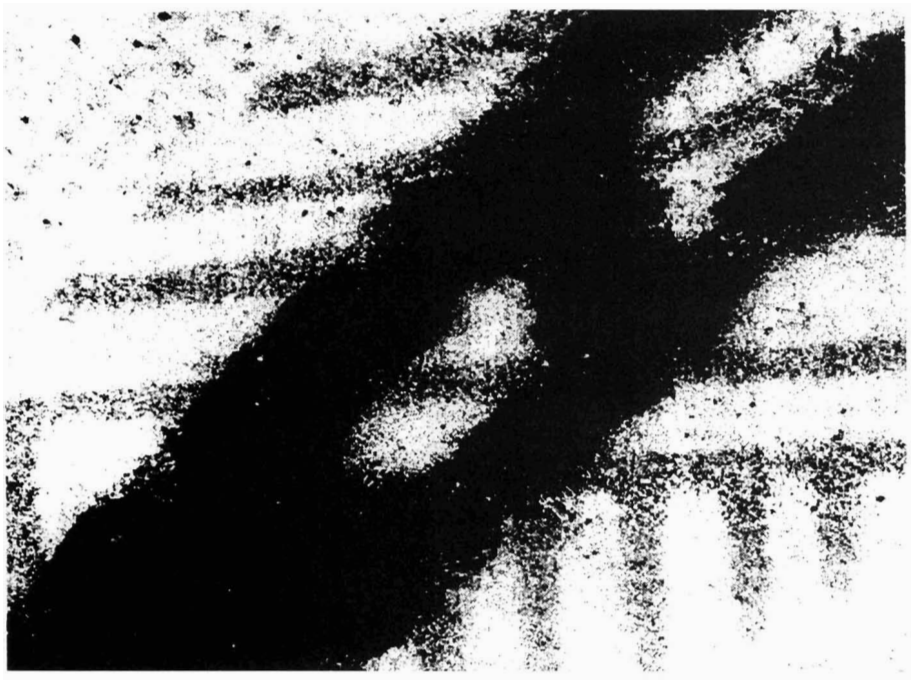


Figure 9. Two closely adjacent lines bridged by ink in the questioned signature.

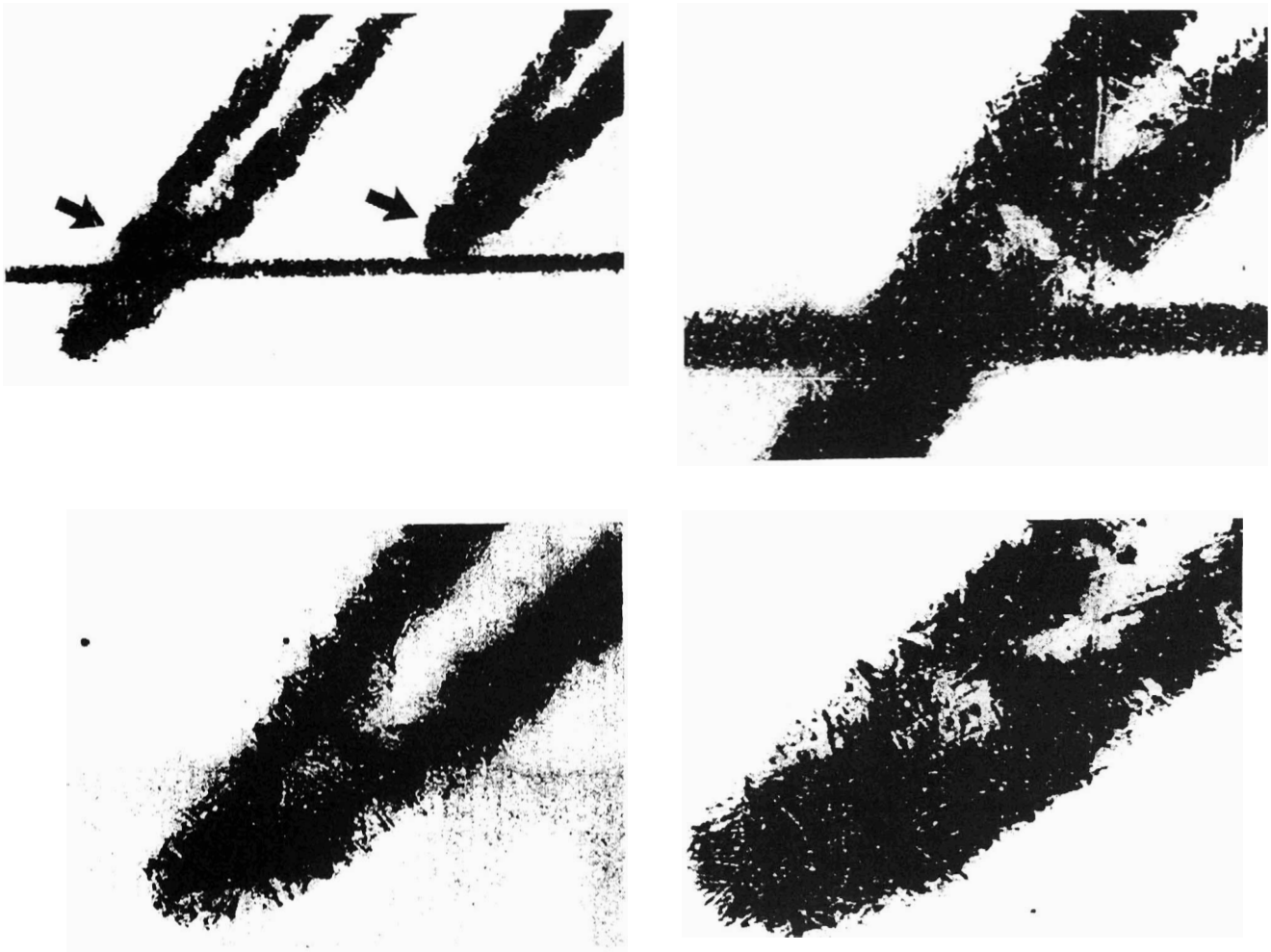


Figure 9a. Illustrations of the bridging of closely adjacent lines due to repulsion of liquid ink pen inks from the surface of the security printing.

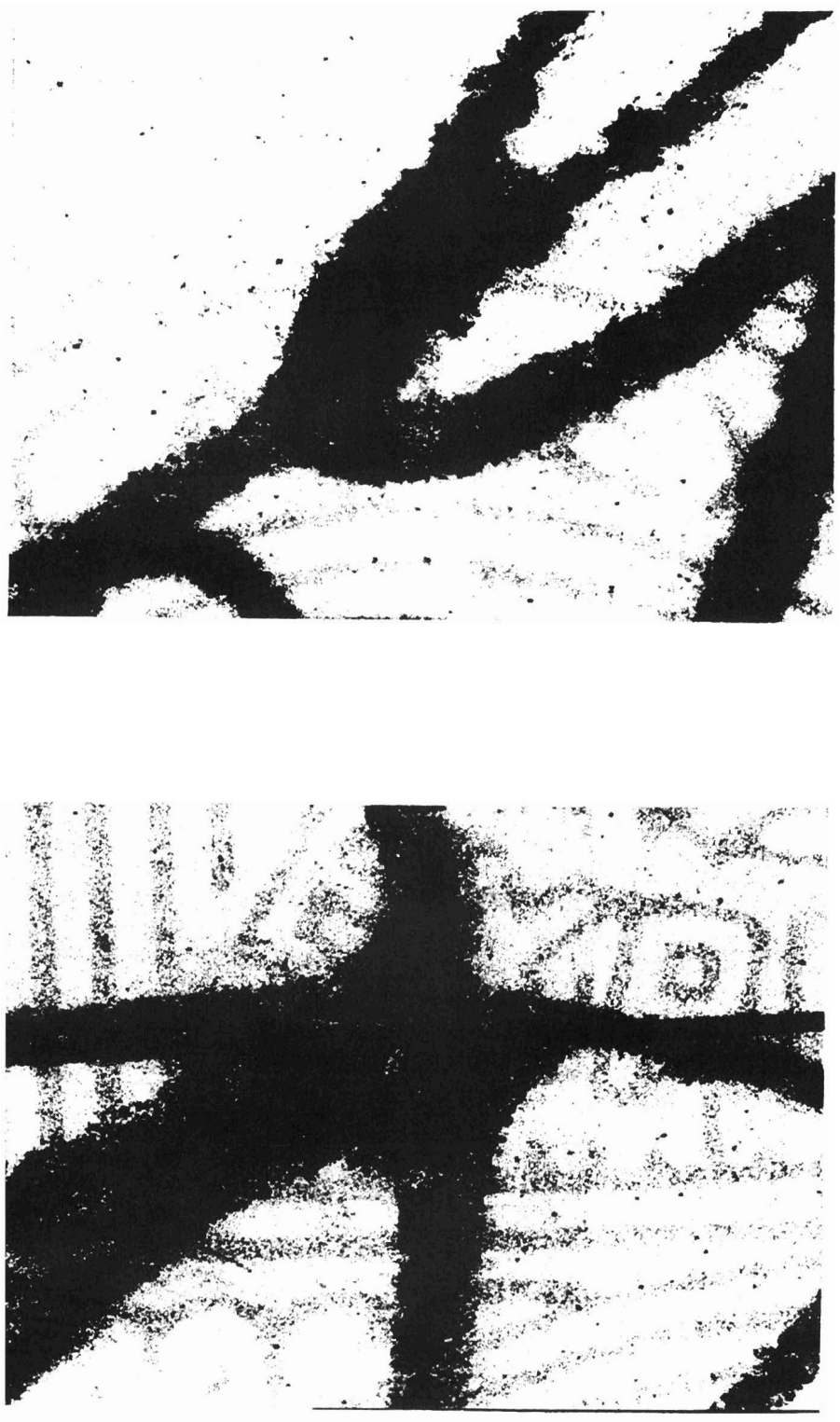


Figure 10. Some sharp angles in the questioned signature filled in with ink.

4. Depending on the degree of inking and the force of application, many of the stamped impressions exhibited ink squash which manifested itself as parallel dark lines on either side of the ink line similar to what is observed in letter press printing. This was most apparent when the stamp was used more than once without re-inking (Figure 16).
5. Both examiners observed that the detail of the signature impressions produced by their stamps was frequently quite good. The stamps reproduced the appar-

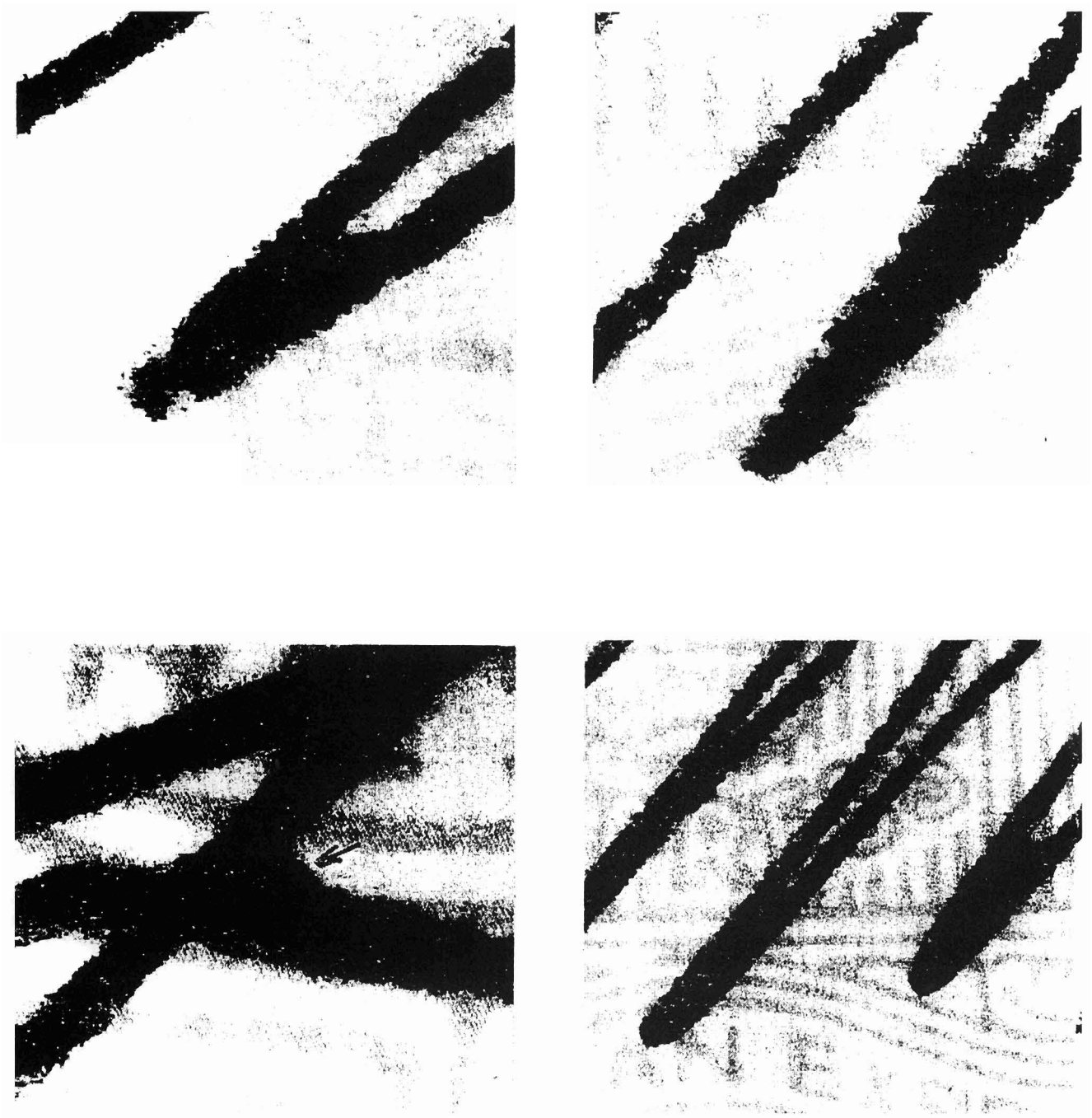


Figure 10a. The top two figures illustrate the "filling in" observed in a number of troughs in writings made with different fountain pens on sample cheques. The lower two figures illustrate occasional "filling in" of troughs and intersections made by fibre-porous tip pens on sample cheques.

ent thick and thin lines corresponding to the original variation of pen pressure exhibited throughout the master signatures.

6. On occasion, the application of the stamp pad ink was relatively poor and, in some circumstances, could give the impression of a writing completed with a pen with ink supply problems, i.e., slight breaks in the line or irregular thinning of the density of ink applied to the document. This was more evident with stamp impressions on plain paper rather than on the sample cheques.

Examination of test "writings" on sample cheques using various liquid ink pens

Both examiners observed that whilst a relatively small number of stamp pad inks showed the rejection effect described above, a much greater proportion of inks tested

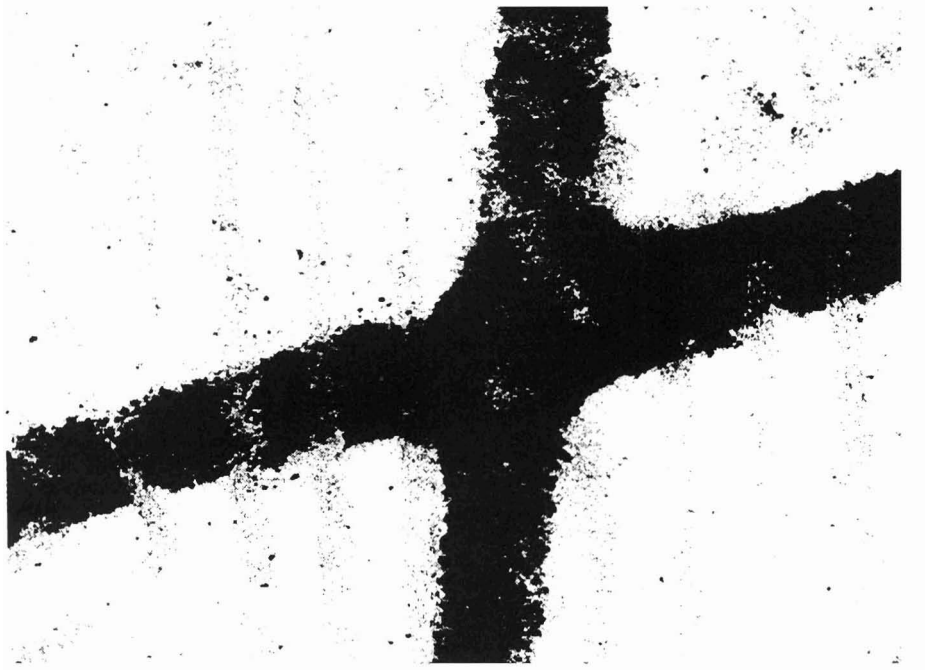


Figure 11. Filling in of corners at the point of intersection between two lines at near right angles to one another in the questioned signature.

from fibre tip pens and porous tip pens (13 out of 20 for Mr. Radley and 9 out of 11 for Mr. Westwood) showed a fair degree of rejection. Mr. Westwood also observed that 12 out of 14 different roller ball pens and four fountain pens from different sources showed a similar degree of rejection. Within a matter of seconds, the water repellent vehicles and pigments within the lithographic ink will cause most of the "liquid ink" from many fountain pens, roller ball and fibre/porous tip pens to be rejected from its surface and to be taken up by the adjacent absorbent areas of the paper stock (Figures 5 and 12).

The fact that the liquid ink is deposited on top of the background printing and then rejected means that there is an excess of ink at various points along the ink line. This excess rejected ink flows to more absorbent areas where there is no background printing. Depending upon many factors the excess ink may form pools of ink in peaks and troughs as well as nodules along the ink line. These factors include:

1. the rate of ink flow from the pen;
2. the angle at which the ink line crosses over the individual printed lines;
3. the complexity of the printed background in any particular position on the cheque;
4. the surface texture and composition of the cheque;
5. any inconsistencies in the absorbency of the background cheque paper; and
6. capillary attraction between two adjacent deposits of the same fluid.

Simultaneous microscopic observation of the writing tip and ink line produced by fountain pens and fibre/porous tip pens moving across the surface of sample cheques in a zig-zag pattern allowed Mr. Westwood to observe the following two phenomena.

1. Occasionally an apex or trough which was initially filled in by ink will redefine its appearance as the ink is rejected by the lithographic printing within the apex or trough. The result is an apex or trough which was originally momentarily filled in before becoming substantially devoid of this initial ink deposit.
2. The opposite of (a) where ink is substantially rejected from the lithographic printing and flows into the apex or trough to create a filled in appearance.

The complexity, position, and orientation of the lithographic background printing which is located within any given trough, apex, or intersection of the ink lines are the features of the cheque which seem to determine which phenomenon will occur.

The appearance of bridging between two close lines is perhaps unusual when one is writing with fountain pens, felt/porous tip pens and roller ball pens on a plain paper surface. However, in this case, one has to take into account the nature of the writing surface which has been described above. As already noted, the nature of the background printing can cause liquid inks to run in unexpected directions and thereby form lumps or nodules which on occasion can form bridges linking two closely adjacent written lines. Figure 9a (bridging nodules) and 13a (nodules) illustrate a number of examples of this phenomenon in writings made with fountain pens, fibre tip pens and roller ball pens.

Extensive writing on a number of sample cheques with several of these writing instruments did not produce detectable evidence of impressions or nib tracks in many instances.

Discussion

It was noted with respect to the questioned signature

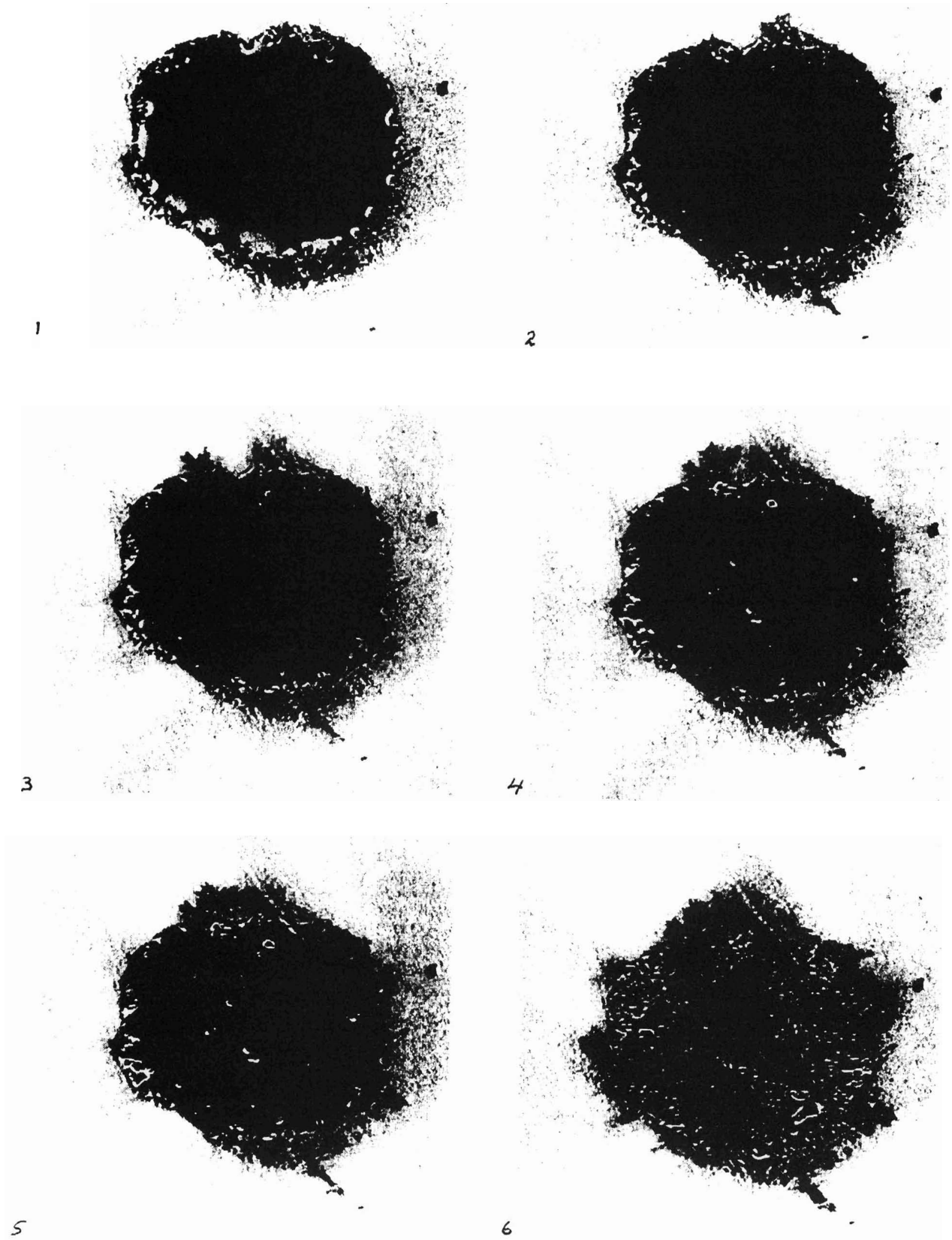


Figure 12. Time lapse video-micrographs of a full stop made with a porous tip pen on a sample American Express Bank cheque. Note in particular the growth and movement of the ink at the top of the dot: a crescent shape begins to form which later becomes a circle which in turn is filled in by the ink. Note also the growth of a nodule in the lower right hand segment.

Figure 13. Rubber stamp impression of control signature exhibiting nodules of ink.

that the bridging of the two closely adjacent lines (Figure 9) did not go beyond the outer edges of each line. This suggests that if the bridge was caused by a hair or fibre adhering to the face of the stamp, the particular hair or fibre happened to match in length the distance between the two lines at this point. Such a coincidence is perhaps unlikely. It could be the case that the bridge was formed by a build up of debris between the two lines of the signature stamp. A microscopic examination of the bridge in the questioned signature and the joining of nodules to form bridges which occurred from time to time in the test "signatures" on sample cheques (Figure 9a) failed to reveal any significant distinguishing features between the bridges of the questioned signature and the bridges which occurred in the test stamp and written signatures.

It should be noted with respect to Figure 8 that the shape of the nodule near the end of the underscore of the questioned signature conforms to the shape of the inner base of the letter "X" in the background printing of the letters "EX." It is very probably the case that this nodule has been formed as a result of the migrating ink moving into the more absorbent area between the lower extremities of the "X." The lithographic printing ink of the "X" has acted as a barrier to contain the flow of the migrating ink. Given the degree of coincidence between the shape of this nodule and the shape of the internal lower extremities of the "X" it is highly unlikely that this nodule is a feature of the structure of a rubber/plastic stamp.

The remaining two nodules found in the questioned signature are similar to the nodules which occur with the use of a rubber stamp or some liquid ink pens when applied to the sample cheques bearing security printing. The experimental use of various liquid ink pens on plain writing paper failed to produce nodules similar to those which appear on the questioned signature. Similar nodules did sometimes occur when the various rubber stamps were used on plain writing paper. Given the nature of the questioned cheque, the presence of the nodules on the questioned signature does not allow a distinction to be made between a rubber/polymer stamp or a liquid ink pen as the implement used to produce this signature.

In view of the observation noted earlier regarding the absence of impressions in a number of the test writings using liquid ink pens, the absence of impressions associated with the questioned signature in this case did not necessarily preclude the use of a fibre or porous tip pen, a roller ball pen or even a fountain pen.

It was noted that although the density of the ink varied throughout the questioned signature there was no detectable evidence of ink squash in the questioned signature. It was Mr. Westwood's view that one would expect to find some evidence of ink squash appearing along the edges of those portions of the lines which are not so heavily inked.

"Filling-in" was mentioned above as being a characteristic of a stamp impression. The same feature was also noted to occur with the use of fountain pens and fibre/porous tip pens when used to write on the sample cheques. Figure 10a records "filling in" in the thin apexes and troughs in writings as well as at intersection points made using various fountain pens and fibre/porous tip pens on the sample cheques.

Finally, putting aside the influence of the background printing on the questioned signature ink, Mr. Westwood noted that the edge detail of the questioned signature was far superior to that which is normally encountered with rubber stamp impressions. It should be noted, however, that the stamp which Mr. Radley had produced for the purposes of his experiments did exhibit good edge detail.

Non stamp-related observations

There were three other matters of concern which did not directly relate to the inherent appearance of the questioned signature but rather its positioning on the cheque. It was noted that the underscore had been lengthened by approximately 3mm. The commencement point of the questioned signature relative to the printed entry "HK$" and the low baseline alignment of the left hand extrem-

Figure 13a. Illustrations of the presence of nodules on lines made with liquid ink pens on sample cheques.

ity could not be fully accounted for in the known course of business signatures.

These three features of the questioned signature could well be independent of the use of a rubber stamp to produce the questioned signature. The same features could equally be found with respect to a written signature. They do not as a group provide evidence of the use of a rubber stamp. They may however give rise to some doubt as to the genuineness of the signature, regardless of how it was produced.

Figure 14. Illustration of "bridging" between close ink strokes caused by hairs or fibres adhering to the rubber stamp.

Conclusion

Mr. Radley concluded that the questioned signature was the product of a rubber/polymer stamp impression. Mr. Westwood found that a number of the liquid ink pens he experimented with on American Express Bank cheques did produce features which accounted for those characteristics which might otherwise assist in identifying the questioned signature as having been produced by a rubber stamp. It should be noted however that not every feature was accounted for in the use of any one writing instrument, although this could be the case given further experimentation. Having regard to the peculiarities of this particular questioned document and the inherent quality of the questioned signature, Mr. Westwood concluded that it was probably produced by the act of writing.

The matter did not proceed to litigation due to certain evidential difficulties regarding the internal operations of the bank.

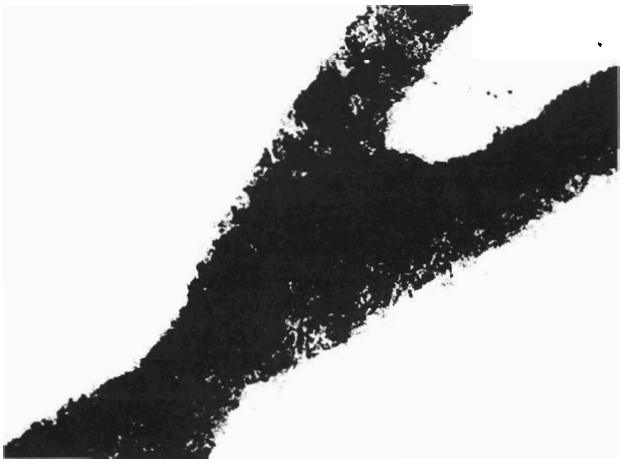
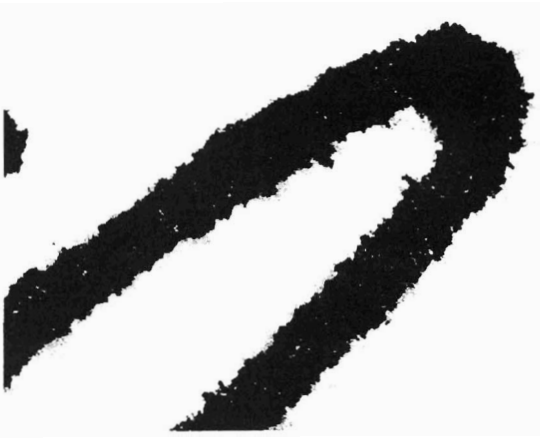


Figure 15. Illustration of "filling in" between stamp impression ink lines sharply intersecting one with another.



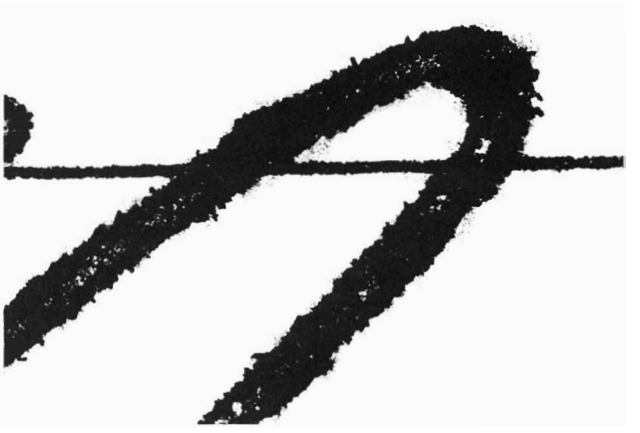


Figure 16. Two consecutive stamp impressions: the first impression does not exhibit ink squash whereas the second impression exhibits obvious ink squash.

The authors trust that this paper will provoke thought and discussion and that it will be of assistance to document examiners confronted with a questioned liquid ink signature written over a fine complex pattern of lithographic printing.

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