Journal of Criminal Law and Criminology

Volume 55
Issue 3 *September*

Article 11

Fall 1964

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DISCUSSION OF THE SEQUENCE OF FLUID INK LINES AND INTERSECTING PAPER FOLDS, PERFORATIONS, TEARS, AND CUT EDGES

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SEQUENCE WITH INTERSECTING PAPER FOLDS

The evidence in problems involving the sequence of fluid ink and intersecting folds may be of such a distinct, positive nature that the most definite, unreserved conclusion can be made. These particular problems of sequence, in fact, can be definitely resolved a greater percentage of the time than other questions in this particular field. For instance, the sequence of paper folds with typewriting, pencil strokes, or ball point pen strokes are oftentimes more difficult to determine, and evidence in the latter problems is usually more difficult to clearly demonstrate by photography.

The basic reason for this is the difference in the nature of fluid ink and its receptiveness to paper over ball point inks and pencil. Fluid ink is an aqueous agent which stains the paper, rather than leaving a layer of oil, clay, or carbon based material on the surface. This fluid ink stain on paper is visibly more responsive to different or changed paper conditions.

Of course, the evidence indicating sequence of these problems is effected by all the features and circumstances involved. Basically, they include the type of fluid ink, the kind of paper and its condition at the time, the kind of pen and pen-point used, the speed and pressure of the ink writing, the direction of the ink stroke in relation to the angle of the pen, the backing under the paper when the stroke was made, and, of course, the particular features about the fold.

It is absolutely necessary to consider each and every material and condition making up a problem of this type. The following list is an outline of such features to be considered before a conclusion is reached on the sequence of fluid ink lines and intersecting folds in the paper.

PAPER: Thickness
Porosity
Surface finish
Condition at the time

INK: Type and make
Quick-drying ability
Penetration in particular paper
Depth of color, consistency
Amount of ink in lines
Evenness of ink flow

TYPE OF PEN: Fountain, nib, quill

PEN POINT: Sharpness of nibs, elasticity of nibs

PEN STROKE: Speed
Pressure exerted
Direction of stroke in relation to nib tracks
Direction of stroke in relation to angle of pen with the paper surface
Direction of stroke in relation to direction of paper fold

PAPER FOLD: Convex or concave
Sharpness of crease
Extent of broken fibres
Evidence of excessive wear or refolding

NUMBER OF INTERSECTIONS: Consistency of evidence at each intersection with the same ink and fold.

In these problems of sequence, if certain evidence is not distinctive or entirely fails to prove one sequence, this is not necessarily proof of the reverse sequence. In fact, when a problem does lack dis-

tinct evidence of one sequence, extreme caution should be exercised by the examiner regarding any conclusion. In sequence problems the correct answer must be down one of two roads. This alone is a temptation for the overeager examiner or pseudo-scientist to make a definite conclusion on what, for practical purposes, is insufficient evidence.

As an example, take the problem of an ink line made *after* a fold in the paper, where the paper is subsequently refolded and opened many times. This subsequent folding may completely eliminate the original stain at the point of intersection which went out into the broken fibres beyond the width of the ink line, thus suggesting that the fold was made after the ink was written. Other circumstances with these problems may contradict what normally would be clear evidence of one sequence. Because of these possible inconsistencies of evidence, it is essential that every consideration be given to all the materials and circumstances making up each individual sequence problem.

Examination techniques of sequence problems involving fluid ink and paper conditions vary to a great extent. On some occasions, the correct conclusion can be made with good eyesight and sufficient light. On most occasions, magnification to some degree is necessary to analyze all of the evidence in the problem. Strong magnification of the intersection with transmitted light may in some instances be necessary to show the evidence in the clearest manner.

There are practically an unlimited number of variations possible in the materials and circumstances involving sequence problems of fluid ink lines and paper folds. However, there are certain basic evidences, as well as dangerous pitfalls, which can be brought out.

Fluid Ink Lines Written Over Folds

There are many different results with these problems of sequence, but the most definite and irresistable evidence is the spreading of fluid ink into the broken fibres of a fold away from the edges of the ink line. This condition only occurs when the paper was folded before the ink line was written. The obvious reason for this phenomena is that the porous, broken fibres of paper in the fold attract and soak up the fluid ink more readily than the unbroken fibres on the flat surface of the paper.

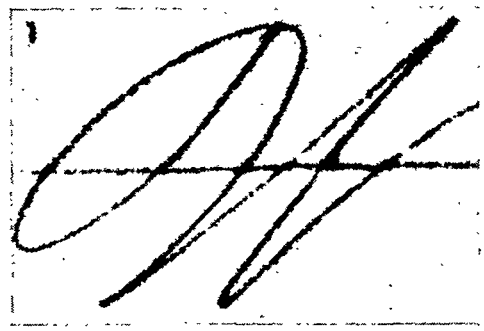

FIGURE 1

Fluid ink lines written over a convex fold. Note that two of the light upward strokes show a skip in the ink line after the point of intersection with the fold.

Equally strong evidence that a line was written over a fold in the paper is the visibly greater density or concentration of ink at the point of intersection than shown in the line just preceding or following the fold.

There is only one situation to the writer's knowledge where this same evidence can occur when the ink line was made before the fold. This is when the paper is folded across the ink line before the ink has completely dried. However, if the fold is concave to the side of the paper bearing the ink line, there is bound to be an off-set of the still-wet ink lines on the paper on the opposite sides of the fold. If it is a convex fold, there is in all probability evidence of smudging along the ink line near the point of intersection, brought about by the action of creasing the paper.

Unfortunately, in sequences of this order the evidence of ink spreading into the fold beyond the edge of the line is not always clear. In fact, this evidence on occasion is entirely lacking. It may be due to a rapid drying ink, or to a fold which is not creased sharply enough to make an appreciable difference in the paper surface. Lack of evidence may also result because the ink line was made very rapidly with a minimum amount of ink flow, or because the pen-pressure was very slight at the point of intersection or a combination of some of these events.

An important consideration in connection with the sequence of a fluid ink line and a paper fold is *whether the fold is convex or concave.* If the fold was sharply creased before the ink line was written, the stain into the broken fibres of the fold is more likely to occur when the fold is convex than when it is concave. One reason for this is that the paper

FIGURE 2

Fluid ink lines written over a concave fold. Note the upstroke in the beginning loop skipped over the fold leaving no point of intersection. The heavy downstrokes show a widened ink line immediately following the point of intersection. It is also interesting to note practically no change in the second and final upstrokes.

fibres along the fold are broken and loosened more on the outside surface (convex) than on the inside surface (concave). (See figure 1.)

Secondly, the pen-point and ink are more greatly effected by a "bump," or convex fold in the paper than a "dip" or concave fold. It is especially true if the ink line at the point of intersection was made rapidly with little pressure. Such an ink stroke at the point of intersection with a concave fold on occasion skips right over the paper where it has been creased inward, virtually leaving no point of intersection.

On the other hand, a rapid, lightly made ink stroke over a convex fold also occasionally leaves the paper surface for a short distance, but *after* the point of intersection. This action is similar to the "jump" that a skier makes off a ski-jump, the upward turn at the end of the jump being the top of the convex fold in the paper.

It is a common occurence at an intersection of a fluid ink line made over a concave fold to find that the ink line width diminishes slightly at the point of intersection, but shows a "bulb," or slightly greater line width at the far side of the fold. (See figure 2.) This, too, is similar to a skier's tracks, where on a downhill run they are very slight over a declivity, but make a greater than average depression in the snow just on the far edge of the declivity.

An important consideration in these problems of sequence is the type of pen-point used and the angle of the pen-point to the paper and to the direction of the line at the point of intersection. Evidence that an ink line which was written downward (normally the pressure stroke) was over a fold often is more obvious if there is some elasticity in the pen-point nibs. This is true with both convex and concave folds.

The "bump" in a convex fold will cause the nibs to spread apart more just before and at the point of intersection with an elastic pen-point than with a point which has little or no elasticity. This spreading of the nibs, of course, causes the line to widen at the intersection. Even if the fibres of the fold are not broken enough to attract ink beyond the original line width (which does occur at times with good paper), the fact that the line is wider at the intersection than just beyond it is strong evidence proving the fold was made first.

Conversely, if a concave fold is sharp causing the paper not to lie perfectly flat on the supporting surface, an elastic pen-point will cause a greater widening of the ink line on the far side of the fold.

Another point to be considered is evidence indicating how sharp, or pointed the pen nibs are in the instrument used. Generally, fountain pen nibs are not as sharp as the nibs of a straight or dip pen. Nevertheless, crossings with an upstroke (where the pen is pointed in the same general direction of the stroke), over a sharply creased convex fold may cause the nibs of a fountain pen as well as a straight pen to "catch" on the fold, completely stopping the pen movement and sometimes making a hole in the paper. When such an event occurs, microscopic examination is hardly necessary to see the evidence.

A study of ink lines made after folds in paper when the ink is blotted shows little difference in the common evidence of this sequence. Practically all commercial inks spread into broken fibres of a fold to some degree before completely drying or being blotted. However, when a good deal of the ink in the line has been absorbed in the blotter, the evidence may be much less distinct.

Summary. The most important and persuasive evidence that an ink line was made after a fold in the paper is the presence of a stain beyond the edge of the line at the point of intersection. Other evidences include: the skip or brief narrowing of a line on the far side of a convex fold; the complete skip over the point of intersection with a concave fold; the narrowing of a line at the point of intersection with a concave fold sometimes followed by a slightly greater line width just after the point of intersection.

Folds Made After Fluid Ink Lines

The most distinctive evidence of an ink line having been made before the paper was folded is the *lack* of any change in its width in the area of

FIGURE 3

A convex fold made after fluid ink lines. The broken and unstained paper fibres at the points of intersection with the ink lines unfortunately are not always so apparent in every case. Note the consistent line width of the fluid ink before and after the fold and some ink stains still remaining at the points of intersection.

the intersection or in the concentration of ink at the point of intersection. If the paper has been strongly creased, and opened and refolded a number of times, often the continuous stain of ink in the original line is broken showing unstained paper fibres at the point of intersection. (See figure 3.) However, a continuous, unchanging line width at the point of intersection with a fold must be considered in combination with the ink, paper and all of the circumstances surrounding the particular problem. In most sequence problems, the strength and porosity of the paper is probably the most important single factor in relation to questions of sequence.

Unfortunately, all paper creases are not sharp folds which visibly affect fluid ink lines written over it. Some paper creases, especially concave folds in a good grade of paper, may disturb the fibres on this side of the sheet so little that a rapidly made ink line intersecting it shows no evidence of having been written last. It is true a greater percentage of the time with fine, narrow strokes having little or no shading, than with heavier pressure strokes. Lack of evidence may also result when a folded paper is carefully flattened before an ink stroke is made over it or when a quick-drying ink is used. If an ink line intersects a fold more or less perpendicularly rather than at a sharp angle, the evidence is more likely to be less distinct showing the ink line subsequent to the fold.

Still another feature of the paper and fold which must be considered is the evidence of wear and dirt. Papers which have been folded and kept in a wallet or purse for a long time, or which have been excessively handled or dirtied in an unusual manner, may lack evidence at the intersection which at one time was clearly present. If one finds no stain beyond the edge of a fine ink stroke at the point of intersection with a fold that has been excessively worn or dirtied, he should carefully consider the possibility that such evidence in the ink did exist at one time. It is an unusual circumstance for an ink stain that spread into the fibres of a fold beyond the line width to be entirely eliminated, but it can happen. If a particular problem warrants consideration of this possibility, the strength and porosity of the paper, the staining ability of the ink, and the amount of ink in the line before and after the fold should be carefully analyzed. The direction of the original paper fold would be important, but this reference concerns paper so worn or damaged one could not possibly determine the direction of the original fold.

Of course, the likelihood of ink in a fold being destroyed is much less likely if the fold is concave rather than convex. With a concave fold, the ink line at the point of intersection is better protected against wear and tear than a line over a convex fold.

One should be aware of what at times is an optical illusion seen at the intersection of an ink line made prior to a sharp convex crease in heavy paper. When a sharp fold has been made and the paper subsequently flattened again (or folded at the opposite way and then flattened), a "ridge" may remain along the fold, especially if the paper is a very heavy grade. This elevation of the paper along the fold, at the point of intersection, has also raised the ink line where it follows the contour of the "ridge." Sometimes it seems that the ink line widens on this ridge, similar to the way a line widens slightly when it crosses over a convex fold. The fact is that the ink line width appears to be greater at the fold because it is curving over a rounded surface which was stained when it was originally flat. A careful observation of this sequence, however, reveals that where the line at the fold seems to widen slightly on one side, it actually is the same width as just before and after the fold. (See figure 4.)

Another optical illusion caused by paper folds is what seems to be a slight change in direction of an ink line after the point of intersection. Such a change in direction actually occurs at times in a line written over a fold, as the continuous pen-movement has been physically interrupted. An illusion similar to this is caused by the slight change in the lie of the paper after the fold has been made.

FIGURE 4

A convex fold made over an ink line on filing card paper. The card, after folded and then flattened, left a "ridge." The heavier ink line, following the contours of the "ridge," leave an illusion of showing a change at the point of intersection.

Careful observation should be made of the ink lines throughout all the writing in a document involving such a problem of sequence. An examination may illustrate that the writing was done with a faulty pen or with ink that did not flow from the pen evenly or continuously. Fluid ink lines showing non-discriminate skips or heavy deposits on the flat surface should be most thoroughly studied. What appears to be evidence of a change in a line presumably caused by a fold, may actually be a common result of the defective pen or ink being used.

Summary. In most instances, the nature of evidence illustrating that an ink line was made over a fold is more distinctive than the evidence showing a fold was made after the ink line. This is simply due to the fact that usually a preceding fold will cause a positive, visible reaction to an ink line that could not occur for any other reason. Conversely, the visible reaction when a fold has been made over an ink line is, in most instances, less distinct. For this reason, it is normally easier to demonstrate by photography that a fluid ink line was made after a fold than to prove a fluid ink line was made before a fold.

It is hardly necessary to point out that with the greater number of crossings between a questioned writing and a common fold, the greater opportunity there is to illustrate conclusive evidence proving the correct sequence. If a problem of sequence involves three or four crossings between continued fluid ink writing and a common fold (admittedly not a common occurrence), and one of these illustrate irrefutable evidence the ink went over the fold while the others do not, there can be no question but that the ink was subsequent to the fold. On the other hand, the greater the number of crossings between a continuous fluid ink writing and fold where evidence indicates the fold was made last, the more definite basis there is for the conclusion of this sequence.

SEQUENCE WITH TEARS, CUT EDGES, OR PERFORATIONS IN PAPER

The evidence proving sequence with fluid ink lines and tears, cut edges, or perforations in paper is basically consistent with the evidence of sequence between these lines and intersecting paper folds. However, tears, cut edges, and perforations practically always disturb the original condition of the paper more violently than a fold, hence the evidence of sequence is more distinctive in a greater percentage of the cases.

A tear is distinguished from a cut edge and most perforations as it is the result of two parts of a sheet being pulled apart leaving fractured, uneven paper fibres. A cut edge results from a sheet being sliced apart by a sharp blade or blades leaving a smooth edge of evenly broken fibres. A perforation caused by a blunt instrument tears the edges of the paper, but most perforations, such as caused by a bank date perforator, leave holes with cleanly cut perimeters.

Fluid ink coming in contact with a torn edge generally shows more distinct evidence of being done last than when contacting a cleanly cut edge. This, obviously, is because a tear in paper causes a greater disturbance and change in the original position of the paper fibres than is caused by a clean cut. The fractured, jagged ends of paper fibres in a tear, or the stripping of a calendered paper surface, more readily attracts the fluid ink than a cleanly cut edge.

The typical evidence of a fluid ink line made after a cleanly cut edge is the presence of ink along the side of the cut (those paper fibres which were not exposed to the surface of the paper before it was cut). The heavier the intersecting ink line, the more pronounced is the ink along the side of the cut sheet. Often, a heavy ink line over a cut edge not only extends down along the sides of the cut edge, but continues the staining action onto the opposite side of the sheet.

When one is studying such a problem of fluid ink and an intersecting cut edge, care should be taken concerning what is the surface of the paper and the "side" of the paper at the cut. With lightweight paper, or with paper cut by dull scissors, the edges of the cut may be squeezed together so that one

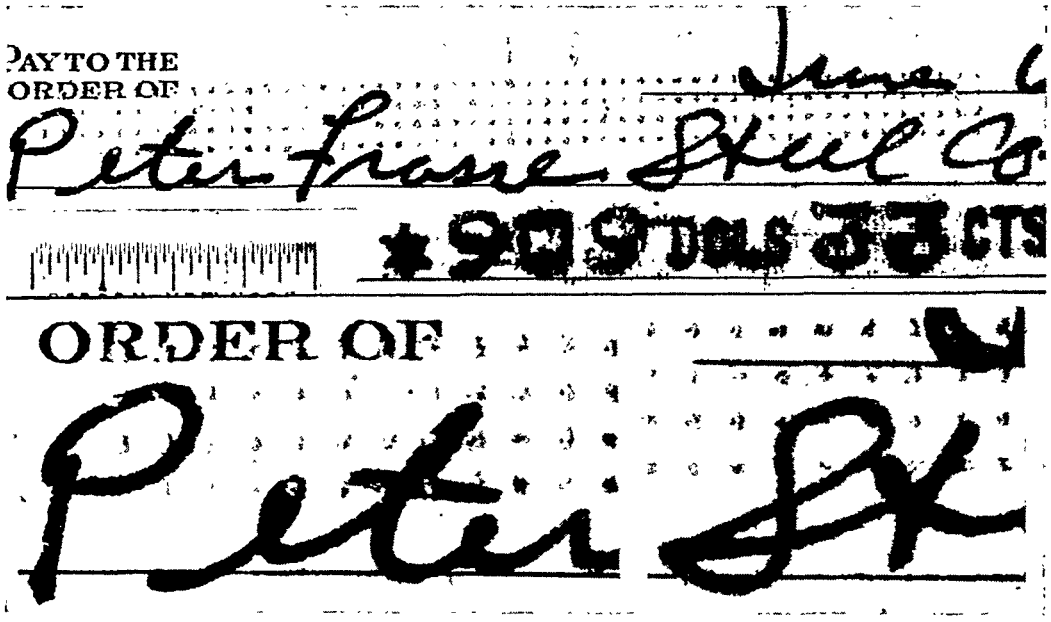

FIGURE 5

The payee's name on this check was originally "Pete Frass," later altered to "Peter Frasse Steel Co." The original name was written before the amount was put on the check with a checkwriter, along with the "Payee Perforator" embossings, consisting of four rows of raised impressions in the paper through the name. These embossings broke through the ink stains where they contacted the original writing leaving unstained paper fibres. (As in the "P," "t" and "F".) The fluid ink in the added writing, done after the "Payee Perforator" embossings, shows the different sequence by the attraction of ink into the broken fibres of the embossings.

cannot actually see the "side" of the sheet. In this case, one may not see those paper fibres which were unexposed to the surface before the cut was made, but instead is looking at the curled or squeezed-together surfaces of the paper.

Ink which has not bled downward from the surface of a cut edge onto the side of a sheet does not conclusively prove that the cut was made last. On rare occasions, when a fine line is made extremely rapidly and the pen is beginning to be lifted off the paper just as it intersects the cut edge, it is possible the very slight amount of ink stain will not extend down the side of the edge before drying. This, naturally, is more apt to happen with a fast-drying ink or with ink which is less aqueous, or with paper which is less porous. All such factors and circumstances must be carefully weighed before reaching a conclusion.

Shortly before this article was written, examinations were made by the author in a case involving alterations of over 300 checks, where additions were made to the original payees' names (written in fluid ink). The alterations were made after the amount had been put on each check by a checkwriting machine and after the checks had gone through the bank. Reference is made to this particular case as it affords an excellent example for determining the sequence of tears and perforations in paper with fluid ink.

The company employee who originally made out the fraudulent checks first wrote a fictitious personal name on the face. Then he put in the amount on the check using a company checkwriting machine and forged the payor's signature. Next, he wrote the fictitious payee's name on the back very lightly, followed by his own signature, also written very lightly, and cashed the check. When the checks were returned from the bank, the same employee then erased the two lightly written endorsements on each check and put a fictitious rubber stamp endorsement of an actual company over the erased area. Then, he changed the personal name of the payee on the face of the check to this same firm name with whom the victim company was actually doing business. As an example, one payee's name was originally written "Pete Frass," but after the check was returned from the bank, it was altered, making the payee "Peter Frasse Steel Co., Inc." (See figure 5.) Another rather clever alteration was the personal

name "Pat Transmissi" later added to, making the payee "Patron Transmission Co." A third was the name "Trave Insiera" (without an "i" dot), later changed to "Travelers Insurance Co."

The personal names were first written on the checks to allay any suspicions at the bank when the checks were cashed by the employee. The later addition making the payee an actual firm name on the face of the check and the stamp endorsement bearing the firm's name being put over the original, erased handwritten endorsements on the back, was done to cover up the fraud from the company. (Many of the imaginary personal names that were made up so they could later be altered to actual firm names were quite ingenious. In fact, the thefts continued for more than a year before they were discovered, and the losses amounted to over $130,000.)

In every instance, the original payee's name was written on the face of the check *before* the amount was put on with a check-writing machine. Along with the amount in words and figures, this check-writer also caused four rows of "bumps", or raised knobs along the area of the check where the payee's name was written. (These embossings are referred to as the "Payee Perforator".) These were not complete perforations in the paper, but embossings raised just enough to cause a slight tear around their circumference.

Where these embossings intersected with the fluid ink lines of the original payee's name, there was just enough tear around the circumference of each embossing to show unstained paper fibres, clearly illustrating the sequence of the ink line written before the amount was put on the check. Where the ink lines of the added writing in the payee's name intersected with the embossings, the paper was quite visibly stained beyond the normal width of the ink line into the broken fibres around the circumference of the embossings. Of course, where some embossings had greater fibre damage or where the ink line was heavier or wider, the evidence that the line was written last was more apparent.

Even though the employee used the same ink and pen most of the time when he added to the payees' names on the checks after they were returned from the bank, the evidence as described was very clear in each instance when the added writing touched one of the "payee perforator" embossings.

A second important feature in the case was that on many of the checks, the payee's name also intersected with perforations in the check caused by the bank-dating machine. Here again, the ink in the original payees' names showed no change at the intersection with the holes. White, unstained paper fibres were clearly apparent around the sides of each perforation. But, where the ink line of the added part to the payees' names intersected with the bank stamp perforations, the sides of the holes were clearly stained and in many instances the ink actually stained or bled through onto the back surface of the check around the holes.

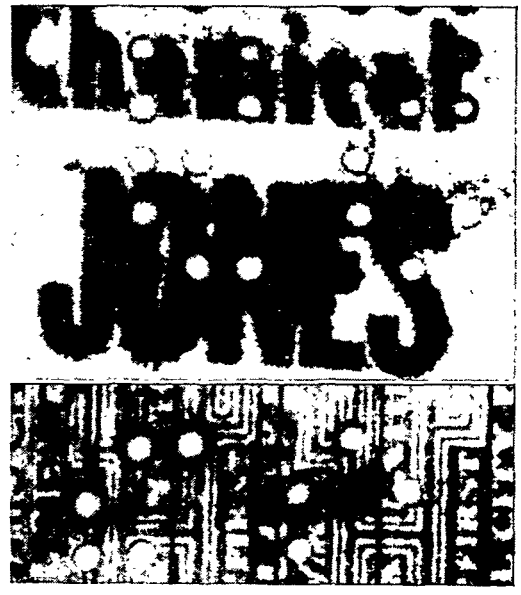

FIGURE 6

An illustration showing evidence of an ink stamp endorsement on the back of a check being made after the check had gone through the bank. In the top photograph, part of the stamped endorsement on the back of the check is shown where it intersects with perforations caused by the bank dating machine. The bottom section shows the same perforations seen from the face of the check, where the ink from the stamp endorsement bled through leaving a stain around the perimeters of five holes.

Additional evidence proving the fraudulent operation was found on a few checks where the bank-dating perforations also intersected with the ink used in the stamp endorsement that was put over the erased area on the back. Here, too, the ink from the stamp endorsement stained the sides of the perforations and in some instances bled through to the face of the check, proving the sequence of the stamp endorsement made *after* the bank date perforations (See figure 6).

As was described previously in connection with

folds, the aqueous, staining nature of fluid ink visibly changes when it comes in contact with a change in the surface of the paper. This is almost always true when the paper has been torn, cut, or perforated. One possibility, however, for making an erroneous conclusion to these sequence problems is mistaking some other disturbance of an ink line resulting in a similar appearance to evidence caused by ink contacting a tear or cut edge. For instance, an ink line that preceded a tear or cut edge, but which was done with washable ink and later accidently or purposely wetted, may spread or change in a manner similar to the evidence of ink being written subsequent to a tear or cut edge. In such a case, though, there almost surely will be an indication by the stains in the paper or in the thinness of the ink that the change was caused by wetting and not by a difference in the surface of the paper.

Summary. The evidence illustrating a fluid ink line was made *after* a tear, perforation or cut edge in the paper is usually distinctive. If examined carefully and with an open mind, it is very unlikely to be misinterpreted or to be mistaken for evidence of a change in an ink line resulting from some other cause. Since evidence is usually much more distinct showing an ink line was made after a tear or cut edge in paper as compared to a fold in paper, the basis for one to conclude an ink was written *before* a tear or cut edge (as compared with a fold in paper) in most instances is stronger.