CASE REPORT

Richard W. Vorder Bruegge,[1] *Ph.D.*

Photographic Identification of Denim Trousers from Bank Surveillance Film[1]

ABSTRACT: The ability to identify denim trousers (e.g., "blue jeans") from bank surveillance film through side-by-side comparison is documented herein. Individual identifying characteristics that are generated in the manufacturing process and during normal wear-and-tear may be recognized on denim trousers and in photographs depicting those trousers. These characteristics may include folds, creases, and puckering which manifest themselves as high and low areas ("ridges and valleys") along and adjacent to the seams and hems. As the jeans are worn and washed over time, the visibility of these ridges and valleys is amplified through abrasion of the ridges, resulting in a loss of dark dye and marked tonal brightening. Given sufficient abrasion, even small ridges may exhibit sufficient contrast against the dye-rich background to be recorded on bank surveillance films, permitting a comparison with trousers recovered from suspects. The application of this technique in a case involving a series of bombings and bank robberies in Spokane, Washington, is discussed.

KEYWORDS: forensic science, photographic comparison, identification from photographs, clothing identification, identification of denim clothing, clothing wear marks, bank surveillance film, blue jeans, side-by-side comparisons, barcode patterns

Whenever an item recovered from a suspect or a suspect's home can be associated with the commission of a crime, it can offer strong circumstantial evidence in the prosecution of the case against that individual. The association of articles of clothing worn by bank robbers depicted in bank surveillance images with clothing recovered from suspects is one example of such circumstantial evidence.

The FBI Laboratory's Special Photographic Unit conducts forensic examinations of imaging evidence of every kind, including film negatives, photographic prints, video tape recordings, and digital images. A primary area of examinations includes the photographic comparison of clothing worn by bank robbers depicted in surveillance images (film or video) with clothing recovered from suspects. Such examinations have been conducted for approximately 30 years and currently represent more than 25% of the unit's caseload. Other major areas of examinations include facial comparisons, photogrammetric examinations (e.g., bank robber height determinations), and image analysis through analog and digital image processing techniques.

In 1996, investigation into a series of bombings and bank robberies in the Spokane, Washington area resulted in the identification of four suspects and the recovery of numerous articles of clothing from their homes and vehicles. The clothing, including 27 pairs of denim trousers ("blue jeans"), was subsequently submitted to the Special Photographic Unit for comparison with surveillance images from the bank robberies. What follows is a description of the process through which one of the seized pairs of blue jeans was identified as the pair worn by one of the bank robbers.

Photographic Comparisons and the Principle of Individualization

The principle behind photographic comparisons is the same as that behind the comparison of fingerprints, footwear impressions, bullets, firearms, or any other kind of physical evidence—the principle of individualization. As described by Tuthill:

> "The individualization of an impression [or other piece of physical evidence] is established by finding agreement of corresponding individual characteristics of such number and significance to preclude the possibility (or probability) of their having occurred by mere coincidence, and establishing that there are no differences that cannot be accounted for (1)."

The key element in conducting a successful comparison in any examination of physical evidence is the ability to resolve the individual characteristics that differentiate the item from all other similar items. This holds for photographic examinations involving clothing, faces, firearms, vehicles, or other items. When conducting an examination through photographic comparison, two interrelated factors have the greatest impact on the ability to conduct a successful examination: (1) the quality of the images recorded on the film (or video tape or digital imaging system); and (2) the presence of individual characteristics on the known object that are sufficiently visible to be identifiable on the recorded images. In the case of the bank robber's blue jeans considered herein, both of these factors were favorable to an individualization.

Another factor that is important to consider when applying the principle of individualization to photographic comparisons relates to apparent differences that can result from the photographic process. This is a factor that most individuals do not actively consider when examining photographs, video, or other images. When a photograph is taken, a three-dimensional scene is converted into a flat, two-dimensional representation. When looking at such a photograph, the viewer does not generally interpret the scene depicted as being two-dimensional, but automatically understands that the scene is three-dimensional. The perspective depicted in the photograph, including the relative size of known or familiar objects in the scene, is used by the viewer to interpret the geometric relationships between objects within the scene and between the camera and the scene. Furthermore, most viewers understand that the photographic process is an imperfect one, in which the actual colors and shades of a scene are rarely replicated perfectly. The meaningful comparison of objects depicted in photographs with items of evidence must include specific consideration of such changes introduced by the photographic process.

A final critical factor that must be considered in photographic comparisons involves the potential for an object to exhibit temporary or permanent changes in its characteristics such as shape or tonality between the time it was photographed and the time it is examined. Clothing is particularly prone to changes in shape while being worn, as the material is stretched, folded, or bunched. Similarly, clothing tends to fade after repeated washings, so that differences in the shape or tonality of an object depicted in a photograph and an object seized as evidence do not necessarily indicate that they are not the same object. The potential for such differences is considered by the examiner to such an extent that the most critical aspect of a photographic comparison frequently involves establishing that observed differences can be accounted for.

Methodology of Clothing Comparisons

In clothing comparison cases, the bank film depicting the unknown bank robber is labeled the "Questioned" item of evidence. The recovered clothing is the "Known" item since its source is known. Upon receipt of the bank film and recovered clothing, every frame of the film is examined to locate those frames which best depict the bank robber and his clothes.

Examination of the original film is critical, since it will contain the highest level of detail in both the shadows and highlights. Photographic prints produced from bank film through automated processors are generally exposed to produce adequate contrast and image quality for the overall scene, rather than for the specific portions that contain the bank robber and his clothing. In such machine-processed prints, fine details needed to individualize the clothing may not be visible due to under- or over-exposure in the portion of the print depicting the clothing. In an examination using the original film, various exposures may be tested to maximize the detail visible in the final print.

It is also important to select frames in which the questioned individual or item is at rest. Motion blur can be a major factor in causing fine detail to be absent from an image. Likewise, if the resolution of an image is less than that necessary to distinguish the fine detail, then it is impossible to make an identification or elimination based on that detail.

It is during the review of the film that analysis begins, with the observation of the class characteristics of the clothing. Once such characteristics are noted on the clothing worn by the bank robber, preliminary comparisons are conducted with the known items of clothing. For example, if the bank robber is wearing corduroy pants

(recognizable by the presence of well-defined vertical ribs and wells), then any submitted denim trousers can be eliminated. However, if an elimination is not immediately forthcoming, then photographic enlargements of the best frames are produced at exposure and contrast levels that lead to the highest possible detail in the area of interest. The search for individual identifying characteristics and the point-by-point comparison with the submitted trousers can then proceed.

Identifying Characteristics of Denim Trousers

In order to conduct clothing comparisons, examiners in the Special Photographic Unit must be knowledgeable regarding the means by which clothing develops class and unique characteristics. This knowledge is obtained, in part, through on-site inspection at manufacturing facilities throughout the United States, as well as through technical discussions with manufacturers. Descriptions of the procedures included herein are based on inspections and discussions in which the author has participated since 1995.

The most general of class characteristics exhibited by denim trousers include the manufacturer, style, and size. The style and size may affect additional class characteristics of the trousers such as cut of the leg (i.e., straight, tapered, boot-cut, etc.), presence and type of buttons or zippers in the fly (and elsewhere), presence of rivets, pocket stitching, presence and style of patches or labels on the waist, and number and type of belt loops.

Unique or individual identifying characteristics of denim trousers typically arise as defects generated by the manufacturing process (e.g., drop-stitches—locations where a stitch is missed) and through normal wear-and-tear. The latter may include paint, ink, blood, dye or other stains, rips, tears, holes, fold creases, wrinkles, and other wear marks. Such characteristics have been used in clothing identifications by the Special Photographic Unit for approximately thirty years (2) and were discussed by FBI Special Agent Joseph M. Avignone in a presentation to the 1989 American Academy of Forensic Sciences Annual Meeting ("Clothing Identification Analysis of Bank Robbery Films"). Finally, in some cases individualizing patterns of wear marks can result from creases or puckers introduced during the manufacturing process.

It is important to note that in making clothing comparisons the examiner is concerned with the morphology of the individual identifying characteristics and their approximate location relative to fixed landmarks on the article of clothing. To an extent, the examination is one of pattern recognition. Specific measurements detailing the precise location of identifying marks on clothing are not necessary for an association to be made, nor can they be made in the majority of cases due to several factors, not the least of which is temporal variations in the shape of the clothing such as folding, billowing, or "bunching up" of the material. Furthermore, photogrammetric analysis of the type used in examining surveillance images is adequate when measuring linear distances such as heights, but is less accurate when measuring curved objects such as a draped trouser leg, whose three-dimensional shape cannot be uniquely determined from a single image, particularly when the exact location and orientation of that object in space is not known. This is in contrast to comparisons of impressions in which the impression is typically left on a planar surface or on an object whose shape can be uniquely defined so that later corrections can be made for distortions.

Folds and "Barcode" Wear Patterns on Denim Trousers

The side seams, inseams, and hems of denim trousers typically develop a pattern of puckers or "ridges-and-valleys" which, after

FIG. 1—*Pucker or "ridge-and-valley" pattern along seam of blue jeans resembles a "barcode."*

being worn down, will appear as an alternating sequence of light and dark bands, resembling a "barcode" (Fig. 1). These puckers are generated during the manufacturing process as the operator pushes the material being stitched through the sewing machine. This process is not automated and causes material to alternately bunch up and stretch as it is guided through the sewing machine, creating an irregular waveform pattern that becomes ingrained in the seam or hem. Later shrinkage may increase the amplitude of this waveform, and, therefore, increase the prominence of this pattern.

In contrast to an actual UPC bar code in which the alternating pattern is pre-defined, no attempt is made by the sewing machine operator to produce a specific pattern, nor to replicate this pattern of puckers in subsequent seams or hems. Nor is it likely that such patterns could be repeated since the operation is performed by hand. Therefore, the waveform is assumed to represent a unique manufactured characteristic. Over time, as the trousers are worn and washed, the raised portions of the waveform become abraded, which leads to a loss of the dyed surface layer and exposure of the un-dyed core of the white cotton yarn. When the trousers in question are blue jeans (or any other dark denim trouser, such as black jeans) the removal of the dark dye and exposure of the white yarn cores on the ridges leads to a visible brightening of these ridges. Since the fabric in the valleys retains a dark dyed surface layer between bright, abraded ridges, a recognizable alternating bright and dark pattern results, which is referred to here as a "barcode" pattern.

It has been suggested that the alternating pattern of bright and dark areas along the seams and hems of blue jeans and other dark-dyed denim trousers might also be likened to a "railroad track" pattern. However, such a characterization implies a regular spacing and constant width to the bright and dark patches along the seam or hem. Inspection of the seam in Fig. 1 reveals that this is not the case. Instead, the width and spacing of the bright and dark patches are irregular, as in a barcode. This irregularity is what makes the barcode pattern useful as an identifying characteristic. Although a validation study has yet to be performed to test the theory that all denim trouser barcode seam patterns are unique, it has been observed in numerous examinations that it is possible to distinguish pairs of jeans from one another based solely on differences in the patterns along the seams.

In some cases, individual folds or creases are also generated during manufacture or through later processing of the trousers. For example, folding of the trousers and subsequent ironing can lead to a marked raised crease which is then subject to increased abrasion. As the abrasion increases, the visibility of the crease against the background is amplified as the dye-bearing outer layer is removed, revealing the un-dyed white cotton cores of the yarn underneath. Alternately, in some cases puckering along the seams and hems can result in individual low areas which remain dye-rich (and therefore dark) while the surrounding areas are worn in a uniform fashion, leaving a single dark feature against a lighter background. Such individual characteristics may be more significant than the barcode pattern in a photographic comparison since they typically stand out from the solid background of the denim and are more easily identifiable as random features. This was the case in the analysis of the Spokane bank robbery film and examples of such characteristics are discussed below.

Effects of Stitching and "Cross-over" Wear Patterns

When two pieces of fabric are brought together to make a seam, they may be stitched together in one of two ways: they may be "felled" or they may be "chainstitched." Many denim trousers are constructed with felled inseams and chainstitched side seams. A felled inseam consists of two pieces of fabric that are folded over upon one another prior to being sewn with a double-stitch. This leaves a seam that is 4-plies thick, with stitching visible on the outside of the garment. The presence of an extra 3-plies-worth of material along a felled seam plays an important role in the generation of the barcode pattern by making the seam stand up higher than the surrounding material, thus exposing it to more wear through abrasion and an associated loss of the dye-rich outer layer.

In a chainstitched side seam, the two pieces of fabric are pinched together and sewn in such a way that the stitching is not visible on the exterior of the garment. However, such a chainstitched seam is only 2-plies thick, and will be weaker than one that is felled. Furthermore, the chainstitch leaves flaps of excess material on the interior of the garment which are free to fold over and lay flat against the garment. Frequently, the seam is pressed open or "seambusted" so that one flap lies against the material on each side of the seam. Alternately, the flaps are sometimes sewn together, creating a single 2-ply flap that is then free to fold down to one side or the other of the seam. In either case, the extra layers will raise the fabric in the vicinity of the seam, making these areas more prone to abrasion than surrounding ones.

In addition to the key role the flaps of excess material play in amplifying the visibility of the barcode pattern along a side seam, these flaps are also crucial in the generation of another characteristic known as a "cross-over." The flap or flaps of material do not necessarily fold to one side or the other along the entire length of the seam. In some places the flap will fold back to the other side of

the seam, and in the process create an unusually thick portion of material where the flap effectively stands on end. This point thus represents the location on the seam with the thickest cross-section of material, and therefore the most likely point of abrasion and wear. Furthermore, by changing the side on which the flap lies, the raised part of the seam that amplifies the barcode pattern will also change sides or "cross-over." Exterior and interior views of a chainstitched side seam that exhibits a cross-over are presented in Fig. 2.

Cross-over features are observed on denim trousers at locations along the seam ranging from the hip to just above the hem, with no apparent correlation between the location of this feature and the trouser manufacturer or style. In some cases, denim trousers have

been found to exhibit more than one cross-over along a single seam. Furthermore, it has been observed that the location and occurrence of cross-over features can differ on pairs of denim trousers owned and worn by the same individual. From these limited observations one might propose that the location and frequency of cross-over features are independent of the manufacturer and wearer. However, a thorough validation study to test this proposal has yet to be performed. Nevertheless, as with differences in the barcode patterns, the cross-overs create observable wear patterns that persist over time, making it possible to use differences in the location and nature of cross-over features to distinguish one pair of denim trousers from another. Thus, one can use cross-overs as an identifying characteristic in photographic comparisons.
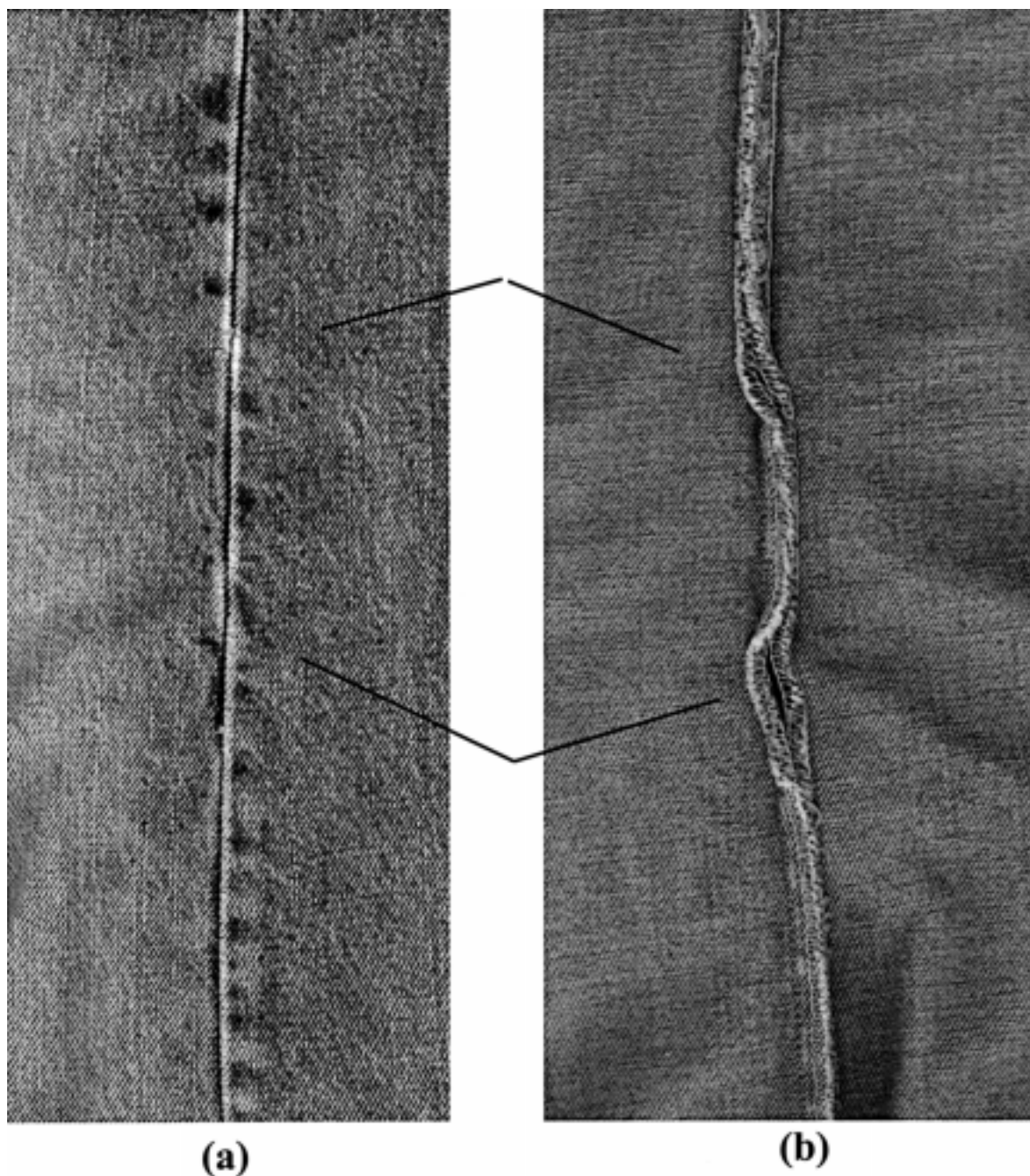

FIG. 2—*Cross-over pattern. (a) Exterior view. (b) Interior view—actual view has been reversed to match the orientation of the exterior view shown in (a).*

Spokane Bank Robbery and the Observed Characteristics of the Robber's Trousers

On April 1, 1996, two bank robbers entered a branch of the U.S. Bank in Spokane, Washington. The surveillance cameras were triggered by the bank personnel and several hundred frames depicting the movements of the robbers in the bank were taken. Many of the frames depict one robber carrying a large firearm, and wearing a dark mask, parka, athletic footwear, and denim trousers. Figure 3 contains two of the best views of this robber and his trousers. To the great benefit of this examination, a number of the frames contained on the bank film depict the robber standing perfectly still while presenting direct views of his right outseam and left inseam.

Subsequent investigation of this robbery, a second robbery of the same bank on July 12, 1996, and several related bombings, led to the identification of four suspects. During searches of their homes, numerous articles of clothing were recovered, including 27 pairs of denim trousers, all of which were blue jeans. These articles of clothing were submitted to the Special Photographic Unit for comparison with the bank film from both robberies.

The bank robber's parka extends below the waist, effectively masking the manufacturing characteristics of the belt loops, pockets, and fly. However, individual characteristics are recognized on and near the left inseam, right outseam, and hems (Fig. 4). Shadowing and the prominence of the film grain prevent one from clearly resolving the left inseam's barcode pattern (Fig. 4a).

Nevertheless, a number of distinctive individual characteristics can still be recognized near the left inseam and hem. The first is a bright linear feature extending up from just left of the inseam-hem intersection. This narrow linear feature parallels the inseam for a short distance then angles away from it, well up the calf ("1"). A second feature consists of a connected set of dark patches in the general shape of an "H" which span the inseam-hem intersection ("2"). The right leg of the "H" is relatively broad and is defined on the right by a bright lineament. The left leg of the "H" is narrower and abuts the left edge of the inseam, with its outer edge defined by the linear feature ("1") described above. A third feature immediately to the left of the "H" consists of a pair of bright, short, lineaments extending from the hem. This pair of marks form a "V"-shape that tilts to the left so that the right side is vertical and the left side extends at an angle of approximately 45-degrees ("3"). Finally, a pair of bright features resembling the Greek letter "Π" ("4") are observed to the immediate right of the dark "H" along the hem.

(a)　　　　**(b)**

FIG. 3—*(a) Bank surveillance photograph depicting view of Spokane bank robber's left leg. (b) Bank surveillance photograph depicting view of Spokane bank robber's right leg.*
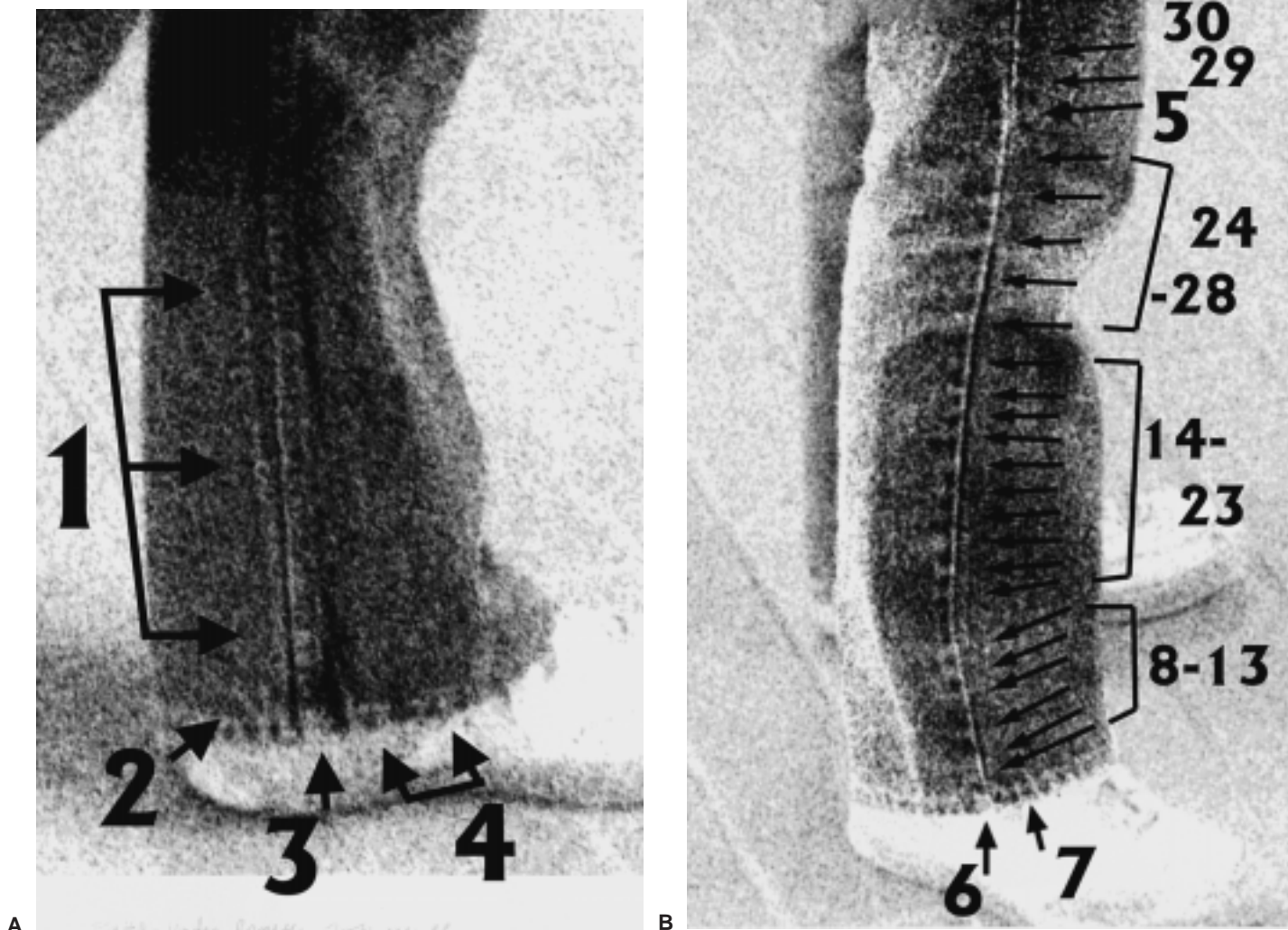
A   B

FIG. 4—(a) Enlarged portion of Fig. 3(a) showing details of left leg. (b) Enlarged portion of Fig. 3b showing details of right leg. See text for discussion of features identified by numbers.

On the right outseam a distinctive barcode pattern is observed extending up from the hem to above the knee (Fig. 4b). This barcode occurs to the left of the crease that defines the edge of the seam. Above the knee, a "cross-over" is observed ("5"). This crossover represents a location in which the barcode pattern of bright and dark patches switches to the right side of the crease. The point where the side seam meets the hem is marked by a broad bright patch, whose upper right edge is sharply defined along a diagonal from the side seam to the hem ("6"). From the point where the right side seam meets the hem up to the cross-over, twenty-one (21) individual bright patches (of various widths and distinctiveness) are observed ("8–28"). Additional bright patches were noted both above the cross-over and along the hem to the right of the "H" ("7, 29–30").

Identification of Submitted Blue Jeans

Having noted the extensive set of individual characteristics on the blue jeans worn by the parka-clad bank robber in the April 1 bank film, it was then a straightforward process of comparing these observations with the blue jeans submitted to the Laboratory. The 27 pairs of blue jeans were inspected individually, and the presence or absence of identifying characteristics similar to those on the bank robber's jeans noted. Of these pairs of blue jeans, 26 pairs were found to have individual characteristics that were sufficiently different from those exhibited on the bank robber's trousers to permit their elimination as those worn by the bank robber. The 27 pair, a pair of JC Penney "Plain Pocket" blue jeans was found to have characteristics matching all of the individual characteristics noted on the bank robber's jeans. Through consultation with the manufacturer it was determined that these jeans had been constructed in Clarksville, Tennessee in 1991, using standard hand-guided sewing practices common throughout the blue jean industry. This consultation confirmed that the observed characteristics could be expected to be the result of random processes. Therefore, since the morphology and relative location of these random characteristics was consistent between the bank robber's trousers and the submitted blue jeans, the submitted blue jeans were individualized as the ones worn by the bank robber.

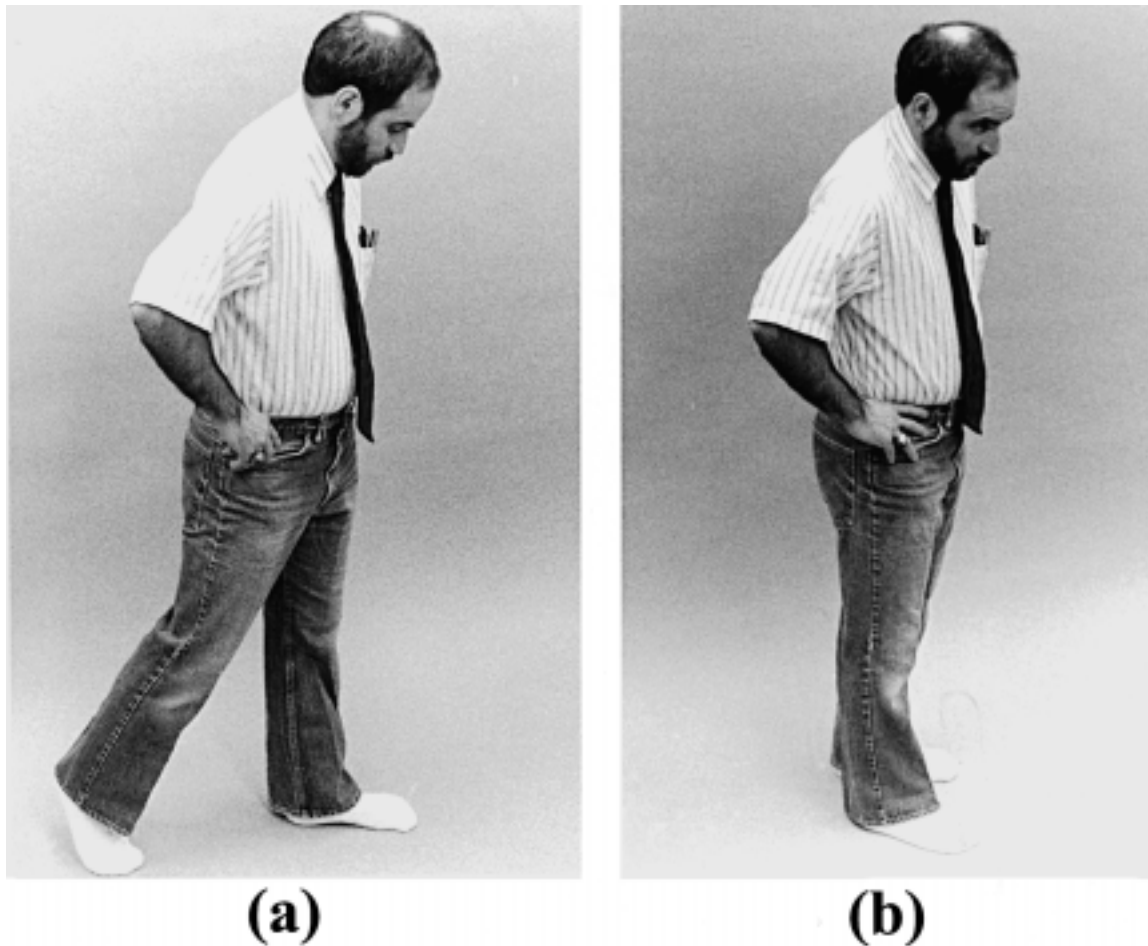Figure 5 depicts modeling of the blue jeans identified as those

FIG. 5—*Modeling of JC Penney "Plain Pocket" blue jeans, size 34 (W) × 30 (L), recovered from suspect's home. (a) Left inseam. (b) Right side seam.*

worn by the bank robber. Figures 6 and 7 show side-by-side, point-by-point comparisons of the blue jeans depicted in the bank surveillance images (left) and the modeled JC Penney "Plain Pockets" jeans (right).

In a photographic comparison, the modeling photographs serve an additional purpose beyond simple documentation. They also serve to confirm that the photographic process is not introducing any unexpected anomalies into the appearance of the item under examination. When modeling an article of clothing, the geometry between the camera and the subject is arranged so as to approximate that between the bank surveillance camera and the questioned individual. Furthermore, film similar to the original bank surveillance film is used, along with a lens that has a focal length comparable to the one used in the bank. The lighting conditions are also adjusted to approximate those in the bank at the time of the crime. If lighting becomes a critical issue in the photographic comparison of an item, it is sometimes necessary to return to the scene of the crime and model the item in place at the same time of day and time of year as in the original image.

In this case, the selected geometry, film, and studio lighting were sufficient to recreate the resolution, perspective, and lighting conditions in the questioned images and to confirm that no anomalies were introduced by the photographic process, as well as to document the findings. This permits the examiner to make a side-by-side comparison approaching a one-to-one comparison as shown in Figs. 6 and 7. Recall, however, that an exact one-to-one compari-

son of a garment through this technique is not usually possible due to the pliable nature of clothing and the difficulty of replicating every fold and crease in a garment that is being worn by a subject in motion.

Defense Challenges

During the trials of the suspects, the defense offered an exporter of used blue jeans as an expert witness to testify that the most prominent of the characteristics noted above were common to blue jeans, including the linear wear mark ("1"), the "V" and "H" marks ("2" and "3"), and the cross-over ("5"). As proof, the defense offered 34 pairs of blue jeans described as having such characteristics. These jeans had been culled from over 400 pairs examined by the exporter at the request of the defense. The exporter identified the 34 pairs of blue jeans as the ones which best showed characteristics similar to those of the blue jeans worn by the bank robber.

For the rebuttal portion of the trial the 34 pairs of blue jeans were examined by the author. None of the 34 pairs of trousers offered by the defense shared more than one or two of the prominent characteristics described above in even a gross manner. For example, none of the pants that had a feature which could be referred to as an "H" also exhibited features that would correspond to the "V" or cross-over features. This finding helps emphasize the significance of being able to identify multiple individual characteristics when
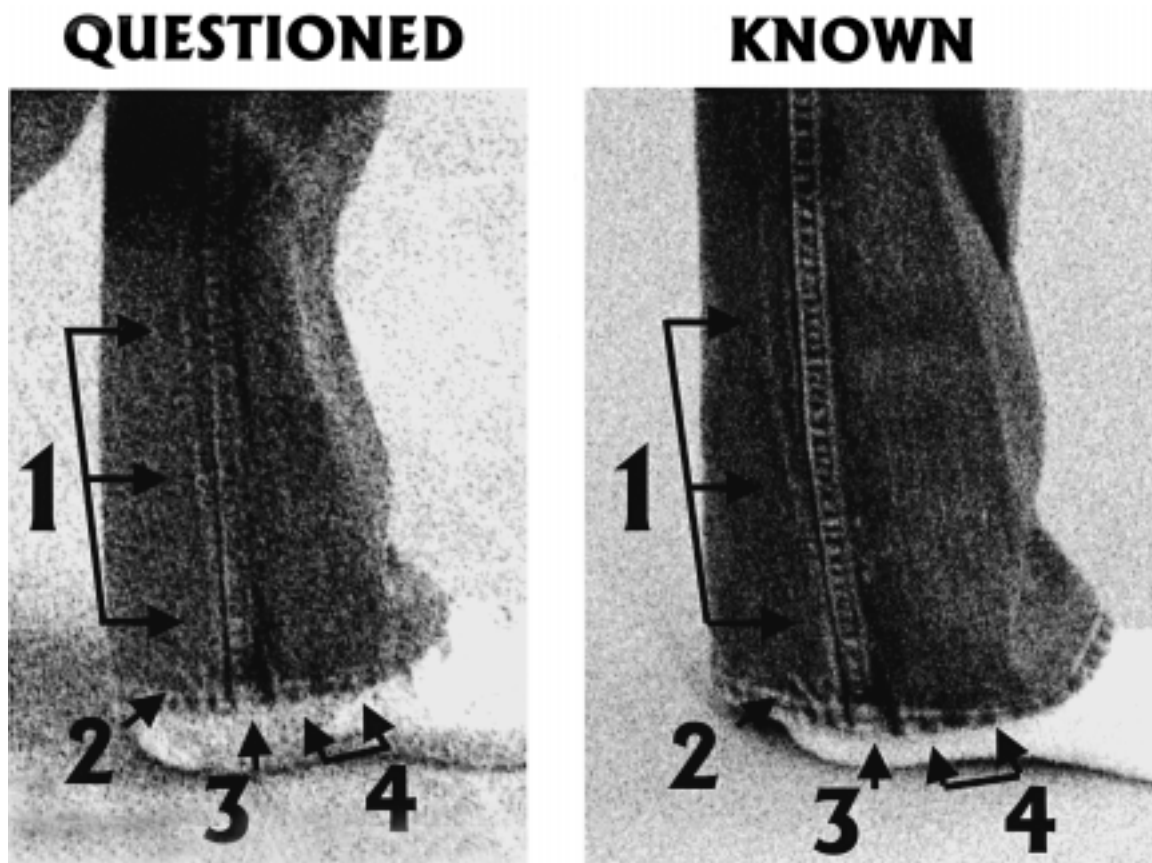
FIG. 6—*Side-by-side comparison of Spokane bank robber's left leg ("Questioned") and left leg of model wearing blue jeans recovered from suspect's home ("Known"). Numbers refer to features described in text.*

attempting to make an association or elimination in such a comparison.

Furthermore, detailed inspection revealed that most of the characteristics identified by the defense expert as "similar" on these jeans could be readily distinguished from those on the bank robber's jeans. For example, the left upright of the "H" feature on one pair of proffered jeans was markedly wider than the one observed on the bank robber's jeans, while on a second pair the right upright on the "H" feature was not sharply defined by a bright lineament as on the bank robber's jeans. The ability to make such distinctions in this case further highlights the high quality of the Spokane film images.

While a rigorous validation study would be necessary to confirm it, this demonstration did serve to strengthen the proposition that the individual wear marks observed on the known blue jeans are the result of random processes and can be considered unique, individualizing characteristics. Furthermore, when taken together, the presence of such a large number of significant characteristics in a known pair of blue jeans precludes the possibility (or probability) of their having occurred by mere coincidence, and they can thus serve as a set of points of identification.

Discussion

Caution must be exercised when reaching conclusions based on an analysis of wear patterns alone as described herein. Stray marks on clothing such as paint or blood stains and rips or tears can be fully expected to occur in random locations and patterns and to persist as visible features over time. FBI examiners have been making photographic identifications based on such random features for approximately thirty years. The case described herein differs from such identifications in that the individual wear marks used as the basis for the identification represent features intrinsic to the denim trousers, and do not originate from any source other than through the manufacturing process and damage-free daily wear. Until a validation study can be conducted to establish the frequency of occurrence and the probable location of stray wear marks such as the cross-over, "H", or "V," it will not be possible to quantify the significance of individual occurrences of such marks when making comparisons. Such a study is planned, but has yet to be begun.

Furthermore, such wear marks can be expected to change over time. As a crease or wrinkle is abraded over time the width of the exposed white un-dyed core increases. If two ridges adjacent to one another are subjected to enough abrasion, it is possible that these bright features would eventually merge into a single feature. A failure to consider this possibility might lead to an erroneous conclusion. A second study is being planned in which the evolution of denim trouser wear patterns will be documented photographically over time.

Despite the lack of such validation studies, it should be remembered that in this and other cases the overall significance of wear marks is not necessarily based on a quantitative assessment, but on a qualitative assessment. A single characteristic such as a stain or unusual tear may be sufficient if there is enough image detail pre-
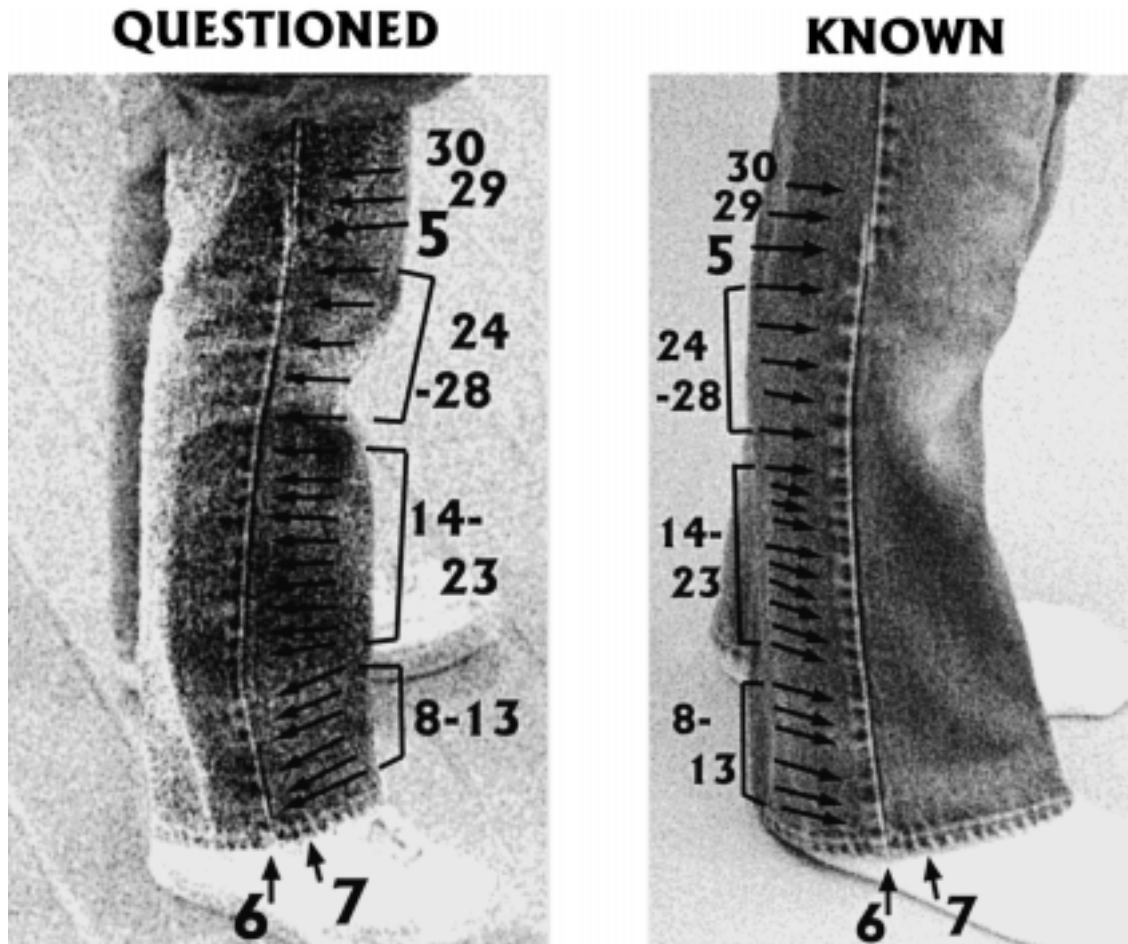
FIG. 7—*Side-by-side comparison of Spokane bank robber's right leg ("Questioned") and right leg of model wearing blue jeans recovered from suspect's home ("Known"). Numbers refer to features described in text.*

sent to reveal that it is unique and unlikely to be duplicated elsewhere. A determination of whether individual characteristics like the ones discussed herein are unique or not will remain unanswered until validation studies can be conducted. Until that time, the ability to individualize an item based on a single such characteristic will remain a matter of opinion. However, if it should turn out that such characteristics can be duplicated, it is much less likely that combinations of multiple characteristics can be duplicated. The fact that the defense in this case was unable to find any pair of trousers that exhibited more than one or two gross characteristics similar to the five major characteristics identified on the questioned trousers supports (but does not prove) the hypothesis that combinations of gross characteristics may be sufficient for identification.

This leads to another caution in the conduct of such examinations. The quality of the bank surveillance images is a critical component in this type of comparison analysis, since the wear patterns used as points of identification may be very small. If the quality of the surveillance images is insufficient to resolve a specific characteristic, then that characteristic cannot be used as a point of identification. Furthermore, in such a case, the absence of a characteristic from the surveillance image due to poor resolution cannot be used as a justification for eliminating an item. As banks and other businesses convert their surveillance systems from film to video systems, the likelihood of an examiner being able to reach a meaningful conclusion in this type of case will be severely restricted. This is due to the much lower resolution provided by video systems which are typically one-tenth that of film systems (3). Unless the identifying characteristics under consideration are sufficiently large, video systems cannot be relied upon to record them with sufficient detail to permit their use in a comparison. Hopefully, higher resolution systems such as High-Definition Television (HDTV) and high resolution digital still cameras will replace low-end VHS systems in surveillance systems as their costs are reduced.

As a final caution, the importance of experience and training in the conduct of examinations such as this cannot be underestimated. Without a good working knowledge of the photographic process, an inexperienced individual might misinterpret a simple difference in perspective or a defect in the film as true differences in the shape, size, or characteristics of a photographed object when compared with an item of evidence. Similarly, without an understanding of the means by which clothing is manufactured and the means by which class and individual identifying characteristics are generated, an individual could misinterpret the significance of a given characteristic or set of characteristics and reach an incorrect conclusion. To avoid these problems, individuals should receive extensive training prior to conducting examinations on actual casework.

Summary

Wear patterns and characteristics along and adjacent to the seams and hems of denim trousers can be used as a means of positively identifying or eliminating the trousers worn by individuals depicted on bank surveillance film. These characteristics can have their origin in the manufacturing process, and their visibility will be amplified through abrasion and the resultant removal of dye-rich outer layers. By comparing the morphology and location of such characteristics on trousers depicted in surveillance images with the characteristics on trousers recovered from suspects, an examiner can conduct a point-by-point analysis as a means of attempting to identify or eliminate the suspects' trousers.

If the questioned image is of insufficient quality to distinguish such characteristics, then it may not be possible to reach a conclusion. However, if the image quality is good and if a sizeable number of wear characteristics can be observed, then a unique association is possible, as demonstrated in this case. Statistical studies remain to be conducted to assess the significance of single characteristics as a means of individualizing denim trousers.

References

1. Tuthill H. Individualization: Principles and procedures in criminalistics. Salem, OR: Lightning Powder Company, Inc., 1994.
2. Avignone JM, Rielly D. Photographic analysis of bank robbery films. FBI Law Enf Bull 1979;48(11):21–5.
3. Blitzer HL. Assessing forensic imaging options. Security J 1997;9:35–41.

Additional information and reprint requests:
Richard W. Vorder Bruegge
Examiner of Questioned Photographic Evidence
FBI Laboratory
Special Photographic Unit
Room 3449
935 Pennsylvania Avenue, N.W.
Washington, DC 20535