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POST-MORTEM IDENTIFICATION BY MEANS OF COMPARATIVE
IMAGE ANALYSIS OF A TATTOO MARKING(U) ARMY ENGINEER
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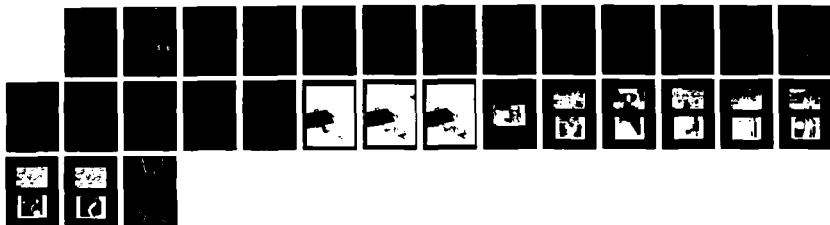
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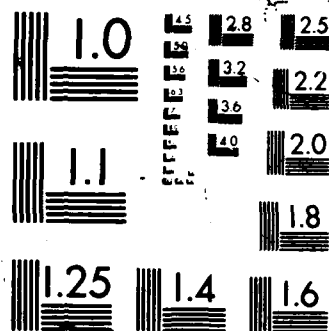
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The author is presently engaged in research regarding the digitizing and computer processing of photographic imagery. Much of this effort has been in the field of microdensitometry, particularly with regard to the establishment of standards of procedure. Currently, this investigation has been concerned with the effects of using square shaped recording apertures. During this investigation, pathologists working to identify victims of an air crash involving U.S. Army personnel requested comparative image analysis of a tattoo marking to support identification of one of the bodies.		

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Post-Mortem Identification by Means of
Comparative Image Analysis of a Tattoo Marking

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Introduction

The author is presently engaged in research regarding the digitizing and computer processing of photographic imagery. Much of this effort has been in the field of microdensitometry, particularly with regard to the establishment of standards of procedure. Currently, this investigation has been concerned with the effects of using square shaped recording apertures.

During this investigation, pathologists working to identify victims of an air crash involving U.S. Army personnel requested comparative image analysis of a tattoo marking to support identification of one of the bodies.

Initial Photos Received

Initially, the following items were received at USAETL from a liaison officer working with the pathologists:

1. One 20 cm x 25 cm (8 in x 10 in) black and white post-mortem photo.
2. Two 8 cm x 13 cm (3 in x 5 in) color ante-mortem photos which I labeled 1 and 2A. Along with these photos was a written request to see what can be done to compare a tattoo, circled on the upper

right arm of the suspected individual appearing in both pictures, with the tattoo in post-mortem picture.

Although prints were adequate for an initial analysis, the negative transparencies would be required for digital image computer processing. Accordingly, a request was made for any available negative transparencies.

Analysis of Prints

The analysis of the tattoo on the suspected individual in photo number 1 (see photo section at the end of this report) indicated very poor image quality. The photo is out of focus and the right arm is in shadow, resulting in a very low contrast and poor resolution of the tattoo markings.

The tattoo in photo 2A is sharper by comparison and has good contrast; unfortunately, much of it is hidden by the right sleeve.

The post-mortem photo is of good quality and reveals fine detail of what remains of the tattoo after cleaning and treatment of the arm area. In the central part of the tattoo is a serpent's head. Extending from it is a wavy line representing its tongue. The end of the tongue is forked. The lower border is scalloped and forms a diamond shaped area with the head and tongue symbols. What remains of the right border reveals a relatively smooth line.

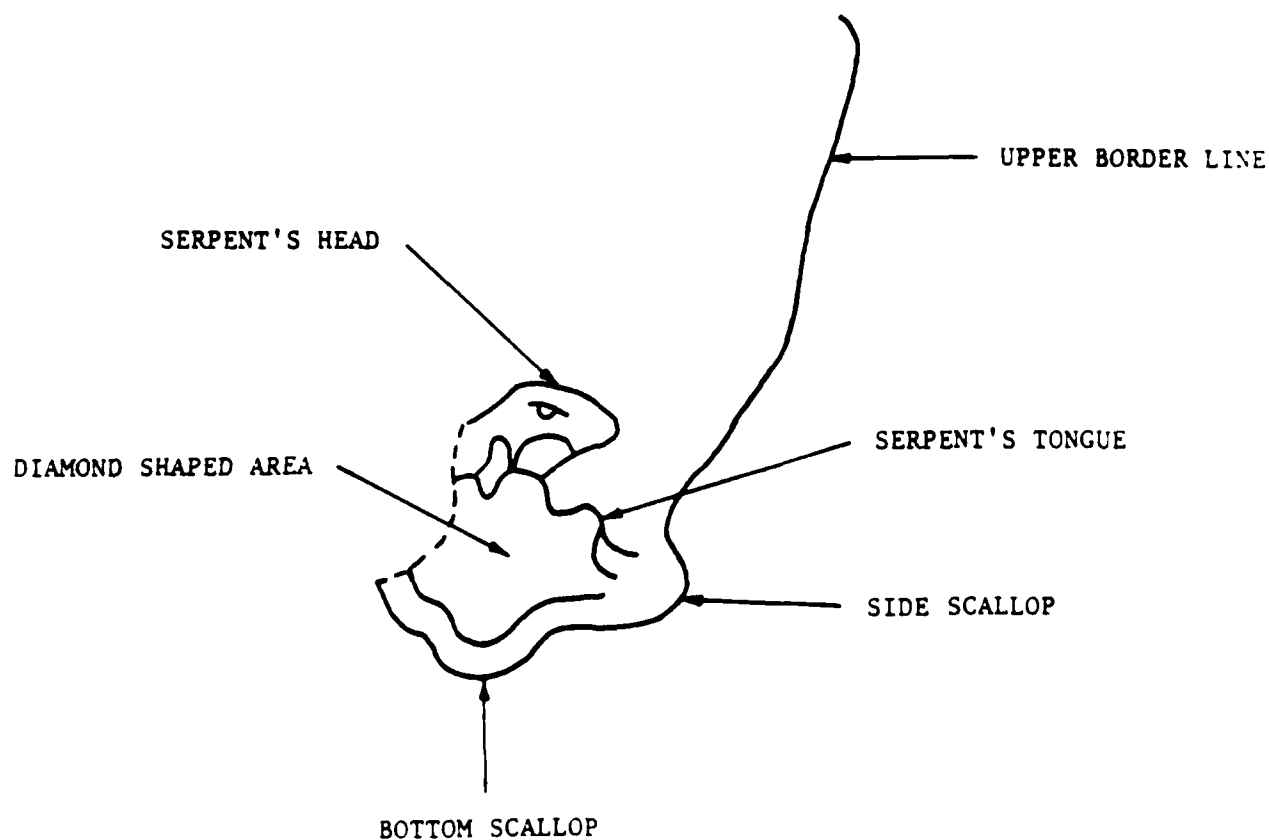


FIGURE 1 IMPORTANT TATTOO LANDMARKS

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Overlay B, of the post-mortem photo, outlines these important landmarks (see also Figure 1).

Tattoo Comparison Through Optical Projection

Of the two color prints furnished, it was judged that photo 2A would be best for tattoo comparison using an optical opaque projector. Aside from the fact that photo 2A was of higher quality than photo 1, what was more important was the fact that the camera angles of photo 2A and the post-mortem photo were very close to one another, thus making a comparison through optical projection possible.

Photo 2A was placed in a Saltzman Projector and the right arm image enlarged to the projector maximum of 4.3 times. The borders of the arm, sleeve and tattoo were then traced onto a sheet of paper (See Figure 2). Photo 2A was removed from the projector and replaced with this tracing. The post-mortem photo was then placed under the projector and the degree of enlargement, of the arm tracing, was adjusted until the projected tattoo outline was in registration with the tattoo in the post-mortem photo. The resulting enlargement (see Figure 3) was used to make overlay A of the post-mortem photo. The comparison seems to be very favorable, with the projected tattoo borders outlining the diamond shaped area at the lower part of the tattoo in the post-mortem photo.

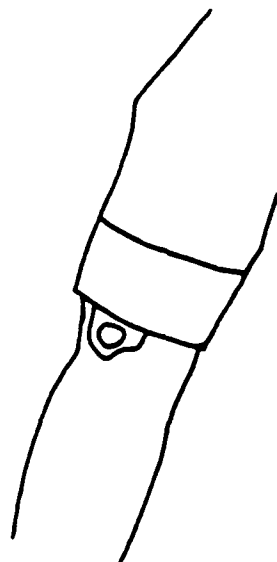


FIGURE 2 OPTICAL ENLARGEMENT (4.3X) OF THE SUSPECTED
INDIVIDUAL'S RIGHT ARM AND TATTOO IN PHOTO 2A

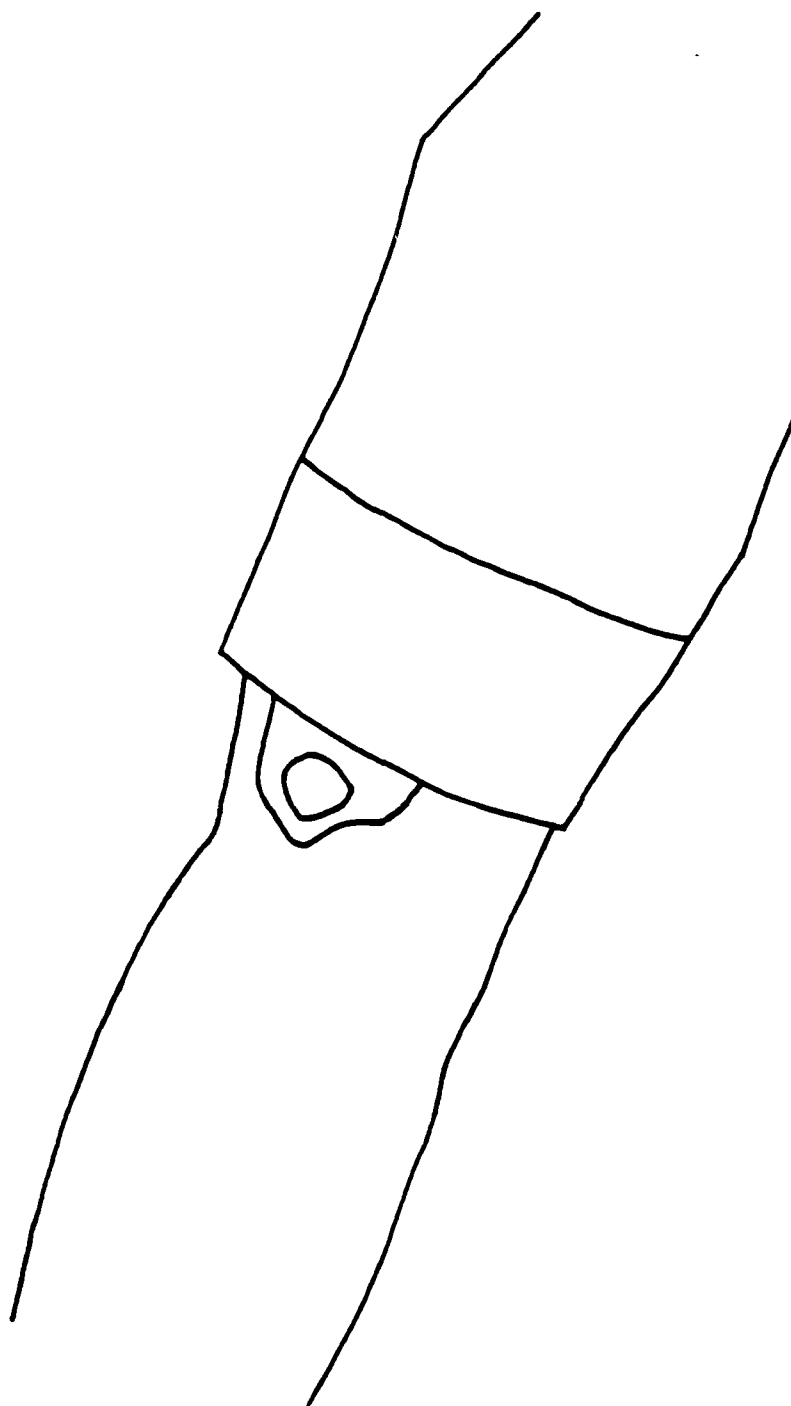


FIGURE 3 OPTICAL ENLARGEMENT (11.5X) OF THE SUSPECTED
INDIVIDUAL'S RIGHT ARM AND TATTOO IN PHOTO 2A

An interesting point about overlay A is that it indicated the approximate location of the elbow joint by the shape of the bare arm (see also photo 2A). If what is protruding below the skin in the center of the arm overlay is related to the elbow joint (cartilage, ligament, etc.), then the tattoo in the post-mortem photo would be in the same relative position to the elbow joint as it is in photo 2A. This would be an important correlation.

Unfortunately, photo 2A did not possess sufficient resolution to exhibit any detail within the tattoo, but only a rough outline of its borders. Nevertheless, this initial investigation was quite encouraging, although more data would still be needed for a good comparative analysis.

Color Negatives Received

About a week after the request for transparencies, 14 rolls of color negatives belonging to the family of the suspected individual were received at USAETL. They were of typical tourist type scenes taken while he was on leave from the Army.

Optical Analysis of the Color Negatives

Each of the negatives, 371 frames in all, were carefully analyzed using a Bausch & Lomb Stereo-Zoom Microscope for views of the suspected individual showing his right arm tattoo. Of all of

these, only nine frames showed such views, and of these, only six were considered suitable for digital image computer processing.

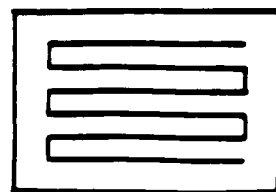
Photo Emulsion Types of the Selected Negatives

<u>Photo Number</u>	<u>Emulsion Type</u>
1	KODAK CL 200 5093
2A-6A	KODAK CP 100 5094

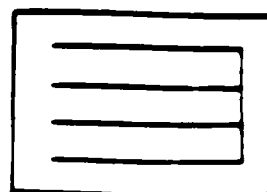
Digitizing of the Color Negatives

The negative containing the best image detail was for photo 4B. This was the first one to be analyzed using a Perkin-Elmer Scanning Microdensitometer; a device used for measuring and digitizing photographic transparencies for computer processing. The digitizing parameters established for negative 4B would then be used for digitizing the other five selected negatives. Figure 4 illustrates the type of parameters that must be considered when making digital recordings.

Measurements on negative 4B indicated that the smallest tattoo line width, that of the serpent's tongue, was about 50 micrometers. The upper border line width was approximately 100 micrometers and the width of the entire tattoo was in the order of about 0.4mm. The film also exhibited considerable grain noise. Poor lighting conditions and out-of-focus camera settings during

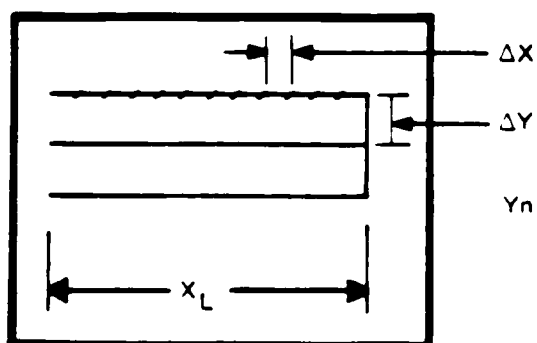


RASTER SCAN



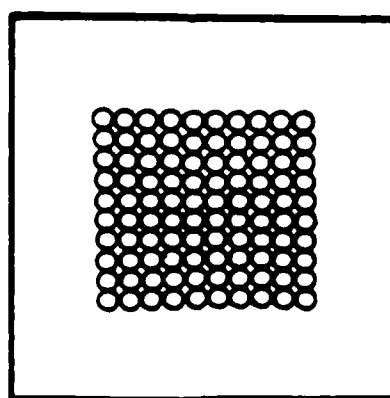
EDGE SCAN

SCANNING MODES



Scanning Variables

Symbol	Definition
ΔX	Distance (microns) (Sampling Increment)
ΔY	Distance (microns)
Y_n	Number of Scans
X_L	Scan Length



SCANNING ARRAY

FIGURE 4 MICRODENSITOMETER RECORDING PARAMETERS

exposures served to compound the problem of trying to digitize these extremely small images.

The actual digital recording of the tattoo imagery was accomplished by using a 12 micrometer aperture and sampling every 6 micrometers. This would serve to enhance the size of the tattoo markings while also filtering out some of the grain noise. Digital recordings were made in the red, green and blue color bands. Each digital color image was composed of 786,432 sampled points.

Computer Processing of the Digital Imagery

Computer Processing of the images was performed on a Comtal Vision One/20 Digital Image Processing System. The actual processing performed on each image consisted mainly of adjusting the brightness and contrast levels in each of the three color bands in order to bring out as much detail as possible. An attempt to further filter out grain noise and sharpen edges proved unsuccessful. The geometry of the images was not altered in any way.

Hard copies of the computer images were made by means of a Dunn Camera on Polaroid Type 59 film. Each of these photos represent an image magnification of 28 times that of the negative. An overlay was prepared for each computer image photo in order to outline tonal boundaries and significant landmarks.

Analysis of Computer Generated Images

Photo 2A is a print made directly from the negative, while photo 2B is a computer generated image of the tattoo area outlined on the 2A overlay. This procedure will be maintained for all of the computer images being displayed in this report.

Computer image 2B, with its overlay, served to verify the shape of the tattoo on overlay A of the post-mortem photo. Overlay A was created using the Saltzman Optical Projector. The white marks in the 2B image are a result of small gouges in the emulsion which were present when the film was received at USAETL.

Computer image 3B was produced from a negative that was out of focus. This served to cause a ballooning of all of the line work in the tattoo as well as a loss in resolution. Although part of the tattoo is covered by a sleeve, more of it is exposed than in photo 2B. What is revealed appears to be a partial outline of the serpent's head in its correct proximity to the diamond shaped area at the bottom of the tattoo. See Figure 1 and overlay B of the post-mortem photo.

Computer image 4B, as stated earlier, possesses the best detail. What is striking about this tattoo image is the wavy line of the serpent's tongue, the bottom scallop, the side scallop, the upper border line as well as a vague indication of the serpent's head

and diamond shaped area. This image correlates very well with overlay B of the post-mortem photo.

Computer image 5B, though quite grainy, does exhibit a vague outline of the tattoo. What is of particular interest is the bottom and side scallops as well as the upper border line. This image also compares quite well with overlay B of the post-mortem photo.

Computer image 6B was selected because of its fine grain and good contrast; there is a better definition of the line work than in 5B, unfortunately not too much of the tattoo is visible except for the side scallop and upper border.

Of all the frames analyzed, photo 7A was the only one which presented a view of the entire tattoo; unfortunately, the suspected individual is standing about 23 meters from the camera. The width of the tattoo on the negative is approximately 0.18mm.

Computer image 7B was generated by digitizing the indicated area on photo 7A using an effective aperture size of 6.0 micrometers. The sampling increment was also held to 6.0 micrometers. The outline of the tattoo is somewhat vague; however, it does reveal something of the general shape of the tattoo inside of the oval boarder. The narrow portion of the tattoo, extending upward from the center region to the top boarder line, is believed to be the tail of the serpent.

Computer image 8B was generated by using an effective recording aperture of 6.0 micrometers and a sampling increment of 3.0 micrometers. This area is twice as large as 7B; however, the tattoo image is now starting to break up due to the excessive grain noise in the emulsion. What does appear is only the general shape of the internal portion of the tattoo as outlined in the discussion of image 7B.

Summary

Based on the foregoing analysis, there is a very good correlation between the tattoo on the suspected individual's upper right arm near the elbow, as shown in the selected color photos, with the tattoo in the post-mortem photo. The imagery characteristics used in reaching this determination have been shape, tone, pattern, scale and relationship.

Results

After completion of the analysis, identification team members including two pathologists, a facial reconstruction expert and a forensic photographer with the Criminal Investigation Division visited USAETL for a briefing.

The briefing included all photos and overlays, with emphasis on critical points of correlation. Some of the computer generated

images were displayed on the Vision One/20 Image Processing System. Identification team members also studied the original color negatives with a zoom microscope.

At the conclusion of the briefing, the identification team concurred with the comparative analysis between the pre-mortem and post-mortem tattoo images. The correlation between images supported identification of the victim.

Conclusion

In this particular analysis, the problem to be overcome was mainly one of digital data extraction, with minimal computer processing necessary. Initially, the imagery affording the best detail is first selected and its most critical components measured. Once this is done, the digitizing parameters were then derived keeping in mind the Nyquist Sampling Criterion and the degree of graininess in the emulsion. The use of hard copy prints of the computer generated images, together with overlays outlining tonal boundaries, proved to be most successful in bringing this analysis to a successful conclusion.



POST-MORTEM REMAINS

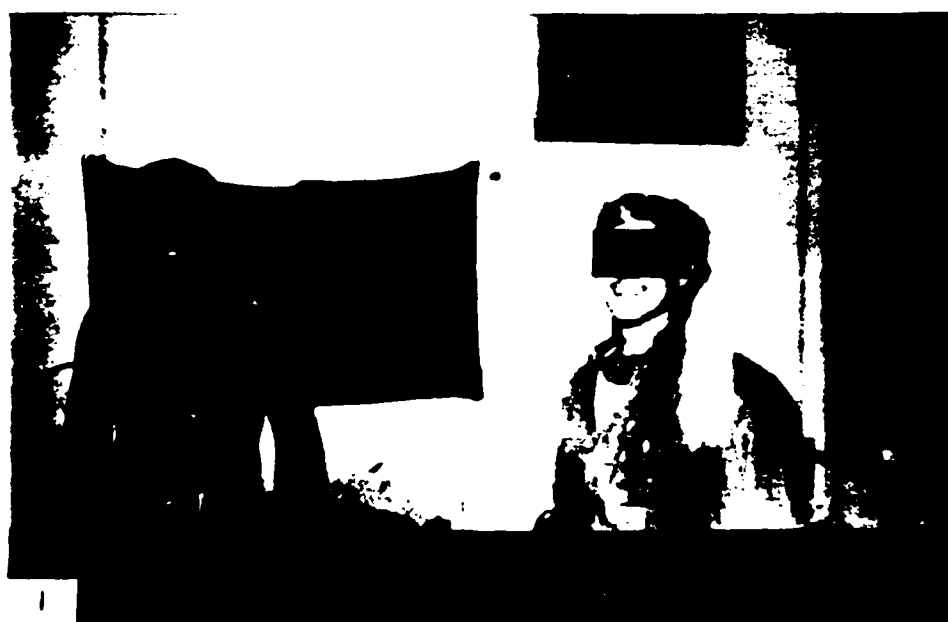


POST-MORTEM REMAINS

OVERLAY A



OVERLAY ■ POST-MORTEM REMAINS



PHOTOGRAPH 1



PHOTOGRAPH 2A



2B

COMPUTER IMAGE 2B



PHOTOGRAPH 3A



3B

COMPUTER IMAGE 3B



PHOTOGRAPH 4A



COMPUTER IMAGE 4B



PHOTOGRAPH 5A

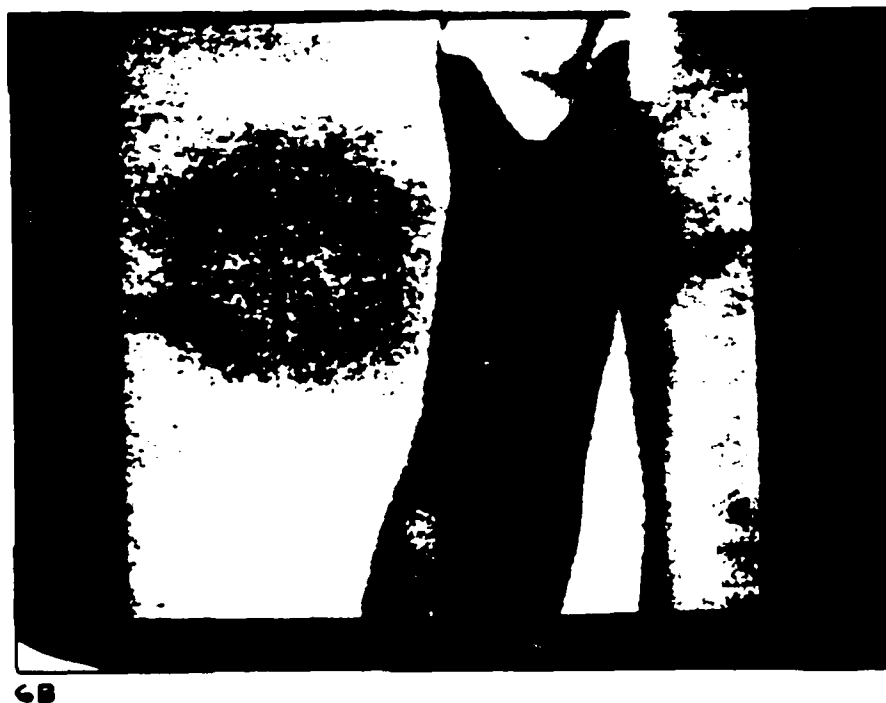


5B

COMPUTER IMAGE 5B



PHOTOGRAPH 6A



COMPUTER IMAGE 6B



PHOTOGRAPH 7A



COMPUTER IMAGE 7B



PHOTOGRAPH 8A



8B

COMPUTER IMAGE 8B

END

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