CPRC

CANADIAN POLICE RESEARCH CENTRE

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CENTRE CANADIEN DE RECHERCHES POLICIERES

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D-SIGHT™ MICRO-INSPECTION TECHNOLOGY

By: Mr. Ron Gould
Mr. Tony Marincak
Mr. Jerzy Komorowski
institute for Aerospace Research
National Research Council of Canada

TECHNICAL MEMORANDUM

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Canadian Police Research Centre

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NOTE: Further information about this report can be obtained by calling the CPRC information number (613) 998-6343

EXECUTIVE SUMMARY

D-Sight™ is an optical enhancement technique originally introduced in the automobile manufacturing sector. The technique is being further developed at the Institute for Aerospace Research at the National Research Council of Canada (IAR/NRC) to inspect aircraft exterior surfaces for impact damage and corrosion.

The IAR/NRC have developed a temporary film coating procedure which has allowed them to adapt this technique to the inspection of paper surfaces. This also led them to investigate counterfeit money, illegal passports, tampered credit cards and bite mark replicas.

The next step in deciding whether this technology has an application in the police and security community is to put the prototype system into use by police forces.

SOMMAIRE

Le procédé de rehaussement optique D-Sight"" fait appel à une amelioration technique utilisée à l'origine dans le secteur de la construction automobile. L'Institut de recherche aérospatiale (IAR) du Conseil national de recherches du Canada travaille actuellement sur ce procédé pour qu'il puisse servir à détecter la presence de dommages d'impact et de traces de corrosion sur les surfaces extérieures des aéronefs.

Après avoir mis au point un procédé de pelliculage temporaire qui lui a permis d'adapter cette technique à l'inspection des surfaces de papier, I'IAR en est venu à s'interesser à la detection de la fausse monnaie, des faux passeports, des cartes de credit trafiquées et des empreintes de morsures.

La prochaine étape nécessaire avant de decider de l'utilité de ce procédé dans les services de police et de sécurité, consistera à mettre le système prototype à la disposition des forces policieres.

INTRODUCTION

In the spring of 1994 the Canadian Police Research was introduced to the D-Sight™ technology which is being developed in the Institute for Aerospace Research (IAR) of the National Research Council. D-Sight'" is a non-destructive, optical inspection technique for inspecting metallic and composite surfaces on aircraft for corrosion and damage. Figure 1 shows an ambient light view of the side of an aircraft which appears free of any damage. Looking at Figure 2, the D-Sight™ image shows buckling in the skin of the aircraft, the evidence of damage as a result of a belly landing.

Figure 3 shows a ambient light image of a resurfaced aileron where the area has been re-painted and a new "NO STEP" decal has been applied to the surface. Figure 4 is the D-Sight™ image of the same surface. One can see the original "NO STEP" decal under the paint and just above the new one.

These pictures encouraged the CPRC to look more closely at the use of this technology.

This memorandum describes several potential applications of the D-Sight™ technology that may be of interest to the police and security communities.

BACKGROUND

In 1987 the IAR Structures, Materials and Propulsion Laboratory initiated a project to evaluate D-Sight™ a surface inspection technique, to see if it had potential for use as an Non-Destructive Inspection technique. D-Sight™ originally introduced in the automobile industry where it is used as a surface quality assurance method. An NRC engineer suggested the use of D-Sight™ to locate surface indentations associated with low energy impact damage as well as edge delamination in graphite/epoxy composites. D-Sight'" was shown to be an effective tool for locating barely visible impact damage. The use of D-Sight™ is being expanded with programs evaluating its use for the detection of corrosion and cracks in metallic aircraft structures.

The optical setup for D-Sight™ consists of a light source, a retro-reflective screen and the object being inspected (Figure 5). The surface being inspected must be reflective, however non-reflective surfaces can be made reflective temporarily by wetting with a fluid or temporarily coating with solid films. The light from the source is first reflected by the inspected surface to a retro-reflective screen. The screen returns a cone of light to the surface under inspection which is then reflected to the lens of a video camera located beside the light source. The video camera captures the D-Sight™ image which is stored in a personal computer. When a flat surface is observed the light intensity is uniform, however when a wavy or damaged surface is observed the D-Sight'" process amplifies these surface changes presenting the viewer a brighter/darker area associated with the damage. D-Sight™ can be viewed as a slope detecting technique with positive sloped surfaces appearing dark and negative slopes being light in appearance.

With the D-Sight™ technique described in this document, the surfaces under inspection are not only metallic but also paper, wood, plastic and painted surfaces. In order to see the topography of these surfaces, a vacuum process is used to conform various thin film materials to the surface in an NRC process (patent pending). This process was developed to temporarily modify the reflective properties of these materials in order to use the D-Sight™ inspection technique.

D Sight™ is the property of Diffracto Limited, 2835 Kew Drive, Windsor, Ontario. (519) 945-6373

POTENTIAL APPLICATIONS FOR D-SIGHT™

Notes:

1) All images presented in the figures are degraded due to the resolution of the printer.
2) Images labeled "Normal Image" were obtained with the same optical setup as used for capturing the D Sight™ image but with the retro-reflector removed and should be considered as ambient light views.
3) The following examples have been investigated in exploratory studies and hence the results should not be considered optimal.

Wood Plane Test

Figure **6** has two pictures, the top is the normal image of the end face of an old wooden carpenter's wood plane. If a "maker's mark" could be identified then the age/value of the plane could be established. The D Sight™ image clearly indicates the maker as "NICHOLSON".

Antique Weapon

Figure 7 is a D-Sight™ image of an eighteenth century gun barrel which was brought to NRC by personnel of the Canadian War Museum. As in the wood plane case a "maker's mark" could not be easily established due to the corroded condition of the article. The name "SOULLARD" is identifiable in the D-Sight™ image. This means that the weapon was probably produced before 1790, the year that Mr. Soullard died.

Bite Mark

Figure 8 shows three views of a replica made from a human bite mark. The top picture shows the normal image, the middle picture the D-Sight™ image which shows considerably more detail. The bottom picture shows the specimen rotated by 90 degrees.

Passport

Two passports are shown side-by-side, open at the biographic/data page. In the D Sight™ image, Figure 9, the passport at the top is genuine and shows the two embossed seals and

the thickness of the photo and adhesive film under the security sheet. The passport at the bottom has been tampered with and another photograph has been substituted. The appearance of the security sheet material is dramatically different as a result of the tampering.

Paper pad

The four pictures in Figure 10 are from the same pad of paper. Image A is the normal image of the top sheet with the hand-written message "Hand Over The Money". Image B shows the normal image of the second page (one page down). Image C shows the D-Sight™ image of the top page and image D shows the D-Sight™ image of the second page showing the impression from the writing on the pad of paper.

Credit Card

Figure 11 shows a D-Sight™ image of an altered credit card. One can see the stippled effect from the heat that has been applied to the plastic surface to soften the material so that it could be flattened and new digits impressed. Traces of the original digits can still be identified.

Counterfeit Currency

Figure 12 shows the D-Sight™ image of a counterfeit Canadian $50 bill printed by an ink-jet printer. The counterfeit bill is shown in a normal image with the D Sight'" image below. Because there is no intaglio (raised or embossed) printing there is no definition or any pattern in the D-Sight™ image . The image does illustrate the features of the paper many of which are from the mechanical "distressing" carried out in an attempt to emulate the feel of genuine currency.

Figure 13 shows the normal image of three American bills a $50, $100, and $100. Figure 14 shows the same three bills in a D-Sight™ image. Notice that only the middle bill is genuine. Also notice that compared to the normal image there are several features such as the serial number and the seal over the number 100 which do not appear in an image of a genuine bill.

Figure 15 is the D-Sight™ image of two $100 American bills with the one on the left genuine and the one on the right counterfeit. One can readily see the differences in the two paper surfaces.

Other foreign bills were viewed under D-Sight™ and all clearly indicated the intaglio printing and additional security features included in them. It was also clearly apparent to the researchers that with the coming of inexpensive computer color printers that D-Sight'" clearly identifies these both quickly and easily because of the lack of intaglio printing and the particular characteristics of the paper.

FUTURE

The D-Sight™ technology offers the police or security personnel a new way to look for and at evidence. The technique is simple to apply and there is no need for extensive

training. By having the ability to store the images in computers the investigator can readily compare past stored images to the article under investigation.

This memorandum describes the D-Sight™ technology and profiles several possible situations where it might provide better visual information. In police identification work this could be instrumental in solving a crime. As a result, the CPRC is, over the next year, offering the technology to several police organizations with the idea that they may find suitable applications. The D-Sight™ forensic prototype setup is initially being offered to the RCMP Central Forensic Laboratory in Ottawa.

For further information regarding D-Sight™ please do not hesitate to call John Arnold, Chief Scientist at (613) 993-3737.

LIST OF FIGURES

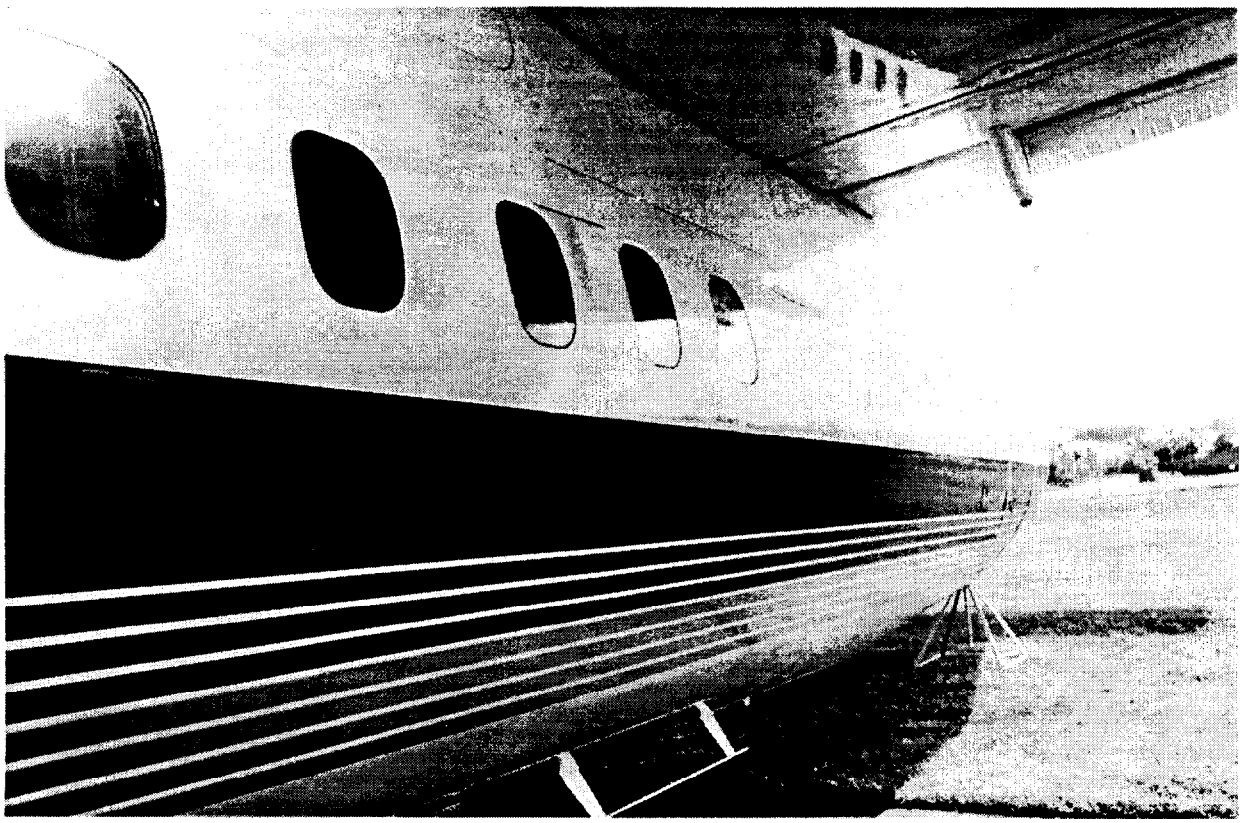


FIGURE 1. NORMAL AMBIENT LIGHT IMAGE OF SIDE OF AIRCRAFT FUSELAGE

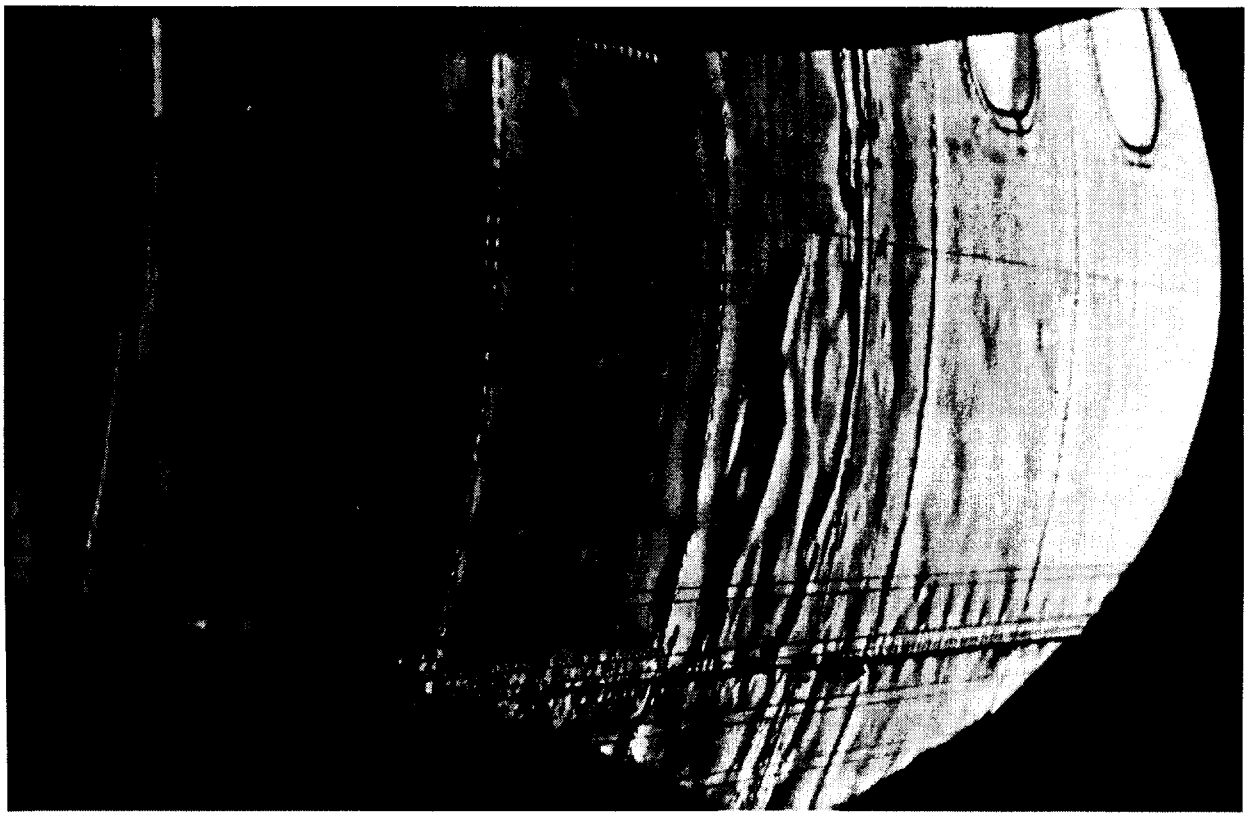


FIGURE 2. D SIGHT IMAGE OF SIDE OF AIRCRAFT FUSELAGE

FIGURE 3 NORMAL AMBIENT LIGHT IMAGE OF AILERON SURFACE

FIGURE 4. D SIGHT IMAGE OF AILERON SURFACE

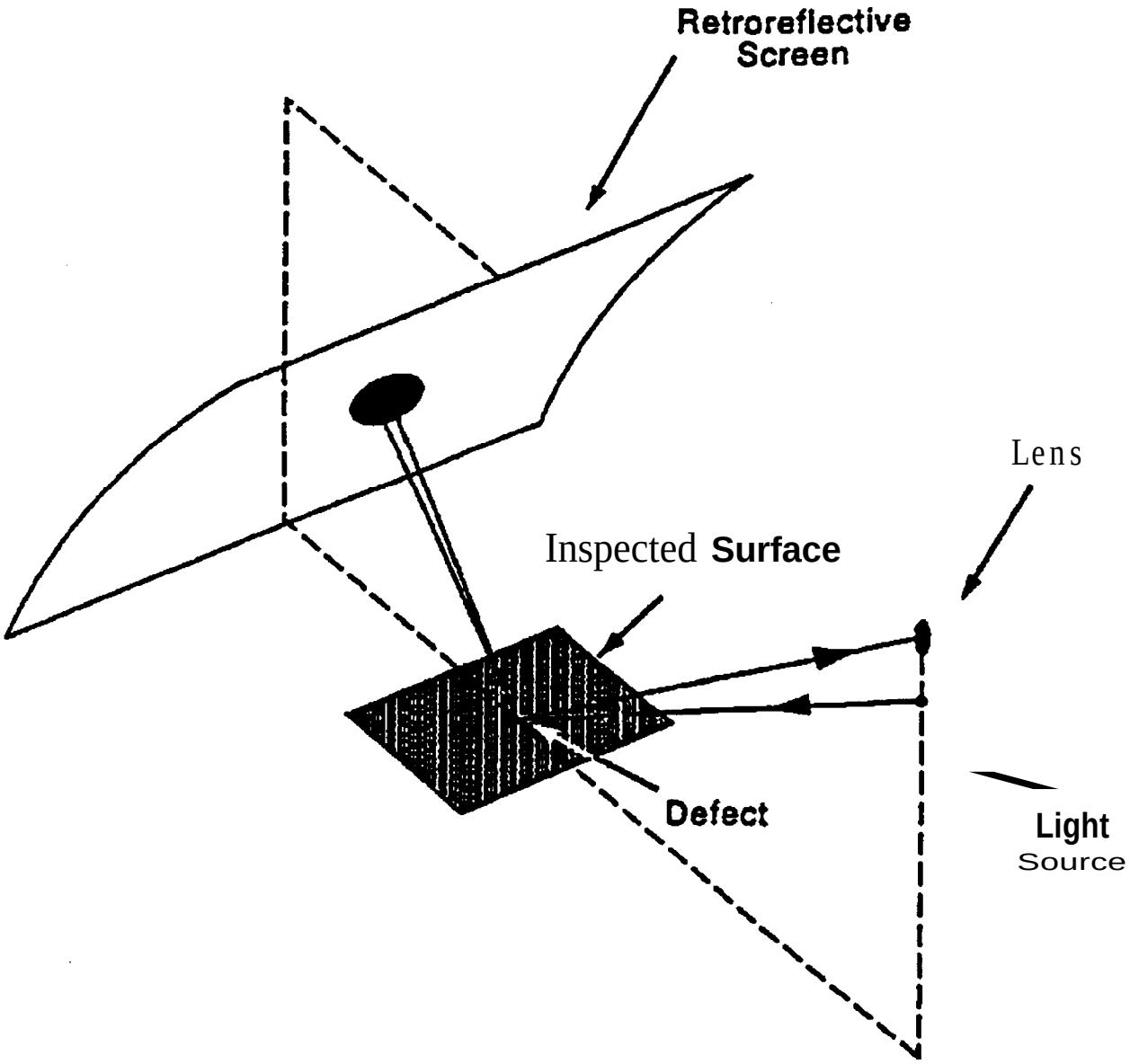
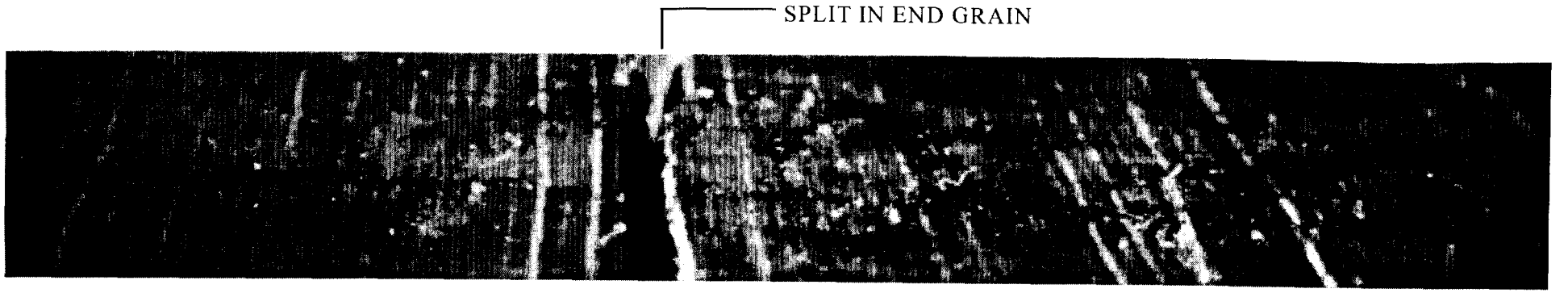
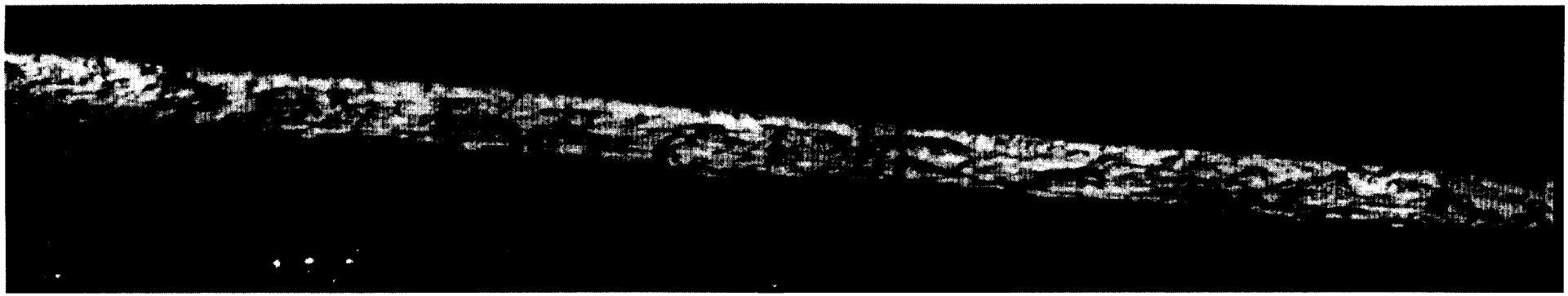


FIGURE 5. D SIGHT OPTICAL SET-UP



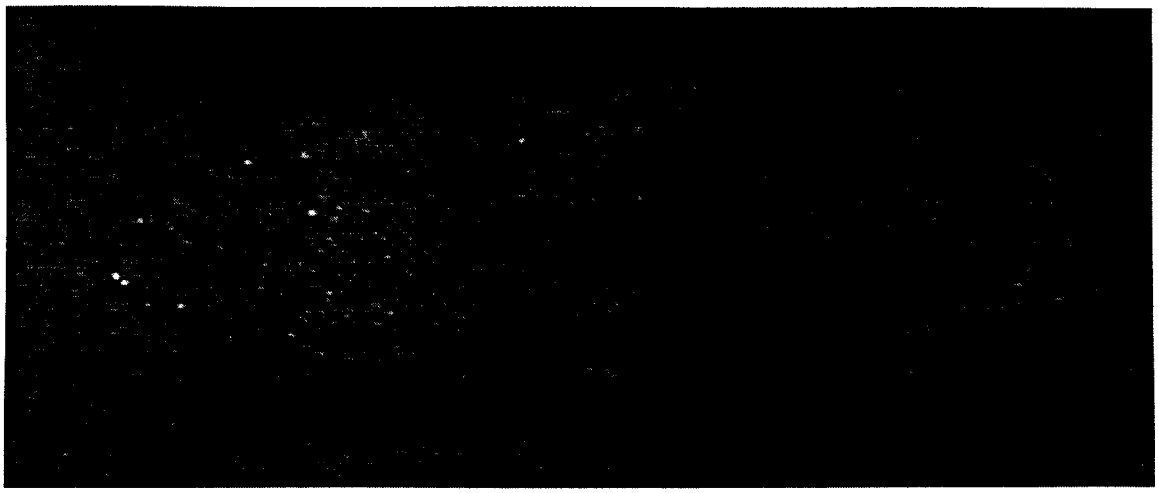
NORMAL IMAGE OF WOODEN WOOD PLANE

FIGURE 6. D SIGHT IMAGE OF WOODEN "NICHOLSON" WOOD PLANE

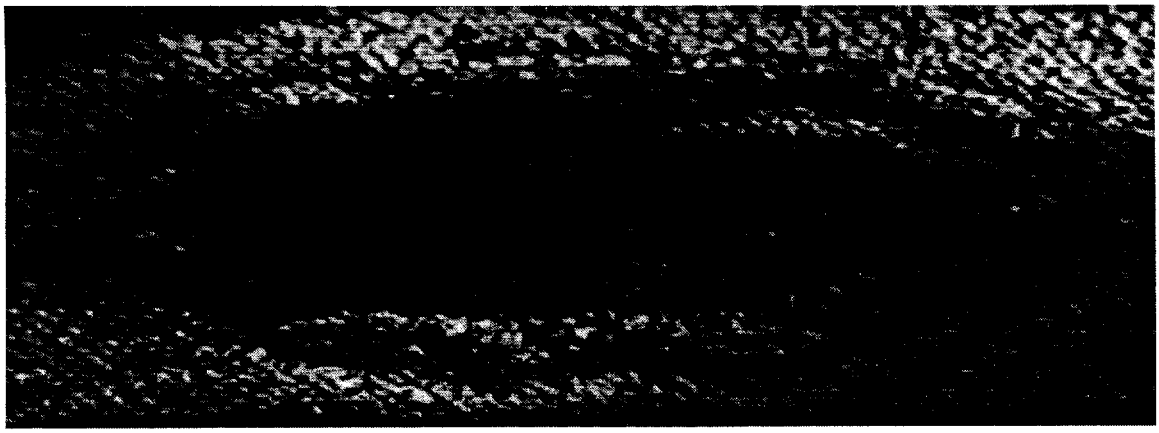


MAKER'S MARK "SOULLARD"

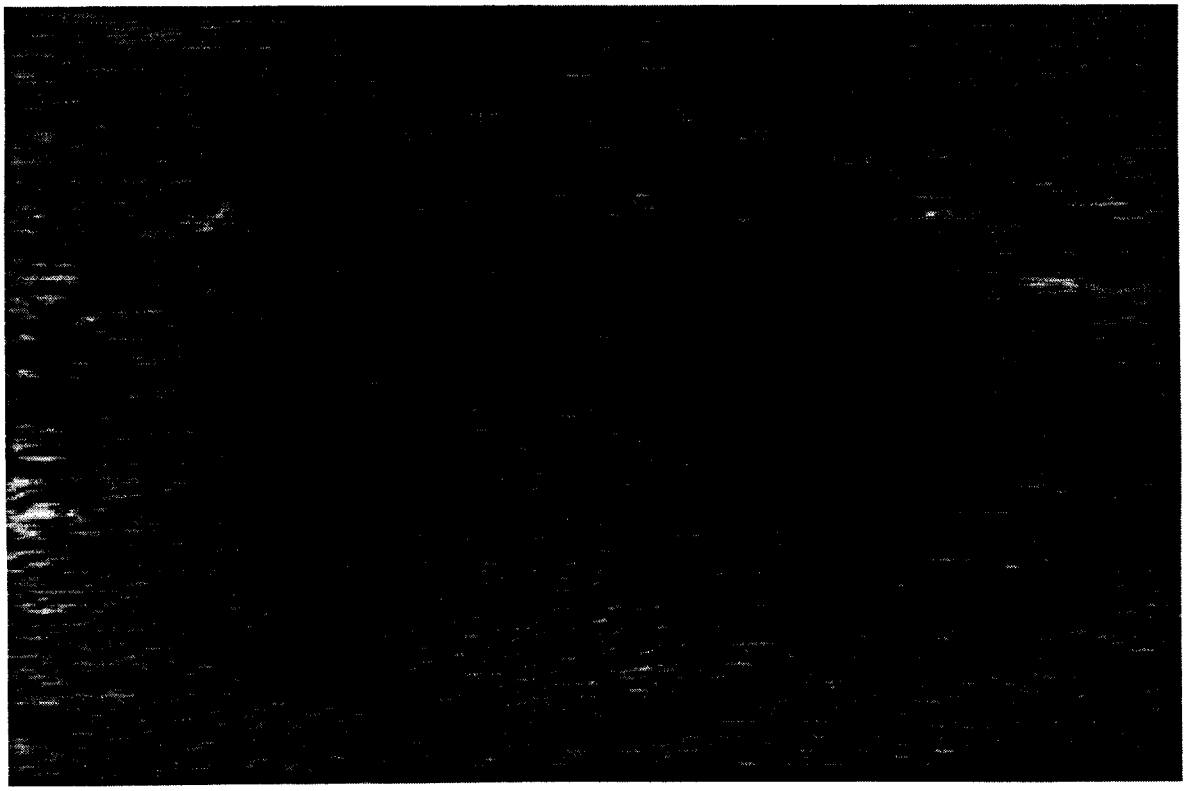
FIGURE 7. D SIGHT IMAGE OF 18th CENTURY GUN BARREL



A) NORMAL IMAGE



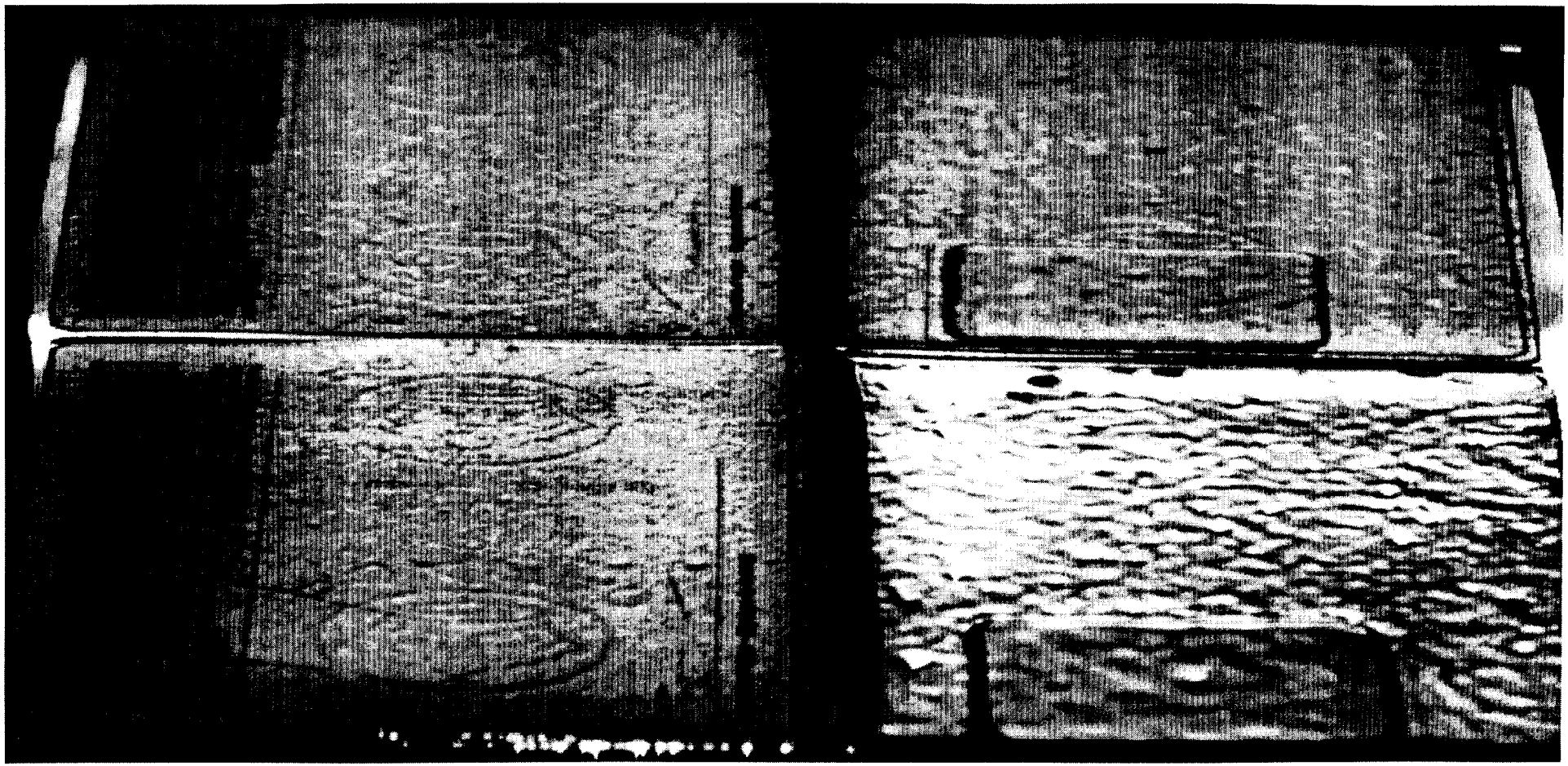
B) D SIGHT IMAGE



C) D SIGHT IMAGE (90 deg)

FIGURE 8. HUMAN BITE MARK (from replica)

UNTAMPERED

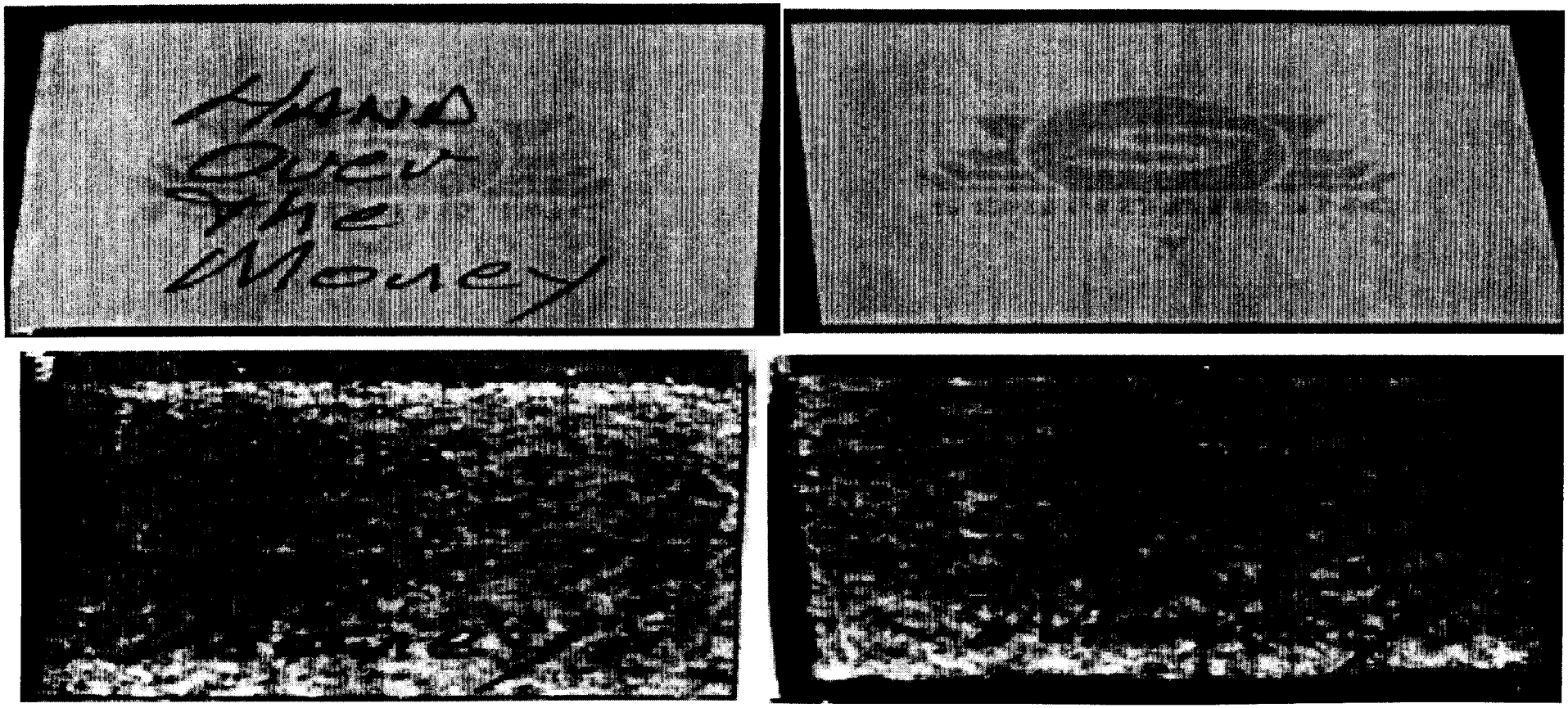


TAMPERED - (PHOTO SUBSTUTION)

FIGURE 9. D SIGHT IMAGE OF TWO PASSPORTS

A) TOP PAGE, NORMAL IMAGE

B) 2nd PAGE, NORMAL IMAGE



C) TOP PAGE, D SIGHT IMAGE

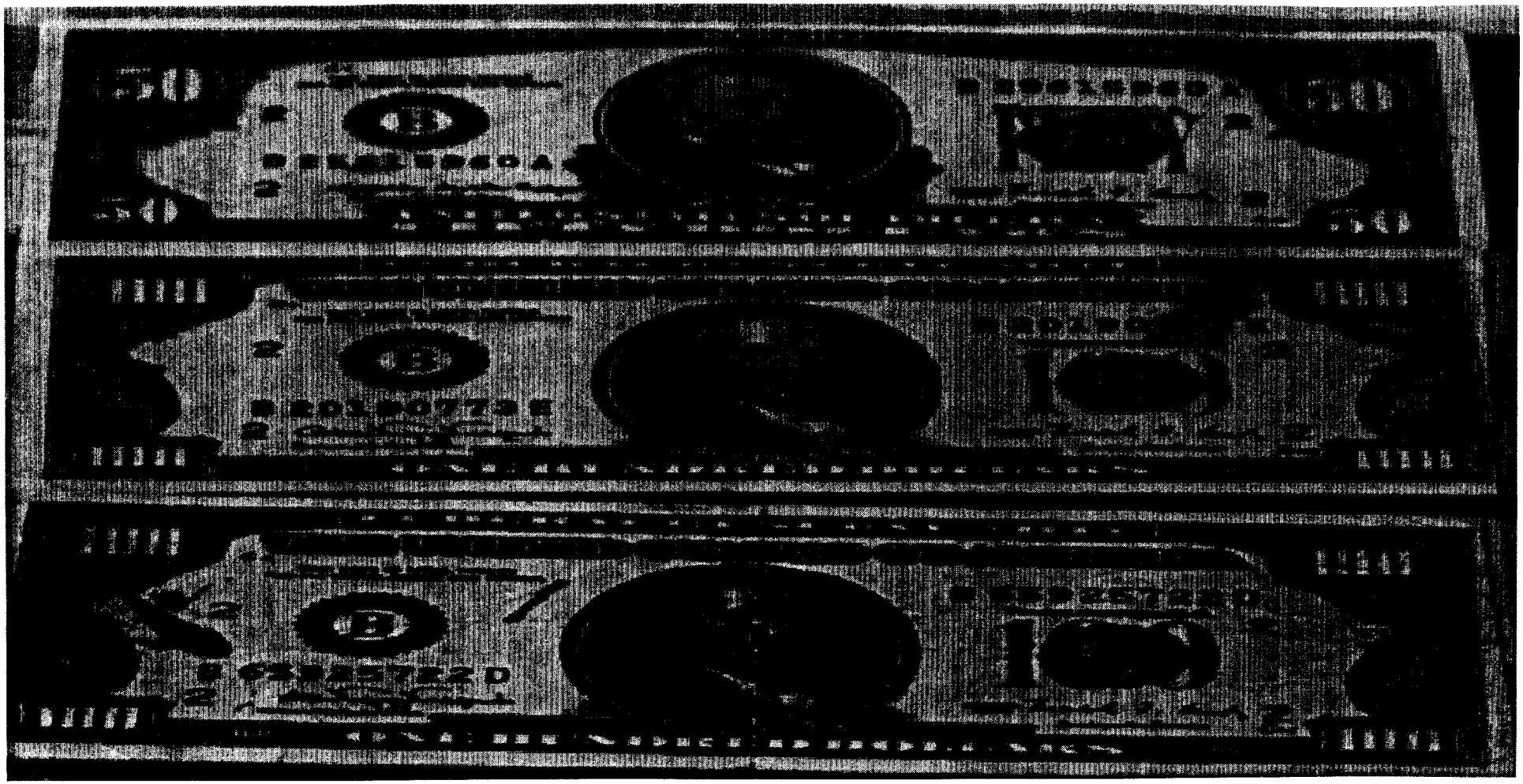
D) 2nd PAGE, D SIGHT IMAGE OF IMPRESSION

FIGURE 10. WRITING PAD IMPRESSION

NORMAL IMAGE

D SIGHT IMAGE

FIGURE 12. COUNTERFEIT CANADIAN $50 BILL (INKJET PRINTER)



M

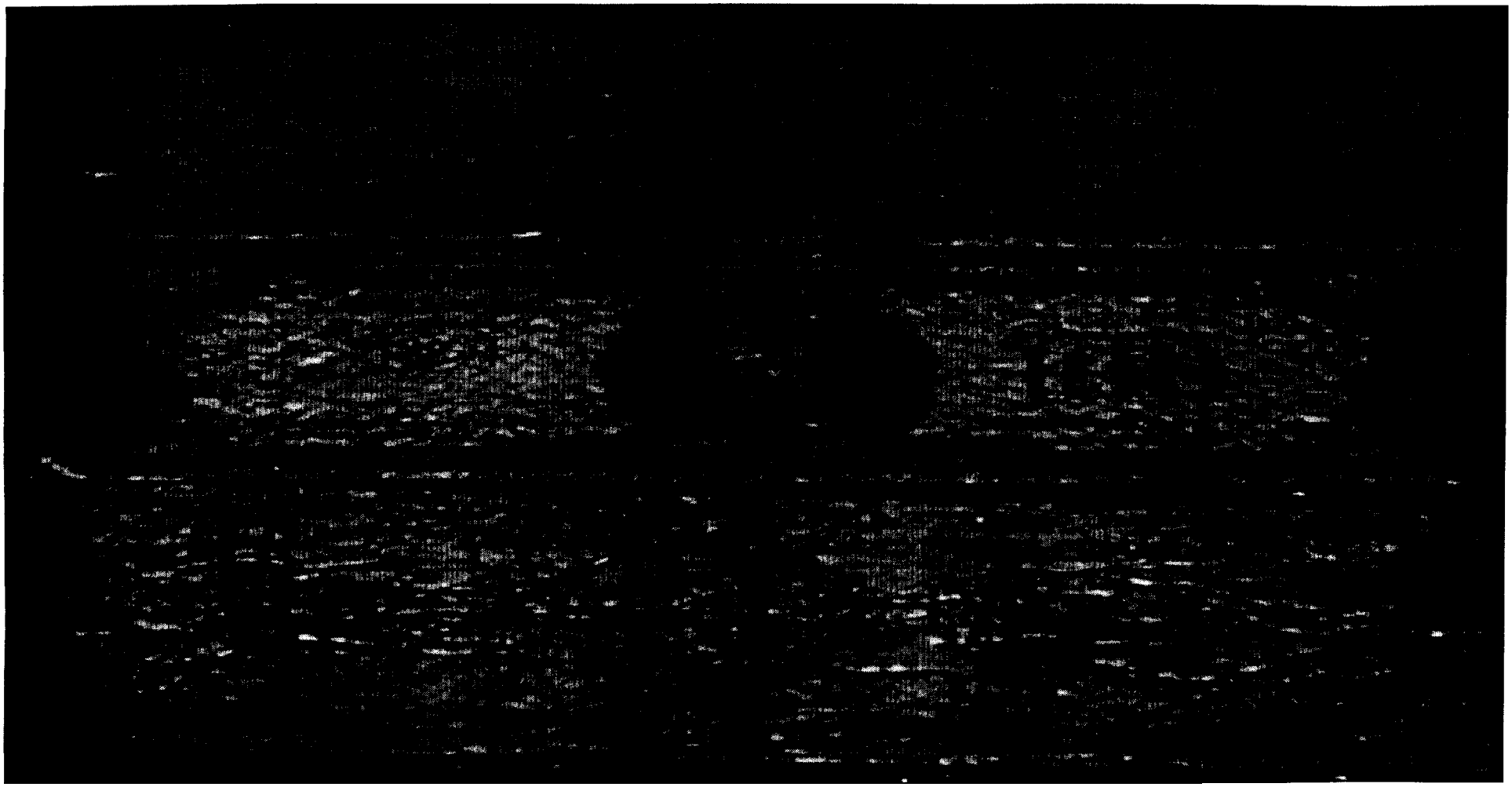
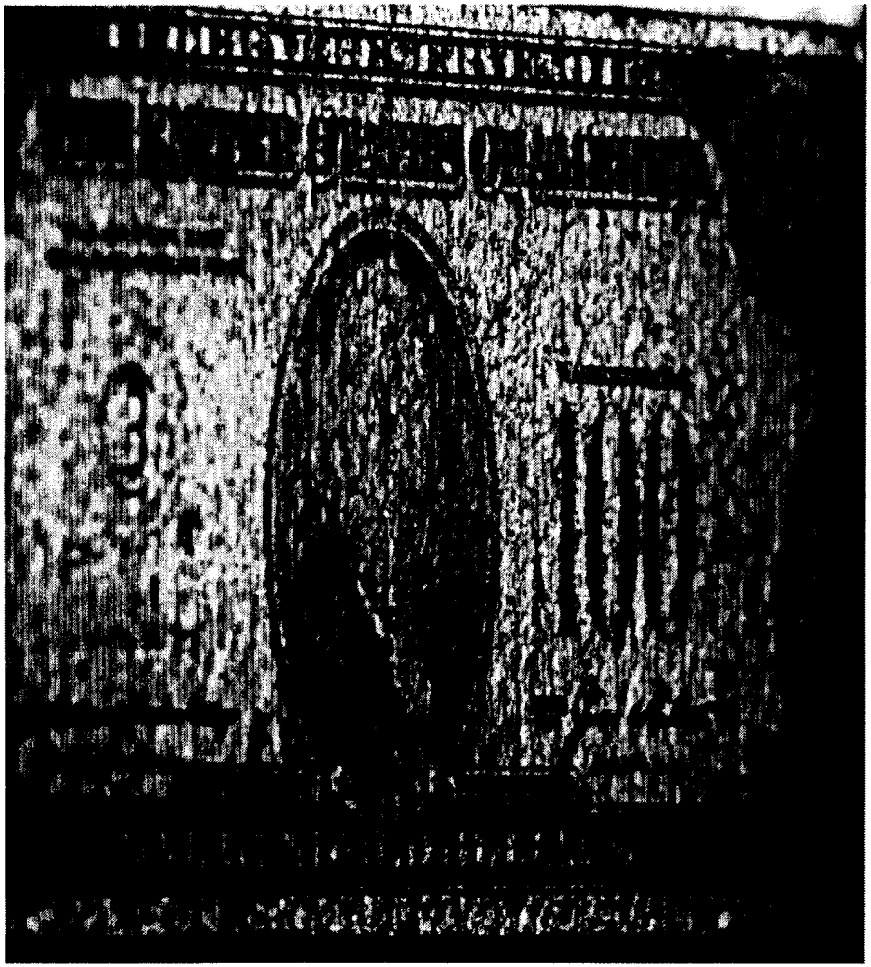
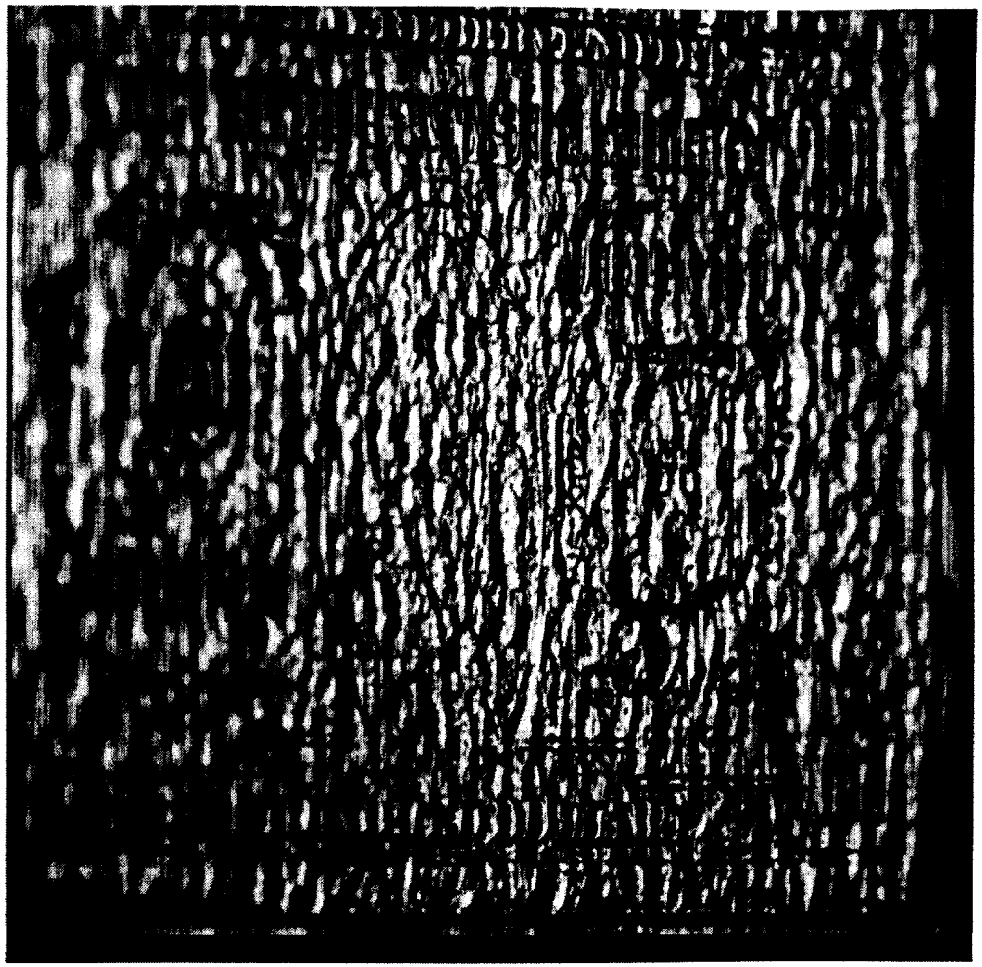


FIGURE 14. D SIGHT IMAGE OF BILLS IN FIGURE 13



GENUIN≅



COUNTERFEIT

FIGURE 15. D SIGHT IMAGE OF US $100 BILLS