FEASIBILITY OF USING MOIRE FRINGES AS AN AID TO REVEALING AND COMPARING FAINT FINGERPRINTS AND PARTIAL PRINTS

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ABSTRACT

Moire patterns formed from a transparent grid over a fingerprint might sometimes provide aid for print comparisons because of their particular spatial sensitivity to small deviations between two patterns, particularly when the reference grid is slowly moved over two fingerprints. The specificity of description of these pattern changes is subjective and such that it may be limited to individual expert assessment and may not be practical for a database for general use.

The Moire fringe methods studied appear to be of value only in special cases where conventional methods have difficulties, e.g. minutae not registered and where the print specialists may seek additional aids to support their main conclusions. The Moire method appears to be useful on some occasions such as when only a partial print is available and other tests are inconclusive. In the case of a fingerprint on a newspaper where the print matrix of dots obscures or confuses the minutae detail, image processing may retrieve a print but without sufficient minutae and which then would benefit from an additional test.

The method of Moire fringes has been tried on prints on a number of different types of surfaces. Their use in actually revealing faint prints is not yet practical but they sometimes can be used on prints of less than desirable quality which have been recovered from latent fingerprints by other means.

1. Introduction

The aim has been to test whether Moire fringes, formed when a transparent sheet with a grid of lines is placed over a similar grid, may help in identifying fingerprints and partial prints in difficult cases.

In 1874, when examining the manufacture and theory of diffraction gratings, Lord Rayleigh made the following observation: *when two families of curves are superimposed, a new family often appears*. This new family is commonly called a *Moire* pattern with the individual curves being referred to as *Moire fringes*. The effect is easily seen when a transparent grid is laid over a similarly spaced grid of lines on a regular or irregular pattern. They can often be seen in some curtain materials and on overlapping wire meshes. Moire patterns are particularly sensitive to small spatial changes or orientations in a pattern of lines, regular or otherwise and have been used in industry for the control of precision tools and for checking contours. A recent application has been for restoring the images of the aerofoil sections of sail shapes for the "Kookaburra" 12 metre America's Cup Yachts (Thornton et al, 1987).

The present work is to examine the possibility of using Moire patterns to assist in fingerprint identification in certain cases where current methods experience problems. Some difficult cases of fingerprint identification occur when only a partial print or a weak print is available and "points" such as bifurcations are not clear for use of the Automatic Fingerprint Identification System (AFIS) computer method. It was also considered that Moire fringes might assist when other tests could benefit from an additional check using a quite different approach, based on the spatial sensitivity of the Moire patterns.

2. Background

Fingerprints have been traditionally classified in a three-way process by general shapes and contours, by noting the finger positions of the pattern types and by relative size, determined by counting the ridges in loops and by tracing the ridges in whorls. The information thus obtained is incorporated in a concise formula known as the individual's fingerprint classification.

The Galton-Henry system of fingerprint classification published in June 1900 was officially introduced at Scotland Yard in 1901, displacing the anthropometric (comparative human-body measurement) system of Alphonse Bertillon for criminal identification records. The system was adopted immediately by scores of law enforcement agencies around the world and is the most widely used method of fingerprint classification. The problem has been in classifying and identifying fingerprints, which has always been a skilled task. Even when computers are employed, it is no easy matter.

In recent years a new system has been introduced in recognising a fingerprint by means of a computer through the use of a much smaller section of features than those normally used. There are two major types of ridges to be seen in fingerprints. Either a single ridge splits into two separate ridges, which is called a node, or a single ridge comes to an abrupt stop, which is called an end (see Fig. 1). Fingertips have somewhere between 50 and 100 such minutae "points" but only 12 (Australian law) to 16 (UK law) are needed to make a positive identification. (U.S. law requires fewer than 12 provided there is other supporting evidence.) This system of identifying fingerprints needs about a hundred times less information than the traditional method, so it is amenable to high speed computer-automated checking. To make it work, a high-definition fingerprint is needed (see Fig. 2) but difficult "latent" cases are often successful (see Appendix E).

Police forces throughout Australia have access to the central AFIS computer. The difficult task of transferring the prints from cards began some 2 years ago. The AFIS NEC computer, based at the Central Fingerprint Bureau in Parramatta, contains 1.4 million Australian fingerprints - from 1.2 million men and 200,000 women - plus several thousand prints obtained from overseas law enforcement agencies, including the FBI in the United States. The successful identification rate is around 21% - one of the highest in the world. The speed at which prints can be sorted is approximately 100,000 per minute compared with 50 per minute for manual searching with a card index as used previously. The computer can work with partial prints which, with previous manual systems, required long and tedious searchings by highly skilled officers. However, it is with difficult cases of partial prints or prints on poor surfaces or for poor images of "latent" prints, that additional aids would be of value.

Print comparisons often involve latent images of questionable quality that have been picked up at the scene of the crime, not direct readings from the fingers of suspects. Getting an image of these and then matching such prints is as much an art as a science. While computers can be used to narrow the range of possible matches, experts are needed to finish the examination. Other difficult cases arise from prints on printed material such as newspaper where the printer's matrix of dots can cause confusion.

3. Persons and Organisations with whom initial discussions were held or Contacts Established

Mr. C. Canter, Acting Secretary, Corporate Services, Commissioner's Office, NSW Police Dept., Dt. Sgt. P. Butcher, Dt. Sgts. T. Patterson and A. Riddell, Fingerprint Section, NSW Police Dept., 8th Floor, 130 George Street, Parramatta. We also contacted Mr M. Bell, Director of

Computer Operations at Goulburn Street on future computer transmission matters. Contact was established with the U.S. Dept. of Justice, National Crime Justice Reference Service who provided useful documents (relevant report in Appendix D).

4. The Concept for the Investigation

When a transparent faint grid of lines is placed over another grid (such as a fingerprint) a well defined pattern of dark and light fringes are formed when the grids have comparable spacing. Different Moire patterns do occur for the main types of fingerprints (e.g. whorl, arch, loop) as shown in Fig. 3. Such Moire fringe patterns are very sensitive to changes in grid orientation and relative displacement. When the reference grid is moved or rotated there is considerable sensitivity of the fringe patterns and fringe generation points to small changes in the relative location of ridges in a good fingerprint. This should enable comparisons to be made of small partial sections of prints and since Moire fringes are usually of higher contrast than when low-contrast grids are used to form them it was hoped that this would assist in the comparison with other reference prints to try to match the identical pattern and its sensitivities. The spatial sensitivity to movement of an overlaid grid was felt to be worth investigation as an additional new parameter in pattern recognition and comparison.

5. Literature Search

A literature search on relevant aspects of fingerprint studies was made using Dialog computerised international data bases (completed by the University of Technology, Sydney's Library), 77 pages (Appendix A). No previous reference to Moire fringes was found for fingerprint work.

6. Methodology and Techniques

The Moire fringes from a fingerprint are different in spacing and in their location of origin on the grid surface when the grid is moved and also in respect to the subsequent direction of movement, even for very small changes in the spacing and direction of the underlying grid structure. For two very similar fingerprints the fringe method might be able to identify them as being different by slowly sliding or rotating the same transparent grid over each one, side by side, and noting if there were differences in the fringe pattern and the way it moved. New fringes often appear to be formed at different spots on two similar prints and the two moving patterns can appear to differ enough to confirm that one print is different from the other. An identically sized print image is required for the comparison because of the spatial sensitivity using the same overlaid grid.

The differences in the way the fringes appear to be generated when the grid is moved or rotated was considered as a way of setting up a method to help identify different cases, e.g. we could note the position where they appear to start from in each of two similar prints when the grid is moved up, down, diagonally and when rotated. These differences need to be categorised in a manner suitable for practitioners and eventually for a computer data base. The experiments were arranged as follows:

(i) Use of low contrast linear grids of lines over weak prints and partial prints to observe the type of fringe pattern formation and characteristics of its motion when the grid is translated and/or rotated. Repeat for cases under different conditions (e.g. pressures and deformation). Determine new parameters (such as shape of new fringes generated and their location when the grid is moved, e.g. circles or cusps or V-shape generation at specified axis of the print) for inclusion in a new data base to aid conventional methods.

(ii) The procedure was then to be applied to prints made on problem surfaces and to images (obtained elsewhere) from latent prints.

(iii) Prints made by blood, oil or paint were also to be examined.

7. A method of Classifying Moire Patterns of Prints

Although there is no need for assistance to the AFIS system for good prints, we used good prints to test the proposed method of classification of Moire patterns from prints to establish feasibility. After observing many patterns on different fingerprint types of good definition, a basic classification method is suggested for fringe origin locations and shape of fringe patterns when the overlay grid is moved in 4 different ways, vertical, horizontal, diagonally and rotation plus reversal of each direction. Table 1A illustrates the procedure and Table 1B a sample result for collecting the data on a single print-to-print comparison for use in a data base. It was thought that whereas the AFIS method of counting minutae "points" is in a series of straight lines the Moire moving pattern method might offer an extra "degree of freedom" for classification by observing patterns such as vortex types and saddle points plus the particular location of the origin of fringes in a moving pattern when the grid is moved slowly over the print.

Methods of categorising and utilising these features have been considered for possible routine computer application. A disadvantage is that the method needs the movement of the fringes to help identification so that if a picture of similar prints were passed on to someone else, it would be necessary to also provide the transparent grid to be used with the pictures and to compare the prints at the same scale. Nevertheless, the pattern is very sensitive to even small differences

so that even if only part of a fingerprint were available, it should be possible to carefully compare that part with the corresponding part of a full fingerprint in cases where an additional piece of information using this different test might be a helpful aid when minutae are not available or inadequate. However, a problem appears to be the skill level of the observer in interpreting the patterns and geometry characteristics in a manner which would be reliable for database usage by a larger group of people. It is time consuming and needs a careful operator. Also, the Moire patterns were found to be insensitive to recognition of bifurcations and other "points" which are critical in the AFIS method. Therefore, it would appear to be of limited use unless in difficult cases rejected by the AFIS system and where further close scrutiny by experts is needed.

TABLE 1A
Chart of Procedure for Comparing Prints of the Same Size with Transparent Line Grid Overlaid

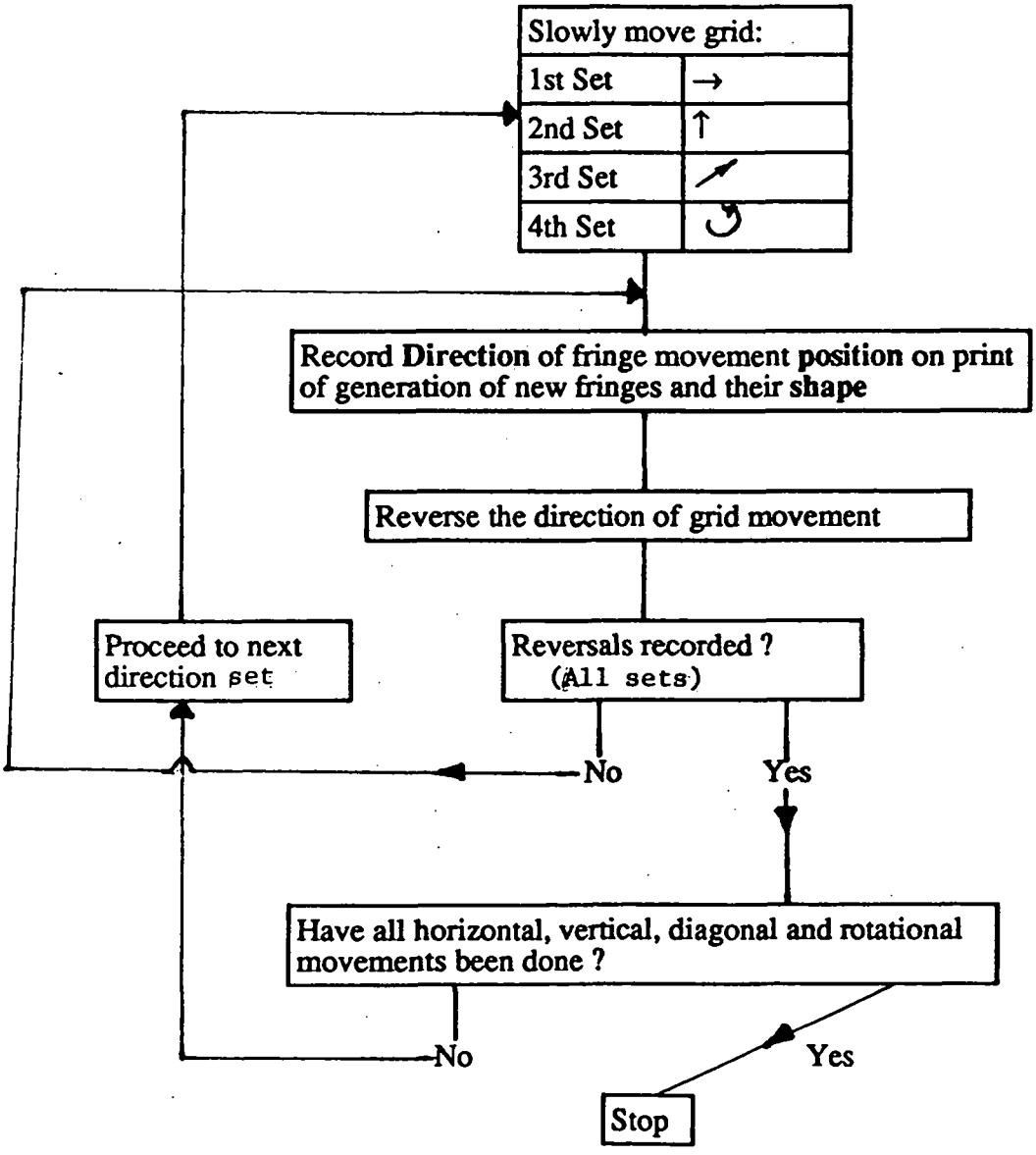

TABLE 1B

Some Entries in Data Base Entry Sample
for a Fingerprint Match Trial
Given print (•) tested against reference print (x)

Fringe Pattern	MOTION		SPACING		ORIGIN					SHAPE		
	Fringe Motion		Closer	Wider	Location of Fringe Generation					(of new Fringes)		
					A	B	C	D	E	Y	O	⬭
Grid	R	L			A				B	cusp type	circle	ellipse
Motion	→	←	C	W			E					
					D				C			
↑	x •				x •						x	•
↓		• x		• x	x •						x	•
→	x	•	(P)									
←	•	x										
↗	x•											
↙		•x										
↺	•	x	(Q)									
↻	x	•										

Above case is not matched because of important differences at *P,Q*
Location of fringe origin can be specified in more detail if required.

Note: Not all data cells are relevant for every print.

If we get retrieval search "hits" on all of the above comparisons, the two prints (of exactly the same size image) are likely to be the same with a very high probability. (There is difficulty in guaranteeing a specific probability value when performed by persons with different experience and skill). If warranted, this method could be extended to a specialised data base procedure as in the methods referred to in Appendix B which, although they are expressed very mathematically, are essentially retrieval systems where a data base has a large number of facts but only a few rules.

8. Feasibility of Moire Patterns in Difficult Cases

Work has been done on the possible use of Moire fringes to assist with fingerprints on difficult surfaces or other instances where an AFIS system may not always be amenable or prints are "rejected". This can include blood, grease and paint on paper, newsprint and newsphotos, magazine paper and cardboard.

a) Blood

Sample blood prints tested on newspaper are shown in Fig. 4 and difficulties and techniques are no doubt well known to fingerprint experts. Fringes can be obtained over the better parts of some prints but are probably only of value as a last resort to help support expert opinion. Some cases hold promise for simple application but others, such as smeared prints, appear to need appropriate image processing techniques to obtain a workable print. Absorption problems occur in some materials and blurring can prevent a good Moire pattern being formed. Pressure of application is also a practical factor since some light pressure cases do not give a workable print and heavy prints of blood obliterate the detail. Faint prints did not give a useful increase in fringe contrast.

b) Grease

Grease fingerprints from a motor mechanic's workshop on various papers have been studied (samples in Fig. 5). Moire fringes can be produced in some cases but, as for blood, are probably of a limited value.

c) Blood, grease, paint prints on newsprint (with printed matrix)

A frustrating problem, as explained to us by fingerprint specialists at the NSW Police Fingerprint Section, is that a print (or section of it) may need to be extracted from the printed matrix of dots on a newspaper text, photo or other printed material in order to examine detail. A clear example chosen to show such a matrix is as in Fig. 5. Moire fringes by themselves are unable to do this but if the image of a fingerprint on such a matrix were digitised for computer input to memory the desired "clean" print image could be extracted by using a Fast Fourier Transform image processing program to obtain an image by reasonably conventional means. (The ideal way would be if a separate copy of the newspaper or magazine sheet were available. Its digitised image could be subtracted from the fingerprint plus matrix image leaving the fingerprint which could then be restored by image processing.) In addition, or alternatively, the Moire pattern could also be processed in the same way, to eliminate the effects of extraneous printing dots and then compared with the reference (suspect) print or relevant part of it. In some cases the latter procedure (i.e. of processing the Moire pattern rather than the original print) may be better because the Moire pattern is insensitive to the minutae on the print and also to the print-matrix of dots and gives only a normal line image. Therefore, in difficult cases where minutae

identification and counts are not possible it may be a useful method for comparisons based on the motion/shape/origin points method of identification of Moire fringe patterns described previously.

Examples of digitised Moire patterns on an IBM PC are shown in Fig. 6 to see the level of detail observable in good examples. A Fourier Transform software program was used on some test images. The method could not be investigated fully on actual prints due to inadequacies of the video camera available and lack of time and funds at the end of the project. However, it is considered to be worth investigation.

9. The Use of Images Obtained from Latent Prints from Recently Developed Techniques

Several recently developed techniques appear to hold promise for obtaining workable images from difficult cases on difficult surfaces and which might then be usable with the Moire method if other techniques are insufficient and an additional test is sought.

Some are listed below and more information is given in Appendix C (in addition to the techniques included in the literature search, Appendix A):

a) A new portable lamp using photo-luminescence developed by Professor R. Warrener, Head of the Department of Chemistry at the Australian National University and physicist, Dr. M. Stoilovic. This has the advantage of being easily used at the scene of a crime.

b) Use of iodine vapour for latent prints on skin. The following outline is from Science Year 1981 (Publisher: World Book Science Annual): In strangulation, for example, the ultimate evidence would be the murderer's fingerprints on the victim's neck. But skin does not register fingerprints - at least they were not detectable with older methods of print detection. Experimental studies with a newly devised detection technique, however, show that latent fingerprints on a cadaver may last for up to 24 hours. If the body is refrigerated, the prints will last even longer, according to the report.

   In this technique, iodine vapour is blown over the area on the skin of the victim. The iodine dissolves in the exuded body oil of the area which carries the fingerprints, causing the area to turn purple. The technician then applies liquid iodine and presses a silver plate on the site. The resulting chemical reaction produces silver iodide, which reveals the fingerprint pattern when exposed to light. An example is shown in Fig. 7.

c) A vacuum deposition of metal method.

A new technique announced in 1988 in the UK by the Scientific Research and Development Branch of the Home Office allows a visible pattern to be achieved from a latent fingerprint on plastics, smooth leather, glass and photographs. The following is from the Physics Bulletin 39 100, 1988. "Vacuum coating equipment is being used by police centres in London, Glasgow and Belfast to make fingerprints visible on "difficult" materials such as polythene bags (see Fig. 8). For plastics, and, for instance, smooth leather surfaces, glass and photographs, conventional methods are ineffective, but a vacuum metallisation coater manufactured by Edwards High Vacuum International is now being employed to develop a visible pattern from a latent fingerprint.

The E600 vacuum metalliser evaporates two thin layers of metal on to the object to be tested. First, a gold layer is deposited uniformly over the surface, where it is absorbed by the ridges of sweat that form the latent fingerprint. The second layer deposited is of zinc, which will only condense on to another metal. It therefore adheres only to the gold-coated areas that lie between the sweat ridges. The object carrying the developed fingerprint is then removed from the vacuum chamber and photographed quickly, before the zinc oxidises (when it becomes less opaque). Transmitted light, which is used for transparent or translucent materials, and reflected light, for opaque materials, give (respectively) a negative or positive image of the fingerprint on the photographic film.

The technique was developed in the UK by the Scientific Research and Development Branch of the Home Office, and has now been put into general operational use".

Moire fringes of fair quality can be produced on the sample and could be an extra aid in some instances such as when minutae are not registered.

d) Use of a gram-negative bacterium for an updated "bacterial print" method as reported in "New Scientist", June 4, 1987 and "Forensic Science International". Details are given in Appendix C.

10. Problem Cases from Over-inking and Other Faults

Problem cases include uneven, inked prints such as in Figs. 9 and 10 where size reduction was used to make the print usable for Moire fringe patterns over the usable sections. Tests were done on rejected prints (e.g. due to over-inking or other technicalities) processed by the NSW

Police NEC fingerprint computer to see if their Moire patterns might be useful in a back-up situation to the computer-based "points" method. This requires photo-reduction of the output print to a size suitable for an overlay grid to produce visible Moire fringes.

Essentially, the results were that in order to get the AFIS print down to a size suitable for Moire fringes to be formed, the usable small sections of a print were sometimes of insufficient clarity to allow good testing by the Moire classification method. Quality photographic reduction appears to be needed for any useful results, not photocopy reductions. However, some cases were such that classification of fringe movement and shape changes were obtained and the application to "rejected" prints may be an aid on some such occasions where an additional piece of information is sought. (It has been claimed in the U.S. by the company, Fingermatrix Inc. that 25% of inked fingerprint cards are not usable. That company markets a "live" fingerprint reading system using electronic imaging with no contact or ink and the image can then be transmitted to a central AFIS centre. The applications include separate local security systems. Some further information is included in Appendix C.)

11. A Possible Application in the Fishing Industry

We note (Harper's Magazine 272 June 1986 p.30) that the circuli or rings on single scales of salmon have patterns somewhat similar to fingerprints. The patterns are shown in Fig. 11 and are sufficiently characteristic of the origin of the fish to be used as identification of the actual geographic origin of the fish to a surprising accuracy. The Biosciences company in Seattle has sold a scale-based method using video camera and computer based matching to US Government fisheries departments.

We have tested the patterns for the effectiveness of Moire fringes as an identifier in a similar way tested for fingerprints and found that the patterns are sensitive in the same way. However, the specific types of detail used for fish origin location depend on the way the ridges have been affected by diet, temperature and salinity. It was at first thought that the method may be useful in identifying illegal fishing catches from specific geographical regions. However, the comparisons are not based on precise shape differences. Nevertheless, the Moire method may be useful in revealing other information on fish scales when tagged fish are tested at time of release and later inspection. Changes in specific sections of scales of the same fish may provide information on the micro-pattern changes not registered by ordinary visual inspection.

12. Conclusions

The overall conclusion of the investigation is that Moire fringe methods appear to be of value only in special cases where conventional methods have difficulties, e.g. minutae not registered

and where the print specialists may seek additional aids to support their main conclusions. Moire patterns might sometimes provide aid to comparisons because of their particular spatial sensitivity to small deviations between two patterns, particularly when the reference grid is slowly moved over two fingerprints. The specificity of the description of these pattern changes is subjective and such that it may be limited to individual expert assessment and may not be practical for a database for general use.

The method of Moire fringes has been tried on prints on a number of different types of surfaces. It appears to be useful on some occasions such as when only a partial print is available and other tests are inconclusive.

For latent prints we note the recent developments for revealing latent fingerprints on plastics, smooth leather, glass and photographs. A photograph of a sample from a situation on plastics has been tested and the Moire fringes seem to be reasonable.

Some reject prints from the NSW Police computer have been photo-reduced several times to test if the Moire method can reveal any useful information. It appears that in some cases, the fringes may be useful over small sections when an additional piece of information might be sought to support other tests. Careful high quality photographic reduction would probably be necessary.

Tests have been done on the fingerprints made with blood, grease and paint on various surfaces. The usability with Moire fringe is limited and dependent on the type of paper, the extent of smearing and the pressure which has been applied when the print was made. Absorptive cardboard has generally proved not amenable to the method. Newspaper and magazine paper has, on occasion, proved amenable depending on pressure. The possibility of further research has been considered with respect to image processing. Some images with unwanted backgrounds (such as newsprint, pictures or print) need Fast Fourier Transform processing to "clean up" the image. The method has been applied to other images using a video camera and appropriate software but the particular video camera is not suitable for the fingerprint work and funds were not available to take matters further, at present.

A database method for setting up a possible mode of identification for classification with Moire fringes has been initiated. However, a problem appears to be the skill level of the observer using the Moire method and interpreting the patterns and geometry characteristics in a manner which would be reliable for database usage by other persons.

It was noted quite separately that the ridge patterns on fish scales (e.g. Salmon) can reveal the specific origin of the fish and its type of diet. It was initially thought that Moire fringes can be formed from the scale images and may offer a means of obtaining scientific information from individually tagged fish over a period of time.

Acknowledgements:

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Thanks are due to Detective Sgts. P. Butcher, T. Patterson and A. Riddell of the NSW Police Department Fingerprint Section for initial discussions and background information and to Mr. C. Canter, Acting Secretary, Corporate Services and Mr M. Bell, Director of Corporate Operations, NSW Police Department for useful initial contact information. The interest and encouragement of Mr. Justice R.N.J. Purvis has also been greatly appreciated. The quick responses of the US Department of Justice, National Crime Justice Reference Service to our requests for information is also gratefully acknowledged.

We thank Dr. Lindsay Botten, Mr. Martin Caden and Mr. Eric Lindsay of the School of Mathematical Sciences for useful discussions on image processing during the investigations.

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ORIGINAL FIGS 1 TO 11 WITH ORIGINAL REPORT

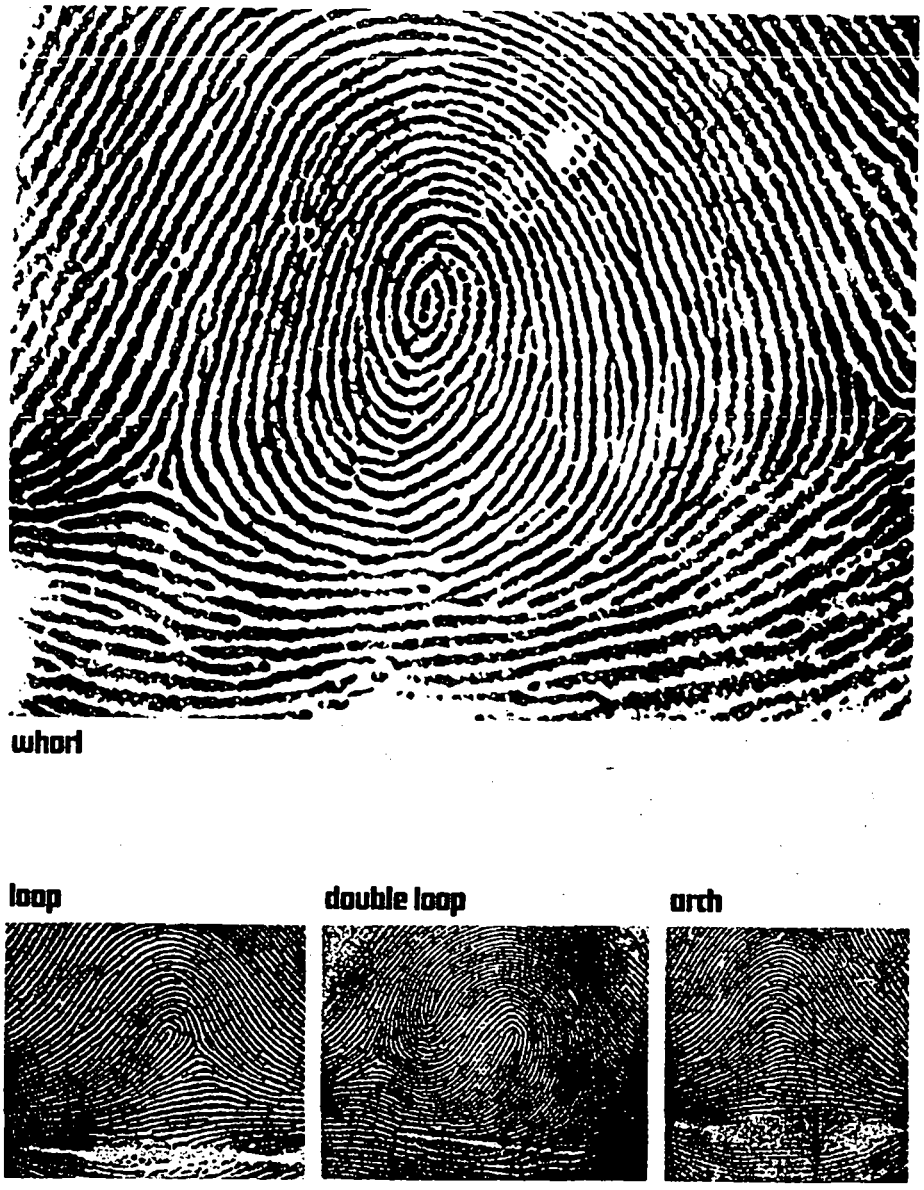


FIG. 1

Enlarged print (whorl type) showing minutae of the type used in modern fingerprint identification.

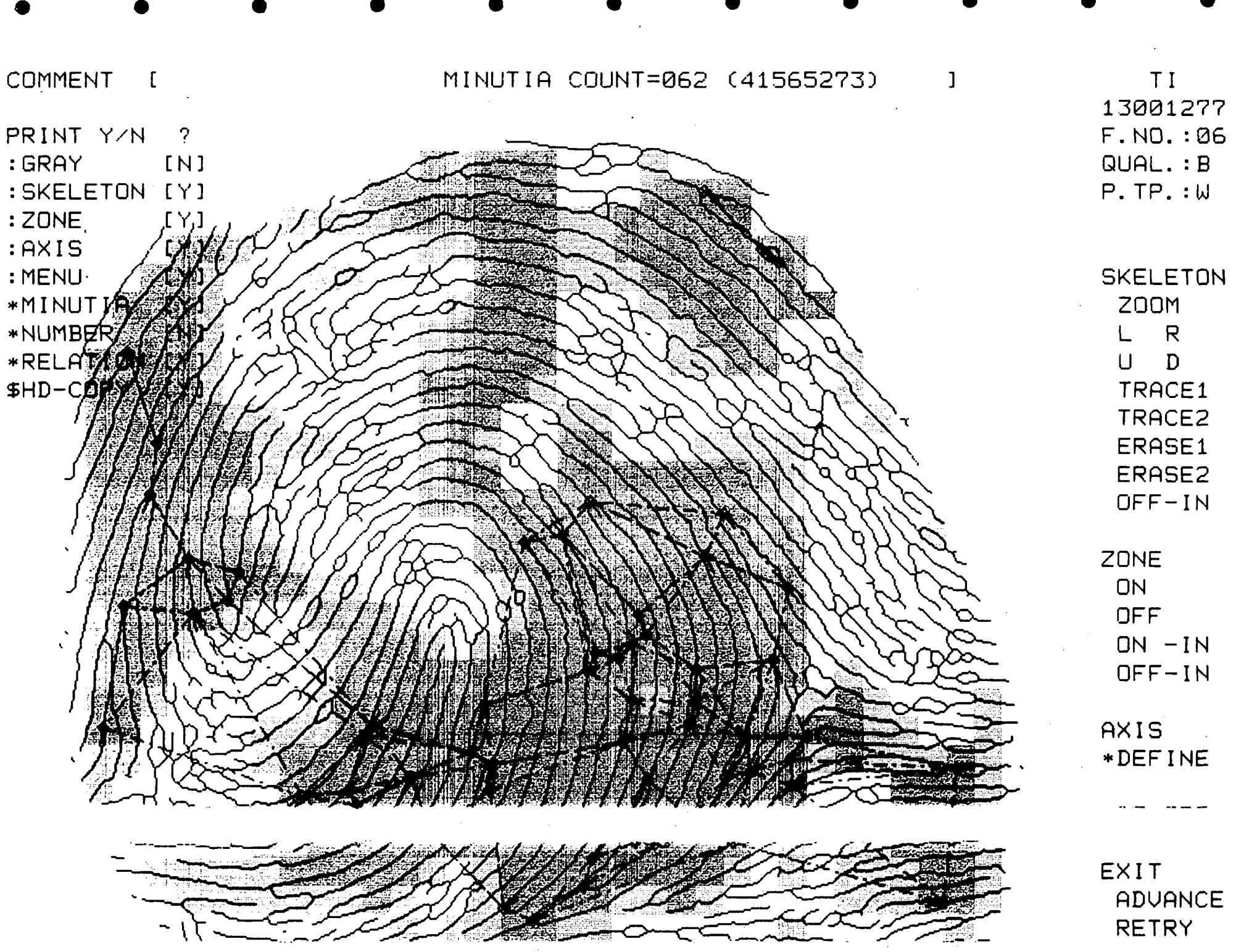
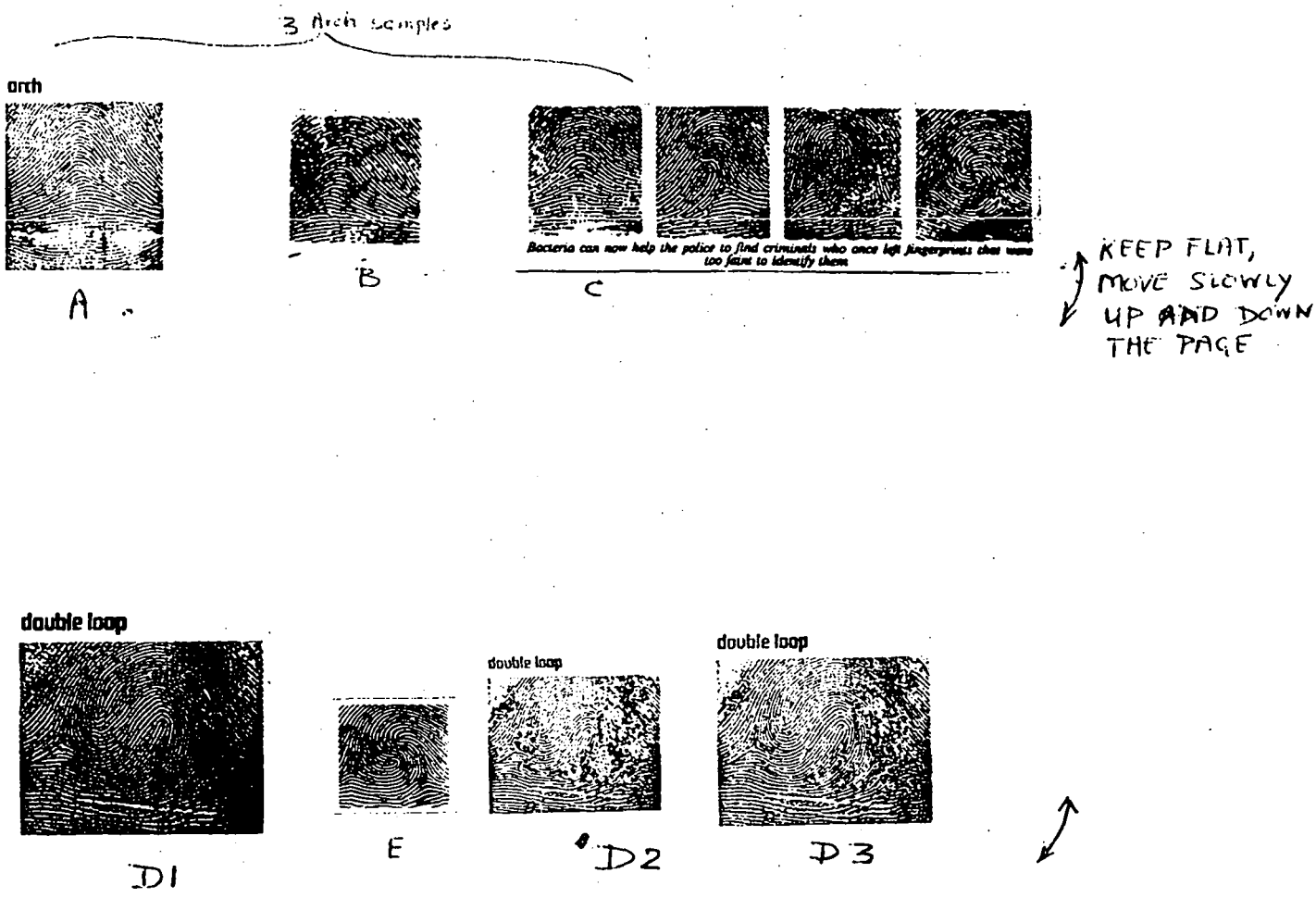


FIG. 2

An example of a finferprint as processed by the AFIS NEC computer (based on minutae count with the search trackings shown).



A, B, C	3 examples of arch prints. Fringe patterns are similar but differences can be seen when <u>slowly</u> sliding grid up and down on flat surface.
D1, D2, D3	The same double loop print with different size copies and darkness.
E	A different double loop print for comparison with D1, D2, D3.

FIG. 3

Some simple examples to show the general principle of Moire fringes applied to fingerprint patterns.

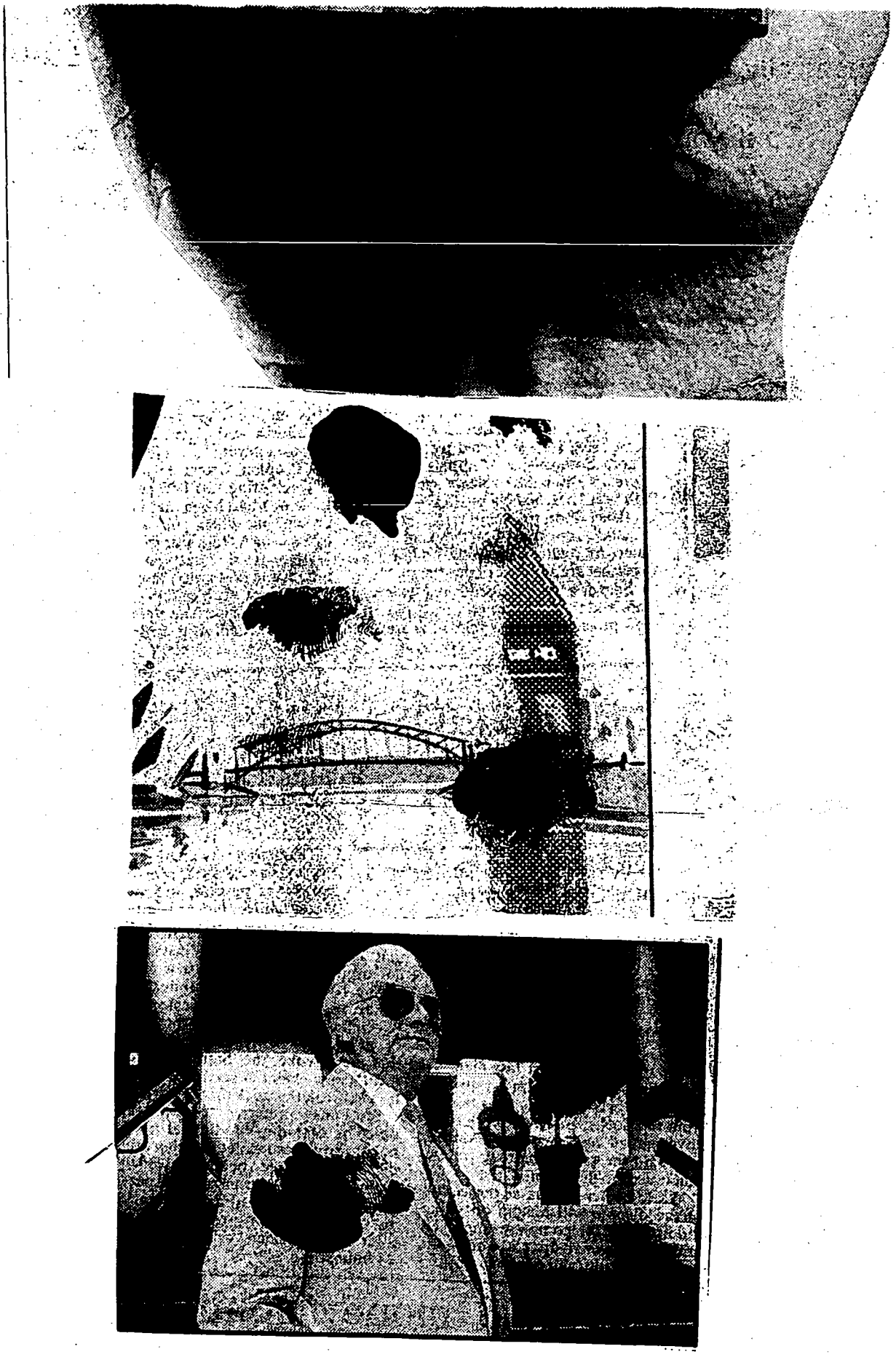
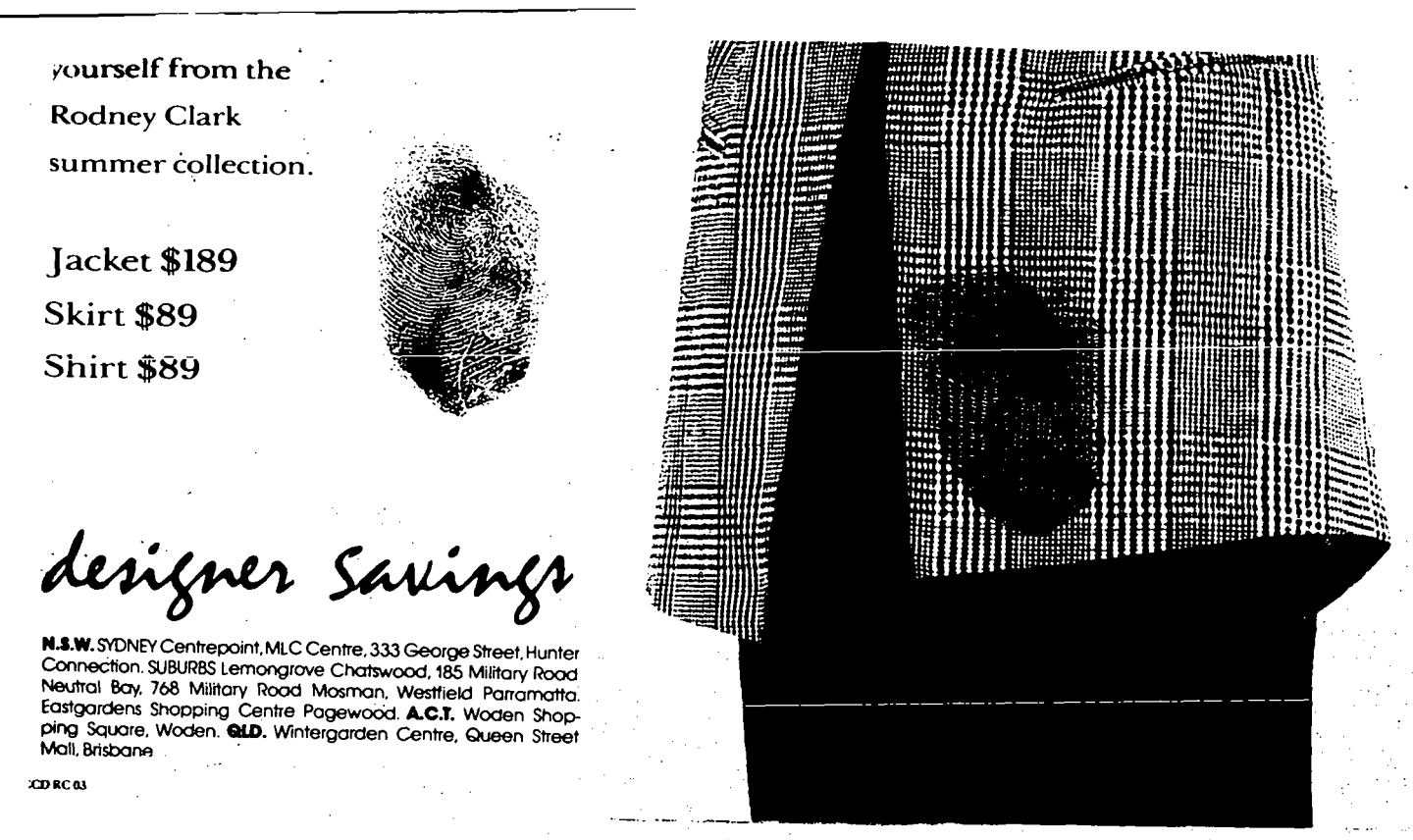


FIG. 4

Samples of blood prints tested (unsuccessfully).

FIG. 5a

Section of a newspaper advertisement clearly showing the pattern of dots of a printer's matrix which can obscure and confuse minutae detail in a fingerprint as seen in lower example.



commence on August 31, for 3 weeks.

NEWCASTLE

The sittings commence on September 7, for 2 weeks. The Presiding Judge will be Justice Yeldham.

GRIFFITH

Pre-trial conferences will be held during week commencing August 10.

A final callover will be held on August 21, at 2, before Justice Finday. The sittings commence on September 21, for 3 weeks.

BATHURST

A callover of list will be held on Tuesday, August 18, to allocate pre-trial conference dates. Pre-trial conferences will be held during week commencing on August 31. The sittings commence on October 12, for 3 weeks.

Justice Slattery, Broken Hill, 10. Hrg: Barraclough, Royan Truck & anor; McKenzie, McKenzie & anor; Galea, Carr; Cornish, Wylie. Justice Wood, Newcastle, 10. Hrg: Crozier, BHP; Silcock, Newcom Coll; PL: Porter, Carrington Abrasive Cleaners PL; Kurowski, BHP; Davis, BHP; Nedler, Health Admin Corp.

Continued Page 37

SHIPPING

The following information was supplied by the Maritime Services Board at 3 pm yesterday.

EXPECTED ARRIVALS TODAY

CANOPUS, GB 1, HSI, 230 1777; COL, Q'LAND, GI 1, COL, 267 9977; ELLEN HUDIC, GI 2, ABC, 699 4727; METAL TRADER, Pyr 9, PAT, 233 6722; THEA 8, DH 6, REL 241 3991.

EXPECTED DEPARTURES TODAY

KHUD IOGANSON, GI 2, OPAL, 278 051; KUMUL EXPRESS, GI 1, NFL, 20522; NEDL KEMBLA, Pyr

Darwin 19-31, Alice Springs 4-16.

WEATHER SYNOPSIS

The surface winds were chiefly light to moderate. The reported extremes of temperature were 22 degrees at Grafton to 5 degrees at Thredbo. Night time temperatures were up to 7 degrees above average in some parts.

RAINFALL SYNOPSIS

The highest recorded [illegible] mm at Milton.

RAINFALL REGISTE[illegible]
(24 hours to 9 am [illegible])

Upper Western Tib[illegible]
White Cliffs 3.
Lower Western Broken[illegible]
Menindee 0.4.
Central West Plains: [illegible] 0.2.
Riverina: Griffith 0.8, [illegible] Springs 0.8, Deniliquin 1, Jerilderie 0.2, Narrandera 0.6, Tocumwal 0.6.
North West Slopes: Bendemeer 0.4, Woolbrook 0.4.
Central West Slopes: Forbes 0.2, Parkes 1.
South West Slopes: Gundagai 0.6, Wagga 0.2.
Northern Tablelands: Armidale 0.2, Bonalbo 11, Drake 34, Highrent 0.4, Jeogla 0.2, Tabulam 0.6, Tabulam Mulrne, 0.8, Wattlegrove 0.2.
Central Tablelands: Blackheath 4, Hampton 2, Katoomba 8, Lithgow 7, Mt Victoria 6, Orange A/port 0.2.
Southern Tablelands: Bombala 2, Canberra 0.2, Canberra A'port 0.2, Cooma 0.6, Delegate 1, Goulburn 1, Nimmitabel 1, Berridale 2, Perisher Valley 1.
Northern Rivers: Cape Byron 15, Casino 2, Grafton 3, Kyogle 2, Lismore 3, Murwillumbah 8, Woodburn 2, Yamba 12.
Mid North Coast: Coffs Hbr, M.O 14, Dorrigo 6, Kempsey 10, Meldrum 5, Nambucca Hds 21, Smoky

Satellite picture — noon yesterday

Cloud over NSW and the Qld coast is brought by onshore winds and an uppet air disturbance over NSW. Cloud over SW SA is associated with an upper air disturbance.

Metropolitan: Balgowlah 2, Bankstown 2, Bexley 4, Concord 2, Epping 4, Five Dock 2, Frenchs Forest 6, Gordon 5, Mosman 4, Newport Beach 11, Northbridge 0.4, Oatley 11, Palm Bch 6, Pymble 5, Sydney 4, Mascot M.O. 3, Turramurra 4, Waverton 4, West Lindfield 5, Berowra 2, Blacktown 1, Glenorie 1, Liverpool 1, Penrith 1, Richmond M.O. 1, Westmead 2.

Sunshine

Sunshine will be recorded if [illegible] there is [illegible] or if the [illegible] than high[illegible]

DAILY [illegible]

Monday, [illegible]	3.4
Tuesday, [illegible]	10.2
Wednesday, [illegible]	10.0
Thursday, 6.8.87	10.4
Friday, 7.8.87	5.0
Saturday, 8.8.87	10.1
Sunday, 9.8.87	3.5

Today's weather, P 26.

SNOW REPORT

FIG. 5b

Two examples of print matrix of dots obscuring detail in a fingerprint (an identical print used for comparison in each case). Careful selection of a grid size on a transparent overlay can give fringes formed by only the fingerprint pattern not the dot pattern thus providing a spatial pattern sensitivity comparison which can be an aid. Confusion in comparisons can occur if one print is skewed during application under pressure giving local distortion in ridge pattern. In cases such as shown here the Fourier transform pattern of the known background pattern can be digitally subtracted from the combined (fingerprint & background) pattern transform to subsequently allow fingerprint to be separated.

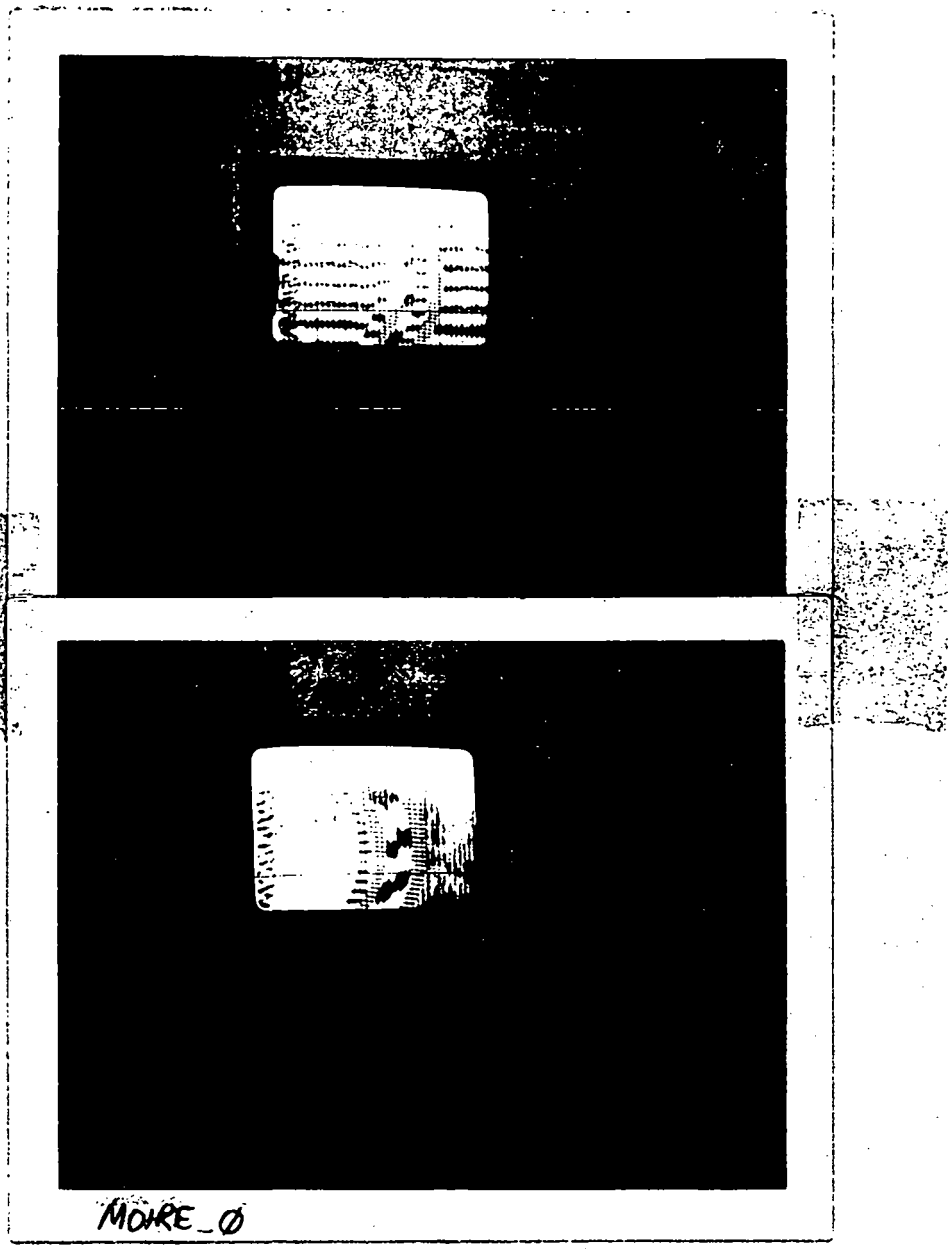
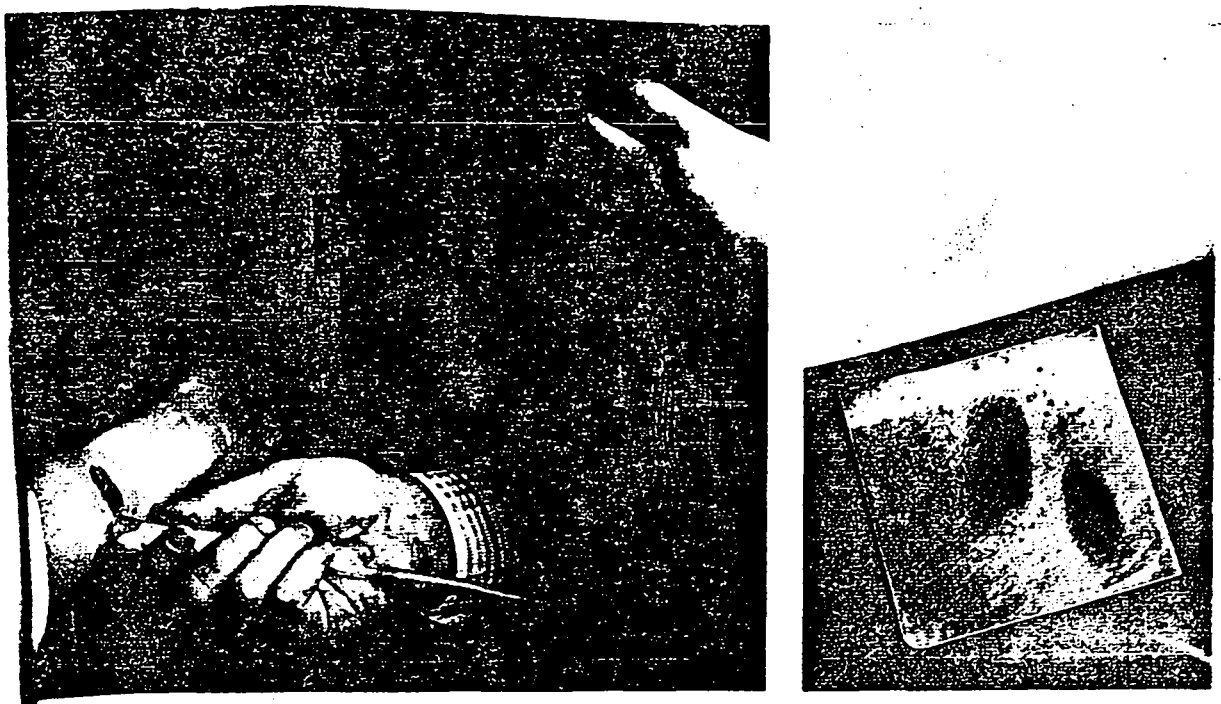


FIG. 6

Digitised display of part of a Moire pattern allowing greater resolution and fine detail of different line spacings by very small movement of transparent grid in lower display.



Searching for fingerprints, a police aide blows iodine vapor onto a victim's arm, *above*. When pressed against a silver plate, the stain reacts chemically to transfer the fingerprint to the plate, *above right*.

FIG. 7

FIG. 8

Latent fingerprint on a polythene bag made visible by a vacuum metallising process at UK Scientific Research & Development Branch, UK Home Office)
(Physics Bulletin, 39, No. 3, p.100 March 1988)

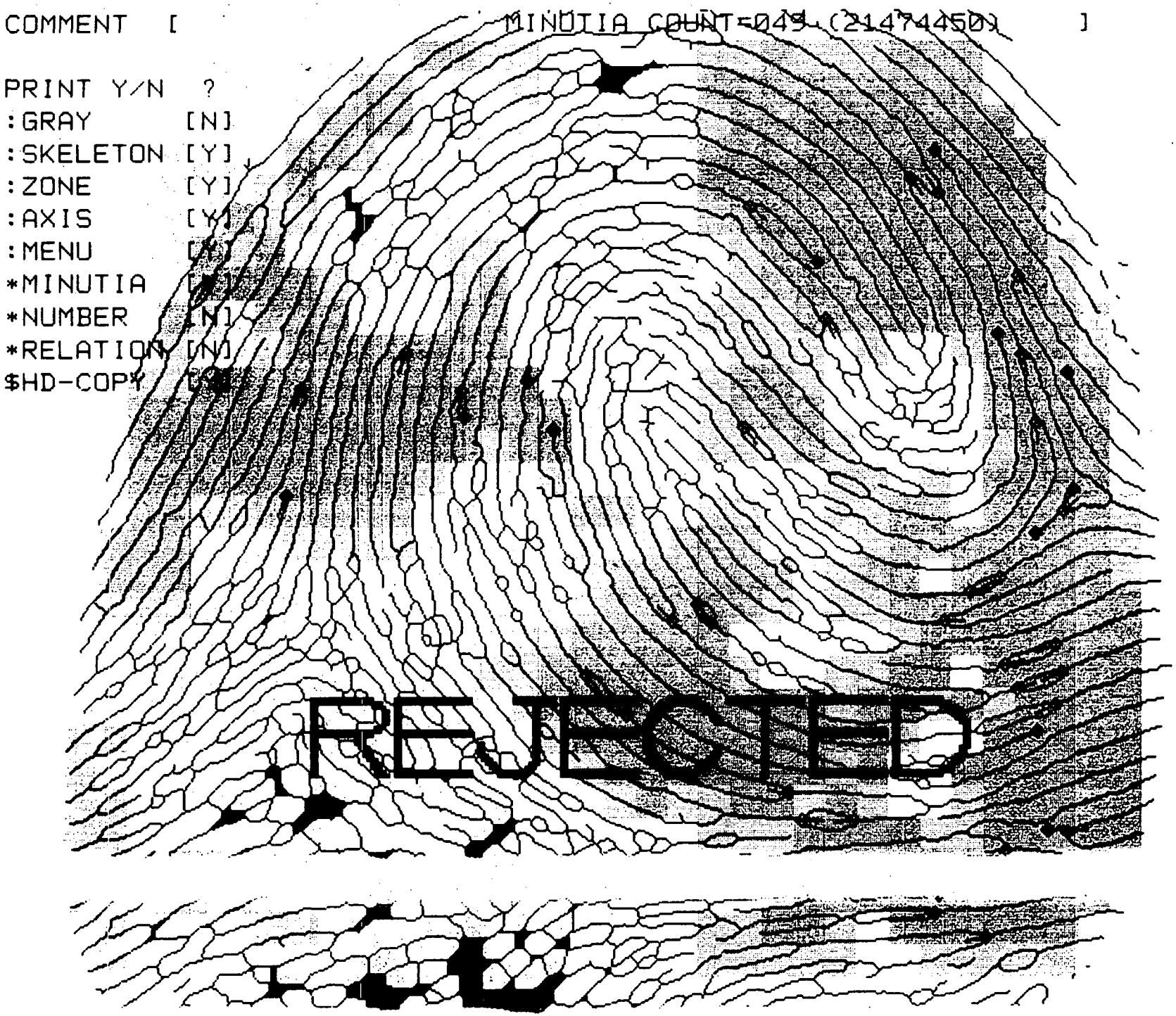


FIG. 9a

Example of rejected print from AFIS due to uneven inking.

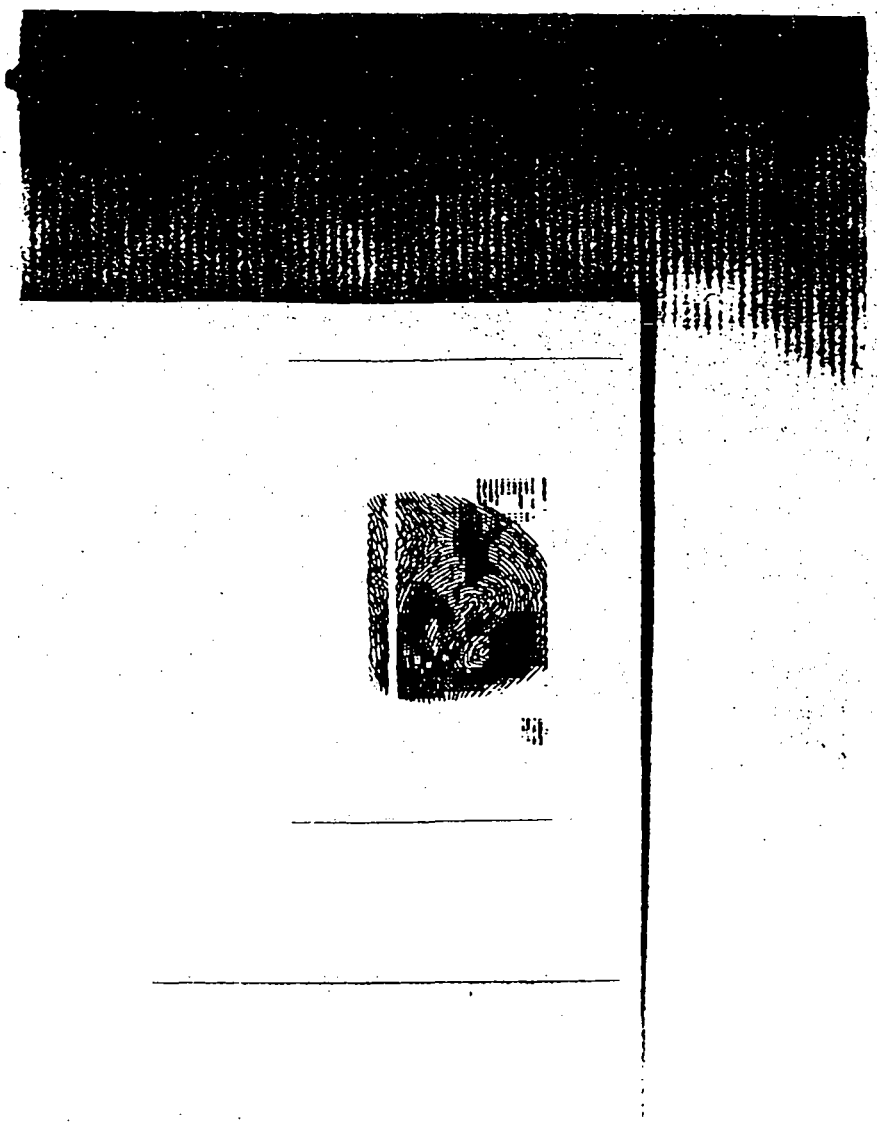
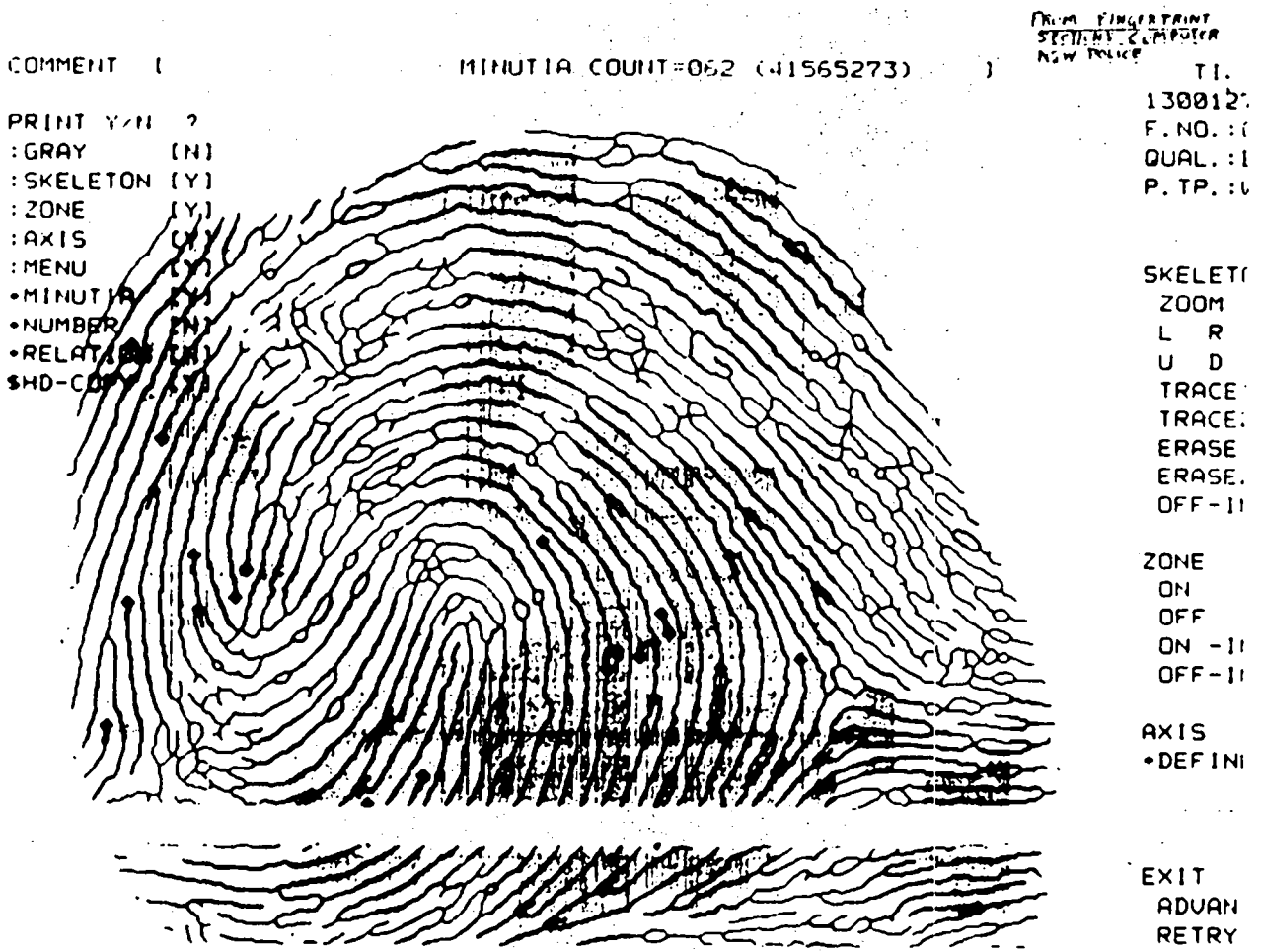


FIG. 9b

Size reduction of rejected print (Fig. 9a) to test with Moire fringes based on spatial sensitivities of non-spoiled areas of the print.

FIG. 10

Reduction (left) of an AFIS print (below) to a size suitable to a smaller spaced grid to get a continuous Moire pattern. The fringes were found to be not sufficiently sensitive to the minutae (which are critical to the AFIS comparison method).



[Photographs]

SALMON PRINTS

These photographs, from the January/February issue of Science 86, show the circuli, or rings, on a single scale of an Alaskan salmon, left, and a Soviet sockeye, right. Salmon add from ten to thirty rings each year; the size and shape of these rings are influenced by the fish's diet, as well as by the temperature and salinity of the water. Salmon hatched in the same place will show similar patterns, and a salmon's home stream (and thus, according to international law, its nationality) can be determined by matching its print against known samples. BioSonics, a Seattle company, recently began selling the first video and computer salmon matching system to government fisheries departments.

page 30

FIG. 11

APPENDICES A - E

WITH ORIGINAL DOCUMENT