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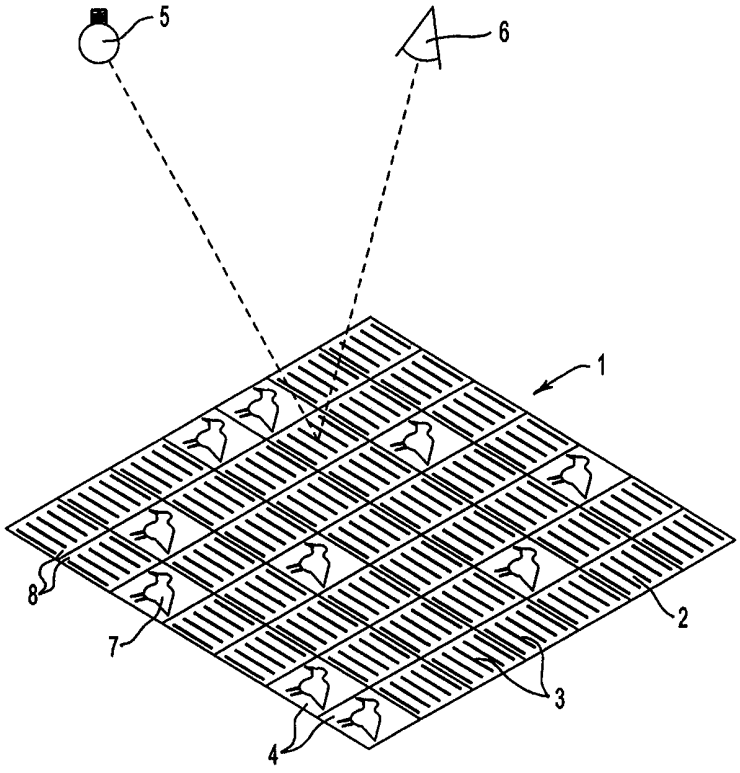
(54) Title: MICROGRAPHIC DEVICE

(57) Abstract

A device (1) has a surface relief structure (2) which has a plurality of regions (3). The regions (3) include grey scale regions (4) which are too small to be separately resolvable to the human eye. Each grey scale region (4) is one of a limited number of different grey scale region structure types. The different grey scale region structure types appear, by reason of their differing diffuse scattering characteristics, to have different intensities when the device (1) is illuminated by a light-source (5) and viewed by an observer (6). The device is useful in authentication applications and has particular applicability as an anti-forgery security device on bank notes, credits cards, cheques, share certificates and other similar documents.



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MICROGRAPHIC DEVICE

This invention relates to a micrographic device. It relates particularly but not exclusively to a security device which generates a grey scale image when illuminated by a light source and viewed by an observer, and to an authentication device which incorporates graphic elements line art or images represented in microscopic size in repeated regions of its surface relief structure. The device may be used in a number of different applications, and it has particular applicability as an anti-forgery security device on bank notes, credit cards, cheques, share certificates and other similar documents.

Recent improvements in reproduction technology have made it easier for a person to forge a copy of a valuable document. Various different types of security devices are available to protect against copying. One such type of security device is a hologram of the type which has been applied to VISA™ and MasterCard™ credit cards since 1984. When viewed under appropriate illumination conditions (best seen with a point light source such as a single incandescent globe), holograms generate an image which appears to change as the angle of observation changes. When not illuminated, the hologram as a silver appearance. Holograms provide protection against colour photocopying and similar reproductive techniques because such reproductive techniques cannot reproduce the ability to generate images which differ when viewed from different angles.

Holograms are a member of a class of security devices referred to as optically variable devices (OVDs). Newer and more secure optically variable devices have been developed, including dot matrix hologram technology (EP0 467 601 A2), KINEGRAM™ technology (EP105099, EP330738, EP375833) as first used on the Saudi Arabia passport in 1987 and later on the Austrian 5000 Schilling bank note in 1990, CATPIX™ grating technology (PCT/AU89/ 00542) used on the Australian plastic ten dollar bank note issued in 1988 and the Singapore plastic 50 dollar bank note in 1990, PIXELGRAM™ diffraction technology (PCT/AU90/00395, US patent 5428479) and EXELGRAM™ diffraction technology (PCT/AU94/00441) which appeared on Australian opal stamps and Vietnam bank cheques issued in 1995 and on AMEX™ travellers cheques and Hungarian bank notes in 1997.

The contents of International patent applications PCT/AU90/00395 and PCT/AU94/00441, both in the name of the present applicant, are hereby incorporated herein by reference.

OVDs typically consist of a thin layer of a metallised foil applied by means of an adhesive to a substrate. A typical OVD appears silver in colour, and this can adversely affect the contrast in images viewed by an observer.

Rough treatment of a document bearing an OVD can result in substantial diminution in the optically variable effects produced by the OVD, with a resulting reduction in the degree of security afforded.

Most OVDs can be simulated to some extent by holographic copying techniques. While holographic copying equipment is not as readily available as colour photocopiers, the technology is available to the determined forger. Simulations made using holographic copying typically do not incorporate all of the security features of original OVDs, and they typically have a lower quality, but they are often of sufficient quality to mislead unsuspecting members of the public. It is therefore desirable for security devices copied by holographic techniques to be obviously different from the original.

It is an object of the present invention to provide some improvements in security device technology.

According to one aspect of the present invention, there is provided a device having a surface relief structure which has a plurality of light scattering regions, each region having a number of structures which scatter incident light in different directions, so that the region appears to an observer to be a particular shade of grey. This allows the device to simulate an optically invariable "printed" appearance, which is not capable of being copied by holographic techniques.

The particular shade of brown or grey generated by a light scattering region is dependent upon the number of scattering centres and feature sizes of those scattering centres within a given surface area.

The particular resolution of the "printed" appearance depends upon the size of each scattering region. It is preferred although not necessary that the regions be too small to be separately discernible to the unassisted human eye. It is preferred that each region is of size 120 micron by 120 micron or less.

It is preferred that the device include both diffractive surface relief structure regions and scattering regions, so that, under appropriate illumination conditions, both optically variable effects and "printed"-type effects can be seen by the observer.

Where the device is a foil applied to the surface of a valuable document such as a bank note, the "printed" effects caused by the scattering regions can be made to line up with and complement the printed effects such as guilloche effects on the rest of the valuable document. This gives the device a more integrated appearance with the rest of the document, rather than the separate "appended" appearance of a typical OVD.

According to another aspect of the invention, there is provided a device having a surface relief structure which has a plurality of regions, wherein the regions include grey scale regions which are too small to be separately resolvable to the human eye, each grey scale region being one of a limited number of different grey scale region structure types, the different grey scale region structure types appearing, by reason of the differing diffuse scattering characteristics, to have different intensities when the device is illuminated by a light source and viewed by an observer.

As a preferred feature, one or more of the grey scale region structure types may have one or more graphic elements, line art or images represented in microscopic size in their surface relief structures. This results in multiple replication of the graphic elements line art or images across the device, making it impossible to destroy all copies by reason of rough usage.

In this preferred form, the same image may be represented in each grey scale region structure type, but with differing diffuse scattering characteristics. Alternatively, different graphic elements, line art or images may be represented in the different grey scale region structure types.

According to another aspect of the invention there is provided a device having a surface relief structure which has a regular array of regions, each region being too small to be separately resolvable to the human eye, wherein a large number of the regions are micrographic regions, each micrographic region having one or more graphic elements, line art or images represented in microscopic size in its surface relief structure.

In some embodiments, each micrographic region may have an identical image represented in its surface relief structure. In other embodiments, each micrographic region may have a structure which is one of a limited number of micrographic region structure types.

Some embodiments may be constructed in such a way that, when the device is illuminated by a light source and viewed by an observer, the observer sees in macroscopic form an image which corresponds with a microscopic image represented in the surface relief structure of some or all of the regions.

It is preferred that the device also be an optically variable device.

In a preferred form, the device includes a plurality of diffracting regions such that, upon illumination by a light source, the device generates one or more diffraction images which are observable from one or more ranges of viewing angles around the device. Non-diffracting regions may provide a contrast enhancing dark background to the diffraction image or images. Alternatively, non-diffracting regions may provide grey scale enhancements to the diffraction image or images.

In some embodiments, some or all of the regions may be hybrid regions which include both periodic surface structure which has diffractive effects and graphic elements, line art or images which have diffuse scattering effects.

In some embodiments, regular arrays of alpha numeric characters or similar size graphics can be used to generate an optical effect which includes both diffractive and diffuse scattering components.

Microscopic text may be embossed onto or engraved into the tops of diffractive periodic surface structure elements and/or between diffractive periodic surface structure elements, in order to give an additional authentication feature.

The inventive device is particularly useful for authentication purposes. Authentication of the device may take place by microscopic examination and recognition of the regions. Alternatively, authentication of the device may take place by machine recognition of the regions.

The invention will hereafter be described in greater detail with reference to the attached drawings which show example forms of the invention. It is to be

understood that the particularity of those drawings does not supersede the generality of the preceding description of the invention.

Figure 1 is a schematic diagram illustrating the operation of the invention.

Figure 2 is a sample line art image which, when applied in microscopic format to the surface relief structure of a device creates a suitable region for use in accordance with the invention.

Figure 3 shows the trapezoidal shapes used to generate the image of Figure 2.

Figure 4 shows some numerals which are suitable for use in the same manner.

Figure 5 shows some graphics which are suitable for use in the same manner.

Figure 6 shows the rectangular shapes used to generate the image of Figure 5.

Figure 7 shows some graphics which are suitable for use in the same manner.

Figure 8 shows some writing which is suitable for use in the same manner.

Referring now to Figure 1, there is shown device 1 having surface relief structure 2 which has a plurality of regions 3. Regions 3 include grey scale regions 4, which are too small to be separately resolvable to the human eye. (They are shown in much magnified state in Figure 1). Each grey scale region 4 is one of a limited number of different grey scale region structure types. The different grey scale region structure types appear, by reason of their differing diffuse scattering characteristics, to have different intensities when device 1 is illuminated by light source 5 and viewed by an observer 6.

The grey scale region structure types may be developed by selecting a limited number of diffuse scattering structures, each of which has different scattering characteristics. A diffuse scattering structure may be created randomly. However, most graphic elements, line art drawings and images naturally possess diffuse scattering characteristics, and it is a preferred feature of the present invention that the diffuse scattering regions use relief structures

which incorporate graphic elements such as alpha numeric characters or recognisable shapes, line art drawings, or other images. The use of such recognisable images in the diffuse scattering regions adds to the security of the device in that of authenticity of the device can be checked by microscopic examination of the diffuse scattering regions.

Although a single image has predetermined scattering characteristics, and hence a predetermined grey scale intensity value, the diffusion characteristics and grey scale value can be altered by altering such features as depth of the surface relief structure, sharpness of the surface relief structure profile, and introduction or removal of random "noise" structures by varying the number of scattering centres and feature sizes of the scattering centres within the region. It is therefore possible to use the same image to generate all of the different grey scale region structure types.

It is of course not necessary to use the same image in each grey scale region, and different grey scale region structure types may use different images.

As stated above, the grey scale regions are too small to be separately resolvable to the human eye. For a normal human eye, the smallest resolvable structure has a width of about 0.25mm. Any size below this is suitable, although the presently preferred size is a region approximately 30 micron x 30 micron. It is not necessary that the region be square; it may be hexagonal, circular, or any other suitable shape. In International Application PCT/AU94/00441 there is extensive discussion concerning the merits of using long narrow strips, rather than small squares. It is also possible for the surface relief structure to be substantially continuous, so that there is no clearly discernible separation between notional adjoining surface regions.

In a special case of the present invention, the microscopic image produced by the device upon illumination may be the same image as the microscopic image which is represented in the surface relief structure of some or all of the regions. By way of example, Figure 2 shows a pigeon comprised of approximately 1,024 x 1,024 pixels. In an electron beam writing device operating at a high resolution, this corresponds with a surface region of approximately 30 micron x 30 micron. In a macroscopic image generated by

light illuminating a surface relief structure into which the microscopic pigeon shape has been embossed, the pigeon shape will be responsible for one tiny dark dot. When the pigeon shape has been embossed into a large number of different areas of the surface relief structure corresponding with the macroscopic shape of the pigeon, wherein each embossing represents a single pixel of the macroscopic image, the result after illumination will be a macroscopic image of the pigeon. This is of course a special case, and the dark image dots created by individual pigeon shape embossing can be used to create any desired macroscopic image.

The image shown in Figure 2 began as a line art image. The line art image was converted by a mathematical conversion process into a group of geometrical figures, as shown in Figure 3, to facilitate engraving by the electron beam lithography process. The engraving process results in the image of Figure 2.

The graphics in Figure 4 consist of the numerals "50" arranged in a pattern, with the total pattern being of suitable resolution for transfer by electron beam lithography process onto a surface region of approximately 30 micron x 30 micron in size.

Figure 5 shows some more graphics comprised of the alphabetic letters CSIRO, and the logo of the Commonwealth Scientific and Industrial Research Organisation. This art work also began as line art, which was converted into a pattern of rectangles as shown in Figure 6, to facilitate transfer by the electron beam lithography process to a surface relief structure region approximately 30 micron x 30 micron in size, resulting in the structure of Figure 5.

Figure 7 shows some more graphics comprised of alpha numeric symbols and other symbols and shapes, once again suitable for transfer by electron beam lithography to a surface region approximately 30 micron x 30 micron in size.

Figure 6 shows one of Shakespeare's sonnets written in dot-matrix style letters within a square region. This text arrangement is suitable for transfer by electron beam lithography to a surface region approximately 30 micron by 30 micron in size.

Device 1, in addition to grey scale regions 4, may include a plurality of diffracting regions 8, such that, upon illumination by light source 5, device 1 generates one or more diffraction images which are observable from one or more ranges of viewing angles 6 around the device. With this preferred feature, the device acts as an optically variable device with the additional benefits of the present invention. The non-diffracting regions, which may include some or all of the grey scale regions 4 may provide a contrast-enhancing dark backgrounds to the diffraction image or images. As indicated previously, optically variable devices typically have a silver background, which may detract from the contrast of the diffraction image generated. The use of diffusely scattering regions 4 results in a dark background, which enhances image contrast.

Further or alternatively, grey scale regions 4 may provide a grey scale enhancement to the diffraction image or images. This may be by way of highlights, enhancements, an integral part of image, or a super imposed image.

The above description has proceeded on the assumption that diffracting surface regions are separate from diffusely scattering surface regions. However, it is possible that a single surface region may include both diffuse scattering and diffractive effects. A single region may be a hybrid region which includes both periodic surface structure, which has diffractive effects, and graphic elements, line art or images which have diffuse scattering effects.

It is also possible to use regular arrays of alpha numeric characters or similar symbols to generate an optical effect which includes both diffractive and diffuse scattering components.

Micrographic surface structure regions according to the invention have a number of different practical applications including the following:

1. They can be used as an additional level security feature which can be checked using high speed microscopic machine vision systems.

2. The non-periodic structure of the micrographic regions means that holographic or contact copying of the structures is impossible to achieve.

3. Because diffusely scattering micrographic regions are impossible to copy holographically, the differences in grey scale level of the micrographic grey scale elements become indistinguishable on a copied device and therefore any

macroscopic graphic feature constructed out of at least two types of micrographic regions will be unobservable on the copied device.

4. Micrographic regions can therefore be used as a unique background optically invariable security feature on diffractive images originated using electron beam lithography techniques.

5. Because individual micrographic surface structures appear many hundreds or even thousands of times as a background to the diffractive features of an OVD, the micrographic information possesses multiple redundancy and is available for microscopic identification and authentication purposes even after severe scratching of the OVD foil.

6. Micrographic regions can be used as a contrast enhancing dark background to the diffractive features of an OVD so that the apparent brightness of the diffractive features is increased.

7. Micrographic regions can be used to make OVDs appear far less metallic than normal metallised foil. The diffuse scattering effect of the micrographic regions is the source mechanism for this result.

It is to be understood that various alterations additions and/or modifications may be made to the parts previously described without departing from the ambit of the invention.

CLAIMS

1. A device having a surface relief structure which has a plurality of regions,

wherein the regions include grey scale regions which are too small to be separately resolvable to the human eye,

each grey scale region being one of a limited number of different grey scale region structure types,

the different grey scale region structure types appearing, by reason of their differing diffuse scattering characteristics, to have different intensities when the device is illuminated by a light source and viewed by an observer.

2. A device according to claim 1 wherein each grey scale region structure type has one or more graphic elements, line art or text images represented in microscopic size in its surface relief structure.

3. A device according to claim 2 wherein each microscopic region is of size 120 micron by 120 micron or less.

4. A device according to claim 2 wherein the same image is represented in each grey scale region structure type, but with differing diffuse scattering characteristics.

5. A device according to claim 2 wherein different graphic elements line art or images are represented in different grey scale region structure types.

6. A device having a surface relief structure which has a regular array of regions, each region being too small to be separately resolvable to the human eye, wherein a large number of the regions are micrographic regions, each micrographic region having one or more graphic elements, line art or text images represented in microscopic size in its surface relief structure.

7. A device according to claim 6 wherein each micrographic region has an identical image represented in its surface relief structure.

8. A device according to claim 6 wherein each micrographic region has a structure which is one of a limited number of micrographic region structure types.

9. A device according to any one of claims 1 to 8 wherein, when the device is illuminated by a light source and viewed by an observer, the observer sees in microscopic form an image which corresponds with a microscopic image represented in the surface relief structure of some or all of the regions.

10. A device according to any one of claims 1 to 9 further including a plurality of diffracting regions such that, upon illumination by a light source, the device generates one or more diffraction images which are observable from one or more ranges of viewing angles around the device.

11. A device according to claim 10 wherein non-diffracting regions provide a contrast-enhancing dark background to the diffraction image or images.

12. A device according to claim 10 wherein non-diffracting regions provide grey scale enhancement to the diffraction image or images.

13. A device according to claim 2 or claim 6 wherein some or all of the regions are hybrid regions which include both periodic surface structure which has diffractive effects and graphic elements line art or images which have diffuse scattering effects.

14. A device according to claim 13 wherein microscopic text is embossed onto or engraved into the tops of diffractive periodic surface structure elements and/or between diffractive periodic surface structure elements.

15. A device having a surface relief structure which has a plurality of light scattering regions, each region having a number of structures which scatter incident light in different directions, so that the region appears to an observer to be a particular shade of grey.

16. A valuable document incorporating a device according to any one of claims 1 to 15 wherein printing on the valuable document matches up with, and appears to be continuous with regions on the device which have a printed appearance.

17. A device according to any one of claims 1 to 15 which is used for authentication purposes, wherein authentication of the device takes place by microscopic examination and recognition of the regions.

18. A device according to any one of claims 1 to 15 which is used for authentication purposes, wherein authentication of the device takes place by machine recognition of the regions.

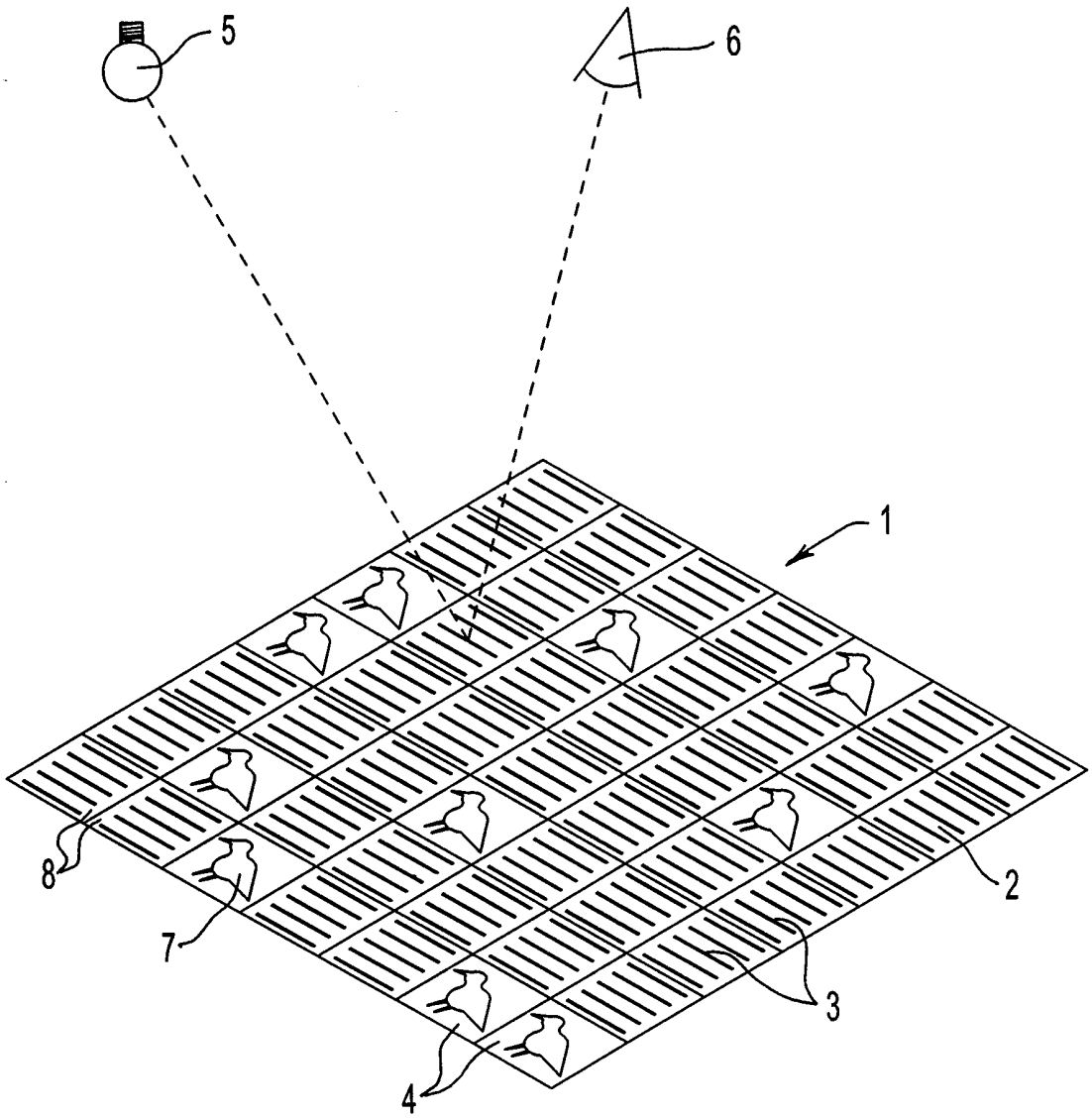

FIG 1

FIG 2

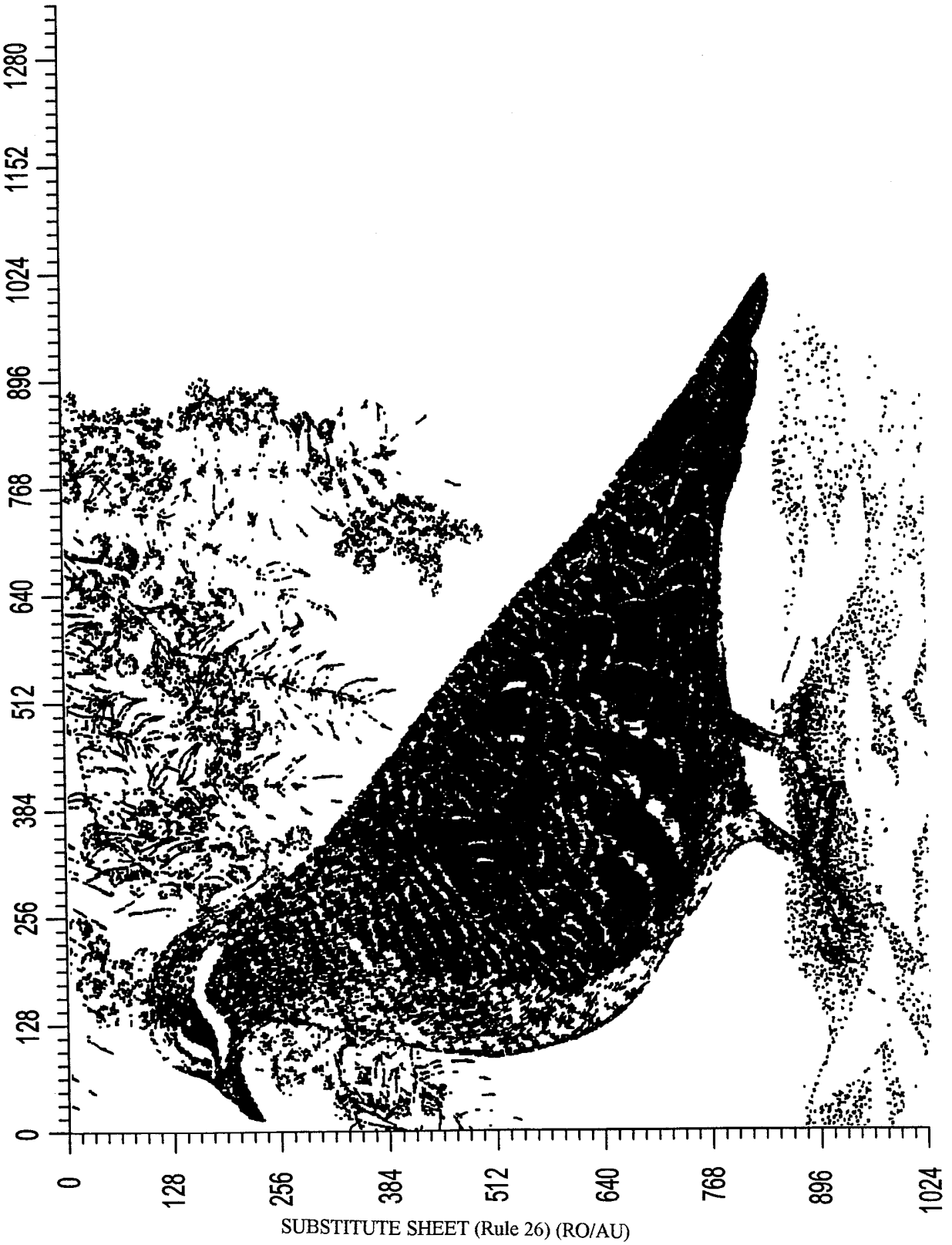
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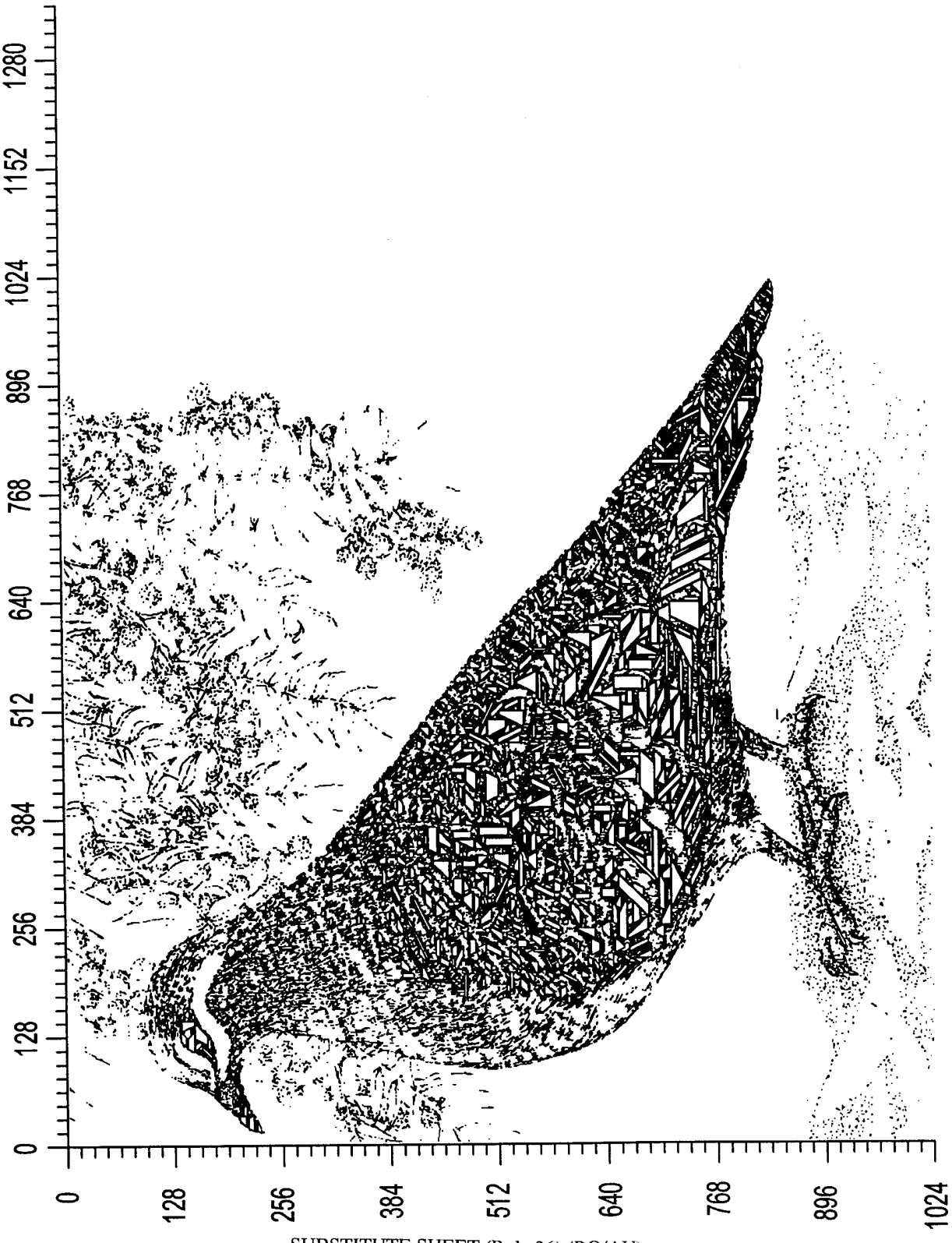
FIG 3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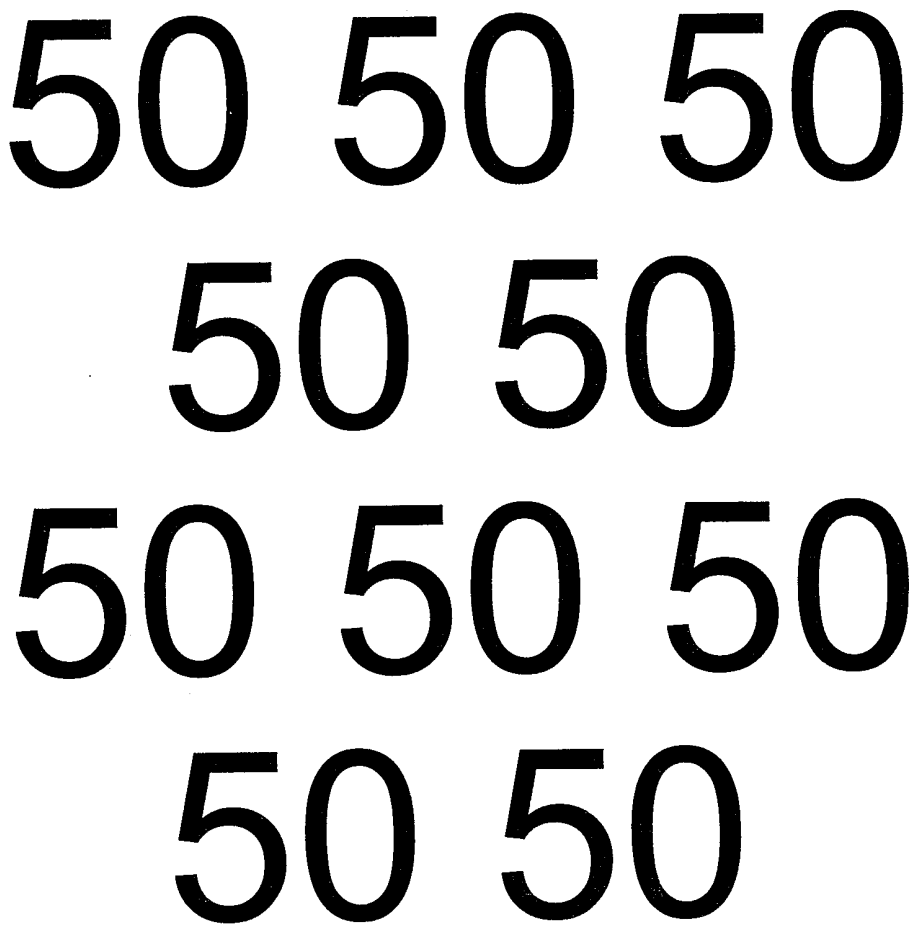
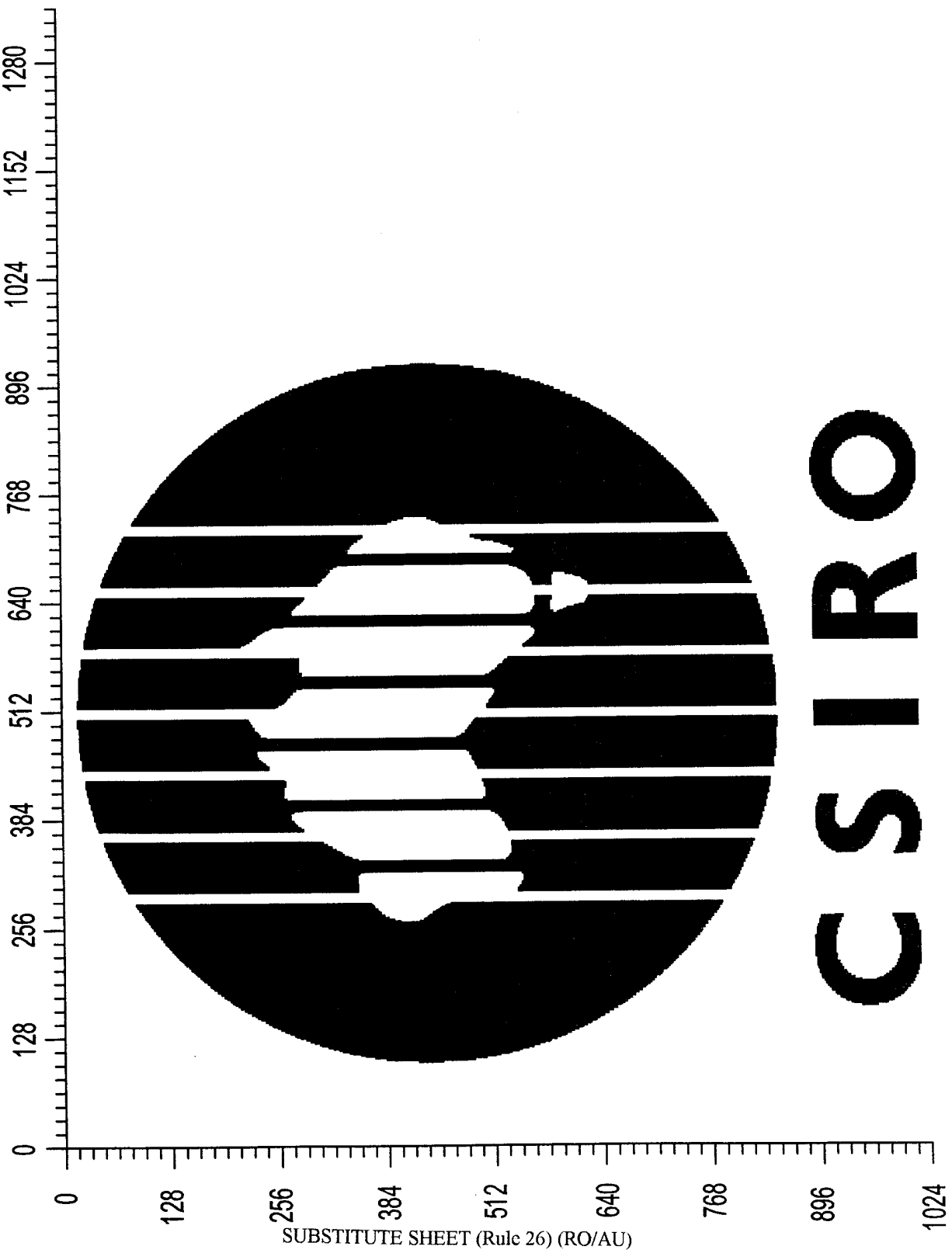


FIG 4

FIG 5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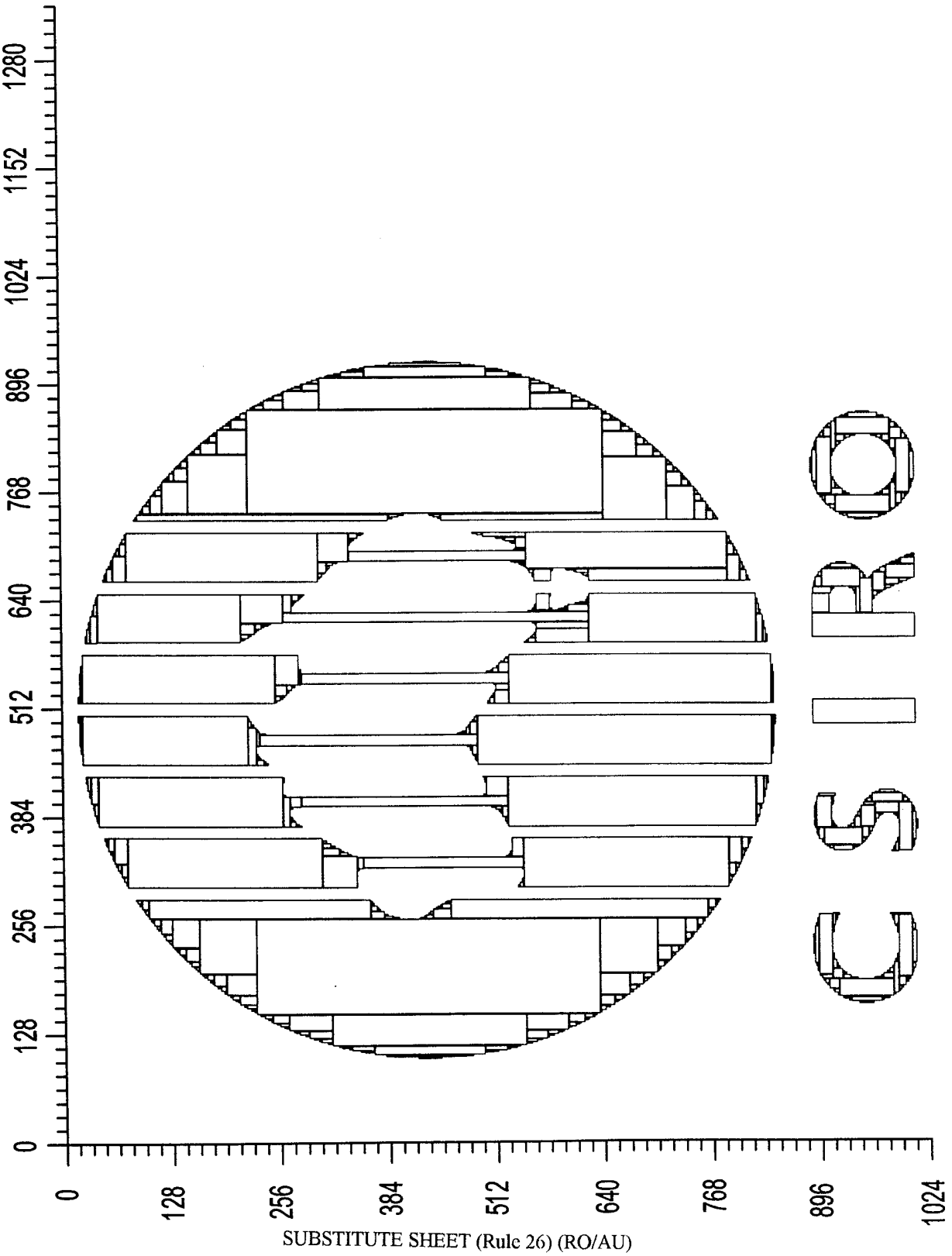
CSIRO

FIG 6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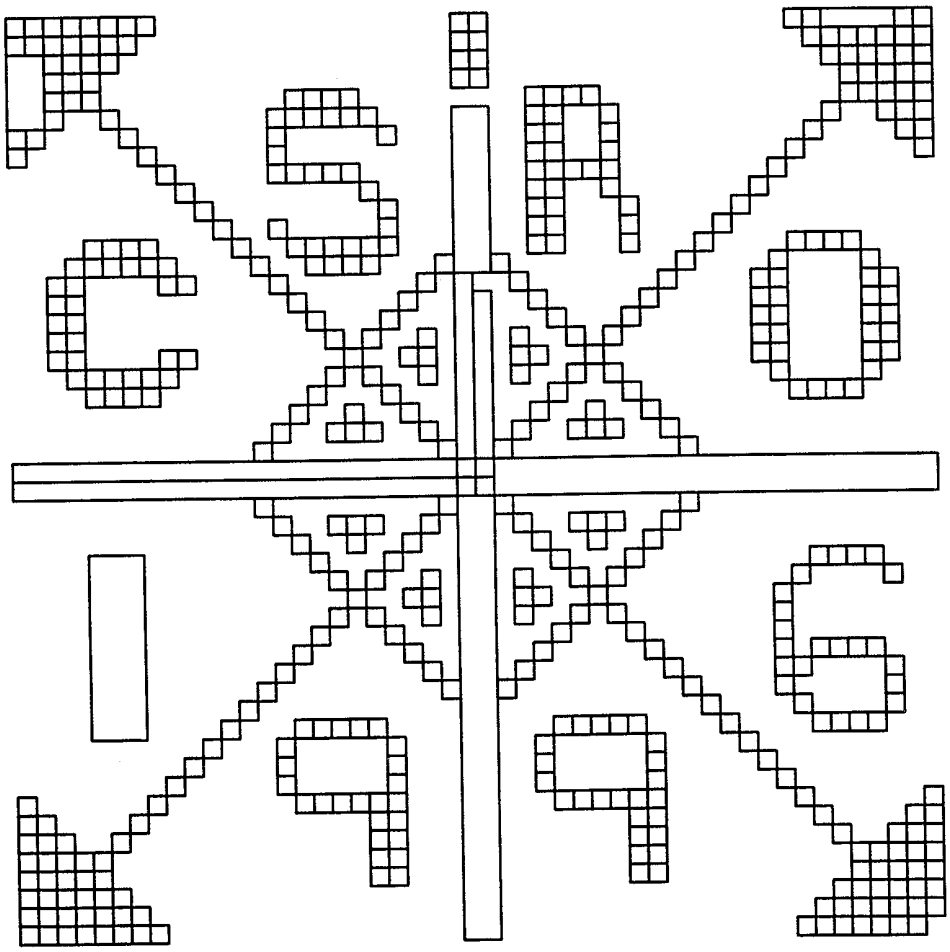
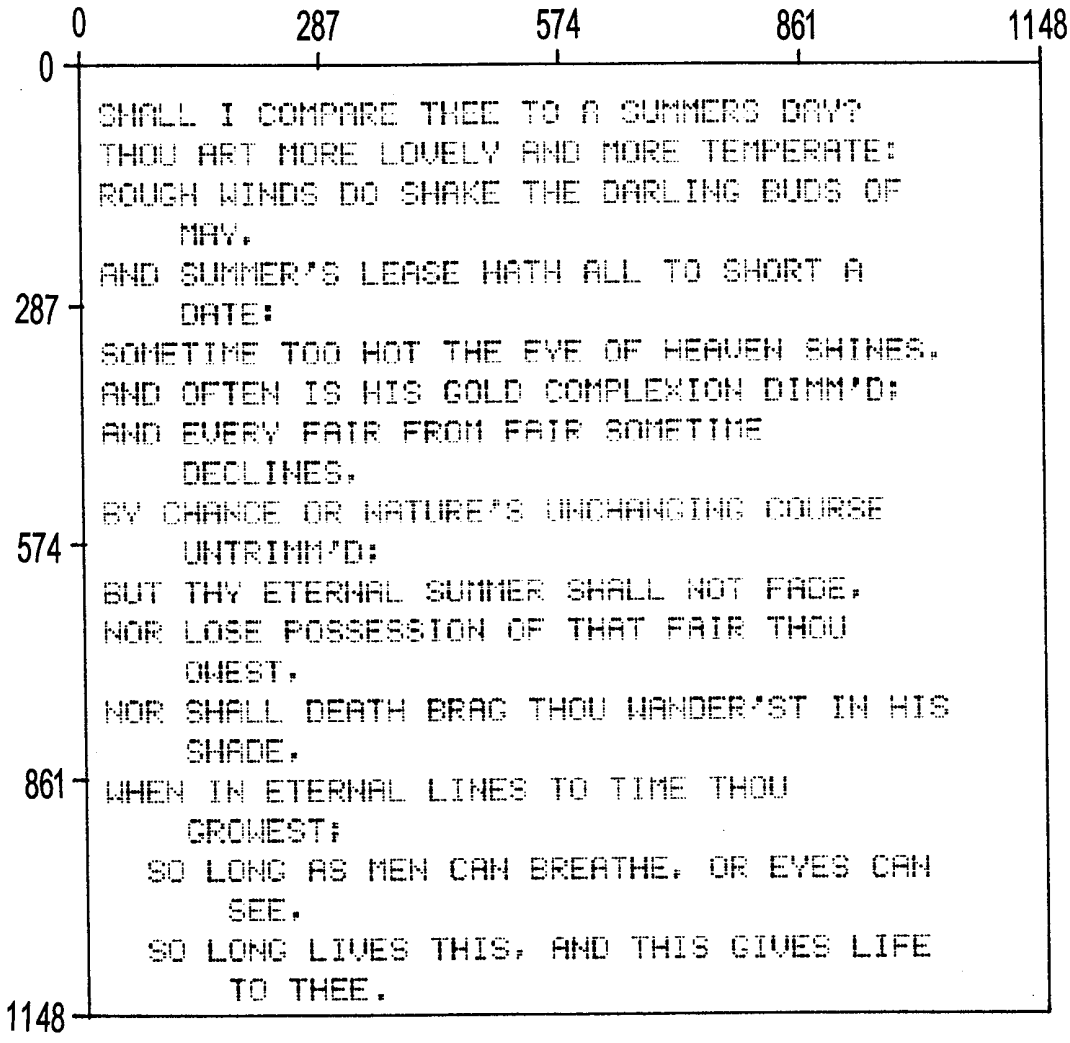


FIG 7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AND SUMMER'S LEASE HATH ALL TO SHORT A
DATE:
SOMETIME TOO HOT THE EYE OF HEAVEN SHINES,
AND OFTEN IS HIS GOLD COMPLEXION DIMM'D;
AND EVERY FAIR FROM FAIR SOMETIME
DECLINES,
BY CHANCE OR NATURE'S UNCHANGING COURSE
UNTRIMM'D;
BUT THY ETERNAL SUMMER SHALL NOT FADE,
NOR LOSE POSSESSION OF THAT FAIR THOU
OWEST,
NOR SHALL DEATH BRAG THOU WANDER'ST IN HIS
SHADE,
WHEN IN ETERNAL LINES TO TIME THOU
GROWEST;
SO LONG AS MEN CAN BREATHE, OR EYES CAN
SEE,
SO LONG LIVES THIS, AND THIS GIVES LIFE
TO THEE.

FIG 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU 98/00821

A. CLASSIFICATION OF SUBJECT MATTER

Int Cl[6]: B44F 1/12, B42D 15/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC: B44F 1/12, B42D 15/10, 205/00, 207/00, 211/00, 213/00, 227/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPAT: IPC + (grey: or diffract: or scatter)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 95/25640, A, (SCHROEDER) 28 September 1995 Whole document	1
X	AU 37390/93, A, (COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION) 16 September 1993 Whole document	1-12, 15-18
X	AU 23547/97, A, (COMMONWEALTH SCIENTIFIC AND INDUSTRIAL ORGANISATION) 14 August 1997 Whole document	1-12, 15-18

[X] Further documents are listed in the continuation of Box C

[X] See patent family annex

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search	Date of mailing of the international search report
20 October 1998	- 8 NOV 1998
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No.: (02) 6285 3929	Authorized officer **BARRY STEPHENS** Telephone No.: (02) 62832106

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU 98/00821

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	AU 39931/97, A, (COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION) 15 January 1998 Whole document	1-18
X	AU 68372/94, A, (COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION) 8 December 1994 Whole document	1-12, 15-18

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/AU 98/00821

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
WO	95/25640	AU	17077/95	CA	2163341	CN	1128006
		EP	703094	EP	805409	ES	2102296
		ES	2102307	ES	2105936	US	5787186
AU	93/37390	WO	9318419				
AU	94/68372	WO	9428444	EP	704066		

END OF ANNEX