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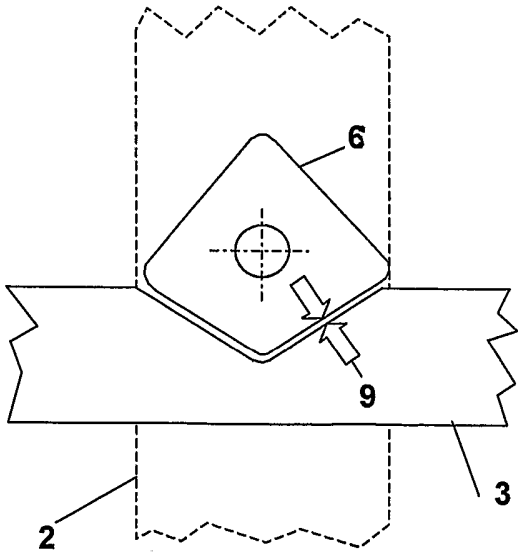
(54) **Title:** DESIGN OF SWITCHES FOR MECHANICAL FINGERPRINT SENSING



(57) **Abstract:** A fingerprint sensor defined by an array of switches including, each switch (1) comprising first and second contact portions (3, 6) separated by a gap, and a bridge member defined by a portion of a continuously conductive film for connecting the first and second portions across the gap (9). One of the contact portions is defined by a contact pad (6) and the length of the gap in the direction substantially parallel to the adjacent edges of the first and second contact portions is greater than the width of the gap between the first and second contact portions.

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DESIGN OF SWITCHES FOR MECHANICAL FINGERPRINT SENSING

The present invention is concerned with a fingerprint sensor and a method of identity verification using a sensed fingerprint pattern. Embodiments of the present invention are particularly concerned with an array of switches defining a digitiser including a matrix or array of individual sensing cells for sensing the presence or absence of an epidermal fingerprint ridge and thereby sensing fingerprint patterns.

Embodiments of the present invention are concerned with improvements to fingerprint sensors of the type described in EP 459,808, EP 699,325, GB 2,243,235, WO 98/11499 and Now 98/11500.

Both WO 98/11500 and WO 98/11499, for example, describe digitisers defined by a matrix of sensing cells where each sensing cell is defined by a switch which can be closed in response to the presence of a fingerprint epidermal ridge. A problem with the prior art systems is the possibility that current can sneak between adjacent sensing cells. This can distort the sensor output and restricts how close adjacent sensing cells can be.

The present invention in a first aspect provides a fingerprint sensor as set out in claim 1.

The present invention in a second aspect provides a fingerprint sensor as set out in claim 12.

The present invention in a third aspect provides a fingerprint sensor as set out in claim 14.

The present invention in a fourth aspect provides a method of verifying the identity of a person as set out in claim 16.

Preferred features of the invention in its various aspects are defined in the dependent claims.

Embodiments of the invention will now be described, by way of example only, with reference to the attached figures (which are not to scale), in which:

Figures 1 and 2 are cross-sectional views through fingerprint sensors embodying the present invention;

Figures 3 and 4 illustrate the sensing (ie upper) surface of the sensors of figures 1 and 2;

Figure 5 is an enlarged view of the contact pad of figure 3 illustrating the resistance of the current paths between the contact pad and its respective second conductor;

Figure 6 is an enlarged view of an alternative contact pad construction to that of figure 5;

Figures 7 and 8 illustrate cross-sectional views through alternative fingerprint sensors embodying the present invention;

Figures 9 and 10 illustrate the sensing (i.e. upper) surface of an alternative sensor construction;

Figures 11a and 11b illustrates the relative resistance of the different current paths available from the contact pads of figures 7 to 10;

Figures 12 and 13 illustrate alternative contact pads suitable for the sensor construction of figures 7 to 10; and

Figure 14 illustrates a comparison method embodying the present invention.

As discussed above, the present invention is concerned with digitisers comprising a matrix of individually actuable sensing cells 1. The cells are defined by the cross-over points of two sets of parallel conductors 2,3. A second set of parallel conductors 3 overlies and is separated from a first set of parallel conductors 2.

In order to create a switch at each cross-over point, a conductive via 4 through the insulating material 5 separating the two sets of conductors 2,3 connects a lower conductor 2 with a contact pad 6 in the same plane as the second conductor 3 (or alternatively in an arrangement not illustrated, a second contact pad itself connected to the second conductor). One set of conductors defines input or drive buses and the other set of conductors defines output or sensing buses.

The present invention is essentially only concerned with the shape of the contact pads, and how this relates to the conductor with which it is connected when the respective switch is closed. The construction of digitisers embodying the present invention is in all other aspects identical to one or other of the constructions described in EP 459, 808, EP 699,325, GB 2, 43,235, WO 98/11499 and/or WO 98/11500. For efficiency of the process, the applicant therefore expressly incorporates the disclosure of these documents in this application and confirms that the described digitisers or fingerprint sensors are or may be constructed in one or other of the manners described in all of these publications.

As described in, for example, WO 98/11499 and/or 98/11500, each sensing cell 1 comprises a second conductor 3 overlying and separated from a first conductor 2 with the first conductor being connected to a contact pad 6. A resiliently deformable membrane 7 including a continuously conductive film 8 of the type described in WO 98/11499 overlies the switch contacts defined by the contact pads 6 and second conductors 2. Downward pressure on the conductive membrane 7 caused by, for example, pressure from an epidermal fingerprint ridge causes the film 8 to contact the second conductor 3 and contact pad 6 at a respective cell and thereby allows current to flow between the first and second conductors 2,3 (one of which defines an input bus and the other an output bus).

In the fingerprint sensor (or digitiser) of Figures 3 and 4, the contact pad 6 is a rectangular pad within the second conductor but separated therefrom by track or groove 9 of insulating material. The contact pad arrangement is simple to make as it is simply a question of a different metal or conductor pattern on the devices surface. The pattern is controlled in the known manner as described in, for example, EP 459,808, EP 699,325, GB 2243325, WO 98/11499 and/or WO

98/11500. The inventor has appreciated that this results in a lower likelihood of sneak currents when one, for example, uses a continuously conductive membrane of the type described in WO 98/11499 to form the contact bridge for the array of switches making up the digitiser.

The resistance of a continuously conductive membrane of the type described in WO 98/11499 is defined as ohms per square . Referring to Figure 4, the use of a contact pad 6 entirely surrounded by the second conductor 3 forming the other switch contact means that the effective resistance of the continuously conductive film 8 between the contact pad 6 and its respective conductor 3 can be made significantly lower than that between the contact pad and adjacent contact pads and/or conductors of adjacent sensing cells. For the example, in the configuration of Figure 5, there are forty-six squares 10 in the track or groove 9. For a continuously conductive film having a sheet resistance of R ohms per square, the resistance between the contact pad 6 and its respective second conductor 3 would be R/46 ohms per square as each square can be considered to be a resistance in parallel to the other squares.

Referring to figure 6, in an alternative configuration, the contact pad 6 is a circular or oval pad within the second conductor but separated therefrom by a track or groove 9 of insulating material.

In the prior art digitisers of, for example, WO 98/11499 and/or 98/11500 , the contact pads are rectangular. In the fingerprint sensors of Figures 7 to 13, the contact pad 6 is substantially triangular. The inventor has appreciated that this results in a lower likelihood of sneak currents when using a continuously conductive membrane of the type described in WO 98/11499 to form the contact bridge for the array of switches making up the digitiser.

The resistance of a continuously conductive membrane of the type described in WO 98/11499 is defined as ohms per square . Referring to Figures 11a and 11b , the use of a triangular contact pad 6 means that the effective resistance of the continuously conductive membrane between the contact pad and its respective conductor can be made significantly lower than that between the contact pad and adjacent contact pads and/or just conductors of adjacent sensing cells. For the example, in the configuration of Figure 11a there are six

squares 9 in parallel between the contact pad and the second conductor, six squares in series between the contact pad and adjacent contact pads, and four squares in series between the contact pad and the sensor conductor of all adjacent sensing cell. As shown in Figure 11b this means that for a continuously conductive membrane having a resistance of R ohms per square, the resistance between the contact pad and its second conductor is significantly lower that that between the contact pad and other elements. This reduces the likelihood of sneak currents and allows one to eliminate or reduce the effect of any sneak currents by setting appropriate measurements thresholds in the circuitry which monitors the status of the sensing cells.

Referring to figures 12 and 13, in two further alternative constructions the contact pad is shaped either like a triangle (see figure 12) or like a squashed diamond (see figure 13) and is separated by a constant width gap from a respective second conductor having an indentation matching a side of the contact pad. As will all the embodiments described abobe, this arrangement results in a longer thinner gap between the contact pad and the respective seconf conductor and therefore results in a lower resistance because of the resistance of the connecting portion of the overlying membrane or bridge member being lower than that for a shorter fatter gap.

Referring to Figure 14, a fingerprint reader is coupled to a data processor including a comparator for a comparing fingerprint pattern sensed by the print reader with a fingerprint pattern stored in a memory. When the sensed and stored patterns match, the comparator generates an acceptance signal indicating that the sensed pattern matches the stored pattern. The acceptance signal may, for example, be used to authorise a financial transaction or open a door by releasing a lock.

The print reader may be of any of the known types of print reader. For example, the print reader or sensor may be as described in EP 459,808 or EP 1,021,785

The print reader generates a bit map or digital signal train representing an image of the sensed fingerprint. The memory includes a stored bit or digital signal

train representation, or image of a fingerprint pattern corresponding to, for example, an authorised person or user.

The comparator directly compares the bit map produced by the print reader or sensor with the bit map stored in the memory.

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CLAIMS

1. A fingerprint sensor comprising an array of switches including a switch comprising first and second contact portions separated by a gap, and a bridge member for connecting the first and second portions across the gap, wherein the length of the gap in the direction substantially parallel to the adjacent edges of the first and second contact portions is greater than the width of the gap between the first and second contact portions.

2. A fingerprint sensor according to claim 1 wherein the bridge member is formed by a portion of a substantially continuously conductive film.

3. A fingerprint sensor according to any preceding claim, the array of switches being defined by the cross-over points of a plurality of parallel first conductors and a plurality of parallel second conductors overlying the first conductors, and switch means being associated with each cross-over point, each switch means including a first contact portion connected to one of the first conductors and a second contact portion connected to one of the second conductors wherein the first and second contact portions of each switch are separated from one another, and the array further including an overlying resiliently deformable surface layer providing, for each switch, a contact bridge for connecting the contract portions of the switch means in response to an applied pressure on the surface layer.

4. An fingerprint sensor according to claim 3 wherein a switch includes a first contact pad defined by said first contact portion and being electrically connected to one of said first conductors.

5. A fingerprint sensor according to any of claims 3 or 4 including an insulating layer overlying the first conductors, and having respective first vias for each first contact pad.

6. A fingerprint sensor according to claim 5 wherein the first and second conductors are formed on opposite sides of an insulating support, the first contact

portions are on the same side of the support as the second conductors and each first contact portion is connected to its respective first conductor by a conductive via passing through the insulating support.

7. A fingerprint sensor according to any of claims 3 to 6 wherein the membrane has a continuously conductive film.

8. A fingerprint sensor according to any preceding claim wherein the first contact portion is surrounded by the second contact portion.

9. A fingerprint sensor according to any preceding claim including, a switch comprising first and second contact portions separated by a gap, and a bridge member for connecting the first and second portions across the gap, wherein the first contact portion has a first edge facing the second contact portion, and at least one other edge facing a contact portion of at least one adjacent switch, and wherein the area of the gap between the first edge and the second contact portion comprises less squares than the area of the space between the at least one other edge and the contact element of the at least one adjacent switch.

10. A fingerprint sensor according to claim 9 wherein the first contact portion is substantially triangular

11. A fingerprint sensor according to claims 3 and 10 wherein the plurality of parallel first conductors are substantially orthogonal to the plurality of second conductors, and the said first edge of the first contact portion is substantially parallel to the second conductors.

12. A fingerprint sensor comprising an array of switches including, a switch comprising first and second contact portions separated by a gap, and a bridge member for connecting the first and second portions across the gap, wherein the first contact portion is surrounded by the second contact portion.

13. A fingerprint sensor according to claim 12, the array being defined by the cross-over points of a plurality of parallel first conductors and a plurality of parallel second conductors overlying the first conductors, and switch means being associated with each cross-over point, each switch means including a first

contact portion connected to one of the first conductors and a second contact portion connected to one of the second conductors wherein the first and second contact portions of each switch are separated from one another, and the array further including an overlying resiliently deformable surface layer providing, for each switch, a contact bridge for connecting the contract portions of the switch means in response to an applied pressure on the surface layer.

14. A fingerprint sensor comprising an array of switches including, a switch comprising first and second contact portions separated by a gap, and a bridge member for connecting the first and second portions across the gap, wherein the first contact portion has a first edge facing the second contact portion, and at least one other edge facing a contact portion of at least one adjacent switch, and wherein the area of the gap between the first edge and the second contact portion comprises less squares than the area of the space between the at least one other edge and the contact element of the at least one adjacent switch.

15. An array of switches according to claim 14 wherein the first contact portion is substantially triangular

16. A method for verifying the identity of a person including steps of:
sensing a fingerprint pattern;
producing a digital representation of the sensed fingerprint pattern;
comparing the digital representation of the sensed fingerprint pattern to a stored digital representation of a stored fingerprint pattern; and
generating a signal when the stored and sensed fingerprint patterns;
wherein the comparison is made using complete digital representations of the sensed and stored fingerprint patterns.

17. Method according to claim 16, wherein the digital representations are bitmaps of the sensed and stored fingerprint patterns.

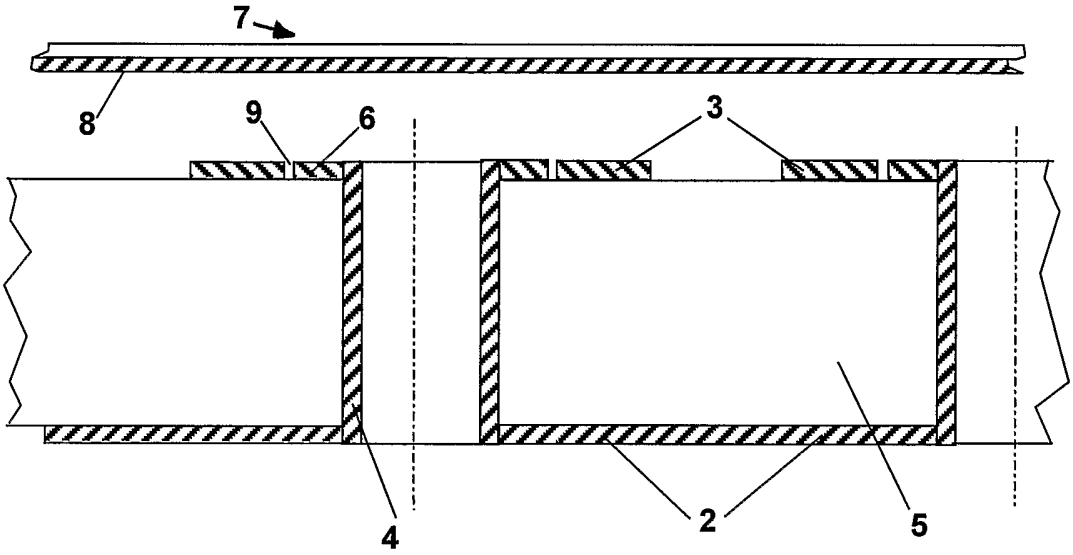

Figure 1

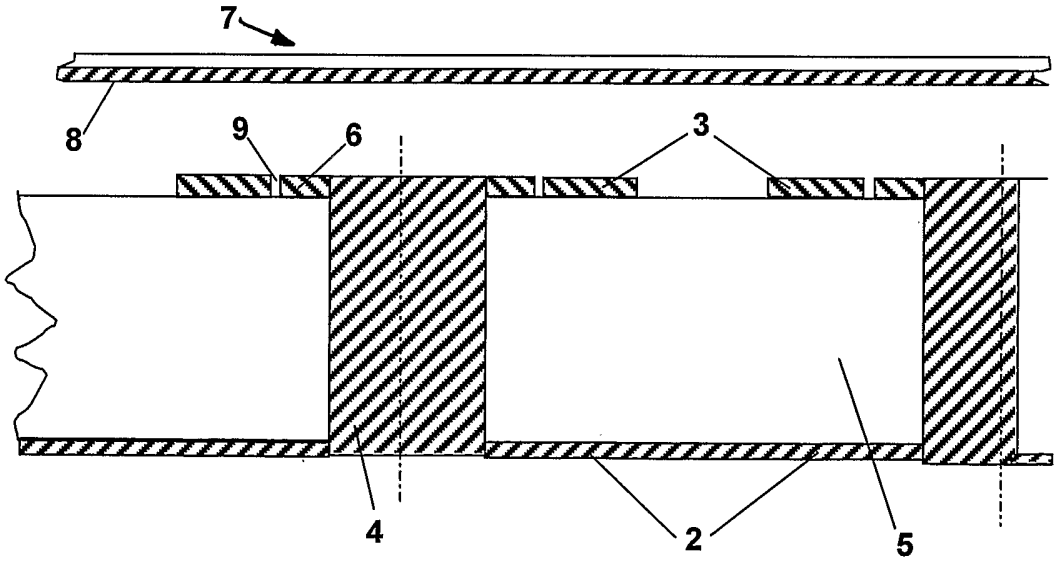

Figure 2

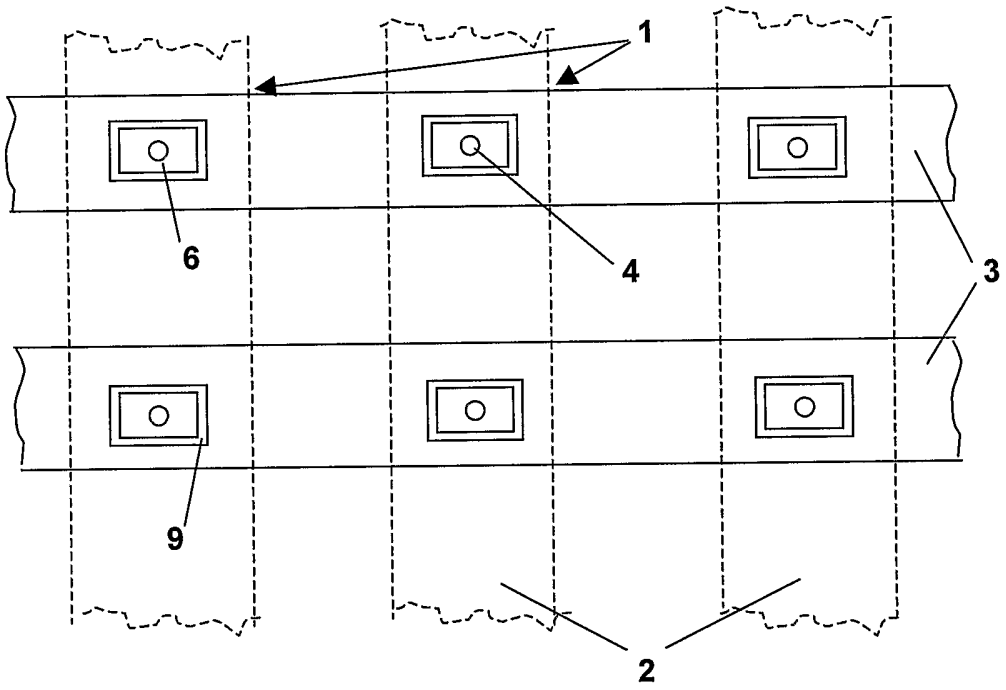

Figure 3

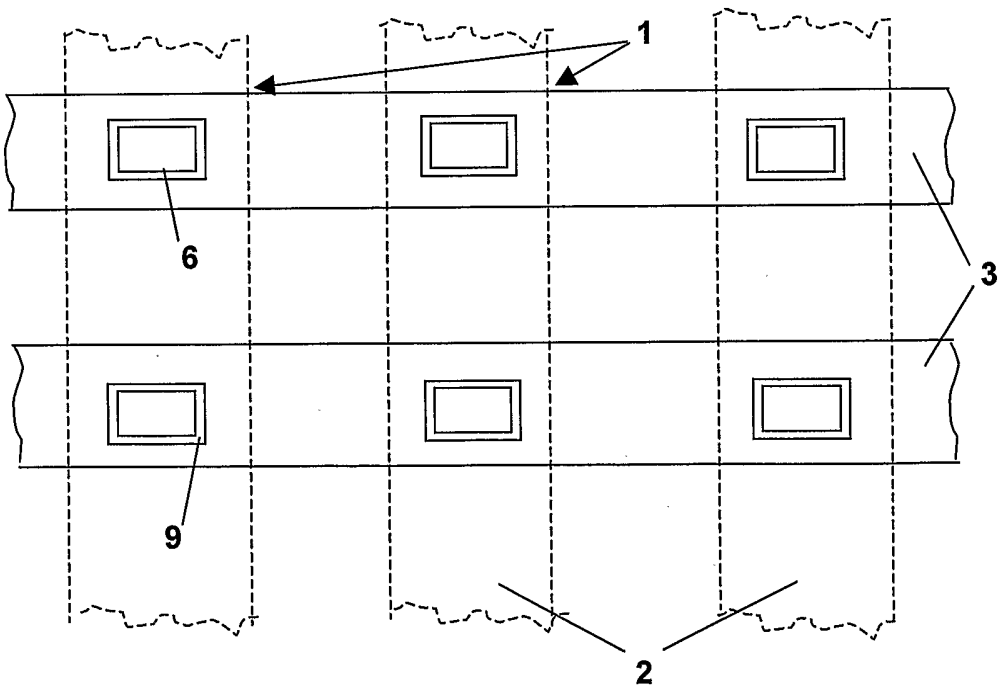

Figure 4

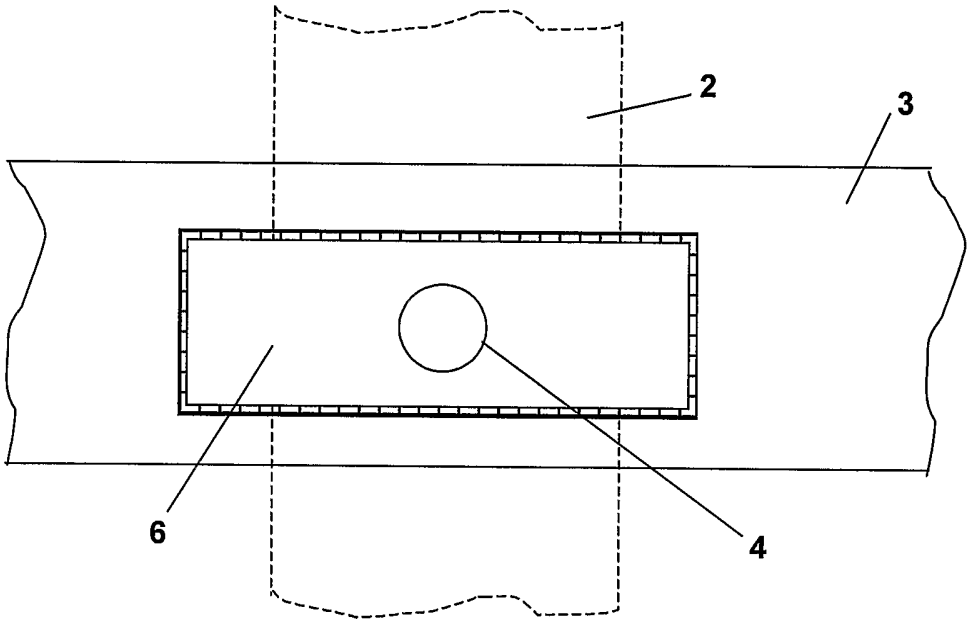

Figure 5

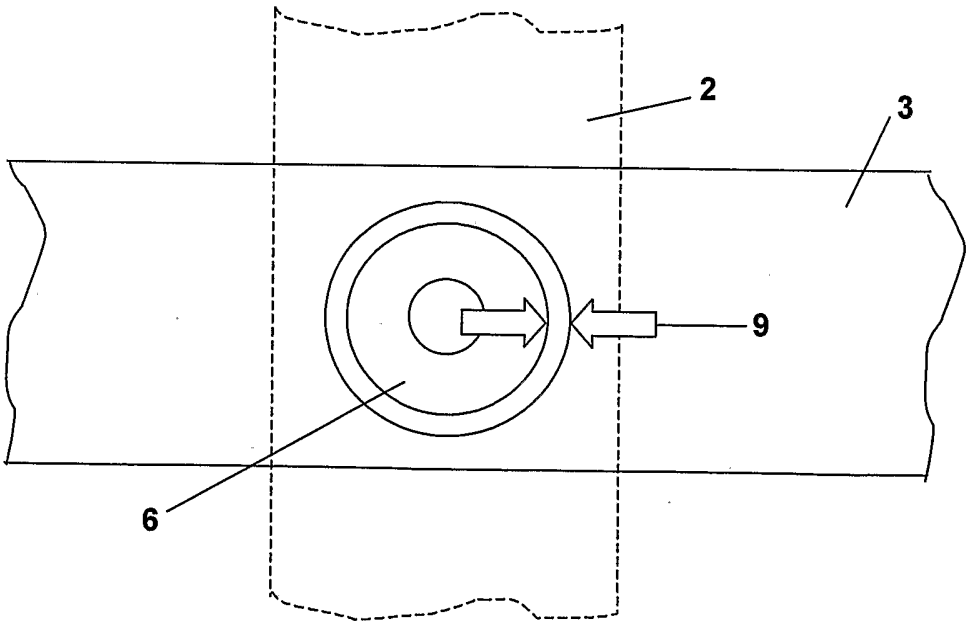

Figure 6

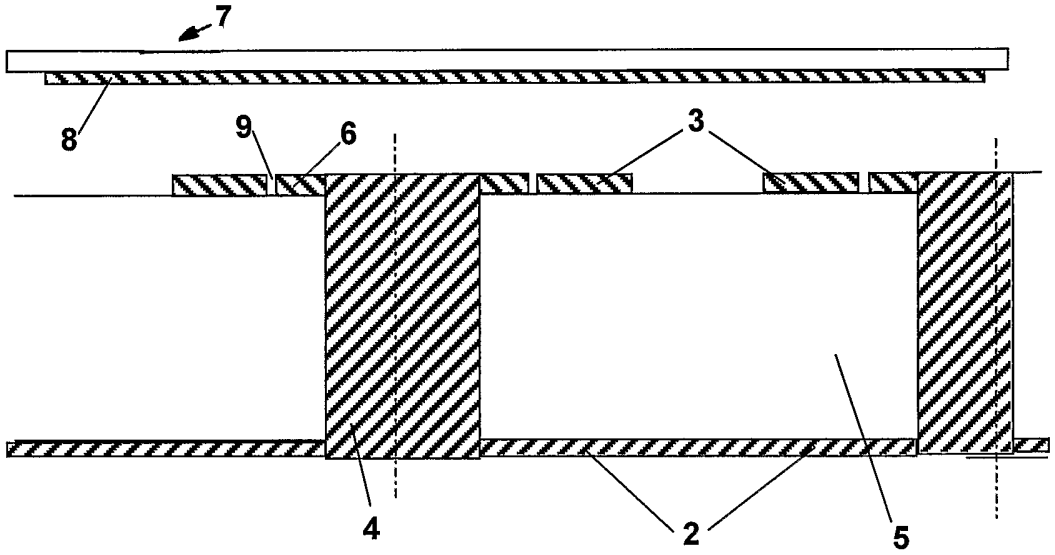

Figure 7

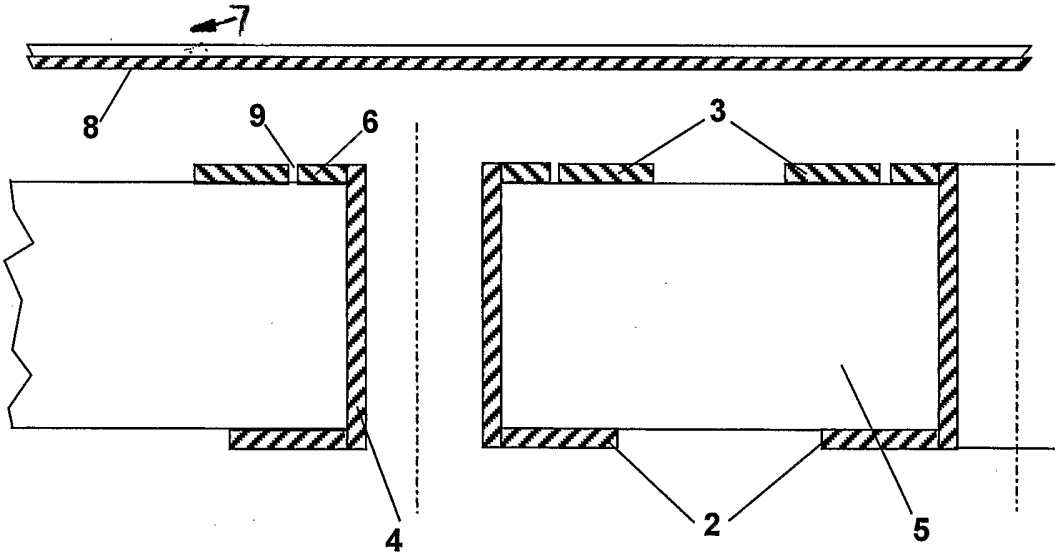

Figure 8

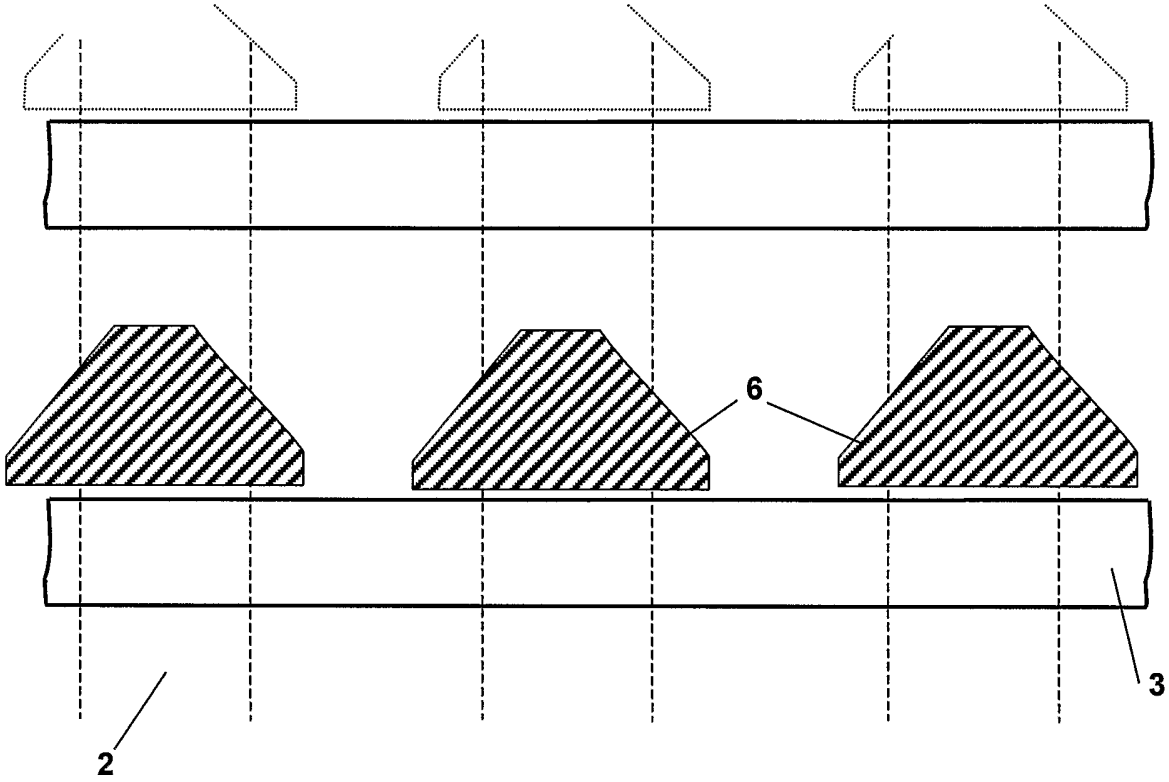

Figure 9

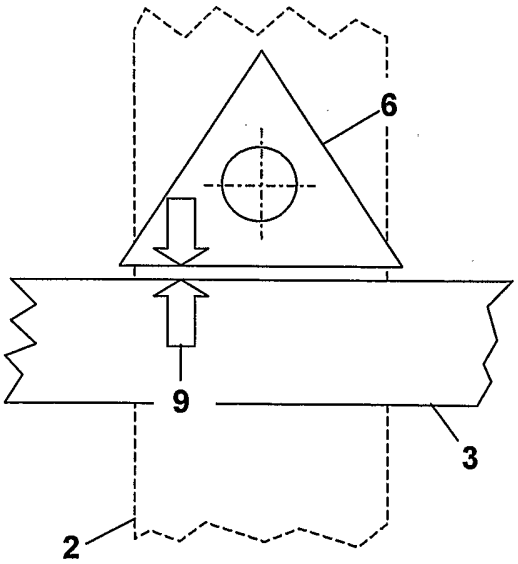

Figure 12

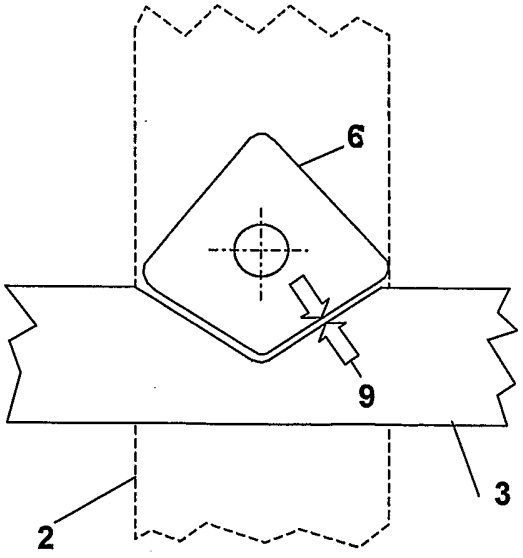

Figure 13

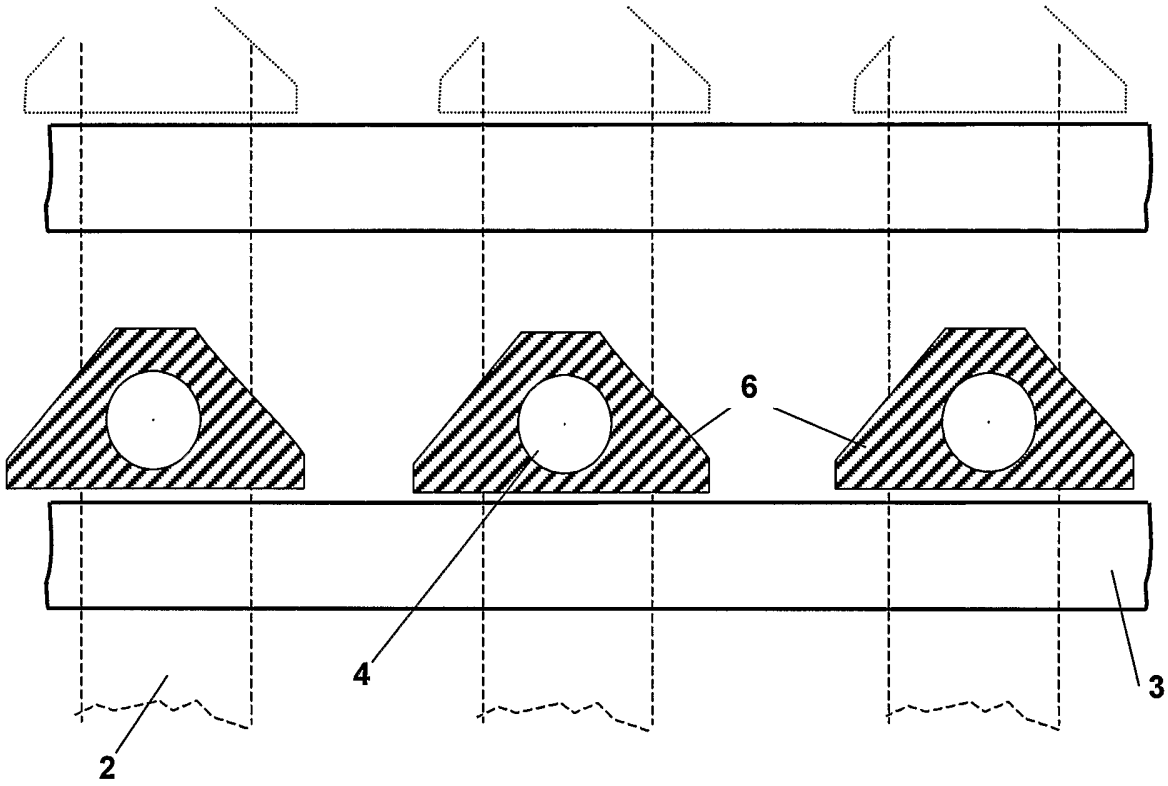

Figure 10

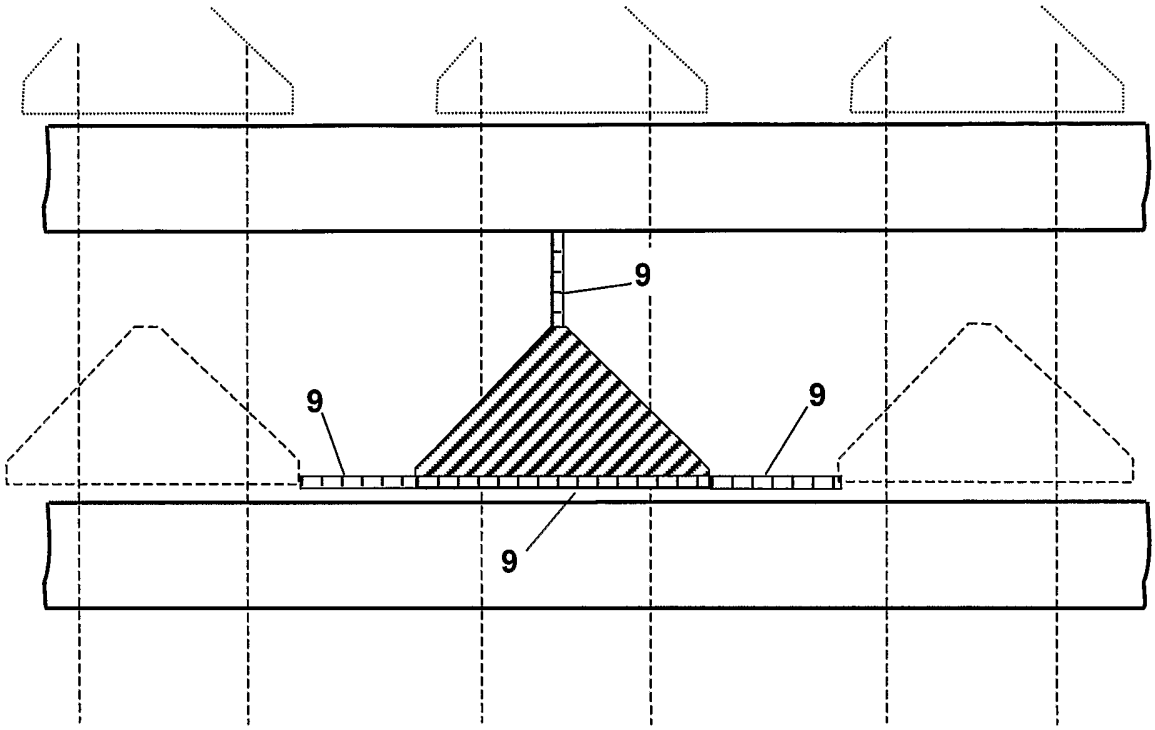

Figure 11a

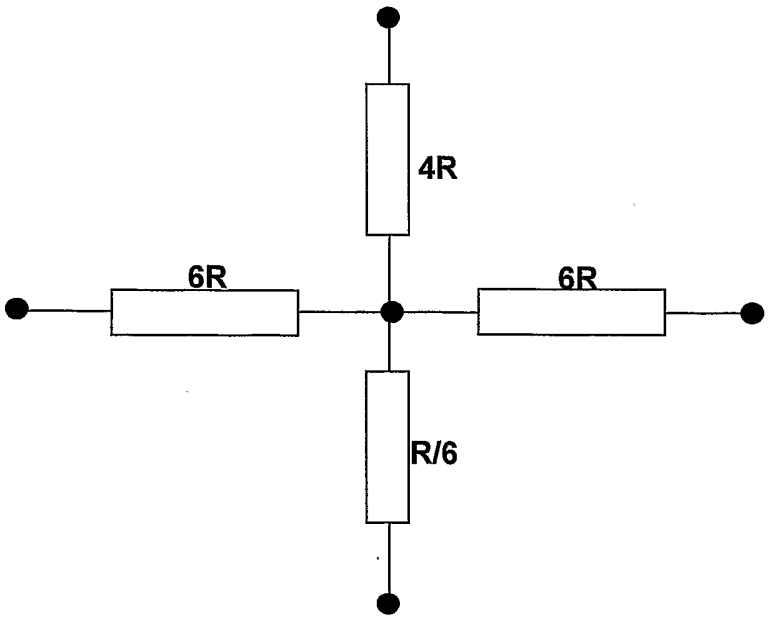

Figure 11b

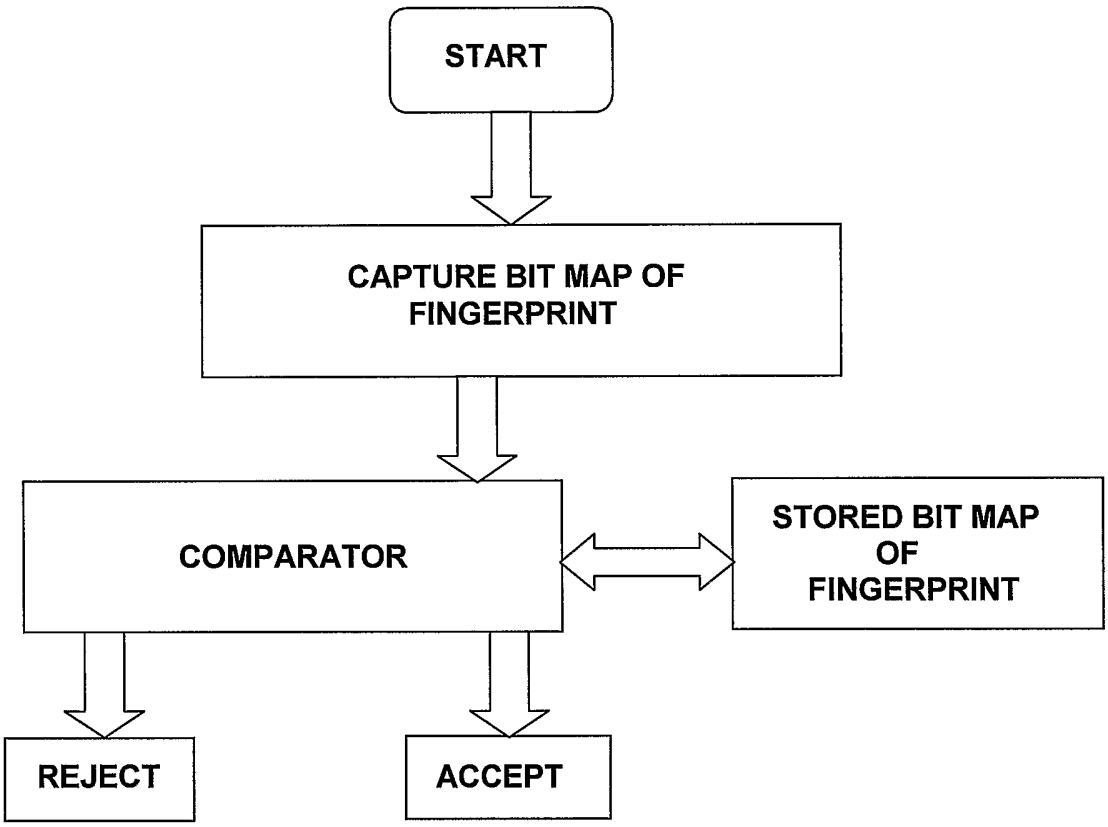
START
CAPTURE BIT MAP OF FINGERPRINT
COMPARATOR
STORED BIT MAP OF FINGERPRINT
REJECT
ACCEPT

Figure 14

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB2005/003640

A. CLASSIFICATION OF SUBJECT MATTER
G06K9/00

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)
G06K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 98/11499 A (PERSONAL BIOMETRIC ENCODERS LTD; ROSS, WILLIAM, LESLIE) 19 March 1998 (1998-03-19) cited in the application page 4, line 19 - page 5, line 23 page 7, lines 3-26 page 11, lines 3-12 claims 1,5,14,27,28	1-17
X	WO 98/11500 A (PERSONAL BIOMETRIC ENCODERS LTD; ROSS, WILLIAM, LESLIE) 19 March 1998 (1998-03-19) cited in the application page 8, line 17 - page 9, line 9 page 12, line 25 - page 13, line 21 figures 7d,10	1-17

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

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
2 January 2006	18/01/2006

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB2005/003640

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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Information on patent family members

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