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D E S C R I P T I O N



IMAGE READING APPARATUS

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Technical Field

The present invention relates to a reading apparatus for reading a target object having a fine recessed or projecting pattern such as a fingerprint.

Background Art

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A conventional reading apparatus for reading a target object having a fine recessed or projecting pattern such as a fingertip has a structure like the one disclosed in USP No. 5,635,723 in which a two-dimensional photosensor is formed on a surface light source, and an optical component is formed on the two-dimensional photosensor. The invention of this reference detects changes in capacitance when a finger touches the optical component, and sequentially detects the detection results as electric charges, which are generated by photosensors arranged two-dimensionally and correspond to an incident light quantity from the optical component. In this structure, many light guide fibers are mounted on the two-dimensional photosensor without any optical lens, so that the whole apparatus can be downsized. Recently, another type of structure is examined in which an optical component formed from many light guide fibers is made thinner into a light

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scattering film or in which the upper surface of a
photosensor is covered with a transparent resin layer
having an uneven surface without any optical component.
For example, this type of structure is disclosed in U.S.
5 Patent Application No. 09/128,237 (Aug. 3, 1998) filed
by the present applicant.

In this reading apparatus, a finger directly
touches the upper surface of the two-dimensional
photosensor. If the finger is charged with static
10 electricity, this static electricity may cause a
malfunction of the two-dimensional photosensor or may
damage it in the worst case. If the pattern of a
fingerprint is copied onto a sheet by any means, since
the reading apparatus is not equipped with any means
15 for discriminating a sheet from a human finger, the
apparatus determines matching so long as the pattern is
the same. When this fingerprint matching is set as a
log-in condition for a personal computer or a host
computer of a network, the computer cannot be reliably
20 protected from a third person's access.

Disclosure of Invention

It is the first object of the present invention
to provide a reading apparatus which prevents a
photosensor from malfunction or damage by static
25 electricity. It is the second object of the present
invention to provide a reading apparatus capable of
ensuring the reliability by reading a pattern after,

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e.g., detecting whether the object is man.

According to the present invention, there is provided a reading apparatus for reading a target object having a shadow pattern, comprising a light source, a photosensor device having a plurality of photosensors formed on the light source, and a transparent conductive layer formed on the photosensor device.

According to the present invention, there is provided a reading apparatus for reading a target object having a shadow pattern, comprising: a light source; a photosensor device having a plurality of photosensors formed on the light source; at least one pair of transparent conductive layers formed on the photosensor device to detect a resistance of a target object; and an operator for, when a value of the resistance of the target object, which is detected falls within the predetermined value, starting reading the target object.

Additional objects and advantages of the invention will be set forth in the description which follows, and in part will be obvious from the description, or may be learned by practice of the invention. The objects and advantages of the invention may be realized and obtained by means of the instrumentalities and combinations particularly pointed out hereinafter.

Brief Description of Drawings

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate presently preferred embodiments of the invention, and together with the general description given above and the detailed description of the preferred embodiments given below, serve to explain the principles of the invention.

FIG. 1 is an enlarged sectional view of part of a fingerprint reading apparatus according to the first embodiment of the present invention;

FIG. 2 is a plan view of part of the fingerprint reading apparatus shown in FIG. 1;

FIG. 3 is a block diagram of the fingerprint reading apparatus shown in FIG. 1;

FIG. 4 is a circuit diagram of a photosensor section and photosensor driver shown in FIG. 3;

FIG. 5 is an equivalent circuit diagram of a single photosensor shown in FIG. 1;

FIGS. 6A to 6D are circuit diagrams for explaining changes in voltage applied to each electrode of the photosensor shown in FIG. 5 and state of the photosensor;

FIG. 7 is a plan view of part of a fingerprint reading apparatus according to the second embodiment of the present invention;

FIG. 8 is a circuit diagram of part of the

fingerprint reading apparatus shown in FIG. 7;

FIG. 9 is a plan view of part of a fingerprint reading apparatus according to the third embodiment of the present invention;

5 FIG. 10 is a circuit diagram of part of the fingerprint reading apparatus shown in FIG. 9; and

FIG. 11 is a plan view showing a modification of the fingerprint reading apparatus shown in FIG. 9.

Best Mode of Carrying Out the Invention

10 (First Embodiment)

FIG. 1 is a sectional view of part of a reading apparatus according to the first embodiment of the present invention. This reading apparatus can read a target object in any form having a fine recessed or
15 projecting pattern. In the following embodiment, the reading apparatus will exemplify a fingerprint reading apparatus for reading a fingerprint. This fingerprint reading apparatus has a two-dimensional photosensor (photosensor device) 2 on a surface light source 1.

20 A transparent conductive layer 3 made of ITO or the like is formed on the two-dimensional photosensor 2. The surface light source 1 is formed of an electroluminescence or formed as an edge light type backlight used in a liquid crystal display device.

25 Although not shown, the edge light type backlight typically has a light-reflecting plate on the lower surface of a light guide plate, one or several point

light sources such as light-emitting diodes are disposed next to the light guide plate, and a surface of the point light source that does not correspond to the light guide plate is covered with a light-reflecting sheet. The transparent conductive layer 3 dissipates static electricity and is grounded in a given region (not shown). The transparent conductive layer 3 is formed by, e.g., deposition on the upper surface of an overcoat film 23 (to be described later) of the two-dimensional photosensor 2. The transparent conductive layer 3 is formed slightly larger than a square sensor region 4 of the two-dimensional photosensor 2 indicated by the one-dot chain line in FIG. 2. Note that the two-dot chain line in FIG. 2 represents a finger 5.

The two-dimensional photosensor 2 will be described. The two-dimensional photosensor 2 has a structure in which a plurality of photosensors 11 (only one photosensor is shown in FIG. 1) are arranged in a matrix. The two-dimensional photosensor 2 has a transparent substrate 12 made of an acrylic resin, glass or the like. A bottom gate electrode 13 serving as a light-shielding electrode made of chromium or aluminum is formed for each photosensor 11 on the upper surface of the transparent substrate 12. A light-transmitting bottom gate insulating film 14 made of silicon nitride is formed on the entire upper surface

of the bottom gate electrode 13 and the upper surface of the transparent substrate 12. A semiconductor layer 15 made of amorphous silicon is formed on an upper surface portion of the bottom gate insulating film 14 which corresponds to the bottom gate electrode 13.

n^+ -type silicon layers 16 and 17 are respectively formed on the two sides of the semiconductor layer 15 on the upper surface of the bottom gate insulating film 14. A light-transmitting blocking layer 18 made of

silicon nitride is formed on the upper surface of the semiconductor layer 15. Source and drain electrodes 19 and 20 as light-shielding electrodes made of chromium or aluminum are formed on the two sides of the upper surface of the blocking layer 18, the upper surfaces of the n^+ -type silicon layers 16 and 17, and the upper surface of the bottom gate insulating film 14. A

light-transmitting top gate insulating film 21 made of silicon nitride is formed on the entire upper surfaces of the source and drain electrodes 19 and 20 and the exposed surface of the blocking layer 18. A top gate

electrode 22 as a transparent electrode made of ITO or the like is formed on an upper surface portion of the top gate insulating film 21 which corresponds to the semiconductor layer 15. A light-transmitting overcoat

film 23 made of silicon nitride is formed on the entire upper surface of the top gate electrode 22 and the upper surface of the insulating film 21. In this

two-dimensional photosensor 2, when a light beam is incident at random from the lower surface side, one part of the light beam is shielded by the bottom gate electrode 13, and the other part of the light beam passes through the light-transmitting layers excluding the source and drain electrodes 19 and 20, so that the light beam is not directly incident on the semiconductor layer 15.

Operation of this fingerprint reading apparatus will be explained in short. A light beam emitted from the upper surface of the surface light source 1 passes through the light-transmitting portion of the two-dimensional photosensor 2 and the transparent conductive layer 3. The finger 5 (see FIG. 2) in contact with the transparent conductive layer 3 is irradiated with this transmitted light beam at random from the lower surface side. The light beam reflected by the surface of the finger 5 passes through the transparent conductive layer 3 and the neighboring top gate electrode 22 serving as a transparent electrode, and is incident on the incident surface (exposed surface) of the semiconductor layer 15 between the source and drain electrodes 19 and 20. In this case, portions corresponding to projections (ridges) of the skin surface of the finger 5 in contact with the surface of the transparent conductive layer 3 become bright. Portions corresponding to recesses (valleys)

of the skin surface of the finger 5 become dark. As a result, an image whose contrast is optically emphasized in accordance with the ridges and valleys of the skin surface of the finger 5 can be obtained to read the
5 fingerprint of the finger 5.

In this fingerprint reading apparatus, since the transparent conductive layer 3 is formed and grounded on the two-dimensional photosensor 2, static electricity discharged from the finger 5 in contact
10 with the transparent conductive layer 3 on the two-dimensional photosensor 2 can dissipate via the transparent conductive layer 3. This can prevent the two-dimensional photosensor 2 from malfunction or damage by this static electricity.

15 FIG. 3 is a block diagram showing part of the fingerprint reading apparatus. This fingerprint reading apparatus comprises a photosensor section 31, a photosensor driver 32, a CTR (controller) 33, a clock generation section 34, an A/D (analog-to-digital)
20 conversion section 35, an S/P (serial-to-parallel) conversion section 36, a standard pattern memory 37, a collation section 38, a determination section 39, and the like.

As shown in FIG. 4, the photosensor section 31 has
25 a structure in which the photosensors 11 constituting the two-dimensional photosensor shown in FIG. 1 are arranged in a matrix. As shown in FIG. 1, the

photosensor has a bottom gate type transistor formed by the bottom gate electrode (BG) 13, semiconductor layer 15, source electrode (S) 19, drain electrode (D) 20, and the like, and a top gate type transistor formed by the top gate electrode (TG) 22, semiconductor layer 15, source electrode (S) 19, drain electrode (D) 20, and the like. That is, the photosensor is constituted by a photoelectric conversion thin-film transistor in which the bottom gate electrode (BG) 13 and top gate electrode (TG) 22 are respectively formed below and above the semiconductor layer 15. The equivalent circuit of this transistor is shown in FIG. 5.

Referring back to FIG. 4, the bottom gate electrode (BG) of each photosensor 11 is connected to one of a plurality of bottom electrode lines 41 extending in the row direction. The drain electrode (D) of each photosensor 11 is connected to one of a plurality of signal lines 42 extending in the column direction. The top gate electrode (TG) of each photosensor 11 is connected to one of a plurality of top electrode lines 43 extending in the row direction. The source electrode (S) of each photosensor 11 is grounded.

As shown in FIG. 4, the photosensor driver 32 shown in FIG. 3 comprises a bottom address decoder 44 serving as a vertical scanning circuit connected to the bottom electrode lines 41, a column switch 45 serving

as a horizontal scanning circuit connected to the signal lines 42, and a top address decoder 46 connected to the top electrodes 43. The bottom address decoder 44 applies a bottom gate voltage V_{BG} to the bottom gate electrodes (BG) of the photosensors 11 aligned on each row via a corresponding bottom electrode line 41. The top address decoder 46 applies a top gate voltage V_{TG} to the top gate electrodes (TG) of the photosensors 11 aligned on each row via a corresponding top electrode line 43.

The column switch 45 receives a drain voltage V_{DD} via a precharge transistor 47. The column switch 45 outputs an output signal V_{OUT} via a buffer 48. Every time the precharge transistor 47 is turned on upon reception of a precharge voltage V_{PC} , the column switch 45 outputs an output from each photosensor 11 connected to a signal line 42 as the output signal V_{OUT} via the buffer 48.

The clock generation section 34 shown in FIG. 3 includes an oscillation circuit and a frequency division circuit, and outputs clock and reset signals having predetermined frequencies to the CTR 33. The CTR 33 outputs the bottom and top gate voltages V_{BG} and V_{TG} as sense and reset signals to the photosensor driver 32 on the basis of the clock and reset signals input from the clock generation section 34, and outputs the precharge and drain voltages V_{PC} and V_{DD} to the

precharge transistor 47 shown in FIG. 4.

The A/D conversion section 35 shown in FIG. 3

A/D-converts the output signal V_{out} output from the
photosensor section 31 via the photosensor driver 32

5 (i.e., the column switch 45 shown in FIG. 4). The S/P
conversion section 36 converts the serial output

signals from the A/D conversion section 35 into

parallel output signals. Fingerprint image signals

corresponding to fingerprints of a plurality of

10 specific persons are stored as standard pattern signals
in the standard pattern memory 37 in advance. The

collation section 38 collates an output signal from the
S/P conversion section 36 with standard pattern signals
sequentially read out from the standard pattern memory

15 37, and outputs each collation signal to the deter-
mination section 39. The determination section 39

determines based on the collation signal from the

collation section 38 whether a fingerprint image signal
corresponding to the output signal V_{OUT} from the

20 photosensor section 31 matches the standard pattern

signal of a specific person stored in the standard
pattern memory 37 in advance, and outputs a determina-
tion signal.

Operation of the photosensor 11 will be described

25 with reference to FIGS. 5 and 1. When a positive

voltage (e.g., +10V) is applied to the bottom gate

electrode (BG) while a positive voltage (e.g., +5V) is

kept applied between the source electrode (S) and drain electrode (D) of the photosensor 11, a channel is formed in the semiconductor layer 15 to flow a drain current. In this state, when a negative voltage (e.g.,
5 -20V) having a level enough to make the channel formed by the electric field of the bottom gate electrode (BG) disappear is applied to the top gate electrode (TG), the electric field from the top gate electrode (TG) acts in a direction to eliminate the channel formed by
10 the electric field of the bottom gate electrode (GB), thereby pinching off the channel. At this time, when the semiconductor layer 15 is irradiated with a light beam from the top gate electrode (TG) side, the electron-hole pairs are induced in the semiconductor
15 layer 15 on the top gate electrode (TG) side. The electron-hole pairs are accumulated in the channel region of the semiconductor layer 15 to cancel the electric field of the top gate electrode (TG). A channel is then formed in the semiconductor layer 15 to
20 flow the drain current. This drain current changes in accordance with a change in incident light amount of the semiconductor layer 15. As described above, in this two-dimensional photosensor 2, the electric field from the top gate electrode (TG) acts in a direction to
25 prevent channel formation using the electric field of the bottom gate electrode (BG) to pinch off the channel. The drain current obtained when no light beam is

incident can be greatly reduced, e.g., to about 10^{-14} A. The difference between the drain current obtained when no light beam is incident and the drain current obtained when a light beam is incident can be made sufficiently large. The amplification factor of the bottom gate type transistor at this time can change in accordance with a change in incident light amount to increase the S/N ratio.

In the two-dimensional photosensor 2, one photosensor 11 can have both a sensor function and a selection transistor function. These functions will be briefly described below. When a voltage of, e.g., 0V is applied to the top gate electrode (TG) while a positive voltage (+10V) is kept applied to the bottom gate electrode (BG), holes are discharged from the trap level between the semiconductor layer 15 and the top gate insulating film 21 to allow refresh or reset operation. More specifically, when the reading apparatus is continuously used, the trap level between the semiconductor layer 15 and the top gate insulating film 21 is buried with the holes generated upon irradiation and the holes injected from the drain electrode (D). A channel resistance set while no light beam is incident is reduced, and the drain current obtained when no light beam is incident increases. Therefore, the top gate electrode (TG) is set at 0V to discharge these holes to allow reset operation.

When the positive voltage is not applied to the bottom gate electrode (BG), no channel is formed in the bottom gate type transistor. Even if a light beam is incident, no drain current flows to set the nonselected state. More specifically, by controlling the voltage applied to the bottom gate electrode (BG), the selected state and the nonselected state can be controlled. In the nonselected state, when 0V is applied to the top gate electrode (TG), the holes can be discharged from the trap level between the semiconductor layer 15 and the top gate insulating film 21 to allow reset operation in the same manner as described above.

As a result, as shown in FIGS. 6A to 6D, for example, the top gate voltage V_{TG} is controlled to 0V and -20V to allow control of the sensed state and the reset state. The bottom gate voltage V_{BG} is controlled to 0V and +10V to allow control of the selected state and the nonselected state. That is, by controlling the top gate voltage V_{TG} and the bottom gate voltage V_{BG} , one photosensor 11 can have both the function serving as a photosensor and the function serving as the selection transistor.

Operation of the two-dimensional photosensor 2 will be explained with reference to FIGS. 3 and 4. The clock generation section 34 outputs clock and reset signals having predetermined frequencies to the CTR 33. The CTR 33 outputs the bottom and top gate voltages V_{BG}

and V_{TG} as sense and reset signals to the photosensor driver 32 on the basis of the clock and reset signals from the clock generation section 34, and outputs the precharge and drain voltages V_{PC} and V_{DD} to the
5 precharge transistor 47.

Photosensors 11 on the first row are reset by setting the bottom and top gate voltages V_{BG} and V_{TG} to 0V. During this resetting, the precharge voltage V_{PC} is applied to the precharge transistor 47 for a
10 predetermined time, and the drain voltage V_{DD} (+5V) is applied to all the signal lines 42 to precharge the photosensors 11. The top gate voltage V_{TG} is set to -20V to change the photosensors 11 to a sense state. The bottom gate voltage V_{BG} is set to +10V to change
15 the photosensors 11 to a selected state. An output signal V_{OUT} from each photosensor 11 changes to 0V or remains at +5V depending on the incident light quantity (light quantity). The output signal V_{OUT} from each photosensor 11 is output from the column switch 45 via
20 the buffer 48. The same operation is performed for photosensors 11 on the second to final rows. A description of the subsequent operation will be omitted.
(Second Embodiment)

FIG. 7 is a plan view showing part of a
25 fingerprint reading apparatus according to the second embodiment of the present invention. In this fingerprint reading apparatus, a pair of transparent

conductive films 3A and 3B in a comb tooth shape are formed within and around a sensor region 4 on the upper surface of an overcoat film 23 of a two-dimensional photosensor 2. When a finger 5 touches the two-dimensional photosensor 2 including the pair of transparent conductive films 3A and 3B, the pair of transparent conductive films 3A and 3B detect the resistance of the touching finger 5 and start fingerprint reading operation by this detection signal (to be described later). The pair of transparent conductive films 3A and 3B can also have an antistatic function. The pair of transparent conductive films 3A and 3B are formed into a comb tooth shape in order to detect a relatively small resistance of the finger 5 with high sensitivity.

FIG. 8 shows part of the circuit of the fingerprint reading apparatus. In FIG. 8, the same reference numerals as in FIG. 4 denote the same parts, and a description thereof will be properly omitted. One transparent conductive film 3A is connected via a resistor 51 to a CTR 33 (see FIG. 3) for outputting the drain voltage V_{DD} , whereas the other transparent conductive film 3B is grounded. The CTR 33 is connected between one transparent conductive film 3A and the resistor 51 via an inverter 52. The CTR 33 outputs a switching signal to a switch controller 53 upon reception of an H-level signal from the inverter

52. The switch controller 53 outputs a switch control signal to a switch 54 upon reception of the switching signal from the CTR 33. The switch 54 is a normally open switch formed between a column switch 45 and a precharge transistor 47.

In the fingerprint reading apparatus, when the finger 5 touches the two-dimensional photosensor 2 including the pair of transparent conductive films 3A and 3B, a resistance corresponding to a touch portion of the finger 5 is generated between the pair of transparent conductive films 3A and 3B to decrease the potential between the transparent conductive film 3A and the resistor 51 to a potential divided by the resistor 51 and the resistance value of the finger.

The input of the inverter 52 falls from H level to L level to change the output of the inverter 52 to H level, and this H-level signal is output to the CTR 33. The CTR 33 outputs a switching signal to the switch controller 53 upon reception of the H-level signal from the inverter 52. Upon reception of the switching signal from the CTR 33, the switch controller 53 outputs a switch control signal to the switch 54 to close the switch 54. Then, the column switch 45 is connected to the precharge transistor 47 via the switch 54 to set the same state as shown in FIG. 4 and start fingerprint reading operation.

As described above, in the fingerprint reading

apparatus, when the finger 5 touches the two-dimensional photosensor 2 including the pair of transparent conductive films 3A and 3B, the resistance of the touching finger 5 is detected to start fingerprint reading operation by this detection signal. Fingerprint reading operation can start automatically, conveniently. Since the other transparent conductive film 3B applied to most of the sensor region 4 of the two-dimensional photosensor 2 is grounded, as shown in FIG. 7, the antistatic function is enhanced. Note that when, for example, a copying sheet on which a fingerprint image of the finger 5 is copied is placed on the two-dimensional photosensor 2 including the pair of transparent conductive films 3A and 3B, no resistance is detected by the pair of transparent conductive films 3A and 3B because the copying sheet is insulated, and thus illicit use by the copying sheet can be prevented.

(Third Embodiment)

FIG. 9 is a plan view of part of a fingerprint reading apparatus according to the third embodiment of the present invention. In this fingerprint reading apparatus, pairs of transparent conductive films 3A and 3B in a comb tooth shape are respectively formed on the four corners of a square sensor region 4 on the upper surface of an overcoat film 23 of a two-dimensional photosensor 2. When a finger 5 touches the

two-dimensional photosensor 2 including the four pairs of transparent conductive films 3A and 3B, the four pairs of transparent conductive films 3A and 3B detect the resistance of the touching finger 5 and start fingerprint reading operation by this detection signal (to be described later). These pairs of transparent conductive films 3A and 3B can also have an antistatic function.

FIG. 10 shows main part of the circuit of the fingerprint reading apparatus. In FIG. 10, the same reference numerals as in FIG. 8 denote the same parts, and a description thereof will be properly omitted. The output sides of four inverters 52 corresponding to the four pairs of transparent conductive films 3A and 3B are connected to both a CTR 33 and the input side of one AND circuit 55. The output side of the AND circuit 55 is connected to the CTR 33.

In this fingerprint reading apparatus, when the finger 5 touches the two-dimensional photosensor 2 including the four pairs of transparent conductive films 3A and 3B, resistances corresponding to touch portions of the finger 5 are generated between the respective pairs of transparent conductive films 3A and 3B, the outputs from the four inverters 52 change from L-level signals to H-level signals, and these H-level signals are output to the AND circuit 55. When the AND circuit 55 receives the H-level signals from all the

four inverters 52, it outputs an AND signal to the CTR 33. In this case, the inverters 52 directly output the H-level signals to the CTR 33, but the CTR 33 ignores these H-level signals. Referring to FIG. 8, the CTR 33
5 outputs a switching signal to a switch controller 53 upon reception of the AND signal from the AND circuit 55. Upon reception of the switching signal from the CTR 33, the switch controller 53 outputs a switch control signal to a switch 54 to close the switch 54.
10 Then, a column switch 45 is connected to a precharge transistor 47 via the switch 54 to set the same state as shown in FIG. 4 and start fingerprint reading operation.

In this fingerprint reading apparatus, when the
15 touch position and state (whether the finger 5 touches appropriately) of the finger 5 with respect to the sensor region 4 of the two-dimensional photosensor 2 is erroneous, i.e., the finger 5 does not touch all the four pairs of transparent conductive films 3A and 3B,
20 the AND circuit 55 outputs no AND signal. In this case, the finger 5 touches one to three pairs of transparent conductive films 3A and 3B out of the four pairs of transparent conductive films 3A and 3B, and inverters 52 corresponding to the pairs of transparent conductive
25 films 3A and 3B touched by the finger 5 output H-level signals to the CTR 33. The CTR 33 outputs a finger touch error signal to a controller (not shown) on the

basis of the absence of the AND signal from the AND circuit 55 and the presence of the H-level signals from the inverters 52. The controller informs the operator of the erroneous touch position or state of the finger 5 with respect to the sensor region 4 of the two-dimensional photosensor 2 by any informing means such as a display "please place your finger again" or voice. (Modification of Third Embodiment)

This fingerprint reading apparatus can exhibit an antistatic function because the other transparent conductive film 3B of each pair is grounded as shown in FIG. 10. In the third embodiment, however, the central portion in the sensor region 4 is less resistant to static electricity because the pairs of transparent conductive films 3A and 3B are respectively formed at the four corners of the square sensor region 4 on the two-dimensional photosensor 2, as shown in FIG. 9. Therefore, for example, an electrostatic dissipation transparent conductive film 3C in an almost cross shape may be formed at the central portion in the sensor region 4, as shown in FIG. 11.

Note that in the fingerprint reading apparatus in FIG. 1, the transparent substrate 12 is placed on the surface light source 1, and the photosensor section 31 having photoelectric conversion thin-film transistors is formed on the transparent substrate 12. Alternatively, the transparent substrate 12 may be omitted,

and the photosensor section 31 having photoelectric conversion thin-film transistors may be directly formed on a light guide plate constituting the surface light source 1. Each photosensor is not limited to the double gate type photoelectric conversion thin-film transistor described in the above embodiments, and may be a single gate type thin-film transistor or diode type thin-film transistor.

As has been described above, according to the present invention, since the transparent conductive layer formed on the photosensor device has an electrostatic dissipation function, even if, e.g., a finger in contact with the transparent conductive layer on the photosensor device is charged with static electricity, this static electricity can dissipate via the transparent conductive layer. The photosensor device can be prevented from malfunction or damage by the static electricity. In addition, a pair of transparent conductive layers are formed apart from each other. The resistance value of a target object placed between the conductive layers is measured to determine whether the resistance value falls within a predetermined range. Only when collation is attained, collation starts. Collation using a copy can be avoided to improve the reliability.

Additional advantages and modifications will readily occur to those skilled in the art. Therefore,

the invention in its broader aspects is not limited to
the specific details and representative embodiments
shown and described herein. Accordingly, various
modifications may be made without departing from the
5 spirit or scope of the general inventive concept as
defined by the appended claims and their equivalents.

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C L A I M S

1. A reading apparatus for reading a target object having a shadow pattern, comprising:

a light source;

5 a photosensor device having a plurality of photosensors formed on said light source; and

a transparent conductive layer formed on said photosensor device.

10 2. A reading apparatus according to claim 1, wherein said photosensor device comprises a two-dimensional photosensor formed by two-dimensionally arranging photosensors.

3. A reading apparatus according to claim 1, wherein said transparent conductive layer dissipates
15 static electricity.

4. A reading apparatus according to claim 1, wherein said transparent conductive layer comprises a pair of transparent conductive layers separated from each other, and when the target object simultaneously
20 touches said pair of transparent conductive layers, said pair of transparent conductive layers detect a resistance of the target object.

5. A reading apparatus according to claim 4, further comprising detection means for detecting
25 whether a resistance value of the target object falls within a predetermined value, and means for starting reading the target object when the resistance value

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falls within the predetermined value.

6. A reading apparatus according to claim 1,
wherein said transparent conductive layer comprises
pairs of transparent conductive layer portions formed
5 at a plurality of peripheral portions in a sensor
region of said photosensor device.

7. A reading apparatus according to claim 6,
further comprising detection means for, when the target
object simultaneously touches said pairs of transparent
10 conductive layers, detecting whether resistance values
at a plurality of touch portions of the target object
fall within a predetermined value, and means for
starting reading the target object when all detection
results fall within the predetermined value.

15 8. A reading apparatus according to claim 6,
wherein said transparent conductive layer comprises
pairs of transparent conductive layer portions formed
at a plurality of peripheral portions in the sensor
region of said photosensor device, and an electrostatic
20 dissipation transparent conductive layer formed at a
central portion in the sensor region of said
photosensor device.

9. A reading apparatus for reading a target
object having a shadow pattern, comprising:

25 a light source;

a photosensor device having a plurality of
photosensors formed on said light source;

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at least one pair of transparent conductive layers formed on said photosensor device to detect a resistance of a target object; and

5 an operator for, when a value of said resistance of the target object, which is detected falls within the predetermined value, starting reading the target object.

10 10. A reading apparatus according to claim 9, wherein one of said pair of transparent conductive layers is grounded.

15 11. A reading apparatus according to claim 9, wherein each photosensor of said photosensor device is a photoelectric conversion thin-film transistor in which a first gate electrode made of a light-shielding material is formed on the light source side, and a second gate electrode made of a light-transmitting material is formed on the transparent conductive layer side.