(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 390 848 A1**

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
30.11.2011 Bulletin 2011/48

(51) Int Cl.:
G07D 5/02 *(2006.01)*

(21) Application number: **11166244.1**

(22) Date of filing: **16.05.2011**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **25.05.2010 JP 2010119902**

(71) Applicant: **Asahi Seiko Co. Ltd.**
Minato-ku,
Tokyo 107-0062 (JP)

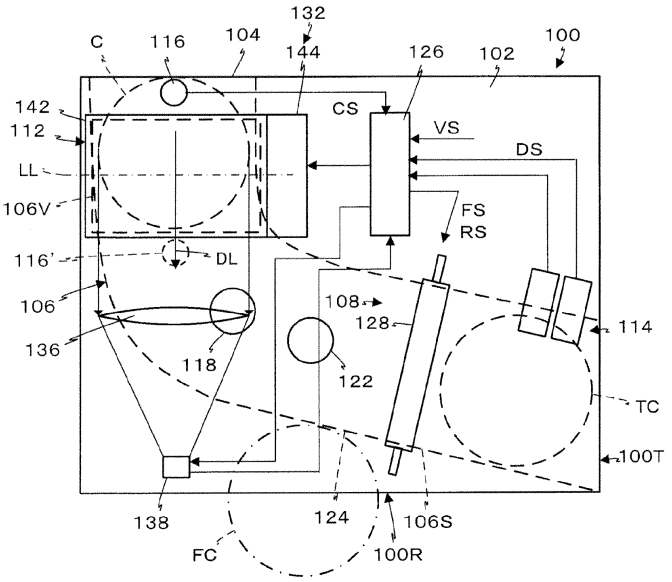
(72) Inventors:
- **Abe, Hiroshi**
  Saitama (JP)
- **Suzuki, Daishi**
  Saitama (JP)

(74) Representative: **Skone James, Robert Edmund**
Gill Jennings & Every LLP
The Broadgate Tower
20 Primrose Street
London EC2A 2ES (GB)

(54) Coin sorting device

(57) A coin which has been put into a coin slot (104) rolls along a coin passage (106). Light projected by a planar floodlight projector (132) positioned in parallel to the coin passage (106) transmits through a half mirror (134) toward the coin passage. A reflected light from the coin rolling along the coin passage is reflected by the half mirror (134), is guided in parallel to the coin passage (106), and reaches an image pickup element (138) via a converging lens (136). The image information picked up by the image pickup element (138) is compared with the reference information to determine the authenticity of the coin which has been put in. If the coin is determined to be a fake coin, a gate is not opened, and the coin is returned. If the coin is determined to be a true coin, the gate is opened, and the coin is accepted as a true coin.

Fig.1



EP 2 390 848 A1

Description

[0001] The present invention relates to a coin sorting device which is configured to pick up and digitize the pattern of the head or tail of a coin, make authenticity determination by comparing the digital information with the reference information, and sort out the coin into a true or fake coin based on the determination result.
Particularly, the present invention relates to a small coin sorting device capable of determining the authenticity of a coin based on the digital image information picked up by an image pickup device.
More particularly, the present invention relates to a small coin sorting device which can be also used in a slot gaming machine and determines the authenticity of a medal serving as a game medium based on the digital image information picked up by an image pickup device.
It is to be noted that, for the purpose of the present specification, "coins" conceptually include not only coins used as currency but also medals and tokens used in gaming machines.

[Background Art]

[0002] There is a coin recognition device known as a first conventional technique. According to the first conventional technique, while a coin is transversely and horizontally conveyed along a conveyance path, the pattern of the surface of the conveyed coin can be seen from the lower side of a slit-like window positioned in the lower side of the conveyance path. A half mirror is obliquely installed below the window, and a reading unit is positioned below the mirror. The reading unit is composed of a line image sensor such as a CCD and is configured to receive the specular reflection light from the coin surface through the half mirror. A light source is installed via a slit beside the half mirror. The light source is composed of a line light source such as a fluorescent lamp or a line filament lamp. The half mirror and the slit cause the irradiation direction from the light source to the coin surface to be on the axis perpendicular to the coin surface, and the reading unit is positioned on the perpendicular axis to receive the specular reflection light from the coin surface (for example, see Patent Document 1).
[0003] There is a coin sorting device known as a second conventional technique. According to the second conventional technique, while a medal, which has been put in, moves along a medal passage, determination is made on whether or not the medal is authorized based on the two-dimensional image information obtained by a CCD camera, and, if the medal is determined to be unauthorized, the moving direction of the medal is set to a medal return passage to reject the unauthorized medal. On the other hand, if the medal is determined to be authorized, the moving direction of the medal is set to a medal passage and the medal is detected by a medal slot sensor, so that a game is played using the authorized medal (for example, see Patent Document 2).

[Citation List]

[Patent Document]

[0004]

[Patent Document 1] Japanese Unexamined Patent Application Publication No. H07-210720 (FIGs. 1, 6, 10 and 18, Paragraph Numbers 0006 to 0060)
[Patent Document 2] Japanese Unexamined Patent Application Publication No. 2006-263281 (FIG. 3, 4 and 7, Paragraph Numbers 0028 to 0030)

[Summary of the Invention]

[Problems to be Solved by the Invention]

[0005] According to the first conventional technique, the coin reading unit is positioned on the extension perpendicular to the coin surface, and must be therefore separated far away from the coin path in consideration of a focal length, thereby causing a problem of the increased size of the device.
In other words, there have been some cases when the device could not be used in a vending machine or a gaming machine.
In order to solve this problem, it is conceivable to use a line sensor in the reading unit.
However, this solution cannot be readily adopted because, if the line sensor is used, the picked-up image of a line is recognized as a plane and subjected to determination, thereby necessitating a positive conveyance means for conveying the coin and causing the disadvantages in durability, size and power consumption.
[0006] The medal sorting device according to the second conventional technique is downsized by using a CCD camera to pick up the linear image of the medal; therefore the image of a part of the medal is picked up.
If the medal is rolling, the phase thereof shifts due to the rolling of the medal; therefore, even if the images are continuously picked up, the continuously picked-up partial images cannot be combined into the plane image of the coin, and authenticity determination has to be made based on the partial images, thereby posing a problem of poor determination accuracy.
In order to solve this problem, it is conceivable to position the CCD camera in the direction perpendicular to the plane of the coin to pick up the image of the entire medal.
However this solution increases the size of the device like in the first conventional technique, thereby making it difficult to install the device as a medal sorting machine in a gaming machine.
[0007] A first object of the present invention is to provide a small coin sorting device capable of making authenticity determination based on the picked-up image information.
A second object of the present invention is to provide a small coin sorting device capable of making authenticity

determination based on not only the image information but also the material and thickness information.
A third object of the present invention is to provide a low-price small coin sorting device capable of making authenticity determination based on further image information in addition to achieving the first and second objects thereof.

[Means for Solving the Problems]

[0008] In order to achieve these objects, the present invention provides:

a coin sorting device which is configured so that a two-dimensional image pickup device positioned in the opposite to a coin passage, in which a coin falls or rolls by gravity from a coin slot positioned at an upper part of the two-dimensional image pickup device, picks up a two-dimensional image of the rolling coin, a determination device makes authenticity determination of the picked-up image based on a reference image, and a diverting device sorts out the coin as a true or fake coin based on the determination; wherein the two-dimensional image pickup device includes a floodlight projector, a half mirror, a lens, and an image pickup element; the half mirror being positioned beside the coin passage at a position close to the coin slot, a longitudinal line of which is positioned in a direction orthogonal to a coin moving line in the opposed coin passage; the floodlight projector comprising a planar floodlight projector positioned to be adjacent to an opposite side to the coin passage with respect to the half mirror; and the lens and the image pickup element being positioned along the coin passage and below the half mirror; and wherein the determination device makes the authenticity determination by comparing the image information from the image pickup element with the reference image.
A second aspect of the invention is the coin sorting device according to the first aspect of the invention, wherein the planar floodlight projector comprises a plate-shaped light guide having a predetermined thickness and positioned in parallel to the coin passage, an LED projecting light from an end face of the light guide toward the interior thereof, a reflective sheet in close contact with the opposite side of the light guide to the half mirror, and a diffusion sheet in close contact with the side of the light guide facing the half mirror.

[Effects of the Invention]

[0009] According to the present configuration, the half mirror is positioned close to the coin slot, the planar floodlight projector is positioned to be adjacent to an opposite side to the coin passage with respect to the half mirror, and the lens which requires a focal length is positioned in the plane parallel to the coin passage. Therefore, even if a long focal length is used, the length will increase only in the direction parallel to the coin passage but not in the direction away from the coin passage.
Therefore, the above configuration reduces the size of the coin sorting device capable of making authenticity determination based on the image.

[0010] According to the second aspect of the invention, the planar floodlight projector positioned in the opposite side to the coin passage with respect to the half mirror planarly and uniformly projects light onto the coin passage, or namely the coin falling or rolling along the coin passage, via the half mirror.
The flat surface of the light guide is parallel to the coin passage, and the LED serving as an illuminant projects light onto the side end face of the light guide, which is to say that the LED is juxtaposed to the light guide.
The reflective sheet is in close contact with the opposite side of the light guide to the coin passage to direct any light, which may be leaked out from the light guide, toward the coin passage. Furthermore, the diffusion sheet, which is inclose contact with the side of the light guide facing the coin passage, uniformly diffuses the light into the incident surface, and, as a result, uniformly projects the light onto the coin passage via the half mirror within the range of the incident surface of the light guide.
The light reflected from the coin moving along the coin passage is reflected by the half mirror, moves in parallel to the coin passage, is converged by the lens positioned on the extension of the plane parallel to the coin passage, and then reaches the image pickup element, which picks up an image.
The floodlight projector comprises the planar floodlight projector, beside the end face of which the LED serving as an illuminant is positioned.
Furthermore, the lens which requires a focal length is positioned in the plane parallel to the coin passage, so that the size thereof can be suppressed to about the maximum distance from the coin passage to the half mirror, and accordingly the inventive device can be downsized.

[Brief Description of the Drawings]

[0011]

FIG. 1 is a front view of a coin sorting device according to an embodiment of the present invention.
FIG. 2 is a left side view of the coin sorting device according to the embodiment of the present invention.
FIG. 3 is a flow chart for illustrating the operation of the coin sorting device according to the embodiment of the present invention.

[Embodiment of the Present Invention]

[0012] The present invention is a coin sorting device which is configured so that a two-dimensional image pick-

up device positioned in the opposite to a coin passage, in which a coin falls or rolls by gravity from a coin slot positioned at an upper part of the two-dimensional image pickup device, picks up a two-dimensional image of the rolling coin, a determination device determines the picked-up image based on a reference image, and a diverting device sorts out the coin as a true or fake coin based on the determination; wherein the two-dimensional image pickup device includes a floodlight projector, a half mirror, a lens, and an image pickup element; the half mirror being positioned beside the coin passage at a position close to the coin slot, a longitudinal line of which is positioned in a direction orthogonal to a coin moving line in the opposed coin passage; the floodlight projector comprising a planar floodlight projector positioned to be adjacent to an opposite side to the coin passage with respect to the half mirror, the planar floodlight projector which comprises a plate-shaped light guide having a predetermined thickness and positioned in parallel to the coin passage, an LED projecting light from an end face of the light guide toward the interior thereof, a reflective sheet in close contact with the opposite side of the light guide to the half mirror, and a diffusion sheet in close contact with the side of the light guide facing the half mirror; and the lens and the image pickup element being positioned along the coin passage and below the half mirror; and wherein the determination device makes the authenticity determination by comparing the image information from the image pickup element with the reference image.

[Embodiment]

[0013] A coin sorting device 100 is incorporated in a vending machine, a gaming machine, a fare adjustment machine or the like, and has capabilities of determining the authenticity of a coin which has been put thereinto, and diverting a fake coin FC to a return slot 100R, or, if the coin is a true coin TC, determining the denomination thereof and guiding the true coin to an true coin slot 100T. The coin sorting device 100 according to the embodiment comprises a main unit 102, a coin slot 104, a coin passage 106, a gate 108, a two-dimensional image pickup device 112, a count sensor 114, a slot sensor 116, a thickness sensor 118, and a material sensor 122.

[0014] First, the main unit 102 will be explained.
The main unit 102 has such capabilities that the coin slot 104 and the coin passage 106 are formed and that the gate 108, the two-dimensional image pickup device 112, the count sensor 114, the slot sensor 116, the thickness sensor 118, and the material sensor 122 are installed.
The main unit 102 is of a rectangular box shape and is made of resin.

[0015] The coin slot 104 will be explained.
The coin slot 104 has a capability of receiving a coin, which has been put into a slot (not shown) of a vending machine or the like.
The coin slot 104 is formed aside in a left end of an upper surface of the main unit 102.
The coin slot 104 is a rectangular slit-shaped opening formed to have the vertical and horizontal dimensions slightly larger than the diameter and thickness of the used coin.

[0016] The coin passage 106 will be explained.
The coin passage 106 has a capability of guiding the falling or rolling coin C which has been put into the coin slot 104.
The coin passage 106 is formed in the main unit 102, and has a slit-shaped cross section which is approximately the same as that of the coin slot 104, and a front shape comprising a vertical coin passage 106V vertically extending from the coin slot 104 and, in the downstream thereof, a slanted coin passage 106S slanted obliquely downward to the left as shown in FIG. 1.
Therefore, the coin C put into the coin slot 104 vertically falls along the vertical coin passage 106V, is then guided to the right side by a guide rail 124, and rolls on the guide rail 124 to move in the slanted coin passage 106S.

[0017] The gate 108 will be explained.
The gate 108 has a capability of rejecting the coin C from the coin passage 106 in accordance with a fake coin FC signal FS and a reject signal RJ from a control unit 126.
In other words, the gate 108 is a diverting device.
The gate 108 is a diverting plate 128 retractably positioned in the slanted coin passage 106S.
When the diverting plate 128 advances into the slanted coin passage 106S, the diverting plate causes the rolling coin C to deviate from the guide rail 124 and fall, thereby returning the coin to a return slot (not shown).
When the diverting plate 128 retracts from the slanted coin passage 106S, the coin C rolls on the guide rail 124 and passes through the gate 108.
The diverting plate 128 advances into the slanted coin passage 106S to cause the coin C rolling on the guide rail 124 to deviate from the guide rail 124 and fall, in accordance with the fake coin signal FS and the reject signal RS from the control unit 126.

[0018] The two-dimensional image pickup device 112 will be explained.
The two-dimensional image pickup device 112 has a capability of picking up a two-dimensional image of one surface of the coin C moving along the coin passage 106.
The two-dimensional image pickup device 112 comprises a floodlight projector 132, a half mirror 134, a converging lens 136, and an image pickup element 138.

[0019] First, the floodlight projector 132 will be explained.
The floodlight projector 132 has a capability of projecting light onto one surface of the coin C moving along the coin passage 106, via the half mirror 134.
The floodlight projector 132 according to the present invention is a planar floodlight projector 142.
The reason for using the planar floodlight projector 142 is that images can be picked up without any influence of shadow even when the rotation phase of the coin C shifts.
The planar floodlight projector 142 comprises an LED

144, a light guide 146, a reflective sheet 148, and a diffusion sheet 152.

[0020] Next, the LED 144 will be explained.

The LED 144 is an illuminant for projecting light onto the coin C.

A three-color LED is used as the LED 144, and visible white light is used for light projection.

However, a white LED may be used.

As shown in FIG. 1, the LED 144 is positioned to face a side end face of the light guide 146, and the LED can be therefore positioned in the plane parallel to the coin passage 106, saving installation space. The position of the LED 144 shown in FIG.

2 is illustrated for the sake of convenience.

[0021] Next, the light guide 146 will be explained.

According to the present embodiment, the light guide 146 is of the shape of a rectangular thin plate made of a resin in consideration of cost, and the surface thereof is positioned in parallel to the coin passage 106. The resin is transparent or, if a diffusion material is mixed, milky white. If the diffusion material is mixed, the diffusion sheet 152 will become unnecessary. The light guide 146 may be composed of a glass substrate.

According to the present embodiment, the light guide is opposed to a rectangular opening 154 provided in one side wall of the vertical coin passage 106V adjacent to the coin slot 104.

The opening 154 is formed to be wider than the diameter of the coin C, and is for obtaining the information about the diameter of the coin C in the horizontal direction. The opening is formed in such a manner that the vertical size thereof is slightly smaller than the diameter of the coin C. This is for the purposes of preventing the freely falling coin C from deviating from the coin passage 106, and of restricting the size of the half mirror 134 in the vertical direction to restrict the distance of the half mirror 134 obliquely positioned at an angle of 45 degrees with respect to the coin passage 106 and to eventually downsize the inventive device. However, if another escape preventing means is provided, the vertical size of the opening 154 may be increased to be larger than the diameter of the coin C.

[0022] Next, the reflective sheet 148 will be explained.

The reflective sheet 148 has capabilities of preventing light from diffusing toward the opposite side of the light guide 146 to the coin passage 106, and of reflecting the light toward the coin passage 106.

The reflective sheet 148 is in close contact with the opposite side of the light guide 146 to the coin passage 106. Instead of the sheet, a silver film may be vapor-deposited on the light guide 146.

[0023] Next, the diffusion sheet 152 will be explained.

The diffusion sheet 152 has a capability of uniformly diffusing into a plane the light projected from the surface of the light guide 146 facing the coin passage 106.

Therefore, the projected light from the LED 144, which is guided by the light guide 146 or reflected by the reflective sheet 148, is caused to have a uniform light amount over the entire plane by the diffusion sheet 152, and is projected onto the coin passage 106, and thus to the coin C.

The projected light from the diffusion sheet 152 is projected squarely with respect to the coin passage 106, or namely the coin C moving along the coin passage 106.

Squarely projecting the light prevents any optical shadow from being caused by irregularities on the surface of the coin.

The light guide 146, the reflective sheet 148, and the diffusion sheet 152 are so thin as to downsize the floodlight projector 132.

[0024] Next, the half mirror 134 will be explained.

The half mirror 134 according to the present invention has capabilities of reflecting some types of light and transmitting other types of light. Specifically, the half mirror has capabilities of transmitting the projected light from the floodlight projector 132 and reflecting the reflected light from the coin C.

In other words, the half mirror 134 projects the projected light from the floodlight projector 132 squarely with respect to the coin C in the coin passage 106, and reflects the reflected light from the coin C into the plane parallel to the coin passage 106.

According to the present embodiment, the half mirror 134 is a thin transparent resin on which chromium is vapor-deposited by plating, with consideration given to cost. However, a glass plate plated with chromium may be used.

The half mirror 134 is obliquely positioned beside the opening 154 at an angle of 45 degrees with respect to the plane of the coin passage 106, so that the far end of the half mirror from the coin passage 106 is positioned lower.

Specifically, the half mirror 134 is slanted at an angle of 45 degrees with respect to the coin passage 106 directly below the coin slot 104.

The longitudinal line LL of the half mirror 134 is positioned in the direction orthogonal to the moving line DL (which is a perpendicular line opposed to the vertical coin passage 106V) of the coin C in the coin passage 106 facing the half mirror.

[0025] The converging lens 136 will be explained.

The converging lens 136 has a capability of converging the reflected light from the half mirror 134 into a predetermined small range.

Because of the above described function, the converging lens 136 is a convex lens with a predetermined refractive index, which is positioned below the half mirror 134 positioned near to the coin slot 104 and in the middle of the height of the main unit 102, and which has a diameter similar to or smaller than that of the half mirror 134.

In order to reduce the cost and size of the inventive device, it is preferable that the shapes of the floodlight projector 132 and the like be devised to downsize the converging lens 136.

[0026] Next, the image pickup element 138 will be explained.
The image pickup element 138 has a capability of picking up an optical image converged by the converging lens 136.
The image pickup element 138 is positioned below the converging lens 136.
A CCD image sensor or CMOS image sensor since is used as the image pickup element 138 to downsize the inventive device.

[0027] The count sensor 114 will be explained.
The count sensor 114 has a capability of detecting the coin C passing through the gate 108.
The count sensor 114 is a photoelectric or magnetic sensor positioned at the end of the slanted coin passage 106S in the downstream of the gate 108. One or more of the count sensor(s) is provided.
In other words, the count sensor 114 outputs a detection signal DS of the coin C which is determined to be a true coin TC. Thus, the number of accepted true coins can be determined by counting the detection signals DS.

[0028] The slot sensor 116 will be explained.
The slot sensor 116 has a capability of detecting the coin C put into the coin slot 104.
The slot sensor 116 is positioned beside the coin passage 106 adjacent to the coin slot 104, and outputs a coin signal CS when detecting the distal end, or namely lower end, of the coin C.
A transmissive optical sensor or magnetic sensor can be used as the slot sensor 116.
The slot sensor 116 may be positioned directly below the two-dimensional image pickup device 112 as shown by a reference numeral 116' in FIG. 1. In this case, the two-dimensional image pickup device 112 can be positioned more closely to the coin slot 104. Then, based on the output of the detection signal CS of the coin C from the slot sensor 116', the floodlight projector 132 projects light and the image pickup element 138 picks up an image. Positioning the slot sensor in the position shown by a reference numeral 116' has the advantages of increasing the distance between the two-dimensional image pickup device 112 and the gate 108 and of increasing the time required for image determination.

[0029] Next, the thickness sensor 118 will be explained.
The thickness sensor 118 has a capability of detecting the thickness of the coin C rolling along the guide rail 124 in the coin passage 106.
The thickness sensor 118 has a conventionally publicly-known configuration which is, for example, composed of a pair of coils positioned in the opposite to the slanted coin passage 106S in the downstream of the two-dimensional image pickup device 112.
When the thickness sensor 118 is opposed to the coin C rolling along the slanted coin passage 106S, the output thereof is varied by the thickness of the coin C.
The varied output is compared with a reference value to determine whether or not the coin has an appropriate thickness.

[0030] Next, the material sensor 122 will be explained.
The material sensor 122 has a capability of detecting the material of the coin C rolling along the guide rail 124 in the coin passage 106.
The material sensor 122 has a conventionally publicly-known configuration which is, for example, composed of a pair of coils positioned in the opposite to the slanted coin passage 106S in the downstream of the two-dimensional image pickup device 112.
When the material sensor 122 is opposed to the coin C rolling along the slanted coin passage 106S, the output thereof is varied by the internal electromotive force of the metal constituting the coin C.
The varied output is compared with a reference value to determine whether or not the coin is made of an appropriate material.
Either of the thickness sensor 118 or the material sensor 132 may be positioned in the upstream.

[0031] Next, the control unit 126 will be explained.
The control unit 126 has capabilities of receiving the signals VS from the count sensor 114, the slot sensor 116, the image pickup element 138, the thickness sensor 118, the material sensor 122, and a control unit of a vending machine and controlling the floodlight projector 132, the image pickup element 138, and the gate 108 based on a predetermined program.
The control unit 126 is composed of, for example, a microcomputer.

[0032] Next, the operation of the present embodiment will be explained with reference to the flow chart of FIG. 3.
In step S1, determination is made of whether or not any coin signal CS has been output from the slot sensor 116.
If no coin signal CS has been output, step S1 is looped.
If any coin signal CS has been output from the slot sensor 116, the process proceeds to step S2.

[0033] In step S2, a projection command is output to the floodlight projector 132, and the process proceeds to step S3.
In the floodlight projector 132 which received the projection command, the LED 144 emits light.
The projected light from the LED 144 is projected through the side end face of the light guide 146 into the light guide 146, and then the light projected from the surface thereof facing the coin passage 106 and the light projected from the opposite surface thereof and reflected by the reflective sheet 148 move to the diffusion sheet 152.
The projected light from the light guide 146 is diffused into the diffusion sheet 152, from the entire surface of which the light is uniformly projected onto the coin passage 106.
The projected light from the diffusion sheet 152 transmits through the half mirror 134 and is projected onto the coin passage 106, specifically to the coin C moving (falling) along the vertical coin passage 106V.
The reflected light from the coin C is reflected in parallel to the coin passage 106 and downward by the half mirror 134.

This reflected light is converged by the converging lens 136 and enters into the image pickup element 138.

[0034] In step S3, determined is made of whether or not a predetermined period of time T1 has elapsed since detection by the slot sensor 116. If no predetermined period of time has elapsed, step S3 is looped. If the predetermined period of time has elapsed, the process proceeds to step S4.

The predetermined period of time is a period until the surface of the coin C, the distal end of which has been detected by the slot sensor 116, is positioned approximately at the center of the opening 154.

[0035] In step S4, an image is picked up by the image pickup element 138, and the process proceeds to step S5.

In step S4, the image is picked up of approximately the entire surface of the coin C moving along the coin passage 106.

[0036] In step S5, physical information from the thickness sensor 118 is obtained, and the process proceeds to step S6.

[0037] In step S6, physical information from the material sensor 122 is obtained, and the process proceeds to step S7.

[0038] In step S7, the picked-up image information from the image pickup element 138 is compared with the reference image information, and, if the coin is determined to be a true coin, the process proceeds to step S8.

If the coin is determined to be a fake coin FC, the process returns to step S1.

Then, the fake coin FC is blocked by the gate 108, and is caused to fall to the return opening 100R to be returned.

[0039] In step S8, the physical information from the thickness sensor 118 is compared with the reference information, and, if the coin is determined to be a true coin, the process proceeds to step S9.

If the coin is determined to be a fake coin FC, the process returns to step S1.

Then, the fake coin FC is blocked by the gate 108, and is caused to fall to the return opening 100R to be returned.

[0040] In step S9, the physical information from the material sensor 122 is compared with the reference information, and, if the coin is determined to be a true coin, the process proceeds to step S10.

If the coin is determined to be a fake coin FC, the process returns to step S1.

Then, the fake coin FC is blocked by the gate 108, and is caused to fall to the return opening 100R to be returned.

[0041] In step S10, the gate 108 is opened, and the process proceeds to step S11.

[0042] In step S11, determination is made of whether or not any detection signal DS from the count sensor 114 is sensed, and, if any detection signal DS is sensed, the process proceeds to step S12.

If no count signal DS is sensed, step S11 is looped.

[0043] In step S12, the gate 108 is closed, and the process proceeds to step S13.

Therefore, the true coin TC falls from the true coin slot 100T.

[0044] In step S13, the count of the coin C is incremented by one, and the process returns to step S1.

[0045] According to the present invention, the thickness sensor 118 and the material sensor 122 are not necessarily used.

Therefore, if it is acceptable to make authenticity determination only using the image picked up by the two-dimensional image pickup device 112, the thickness sensor 118 and the material sensor 122 will not have to be provided. For example, if the coin sorting device 100 is used in a gaming machine such as a slot machine, it may be acceptable to make authenticity determination only using the two-dimensional image pickup device 112.

Claims

1. A coin sorting device which is configured so that a two-dimensional image pickup device (112) positioned relative to a coin passage (106), in which a coin falls or rolls by gravity from a coin slot (104) positioned at an upper part of the two-dimensional image pickup device, picks up a two-dimensional image of the rolling coin (C), a determination device (126) makes authenticity determination of the picked-up image based on a reference image, and a diverting device (108) sorts out the coin as a true or fake coin based on the determination;
   wherein the two-dimensional image pickup device includes a floodlight projector (132), a half mirror (134), a lens (136), and an image pickup element (138);
   the half mirror being positioned beside the coin passage at a position close to the coin slot, a longitudinal line (LL) of which is positioned in a direction orthogonal to a coin moving line (DL) in the opposed coin passage;
   the floodlight projector comprising a planar floodlight projector (142) positioned to be adjacent to an opposite side to the coin passage with respect to the half mirror; and
   the lens and the image pickup element being positioned along the coin passage and below the half mirror; and
   wherein the determination device makes the authenticity determination by comparing the image information from the image pickup element with the reference image.

2. The coin sorting device according to claim 1, wherein the planar floodlight projector comprises a plate-shaped light guide (146) having a predetermined thickness and positioned in parallel to the coin passage, an LED (144) projecting light from an end face of the light guide toward the interior thereof, a reflective sheet (148) in close contact with the opposite side of the light guide to the half mirror, and a diffusion

sheet (152) in close contact with the side of the light guide facing the half mirror.

Fig.1

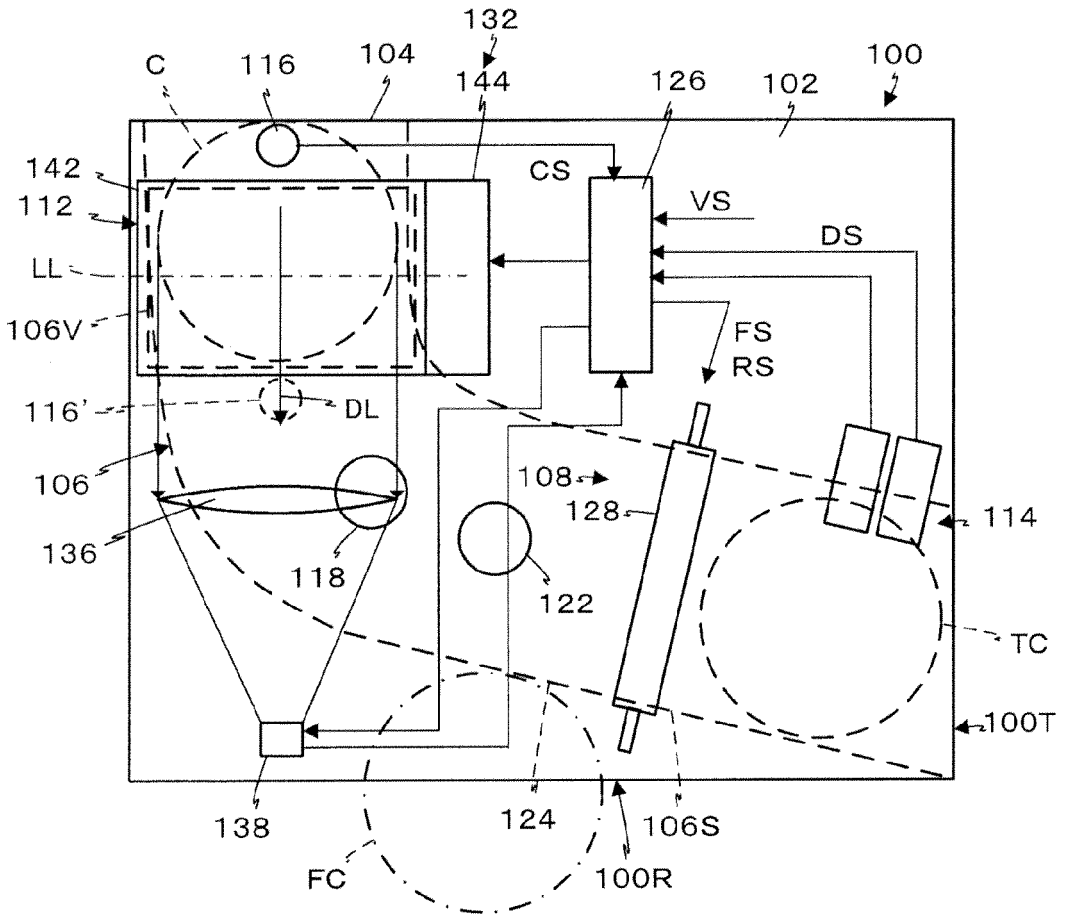

132
C
116
104
144
126
102
100
142
112
CS
VS
DS
LL
106V
FS
RS
116'
DL
106
108
128
114
136
118
122
TC
100T
138
124
106S
FC
100R

Fig.2

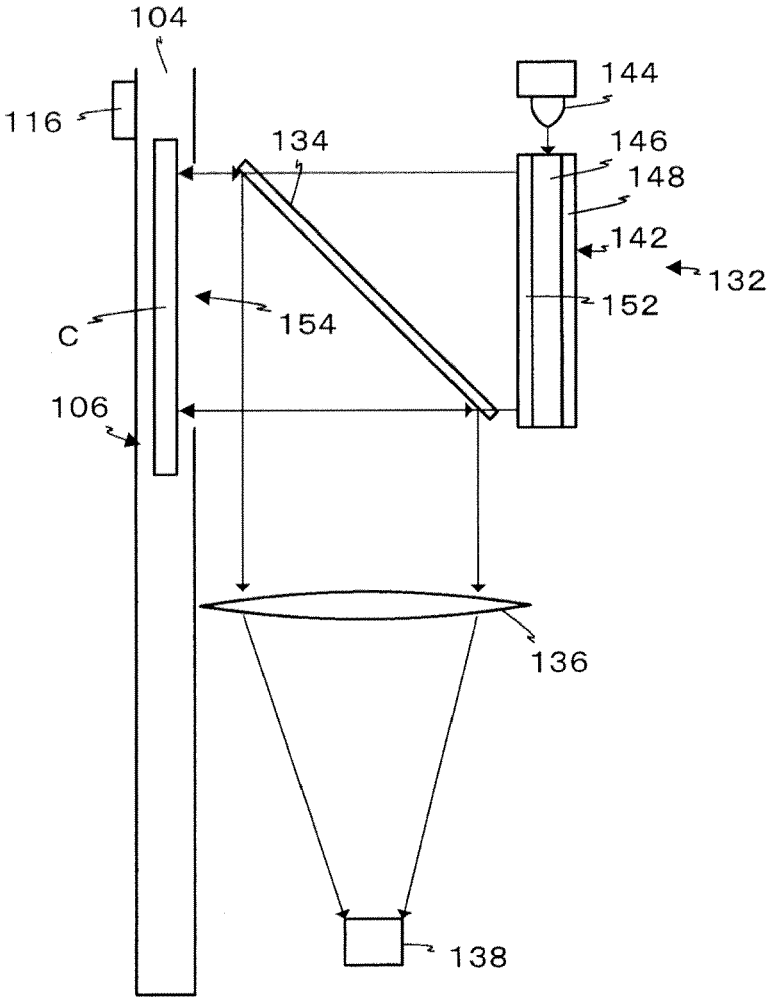
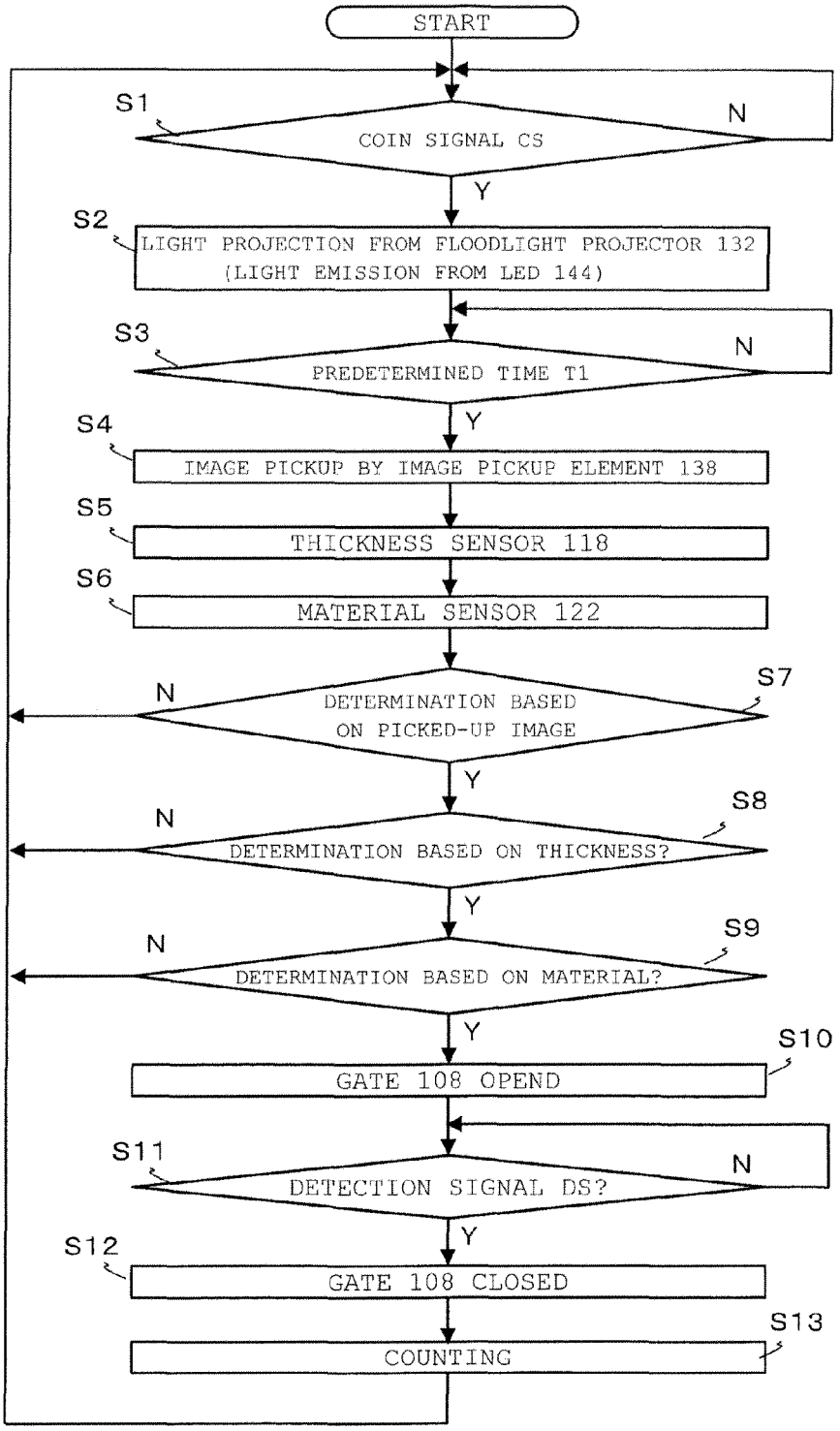


Fig.3


START
S1
COIN SIGNAL CS
N
Y
S2
LIGHT PROJECTION FROM FLOODLIGHT PROJECTOR 132
(LIGHT EMISSION FROM LED 144)
S3
PREDETERMINED TIME T1
N
Y
S4
IMAGE PICKUP BY IMAGE PICKUP ELEMENT 138
S5
THICKNESS SENSOR 118
S6
MATERIAL SENSOR 122
S7
DETERMINATION BASED
ON PICKED-UP IMAGE
N
Y
S8
DETERMINATION BASED ON THICKNESS?
N
Y
S9
DETERMINATION BASED ON MATERIAL?
N
Y
S10
GATE 108 OPEND
S11
DETECTION SIGNAL DS?
N
Y
S12
GATE 108 CLOSED
S13
COUNTING

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 11 16 6244

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	DE 201 14 010 U1 (WITKOWSKI GMBH AS [DE]) 25 October 2001 (2001-10-25) * abstract; claims; figure 2 * * page 3 - page 5 *	1,2	INV. G07D5/02
Y	DE 43 38 780 A1 (LAUREL BANK MACHINE CO [JP]) 19 May 1994 (1994-05-19) * abstract; claims; figure 6 * * column 8, line 36 - column 9, line 32 *	1,2	
A	DE 10 2006 017256 A1 (GIESECKE & DEVRIENT GMBH [DE]) 18 October 2007 (2007-10-18) * claims; figures 2,4,6,8 *	1,2	
A	DE 100 28 934 A1 (ZIMMERMANN GMBH & CO KG F [DE]) 10 January 2002 (2002-01-10) * abstract; claims 1-4; figure 1 * * paragraph [0017] - paragraph [0018] *	1,2	
A	DE 10 2005 028668 A1 (WALTER HANKE MECH WERKSTAETTEN [DE]) 4 January 2007 (2007-01-04) * abstract; claim 1; figures *	1,2	TECHNICAL FIELDS SEARCHED (IPC) G07D
A	JP 9 044641 A (SANKYO SEIKI SEISAKUSHO KK) 14 February 1997 (1997-02-14) * abstract *	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	13 September 2011	Rother, Stefan

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 11 16 6244

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

13-09-2011

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 20114010 U1	25-10-2001	NONE	
DE 4338780 A1	19-05-1994	GB 2272762 A	25-05-1994
		JP 6208613 A	26-07-1994
DE 102006017256 A1	18-10-2007	CN 101467182 A	24-06-2009
		ZA 200808483 A	28-10-2009
DE 10028934 A1	10-01-2002	DE 20023667 U1	12-05-2005
		EP 1096432 A2	02-05-2001
		NO 20005366 A	27-04-2001
		US 6552781 B1	22-04-2003
DE 102005028668 A1	04-01-2007	WO 2006133972 A1	21-12-2006
JP 9044641 A	14-02-1997	JP 3090594 B2	25-09-2000

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP H07210720 B **[0004]**
- JP 2006263281 A **[0004]**