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

(11) EP 2 249 315 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
19.11.2014 Bulletin 2014/47

(21) Application number: **10161039.2**

(22) Date of filing: **26.04.2010**

(51) Int Cl.:
G07D 7/16 *(2006.01)*

(54) **Medium thickness detection apparatus**

Vorrichtung zur Erkennung der Dicke eines Mediums

Appareil de détection d'épaisseur de support

(84) Designated Contracting States:
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 SE SI SK SM TR

(30) Priority: **27.04.2009 JP 2009107633**

(43) Date of publication of application:
10.11.2010 Bulletin 2010/45

(73) Proprietor: **Hitachi-Omron Terminal Solutions, Corp.**
Shinagawa-ku
Tokyo
141-0032 (JP)

(72) Inventor: **MAI, Jian Zhong**
Tokyo 100-8220 (JP)

(74) Representative: **MERH-IP**
Matias Erny Reichl Hoffmann
Paul-Heyse-Strasse 29
80336 München (DE)

(56) References cited:
EP-A1- 1 764 751
US-A1- 2001 035 329
US-A1- 2006 055 105

EP 2 249 315 B1

Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a medium thickness detection apparatus which detects thickness of media such as bills, securities, postage stamps which are utilized in transaction with automatic transaction facilities.

[0002] In general, in a bill handling apparatus configured inside the automatic transaction facilities which are installed at an automatic transaction corner of financial institutions and the like, discernment of a deteriorated state of circulating notes or counterfeit bill is important, and thus a bill validator is provided inside the bill handling apparatus.

[0003] In recent years, counterfeiting or altering technology of bills has become subtle, and altered notes are circulating, where various media such as bills, securities, postage stamps (hereafter referred to as leaves) are juggled with a micro tape, paper, seal or the like, which has thus required to correctly detect thickness characteristics of these altered notes to discern. For this purpose, it was required to enhance detection precision of the thickness detection apparatus. As one example thereof, there has been proposed a thickness detection apparatus for the leaves, for discerning whether the leaves are counterfeited or not, by thickness of the leaves (for example, refer to JP-A-2006-4206).

[0004] US 2006/055105 A1 describes a thickness detecting apparatus comprising a cylindrical displaceable rotary body and a cylindrical stationary rotary body which are opposed to each other. The apparatus detects a thickness of a sheet to be transferred.

[0005] US 2001/0035329 A1 describes a bill counter which has thickness detection units. Waveform outputs from the thickness detection units are compared with waveform data previously stored in a storage unit.

[0006] Detection technology disclosed in the thickness detection apparatus of the leaves is one where a protuberance adhered with a tape or the like is detected by elastic dislocation of a detection roller, and amount of this dislocation is detected by a dislocation detection sensor, so as to detect that a tape or the like is adhered, by installing in an opposing way standard rollers, and detection rollers which elastically dislocate in response to thickness of the leaves, and by sandwiching and carrying the leaves sheet by sheet between these rollers.

SUMMARY OF THE INVENTION

[0007] However, the above-described detection technology requires correct detection of all of a wide detection range of a paper surface. To attain this, it is necessary to align layout closely so as to eliminate clearance among said dislocation detection sensors by narrowing an arrangement space of the dislocation detection sensors, which are arranged in multiple in a carrying width direction, so as to eliminate a non-detection region of the leaves as less as possible, and.

[0008] In the case where the arrangement space of the dislocation detection sensors was made narrow, however, interference of a magnetic field of adjacent dislocation detection sensors themselves is induced, and the interference becomes the more stringent with the closer arrangement, resulting in inhibiting correct measurement. Accordingly, limitation is generated in making the arrangement space of the dislocation detection sensors close, and at present it is necessary to take a certain space apart in the arrangement space of the dislocation detection sensors, and thus it was impossible to increase precision of thickness detection of the leaves. Therefore, in the case where, for example, folded bills or damaged circulating notes such as cut bills were carried in, there was a problem that it was impossible to count number thereof correctly.

[0009] Accordingly, it is an object of the present invention to solve the problem and provide a medium thickness detection apparatus which is capable of detecting thickness of the media correctly, without interference of the magnetic field of the adjacent dislocation detection sensors, even by closely arranging a plurality of the dislocation detection sensors.

[0010] Further, the present invention is the object is solved according to the independent claim. The dependent claims describe preferred developments of the present invention comprising standard rollers; a detection roller group for having an elastic member built-in, allowing elastic deformation in a radius direction, as well as arranging a plurality of detection rollers in the same axis direction opposing to the standard rollers; a carrying unit for sandwiching and carrying a medium between both rollers, by rotation driving at least one side of said opposing standard rollers and the detection roller group; and/or a dislocation detection sensor group for detecting dislocation amount of the roller where said detection rollers displaced elastically, by installing in an opposing way the dislocation detection sensors by each of said detection rollers, and/or based on variation of a magnetic field, which is generated from a coil of each of said dislocation detection rollers installed in an opposing way, wherein it is configured by comprising: a switching unit for dividing a plurality of the dislocation detection sensors, aligned along an axis direction of said detection rollers, to non-adjacent groups which are classified by each of non-adjacent groups themselves which are not adjacent in said alignment direction, and/or switching said non-adjacent groups for acquiring said roller dislocation amount.

[0011] According to the present invention, it becomes possible to avoid interference of the magnetic field among the adjacent dislocation detection sensors, and thus, even by closely arranging the adjacent dislocation detection sensors, detection precision in high resolution can be obtained stably.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

Fig. 1 is a configuration drawing of the inside of a bill carrying apparatus.

Fig. 2 is a configuration drawing of the inside of a discerning part.

Fig. 3 is a front elevation view showing arrangement relation among detection rollers and dislocation detection sensors.

Fig. 4 is a front elevation view showing major parts of an example of a dislocation state of detection rollers.

Figs. 5A and 5B are drawings explaining a switched state of each channel by a non-adjacent group of dislocation detection sensors.

Fig. 6 is a perspective view showing a partial development of a substrate-integral-type dislocation detection sensor.

Fig. 7 is a plan view showing arrangement relation among detection rollers and dislocation detection sensors, arranged in a staggered state.

Fig. 8 is a block diagram of a control circuit of a thickness detection apparatus.

Fig. 9A is a time chart showing detection data in each channel in judging the number of bills, and Fig. 9B is a time chart showing a detection data to perform judgment of the sheet number of bills, by sum of each channel.

Fig. 10 is a time chart showing a detection data in detecting altered notes.

Fig. 11 is a drawing explaining a specific judgment state in detecting altered notes.

DESCRIPTION OF THE EMBODIMENT

[0013] Explanation will be given below on embodiments of the present invention, with reference to drawings. The drawings show, for example, an automatic telling machine (ATM) installed at financial institutions such as banks, and show embodiments with enhanced detection performance of thickness at the discerning part which is built-in said ATM.

EXAMPLES

[0014] Fig. 1 shows a bill carrying apparatus configured inside the ATM, which is one Example of the present invention, and explanation will be given in this Example on the case where bills were processed as an example of a medium.

[0015] In this bill carrying apparatus, 1 represents a temporal stock part for temporarily accumulating bills counted; 2 represents a discerning part for discerning money types, authenticity, orientation, and degree of damage of bills; 3a to 3d represent storage parts for accumulating bills by type; 4 represents a recovery part for storing the bills rejected by the discerning part 2; 5 represents an upper carrying route for carrying bills by looping a money entrance port 20, the discerning part 2, the temporal stock part 1, a money exit port 21 having a shutter, and a return port 22; 6 represents a lower carrying route for carrying bills from the upper carrying route 5 and via the upper part of the storage parts 3a to 3d and the recovery part 4, and again to the upper carrying route 5; 7 represents a money entrance port carrying route for carrying bills from the money entrance port 20 to the upper carrying route 5; 8 represents a money exit port carrying route for carrying bills from the upper carrying route 5 to the money exit port 21 having a shutter; 9 represents a return port carrying route for carrying bills from the upper carrying route 5 to the return port 22; 10 represents a temporal stock part storing and carrying route for carrying bills from the upper carrying route 5 to the temporal stock part 1; 11 represents a temporal stock part sending-out and carrying route for carrying bills from the temporal stock part 1 to the upper carrying route 5; 12a to 12d represent an storage part storing and carrying route for carrying bills from the lower carrying route 6 to the storage parts 3a to 3d; 13a to 13d represent an storage part sending-out and carrying route for carrying bills from the storage parts 3a to 3d to the lower carrying route 6; 14 represents a recovery part carrying route for carrying bills from the lower carrying route 6 to the recovery part 4; 15 represents a passing-through sensor for detecting passing-through of bills; 16 represents a gate for switching a direction for carrying bills; 17 represents a money entrance port bill detection sensor for detecting whether bills are present or not at the money entrance port 20; 18 represents a money exit port bill detection sensor for detecting whether bills are present or not at the money exit port 21, and 19 represents a return port bill detection sensor for detecting whether bills are present or not at the return port 22.

[0016] Fig. 2 is an outline drawing showing a major configuration of the discerning part 2.

[0017] This discerning part 2 is provided with a bill carrying mechanism 31 for discerning while carrying bills 30 introduced thereto. This bill carrying mechanism 31 is installed with a carrying roller part 23 provided with an upper carrying roller 23a and a lower carrying roller 23b erected in an opposing way up and down, at carrying route width. These upper and lower carrying rollers 23a and 23b rotate by rotation force transferred from a carrying motor not shown, and the bill 30 is introduced here in a horizontally long state, and carry sheet by sheet by sandwiching said bill 30 from upper and lower directions. In addition, they have a configuration with high carrying tolerance enabling overlapped carrying, so that smooth carrying is possible even for damaged circulating notes such as folded bills or cut bills.

[0018] In addition, in the discerning part 2, there are provided, subsequent to the carrying roller part 23, a color linear sensor 24 for checking penetration amount of the bill 30 and penetration amount of ink; a magnetic sensor

25 for discerning magnetic properties of magnetic ink coated on the bill 30; a thickness sensor 26 for detecting thickness of the bill 30, presence or absence of a tape and ruggedness of a thread or the like; an encoder 27 for outputting a clock signal in synchronizing with a carrying distance of the bill 30, based on carrying drive at the bill carrying mechanism 31, and a control part 28 for judging money types, number, and authenticity from a detected data of the thickness sensor 26.

[0019] Accordingly, the discerning part 2 discerns to which money type the bill 30 belongs, which was introduced thereto, still more discerns whether it is a true note or a counterfeited note, and still more discerns whether the bill 30 is one sheet or two sheets or three or more sheets, so as to manage the bill 30 to be utilized in transaction. It should be noted that the bill carrying mechanism 31 is configured to make discernment possible, even when the bill 30 is carried from either of the reciprocating directions.

[0020] Explanation will be given next on a specific configuration of the thickness sensor 26 provided to the discerning part 2, with reference to Fig. 3.

[0021] This thickness sensor 26 is provided with a standard roller axis 37 as a rotating axis where rotation force is transmitted from a carrying drive system of the bill carrying mechanism 31; standard rollers 36 arranged, for example, in 6 sheets, in a narrow width space in the same axis direction as this standard roller axis 37; six detection rollers 34a to 34f arranged on a detection roller axis 38 opposing to said six standard rollers 36; a detection roller group 34 which is driven-rotated when these 6 detection rollers 34a to 34f are pressed to the standard rollers 36; dislocation detection sensors 33a to 331, in a total number of 12, arranged in an opposing way, for example, by each 2 sensors, every the detection rollers 34a to 34f; a dislocation detection sensor group 33 for detecting roller dislocation amount where the detection rollers 34a to 34f displaced elastically, based on variation of a magnetic field, which is generated from a coil of each of the dislocation detection sensors 33a to 331, and a sensor processing part 35 for processing input data from said dislocation detection sensor group 33. The standard rollers 36 were shown for the case of arraying 6 rollers in a carrying width direction, however, they may be configured by one long roller axis.

[0022] Fig. 4 is a drawing explaining a major part by magnifying a part of the thickness sensor 26. Here explanation will be given on two sets of a left detection part composed of two dislocation detection sensors 33a and 33b, the detection rollers 34a, and the standard rollers 36 in an upper and lower direction; and a right detection part composed of two dislocation detection sensors 33c and 33d, the detection roller 34b and the standard rollers 36 in an upper and lower direction at the right side thereof, as an example, in view of explaining this thickness sensor 26.

[0023] The detection rollers 34a and 34b are configured by filling soft elastic members 39a, 39b, ---, such as rubber, between an external wheel 32a, which is composed of a cylinder-like member of a metal or the like, and the detection roller axis 38, which becomes a center axis thereof. On the other hand, the standard roller 36 is configured by a metal and provided as a standard surface without dislocation of the exterior circumference surface, to which the detection rollers 34a and 34b are contacted.

[0024] By this, when the bill 30 is meshed between the surfaces of the two set of rollers, that is, the standard rollers 36 and 36 at the both right and left sides, and the detection rollers 34a and 34b at the both right and left sides, the elastic members 39a and 39b deform by thickness amount of the bill 30, and the external wheels 32a and 32b displace in the upper direction.

[0025] This dislocation amount is detected by the two dislocation detection sensors 33a and 33b at the left side, and the two dislocation detection sensors 33c and 33d at the right side, and a detection signal corresponding to thickness of the bill 30 is output. The detection signal is processed at the sensor processing part 35, and a digital signal for the dislocation amount thereof is sent to the control part 28. In the control part 28, it is judged whether the bill 30 is carried or not in two or more sheets in an overlapped state, whether it is a altered note adhered with a tape or the like or not, or whether it is a true note or a counterfeited note or not, based on thickness data of the bill 30 sent.

[0026] In addition, by arranging two dislocation detection sensors 33a and 33b at the both ends in an opposing state, for the one detection roller 34a, in the case where, for example, a tape TA is adhered at the paper surface (refer to Fig. 4), both ends of said tape TA contact over the detection rollers 34a and 34b at the left and right, and the both of the detection rollers 34a and 34b simultaneously mount on said tape TA half-way, and tilt in a directly-opposed direction, by which dislocation of the detection rollers 34a and 34b can be detected.

[0027] In order to detect a wide detection range of the bill 30 correctly, it is preferable that layout of a plurality of the dislocation detection sensors 33a to 331 has narrow arrangement space and eliminates clearance among said sensors, so as to decrease a non-detection region of the bill 30 as low as possible. Therefore, each of the dislocation detection sensors 33a to 331, which are aligned over a carrying width direction, is arranged closely by narrowing arrangement space.

[0028] Therefore, these dislocation detection sensors 33a to 331 are arranged in such close vicinity as having little clearance and resulting in interference of mutual magnetic field by adjacent dislocation detection sensors themselves. Explanation will be given next on thickness detection technology which is capable of detecting thickness of the bill 30 correctly, without interference of the magnetic field of the adjacent dislocation detection sensors 33a to 331, even by closely arranging the space of the dislocation detection sensors 33a to 331.

[0029] This thickness detection technology is such technology to divide a plurality of the dislocation detection sensors 33a to 331 aligned along an axis direction of the detection rollers 34a to 34f, to two channels (channels a and b in Fig. 5) of two non-adjacent groups which are classified by each of non-adjacent groups themselves which are not adjacent in said alignment direction, and alternately switching (ON/OFF) the power of an oscillation voltage to thus divided non-adjacent groups, as shown in Fig. 5A.

[0030] For example, as shown in Fig. 5B, the dislocation detection sensors 33a to 33d are classified to two groups, that is a group having odd number 33a, 33c, --, and a group having even number 33b, 33d, --, from the end, and power of the oscillation voltage is switched by alternately making ON/OFF by each of these groups. That is, while the odd number group 33a, 33c, --- is oscillating, oscillation of the even number group 33b, 33d, --- is stopped.

[0031] It aims at avoiding simultaneous output (interference) of the adjacent dislocation detection sensors, in controlling oscillation of these two kinds of groups, in the case where each of the dislocation detection sensors outputs (oscillates). That is, this grouping contributes as a means for avoiding interference.

[0032] In this way, a magnetic field is generated by oscillating a predetermined frequency by a coil of the dislocation detection sensor, however, because of alternate oscillation by the two kinds of groups separated apart by one space, without simultaneous oscillation from these dislocation detection sensors 33a to 33d, there is no influence of the magnetic field from the adjacent dislocation detection sensors, even when said dislocation detection sensors are arranged closely.

[0033] In this way, it becomes possible to avoid interference of the magnetic field between the dislocation detection sensors, and obtain detection precision in high resolution stably, even when the dislocation detection sensors are arranged closely.

[0034] Fig. 6 shows a configuration example of a substrate integral-type dislocation detection sensor, wherein a plurality of coils 62 have printed wiring in narrow width space, as the dislocation detection sensor on the substrate 61, and a integral-type substrate 63 is configured by laminating, for example, four layers of this substrate 61 having printed wiring. By using this integral-type substrate 63, space of the coils 62 can be narrowed. As a result, a compact-type detection coil with good precision can be obtained, and it can be built-in compactly, having high detection precision.

[0035] It should be noted that explanation was given on magnetic field change by the coil as the dislocation detection sensor, however, for example, a permanent magnet or the like may be used so as to make ON/OFF mechanically. In addition, there may be used a magnetic field detection sensor such as an NR element (a magnetic resistance element), an MI element (a magnetic impedance element), a hole element.

[0036] It should be noted that, the explanation was given in the explanation on unique detection technology for avoiding influence of the magnetic field, however, it is also possible to increase detection precision still more. That is, in the case of the arrangement configuration of the dislocation detection sensors 33a to 331, adjacent space of the detection rollers 34a, 34b, ---, which are arranged in multiple, becomes a part not directly contacting to the bill 30, and thus generates a carrying space 72 of the non-detected place (refer to Fig. 7). To solve this, one example of a configuration will be shown next, which is capable of providing supplemental detection even for said carrying space 72.

[0037] Fig. 7 shows a plan view showing arrangement relation among the detection rollers 34a --- and the dislocation detection sensors 33a ---, arranged in a staggered state. For example, a detection unit 71, which is configured by providing, the 6 standard rollers 36-(refer to Fig. 3), the 6 detection rollers 34a to 34f, and the 12 dislocation detection sensors 33a to 331 having printed wiring onto the integral-type substrate 63, is located in two rows at the front stage side and the rear stage side in a carrying direction of the bill. Among these, the detection roller 34a at the rear stage side takes a configuration to be arranged, in a staggered state in a plan view, so as to correspond to the carrying space 72, as non-detection position between the detection rollers at the front stage side.

[0038] By this configuration, although the carrying space 72 is generated inevitably between a plurality of the detection rollers 34a an 34b, because detection of all surfaces of the bill 30 is possible without missing, by supplemental detection by the detection roller 34a at the later stage side, even for this carrying space 72, ruggedness dislocation of the bill can be detected correctly, even when detection range of the paper surface is wide.

[0039] Explanation will be given next on a control configuration of the thickness sensor 26, with reference to Fig. 8. Here, explanation will be given below on the case of controlling two dislocation detection sensors 33a and 33b, which can be switched in response to one channel a, and the other channel b.

[0040] Oscillation circuits 40a and 40b are provided as an alternate current magnetic field generation unit, and perform LC oscillation in the dislocation detection sensors 33a and 33b and the condensers 41a and 41b, and transistors 42a and 42b are used as negative resistances. After that, in detection circuits 43a and 43b, dislocation output from the oscillation circuits 40a and 40b is detected primarily to extract a dislocation component.

[0041] Said oscillation circuits 40a and 40b are self-excited-type oscillation circuits for detecting dislocation amount of the roller, where the detection roller displaced elastically, based on variation of the alternate current magnetic field, when the alternate current magnetic field was generated. Therefore, it becomes possible to correct dispersion of the magnetic field of each channel, caused by dispersion of the coils or the condensers, by each channel, and thus to ensure a thickness sensor with good precision.

[0042] Offset correction circuits 44a and 44b are circuits, as an adjustment unit for correcting dispersion of temperature variation or mechanical variation, and usually such subtraction correction circuits as to maintain a sensor level, not having the bill 30 before transaction, at a constant level. In a multiplexer circuit 46, the sensor level is subjected to AD conversion sequentially at the timing of a switching control signal 48 by an AD converter 47, and a digital signal of the dislocation output is output to the control part 28 by the sensor processing part 35. Output thereof is input to a judgment part 49 in the control part 28, to judge number of the bill 30 or presence or absence of an adhered substance such as a tape.

[0043] In addition, in judging the dislocation output, it is converted to dislocation amount of the bill by inclination determined from a linear approximation equation of the thickness memorized by a nonvolatile memory 45, to calculate dislocation amount of each bill 30. In this nonvolatile memory 45, there has been memorized, as a memory unit, inclinations of a linear approximation equation of dislocation of each channel a and b, calculated, in advance, from a plurality of dislocation levels. Still more, it has memorized output levels corresponding to two or more roller dislocation amounts relating to roller dislocation amount of the thickness of the bill, including an absent state of the bill, in advance. In this way, judgment processing at the control part 28 is made easy.

[0044] After that, output of the dislocation is input to the judgment part 49 in the control part 28, to judge number of the bill 30 or presence or absence of an adhered substance such as a tape. This control part 28 acts as a difference unit for determining difference between the input level of the dislocation detection sensors 33a --- in passing time of the bill, and the input level in non-passing time of the bill, adjusted by the offset correction circuits 44a and 44b, to judge thickness of the bill, by comparing the output level derived therefrom with the output level memorized by the nonvolatile memory 45. In this comparison judgment, by performing linear approximation between each of the thickness points, thickness dislocation amount can be determined correctly.

[0045] In this way, it becomes possible to determine thickness dislocation amount without influence of dispersion of sensor temperature or the apparatus, as well as secure linearity between thickness dislocation amounts memorized by the nonvolatile memory 45, and thus a thickness sensor with high dynamic range can be prepared. Therefore, it becomes possible to secure a thickness sensor with good precision.

[0046] The switching control signal 48 outputs a sampling timing signal synchronized with an encoder 27 (refer to Fig. 2), as well as outputs a switching timing signal to oscillation control circuits 50a and 50b. That is, the switching control signal 48 switches the channels a an b (refer to Fig. 5) by the non-adjacent group for acquiring the roller dislocation amount within unit detection time for detecting thickness in a carrying direction of thereof, by synchronizing with carrying speed of the bill 30 by the bill carrying mechanism.

[0047] In this way, a ruggedness dislocation image without resolution change for a carrying direction can be obtained, even when carrying speed varies. It should be noted that, as for timing of data loading, it is preferably configured by mechanism to output a pulse for travelling distance of the bill 30 by the encoder 27 or the like. In the case where passing speed of the bill 30 is known in advance, it may be configured by mechanism to output a signal synchronized with assumed passing speed of the bill.

[0048] The oscillation control circuits 50a and 50 b output the switching control signal 48, during an ON period thereof, to the transistors 42a and 42b of negative resistances of the oscillation circuits 40a and 40b, and perform high frequency oscillation by making the transistors 42a and 42b thereof conducted. The oscillation circuits 40a and 40b perform high frequency oscillation only during a period when the oscillation control circuits 50a and 50 b are ON. Therefore, each of the oscillation control circuits 50a and 50b of the adjacent dislocation detection sensors 33a and 33b at the both sides is made ON at one side and OFF at the other side simultaneously, and thus are acting exclusively.

[0049] In the case of data transfer from the sensor processing part 35 to the control part 28 of a high rank control section, the sensor processing part 35 acts as a processing unit, on the premise that detection level before switching is maintained, while a non-detection state switched to other non-adjacent group, and output data processed here is transferred to the control part 28. In this way, the control part 28 can be processed as usual. In particular, because output data transferred to the control part 28 is handled as continued data, where detection level before switching is maintained, a ruggedness dislocation image with high resolution can be obtained.

[0050] In the above-described example, the twelve channels 33a to 331 are classified to two groups, that is a group having odd number 33a, 33c, --, and a group having even number 33b, 33d, -- (channels a and b), however, any grouping may be allowed as long as it is a channel configuration where adjacent dislocation detection sensors do not output simultaneously, that is, not to interfere each other. For example, the dislocation detection sensors separated apart space between the dislocation detection sensors by two or three spaces may be handled as one group.

[0051] Explanation will be given next on a method for judging how many sheets of the bill 30 are carried in the judgment part 49, with reference to Fig. 9. In a waveform 51 represented in Fig. 9A, the vertical axis shows dislocation output of each channel CH0, CH1-CH10, CH11 (a, b), and the horizontal axis shows travelling distance of the bill 30.

[0052] Fig. 9B shows a waveform 52 representing the sum of dislocation outputs of each channel described in Fig. 9A.

[0053] Firstly, the judgment part 49 extracts a region where the bill 30 is contacting onto the detection rollers 34a, ---. In this case, when average value of the bill 30 is equal to or more than threshold value 53 corresponding to 2.5 sheets of the bill 30, it is judged to be equal to or more than 3 sheets; and as for the sheets below that, when it is equal to or more than threshold value 54 corresponding to 1.5 sheets of the bill 30, it is judged to be 2 sheets; and when it is below threshold value 54, it t is judged to be 1 sheet.

[0054] Explanation will be given next on a judgment method for a tape adhered to the bill 30 in the judgment part 49, with reference to Fig. 10 and Fig. 11.

[0055] Fig. 10 shows a waveform 55 of the dislocation detection sensors 33a and 33b among each of the channels a and b, in the case where an altered note adhered with the tape passes (refer to Fig. 4). The vertical axis shows dislocation output, and the horizontal axis shows travelling distance of the bill 30.

[0056] As for a threshold value of these waveforms 55, because thickness of the bill 30 differs depending on places, or total thickness of the bill varies depending on environmental change of the bill itself, it is difficult to set the threshold value as it is. Therefore, firstly, a region is extracted where whole of the bill is mounted onto the roller. In this case, one shown in Fig. 11 is a waveform 56 of the dislocation output, based on center value of total thickness of the bill (center of thickness in a carrying direction and a carrying width direction). And, an image 58, obtained by binary processing at the threshold value 57 of the convex part of each part of the bill from thickness of the bill of an object region, is shown, as a plan view of the bill. And, when the area size thereof is equal to or larger than the threshold value 59, it is judged to have an adhered substance with a certain size, such as a tape. Therefore it can be detected in high precision, whether the bill 30 is carried in two or three sheets in an overlapped state, and whether it is an altered bill by a tape, paper or the like.

[0057] As described above, since it is possible to avoid interference of the magnetic field among the adjacent dislocation detection sensors, even by closely arranging said adjacent dislocation detection sensors, detection precision in high resolution can be obtained stably. Therefore, it becomes possible to detect, by correct judgment, a fine ruggedness variation state of a medium, irrespective of a carrying state of the medium, and thus judgment in high precision satisfying security function of the bill can be performed,.

[0058] The present invention should not be limited to configurations described in one Examples described above, and is applicable based on technological concept described in the appended claims. For example, although the bill 30 was used as one example of the medium, in one Examples described above, the present invention is applicable even to other media such as a slip, a check, a securities credit, a gold certificate and the like.

[0059] The present invention is applicable to automatic transaction facilities such as automatic telling machines, exit fare machines, ticket-vending machines and the like, which handle bills or the like.

Claims

1. A medium thickness detection apparatus comprising

   - standard rollers (36);
   - a detection roller group (34) having a plurality of detection rollers (34a to 34f), each having an elastic member (39) built-in, allowing elastic deformation in a radius direction,
   wherein the detection rollers (34a to 34f) are arranged with their axis (38) parallel to the axis (37) of the standard rollers (36) and the detection rollers (34a to 34f) oppose the standard rollers (36), such as to sandwich a medium,
   - a carrying unit for carrying a medium between the standard rollers (36) and the detection rollers (34a to 34f) by driving in a rotating manner at least one side of said opposing standard rollers (36) and the detection roller group (34), and
   - a dislocation detection sensor group (33) for detecting the amount of dislocation of the detection rollers (34a to 34f) when said elastic members (39) are deformed elastically and said detection rollers (34a to 34f) are displaced elastically,
   wherein dislocation detection sensors (33a to 33l) are installed opposing each of said detection rollers (34a to 34f), wherein each dislocation detection sensor (33a to 331) comprises a coil (63) generating a magnetic field, and wherein the amount of dislocation is detected based on a variation of the magnetic field,
   characterized in that
   - the dislocation detection sensors (33a to 331) of the dislocation detection sensor group (33) are divided into non-adjacent groups of dislocation detection sensors, the sensors of each non-adjacent group being, in the direction of the axis (38) of the detection rollers (34 a to 34f), non-adjacent to each other, and
   - a switching unit is provided for alternately switching on and off the power of an oscillation voltage to the groups of dislocation detection sensors for generating the magnetic field in order to switch between said non-adjacent groups of dislocation sensors for acquiring the amount of detection roller dislocation.

2. The medium thickness detection apparatus according to claim 1, having a configuration located a plurality of the medium thickness detection units, which are configured by comprising said standard rollers (36), said detection roller group (34) and said dislocation detection sensor group (33), in a medium car-

rying direction; and
arranged in a staggered state, at least the detection rollers (34a to 34f) of the medium thickness detection units, which is located at the front stage side and the rear stage side in said medium carrying direction, so that, at a non-detection position between the detection rollers (34a to 34f) at one side, the detection rollers (34a to 34f) at the other side are arranged in an opposing way at the front stage side and the rear stage side.

3. The medium thickness detection apparatus according to claim 1 or 2, wherein said switching unit has a configuration for switching said non-adjacent group for acquiring said roller dislocation amount within unit detection time for detecting thickness in a carrying direction of the medium, by synchronizing with carrying speed of the medium by said carrying unit.

4. The medium thickness detection apparatus according to claim 1, 2 or 3, comprising:

an adjustment unit for adjusting an input level of the dislocation detection sensor (33), in non-passing time of the medium, to a predetermined level;
a memory unit for memorizing, in advance, an output level corresponding to dislocation amount of at least two or more rollers, relating to roller dislocation amount of medium thickness ;
a difference unit for determining difference between the input level of the dislocation detection sensors (33a to 331) in passing time of the medium, and the predetermined level in non-passing time of the medium, adjusted by said adjustment unit; and
a judgment unit for judging thickness of the medium, by comparing the output level determined by said difference unit, and the output level which said memory unit has memorized.

5. The medium thickness detection apparatus according to any one of claims 1 to 4, comprising:

a memory unit for temporarily memorizing data which said dislocation detection sensor (33) detected;
a processing unit for processing data on the premise that detection level before switching is maintained during a non-detection state switched to other non-adjacent group;
a transfer unit for transferring data of the roller dislocation amount to a higher rank control section; and
a control unit for transferring, by said transfer unit, the output data processed by said processing unit.

6. The medium thickness detection apparatus according to any one of claims 1 to 5, wherein a plurality of said dislocation detection sensors (33a to 331) are configured by a coil (62) having printed wiring at a substrate.

7. The medium thickness detection apparatus according to any one of claims 1 to 6, wherein said dislocation detection sensors (33a to 331) are configured by:

an alternate current magnetic field generation unit for generating the alternate current magnetic field; and
a self-excited-type oscillation circuit for detecting dislocation amount of the roller, where the detection rollers (34a to 34f) displaced elastically, based on variation of the alternate current magnetic field, which was generated by said alternate current magnetic field generation unit.

Patentansprüche

1. Mediumdicken-Detektionsvorrichtung, die umfasst:

- Standardwalzen (36);
- eine Detektionswalzengruppe (34), die mehrere Detektionswalzen (34a bis 34f) aufweist, wovon in jede ein elastisches Element (39) eingebaut ist, das eine elastische Verformung in einer Radiusrichtung ermöglicht,
wobei die Detektionswalzen (34a bis 34f) mit ihrer Achse (38) parallel zu der Achse (37) der Standardwalzen (36) angeordnet sind und die Detektionswalzen (34a bis 34f) den Standardwalzen (36) gegenüberliegen, so dass sie ein Medium zwischen sich einschließen;
- eine Trageinheit zum Transportieren eines Mediums zwischen den Standardwalzen (36) und den Detektionswalzen (34a bis 34f) durch Antreiben mindestens einer Seite der Standardwalzen (36) und der Detektionswalzengruppe (34), die einander gegenüberliegen; und
- eine Verschiebungsdetektionssensorgruppe (33) zum Detektieren eines Verschiebungsbetrags der Detektionswalzen (34a bis 34f), wenn die elastischen Elemente (39) elastisch verformt werden und die Detektionswalzen (34a bis 34f) elastisch verschoben werden,
wobei die Verschiebungsdetektionssensoren (33a bis 331) genüberliegend von jeder der Detektionswalzen (34a bis 34f) installiert sind, wobei jeder Verschiebungsdetektionssensor (33a bis 331) eine Spule (62) umfasst, die ein Magnetfeld erzeugt, und wobei der Verschiebungs-

betrag auf der Grundlage einer Variation des Magnetfeldes detektiert wird,

dadurch gekennzeichnet, dass

- die Verschiebungsdetektionssensoren (33a bis 331) der Verschiebungsdetektionssensorgruppe (33) in nicht benachbarte Gruppen von Verschiebungsdetektionssensoren aufgeteilt sind, wobei die Sensoren von jeder nicht benachbarten Gruppe in der Richtung der Achse (38) der Detektionswalzen (34a bis 34f) nicht benachbart zueinander sind, und
- eine Schalteinheit vorgesehen ist, um den Strom einer Oszillationsspannung an den Gruppen der Verschiebungsdetektionssensoren abwechselnd ein- und auszuschalten, um das Magnetfeld zu erzeugen, um zwischen den nicht benachbarten Gruppen von Verschiebungsdetektionssensoren umzuschalten, um den Betrag der Detektionswalzenverschiebung zu erhalten.

2. Mediumdicken-Detektionsvorrichtung nach Anspruch 1, die eine Konfiguration aufweist, bei der mehrere Mediumdicken-Detektionseinheiten, die ausgebildet sind, indem sie mehrere Standardwalzen (36), die Detektionswalzengruppe (34) und die Verschiebungsdetektionssensorgruppe (33) in einer Mediumtransportrichtung umfassen; und wobei mindestens die Detektionswalzen (34a bis 34f) der Mediumdicken-Detektionseinheiten, die an der Vorderstufenseite und der Hinterstufenseite in der Medium-Transportrichtung angeordnet sind, in einem versetzten Zustand angeordnet sind, so dass an einer Nicht-Detektions-Position zwischen den Detektionswalzen (34a bis 34f) auf einer Seite die Detektionswalzen (34a bis 34f) auf der anderen Seite in entgegengesetzter Weise auf der Vorderstufenseite und der Hinterstufenseite angeordnet sind.

3. Mediumdicken-Detektionsvorrichtung nach Anspruch 1 oder 2, wobei die Schalteinheit eine Konfiguration aufweist, um die nicht benachbarte Gruppe zu schalten, um den Walzenverschiebungsbetrag innerhalb einer Einheitsdetektionszeit zu erhalten, um die Dicke in einer Transportrichtung des Mediums durch Synchronisation mit der Transportgeschwindigkeit des Mediums durch die Trageinheit zu detektieren.

4. Mediumdicken-Detektionsvorrichtung nach Anspruch 1, 2 oder 3, die umfasst:

eine Anpassungseinheit zum Anpassen eines Eingangspegels des Verschiebungsdetektionssensors (33) in der Nicht-Durchlaufzeit des Mediums auf einen vorgegebenen Pegel;
eine Speichereinheit zum Speichern eines Ausgangspegels im Voraus, der dem Verschiebungsbetrag von mindestens zwei oder mehr Walzen entspricht, der sich auf den Walzenverschiebungsbetrag der Mediumdicke bezieht;
eine Differenzeinheit zum Bestimmen der Differenz zwischen dem Eingangspegel der Verschiebungsdetektionssensoren (33a bis 331) in der Durchlaufzeit des Mediums und dem vorgegebenen Pegel in der Nicht-Durchlaufzeit des Mediums, der durch die Anpassungseinheit angepasst wird; und
eine Beurteilungseinheit zum Beurteilen der Dicke des Mediums durch Vergleichen des Ausgangspegels, der durch die Differenzeinheit bestimmt wird, und des Ausgangspegels, den die Speichereinheit gespeichert hat.

5. Mediumdicken-Detektionsvorrichtung nach einem der Ansprüche 1 bis 4, die umfasst:

eine Speichereinheit zum vorübergehenden Speichern von Daten, die der Verschiebungsdetektionssensor (33) detektiert;
eine Verarbeitungseinheit zum Verarbeiten von Daten unter der Prämisse, dass der Detektionspegel vor dem Schalten während des Nicht-Detektionszustands beibehalten wird, wenn zu einer anderen nicht benachbarten Gruppe geschalten wird;
eine Übertragungseinheit zum Übertragen von Daten des Walzenverschiebungsbetrags an einen Steuerabschnitt höheren Ranges; und
eine Steuereinheit für die Übertragung der durch die Verarbeitungseinheit verarbeiteten Ausgangsdaten durch die Übertragungseinheit.

6. Mediumdicken-Detektionsvorrichtung nach einem der Ansprüche 1 bis 5, wobei mehrere der Verschiebungsdetektionssensoren (33a bis 331) durch eine Spule (62) ausgebildet sind, die gedruckte Leitungen auf einem Substrat aufweist.

7. Mediumdicken-Detektionsvorrichtung nach einem der Ansprüche 1 bis 6, wobei die Verschiebungsdetektionssensoren (33a bis 331) durch Folgendes gebildet sind:

eine Wechselstrommagnetfelderzeugungseinheit zum Erzeugen des Wechselstrommagnetfeldes; und
eine Oszillatorschaltung eines selbsterregten Typs zum Detektieren des Verschiebungsbetrags der Walze, wobei die Detektionswalzen (34a bis 34f) basierend auf der Variation des Wechselstrommagnetfeldes, das durch der Wechselstrommagnetfelderzeugungseinheit erzeugt wurde, elastisch verschoben werden.

Revendications

1. Appareil de détection de l'épaisseur d'un support, comprenant

- des galets standards (36) ;
- un groupe de galets de détection (34) ayant une pluralité de galets de détection (34a à 34f), ayant chacun un élément élastique (39) intégré, permettant une déformation élastique dans une direction radiale,
dans lequel les galets de détection (34a à 34f) sont agencés avec leur axe (38) parallèle à l'axe (37) des galets standards (36) et les galets de détection (34a à 34s) sont opposés aux galets standards (36) de manière à prendre un support en sandwich,
- une unité portante pour porter un support entre les galets standards (36) et les galets de détection (34a à 34f) en entraînant d'une manière rotative au moins un côté desdits galets standards opposés (36) et le groupe de galets de détection (34), et
un groupe capteur de détection de déplacement (33) pour détecter l'amplitude de déplacement des galets de détection (34a à 34f) quand lesdits éléments élastiques (39) sont déformés élastiquement et lesdits galets de détection (34a à 34f) sont déplacés élastiquement,
dans lequel des capteurs de détection de déplacement (33a à 331) sont installés à l'opposé de chacun desdits galets de détection (34a à 34f); dans lequel chaque capteur de détection de déplacement (33a à 331) comprend une bobine (63) qui génère un champ magnétique, et dans lequel l'amplitude de déplacement est détectée sur la base d'une variation du champ magnétique,
caractérisé en ce que
- les capteurs de détection de déplacement (33a à 331) du groupe capteur de détection de déplacement (33) sont divisés en groupes non adjacents de capteurs de détection de déplacement, les capteurs de chaque groupe non adjacent étant, dans la direction de l'axe (38) des galets de détection (34a à 34f), non adjacents les uns aux autres, et
- il est prévu une unité de commutation pour commuter alternativement en marche et en arrêt la puissance d'un voltage d'oscillation des groupes de capteurs de détection de déplacement pour générer le champ magnétique afin de commuter entre lesdits groupes non adjacents de capteurs de déplacement pour acquérir l'amplitude de déplacement des galets de détection.

2. Appareil de détection de l'épaisseur d'un support selon la revendication 1, ayant une configuration logeant une pluralité d'unités de détection d'épaisseur de support qui sont configurées de manière à comprendre lesdits galets standards (36), ledit groupe de galets de détection (34) et ledit groupe de capteurs de détection de déplacement (33), dans une direction de transport du support ; et
au moins les galets de détection (34a à 34f) des unités de détection d'épaisseur de support, qui sont situés du côté de l'étage avant et du côté de l'étage arrière dans ladite direction de transport de support, sont agencés de manière étagée, de telle manière qu'à une position de non détection entre les galets de détection (34a à 34 f) d'un côté, les galets de détection (34a à 34f) de l'autre côté sont agencés d'une manière opposée du côté de l'étage avant et du côté de l'étage arrière.

3. Appareil de détection de l'épaisseur d'un support selon la revendication 1 ou 2, dans lequel ladite unité de commutation a une configuration pour commuter ledit groupement adjacent pour acquérir ladite amplitude de déplacement des galets dans un temps de détection unitaire pour détecter l'épaisseur dans une direction de transport du support, par synchronisation avec la vitesse de transport du support par ladite unité de transport.

4. Appareil de détection de l'épaisseur d'un support selon la revendication 1, 2 ou 3, comprenant :

une unité d'ajustement pour ajuster un niveau d'entrée du capteur de détection de déplacement (33) dans un temps où le support ne passe pas, à un niveau prédéterminé ;
une unité à mémoire pour mémoriser à l'avance un niveau de sortie correspondant à l'amplitude de déplacement d'au moins deux galets ou plus, en relation avec l'amplitude de déplacement des galets de l'épaisseur du support ;
une unité différentielle pour déterminer une différence entre le niveau d'entrée des capteurs de détection de déplacement (33a à 331) pendant le temps de passage du support, et le niveau prédéterminé dans un temps où le support ne passe pas, ajusté par ladite unité d'ajustement ; et
une unité de jugement pour juger l'épaisseur du support, par comparaison du niveau de sortie déterminée par ladite unité différentielle, et du niveau de sortie que ladite unité à mémoire a mémorisé.

5. Appareil de détection de l'épaisseur d'un support selon l'une quelconque des revendications 1 à 4, comprenant :

une unité à mémoire pour mémoriser temporairement des données que ledit capteur de détec-

tion de déplacement (33) a détecté ;
une unité de traitement pour traiter des données avec pour condition préalable que le niveau de détection avant commutation est maintenu pendant un état de non détection commuté vers un autre groupe non adjacent ;
une unité de transfert pour transférer des données de l'amplitude de déplacement des galets vers une section de commande de rang plus élevé ; et
une unité de commande pour transférer, par ladite unité de transfert, les données de sortie traitées par ladite unité de traitement.

6. Appareil de détection de l'épaisseur d'un support selon l'une quelconque des revendications 1 à 5, dans lequel une pluralité desdits capteurs de détection de déplacement (33a à 331) sont configurés par une bobine (62) ayant un câblage imprimé sur un substrat.

7. Appareil de détection de l'épaisseur d'un support selon l'une quelconque des revendications 1 à 6, dans lequel lesdits capteurs de détection de déplacement (33a à 331) sont configurés par :

une unité de génération de champ magnétique à courant alternatif pour générer le champ magnétique à courant alternatif ; et
un circuit oscillant du type excité par self pour détecter l'amplitude de déplacement du galet, dans lequel les galets de détection (34a à 34f) sont déplacés élastiquement, sur la base d'une variation du champ magnétique à courant alternatif, qui a été généré par ladite unité de génération de champ magnétique à courant alternatif.

FIG.1

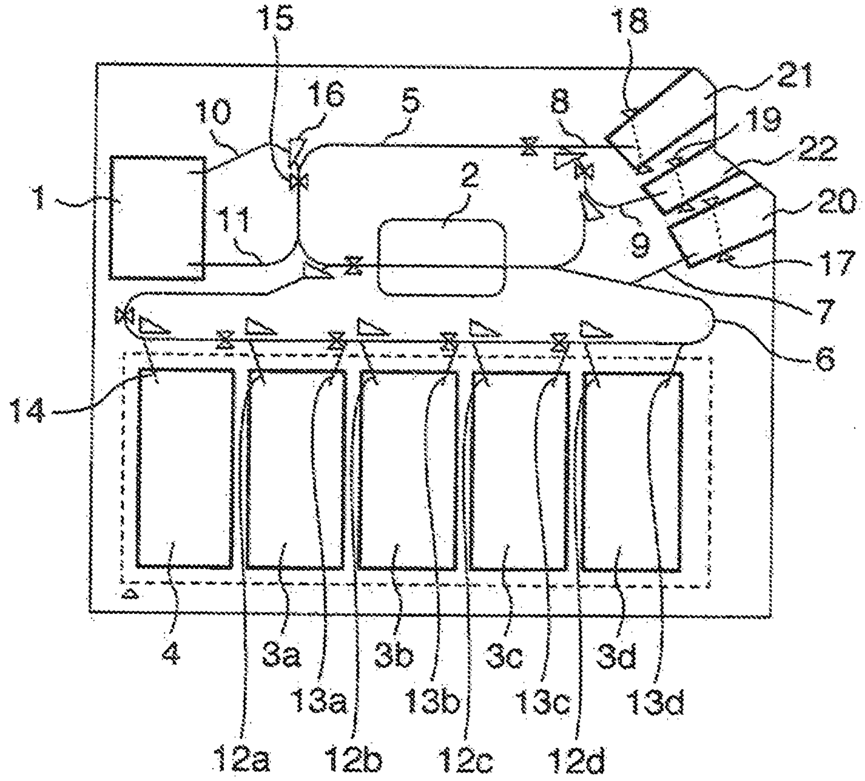

15
18
21
16
5
8
19
10
22
2
1
11
9
20
17
7
6
14
4
3a
3b
3c
3d
13a
13b
13c
13d
12a
12b
12c
12d

FIG.2

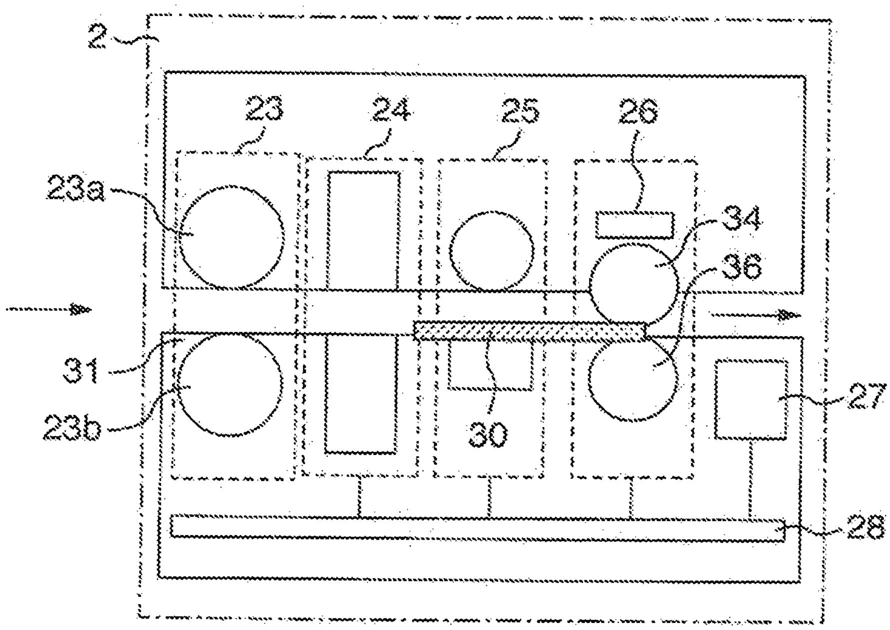

2
23
24
25
26
23a
34
36
31
23b
30
27
28

FIG.3

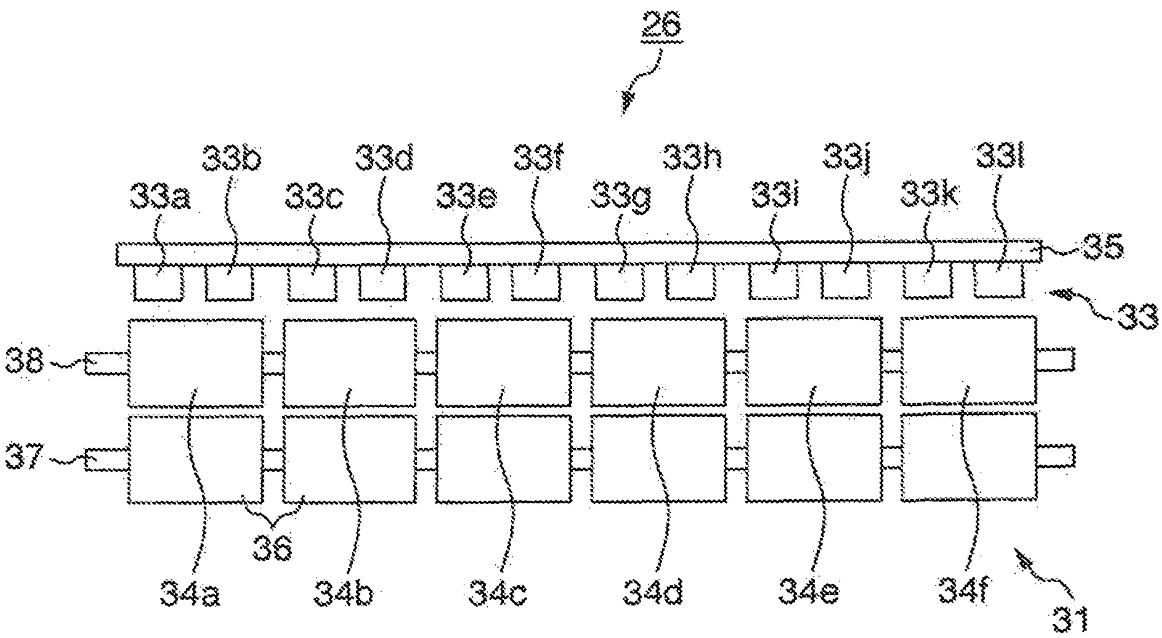

26
33a
33b
33c
33d
33e
33f
33g
33h
33i
33j
33k
33l
35
33
38
37
36
34a
34b
34c
34d
34e
34f
31

FIG.4

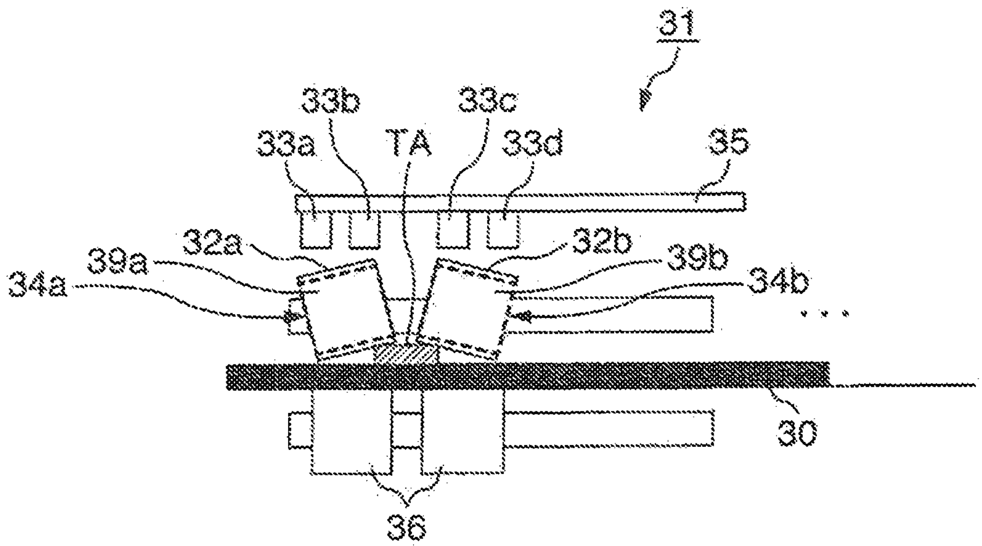

31
33b
33c
33a
TA
33d
35
32a
32b
39a
39b
34a
34b
30
36

FIG.5A

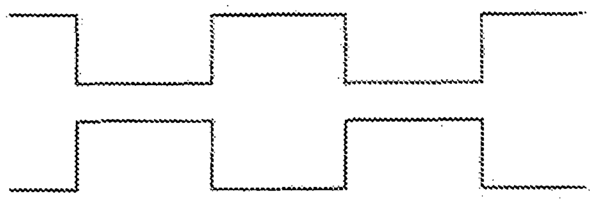


FIG.5B

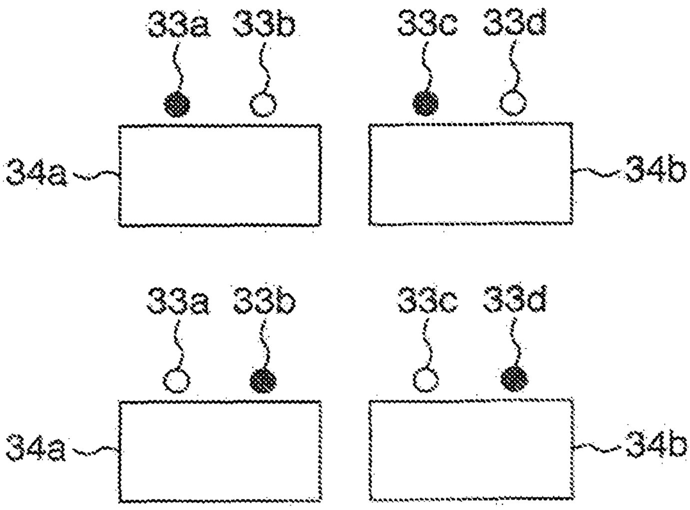


FIG.6

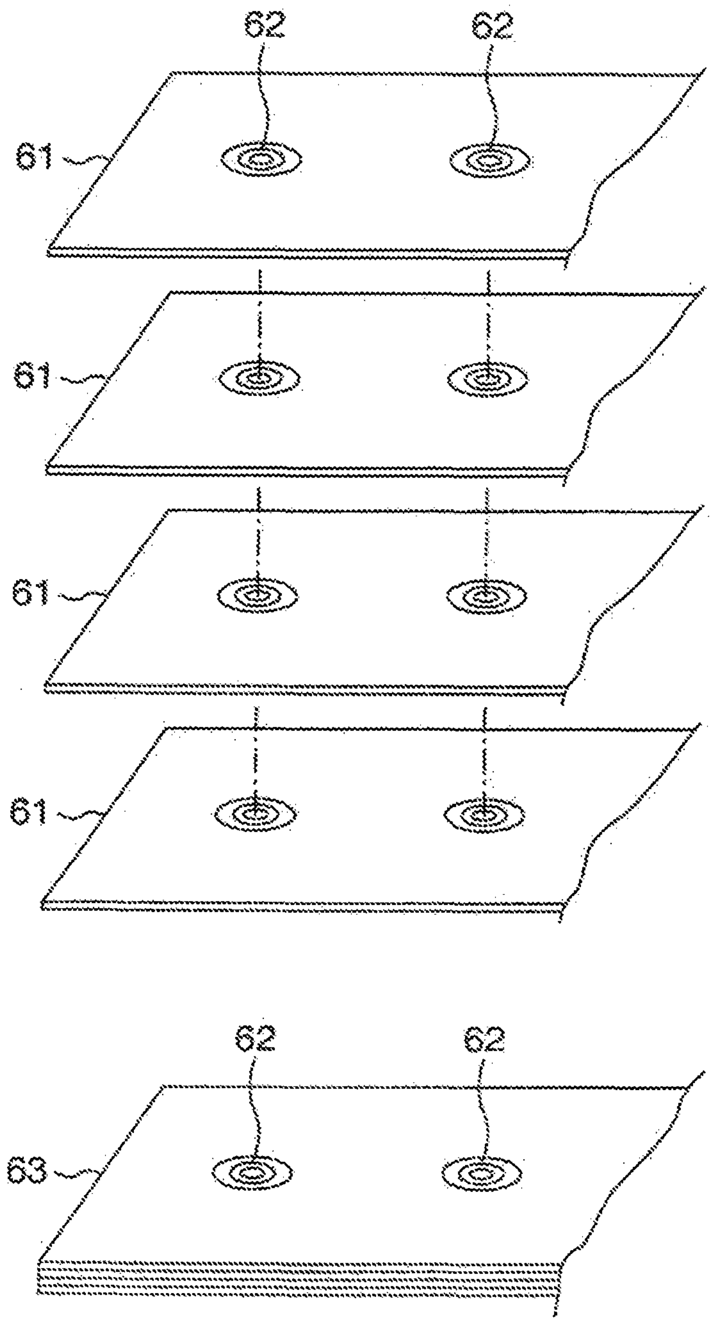


FIG.7

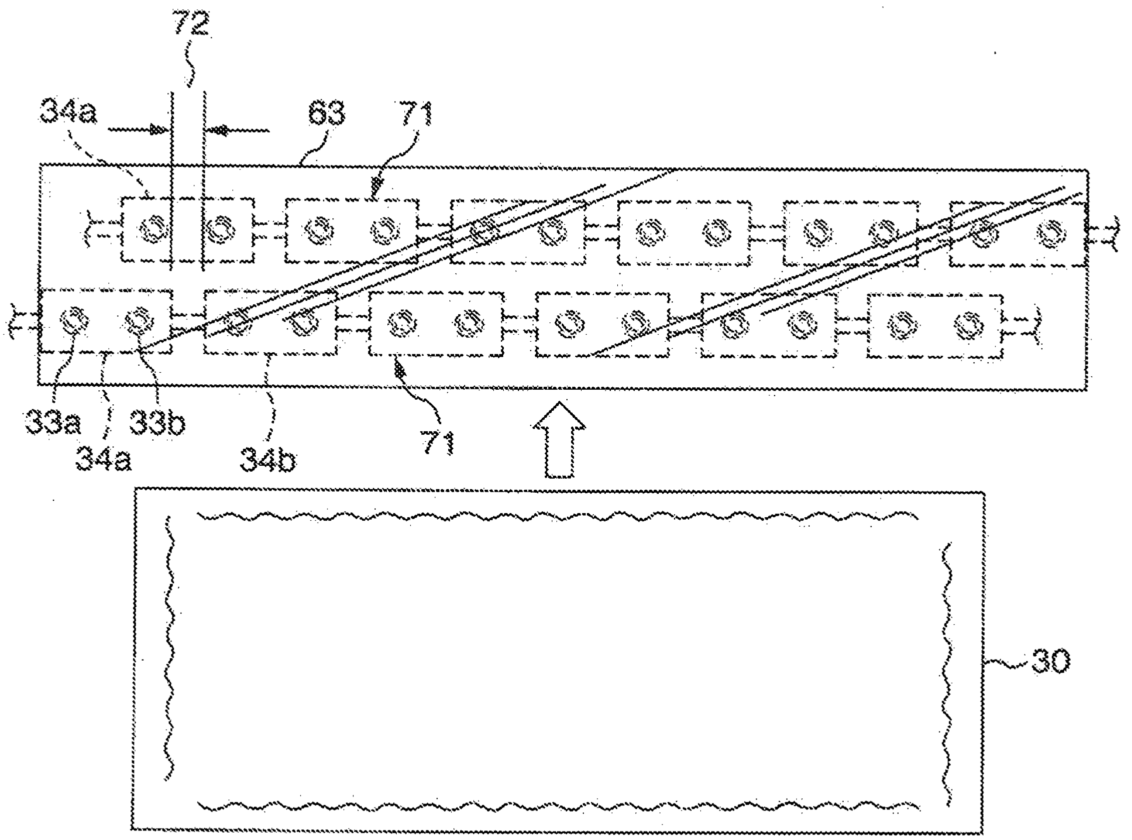


FIG.8

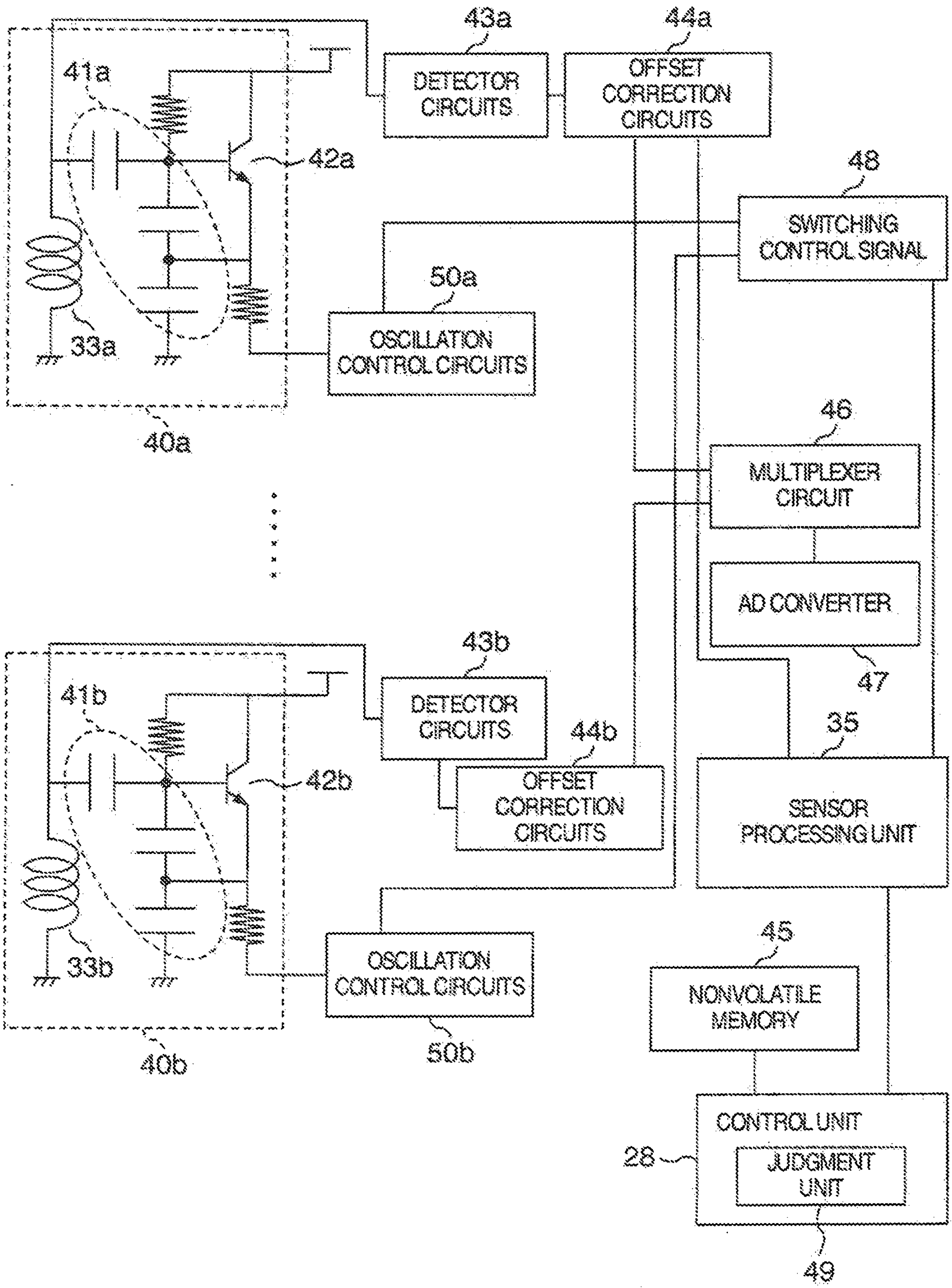

43a
44a
DETECTOR CIRCUITS
OFFSET CORRECTION CIRCUITS
41a
42a
48
SWITCHING CONTROL SIGNAL
50a
33a
OSCILLATION CONTROL CIRCUITS
40a
46
MULTIPLEXER CIRCUIT
AD CONVERTER
47
43b
DETECTOR CIRCUITS
41b
44b
OFFSET CORRECTION CIRCUITS
42b
35
SENSOR PROCESSING UNIT
33b
OSCILLATION CONTROL CIRCUITS
40b
50b
45
NONVOLATILE MEMORY
CONTROL UNIT
28
JUDGMENT UNIT
49

FIG.9A

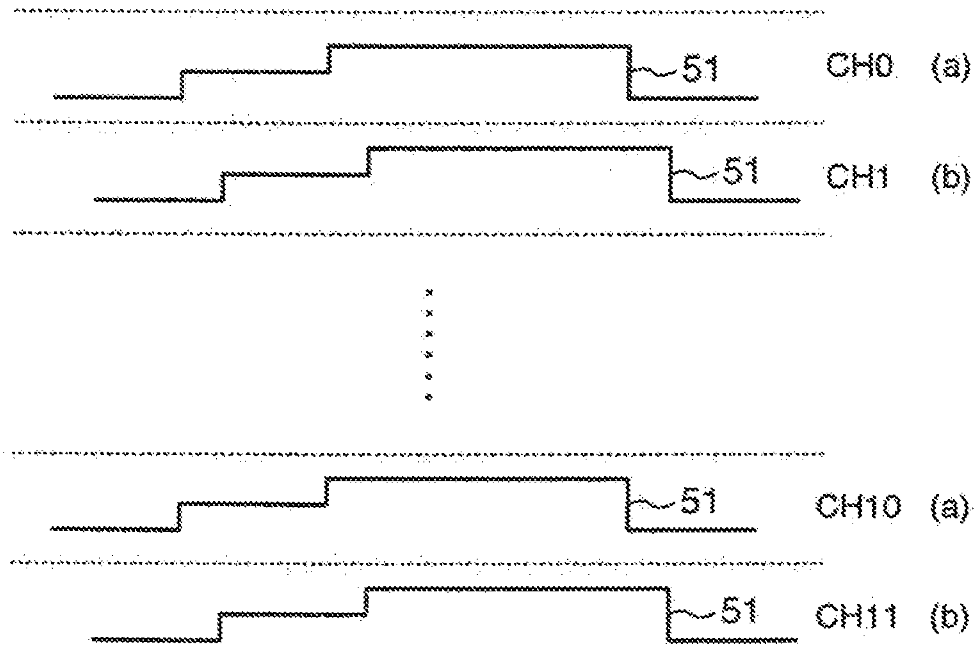


FIG.9B

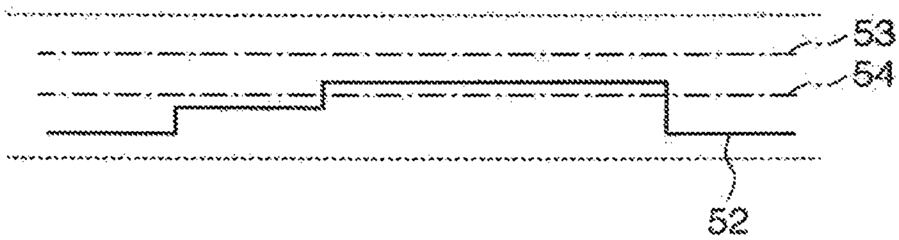


FIG.10

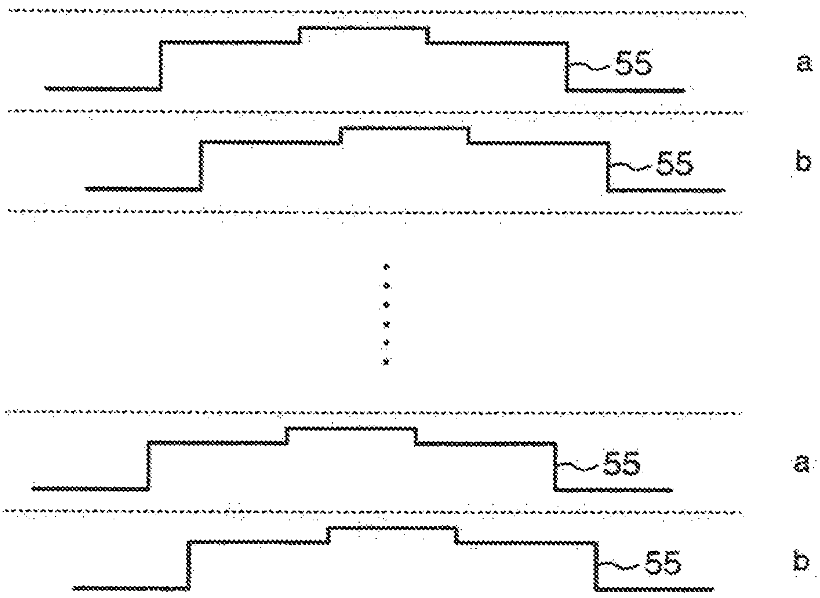
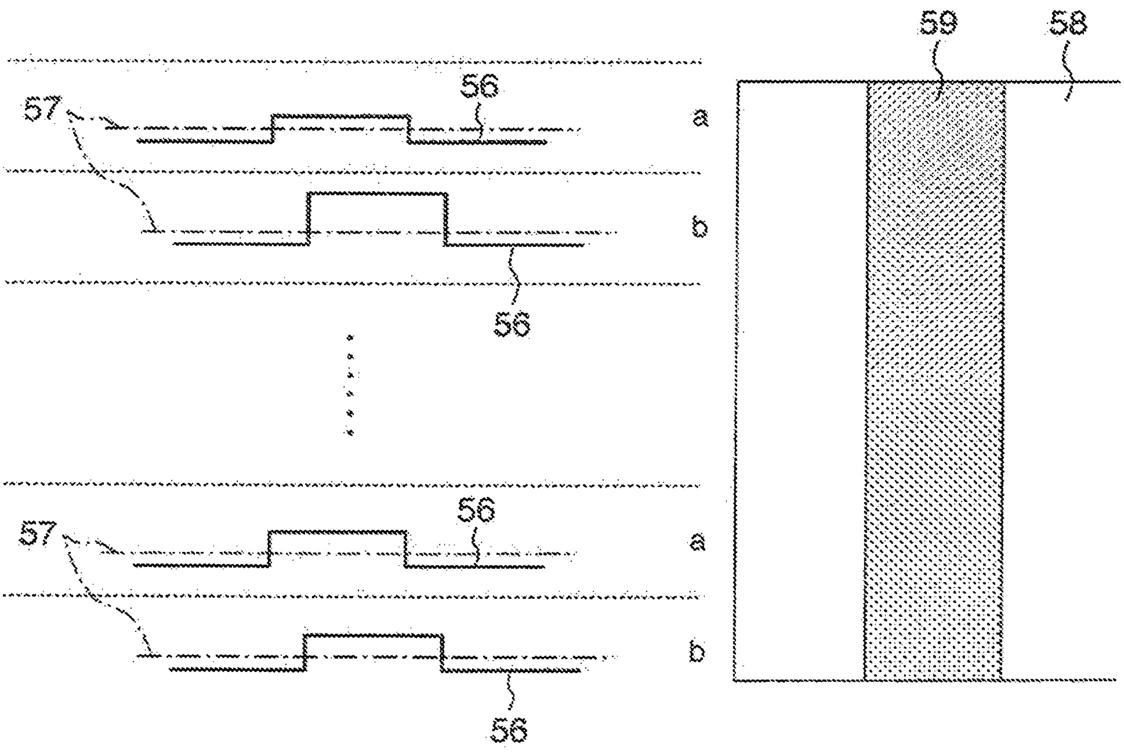


FIG.11



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 2006004206 A **[0003]**
- US 2006055105 A1 **[0004]**
- US 20010035329 A1 **[0005]**