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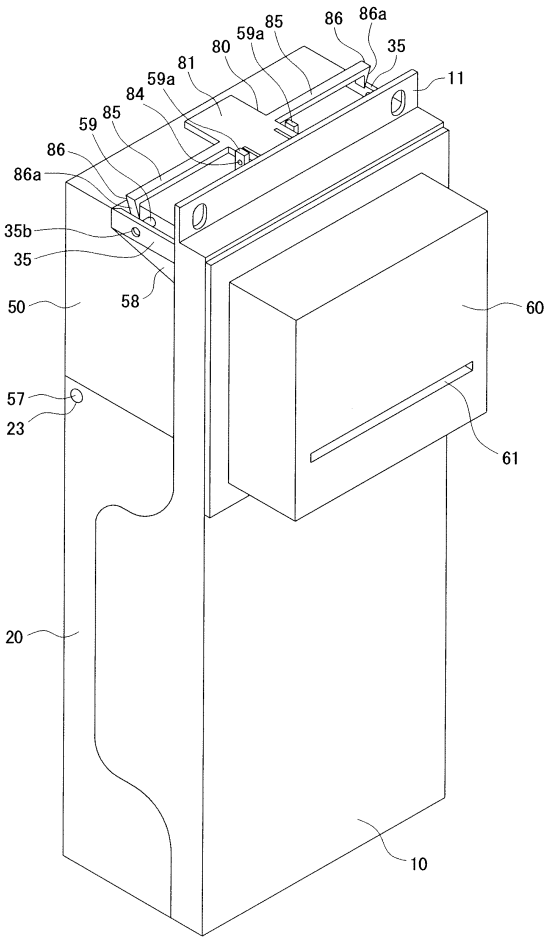
## (54) Bill validator

(57) A light emitting element (54a) and a light receiving element (55a) of an insertion detecting sensor, and light emitting elements (53a, 53b) and light receiving elements (54b, 55b) of an authenticity detecting sensors are disposed together in a rear chute (50) located at a rear side of a bill transport unit (40). Emission light from the light emitting element (54a) of the insertion detecting sensor is incident on the light receiving element (55a) of the insertion detecting sensor through a first optical transmission element (34) of a front chute (30) located at a front side of the bill transport unit (40) and second optical transmission elements (44) in the bill transport unit (40). Emission lights from the light emitting elements (53a, 53b) of the authenticity detecting sensors are incident on the light receiving elements (54b, 55b) of the authenticity detecting sensors through third optical transmission elements (45) in the bill transport unit (40).

Fig. 1

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## Description

**[0001]** The present invention relates to a bill validator for use in an automatic vending machine or the like.

**[0002]** A bill validator for use in an automatic vending machine or the like includes a bill transport mechanism for transporting a bill inserted into a bill insertion port along a bill passage, transport drive means for applying power to the bill transport mechanism, a bill storing mechanism for storing the bill transported to a bill storing position into a bill storing cassette, storage drive means for applying power to the bill storing mechanism, an insertion detecting sensor for detecting insertion of the bill into the bill insertion port, and an authenticity detecting sensor for detecting authenticity of the bill while the bill is transported along the bill passage.

**[0003]** For the insertion detecting sensor and the authenticity detecting sensor, optical sensors constituted of the combinations of light emitting elements and light receiving elements are generally used. The insertion detecting sensor is disposed at the position near the bill insertion port in the bill passage. The authenticity detecting sensor is disposed at the position at the rear side from the insertion detecting region in the bill passage. Each of the insertion detecting sensor and the authenticity detection sensor detects the change in the intensity of light when the light emitted from the light emitting element is incident on the light receiving element via a bill. The detection signals are sent to a controller having an insertion determining function and an authenticity determining function.

**[0004]** The insertion detecting sensor and the authenticity detecting sensor differs from each other in disposed position, and the light emitting element and the light receiving element are disposed so as to face each other with the bill passage therebetween as a rule. Therefore, the light emitting elements and the light receiving elements constituting the respective sensors are discretely disposed at various components located around the bill passage. As a result, the operations relating to assembly, wiring and the like of the light emitting elements and light receiving elements constituting the respective sensors are complicated to increase the manufacture cost, and the operations of inspection, cleaning and the like of the respective sensors become difficult to increase the maintenance cost.

**[0005]** An object of the present invention is to provide a bill validator in which operations relating to assembly and wiring of a light emitting element and a light receiving element constituting an insertion detecting sensor and a light emitting element and a light receiving element constituting an authenticity detecting sensor are easily performed, and operations of inspection, cleaning and the like for the respective sensors can be easily performed.

**[0006]** In order to attain the object, a bill validator involved with the present invention comprises a bill transport unit for transporting a bill inserted into a bill insertion port along a bill passage, an insertion detecting sensor constituted of a combination of a light emitting element and a light receiving element and for detecting insertion of the bill into the bill insertion port, and an authenticity detecting sensor constituted of a combination of a light emitting element and a light receiving element and for detecting authenticity of the bill while the bill is transported along the bill passage. In addition, the light emitting element and the light receiving element constituting the insertion detecting sensor, and the light emitting element and the light receiving element constituting the authenticity detecting sensor are disposed together in a second component separate from a first component provided at the bill insertion port side of the bill transport unit and the bill transport unit. Light emitted from the light emitting element of the insertion detecting sensor is incident on the light receiving element of the insertion detecting sensor through optical transmission means for the insertion detection sensor, and light emitted from the light emitting element of the authenticity detecting sensor is incident on the light receiving element of the authenticity detecting sensor through optical transmission means for the authenticity detecting sensor.

**[0007]** According to this bill validator, the light emitting element and the light receiving element constituting the insertion detecting sensor, and the light emitting element and the light receiving element constituting the authenticity detecting sensor are disposed together in the second component separate from the first component provided at the bill insertion port side in the bill transport unit and the bill transport unit. Therefore, operations for assembly and wiring of the light emitting elements and the light receiving elements constituting the respective sensors can be performed extremely simply, and thereby, the manufacture cost can be reduced. In addition, the light emitting elements and the light receiving elements constituting the respective sensors are disposed together in the second component. Therefore, the operation of inspection, cleaning and the like for the respective sensors can be performed extremely easily, and thereby, the maintenance cost can be reduced.

**[0008]** The above object and other objects, features and advantages of the present invention will become apparent from the following description and accompanying drawings.

**[0009] In the Drawings;**

FIG. 1 is a perspective view of a bill validator seen from the front side, showing one embodiment of the present invention;

FIG. 2 is a perspective view of the bill validator shown in FIG. 1 seen from the rear side;

FIG. 3 is a rear view of the bill validator shown in FIGS. 1 and 2;

FIG. 4 is a sectional view taken along the line s1-s1 of FIG. 3;

FIG. 5 (A) is a partial enlarged horizontal sectional view showing a disposition mode of an insertion detecting sensor, a first optical transmission element

and a second optical transmission element shown in FIG. 4;

FIG. 5 (B) is a partial enlarged horizontal sectional view showing a disposition mode of authenticity detecting sensors and third optical transmission elements shown in FIG. 4;

FIG. 6(A) is a correlation diagram of FIG. 5(A) with a rear chute opened;

FIG. 6(B) is a correlation diagram of FIG. 5 (B) with a rear chute opened;

FIG. 7(A) is a view showing a modified example of the sensor and optical transmission elements relating to an insertion detection;

FIG. 7 (B) is a view showing a modified example of the sensors and optical transmission elements relating to an authenticity detection; and

FIG. 8 is a view showing another modified example of the sensors and optical transmission elements relating to an authenticity detection.

Detailed description of the invention

**[0010]** FIGS. 1 to 6 show one embodiment of the present invention (bill validator). FIG. 1 is a perspective view of a bill validator seen from the front side. FIG. 2 is a perspective view of the bill validator seen from the rear side. FIG. 3 is a rear view of the bill validator shown in FIGS. 1 and 2. FIG. 4 is a sectional view taken along the line s1-s1 of FIG. 3. FIG. 5(A) is a partial enlarged horizontal sectional view showing the disposition mode of an insertion detecting sensor, a first optical transmission element and a second optical transmission element shown in FIG. 4. FIG. 5 (B) is a partial enlarged horizontal sectional view showing the disposition mode of authenticity detecting sensors and third optical transmission elements shown in FIG. 4. FIG. 6(A) is a correlation diagram of FIG. 5 (A) with a rear chute opened. FIG. 6 (B) is a correlation diagram of FIG. 5 (B) with a rear chute opened.

**[0011]** First, the mechanism of the bill validator shown in FIGS. 1 to 6 will be described.

**[0012]** The bill validator shown in FIGS. 1 to 6 includes a main frame 10, a base box 20, a front chute 30, a bill transport unit 40, a rear chute 50, a mask 60, a bill storing cassette 70, a lock releasing lever 80 for the rear chute, and a locking lever 90 for the bill storing cassette.

**[0013]** The base box 20 has a box shape with the top surface and the rear surface opened, and has its front surface fixed to the lower portion of the rear surface of the main frame 10. The base box 20 has a bill storing plate 21 in the shape of a vertically oriented rectangle for pushing in and storing a bill PM into the bill storing cassette 70, a link mechanism 22 longitudinally translating the bill storing plate 21, a storage drive source (not illustrated) having a motor, a reduction gear and a drive lever, bearing holes 23 for the rear chute, which are provided at the left and right of the rear side of the upper portion so that their center lines are oriented in the lateral direction, and bearing holes (no reference numeral) for the bill storing cassette, which are provided at the left and right of the rear side of the lower portion so that their center lines are oriented in the lateral direction.

**[0014]** The link mechanism 22 has a pair of upper links 22a at the left and right with each upper end rotatably connected to the bill storing plate 21 and each lower end rotatably connected to the base box 20, a pair of lower links 22b at the left and right with each upper end rotatably connected to the base box 20 and each lower end rotatably connected to the bill storing plate 21, and an operation shaft 22c shared by the upper link 22a and the lower link 22b. The drive lever of the storage drive source is engaged with the operation shaft 22c, and with the longitudinal movement of the drive lever, the link mechanism 22 changes its form to translate the bill storing plate 21 back and forth.

**[0015]** The front chute 30 has a substantially rectangular shape as a whole, and has its front surface fixed to the upper portion of the rear surface of the main frame 10. The front chute 30 has an upper curved part 31 jutting out rearward, a lower curved part 32 jutting out forward, four rollers 33 in total provided rotatably with spaces provided vertically and laterally with parts of them exposed rearward, a bill transport unit mounting part (not illustrated), a first optical transmission element 34, and locking pieces 35 in a laterally-oriented rectangular shape provided at both sides of the upper portion and projected rearward.

**[0016]** The two rollers 33 at the right side of the four rollers 33 in total correspond to the upper and lower positions of the front side of an endless belt 43 at the right side of the bill transport unit 40 and their exposed portions are in contact with the endless belt 43. The two rollers 33 at the left side correspond to the upper and lower positions of the front side of the endless belt 43 at the left side of the bill transport unit 40, and their exposed portions are in contact with the endless belt 43.

**[0017]** The first optical transmission element 34 is formed into a U shape from a transparent material such as transparent plastic and transparent glass, and is disposed in the front chute 30 so as to be exposed at the position in which both ports (end surfaces) face the lower portion of the front surface of a unit main body 41 of the bill transport unit 40.

**[0018]** Each of the locking pieces 35 is capable of deforming in the lateral direction by resilience, and is provided with an incline surface 35a in the inner side of the rear end of each of them, and a locking hole 35b with its center line oriented in the lateral direction is provided at the intermediate position in the substantially longitudinal direction. The lateral space of the outer surfaces of both the locking pieces 35 substantially corresponds to the lateral dimension of the rear chute 50.

**[0019]** The bill transport unit 40 has the shape of a substantially rectangular parallelepiped as a whole, and is attachabley and detachably mounted to the bill transport unit mounting part of the front chute 30. The bill trans-

port unit 40 has the unit main body 41, pulleys 42 rotatably provided at the left and right of the upper portion of the unit main body 41, pulleys 42 rotatably provided at the left and right of the lower part of the unit main body 41 through a common rotary shaft, two endless belts 43 respectively wound around the two pulleys 42 at the left side and the two pulleys 42 at the right side so as to face both side portions in the width direction of the bill PM, a driven gear (not illustrated) coaxially connected to the lower pulley 42 at the left side, two second optical transmission elements 44, and two third optical transmission elements 45.

**[0020]** Each of the second optical transmission elements 44 is formed into an L shape from a transparent material such as transparent plastic and transparent glass. One (lower side of FIG. 5 (A) ) of the second optical transmission elements 44 is disposed in the unit main body 41 of the bill transport unit 40 so that one (lower side of FIG. 5(A)) of ports (end surfaces) is exposed at one side surface (lower side surface of FIG. 5 (A) ) of the unit main body 41 of the bill transport unit 40 to face a light emitting element 54a of the insertion detecting sensor, and the other one (upper side of FIG. 5(A)) of the ports (end surfaces) is exposed at the front surface of the unit main body 41 of the bill transport unit 40 to face one (lower side of FIG. 5(A)) of the ports of the first optical transmission element 34.

**[0021]** The other one (upper side of FIG. 5(A)) of the second optical transmission elements 44 is disposed in the unit main body 41 of the bill transport unit 40 so that one (lower side of FIG. 5(A)) of ports (end surfaces) is exposed at the front surface of the unit main body 41 of the bill transport unit 40 to face the other one (upper side of FIG. 5 (A)) of the ports of the first optical transmission element 34, and the other one (upper side of FIG. 5(A)) of the ports (end surfaces) is exposed at the other side surface (upper side surface of FIG. 5(A)) of the unit main body 41 of the bill transport unit 40 to face a light receiving element 55a of the insertion detection sensor.

**[0022]** Each of the third optical transmission elements 45 is formed into an L shape from a transparent material such as transparent plastic and transparent glass. One (lower side of FIG. 5(B)) of the third optical transmission elements 45 is disposed in the unit main body 41 of the bill transport unit 40 so that one (upper side of FIG. 5(B)) of ports (end surfaces) is exposed at the rear surface of the unit main body 41 of the bill transport unit 40 to face a light emitting element 53a of one of the authenticity detecting sensors, and the other one (lower side of FIG. 5(B)) of the ports (end surfaces) is exposed at one side surface (lower side surface of FIG. 5(B)) of the unit main body 41 of the bill transport unit 40 to face a light receiving element 54b of the one of the authenticity detecting sensors.

**[0023]** The other one (upper side of FIG. 5(B)) of the third optical transmission elements 45 is disposed in the unit main body 41 of the bill transport unit 40 so that one (upper side of FIG. 5(B)) of ports (end surfaces) is exposed at the rear surface of the unit main body 41 of the bill transport unit 40 to face a light emitting element 53b of the other one of the authenticity detecting sensors, and the other one (upper side of FIG. 5(B)) of the ports (end surfaces) is exposed at the other side surface (upper side surface of FIG. 5(B)) of the unit main body 41 of the bill transport unit 40 to face a light receiving element 55b of the other one of the authenticity detecting sensors.

**[0024]** More specifically, the two second optical transmission elements 44 and the two third optical transmission elements 45 are only disposed in the bill transport unit 40, and the light emitting element 54a and the light receiving element 55a constituting the insertion detecting sensor, the light emitting element 53a and the light receiving element 54b constituting one of the authenticity detecting sensors, and the light emitting element 53b and the light receiving element 55b constituting the other authenticity detecting sensor are not disposed in the bill transport unit 40.

**[0025]** For information, in the present embodiment, the aforementioned first optical transmission element 34 and the aforementioned second optical transmission element 44 correspond to "optical transmission means for the insertion detecting sensor" as set forth in claims, and the aforementioned third optical transmission element 45 corresponds to "optical transmission means for the authenticity detection sensor" as set forth in claims.

**[0026]** The rear chute 50 has the shape of a substantially rectangular parallelepiped as a whole. The rear chute 50 has a curved part 51 jutting out forward, four rollers 52 in total provided rotatably with spaces provided vertically and laterally and with parts of them exposed forward, a first board 53 loaded with the light emitting element 53a of one of the authenticity detecting sensors and the light emitting element 53b of the other authenticity detecting sensor at its left and right positions, a motor, a transport drive source (not illustrated) having a reduction gear and a drive gear, a second board 54 loaded with the light emitting element 54a of the insertion detecting sensor and the light receiving element 54b of one of the authenticity detecting sensors at its upper and lower positions, a third board 55 loaded with the light receiving element 55a of the insertion detecting sensor and the light receiving element 55b of the other authenticity detecting sensor at its upper and lower positions, support pieces 56 provided at the left and right of the rear side of the lower surface, shaft parts 57 provided at the respective support pieces 56 so that their center lines are oriented in the lateral direction, recessed parts (not illustrated) provided at the lower surface with a space provided laterally, in which the upper projected portions of engaging projections 93 at the left and right of a locking lever 90 are inserted, recessed parts 58 provided at both sides of the upper portion, engaging pins 59 provided at the inner side surfaces of the respective recessed parts 58, and a pair of support walls 59a at the left and right for a lock releasing lever provided at the top surface. The rear chute 50 has its left and right shaft portions 57 ro-

tatably inserted into the left and right bearing holes 23 at the upper portion of the base box 20, and is mounted to the base box 20 so as to be able to open and close by the rotation with the bearing portions as the support points.

**[0027]** The two rollers 52 at the right side of the four rollers 52 in total correspond to the upper and lower positions of the rear side of the endless belt 43 at the right side of the bill transport unit 40, and their exposed portions are in contact with the endless belt 43. The two rollers 52 at the left side correspond to the upper and lower positions of the rear side of the endless belt 43 at the left side of the bill transport unit 40, and their exposed portions are in contact with the endless belt 43.

**[0028]** The drive gear of the transport drive source is meshed with the driven gear of the bill transport unit 40 in the state in which the rear chute 50 is closed. Specifically, each of the endless belts 43 of the bill transport unit 40 rotates in a predetermined direction based on the rotational force transmitted from the drive gear (not illustrated) of the transport drive source to the driven gear (not illustrated) to perform bill transport.

**[0029]** The light emitting element 54a provided at the second board 54 and the light receiving element 55a provided at the third board 55 constitute the insertion detection sensor, and as shown by the arrows in FIG. 5 (A) , the light emitted from the light emitting element 54a is incident on the light receiving element 55a through the second optical transmission element 44 at the lower side, the first optical transmission element 34 and the second optical transmission element 44 at the upper side. The signal relating to the change in the intensity of the light detected by the light receiving element 55a when the bill PM passes between the first optical transmission element 34 and the two second optical transmission elements 44 is sent to a controller (not illustrated) having an insertion determining function.

**[0030]** The light emitting element 53a provided at the first board 53 and the light receiving element 54b provided at the second board 54 constitute one of the authenticity detecting sensors, and as shown by the arrows in FIG. 5(B), the light emitted from the light emitting element 53a is incident on the light receiving element 54b through the third optical transmission element 45 at the lower side. Further, the light emitting element 53b provided at the first board 53 and the light receiving element 55b provided at the third board 55 constitute the other authenticity detecting sensor, and as shown by the arrows in FIG. 5(B), the light emitted from the light emitting element 53b is incident on the light receiving element 55b through the third optical transmission element 45 at the upper side. The signals relating to the change of the intensity of the light detected by the light receiving elements 54b and 55b when the bill PM passes between the light emitting element 53a and the one third optical transmission element 45 and between the light emitting element 53b and the other third optical transmission element 45 are respectively sent to the controller having an authenticity determining function.

**[0031]** Specifically, the light emitting element 54a and the light receiving element 55a constituting the insertion detecting sensor, the light emitting element 53a and the light receiving element 54b constituting one of the authenticity detecting sensors, and the light emitting element 53b and the light receiving element 55b constituting the other authenticity detecting sensor are disposed together in the rear chute 50 located at the rear side of the bill transport unit 40.

**[0032]** The center line of each of the engaging pins 59 is oriented in the lateral direction, and each of the diameters is slightly smaller than the diameter of the locking hole 35b of the locking piece 35, and each length is preferably shorter than the lateral space of the recessed part 58. A bearing hole (no reference numeral) for the lock releasing lever, provided so that its center line is oriented in the lateral direction is formed at each of the support walls 59a.

**[0033]** The mask 60 has a box shape with the rear surface opened, and the rear surface is fixed to the front surface of the main frame 10. The mask 60 has a laterally-oriented bill insertion port 61 extending from the front surface to the rear surface, and a curved part 62 jutting rearward from the lower portion of the rear end of the bill insertion port 61.

**[0034]** The bill storing cassette 70 has a box shape with the top surface and the front surface opened. The bill storing cassette 70 has vertically-oriented rails 71 provided along the left and right edges of the front surface opening, a cassette plate 72 in the shape of a vertically-oriented rectangle having the lateral width slightly larger than the lateral space of both the rails 71 and disposed at the rear side of both the rails 71, a coil spring 73 in the shape of a truncated cone biasing the cassette plate 72 forward, an opening 74 in a substantially U-shape provided in the upper portion of the rear surface, shaft portions 75 provided at the lower portions of the left and right surfaces so that their center lines are oriented in the lateral direction, an L-shaped support part 76 for supporting an elastic ring 94 of the locking lever 90 provided at the inner side of the rear surface, and insertion holes 77 for projecting left and right engaging projections 93 of the locking lever 90, which are provided in the top surface with a space in the lateral direction, upward. The bill storing cassette 70 has the left and right shaft portions 75 rotatably inserted in the left and right bearing holes of the lower portion of the base box 20, and is mounted to the base box 20 so as to be able to open and close by the rotation with the bearing portions as the support points.

**[0035]** The vertical dimension of the cassette plate 72 is smaller than the vertical dimension of the bill PM, and the cassette plate 72 is disposed so that its upper end is lower than the upper end of the stored bill PM, whereby the upper portion of the stored bill PM is exposed at the upper side of the cassette plate 72.

**[0036]** The lock releasing lever 80 has a rectangular pressing part 81, an attitude control part 82 with an L-

shaped vertical section extending forward from the rear end of the pressing part 81, elastic pieces 83 provided at both the left and right sides of the attitude control part 82, a shaft part 84 provided at each of the elastic pieces 83 so that its center line is oriented in the lateral direction, bar-shaped parts 85 provided at both the left and right sides of the pressing part 81 and extending in the lateral direction, and an operation part 86 provided at the tip end of each of the bar-shaped parts 85. The lock releasing lever 80 is mounted to the top surface of the rear chute 50 by inserting the respective shaft parts 84 into the bearing holes of the left and right support walls 59a of the rear chute 50 by bending both the elastic pieces 83 inward so that the tilting operation with the bearing portions as the support points can be performed. Further, in this mounting state, the attitude control part 82 is close to an upper projecting part 11 of the main frame 10, so that the angle restriction when the pressing part 81 tilts in such a manner as to be lifted up can be performed by contact of the attitude control part 82 with the upper projecting part 11.

**[0037]** Each of the operation parts 86 has a substantially triangular shape in vertical section, and each outer surface forms an inclined surface 86a which inclines toward the inner side. The lateral space between the lower ends of both the operation parts 86 is slightly smaller than the lateral space between the inner surfaces of the left and right locking pieces 35 of the front chute 30.

**[0038]** The locking lever 90 has a main body 91 forming a substantially U-shape as a whole, a U-shaped pressing part 92 provided to project rearward from the upper edge of the U-shape of the main body 91, the engaging projections 93 provided at the left and right upper sides of the main body 91, and the elastic ring 94 provided at the lower portion of the main body 91. The locking lever 90 is mounted movably in the vertical direction to the inner side of the rear surface of the bill storing cassette 70 by inserting the lower portion of the elastic ring 94 into the support part 76 of the bill storing cassette 70, and inserting the left and right engaging projections 93 into the insertion holes 77 of the bill storing cassette 70.

**[0039]** The U-shaped pressing part 92 of the locking lever 90 is located at the opening 74 of the bill storing cassette 70, but since the pressing part 92 itself is in the U-shape, it does not closes the opening 74 in the closed state which will be described later, and the U-shaped gap formed at the upper side of the U-shaped pressing part 92 functions as an inspection window IW when confirming the presence or absence of the bill PM by direct sight (meaning directly look at the bill itself through nothing).

**[0040]** In the aforementioned bill validator, when the rear chute 50 is in the closed state, the left and right engaging pins 59 of the rear chute 50 are respectively inserted in the locking holes 35b of the left and right locking pieces 35 of the front chute 30. When the rear chute 50 in the closed state is to be opened, the inclined surfaces 86a of the left and right operation parts 86 are pushed in the inner sides of the left and right locking pieces 35 of the front chute 30 by pressing the pressing part 81 of the lock releasing lever 80 downward with a finger tip to extend the left and right locking pieces 35 outward to release the insertion of the left and right engaging pins 59 into the left and right locking holes 35b. Further, when the rear chute 50 in the open state is brought into a closed state, the rear chute 50 is returned to the closed position by rotation with the bearing portions as the support points, and while the left and right locking pieces 35 of the front chute 30 are extended outward by the left and right engaging pins 59, the left and right engaging pins 59 are respectively inserted into the locking holes 35b of the left and right locking pieces 35.

**[0041]** When the rear chute 50 is in the closed state, the bill transport unit 40 is sandwiched by the front chute 30 and the rear chute 50 at its front and rear, and with the existence of the upper curved part 31 and the curved part 51, a bill passage BP in an inversed U-shape including the boundary surface of the respective endless belts 43 and each of the rollers 33 and 52 is formed around the bill transport unit 40. The lower end of the front side of the bill passage BP communicates with the rear end of the bill insertion port 61 via the curved part 62 of the mask 60.

**[0042]** Meanwhile, when the bill storing cassette 70 is in the closed state, the upper side of the main body 91 abuts on the inner side of the top surface of the bill storing cassette 70 by the urging force of the elastic ring 94 of the locking lever 90, the left and right engaging projections 93 project upward, and the upward projecting portions of both the engaging projections 93 are inserted into the left and right recessed portions of the lower surface of the rear chute 50. When the bill storing cassette 70 in the closed state is to be opened, the U-shaped pressing part 92 of the locking lever 90 is pushed downward with a finger tip up to the position in which its lower end abuts on the lower end of the opening 74 to extract the left and right engaging projections 93 from the left and right recessed portions of the lower surface of the rear chute 50. Further, when the bill storing cassette 70 in the open state is to be brought into a closed state, the bill storing cassette 70 is returned to the closed position by the rotation with the bearing portions as the support points, then the U-shaped pressing part 92 of the locking lever 90 is pressed downward with a finger tip up to the position in which its lower end abuts on the lower end of the opening 74 to release the pressure, and the left and right engaging projections 93 are inserted into the left and right recessed portions of the lower surface of the rear chute 50 by the elastic restoring force of the elastic ring 94.

**[0043]** Next, the operation of the bill validator shown in FIGS. 1 to 6 will be described.

**[0044]** When the bill validator is in the operable state, the light emitted from the light emitting element 54a of the insertion detecting sensor is incident on the light receiving element 55a through the second optical transmission element 44 at the lower side, the first optical

transmission element 34 and the second optical transmission element 44 at the upper side (see the arrows in FIG. 5(A)). Further, the light emitted from the light emitting element 53a of one of the authenticity detecting sensors is incident on the light receiving element 54b through the third optical transmission element 45 at the lower side, and the light emitted from the light emitting element 53b of the other authenticity detecting sensor is incident on the light receiving element 55b through the third optical transmission element 45 at the upper side (see the arrows in FIG. 5 (B) ) .

**[0045]** When the bill PM (a 1000-yen note, a 2000-yen note, a 5000-yen note, a 10000-yen note) is inserted into the bill insertion port 61 of the mask 60, and the tip end portion of the bill PM passes between the first optical transmission element 34 and the two second optical transmission elements 44, the intensity of the light which is incident on the first optical transmission element 34 from one of the second optical transmission elements 44, and the intensity of the light which is incident on the other second optical transmission element 44 from the first optical transmission element 34 change, the changes in light intensities are detected by the light receiving element 55a, and the signals are sent to the controller to determine the bill insertion.

**[0046]** When the determination result is that the bill is present, the motor of the transport drive source starts rotation, whereby each of the endless belts 43 of the bill transport unit 40 starts rotation, and the inserted bill PM is transported along the bill passage BP.

**[0047]** When the tip end portion and its rear portion of the bill PM under transport pass between the light emitting element 53a and one of the third optical transmission elements 45 and between the light emitting element 53b and the other third optical transmission element 45, the intensity of the light incident on the one of the third optical transmission elements 45 from the light emitting element 53a changes, and the intensity of the light incident on the other third optical transmission element 45 from the light emitting element 53b changes. The changes of the respective light intensities are detected by the light receiving elements 54b and 55b, the signals are sent to the controller, where the bill authenticity is determined, and when the bill is authentic, the kind of the bill (a 1000-yen note, a 2000-yen note, a 5000-yen note, a 10000-yen note) is also determined.

**[0048]** When the determination result is authentic, bill transport is continued and the bill PM is sent up to the bill storing position (the position where the bill PM reaches the front side of the bill storing plate 21, see the broken line in FIG. 4), where the bill transport is stopped. Specifically, when the bill PM inserted into the bill insertion port 61 is authentic, the bill PM reaches the bill storing position by one continuous transport.

**[0049]** When the bill transport is stopped, the motor of the storage drive source starts rotation, and thereby, the form of the link mechanism 22 changes to translate the bill storing plate 21 leftward. The bill PM located at the bill storing position moves leftward together with the bill storing plate 21 to press and retreat the cassette plate 72 against the urging force of the coil spring 73, and is pushed into the bill storing cassette 70 in such a manner as to ride over the left and right rails 71. After the bill is pushed in, the motor of the storage drive source further rotates to return the link mechanism 22 and the bill storing plate 21 to the original positions, and the bill PM is stored in the state in which both of its side portions in the width direction are held by the left and right rails 71 and the cassette plate 72.

**[0050]** Meanwhile, when the determination result of authenticity is inauthentic (including the unidentifiable case), the motor 105 of the transport drive source rotates in the reverse direction, whereby each of the endless belts of the bill transport unit 40 rotates in the reverse direction, and the bill PM under transport is transported toward the bill insertion port 61 and returned.

**[0051]** The above operation is repeated each time the bill PM is inserted into the bill insertion port 61 of the mask 60, and the authentic bill PM is stored in layer on the rear surface of the cassette plate 72.

**[0052]** When operations of inspection, cleaning and the like for each of the sensors are performed, by the operation of the lock releasing lever 80, the rear chute 50 is opened as shown in FIGS. 6(A) and 6(B). The light emitting elements 54a, 53a and 53b and the respective light receiving elements 55a, 54b and 55b constituting the respective sensors are disposed together in the rear chute 50 located at the rear side of the bill transport unit 40, and therefore, the operations of inspection, cleaning and the like for the respective sensors can be easily performed by opening the rear chute 50.

**[0053]** Further, when the operations of inspection, cleaning and the like are to be performed for the respective optical transmission elements 34, 44 and 45, the rear chute 50 is opened, and thereafter, the bill transport unit 40 is detached from the front chute 30. The light emitting elements 54a, 53a and 53b and the respective light receiving elements 55a, 54b and 55b constituting the respective sensors are not disposed, or wiring is not placed in the bill transport unit 40. Therefore, the bill transport unit 40 can be extremely easily detached, and by detachment of the bill transport unit 40, the operations of inspection, cleaning and the like for the respective optical transmission elements 34, 44 and 45 can be performed extremely easily.

**[0054]** Thus, according to the aforementioned bill validator, all of the light emitting element 54a and the light receiving element 55a constituting the insertion detection sensor, the light emitting element 53a and the light receiving element 54b constituting one of the authenticity detecting sensors and the light emitting element 53b and the light receiving element 55b constituting the other authenticity detecting sensor are disposed together in the rear chute 50 located at the rear side of the bill transport unit 40. Therefore, the operations for assembly and wiring of the light emitting elements 54a, 53a and 53b and

the light receiving elements 55a, 54b and 55b constituting the respective sensors can be performed extremely easily, and thereby, the manufacture cost can be reduced. In addition, the light emitting elements 54a, 53a and 53b and the light receiving elements 55a, 54b and 55b constituting the respective sensors are disposed together in the rear chute 50. Therefore, by opening the rear chute 50, the operations of inspection, cleaning and the like for the respective sensors can be performed extremely easily, and thereby, the maintenance cost can be reduced.

**[0055]** Further, none of the light emitting elements 54a, 53a and 54b and the light receiving elements 55a, 54b and 55b constituting the respective sensors is disposed or wiring is not placed in the bill transport unit 40. Therefore, the bill transport unit 40 can be extremely easily detached, and by detachment of the bill transport unit 40, the operations of inspection, cleaning and the like for the respective optical transmission elements 34, 44 and 45 can be performed extremely easily.

**[0056]** FIG. 7 (A) shows a modified example of the sensor and optical transmission elements according to insertion detection. The points in which the modified example differs from the structure shown in FIG. 5(A) are (1) the light emitting element 54a and the light receiving element 55a constituting the insertion detecting sensor are mounted on the first board 53, and (2) the bar-shaped element is used as a second optical transmission element 46, one (lower side of FIG. 7(A)) of the second optical transmission elements 46 is disposed in the unit main body 41 of the bill transport unit 40 so that one (left side of FIG. 7 (A)) of the ports (end surfaces) is exposed at the rear surface of the unit main body 41 of the bill transport unit 40 to face the light emitting element 54a of the insertion detecting sensor, and the other one (right side of FIG. 7 (A) ) of the ports (end surfaces) is exposed at the front surface of the unit main body 41 of the bill transport unit 40 to face one (lower side of FIG. 7 (A)) of the ports of the first optical transmission element 34, and the other one (upper side of FIG. 7 (A)) of the second optical transmission elements 46 is disposed in the unit main body 41 of the bill transport unit 40 so that one (right side of FIG. 7(A)) of the ports (end surfaces) is exposed at the front surface of the unit main body 41 of the bill transport unit 40 to face the other one (upper side of FIG. 7(A)) of the ports of the first optical transmission element 34, and the other one (left side of FIG. 7 (A) ) of the ports (end surfaces) is exposed at the rear surface of the unit main body 41 of the bill transport unit 40 to face the light receiving element 55a of the insertion detecting sensor. By adopting such a structure, determination of bill insertion can be also performed under the similar principle to the structure shown in FIG. 5(A), and the similar operation and effect to the aforementioned one can be obtained.

**[0057]** For information, in the present modified example, the aforementioned first optical transmission element 34 and the aforementioned second optical transmission element 46 correspond to "optical transmission means for the insertion detecting sensor" as set forth in claims.

**[0058]** FIG. 7(B) shows a modified example of the sensors and the optical transmission elements relating to authenticity detection. The points in which the modified example differs from the structure shown in FIG. 5(B) are (1) the light receiving element 54b of one of the authenticity detecting sensors and the light receiving element 55b of the other authenticity detecting sensor are mounted on the first board and the second board 54 and the third board 55 are excluded, and (2) two of fourth optical transmission elements 47 each forming an L-shape are used, one (lower side of FIG. 7(B)) of the fourth optical transmission elements 47 is disposed in the rear chute 50 so that one (upper side in FIG. 7(B)) of the ports (end surfaces) faces the other one (lower side of FIG. 7 (B)) of the ports of one (lower side of FIG. 7 (B)) of the third optical transmission elements 45, and the other port (left side of FIG. 7(B)) faces the light receiving element 54b of one of the authenticity detecting sensors, and the other one (upper side of FIG. 7(B)) of the fourth optical transmission elements 47 is disposed in the rear chute 50 so that one (lower side of FIG. 7(B)) of the ports (end surfaces) faces the other one (upper side of FIG. 7(B)) of the ports of the other one (upper side of FIG. 7(B)) of the third optical transmission elements 45, and the other port (left side of FIG. 7 (B) ) faces the light receiving element 55b of the other one of the authenticity detecting sensors. By adopting such a structure, determination of bill authenticity can be also performed under the similar principle to the structure shown in FIG. 5(B), and the similar operation and effect to the aforementioned one can be also obtained.

**[0059]** For information, in the present modified example, the aforementioned third optical transmission element 45 and the aforementioned fourth optical transmission element 47 correspond to "optical transmission means for the authenticity detecting sensor" as set forth in claims.

**[0060]** FIG. 8 shows another modified example of the sensors and optical transmission elements relating to authenticity detection. The points in which the modified example differs from the structure shown in FIG. 5 (B) are (1) the light receiving element 54b of one of the authenticity detecting sensors and the light receiving element 55b of the other authenticity detecting sensor are mounted on the first board, and the second board 54 and the third board 55 are excluded, and (2) as the third optical transmission elements, the ones forming a U-shape (reference numeral 48) are used, one (lower side of FIG. 8) of the third optical transmission elements 48 is disposed in the unit main body 41 of the bill transport unit 40 so that one (upper side of FIG. 8) of the ports (end surfaces) is exposed at the rear surface of the unit main body 41 of the bill transport unit 40 to face the light emitting element 53a of one of the authenticity detecting sensors, and the other one (lower side of FIG. 8) of the ports (end surfaces) faces the light receiving element 54b of the one of the authenticity detecting sensors, and the other one

(upper side of FIG. 8) of the third optical transmission elements 48 is disposed in the unit main body 41 of the bill transport unit 40 so that one (lower side of FIG. 8) of the ports (end surfaces) is exposed at the rear surface of the unit main body 41 of the bill transport unit 40 to face the light emitting element 53b of the other authenticity detecting sensor, and the other one (upper side of FIG. 8) of the ports (end surfaces) faces the light receiving element 55b of the other authenticity detecting sensor. By adopting such a structure, determination of the bill authenticity can be also performed under the similar principle to the structure shown in FIG. 5(B), and the similar operation and effect to the aforementioned one can be obtained.

**[0061]** For information, in the present modified example, the aforementioned third optical transmission element 48 corresponds to "light transmission means for the authenticity detecting sensor" as set forth in claims.

**[0062]** In the aforementioned embodiment and the aforementioned modified examples, the similar operation and effect to the aforementioned one can be obtained even when the transmission direction of the light is changed by replacing the disposed positions of the light emitting element 54a and the light receiving element 55a constituting the insertion detecting sensor, or even when the transmission direction of the light is changed by replacing the disposed positions of the light emitting elements 53a and 53b and the light receiving elements 54b and 55b constituting the authenticity detecting sensors.

**[0063]** Further, in the aforementioned embodiment and the aforementioned modified examples, the validators each including the one insertion detecting sensor and two authenticity detecting sensors are shown as examples, but the similar operation and effect to the aforementioned on can be obtained even when the number of the authenticity detecting sensors, and each of the numbers of the third and fourth optical transmission elements 45, 48 and 47 are respectively made one, and the similar operation and effect to the aforementioned one can be naturally obtained even when the number of the first to fourth optical transmission elements 34, 44, 46, 45, 48 and 47 is properly increased by changing the height positions, and two insertion detecting sensors or more, or three authenticity detecting sensors or more are disposed.

**[0064]** Further, in the aforementioned embodiment and the aforementioned modified examples, as the first to fourth optical transmission elements 34, 44, 46, 45, 47 and 48, the ones formed into the predetermined shapes from the transparent material such as transparent plastic and transparent glass are shown as examples, but each of the optical transmission elements can be replaced with optical fiber for optical transmission in accordance with necessity.

**[0065]** Furthermore, in the aforementioned embodiment and the aforementioned modified examples, as the bill transport device, the one having the bill passage BP forming the inversed U-shape is shown as an example, but it goes without saying that as long as the bill transport device includes an insertion detecting sensor for detecting insertion of a bill and an authenticity detecting sensor for detecting authenticity of the bill while the bill is transported along the bill passage, the similar operation and effect as the aforementioned one can be also obtained by applying the present invention.

**[0066]** The embodiments described in this description are to be considered as illustrative and no restrictive. The scope of the invention is indicated by the appended claims, and all the modified examples which come within the meaning of the claims are therefore intended to be embraced in the present invention.

## Claims

1. A bill validator comprising a bill transport unit (40) for transporting a bill (PM) inserted into a bill insertion port (61) along a bill passage (BP), an insertion detecting sensor constituted of a combination of a light emitting element (54a) and a light receiving element (55a) and for detecting insertion of the bill (PM) into the bill insertion port (61), and an authenticity detecting sensor constituted of a combination of a light emitting element (53a, 53b) and a light receiving element (54b, 55b) and for detecting authenticity of the bill (PM) while the bill (PM) is transported along the bill passage (BP);
wherein the light emitting element (54a) and the light receiving element (55a) constituting the insertion detecting sensor, and the light emitting element (53a, 53b) and the light receiving element (54b, 55b) constituting the authenticity detecting sensor are disposed together in a second component (50) separate from a first component (30) provided at the bill insertion port (61) side of the bill transport unit (40) and the bill transport unit (40) ; and
light emitted from the light emitting element (54a) of the insertion detecting sensor is incident on the light receiving element (55a) of the insertion detecting sensor through optical transmission means (34, 44, 46) for the insertion detection sensor, and light emitted from the light emitting element (53a, 53b) of the authenticity detecting sensor is incident on the light receiving element (54b, 55b) of the authenticity detecting sensor through optical transmission means (45, 47, 48) for the authenticity detecting sensor.

2. The bill validator according to claim 1,
wherein the optical transmission means (34, 44, 46) for the insertion detecting sensor comprises a first optical transmission element (34) provided in the first component (30) and a second optical transmission element (44, 46) provided in the bill transport unit (40).

3. The bill validator according to claim 1 or 2,

wherein the optical transmission means (45, 48) for the authenticity detecting sensor comprises a third optical transmission element (45, 48) provided in the bill transport unit (40) .

**4.** The bill validator according to claim 1 or 2,
wherein the optical transmission means (45, 47) for the authenticity detecting sensor comprises a third optical transmission element (45) provided in the bill transport unit (40), and a fourth optical transmission element (47) provided in the second component (50).

**5.** The bill validator according to claim 2,
wherein the bill passage (BP) has an inversed U-shape and is formed around the bill transport unit (40), the first component (30) is disposed at a front side of the bill transport unit (40), and the second component (50) is disposed at a rear side of the bill transport unit (40);
at least one first optical transmission element (34) is used, and the first optical transmission element (34) is disposed in the first component (30) so that both ports are exposed at a position facing a front surface of the bill transport unit (40) ; and
at least a pair of the second optical transmission elements (44) are used, one of the second optical transmission elements (44) is disposed in the bill transport unit (40) so that one port is exposed at one side surface of the bill transport unit (40) to face one of the light emitting element (54a) and the light receiving element (55a) of the insertion detecting sensor, and the other port is exposed at the front surface of the bill transport unit (40) to face one of the ports of the first optical transmission element (34), and the other second optical transmission element (44) is disposed in the bill transport unit (40) so that one port is exposed at the front surface of the bill transport unit (40) to face the other port of the first optical transmission element (34), and the other port is exposed at the other side surface of the bill transport unit (40) to face the other one of the light emitting element (54a) and the light receiving element (55a) of the insertion detecting sensor.

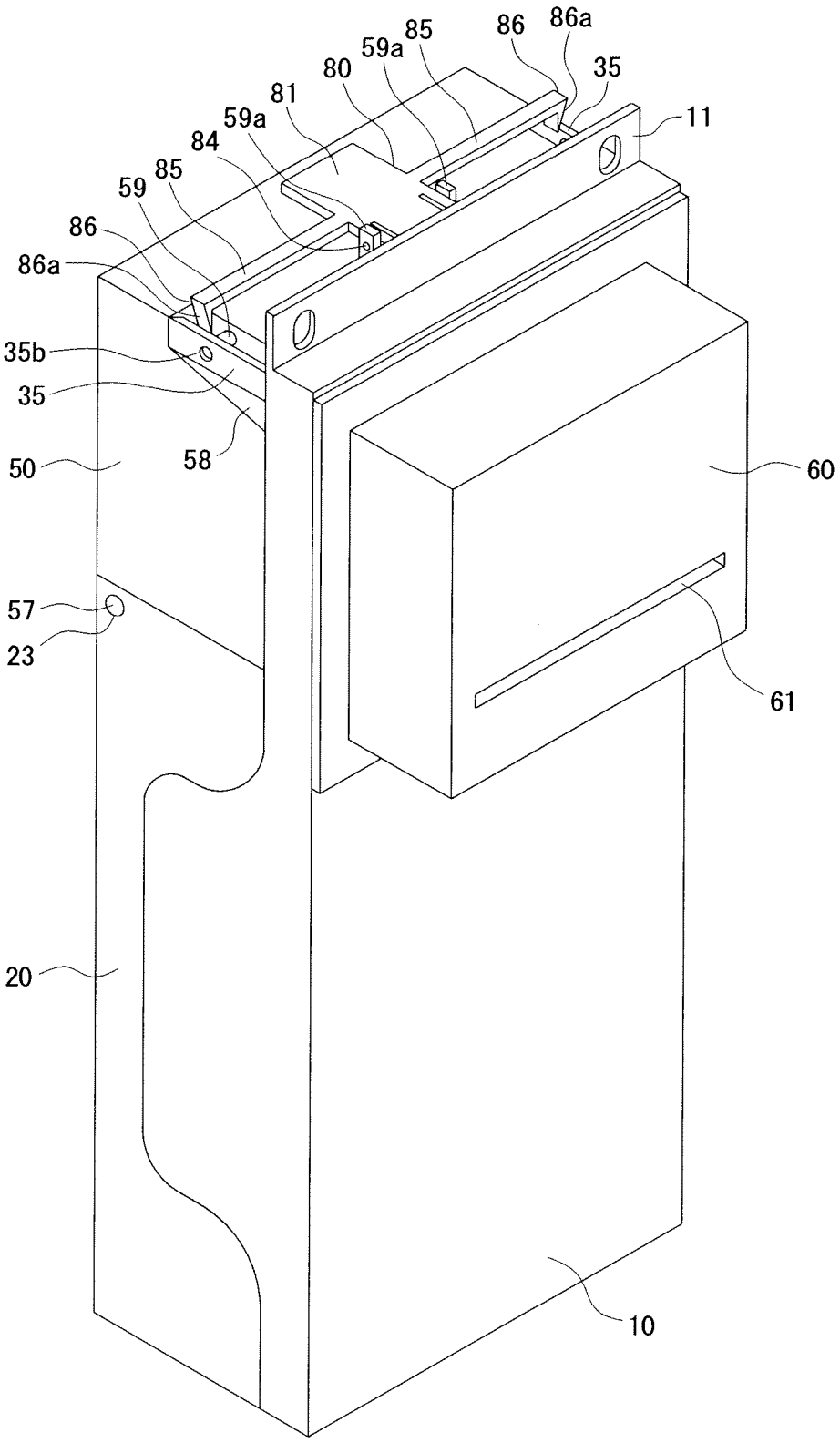
**6.** The bill validator according to claim 2,
wherein the bill passage (BP) has an inversed U-shape and is formed around the bill transport unit (40), the first component (30) is disposed at a front side of the bill transport unit (40), and the second component (50) is disposed at a rear side of the bill transport unit (40) ;
at least one first optical transmission element (34) is used, and the first optical transmission element (34) is disposed at the first component (30) so that both ports are exposed at a position facing a front surface of the bill transport unit (40) ; and
at least a pair of the second optical transmission elements (46) are used, one of the second optical transmission elements (46) is disposed in the bill transport unit (40) so that one port is exposed at a rear surface of the bill transport unit (40) to face one of the light emitting element (54a) and the light receiving element (55a) of the insertion detecting sensor, and the other port is exposed at the front surface of the bill transport unit (40) to face one of the ports of the first optical transmission element (34), and the other second optical transmission element (46) is disposed in the bill transport unit (40) so that one port is exposed at the front surface of the bill transport unit (40) to face the other port of the first optical transmission element (34), and the other port is exposed at the rear surface of the bill transport unit (40) to face the other one of the light emitting element (54a) and the light receiving element (55a) of the insertion detecting sensor.

**7.** The bill validator according to claim 3,
wherein the bill passage (BP) has an inversed U-shape and is formed around the bill transport unit (40), the first component (30) is disposed at a front side of the bill transport unit (40), and the second component (50) is disposed at a rear side of the bill transport unit (40); and
at least one third optical transmission element (45) is used, and the third optical transmission element (45) is disposed in the bill transport unit (40) so that one port is exposed at a rear surface of the bill transport unit (40) to face one of the light emitting element (53a, 53b) and the light receiving element (54b, 55b) of the authenticity detecting sensor, and the other port is exposed at a side surface of the bill transport unit (40) to face the other one of the light emitting element (53a, 53b) and the light receiving element (54b, 55b) of the authenticity detecting sensor.

**8.** The bill validator according to claim 4,
wherein the bill passage (BP) has an inversed U-shape and is formed around the bill transport unit (40), the first component (30) is disposed at a front side of the bill transport unit (40), and the second component (50) is disposed at a rear side of the bill transport unit (40);
at least one third optical transmission element (45) is used, and the third optical transmission element (45) is disposed in the bill transport unit (40) so that one port is exposed at the rear surface of the bill transport unit (40) to face one of the light emitting element (53a, 53b) and the light receiving element (54b, 55b) of the authenticity detecting sensor, and the other port is exposed at a side surface of the bill transport unit (40) ; and
at least one fourth optical transmission element (47) is used, and the fourth optical transmission element (47) is disposed in the second component (50) so that one port faces the other port of the third optical transmission element (45), and the other port faces

the other one of the light emitting element (53a, 53b) and the light receiving element (54b, 55b) of the authenticity detecting sensor.

Fig. 1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80
35
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86a
35b
35
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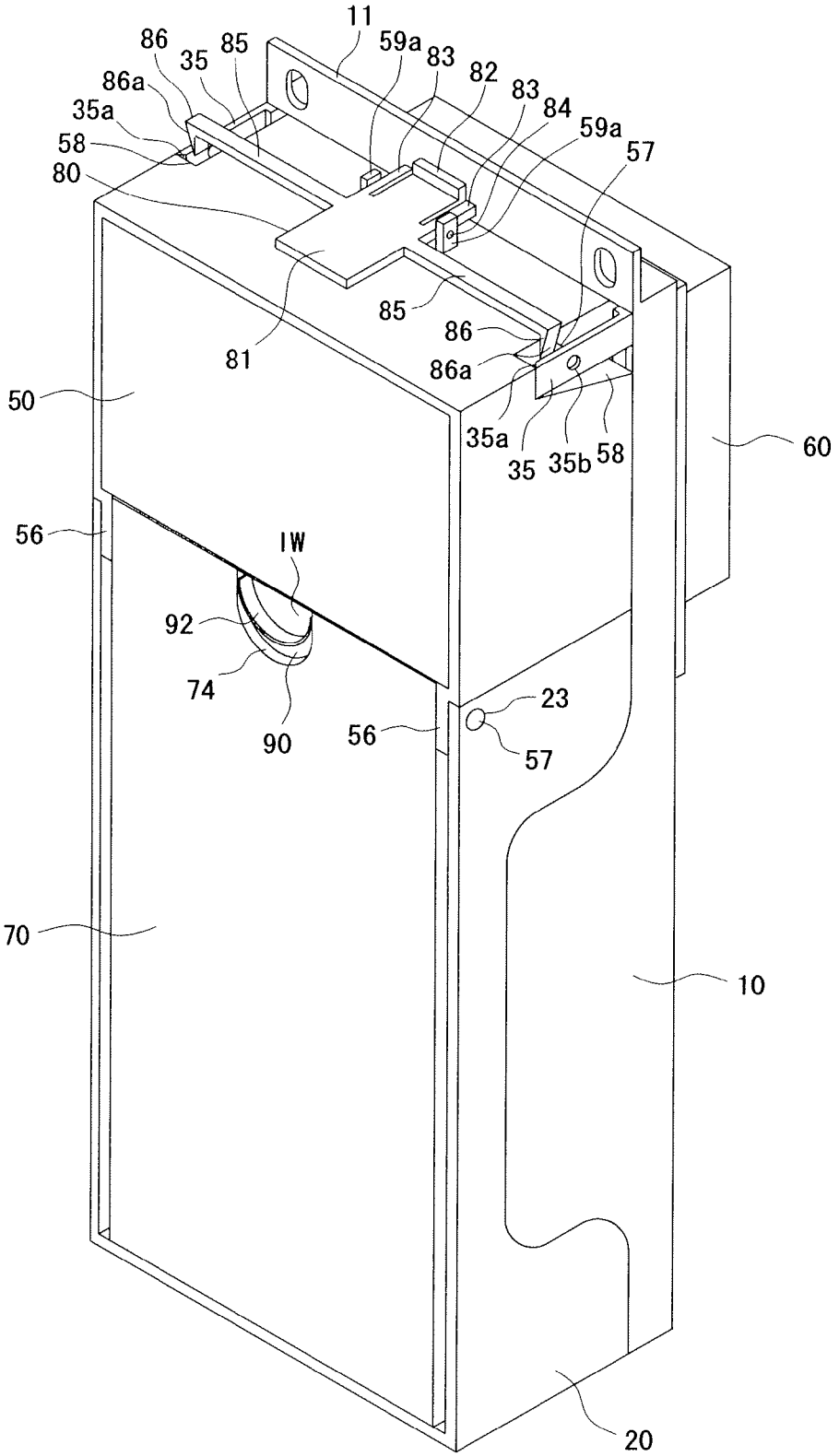
50
60
57
23
61
20
10

Fig. 2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59a
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85
86
86a
35a
35
35b
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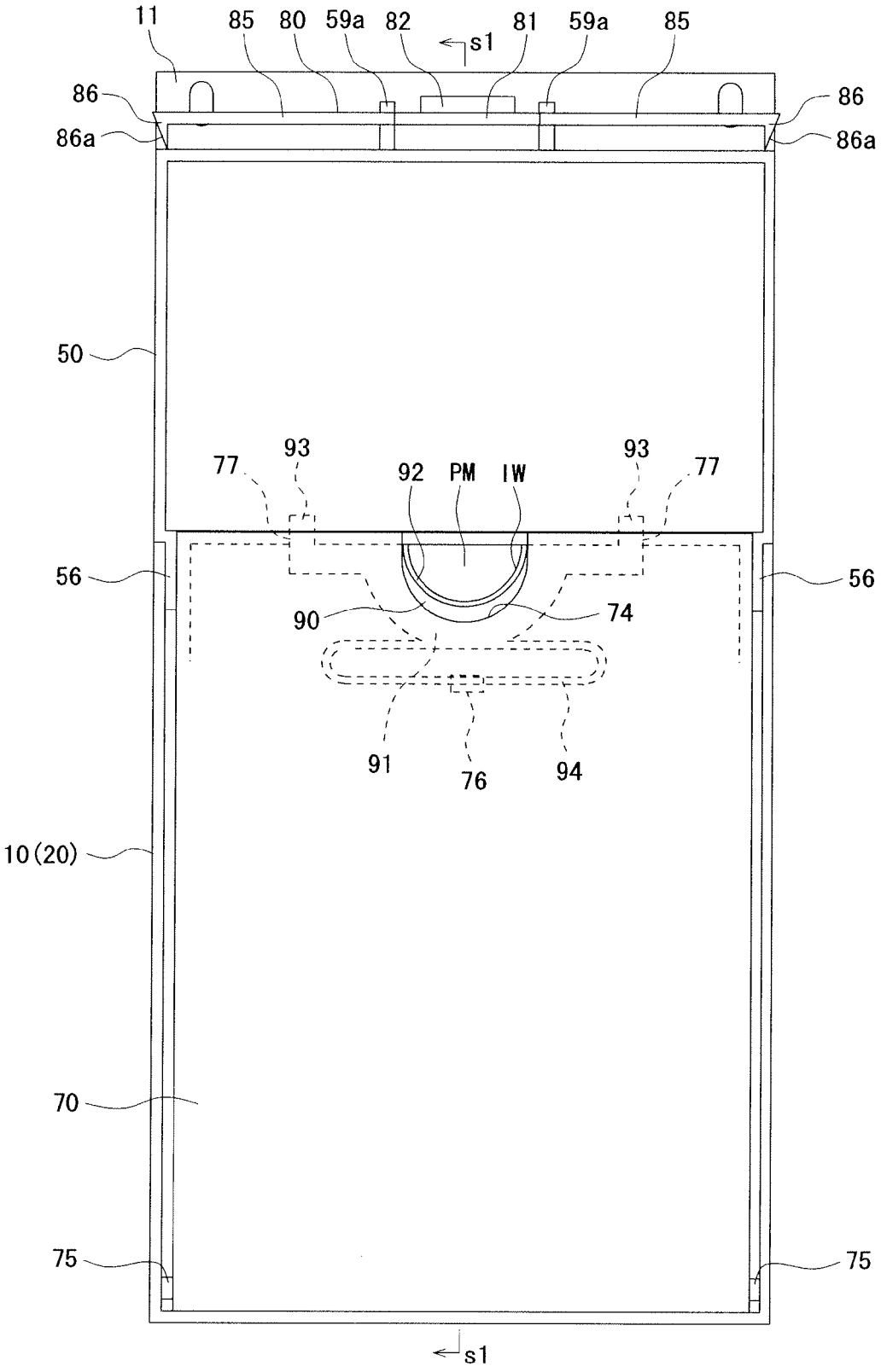
50
60
56
IW
92
74
90
56
23
57
70
10
20

Fig. 3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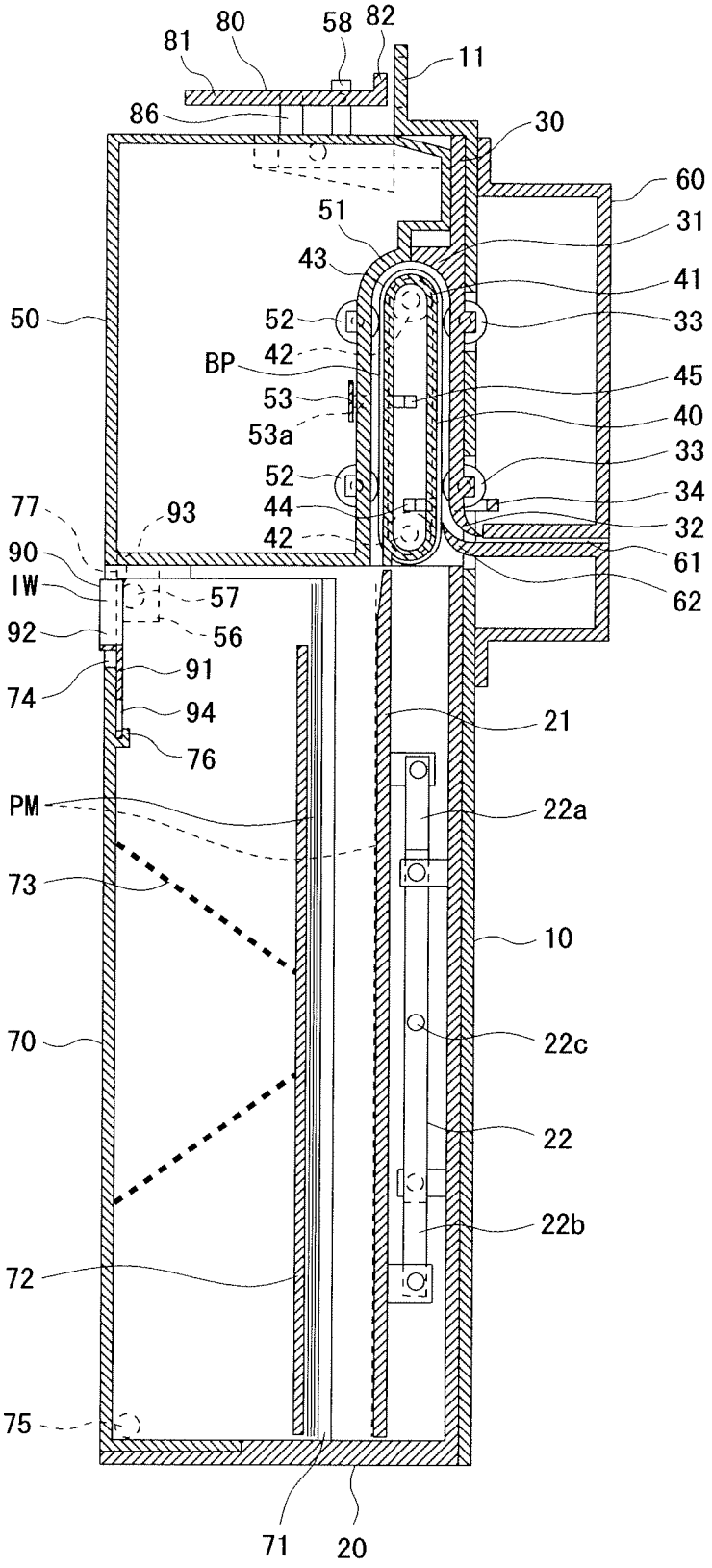
85
80
59a
82
s1
81
59a
85
86
86a
86
86a
50
77
93
92
PM
IW
93
77
56
56
90
74
91
76
94
10(20)
70
75
75
s1

Fig. 4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30
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43
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BP
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53
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52
33
34
77
93
44
32
90
42
61
IW
57
62
92
56
91
74
94
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PM
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73
10
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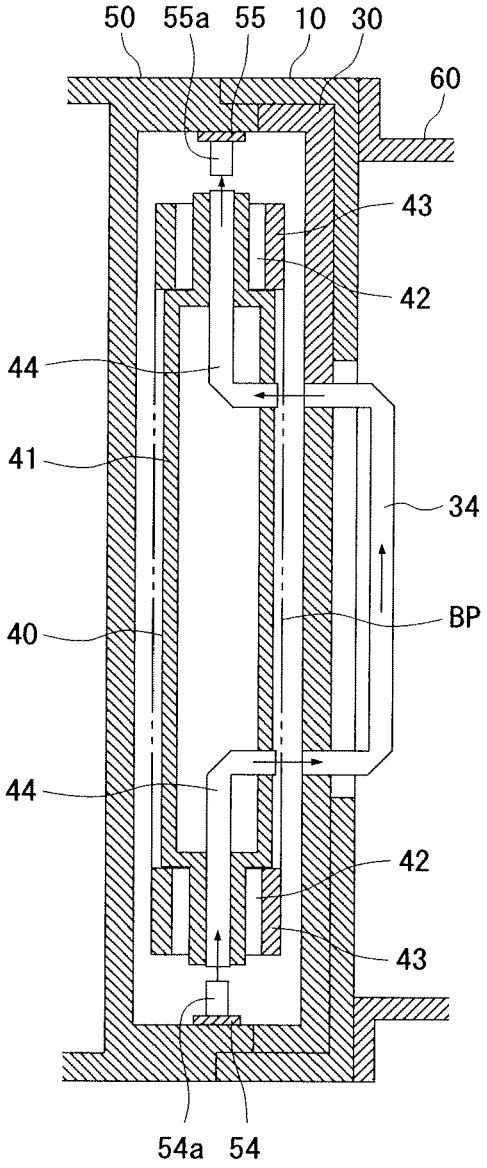
22c
22
22b
72
75
71
20

Fig. 5 (A)


50
55a
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60
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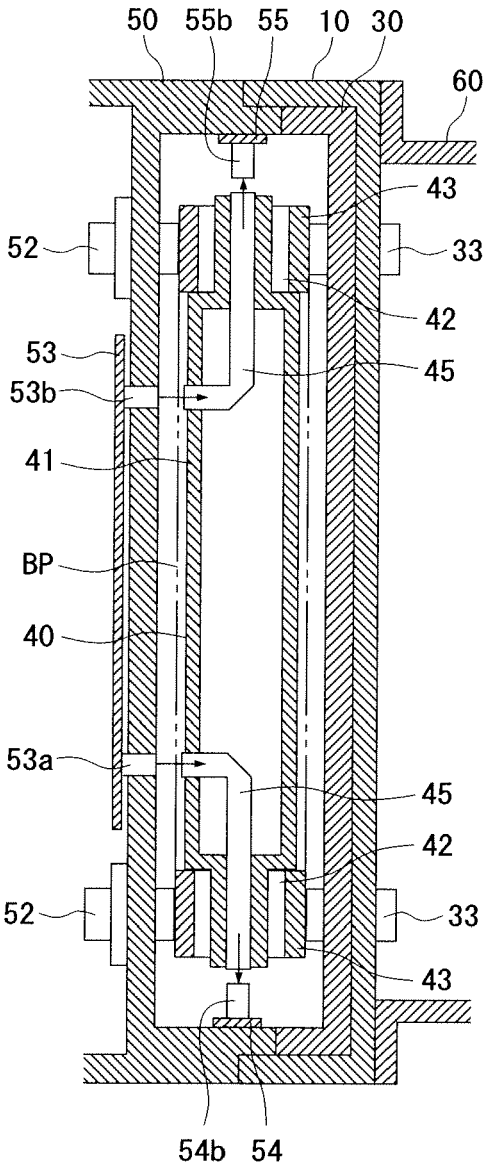
44
41
34
BP
40
44
42
43
54a
54

Fig. 5 (B)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55b
55
10
30
60
43
52
33
42
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45
53b
41
BP
40
53a
45
42
52
33
43
54b
54

Fig. 6 (A)

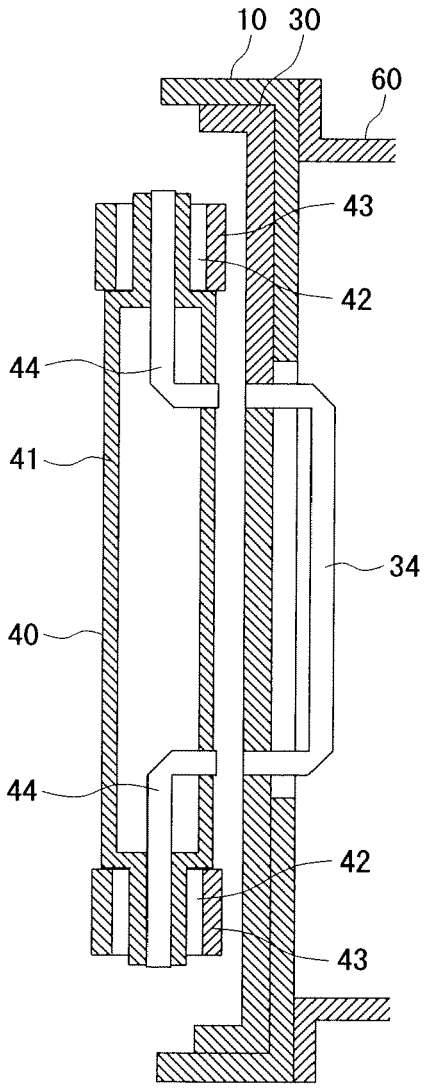



Fig. 6 (B)

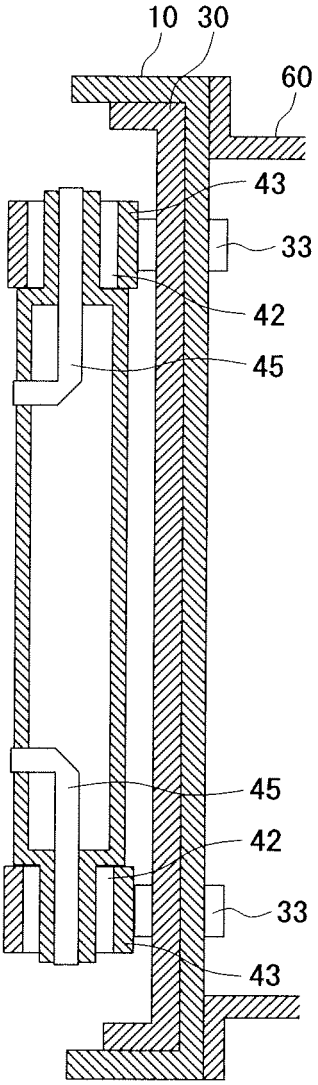
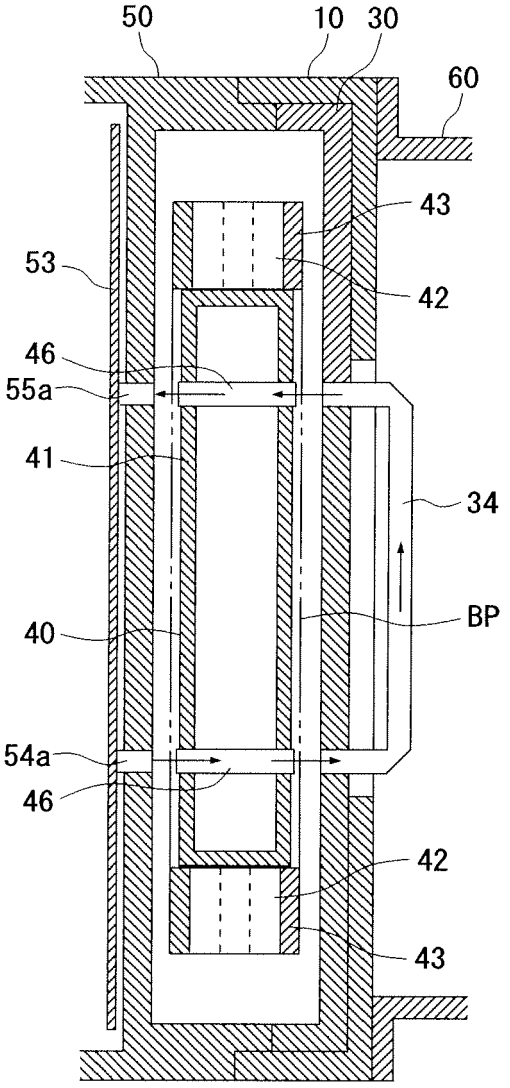


Fig. 7 (A)


50
10
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60
43
53
42
46
55a
41
34
BP
40
54a
46
42
43

Fig. 7 (B)

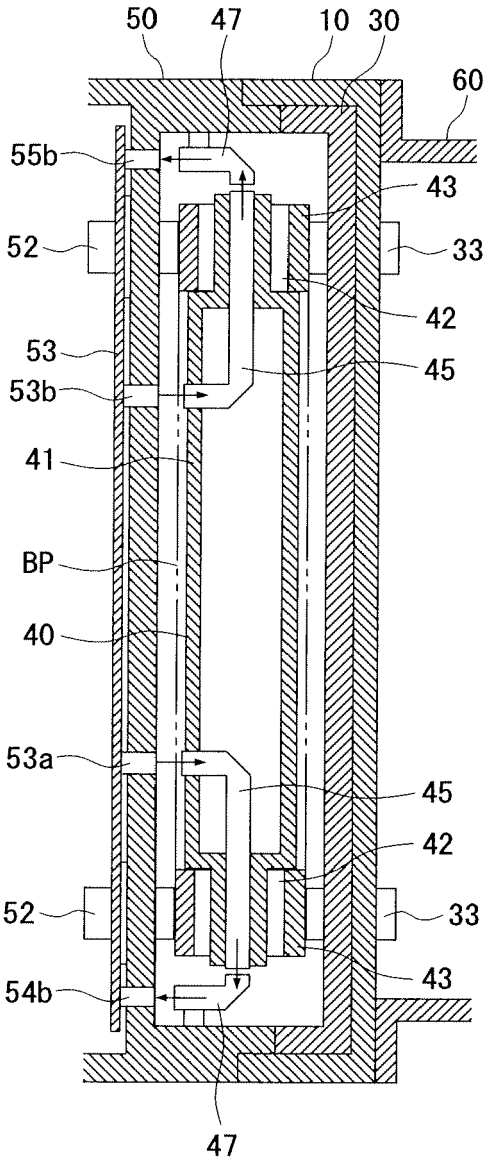
50
47
10
30
60
55b
43
52
33
42
53
45
53b
41
BP
40
53a
45
42
52
33
43
54b
47

Fig. 8