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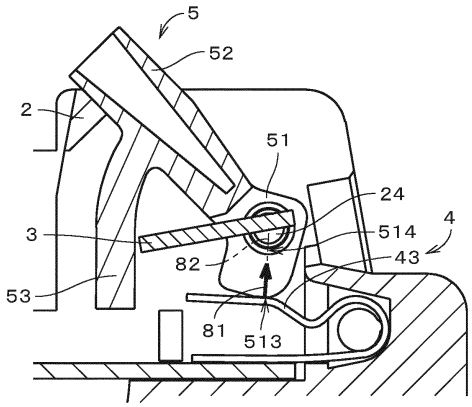
(54) CONNECTING DEVICE

(57) In a connector, when an elastic member (4) is in a non-connected state, a restoring force vector (81) of the elastic member (4) approximately coincides with a straight line connecting a first portion (513) and a second portion (514), i.e., a reference line (82), and the restoring force and the reaction force are balanced. Thus, the position of an operating section (5) is maintained and the elastic member (4) is maintained in the non-connected state. When the position of the operating section (5) is changed and the restoring force vector (81) deviates from the reference line (82) while an electric cable is inserted between a terminal (3) and the elastic member (4) in the non-connected state, the elastic member (4) is restored from the non-connected state by the restoring force and transitions to a connected state in which the electric cable is sandwiched between the terminal (3) and the elastic member (4). This simplifies the structure of the connector.

Fig. 7



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Description

TECHNICAL FIELD

[0001] The present invention relates to a connector for connecting an electric cable.

CROSS-REFERENCE TO RELATED APPLICATIONS

[0002] This application claims priority benefit of Japanese Patent Application No. JP2020-122599 filed in the Japan Patent Office on July 17, 2020 and Japanese Patent Application No. JP2020-169408 filed in the Japan Patent Office on October 6, 2020, the entire disclosures of which are incorporated herein by reference.

BACKGROUND ART

[0003] So-called push-in connectors have conventionally been used as connectors for connecting electric cables in control boards or any other devices. In these connectors, an electric cable is inserted into an insertion hole of a case and pressed against a conducting terminal by a plate spring provided in the case to establish electrical connection.

[0004] For example, a wire connector disclosed in Japanese Patent No. 4202125 (Document 1) is provided with a rod-like operation button that is capable of advancing and retracting into and from a housing. In the wire connector, the rod-like operation button is pressed against the housing so that a plate spring in the housing becomes elastically deformed and separated from a conductive metal fitting. The tip end of the rod-like operation button is engaged with the plate spring to maintain the shape of the plate spring. This allows an open state to be maintained in which the plate spring is separated from the conductive metal fitting. Then, after the electric cable is inserted into the wire connector in the open state, the rod-like operation button is pulled out of the housing so as to cause the plate spring to return elastically and sandwich the electric cable between the conductive metal fitting and the plate spring.

[0005] When connecting an electric cable, the wire connector requires the rod-like operation button to be pulled out of the housing while maintaining a state in which the electric cable is inserted in the wire connector in the open state. This complicates the operation of connecting the electric cable and has difficulty in shortening the time required for the connection operation. Besides, an operator needs to hold the electric cable in one hand and to operate the rod-like operation button with the other hand. This makes a one-hand connection operation difficult.

[0006] Meanwhile, in a connection device disclosed in Japanese Patent No. 6675004 (Document 2), an operation part is pressed into a case to bend a plate spring that has contact with the operation part to a non-connected state, and the operation part in this state is locked in a stepped portion of the case to maintain the plate spring in the non-connected state. In the connection device, the electric cable inserted in the case presses a state releaser to rotate the state releaser and thereby to cause the state releaser to push the above operation part out of the stepped portion of the case. Accordingly, the locking of the operation part in the case is released, and the plate spring is restored and sandwiches the electric cable between the terminal part and the plate spring. This facilitates the operation of connecting the electric cable.

[0007] By the way, the connection device according to Document 2 needs to include the stepped portion for locking the operation part and the state releaser for releasing the locking of the operation part. This may complicate the structure of the connection device.

SUMMARY OF THE INVENTION

[0008] The present invention is directed to a connector for connecting an electric cable, and it is an object of the present invention to simplify the structure of the connector.

[0009] A connector according to a preferable embodiment of the present invention includes a case, a conductive terminal fixed to the case, an elastic member that is attached to the case and that presses an electric cable against the terminal by restoring force to sandwich the electric cable between the terminal and the elastic member, and an operating section that applies a force to the elastic member to bend the elastic member from an initial state to a non-connected state and to maintain the elastic member in the non-connected state. The operating section includes a first portion that the restoring force of the elastic member acts on, and a second portion that develops a reaction force against the restoring force. A vector of the restoring force is regarded as a restoring force vector, and a straight line connecting the first portion and the second portion is regarded as a reference line. When the elastic member is in the non-connected state, the restoring force vector approximately coincides with the reference line, and the restoring force and the reaction force are balanced to maintain a position of the operating section and to maintain the elastic member in the non-connected state, and when the position of the operating section is changed and the restoring force vector deviates from the reference line while the electric cable is inserted between the terminal and the elastic member in the non-connected state, the elastic member is restored from the non-connected state by the restoring force and transitions to a connected state in which the electric cable is sandwiched between the terminal and the elastic member.

[0010] Accordingly, the connector has a simplified structure.

[0011] Preferably, the position of the operating section is maintained even in a state in which the elastic member is further bent in the non-connected state.

[0012] Preferably, the operating section includes a

cam that rotates about a rotating shaft. The cam comes in contact with the elastic member at the first portion and comes in contact with the rotating shaft at a bearing that serves as the second portion. When the elastic member transitions to the non-connected state, the cam rotates to increase a distance between the first portion and the rotating shaft and to bend the elastic member, and when the restoring force vector approximately coincides with the reference line, a rotational position of the operating section is maintained and the elastic member is maintained in the non-connected state.

[0013] Preferably, when the electric cable is connected to the connector, a force is directly or indirectly transmitted from the electric cable inserted to the operating section to change the position of the operating section and to deviate the restoring force vector from the reference line.

[0014] Preferably, when the electric cable is connected to the connector, the electric cable inserted comes in direct contact with the operating section to change the position of the operating section.

[0015] Preferably, the operating section includes an electric-cable receiver that comes in direct contact with a tip end of the electric cable. The electric-cable receiver has a receiving face that expands from the tip end of the electric cable to a surrounding.

[0016] Preferably, when the electric cable is connected to the connector, the electric cable inserted comes in direct contact with the elastic member and deforms the elastic member to apply a force to the operating section via the elastic member and to change the position of the operating section.

[0017] Preferably, the elastic member includes an electric-cable receiver that comes in direct contact with a tip end of the electric cable, and a releaser that extends from the electric-cable receiver toward the operating section. The electric-cable receiver has a receiving face that expands from the tip end of the electric cable to a surrounding. When the receiving face is pushed by the electric cable toward an inner side in a direction of insertion of the electric cable, the elastic member becomes deformed, and the releaser comes in contact with the operating section to apply a force of rotating the cam to the operating section.

[0018] Preferably, the case has a guide face that extends linearly. The elastic member extends along the guide face. The operating section includes an advancing/retracting part that is located between the elastic member and the guide face and that moves linearly in a predetermined advancing and retracting direction while coming in contact with the elastic member at the first portion and in contact with the guide face at the second portion. A distance between the elastic member and the guide face decreases from one side to the other side in the advancing and retracting direction. When the elastic member transitions to the non-connected state, the advancing/retracting part moves from the one side to the other side in the advancing and retracting direction to bend the elastic member, and when the elastic member becomes approximately parallel to the guide face, and the restoring force vector approximately coincides with the reference line in a position in which the elastic member comes in contact with the first portion, a position of the operating section in the advancing and retracting direction is maintained and the elastic member is maintained in the non-connected state. When the electric cable is connected to the connector, the operating section moves from the other side to the one side in the advancing and retracting direction to deviate the restoring force vector from the reference line and to effect a transition of the elastic member from the non-connected state to the connected state by the restoring force.

[0019] Preferably, when the electric cable is connected to the connector, a force is directly or indirectly transmitted from the electric cable inserted to the operating section to move the operating section from the other side to the one side in the advancing and retracting direction and to deviate the restoring force vector from the reference line.

[0020] Preferably, the operating section includes an approximately disk-like or columnar rotator that has a notch in part of a circumference thereof and a projection in another part of the circumference. The case includes a concave operating-section placement part having an inner surface that forms part of an approximately cylindrical surface. The rotator is placed on the operating-section placement part to come in contact with the elastic member at the first portion that forms part of the notch and to come in contact with the inner surface of the operating-section placement part at the second portion that serves as the projection. When the elastic member transitions to the non-connected state, the rotator rotates in a first rotation direction to bend the elastic member, and when the restoring force vector approximately coincides with the reference line, a rotational position of the rotator is maintained and the elastic member is maintained in the non-connected state. When the electric cable is connected to the connector, the rotator is moved to an inner side in a direction of insertion of the electric cable to deviate the restoring force vector from the reference line, and when the rotator is rotated in a second rotation direction opposite to the first rotation direction by the restoring force, the elastic member transitions from the non-connected state to the connected state.

[0021] Preferably, when the electric cable is connected to the connector, a force is directly or indirectly transmitted from the electric cable inserted to the operating section to move the rotator to an inner side in the direction of insertion of the electric cable and to deviate the restoring force vector from the reference line.

[0022] Preferably, the elastic member includes an electric-cable contact part that comes in direct contact with the electric cable in the connected state. A travel path of the electric-cable contact part does not overlap with a motion space of the operating section at least when the elastic member transitions from the non-connected

state to the connected state.

[0023] Preferably, part of the operating section projects from the case.

[0024] Preferably, when the elastic member is in the non-connected state, part of the operating section projects from the case. When the elastic member is in the connected state, the part of the operating section is located inside the case.

[0025] Preferably, the connector further includes a visually recognizable identifier that indicates a state of the elastic member.

[0026] Preferably, the elastic member is a plate spring.

[0027] These and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

[0028]

Fig. 1 is a perspective view of a connector according to a first embodiment.
Fig. 2 is a longitudinal sectional view of the connector.
Fig. 3 is an enlarged sectional view of an area in the vicinity of an operating section.
Fig. 4 is an enlarged sectional view of the area in the vicinity of the operating section.
Fig. 5 is a perspective view of the connector.
Fig. 6 is a longitudinal sectional view of the connector.
Fig. 7 is an enlarged sectional view of the area in the vicinity of the operating section.
Fig. 8 is an illustration of the relationship between the travel distance of the operating section and the rotation moment.
Fig. 9 is a longitudinal sectional view of the connector.
Fig. 10 is an enlarged sectional view of the area in the vicinity of the operating section.
Fig. 11 is a perspective view of the connector.
Fig. 12 is a longitudinal sectional view of the connector.
Fig. 13 is an enlarged sectional view of an area in the vanity of the operating section.
Fig. 14 is an enlarged sectional view of the area in the vicinity of the operating section.
Fig. 15 is an illustration of the relationship between the travel distance of the operating section and the rotation moment.
Fig. 16 is an enlarged sectional view of an area in the vicinity of an operating section of a connector according to a second embodiment.
Fig. 17 is a longitudinal sectional view of the connector.
Fig. 18 is a longitudinal sectional view of the connector.
Fig. 19 is a longitudinal sectional view of the connector.
Fig. 20 is a longitudinal sectional view of the connector.
Fig. 21 is a longitudinal sectional view of the connector.
Fig. 22 is a longitudinal sectional view of the connector.
Fig. 23 is an enlarged sectional view of an area in the vicinity of an operating section of a connector according to a third embodiment.
Fig. 24 is a plan view of the operating section and an elastic member.
Fig. 25 is a longitudinal sectional view of the connector.
Fig. 26 is a longitudinal sectional view of the connector.
Fig. 27 is a longitudinal sectional view of the connector.
Fig. 28 is a longitudinal sectional view of the connector.
Fig. 29 is a longitudinal sectional view of the connector.
Fig. 30 is an enlarged sectional view of an area in the vicinity of an operating section of a connector according to a fourth embodiment.
Fig. 31 is a longitudinal sectional view of the connector.
Fig. 32 is a longitudinal sectional view of the connector.
Fig. 33 is a longitudinal sectional view of the connector.
Fig. 34 is a longitudinal sectional view of the connector.
Fig. 35 is a longitudinal sectional view of the connector.
Fig. 36 is an enlarged sectional view of an area in the vicinity of an operating section of a connector according to a fifth embodiment.
Fig. 37 is a longitudinal sectional view of the connector.
Fig. 38 is a longitudinal sectional view of the connector.
Fig. 39 is a longitudinal sectional view of the connector.
Fig. 40 is a longitudinal sectional view of the connector.
Fig. 41 is a longitudinal sectional view of the connector

DESCRIPTION OF EMBODIMENTS

[0029] Fig. 1 is a perspective view of a connector 1 according to a first embodiment of the present invention. Fig. 2 is a longitudinal sectional view of the connector 1. Fig. 2 also shows a configuration on the rear side of the section. For convenience in illustration, Fig. 2 omits cross

hatching in the section of part of the configuration (e.g., an elastic member 4). The same applies to the other sectional views. The connector 1 is a push-in connector for connecting an electric cable. Figs. 1 and 2 show a state in which an electric cable is not inserted in the connector 1. For example, the connector 1 may be used in a terminal strip such as a control board.

[0030] In the following description, the up-down direction and the right-left direction in Fig. 2 are also simply referred to as the "up-down direction" and the "right-left direction." The direction perpendicular to the plane of the drawing in Fig. 2 is also referred to as the "thickness direction." Fig. 2 shows a section on the front side of the center in the thickness direction of the connector 1. The up-down direction, the right-left direction, and the thickness direction do not necessarily have to coincide with those at the time of attachment for use of the connector 1. The up-down direction does not necessarily have to coincide with the direction of gravity. Almost the same applies to the other embodiments.

[0031] The connector 1 includes a case 2, a terminal 3, an elastic member 4, and an operating section 5. The case 2 houses the terminal 3, the elastic member 4, and the operating section 5 therein. The case 2 may be made of, for example, resin. In the example illustrated in Figs. 1 and 2, the case 2 has two insertion holes 21, each being capable of receiving an electric cable inserted therein. Inside the case 2, two terminals 3, two elastic members 4, and two operating sections 5 are arranged. In other words, the connector 1 includes two sets of the terminal 3, the elastic member 4, and the operating section 5. Note that the connector 1 may include one set, or three or more sets, of the terminal 3, the elastic member 4, and the operating section 5.

[0032] Each set of the terminal 3, the elastic member 4, and the operating section 5 is arranged in a one-to-one correspondence with one of the insertion holes 21. The two sets of the terminal 3, the elastic member 4, and the operating section 5 are the same in shape, size, and other features and arranged in bilateral symmetry. Focusing on the insertion hole 21 on the right side in Fig. 2, the terminal 3 is located above the insertion hole 21 and extends in the right-left direction. The elastic member 4 is located below the terminal 3. The operating section 5 is located above the elastic member 4. The operating section 5 is arranged on the rear side of the terminal 3 in the Fig. 2. The elastic member 4 partly overlaps with the terminal 3 and the operating section 5 in the up-down direction.

[0033] Each terminal 3 is an approximately plate-like conductive member fixed to the case 2. The terminal 3 may be made of, for example, metal. The terminal 3 on the right side and the terminal 3 on the left side in Fig. 2 are electrically connected to each other via a conductive terminal joint 32 that extends in the right-left direction below the two terminals 3. For example, the two terminals 32 and the terminal joint 32 form an integral member.

[0034] Each elastic member 4 is an elastically deformable member attached to the case 2. In the example illustrated in Fig. 2, the elastic member 4 is an approximately band-like plate spring. The elastic member 4 may be made of, for example, metal. The elastic member 4 may be formed of a conductive material, or may be formed of an insulating material such as resin. For example, the elastic member 4 may have a shape that is bent in an approximately L-, V-, or U-letter shape around the central portion in the longitudinal direction. In the following description, the above bent portion of the elastic member 4 is referred to as a "bent portion 41." Moreover, out of two portions of the elastic member 4 that extends sideway from the bent portion 41, one that is located on the lower side is referred to as a "fixed portion 42," and the other that is located above the fixed portion 42 is referred to as a "movable portion 43."

[0035] The case 2 is provided with approximately columnar elastic-member supporters 22 that extend in the thickness direction, and grooves are formed by parts of the elastic-member supporters 22 surrounded by the other portions of the case 2 in the circumferential direction. The bent portions 41 of the elastic members 4 are inserted into these grooves so as to attach the elastic members 4 to the case 2.

[0036] Focusing on the elastic member 4 on the right side in Fig. 2, the fixed portion 42 of the elastic member 4 extends leftward from the bent portion 41 in approximately parallel with the right-left direction below the elastic-member supporter 22. The above terminal joint 32 extending in the right-left direction is in contact with the underside of the fixed portion 42 to restrict downward movement of the fixed portion 42. The fixed portion 42 is therefore substantially fixed to the case 2.

[0037] The movable portion 43 of the elastic member 4 extends to the upper left from the bent portion 41 above the elastic-member supporter 22. In the example illustrated in Fig. 2, the movable portion 43 once extends to the lower left, then bends upward in the vicinity of the left end portion of the elastic-member supporter 22, and extends to the upper left as it moves leftward away from the upper end portion of the elastic-member supporter 22. The tip end (i.e., the left end in Fig. 2) of the movable portion 43 is in contact with the approximately central portion in the right-left direction of the terminal 3 from the underside. The movable portion 43 is also in contact with the operating section 5 from the underside. As will be described later, the movable portion 43 is pushed down by the operating section 5 to become elastically deformed and bent downward using the upper end portion of the elastic-member supporter 22 as a fulcrum and to become separated below from the terminal 3. When the downward pressure against the movable portion 43 is relieved, the movable portion 43 returns to its original state by the restoring force (i.e., returns elastically).

[0038] In the state illustrated in Fig. 2, the tip end of the movable portion 43 of the elastic member 4 is in contact with the terminal 3 from the underside as described above. Thus, the path of insertion of an electric cable,

which will be described later, is closed by the movable portion 43 of the elastic member 4 inside the insertion hole 21 (i.e., in the side closer to the central portion of the case 2 in the right-left direction). The state illustrated in Figs. 1 and 2 is the state before an electric cable is inserted in the insertion holes 21, i.e., the state before use of the connector 1. In the following description, this state is also referred to as the "initial state."

[0039] In the initial state (i.e., an insertion-hole closed state), the elastic member 4 slightly bends in a direction in which the fixed portion 42 and the movable portion 43 approach each other. This prevents the elastic member 4 from dropping off the case 2. This also helps providing sufficient holding power (i.e., gripping power) when an electric cable is sandwiched between the elastic member 4 and the terminal 3, even if the electric cable is relatively thin.

[0040] The operating sections 5 each include a cam 51, an actuator 52, and an electric-cable receiver 53. The cam 51 is an approximately rectangular parallelepiped portion arranged inside the case 2 (i.e., inward of the outer edge of the case 2). The cam 51 is in contact with the movable portion 43 of the elastic member 4 from above. The cam 51 has a through hole extending in the thickness direction and provided with a bearing 54. The bearing 54 is fitted with an approximately columnar rotating shaft 24 provided in the case 2 and extending in the thickness direction. The cam 51 is supported by the case 2 so as to be rotatable about the rotating shaft 24 in a plane that is approximately perpendicular to the thickness direction. The cam 51 and the rotating shaft 24 overlap with the terminal 3 in the thickness direction and are located on the rear side of the terminal 3 in Fig. 2.

[0041] The actuator 52 is an approximately tubular or approximately rod-like member that extends diagonally upward and approximately linearly from the cam 51. In the example illustrated in Figs. 1 and 2, the actuator 52 is an approximately rectangular tubular member having a hole 521 that is open at the upper end and that has a rectangular sectional shape. As will be described later, the hole 521 is capable of receiving the tip end of a tool such as a minus driver inserted therein. The upper end portion of the actuator 52 projects diagonally upward from the outer edge (i.e., outer contour) of the case 2.

[0042] The electric-cable receiver 53 is an approximately plate-like or approximately rod-like member that extends inward in the right-left direction (i.e., to the side closer to the central portion of the case 2 in the right-left direction) from the approximately central portion of the actuator 52 in the longitudinal direction. In the example illustrated in Figs. 1 and 2, the electric-cable receiver 53 bends so as to approach the cam 51 in the longitudinal direction of the actuator 52 as it is separated away from the joint with the actuator 52. In other words, the electric-cable receiver 53 extends from the joint with the actuator 52 toward the cam 51 rather than in a direction perpendicular to the longitudinal direction of the actuator 52.

[0043] Fig. 3 is a longitudinal sectional view illustrating an area in the vicinity of the operating section 5 located on the right side in Fig. 2 in enlarged dimensions. As illustrated in Fig. 3, the cam 51 of the operating section 5 has an approximately rectangular shape having two long sides 511 and two short sides 512 when viewed from the front (i.e., the shape when viewed from the front side in the thickness direction in Fig. 3). The long sides 511 extend upward toward the inside in the right-left direction. The short sides 512 extend downward toward the inside in the right-left direction.

[0044] The bearing 54 is located in the vicinity of the corner formed by the long side 511 on the lower side and the short side 512 on the outer side in the right-left direction (i.e., the lower right corner in Fig. 3). The cam 51 has the shortest distance between the center of the rotating shaft 24 and the outer edge of the cam 51 in a direction that passes through the center of the rotating shaft 24 and that is perpendicular to the long side 511 on the lower side of the cam 51. The distance between the center of the rotating shaft 24 and the outer edge of the cam 51 increases in the clockwise direction about the center of the rotating shaft 24 from the direction that has the minimum distance.

[0045] In the initial state illustrated in Fig. 3, the face of the cam 51 that corresponds to the long side 511 on the lower side (i.e., the lower face) is in surface-to-surface contact with the upper face of the movable portion 43 of the elastic member 4. The operating section 5 is rotatable in the counterclockwise direction about the rotating shaft 24 in Fig. 3 from the initial state. When the operating section 5 rotates counterclockwise from the initial state, the restoring force of the elastic member 4 acts on a portion of the cam 51 that is in contact with the elastic member 4. In the following description, the portion of the operating section 5 that the restoring force of the elastic member 4 acts on is referred to as a "first portion 513." Moreover, a portion of the operating section 5 that develops a reaction force against the restoring force (i.e., bearing 54) is referred to as a "second portion 514."

[0046] Next, a procedure for connecting an electric cable to the connector 1 will be described. The following description is given of how an electric cable is connected into the insertion hole 21 on the right side in Fig. 2. In the case of connecting an electric cable into the insertion hole 21 on the left side in Fig. 2, an operator performs approximately the same operation, except that the right and left sides are reversed.

[0047] First, the operating section 5 is rotated counterclockwise about the rotating shaft 24 in Fig. 3 from the initial state illustrated in Figs. 1 to 3. For the rotation of the operating section 5, for example, the operator may insert the tip end portion of an ordinary tool such as a minus driver into the hole 521 of the actuator 52 of the operating section 5 and move the tool leftward. As an alternative, the operator may hold the tip end portion of the actuator 52 between his/her fingers and move the actuator 52 leftward.

[0048] Fig. 4 shows a state in which the operating sec-

tion 5 is rotated approximately 30 degrees in the counterclockwise direction from the initial state (see Fig. 3). The state illustrated in Fig. 4 is a state in which the operating section 5 is rotated halfway, and does not correspond to a connected state and a non-connected state, which will be described later. In the state illustrated in Fig. 4, a portion of the cam 51 that is located in the vicinity of the corner at the lower left of the rotating shaft 24 serves as the first portion 513 that comes in contact with the elastic member 4. The first portion 513 moves on the cam 51 with the rotation of the cam 51. As illustrated in Figs. 3 and 4, the counterclockwise rotation of the operating section 5 increases the minimum distance between the center of the rotating shaft 24 and the first portion 513. In the following description, the minimum distance between the center of the rotating shaft 24 and the first portion 513 is also simply referred to as the distance between the rotating shaft 24 and the first portion 513. When this distance increases and a downward force is applied from the operating section 5 to the elastic member 4, the elastic member 4 becomes bent and deformed. Specifically, the movable portion 43 of the elastic member 4 is pushed down and separated below from the terminal 3.

[0049] In Fig. 4, a vector of the restoring force of the elastic member 4 acting on the first portion 513 of the operating section 5 (hereinafter, also referred to as the "restoring force vector") is indicated by the bold arrow with the reference sign of 81. The starting point position of the restoring force vector 81 is the first portion 513 of the operating section 5. Also, a reference line 82 that is a virtual straight line connecting the first portion 513 and the second portion 514 is indicated by the dashed double-dotted line. The second portion 514 corresponds to the bearing 54 of the operating section 5 as described above, and to be more specific, a point of intersection of the bearing 54 with a virtual straight line that connects the first portion 513 and the center of the rotating shaft 24. Like the first portion 513, the second portion 514 also moves on the bearing 54 with the rotation of the cam 51. In Fig. 4, the reference line 82 is indicated as the straight line connecting the first portion 513 and the center of the rotating shaft 24. The same applies to the drawings described later.

[0050] In the state illustrated in Fig. 4, the restoring force vector 81 does not coincide with the reference line 82 and is directed upward while being inclined to the left from the reference line 82. Thus, the restoring force of the elastic member 4 produces a clockwise rotation moment on the cam 51. That is, unless the operator continues to apply a force to the operating section 5 in the state illustrated in Fig. 4, the elastic member 4 and the operating section 5 will return to the initial state illustrated in Fig. 3.

[0051] In the actual operation, the operator further rotates the operating section 5 to a state illustrated in Figs. 5 to 7 (hereinafter, referred to as a " non-connected state") without stopping the operating section 5 in the state illustrated in Fig. 4. Figs. 5 and 6 are respectively a perspective view and a longitudinal sectional view of the connector 1 in the non-connected state. Fig. 7 is an enlarged view illustrating an area in the vicinity of the operating section 5 on the right side in Fig. 6.

[0052] In the non-connected state illustrated in Figs. 5 to 7, the upper end portion of the actuator 52 of the operating section 5 is in contact with the case 2. This restricts the movement of the operating section 5 and prevents the operating section 5 from further rotating counterclockwise. In the non-connected state, the electric-cable receiver 53 of the operating section 5 extends downward from the vicinity of the inner end portion of the terminal 3 in the right-left direction. The lower end portion of the electric-cable receiver 53 is located on the path of insertion of an electric cable, which will be described later. In the non-connected state, the portion of the cam 51 that is located in the vicinity of the corner below the rotating shaft 24 serves as the first portion 513 that comes in contact with the movable portion 43 of the elastic member 4. The movable portion 43 of the elastic member 4 extends in an approximately tangential direction of the cam 51 at the first portion 513.

[0053] As illustrated in Fig. 7, if the operating section 5 is further rotated counterclockwise from the state illustrated in Fig. 4, the distance between the rotating shaft 24 and the first portion 513 further increases and the degree of bend of the elastic member 4 increases as well. Specifically, the movable portion 43 of the elastic member 4 is further pushed down and largely separated below from the terminal 3. As a result, the path of insertion of the electric cable described later is opened. The angle formed by the restoring force vector 81 and the reference line 82 decreases, and the restoring force vector 81 approaches the reference line 82 as the operating section 5 further rotates in the counterclockwise direction. This reduces the clockwise rotation moment acting on the cam 51 produced by the restoring force of the elastic member 4.

[0054] In the non-connected state illustrated in Fig. 7, the restoring force vector 81 approximately coincides with the reference line 82, and the restoring force of the elastic member 4 and the reaction force developed against the restoring force by the operating section 5 are balanced. Thus, neither the clockwise rotation moment nor the counterclockwise rotation moment acts on the cam 51. Accordingly, even if the operator moves his/her hand off the operating section 5 (i.e., even in a state in which the operator does not apply any force to the operating section 5), the circumferential position (i.e., rotational position) of the operating section 5 is maintained in the state illustrated in Fig. 7. The elastic member 4 is also maintained in the non-connected state (i.e., stopped tentatively). The non-connected state illustrated in Fig. 7 is a tentative stopped state in which the elastic member 4 is tentatively stopped in a bent position. In the connector 1, the operating section 5 includes only one first portion 513 that the restoring force of the elastic member 4 acts on, and only one second portion 514 that develops a

reaction force against the restoring force. This simplifies the structure of the connector 1.

[0055] Fig. 8 is an schematic illustration of the relationship between the travel distance of the operating section 5 from the initial state and the rotation moment on the operating section 5 produced by the restoring force of the elastic member 4. The horizontal axis in Fig. 8 indicates the travel distance of the operating section 5 from the initial state in the circumferential direction about the rotating shaft 24, and the travel distance in the counterclockwise direction in Fig. 7 is indicated as positive. The vertical axis in Fig. 8 indicates the rotation moment described above, and a clockwise rotation moment in Fig. 7 is indicated as positive. In Fig. 8, the point indicated by the reference sign of 85 corresponds to the non-connected state in which the rotation moment is approximately zero. Note that the actual change in the rotation moment acting on the operating section 5 does not necessarily have to be the same as the change in the rotation moment indicated by the straight line in Fig. 8.

[0056] When the connector 1 is in the non-connected state, an electric cable 91 is inserted in the insertion hole 21 as illustrated in Fig. 9. Fig. 9 shows a state in which the electric cable 91 is inserted in the insertion hole 21 on the right side. The electric cable 91 is inserted from the insertion hole 21 into the case 2 in a predetermined direction of insertion and located between the terminal 3 and the elastic member 4 in the non-connected state. The direction of insertion of the electric cable 91 into the case 2 is a diagonal direction that is inclined relative to the up-down direction and the right-left direction. This prevents the electric cable 91 from projecting out of the connector 1 in the up-down direction and enables the operator to easily insert the electric cable 91 into the insertion hole 21 while visually checking the insertion hole 21. The angle formed by the direction of insertion and the up-down direction may be optimized appropriately according to, for example, the place where the connector 1 is expected to be used, the position of the operator, or the line of sight of the operator.

[0057] For example, the electric cable 91 may be a solid cable, or may be a relatively thick strand. The electric cable 91 may also be an electric cable provided with, for example, a rod-like solderless terminal at the tip end of a relatively thin strand. This rod-like solderless terminal may be an insulator-coated solderless terminal provided with, for example, an insulating sleeve at the root of a rod-like conductor, or may be a bare solderless terminal that includes no insulating sleeve. For example, it is preferable that the tip end portion of the electric cable 91 has a diameter greater than or equal to 0.42 mm. In actuality, the tip end portion of the electric cable 91 has a diameter less than or equal to 2.3 mm. The diameter of the tip end portion of the electric cable 91 may be changed to various values depending on the current capacity of the connector 1 to which the electric cable 91 is connected. The diameters of the other portions of the electric cable 91 other than the above tip end portion may also be changed to various values.

[0058] The tip end of the electric cable 91 comes in direct contact with the electric-cable receiver 53 of the operating section 5 inside the case 2. In the example illustrated in Fig. 9, the right side face of the electric-cable receiver 53 serves as a receiving face 531 that comes in direct contact with the tip end of the electric cable 91 and that expands from the tip end to the surroundings. The receiving face 531 is located on the inner side of the elastic member 4 in the non-connected state in the direction of insertion of the electric cable 91 and expands in a direction that is approximately perpendicular to the direction of insertion. Note that the receiving face 531 does not necessarily have to be the face perpendicular to the direction of insertion.

[0059] The electric cable 91, with the tip end in contact with the receiving face 531 of the electric-cable receiver 53, is moved to the inner side in the direction of insertion. Accordingly, the force is directly transmitted from the electric cable 91 to the operating section 5. Then, the operating section 5 is slightly rotated clockwise about the rotating shaft 24 in Fig. 9. In other words, the position (i.e., the rotational position) of the operating section 5 is changed in the circumferential direction about the rotating shaft 24. The rotation direction of the cam 51 at the first portion 513 is the direction from the outer side to the inner side in the direction of insertion of the electric cable 91 (i.e., the direction toward approximately the left side in Fig. 9).

[0060] Accordingly, the restoring force vector 81 deviates to the left in Fig. 10 from the reference line 82 as illustrated in Fig. 10, and the restoring force of the elastic member 4 produces a clockwise rotation moment on the cam 51 (see the point 86 in Fig. 8). As a result, the operating section 5 is further rotated clockwise, and the elastic member 4 is restored from the non-connected state.

[0061] Then, as illustrated in Figs. 11 to 13, the elastic member 4 transitions to the connected state in which the electric cable 91 is sandwiched between the terminal 3 and the elastic member 4 (i.e., the elastic member 4 holds the electric cable 91 together with the terminal 3), and the electric cable 91 and the terminal 3 are electrically and mechanically connected to each other. In other words, the electric cable 91, after inserted into the connector 1, is automatically connected to the connector 1 (i.e., without the operator operating the operating section 5 using a tool other than the electric cable 91 or his/her fingers). For example, the operator may recognize this transition to the connected state by, for example, vibrations or sounds generated when the electric cable 91 is pressed against the terminal 3 by the movable portion 43 of the elastic member 4. The vibrations or sounds may be generated by, for example, a collision of two members that are any of the elastic member 4, the electric cable 91, the terminal 3, the operating section 5, and the case 2. The connector 1 may employ any of various structures that facilitate the generation of vibrations or sounds or

that amplify the vibrations or sounds.

[0062] As illustrated in Fig. 13, the tip end of the movable portion 43 of the elastic member 4 serves as an electric-cable contact part 45 that comes in direct contact with the electric cable 91 in the connected state. As indicated by the dashed double-dotted lines in Fig. 13, the travel path of the electric-cable contact part 45 during transition of the elastic member 4 from the non-connected state to the connected state does not overlap in the thickness direction with the motion space of the operating section 5 during transition of the operation part 5 from the non-connected state to the connected state. Even when the connector 1 transitions from the initial state to the non-connected state, the travel path of the electric-cable contact part 45 does not overlap with the motion space of the operating section 5 in the thickness direction. This prevents the electric-cable contact part 45 from inhibiting the rotation of the cam 51 by, for example, making inroads into the cam 51 of the operating section 5.

[0063] As illustrated in Fig. 12, when the connector 1 is in the connected state, the actuator 52 of the operating section 5 projects approximately vertically upward from the case 2. Meanwhile, as illustrated in Fig. 6, when the connector 1 is in the non-connected state, the actuator 52 of the operating section 5 is inclined more inward in the right-left direction than in the state illustrated in Fig. 12. On the other hand, as illustrated in Fig. 2, when the connector 1 is in the initial state, the actuator 52 of the operating section 5 is inclined more outward in the right-left direction than in the state illustrated in Fig. 12. Therefore, the operator is able to determine whether the state of the elastic member 4 of the connector 1 is any of the initial state, the non-connected state, and the connected state by visually recognizing the direction of extension of the actuator 52 of the operating section 5 (i.e., the orientation of the actuator 52). That is, the actuator 52 of the operating section 5 serves as a visually recognizable identifier that indicates the state of the elastic member 4.

[0064] In the case of removing the electric cable 91 from the connector 1, for example, the operator may insert the tip end portion of a tool such as a minus driver into the hole 521 of the actuator 52 and rotate the operating section 5 counterclockwise in Fig. 12. When the operating section 5 is rotated to the non-connected state illustrated in Fig. 6, the restoring force vector 81 approximately coincides with the reference line 82, and the elastic member 4 is maintained in the non-connected state in which the elastic member 4 is separated below from the electric cable 91, as described above. This releases the holding of the electric cable 91 by the elastic member 4 and the terminal 3. The operator is able to easily remove the electric cable 91 from the connector 1 by pulling out the electric cable 91 from the insertion hole 21.

[0065] As described above, the connector 1 for connecting the electric cable 91 includes the case 2, the conductive terminal 3, the elastic member 4, and the operating section 5. The terminal 3 is fixed to the case 2. The elastic member 4 is attached to the case 2 and presses the electric cable 91 against the terminal 3 by the restoring force to hold the electric cable 91. The operating section 5 applies a force to the elastic member 4 to bend the elastic member 4 from the initial state to the non-connected state and to maintain the elastic member 4 in the non-connected state. The operating section 5 includes the first portion 513 that the restoring force of the elastic member 4 acts on, and the second portion 514 that develops a reaction force against the restoring force. The vector of the restoring force is regarded as the restoring force vector 81, and the straight line connecting the first portion 513 and the second portion 514 is regarded as the reference line 82.

[0066] When the elastic member 4 is in the non-connected state, the restoring force vector 81 approximately coincides with the reference line 82, and the above restoring force and the above reaction force are balanced. Accordingly, the position of the operating section 5 is maintained, and the elastic member 4 is maintained in the non-connected state. When the position of the operating section 5 is changed and the restoring force vector 81 deviates from the reference line 82 while the electric cable 91 is inserted between the terminal 3 and the elastic member 4 in the non-connected state, the elastic member 4 is restored from the non-connected state by the above restoring force and transitions to the connected state in which the electric cable 91 is sandwiched between the terminal 3 and the elastic member 4.

[0067] The connector 1 with the structure described above eliminates the need to provide other structures such as a stepped portion for locking the operating section 5 in the non-connected state or a state releaser for releasing the locking of the operating section 5. This simplifies the structure of the connector 1. Besides, it is possible to prevent the occurrence of problems such as locking failures due to wear on the stepped portion or any other reasons and to increase the life of the connector 1, unlike in the case where the operating section 5 is locked in the stepped portion or the like of the case 2.

[0068] Note that, when the connector 1 is in the non-connected state, the restoring force vector 81 and the reference line 82 approximately coincide with each other as described above, but they do not necessarily have to precisely coincide with each other (the same applies to connectors 1a to 1d). For example, in the case where the restoring force vector 81 illustrated in Fig. 7 slightly deviates to the left from the reference line 82 (i.e., in a state in which the rotation moment acting on the cam 51 slightly moves toward the point 86 from the point 85 illustrated in Fig. 8), it is only necessary for the connector 1 to maintain the non-connected state by, for example, the frictional force generated between the cam 51 and the elastic member 4. Even in this case, it is possible to simplify the structure of the connector 1 as described above.

[0069] As described above, it is preferable that the operating section 5 includes the cam 51 that rotates about the rotating shaft 24. The cam 51 comes in contact with

the elastic member 4 at the first portion 513 and also in contact with the rotating shaft 24 at the bearing 54 serving as the second portion 514. When the elastic member 4 transitions to the non-connected state, the cam 51 rotates to increase the distance between the first portion 513 and the rotating shaft 24 and to bend the elastic member 4, and when the restoring force vector 81 approximately coincides with the reference line 82, the rotational position of the operating section 5 is maintained and the elastic member 4 is maintained in the non-connected state. Accordingly, the transition of the elastic member 4 to the non-connected state and the state maintenance of the elastic member 4 in the non-connected state can be achieved with a simple structure.

[0070] As described above, in the case of connecting the electric cable 91, it is preferable that the inserted electric cable 91 comes in direct contact with the operating section 5 to change the position of the operating section 5. In this case, because the force of pushing in the electric cable 91 is easily transmitted to the operating section 5, it becomes easy to achieve automatic connection of the electric cable 91 by only a simple operation such as inserting the electric cable 91. Besides, since there is no need to provide the elastic member 4 with a portion that comes in contact with the electric cable 91, it is possible to simplify the shape of the elastic member 4.

[0071] As described above, it is preferable that the operating section 5 includes the electric-cable receiver 53 that comes in direct contact with the tip end of the electric cable 91. It is also preferable that the electric-cable receiver 53 has the receiving face 531 that expands from the tip end of the electric cable 91 to the surroundings. This allows the force of pushing in the electric cable 91 to be efficiently transmitted to the operating section 5.

[0072] As described above, it is preferable that the elastic member 4 includes the electric-cable contact part 45 that comes in direct contact with the electric cable 91 in the connected state, and the travel path of the electric-cable contact part 45 does not overlap with the motion space of the operating section 5 at least when the elastic member 4 transitions from the non-connected state to the connected state. This prevents the electric-cable contact part 45 of the elastic member 4 from coming in contact with the operating section 5 and inhibiting the movement of the operating section 5.

[0073] As described above, it is preferable that part of the operating section 5 (e.g., the actuator 52) projects from the case 2. This enables the operator to easily operate the operating section 5. The operator is also able to operate the operating section 5 with finger without using any tool such as a minus driver.

[0074] As described above, it is preferable that the connector 1 includes a visually recognizable identifier (in the example described above, the actuator 52 of the operating section 5) that indicates the state of the elastic member 4. This enables the operator to easily and speedily recognize the state of the elastic member 4.

[0075] As described above, it is preferable that the elastic member 4 is a plate spring. This further simplifies the structure of the connector 1.

[0076] As described above, in the connector 1, the shape of the elastic member 4 and the position of the operating section 5 are maintained in the non-connected state in which the restoring force vector 81 approximately coincides with the reference line 82 (i.e., in the state in which the rotation moment acting on the cam 51 is approximately zero) before insertion of the electric cable 91. Alternatively, for example, as illustrated in Fig. 14, the position of the operating section 5 may be maintained even in a state in which the elastic member 4 is further bent in the non-connected state.

[0077] In the state illustrated in Fig. 14, the restoring force vector 81 slightly deviates to the right from the reference line 82. Thus, a counterclockwise (i.e., minus) rotation moment acts on the cam 51, and the relationship between the travel distance of the operating section 5 from the initial state and the rotation moment acting on the operating section 5 becomes as indicated by a point 87 illustrated in Fig. 15 that is located at a lower right position when viewed from the point 86 in the connected state and the point 85 in the non-connected state. That is, the elastic member 4 exerts the force of rotating the operating section 5 counterclockwise on the cam 51, but does not exert the force of rotating the operating section 5 clockwise and returning the operating section 5 to the connected state and the initial state on the cam 51. In the example illustrated in Fig. 14, the upper end portion of the actuator 52 of the operating section 5 comes in contact with the case 2 to restrict further counterclockwise rotation of the operating section 5.

[0078] In the connector 1 illustrated in Fig. 14, the position of the operating section 5 is maintained even if elastic member 4 is further bent in the non-connected state as described above. Moreover, the direction of the rotation moment on the cam 51 produced by the restoring force of the elastic member 4 is opposite to the direction of the rotation moment that returns the operating section 5 to the connected state and the initial state. Accordingly, it is possible to more stably maintain the shape of the elastic member 4 in the state in which the elastic member 4 is separated from the terminal 3.

[0079] Next, a connector 1a according to a second embodiment of the present invention will be described. Fig. 16 is a longitudinal sectional view illustrating an area in the vicinity of an operating section 5a of the connector 1a in enlarged dimensions. Fig. 16 shows the connector 1a in the initial state.

[0080] The connector 1a includes a case 2a, a terminal 3a, an elastic member 4a, and the operating section 5a. The connector 1a and the connector 1 illustrated in Fig. 1 differ in the shapes of the case 2a, the terminal 3a, the elastic member 4a, and the operating section 5a and the movements of the elastic member 4a and the operating section 5a, but are the same in, for example, material properties and functions. Like the connector 1, the connector 1a may include two or more sets of the terminal

3a, the elastic member 4a, and the operating section 5a in the case 2a.

[0081] The terminal 3a is an approximately plate-like conductive member fixed to the case 2a. The terminal 3a may be made of, for example, metal. The elastic member 4a is an elastically deformable member attached to the case 2a. The elastic member 4a may, for example, be an approximately band-like plate spring. The elastic member 4a may be formed of a conductive material such as metal, or may be formed of an insulating material such as resin. The elastic member 4a has a shape that is bent in an approximately L-, V-, or U-letter shape abound the central portion in the longitudinal direction.

[0082] Like the elastic member 4 described above, the elastic member 4a includes a bent portion 41a, a fixed portion 42a, and a movable portion 43a. The tip end (i.e., the left end in Fig. 16) of the movable portion 43a is in contact with the approximately central portion in the right-left direction of the terminal 3a from the underside. Thus, the path of insertion of an electric cable, which will be described later, is closed inside the insertion hole 21a. The movable portion 43a is also in contact with the operating section 5a from the underside. As will be described later, the movable portion 43a is pushed down by the operating section 5a to become elastically deformed and bent downward and to become separated below from the terminal 3a. When the downward pressure against the movable portion 43a is relieved, the movable portion 43a returns to its original state by the restoring force (i.e., returns elastically).

[0083] The operating section 5a includes a cam 51a, an actuator 52a, and an identifier 55a. The cam 51a is an approximately triangular plate-like portion with one vertex located at the lower end when viewed from the front, and is arranged inside the case 2a (i.e., inward of the outer edge of the case 2a). The cam 51a is in contact with the movable portion 43a of the elastic member 4a from above. The cam 51a has a through hole extending in the thickness direction and provided with a bearing 54a in the upper portion. The bearing 54a is fitted with an approximately columnar rotating shaft 24a provided in the case 2a and extending in the thickness direction. The cam 51a is supported by the case 2a so as to be rotatable about the rotating shaft 24a in a plane that is approximately perpendicular to the thickness direction. In the cam 51a, the distance between the center of the rotating shaft 24a and the outer edge of the cam 51a becomes a maximum on a straight line that extends from the center of the rotating shaft 24a to the above vertex at the lower end of the cam 51a. The lower portion of the cam 51a overlaps with the terminal 3a in the thickness direction and is located on the rear side of the terminal 3a in Fig. 16.

[0084] The actuator 52a is a portion that extends from the right side portion of the cam 51a to the right, and is an approximately rectangular plate-like portion when viewed from the front. In the initial state illustrated in Fig. 16, a right end portion of the actuator 52a (i.e., the end portion on the side further from the cam 5 1a) is located in the through hole 231a provided at the top of the case 2a. In the initial state, the upper surface of the right end portion of the actuator 52a is located at approximately the same position in the up-down direction as the upper surface of the case 2a around the through hole 231a.

[0085] The top of the right end portion of the actuator 52a has a recess 521a provided at a position where the recess 521a overlaps with the through hole 231a in the up-down direction. In the initial state, the recess 521a is located inside the through hole 231a. The bottom of the right end portion of the actuator 52a has a projection 522a that projects downward. The projection 522a projects toward the path of insertion of an electric cable, which will be described later.

[0086] An identifier 55a is an approximately rectangular columnar portion that extends diagonally upward to the left from the top of the left side portion of the cam 51a. The identifier 55a is located below the through hole 232a provided in the top of the case 2a. The through hole 232a is separated to the left from the above through hole 231a. In the initial state, the identifier 55a as a whole is located inside the case 2 below the through hole 232a.

[0087] Next, a procedure for connecting an electric cable to the connector 1a will be described. First, in the initial state illustrated in Fig. 16, an operator inserts the tip end portion of an ordinary tool 92 such as a minus deriver into the recess 521a of the actuator 52a of the operating section 5a from above and pushes down the tool 92. Accordingly, the operating section 5a is rotated clockwise in Fig. 16 about the rotating shaft 24a.

[0088] As illustrated in Fig. 17, the rotation of the operating section 5a increases the distance between the center of the rotating shaft 24a and the contact between the cam 51a and the elastic member 4a, and the movable portion 43a of the elastic member 4a is pushed down by the cam 51a and separated from the terminal 3a.

[0089] As illustrated in Fig. 17, when the operating section 5a is rotated halfway, a restoring force vector 81a of the elastic member 4a acting on a first portion 513a deviates to the right from a reference line 82a that is a virtual straight line connecting the first portion 513a and a second portion 514a. Thus, a counterclockwise rotation moment acts on the cam 51a, and unless the operator continues to push down the operating section 5a, the elastic member 4a and the operating section 5a will return to the initial state illustrated in Fig. 16. Note that the first portion 513a is a portion of the operating section 5a that the restoring force of the elastic member 4a acts on, and is specifically a portion of the lower end portion of the cam 51a that comes in contact with the elastic member 4a. The second portion 514a is a portion of the operating section 5a that develops a reaction force against the restoring force, and is specifically an point of intersection of the bearing 54a with a virtual straight line connecting the first portion 513a and the center of the rotating shaft 24a.

[0090] The operator pushes the operating section 5a

down against the restoring force of the elastic member 4a until the non-connected state illustrated in Fig. 18. In the non-connected state, the restoring force vector 81a of the elastic member 4a acting on the first portion 513a approximately coincides with the reference line 82a connecting the first portion 513a and the second portion 514a. Accordingly, the restoring force of the elastic member 4a and the reaction force developed against the restoring force by the operating section 5a are balanced.

[0091] Thus, neither the counterclockwise rotation moment described above nor a clockwise rotation moment acts on the cam 51a. Accordingly, even if the operator pulls the tool 92 out of the through hole 231a of the case 2a (i.e., even if the operator does not apply any force to the operating section 5a), the circumferential position (i.e., rotational position) of the operating section 5a is stably maintained in the non-connected state illustrated in Fig. 18. Moreover, the elastic member 4a is also stably maintained (i.e., stopped tentatively) in the non-connected state. The non-connected state illustrated in Fig. 18 is a tentative stopped state in which the elastic member 4a is tentatively stopped in a bent position. At this time, the projection 522a of the operating section 5a is located above the path of insertion of the electric cable, which will be described later. In the connector 1a, the operating section 5a includes only one first portion 513a that the restoring force of the elastic member 4a acts on, and only one second portion 514a that develops a reaction force against the restoring force. This simplifies the structure of the connector 1a.

[0092] In the non-connected state, the upper end portion of the identifier 55a projects upward from the through hole 232a of the case 2a. When part of the operating section 5a (in the example illustrated in Fig. 18, a portion on the left side of the projection 522a) comes in contact with a stopper 28a that is a projection provided in the case 2a, the movement of the operating section 5a is restricted so as to prevent the operating section 5a from further rotating in the clockwise direction. The operator is able to easily determine that the connector 1a is in the non-connected state, by visually recognizing the projection of the identifier 55a from the case 2a.

[0093] In the connector 1a, as approximately in the connector 1 illustrated in Fig. 14, the position of the operating section 5a may be maintained in a state in which the operating section 5a further rotates in the clockwise direction from the rotational position illustrated in Fig. 18 and the elastic member 4a is further bent. This structure is achieved by, for example, making the lower end of the cam 51a in Fig. 18 into an approximately horizontal plane that expands to the right from the first portion 513a in the drawing and moving the position of the upper surface of the stopper 28a downward. In this case, the restoring force vector 81a slightly deviates to the left from the reference line 82a, and a clockwise rotation moment acts on the cam 51a. That is, the elastic member 4a exerts the force of rotating the operating section 5a clockwise on the cam 51a. It is, however, noted that the clockwise rotation of the operating section 5a is restricted by the operating section 5a coming in contact with the stopper 28a. Moreover, the elastic member 4a does not exert the force of rotating the operating section 5a counterclockwise and returning the operating section 5a to the initial state on the cam 51a. Accordingly, the position (i.e., the rotational position) of the operating section 5a is stably maintained, and the shape of the elastic member 4a separated from the terminal 3a is stably maintained.

[0094] When the connector 1a enters the non-connected state, as illustrated in Fig. 19, the electric cable 91 is inserted from the insertion hole 21a of the case 2a into the case 2a in a predetermined direction of insertion and placed between the terminal 3a and the elastic member 4a in the non-connected state. The direction of insertion of the electric cable 91 into the case 2a is a diagonal direction that is inclined to the up-down direction and the right-left direction. The electric cable 91 is the same in, for example, type and diameter as the electric cable 91 described above. In the example illustrated in Fig. 19, the tip end of the electric cable 91 is in contact with part of the case 2a in order to prevent further insertion of the electric cable 91. Moreover, the projection 522a of the actuator 52a of the operating section 5a is in contact with the electric cable 91 from above. In the example illustrated in Fig. 19, the projection 522a of the operating section 5a is in contact with the covered portion of the electric cable 91, but the projection 522a may be in contact with the conductive portion or rod-like solderless terminal of the electric cable 91. As another alternative, the projection 522a may be located slightly above the electric cable 91 without contact with the electric cable 91.

[0095] Then, as illustrated in Fig. 20, the operator moves the electric cable 91 slightly upward from the position indicated by the dashed double-dotted line. For example, the operator may press the tip end of the electric cable 91 against the case 2a and pry the electric cable 91 upward using the tip end as a fulcrum. This allows direct transmission of a force from the electric cable 91 to the projection 522a of the operating section 5a. Then, the operating section 5a slightly rotates counterclockwise in Fig. 20 about the rotating shaft 24a. In other words, the position (i.e., rotational position) of the operating section 5a is changed in the circumferential direction about the rotating shaft 24a.

[0096] Accordingly, the restoring force vector 81a deviates to the right in Fig. 20 from the reference line 82a, and the restoring force of the elastic member 4a produces a counterclockwise rotation moment on the cam 51a. As a result, the operating section 5a is further rotated counterclockwise, and the elastic member 4a is restored from the non-connected state.

[0097] Then, as illustrated in Fig. 21, the elastic member 4a transitions to the connected state in which the electric cable 91 is sandwiched between the terminal 3a and the elastic member 4a, and the electric cable 91 and the terminal 3a are electrically and mechanically connected to each other. In other words, the electric cable

91, after inserted into the connector 1a, is automatically connected to the connector 1a (i.e., without the operator operating the operating section 5a using a tool other than the electric cable 91 or his/her fingers). For example, the operator may recognize this transition to the connected state by, for example, vibrations or sounds generated when the electric cable 91 is pressed against the terminal 3a by the movable portion 43a of the elastic member 4a. The vibrations or sounds may be generated by, for example, a collision of two members that are any of the elastic member 4a, the electric cable 91, the terminal 3a, the operating section 5a, and the case 2a. The connector 1a may employ any of various structures that facilitate the generation of the vibrations or sounds or that amplify the vibrations or sounds.

[0098] When the connector 1a is in the connected state, the identifier 55a of the operating section 5a is housed in the case 2a and does not project from the through hole 232a of the case 2a unlike in the non-connected state. Thus, the operator is able to easily recognize the transition of the connector 1a from the non-connected state to the connected state by visually recognizing the fact that the identifier 55a is housed in the case 2a.

[0099] In the case of removing the electric cable 91 from the connector 1a, for example, the operator may insert the tip end of a tool such as a minus driver into the through hole 231a of the case 2a and push the actuator 52a of the operating section 5a downward. This causes the operating section 5a to rotate clockwise in Fig. 21. When the operating section 5a is rotated to the non-connected state illustrated in Fig. 19, the restoring force vector 81a (see Fig. 18) approximately coincides with the reference line 82a as described above, and the elastic member 4a is maintained in the non-connected state in which the elastic member 4a is separated below from the electric cable 91. This releases the holding of the electric cable 91 by the elastic member 4a and the terminal 3a. The operator is able to easily remove the electric cable 91 from the connector 1a by pulling out the electric cable 91 from the insertion hole 21a.

[0100] As described above, the connector 1a for connecting the electric cable 91 includes the case 2a, the conductive terminal 3a, the elastic member 4a, and the operating section 5a. The terminal 3a is fixed to the case 2a. The elastic member 4a is attached to the case 2a and presses the electric cable 91 against the terminal 3a by the restoring force to hold the electric cable 91. The operating section 5a applies a force to the elastic member 4a to bend the elastic member 4a from the initial state to the non-connected state and to maintain the elastic member 4a in the non-connected state. The operating section 5a includes the first portion 513a that the restoring force of the elastic member 4a acts on, and the second portion 514a that develops a reaction force against the restoring force. The vector of the restoring force is regarded as the restoring force vector 81a, and the straight line connecting the first portion 513a and the second portion 514a is regarded as the reference line 82a.

[0101] When the elastic member 4a is in the non-connected state, the restoring force vector 81a approximately coincides with and the reference line 82a, and the above restoring force and the above reaction force are balanced. Accordingly, the position of the operating section 5a is maintained, and the elastic member 4a is maintained in the non-connected state. When the position of the operating section 5a is changed and the restoring force vector 81a deviates from the reference line 82a while the electric cable 91 is inserted between the terminal 3a and the elastic member 4a in the non-connected state, the elastic member 4a is restored from the non-connected state by the above restoring force and transitions to the connected state in which the electric cable 91 is sandwiched between the terminal 3a and the elastic member 4a.

[0102] The connector 1a with the structure described above eliminates the need to provide other structures such as a stepped portion for locking the operating section 5a in the non-connected state or a state releaser for releasing the locking of the operating section 5a. This simplifies the structure of the connector 1a. Besides, it is possible to prevent the occurrence of problems such as locking failures due to wear on the stepped portion or any other reasons and to increase the life of the connector 1a, unlike in the case where the operating section 5a is locked in the stepped portion or the like of the case 2a.

[0103] As described above, in the connector 1a, it is preferable that the position of the operating section 5a is maintained even if the elastic member 4a is further bent in the non-connected state. At this time, the direction of the rotation moment on the cam 51a produced by the restoring force of the elastic member 4a is opposite to the direction of the rotation moment that returns the operating section 5a to the connected state and the initial state. Accordingly, it is possible to more stably maintain the shape of the elastic member 4a in the state in which the elastic member 4a is separated from the terminal 3a.

[0104] In the connector 1a, it is preferable that the operating section 5a includes the cam 51a that rotates about the rotating shaft 24a. The cam 51a comes in contact with the elastic member 4a at the first portion 513a and also in contact with the rotating shaft 24a at the bearing 54a serving as the second portion 514a. Then, when the elastic member 4a transitions to the non-connected state, the cam 51a rotates to increase the distance between the first portion 513a and the rotating shaft 24a and to bend the elastic member 4a, and when the restoring force vector 81a approximately coincides with the reference line 82a, the rotational position of the operating section 5a is maintained, and the elastic member 4a is maintained in the non-connected state. Accordingly, the transition of the elastic member 4a to the non-connected state and the state maintenance of the elastic member 4a in the non-connected state can be achieved with a simple structure.

[0105] As described above, in the case of connecting the electric cable 91, it is preferable that the inserted elec-

tric cable 91 comes in direct contact with the operating section 5a to change the position of the operating section 5a. In this case, because the force of pushing in the electric cable 91 is easily transmitted to the operating section 5a, it becomes easy to achieve automatic connection of the electric cable 91. Besides, it is possible to simplify the shape of the elastic member 4a.

[0106] It is preferable that the connector 1a includes a visually recognizable identifier 55a that indicates the state of the elastic member 4a. In the example described above, whether the elastic member 4a is in the non-connected state can be determined by visual recognition as to whether the identifier 55a projects from the case 2a. This enables the operator to easily and speedily recognize the state of the elastic member 4a.

[0107] In the connector 1a, it is preferable that the elastic member 4a is a plate spring. This further simplifies the structure of the connector 1a.

[0108] In the connector 1a, the transition from the non-connected state (see Fig. 19) to the connected state (see Fig. 21) does not necessarily have to be implemented by pushing the actuator 52a of the operating section 5a upward by the electric cable 91. For example, the restoring force vector 81a may deviate to the right from the reference line 82a as in Fig. 20 by slightly pushing down the identifier 55a that projects from the through hole 232a of the case 2a with a fingertip 93 of the operator as illustrated in Fig. 22. As a result, the cam 51a is rotated counterclockwise by the restoring force of the elastic member 4a, and the connector 1a transition to the connected state illustrated in Fig. 21.

[0109] As described above, in the connector 1a, it is preferable that part of the operating section 5a (in the example described above, the identifier 55a) projects from the case 2a. This enables the operator to easily operate the operating section 5a.

[0110] In the connector 1a, it is preferable that, when the elastic member 4a is in the non-connected state (see Fig. 18), part of the operating section 5a (i.e., the identifier 55a) projects from the case 2a, and when the elastic member 5a is in the connected state (see Fig. 21), the above part of the operating section 5a is located inside the case 2a. This allows easy and speedy recognition as to whether the elastic member 4a is in the non-connected state as described above. Besides, in the non-connected state, it is possible to easily operate the operating section 5a without using any tool such as a minus driver. It is also possible to prevent the occurrence of operating errors on the operating section 5a in the connected state. In the example illustrated in Fig. 22, the tip end of a rod-like tool or the like may be used, instead of the fingertip 93 of the operator, when pushing the identifier 55a of the operating section 5a into the case 2a.

[0111] Next, a connector 1b according to a third embodiment of the present invention will be described. Fig. 23 is a longitudinal sectional view illustrating an area in the vicinity of an operating section 5b of a connector 1b in enlarged dimensions. Fig. 24 is a plan view of the operating section 5b and an elastic member 4b. Figs. 23 and 24 show the connector 1b in the initial state.

[0112] The connector 1b includes a case 2b, a terminal 3b, the elastic member 4b, and the operating section 5b. The connector 1b and the connector 1 illustrated in Fig. 1 differ in the shapes of the case 2b, the terminal 3b, the elastic member 4b, and the operating section 5b and the movements of the elastic member 4b and the operating section 5b, but are the same in, for example, material properties and functions. Like the connector 1, the connector 1b may include two or more sets of the terminal 3b, the elastic member 4b, and the operating section 5b.

[0113] The terminal 3b is an approximately plate-like conductive member fixed to the case 2b. The terminal 3b may be made of, for example, metal. The elastic member 4b is an elastically deformable member attached to the case 2b. For example, the elastic member 4b may be an approximately band-like plate spring. The elastic member 4b may be formed of a conductive material such as metal, or may be formed of an insulating material such as resin. The elastic member 4b has a shape that is bent into an approximately V- or U-letter shape around each of the upper and lower end portions (i.e., an approximately Z-letter shape).

[0114] Like the elastic member 4 described above, the elastic member 4b includes a bent portion 41b, a fixed portion 42b, and a movable portion 43b. The movable portion 43b includes a cut and bent portion 431b that is partially cut off from the surrounding portion and bent upward. The elastic member 4b further includes an electric-cable receiver 44b and a releaser 46b. The electric-cable receiver 44b extends upward from the upper end of the movable portion 43b. The releaser 46b extends to the left in Figs. 23 and 24 (i.e., in a direction toward the operating section 5b) from the upper end of the electric-cable receiver 44b. The elastic member 4b has an approximately constant width in the up-down direction in Fig. 24, except at the releaser 46b, and the releaser 46b has a width greater than that of the electric-cable receiver 44b. The releaser 46b extends leftward and upward in Fig. 24 from the upper end of the electric-cable receiver 44b (i.e., the right end in Fig. 24). To facilitate the understanding of the drawing, the releaser 46b is illustrated by the dashed dotted line in Fig. 24. Also, the terminal 3b is illustrated by the dashed double-dotted line in Fig. 24.

[0115] The upper end (i.e., the right end in Figs. 23 and 24) of the cut and bent portion 431b of the movable portion 43b is in contact with an approximately central portion in the right and left direction of the terminal 3b from the underside. Accordingly, the path of insertion of an electric cable, which will be described later, is closed inside an insertion hole 21b provided on the left side of the case 2b. The portion of the movable portion 43b other than the cut and bent portion 431b (in Fig. 23, the portion located on the left side of the cut and bent portion 431b) is in contact with the operating section 5b from the underside. As will be described later, the movable portion 43b is pushed down by the operating section 5b to be-

come elastically deformed and bent downward and to become separated below from the terminal 3b. When the downward pressure against the movable portion 43b is relieved, the movable portion 43b returns to its original state by the restoring force (i.e., returns elastically).

[0116] The electric-cable receiver 44b extends to the upper left from the upper end of the movable portion 43b on the right side of the terminal 3b and the operating section 5b in Fig. 23. The electric-cable receiver 44b extends from below the terminal 3b to above the terminal 3 and is located on the path of insertion of an electric cable that is inserted along the lower surface of the terminal 3b. The electric-cable receiver 44b has a receiving face 441b that expands to the surroundings in the direction of insertion of an electric cable.

[0117] The releaser 46b extends to the left side in Fig. 23 (i.e., in a direction approaching the operating section 5b) from the upper end of the electric-cable receiver 44b and partly faces the operating section 5b and the terminal 3b in the up-down direction. The releaser 46b has a tip end portion (i.e., an end portion on the side closer to the operating section 5b) that is bent downward (i.e., in a direction facing the operating section 5b) above the operating section 5b.

[0118] The operating section 5b includes a cam 51b. The cam 51b is an approximately fan-type plate member when viewed from the front and is arranged inside the case 2b (i.e., inward of the outer edge of the case 2b). The center of the fan-type shape is located in a right-side upper end portion of the cam 51b in Fig. 23, and a through hole extending in the thickness direction is provided in the vanity of the center. The through hole is provided with a bearing 54b. The bearing 54b is fitted with an approximately columnar rotating shaft 24b provided in the case 2b and extending in the thickness direction. The cam 51b is supported by the case 2b so as to be rotatable about the rotating shaft 24b in a plane that is approximately perpendicular to the thickness direction. In the example illustrated in Fig. 23, the approximately fan-type cam 51b has a central angle of approximately 90 degrees when viewed from the front.

[0119] In the vicinity of the lower end portion of the cam 51b in Fig. 23, an approximately half-round columnar projection 515b that projects downward (i.e., radially outward of the cam 51b) is provided. The cam 51b is in contact with the movable portion 43b of the elastic member 4b at the projection 515b from above. In the cam 51b, the distance between the center of the rotating shaft 24b and the outer edge of the cam 51b becomes a maximum on a straight line that extends from the center of the rotating shaft 24b to the outer peripheral edge of the projection 515b of the cam 51b (specifically, approximately the center in the circumferential direction of the outer peripheral edge). The lower portion of the cam 51b overlaps with the terminal 3b in the lower portion and is located on the rear side of the terminal 3b in Fig. 23.

[0120] Next, a procedure for connecting an electric cable to the connector 1b will be described. First, in the initial state illustrated in Fig. 23, an operator inserts the tip end portion of an ordinary tool 92 such as a minus driver into the case 2b from a through hole 231b provided in the left end portion of the upper surface of the case 2b. The tip end of the rear portion 92 comes in contact with the upper surface of the left end portion of the operating section 5b located under the through hole 231b. The operator then presses in the tool 92 downward so that the operating section 5b is rotated counterclockwise in Fig. 23 about the rotating shaft 24b.

[0121] As illustrated in Fig. 25, the rotation of the operating section 5b increases the distance between the center of the rotating shaft 24b and the contact between the cam 51b and the elastic member 4b. Accordingly, the movable portion 43b of the elastic member 4b is pushed down by the cam 5 1b, and the cut and bent portion 431b is separated from the terminal 3b.

[0122] As illustrated in Fig. 25, when the operating section 5b is rotated halfway, a restoring force vector 81b of the elastic member 4b acting on a first portion 513b deviates to the left from a reference line 82b that is a virtual straight line connecting the first portion 513b and a second portion 514b. Thus, a clockwise rotation moment acts on the cam 51b, and unless the operator continues to push in the operating section 5b downward, the elastic member 4b and the operating section 5b will return to the initial state illustrated in Fig. 23. Note that the first portion 513b is a portion of the operating section 5b that the restoring force of the elastic member 4b acts on, and is specifically a portion of the projection 515b of the cam 51b that comes in contact with the elastic member 4b. The second portion 514b is a portion of the operating section 5b that develops a reaction force against the restoring force, and is specifically a point of intersection of the bearing 54b with a virtual straight line that connects the first portion 513b and the center of the rotating shaft 24b.

[0123] The operator pushes in the operating section 5b to the non-connected state illustrated in Fig. 26 against the restoring force of the elastic member 4b. In the non-connected state, the restoring force vector 81b of the elastic member 4b acting on the first portion 513b approximately coincides with the reference line 82b connecting the first portion 513b and the second portion 514b. Thus, the restoring force of the elastic member 4b and the reaction force developed against the restoring force by the operating section 5b are balanced.

[0124] Therefore, neither the clockwise rotation moment described above nor a counterclockwise rotation moment acts on the cam 51b. Accordingly, even if the operator pulls the tool 92 out of the through hole 231b of the case 2b (i.e., even in a state in which the operator does not apply any force to the operating section 5b), the circumferential position (i.e., rotational position) of the operating section 5b is stably maintained in the non-connected state illustrated in Fig. 26. The elastic member 4b is also stably maintained in the non-connected state (i.e., stopped tentatively). The non-connected state illustrated

in Fig. 26 is a tentative stopped state in which the elastic member 4b is tentatively stopped in a bent position. In the connector 1b, the operating section 5b includes only one first portion 513b that the restoring force of the elastic member 4b acts on, and only one second portion 514b that develops a reaction force against the restoring force. This simplifies the structure of the connector 1b.

[0125] In the non-connected state, the upper surface of the right end portion of the operating section 5b makes an approximately horizontal surface that is approximately perpendicular to the up-down direction and comes in contact with the tip end portion of the releaser 46b of the elastic member 4b from the underside. Moreover, part of the operating section 5b (in the example illustrated in Fig. 26, the end on the left side of the cam 51b) comes in contact with a stopper 28b that is a projection provided on the case 2b. This restricts the movement of the operating section 5b so as to prevent further counterclockwise rotation of the operating section 5b.

[0126] Alternatively, in the connector 1b, the position of the operating section 5b may be maintained in such a state that the operating section 5b is further rotated in the counterclockwise direction from the rotational position illustrated in Fig. 26 and the elastic member 4b is further bent as in the connector 1 illustrated in Fig. 14. This structure may be implemented by, for example, moving the position of the upper surface of the stopper 28b in Fig. 26 downward. In this case, the restoring force vector 81b slightly deviates to the right from the reference line 82b, and a counterclockwise rotation moment acts on the cam 51b. That is, the elastic member 4b exerts the force of rotating the operating section 5b counterclockwise on the cam 51b. However, the counterclockwise rotation of the operating section 5b is restricted by the left end portion of the cam 51b coming in contact with the stopper 28b. Besides, the elastic member 4b does not exert the force of rotating the operating section 5b clockwise and returning the operating section 5b to the initial state on the cam 51b. Accordingly, the position of the operating section 5b is stably maintained, and the shape of the elastic member 4b separated from the terminal 3b is stably maintained.

[0127] When the connector 1b enters the non-connected state, as illustrated in Fig. 27, the electric cable 91 is inserted from the insertion hole 21b of the case 2b into the case 2b in a predetermined direction of insertion and placed between the terminal 3b and the elastic member 4b in the non-connected state. The direction of insertion of the electric cable 91 into the case 2b is approximately parallel to the right-left direction. The electric cable 91 is the same in, for example, type and diameter as the electric cable 91 described above.

[0128] The tip end of the electric cable 91 comes in direct contact with the electric-cable receiver 44b of the elastic member 4b in the case 2b. In the example illustrated in Fig. 27, the left side face of the electric-cable receiver 44b serves as the receiving face 441b that comes in direct contact with the tip end of the electric cable 91 and expands from the tip end to the surrounding. The receiving face 441b is located on the inner side of the cut and bent portion 431b in the direction of insertion of the electric cable 91 and expands to the surroundings in the direction of insertion as described above.

[0129] The electric cable 91, with the tip end in contact with the receiving face 441b of the electric-cable receiver 44b, is moved to the inner side in the direction of insertion. Accordingly, as illustrated in Fig. 28, the receiving face 441b is pushed toward the inner side in the direction of insertion and becomes deformed in a direction in which the electric-cable receiver 44b and the releaser 46b become flat in the up-down direction. The tip end of the releaser 46b moves downward and pushes down the right end portion of the operating section 5b that is in contact with this tip end. That is, the force generated by pushing in the electric cable 91 is indirectly applied to the operating section 5b via the elastic member 4b that is in direct contact with the electric cable 91. Then, the operating section 5b slightly rotates clockwise in Fig. 28 about the rotating shaft 24b. In other words, the position (i.e., rotational position) of the operating section 5b is charged in the circumferential direction about the rotating shaft 24b. The rotation direction of the cam 5 1b at the first portion 513b is the direction from the inner side to the outer side in the direction of insertion of the electric cable 91 (i.e., the direction toward approximately the left side in Fig. 28).

[0130] Accordingly, as illustrated in Fig. 28, the restoring force vector 81b deviates to the left in Fig. 28 from the reference line 82b, and the restoring force of the elastic member 4b produces a clockwise rotation moment on the cam 51b. As a result, the operating section 5b is further rotated clockwise and the elastic member 4b is restored from the non-connected state.

[0131] Then, as illustrated in Fig. 29, the elastic member 4b transitions to the connected state in which the electric cable 91 is sandwiched between the terminal 3b and the elastic member 4b, and the electric cable 91 and the terminal 3b are electrically and mechanically connected to each other. In other words, the electric cable 91, after inserted into the connector 1b, is automatically connected to the connector 1b (i.e., without the operator operating the operating section 5b using a tool other than the electric cable 91 or his/her fingers). For example, the operator may recognize this transition to the connected state by, for example, vibrations or sounds generated when the electric cable 91 is pressed against the terminal 3b by the cut and bent portion 431b of the elastic member 4b. The vibrations or sounds may be generated by, for example, a collision of two members that are any of the elastic member 4b, the electric cable 91, the terminal 3b, the operating section 5b, and the case 2b. The connector 1b may employ any of various structures that facilitate the generation of the vibrations or sounds or that amplify the vibrations or sounds.

[0132] When the connector 1b is in the connected state, the portion of the operating section 5b that is visible

from the through hole 231b of the case 2b differs in, for example, its orientation or its distance from the through hole 231b, from the portion of the operating section 5b that is visible from the through hole 231b when the connector 1b is in the non-connected state. Thus, the operator is able to easily recognize the transition of the connector 1b from the non-connected state to the connected state by visually recognizing the operating section 5b from the through hole 231b. In the same manner as described above, the operator is also able to easily recognize the initial state of the connector 1b by visually recognizing the operating section 5b from the through hole 231b. That is, the portion of the operating section 5b that is visible from the through hole 231b serves as a visually recognizable identifier that indicates the state of the elastic member 4b. In this case, the portion of the operating section 5b that is visible from the through hole 231b may be subjected to some kind of processing such as coloring that makes more distinctive the difference of the initial state, the connected state, and the non-connected state.

[0133] In the case of removing the electric cable 91 from the connector 1b, for example, the operator may insert the tip end portion of a tool such as a minus driver into the through hole 231b of the case 2b and push down the left end portion of the operating section 5b. Accordingly, the operating section 5b is rotated counterclockwise in Fig. 29. When the operating section 5b is rotated to the non-connected state illustrated in Fig. 27, the restoring force vector 81b (see Fig. 26) approximately coincides with the reference line 82b as described above, and the elastic member 4b is maintained in the non-connected state in which the elastic member 4b is separated below from the electric cable 91. This releases the holding of the electric cable 91 by the elastic member 4b and the terminal 3b. The operator is able to easily remove the electric cable 91 from the connector 1b by pulling out the electric cable 91 from the insertion hole 21b.

[0134] As described above, the connector 1b for connecting the electric cable 91 includes the case 2b, the conductive terminal 3b, the elastic member 4b, and the operating section 5b. The terminal 3b is fixed to the case 2b. The elastic member 4b is attached to the case 2b and presses the electric cable 91 against the terminal 3b by the restoring force to hold the electric cable 91. The operating section 5b applies a force to the elastic member 4b to bend the elastic member 4b from the initial state to the non-connected state and to maintain the elastic member 4b in the non-connected state. The operating section 5b includes the first portion 513b that the restoring force of the elastic member 4b acts on, and the second portion 514b that develops a reaction force against the restoring force. The vector of the restoring force is regarded as the restoring force vector 81b, and the straight line connecting the first portion 513b and the second portion 514b is regarded as the reference line 82b.

[0135] When the elastic member 4b is in the non-connected state, the restoring force vector 81b approximately coincides with the reference line 82b, and the above restoring force and the above reaction force are balanced. Accordingly, the position of the operating section 5b is maintained, and the elastic member 4b is maintained in the non-connected state. When the position of the operating section 5b is changed and the restoring force vector 81b deviates from the reference line 82b while the electric cable 91 is inserted between the terminal 3b and the elastic member 4b in the non-connected state, the elastic member 4b is restored from the non-connected state by the above restoring force and transitions to the connected state in which the electric cable 91 is sandwiched between the terminal 3b and the elastic member 4b.

[0136] The connector 1b with the structure described above eliminates the need to provide other structures such as a stepped portion for locking the operating section 5b in the non-connected state or a state releaser for releasing the locking of the operating section 5b. This simplifies the structure of the connector 1b. Besides, it is possible to prevent the occurrence of problems such as locking failures due to wear on the stepped portion or any other reasons and to increase the life of the connector 1b, unlike in the case where the operating section 5b is locked in the stepped portion or the like of the case 2b.

[0137] As described above, in the connector 1b, it is preferable that the position of the operating section 5b is maintained even if the elastic member 4b is further bent in the non-connected state. At this time, the direction of the rotation moment on the cam 51b produced by the restoring force of the elastic member 4b is opposite to the direction of the rotation moment that returns the operating section 5b to the connected state and the initial state. Accordingly, it is possible to more stably maintain the shape of the elastic member 4b that is separated from the terminal 3b.

[0138] In the connector 1b, it is preferable that the operating section 5b includes the cam 51b that rotates about the rotating shaft 24b. The cam 51b comes in contact with the elastic member 4b at the first portion 513b and also in contact with the rotating shaft 24b at the bearing 54b serving as the second portion 514b. Then, when the elastic member 4b transitions to the non-connected state, the cam 51b rotates to increase the distance between the first portion 513b and the rotating shaft 24b and to bend the elastic member 4b, and when the restoring force vector 81b approximately coincides with the reference line 82b, the rotational position of the operating section 5b is maintained, and the elastic member 4b is maintained in the non-connected state. Accordingly, the transition of the elastic member 4b to the non-connected state and the state maintenance of the elastic member 4b in the non-connected state can be achieved with a simple structure.

[0139] As described above, in the case of connecting the electric cable 91 to the connector 1b, it is preferable that the inserted electric cable 91 comes in direct contact with the elastic member 4b and deforms the elastic member 4b such that the force is applied to the operating

section 5b via the elastic member 4b and changes the position of the operating section 5b. This improves flexibility in the shape and arrangement of the operating section 5b, as compared with the case where the operating section 5b is provided with a portion that comes in direct contact with the electric cable 91.

[0140] In the connector 1b, it is preferable that the elastic member 4b includes the electric-cable receiver 44b that comes in direct contact with the tip end of the electric cable 91 and the releaser 46b that extends from the electric-cable receiver 44b toward the operating section 5b. It is also preferable that the electric-cable receiver 44b has the receiving face 441b that expands from the tip end of the electric cable 91 to the surroundings. Then, it is preferable that the elastic member 4b is deformed by the electric cable 91 pushing the receiving face 441b toward the inner side in the direction of insertion of the electric cable 91, and the releaser 46b comes in contact with the operating section 5b to apply the force of rotating the cam 5 1b to the cam 5 1b. This prevents the occurrence of wear on the operating section 5b due to direct contact with the electric cable 91.

[0141] In the connector 1b, the cut and bent portion 431b of the elastic member 4 serves as an electric-cable contact part that comes in direct contact with the electric cable 91 in the connected state. Preferably, the travel path of the electric-cable contact part does not overlap with the motion space of the operating section 5b at least when the elastic member 4b transitions from the non-connected state to the connected state. This prevents the electric-cable contact part of the elastic member 4b from coming in contact with the operating section 5b and inhibiting the movement of the operating section 5b.

[0142] It is preferable that the connector 1b includes a visually recognizable identifier (in the example described above, part of the operating section 5b that is visible from the through hole 231b) that indicates the state of the elastic member 4b. This allows easy and speedy recognition of the state of the elastic member 4b.

[0143] Note that, in the connector 1b, part of the operating section 5b may project from the case 2b. For example, the connector 1b may include an approximately rod-like projection that extends upward from the cam 51b and projects from the case 2b. In this case, this projection functions as a visually recognizable identifier that indicates the state of the elastic member 4b. Accordingly, the operator is able to easily and speedily recognize the state of the elastic member 4b by visually recognizing the position of this projection of the operating section 5b. The operator is also able to easily operate the operating section 5b by touching this projection with his/her finger. It is preferable that, when the elastic member 4b is in the non-connected state, the projection of the operating section 5b projects from the case 2b, and when the elastic member 4b is in the connected state, the above projection is located inside the case 2b. This allows easy operation of the operating section 5b in the non-connected state without using any tool such as a minus driver and prevents the occurrence of operating errors on the operating section 5b in the connected state.

[0144] In the connector 1b, it is preferable that the elastic member 4b is a plate spring. This further simplifies the structure of the connector 1b.

[0145] As described above, in the case of connecting the electric cable 91 to the connectors 1, 1a, and 1b, the force is directly or indirectly transmitted from the inserted electric cable 91 to the operating sections 5, 5a, and 5b. Accordingly, the positions of the operating sections 5, 5a, and 5b are changed, and the restoring force vectors 81, 81a, and 81b deviate from the reference lines 82, 82a, and 82b. This achieves automatic connection of the electric cable 91 by only a simple operation such as inserting the electric cable 91 and thereby facilitates the connection of the electric cable 91 to the connectors 1, 1a, and 1b.

[0146] Next, a connector 1c according to a fourth embodiment of the present invention will be described. Fig. 30 is a longitudinal sectional view illustrating the area in the vicinity of an operating section 5c of the connector 1c in enlarged dimensions. Fig. 30 shows the connector 1c in the initial state.

[0147] The connector 1c includes a case 2c, a terminal 3c, an elastic member 4c, the operating section 5c, and a releaser 6c. The connector 1c and the connector 1 illustrated in Fig. 1 differ in the shapes of the case 2c, the terminal 3c, the elastic member 4c, and the operating section 5c and the movements of the elastic member 4c and the operating section 5c, but are the same in, for example, material properties and functions. Like almost the connector 1, the connector 1c may include two or more sets of the terminal 3c, the elastic member 4c, the operating section 5c, and the releaser 6c in the case 2c.

[0148] The terminal 3c is an approximately plate-like conductive member fixed to the case 2c. The terminal 3c may be made of, for example, metal. The elastic member 4c is an elastically deformable member attached to the case 2c. For example, the elastic member 4c may be an approximately band-like plate spring. The elastic member 4c may be formed of a conductive material such as metal, or may be formed of an insulating material such as resin. The elastic member 4c has a shape that is bent in an approximately L-, V-, or U-letter shape around the central portion in the longitudinal direction.

[0149] Like the elastic member 4 described above, the elastic member 4c includes a bent portion 41c, a fixed portion 42c, and a movable portion 43c. The tip end (i.e., the left end in Fig. 30) of the movable portion 43c is in contact with the terminal 3c from the underside. Thus, the path of insertion of an electric cable, which will be described later, is closed inside the insertion hole 21c provided on the right side of the case 2c. The movable portion 43c is also in contact with the operating section 5c from the underside. As will be described later, the movable portion 43c is pushed down by the operating section 5c to become elastically deformed and bent downward and to become separated below from the ter-

minal 3c. When the downward pressure force against the movable portion 43c is relieved, the movable portion 43c returns to its original state by the restoring force (i.e., returns elastically).

[0150] The operating section 5c includes an advancing/retracting part 56c and an actuator 52c. The advancing/retracting part 56c is an approximately pentagonal plate-like portion with one of its vertices located at the lower end when viewed from the front, and is arranged inside the case 2c (i.e., inward of the outer edge of the case 2c). The advancing/retracting part 56c overlaps with the terminal 3c in the thickness direction and is located on the rear side of the terminal 3c in Fig. 30.

[0151] The upper end portion of the advancing/retracting part 56c has an approximately arc-like shape that is convex upward when viewed from the front. The upper end of the advancing/retracting part 56c is in contact with an inner surface 25c of the upper end portion of the case 2c from the underside. The inner surface 25c of the case 2c is an approximately flat surface that extends approximately linearly in the right-left direction when viewed from the front. The lower end portion of the advancing/retracting part 56c comes in contact with the movable portion 43c of the elastic member 4c that extends along the inner surface 25c of the case 2c from above. That is, the advancing/retracting part 56c of the operating section 5c is located between the elastic member 4c and the inner surface 25c of the case 2c in the up-down direction.

[0152] The distance in the up-down direction between the inner surface 25c of the case 2c and the movable portion 43c of the elastic member 4c decreases in a direction from the right side to the left side in Fig. 30. The movable portion 43c of the elastic member 4c includes a first sloped portion 432c and a second sloped portion 433c. The first sloped portion 432c is a portion that extends from the tip end of the movable portion 43c to approximately the center thereof, and the second sloped portion 433c is a portion that extends from the right end of the first sloped portion 432c to the bent portion 41c. The first sloped portion 432c and the second sloped portion 433c are sloped to the inner surface 25c of the case 2c in a direction toward the left side in Fig. 30. When viewed from the front side, the angle (acute angle) formed by the first sloped portion 432c and the inner surface 25c is smaller than the angle (acute angle) formed by the second sloped portion 433c and the inner surface 25c. In the initial state illustrated in Fig. 30, the advancing/retracting part 56c is in contact with the second sloped portion 433c of the movable portion 43c at the left side surface of the lower end portion. The left-side surface of the advancing/retracting part 56c extends approximately parallel to the second sloped portion 433c in the initial state when viewed from the front.

[0153] The actuator 52c is an approximately rod-like portion that extends to the right from the right end portion of the advancing/retracting part 56c and projects to the right out of the case 2c. In the example illustrated in Fig. 30, the advancing/retracting part 56c and the actuator 52c are partly in contact with the case 2c and thereby restricts further rightward movement of the operating section 5c.

[0154] In the connector 1c, the actuator 52c is pushed to the left and thereby the advancing/retracting part 56c is moved approximately linearly to the left in Fig. 30 along the inner surface 25c while being into contact with the inner surface 25c of the case 2c and the movable portion 43c of the elastic member 4c inside the case 2c. In the following description, the right-left direction in Fig. 30 that is the travel direction of the advancing/retracting part 56c is also referred to as the "advancing and retracting direction." Also, the inner surface 25c of the case 2c that guides the movement of the advancing/retracting part 56c in the advancing and retracting direction is referred to as the "guide face 25c."

[0155] The releaser 6c is a plate-like member that has an approximately inverted L-letter shape and that is arranged leftward of the operating section 5c. The releaser 6c is supported by the case 2c so as to be rotatable about an approximately columnar rotating shaft 24c provided in the case 2c and extending in the thickness direction, in a plane that is approximately perpendicular to the thickness direction. The rotating shaft 24c is located on the left side and upper side of the left end portion of the terminal 3c that extends approximately parallel to the right-left direction.

[0156] The releaser 6c includes a releaser lower portion 61c that extends downward from the rotating shaft 24c, and a releaser upper portion 62c that extends to the right from the rotating shaft 24c (i.e., in a direction toward the advancing/retracting part 56c of the operating section 5c). The releaser lower portion 61c is located leftward of the left end portion of the terminal 3c and extends to below the terminal 3c. The releaser lower portion 61c is located on the path of insertion of an electric cable. The releaser upper portion 62c is located above the terminal 3c.

[0157] Next, a procedure for connecting an electric cable to the connector 1c will be described. First, in the initial state illustrated in Fig. 30, an operator touches the actuator 52c of the operating section 5c with, for example, his/her finger and moves the actuator 52c to the left so as to push in the actuator 52c into the case 2c. Accordingly, the advancing/retracting part 56c is moved from the right side to the left side in Fig. 30 (i.e., from one side to the other side in a predetermined advancing and retracting direction) while being in contact with the guide face 25c and the movable portion 43c of the elastic member 4c.

[0158] The movement of the operating section 5c causes the movable portion 43c of the elastic member 4c to be pushed down by the advancing/retracting part 56c and to become separated below from the terminal 3c as illustrated in Fig. 31. When the operating section 5c is moved halfway as illustrated in Fig. 31, a restoring force vector 81c of the elastic member 4c acting on a first portion 513c deviates to the right from a reference line 82c

that is a virtual straight line connecting the first portion 513c and a second portion 514c. Accordingly, a rightward force in Fig. 31 acts on the advancing/retracting part 56c, and unless the operator continues to push in the actuator 52c into the case 2c, the elastic member 4c and the operating section 5c will return to the initial state illustrated in Fig. 30.

[0159] Note that the first portion 513c is a portion of the operating section 5c that the restoring force of the elastic member 4c acts on, and is specifically a portion of the lower end portion of the advancing/retracting part 56c that comes in contact with the elastic member 4c. In the state illustrated in Fig. 31, the first portion 513c is a portion of the left side surface of the lower end portion of the advancing/retracting part 56c that comes in contact with the second sloped portion 433c of the movable portion 43c of the elastic member 4c. The second portion 514c is a portion of the operating section 5c that develops a reaction force against the restoring force, and is specifically the upper end of the advancing/retracting part 56c that comes in contact with the guide face 25c.

[0160] The operator pushes in the operating section 5c to the non-connected state illustrated in Fig. 32 against the restoring force of the elastic member 4c. In the non-connected state, the restoring force vector 81c of the elastic member 4c acting on the first portion 513c approximately coincides with the reference line 82c connecting the first portion 513c and the second portion 514c. In the non-connected state, the first portion 513c is the lower end of the advancing/retracting part 56c and is in contact with the first sloped portion 432c of the movable portion 43c of the elastic member 4c. The first sloped portion 432c is approximately parallel to the guide face 25c at a position in which the first sloped portion 432c comes in contact with the lower end of the advancing/retracting part 56c. Accordingly, the restoring force of the elastic member 4c and the reaction force developed against the restoring force by the operating section 5c are balanced.

[0161] From the above, neither the rightward force described above nor a leftward force acts on the advancing/retracting part 56c. Therefore, even if the operator moves his/her finger off the actuator 52c (i.e., in a state in which the operator does not apply any force to the operating section 5c), the position of the operating section 5c in the advancing and retracting direction is stably maintained in the non-connected state illustrated in Fig. 32. The elastic member 4c is also stably maintained in the non-connected state (i.e., stopped tentatively). The non-connected state illustrated in Fig. 32 is a tentative stopped state in which the elastic member 4c is tentatively stopped in a bent position. In the non-connected state, the left end portion of the operating section 5c is in contact with the releaser upper portion 62c of the releaser 6c from the right side. In the connector 1c, the operating section 5c includes only one first portion 513c that the restoring force of the elastic member 4c acts on, and only one second portion 514c that develops a reaction force against the restoring force. This simplifies the structure of the connector 1c.

[0162] In the connector 1c, the operating section 5c may be further moved to the left in the drawing from the condition illustrated in Fig. 32. In this case, the shape of the elastic member 4c remains almost unchanged from the shape illustrated in Fig. 32, and the restoring force of the elastic member 4c and the reaction force developed against the restoring force by the operating section 5c remains balanced. Accordingly, the position of the operating section 5c in the advancing and retracting direction and the state of the elastic member 4c (i.e., the tentative stopped state) is stably maintained.

[0163] In the connector 1c, the operating section 5c may be further moved to the left from the position illustrated in Fig. 32 and the position of the operating section 5c may be maintained in a state in which the elastic member 4c is further bent, as approximately in the connector 1 illustrated in Fig. 14. This structure may be implemented by, for example, bending the first sloped portion 432c of the elastic member 4c slightly upward on the side that is closer to the tip end (i.e., on the left side) than the contact with the advancing/retracting part 56c in Fig. 32. In this case, the restoring force vector 81c is slightly inclined to the left from the reference line 82c, and a leftward force acts on the advancing/retracting part 56c. That is, the elastic member 4c exerts the force of moving the operating section 5c to the left on the advancing/retracting part 56c. Moreover, the elastic member 4c does not exert the force of moving the operating section 5c to the right and returning the operating section 5c to the initial state on the advancing/retracting part 56c. Therefore, the position of the operating section 5c is stably maintained, and the shape of the elastic member 4c that is separated from the terminal 3c is stably maintained.

[0164] When the connector 1c enters the non-connected state, as illustrated in Fig. 33, the electric cable 91 is inserted from the insertion hole 21c of the case 2c into the case 2c in a predetermined direction of insertion and located between the terminal 3c and the elastic member 4c in the non-connected state. The direction of insertion of the electric cable 91 into the case 2c is approximately parallel to the right-left direction. The electric cable 91 is the same in, for example, type and diameter as the electric cable 91 described above.

[0165] The tip end of the electric cable 91 comes in direct contact with the releaser lower portion 61c of the releaser 6c inside the case 2c. In the example illustrated in Fig. 33, the right side surface of the releaser lower portion 61c serves as a receiving face 611c that comes in direct contact with the tip end of the electric cable 91 and expands from the tip end to the surroundings. The receiving face 611c is located on the inner side of the terminal 3c and the movable portion 43c of the elastic member 4c in the direction of insertion of the electric cable 91 and expands to the surroundings in a direction that is approximately perpendicular to the direction of insertion of the electric cable 91.

[0166] The electric cable 91, with the tip end in contact with the receiving face 611c of the releaser lower portion 61c, is moved to the inner side in the direction of insertion. Accordingly, as illustrated in Fig. 34, the receiving face 611c is pushed to the inner side in the direction of insertion, and the releaser 6c is rotated slightly clockwise in Fig. 34 about the rotating shaft 24c. As a result, the releaser upper portion 62c pushes the advancing/retracting part 56c to the right side in Fig. 34. That is, the force generated by pushing in the electric cable 91 is indirectly applied to the operating section 5c via the releaser 6c that comes in direct contact with the electric cable 91. Then, the operating section 5c slightly moves to the right side, so that the position of the operating section 5c in the advancing and retracting direction is changed. The travel direction of the operating section 5c is the direction from the inner side to the outer side in the direction of insertion of the electric cable 91.

[0167] Accordingly, as illustrated in Fig. 34, the portion of the operating section 5c that comes in contact with the elastic member 4c changes from the lower end of the operating section 5c to the left side surface of the lower end portion of the operating section 5c, and the portion of the elastic member 4c that comes in contact with the operating section 5c changes from the first sloped portion 432c to the second sloped portion 433c. The restoring force vector 81c deviates to the right in Fig. 34 from the reference line 82c, and the restoring force of the elastic member 4c produces a rightward force on the advancing/retracting part 56c. As a result, the operating section 5c is further moved to the right and the elastic member 4c is restored from the non-connected state.

[0168] Then, as illustrated in Fig. 35, the elastic member 4c transitions to the connected state in which the electric cable 91 is sandwiched between the terminal 3c and the elastic member 4c, and the electric cable 91 and the terminal 3c are electrically and mechanically connected to each other. In other words, the electric cable 91, after inserted into the connector 1c, is automatically connected to the connector 1c (i.e., without the operator operating the operating section 5c using a tool other than the electric cable 91 or his/her fingers). For example, the operator may recognize this transition to the connected state by, for example, vibrations or sounds generated when the electric cable 91 is pressed against the terminal 3c by the movable portion 43c of the elastic member 4c. The vibrations or sounds may be generated by, for example, a collision of two members that are any of the elastic member 4c, the electric cable 91, the terminal 3c, the operating section 5c, and the case 2c. The connector 1c may employ any of various structures that facilitate the generation of the vibrations or sounds or that amplify the vibrations or sounds.

[0169] When the connector 1c is in the connected state, the position of the actuator 52c of the operating section 5c (i.e., the position thereof in the advancing and retracting direction) differs from the position of the actuator 52c when the connector 1c is in the non-connected state. Thus, the operator is able to easily recognize the transition of the connector 1c from the non-connected state to the connected state by visually recognizing the position of the actuator 52c. In the same manner as described above, the operator is also able to easily recognize the initial state of the connector 1c by visually recognizing the position of the actuator 52c. That is, the actuator 52c of the operating section 5c serves as a visually recognizable identifier that indicates the state of the elastic member 4c.

[0170] In the case of removing the electric cable 91 from the connector 1c, for example, the operator may touch the actuator 52c of the operating section 5c with his/her finger and move the actuator 52c to the left to push in the actuator 52c into the case 2c. When the operating section 5c is moved to the non-connected state illustrated in Fig. 33, the restoring force vector 81c (see Fig. 32) approximately coincides with the reference line 82c as described above, and the elastic member 4c is maintained in the non-connected state in which the elastic member 4c is separated below from the electric cable 91. This releases the holding of the electric cable 91 by the elastic member 4c and the terminal 3c. The operator is able to easily remove the electric cable 91 from the connector 1c by pulling out the electric cable 91 from the insertion hole 21c.

[0171] As described above, the connector 1c for connecting the electric cable 91 includes the case 2c, the conductive terminal 3c, the elastic member 4c, and the operating section 5c. The terminal 3c is fixed to the case 2c. The elastic member 4c is attached to the case 2c and presses the electric cable 91 against the terminal 3c by the restoring force to hold the electric cable 91. The operating section 5c applies a force to the elastic member 4c to bend the elastic member 4c from the initial state to the non-connected state and to maintain the elastic member 4c in the non-connected state. The operating section 5c includes the first portion 513c that the restoring force of the elastic member 4c acts on, and the second portion 514c that develops a reaction force against the restoring force. The vector of the restoring force is regarded as the restoring force vector 81c, and the straight line connecting the first portion 513c and the second portion 514c is regarded as the reference line 82c.

[0172] When the elastic member 4c is in the non-connected state, the restoring force vector 81c approximately coincides with the reference line 82c, and the above restoring force and the above reaction force are balanced. Accordingly, the position of the operating section 5c is maintained, and the elastic member 4c is maintained in the non-connected state. When the position of the operating section 5c is changed and the restoring force vector 81c deviates from the reference line 82c while the electric cable 91 is inserted between the terminal 3c and the elastic member 4c in the non-connected state, the elastic member 4c is restored from the non-connected state by the above restoring force and transitions to the connected state in which the electric cable 91 is sand-

wiched between the terminal 3c and the elastic member 4c.

[0173] The connector 1c with the structure described above eliminates the need to provide other structures such as a stepped portion for locking the operating section 5c in the non-connected state. This simplifies the structure of the connector 1c. Besides, it is possible to prevent the occurrence of problems such as locking failures due to wear on the stepped portion or any other reasons and to increase the life of the connector 1c, unlike in the case where the operating section 5c is locked in the stepped portion or the like of the case 2c.

[0174] As described above, in the connector 1c, it is preferable that the position of the operating section 5c is maintained even if the elastic member 4c is further bent in the non-connected state. At this time, the direction of the force acting on the advancing/retracting part 56c produced by the restoring force of the elastic member 4c is opposite to the direction of the force that returns the operating section 5c to the connected state and the initial state. Accordingly, it is possible to more stably maintain the shape of the elastic member 4c in the state in which the elastic member 4c is separated from the terminal 3c.

[0175] In the connector 1c, it is preferable that the case 2c includes the guide face 25c extending linearly, and the elastic member 4c extends along the guide face 25c. It is also preferable that the operating section 5c further includes the advancing/retracting part 56c that is located between the elastic member 4c and the guide face 25c and that moves linearly in a predetermined advancing and retracting direction (in the example described above, the right-left direction in Fig. 30) while being in contact with the elastic member 4c and the guide face 25c at the first portion 513c and the second portion 514c, respectively. The distance between the elastic member 4c and the guide face 25c decreases in a direction from one side to the other side in the advancing and retracting direction (in the example described above, in a direction from the right side to the left side in Fig. 30). Preferably, when the elastic member 4c transitions to the non-connected state, the advancing/retracting part 56c moves from the above one side to the other side in the advancing and retracting direction (in the example described above, leftward in Fig. 30) to bend the elastic member 4c and to make the elastic member 4c approximately parallel to the guide face 25c at a position at which the elastic member 4c comes in contact with the first portion 513c. Then, when the restoring force vector 81c approximately coincides with the reference line 82c, the position of the operating section 5c in the advancing and retracting direction is maintained, and the elastic member 4c is maintained in the non-connected state. In the case of connecting the electric cable 91, it is preferable that the operating section 5c is moved from the above other side to the one side in the advancing and retracting direction (in the example described above, rightward in Fig. 30) so as to deviate the restoring force vector 81c from the reference line 82c and to cause the elastic member 4c to transition from the non-connected state to the connected state by the restoring force. Accordingly, the transition of the elastic member 4c to the non-connected state, the state maintenance of the elastic member 4c in the non-connected state, and the transition from the non-connected state to the connected state can be achieved with a simple structure.

[0176] In the case of connecting the electric cable 91 to the connector 1c described above, a force is indirectly transmitted from the inserted electric cable 91 to the operating section 5c via the releaser 6c so as to move the operating section 5c from the above other side to the above one side in the advancing and retracting direction and to deviate the restoring force vector 81c from the reference line 82c. However, the present embodiment is not limited to this example. For example, the force may be directly transmitted from the inserted electric cable 91 to the operating section 5c when moving the operating section 5c from the above other side to the above one side in the advancing and retracting direction. That is, in the case of connecting the electric cable 91 to the connector 1c, it is preferable that the force is directly or indirectly transmitted from the inserted electric cable 91 to the operating section 5c so as to move the operating section 5c from the above other side to the above one side in the advancing and retracting direction and to deviate the restoring force vector 81c from the reference line 82c. This achieves automatic connection of the electric cable 91 by only a simple operation such as inserting the electric cable 91 and thereby facilitates the connection of the electric cable 91 to the connector 1c.

[0177] In the connector 1c, the movable portion 43c of the elastic member 4c serves as an electric-cable contact part that comes in direct contact with the electric cable 91 in the connected state. Preferably, the travel path of the electric-cable contact part does not overlap with the motion space of the operating section 5c at least when the elastic member 4c transitions from the non-connected state to the connected state. This prevents the electric-cable contact part of the elastic member 4c from coming in contact with the operating section 5c and inhibiting the movement of the operating section 5c.

[0178] In the connector 1c, it is preferable that part of the operating section 5c (in the example described above, the actuator 52c) projects from the case 2c. This enables the operator to easily operate the operating section 5c by touching the actuator 52c with, for example, his/her finger.

[0179] It is preferable that the connector 1c includes a visually recognizable identifier (in the example described above, the actuator 52c) that indicates the state of the elastic member 4c. This allows easy and speedy recognition of the state of the elastic member 4c.

[0180] When the elastic member 4c is in the connected state, the actuator 52c may be located inside the case 2c. In this case, it is possible to prevent the occurrence of operating errors on the operating section 5c in the connected state. When the elastic member 4c is in the non-

connected state, the actuator 52c projects from the case 2c as described above. This enables the operator to easily operate the operating section 5c without using any tool such as a minus driver in the non-connected state, while preventing the occurrence of operating errors in the connected state. The operator is also able to easily and speedily recognize whether the elastic member 4c is in the non-connected state, by visually recognizing whether the actuator 52c projects from the case 2c.

[0181] In the connector 1c, it is preferable that the elastic member 4c is a plate spring. This further simplifies the structure of the connector 1c.

[0182] Next, a connector 1d according to a fifth embodiment of the present invention will be described. Fig. 36 is a longitudinal sectional view illustrating an area in the vicinity of an operating section 5d of the connector 1d in enlarged dimensions. Fig. 36 shows the connector 1d in the non-connected state.

[0183] The connector 1d includes a case 2d, a terminal 3d, an elastic member 4d, and the operating section 5d. The connector 1d and the connector 1 illustrated in Fig. 1 differ in the shapes of the case 2d, the terminal 3d, the elastic member 4d, and the operating section 5d and the movements of the elastic member 4d and the operating section 5d, but are the same in, for example, material properties and functions. Like almost the connector 1, the connector 1d may include two or more sets of the terminal 3d, the elastic member 4d, and the operating section 5d in the case 2d.

[0184] The terminal 3d is an approximately plate-like conductive member fixed to the case 2d. The terminal 3d may be made of, for example, metal. The elastic member 4d is an elastically deformable member attached to the case 2d. For example, the elastic member 4d may be an approximately band-like plate spring. The elastic member 4d may be formed of a conductive material such as metal, or may be formed of an insulating material such as resin. The elastic member 4d has a shape that is bent into an approximately L-, V-, or U-letter shape around the central portion in the longitudinal direction.

[0185] Like the elastic member 4 described above, the elastic member 4d includes a bent portion 41d, a fixed portion 42d, and a movable portion 43d. The tip end (i.e., the lower end in Fig. 36) of the movable portion 43d is in contact with the terminal 3d from above. Accordingly, the path of insertion of an electric cable, which will be described later, is closed inside an insertion hole 21d provided on the right side of the case 2d. The movable portion 43d is also in contact with the operating section 5d. As will be described later, the movable portion 43d is pushed to the left by the operating section 5d to become elastically deformed and bent and to become separated above from the terminal 3d. When the leftward pressure force against the movable portion 43d is relieved, the movable portion 43d returns to its original state by the restoring force (i.e., returns elastically).

[0186] The operating section 5d includes a rotator 57d and an actuator 52d. The rotator 57d is an approximately disk-shaped or columnar member about a central axis extending in the thickness direction. The rotator 57d is placed on a concave operating-section placement part 26d provided at the bottom of the case 2d inside the case 2d (i.e., on the inner side of the outer edge of the case 2d). The operating-section placement part 26d has an inner surface 261d that makes part of an approximately cylindrical surface. The inner surface 261d of the operating-section placement part 26d has an approximately fan shape when viewed from the front, the fan shape having a central angle of approximately 135 degrees. The left end of the operating-section placement part 26d communicates with a guide face 27d that is a surface sloped toward the upper side in a leftward direction.

[0187] The rotator 57d has a notch 571d recessed toward the above central axis in part of its circumference and also has a projection 572d projecting radially outward in another part of its circumference. In the example illustrated in Fig. 36, the notch 571d is located in the upper right portion of the rotator 57d. The projection 572d is located at the lower end of the rotator 57d. The projection 572d has an approximately triangular shape when viewed from the front.

[0188] The notch 571d has an approximately rectangular shape when viewed from the front. The notch 571d has a notch protrusion 573d at the right edge (i.e., at the edge located in the clockwise direction when viewed from the central portion of the notch 571d), the notch protrusion 573d protruding from the radial outer edge to the inside of the notch 571d (i.e., protruding in the counterclockwise direction). The notch protrusion 573d has an approximately triangular shape when viewed from the front. The notch 571d also has an electric-cable receiver 574d at the left edge (i.e., at the edge located in the counterclockwise direction when viewed from the central portion of the notch 571d), the electric-cable receiver 574d having an approximately flat plate-like shape expanding in the thickness direction. The notch 571d overlaps with the terminal 3d in the thickness direction and is located on the rear side of the terminal 3d in Fig. 36.

[0189] The actuator 52d is an approximately rod-like portion that extends upward from the left end portion of the rotator 57d and that protrudes upward out of the case 2d. In the example illustrated in Fig. 36, the actuator 52d is partly in contact with the case 2d so as to restrict further clockwise rotation of the rotator 57d. Note that the rotator 57d is rotatable counterclockwise along the inner surface 261d of the operating-section placement part 26d from the initial state illustrated in Fig. 36. The rotator 57d is also movable to the left in Fig. 36 along the guide face 27d from the position illustrated in Fig. 36.

[0190] Next, a procedure for connecting an electric cable to the connector 1d will be described. First, in the initial state illustrated in Fig. 36, an operator touches the tip end portion of the actuator 52d of the operating section 5d with, for example, a fingertip 93 so as to rotate the operating section 5d counterclockwise. At this time, the rotator 57d rotates counterclockwise along the inner sur-

face 261d of the operating-section placement part 26d.

[0191] With the rotation of the operating section 5d, as illustrated in Fig. 37, the notch protrusion 573d of the rotator 57d comes into contact with the movable portion 43d of the elastic member 4d and pushes and moves the movable portion 43d diagonally upward to the left (i.e., in a direction approaching the fixed portion 42d). Accordingly, the elastic member 4d is bent, and the movable portion 43d is separated above from the terminal 3d.

[0192] When the operating section 5d is rotated halfway as illustrated in Fig. 37, a restoring force vector 81d of the elastic member 4d acting on the first portion 513d deviates to the right from a reference line 82d that is a straight line connecting a first portion 513d and a second portion 514d. Thus, a clockwise rotation moment acts on the rotator 57d, and unless the operator continues to apply a force to the actuator 52d of the operating section 5d, the elastic member 4d and the operating section 5d will return to the initial state illustrated in Fig. 36. Note that the first portion 513d is a portion of the operating section 5d that the restoring force of the elastic member 4d acts on, and is specifically a tip end portion of the notch protrusion 573d of the rotator 57d that comes in contact with the movable portion 43d of the elastic member 4d. The second portion 514d is a portion of the operating section 5d that develops a reaction force against the restoring force and is specifically the tip end portion of the projection 572d of the rotator 57d that comes in contact with the inner surface 261d of the operating-section placement part 26d.

[0193] The operator rotates the operating section 5d counterclockwise to the non-connected state illustrated in Fig. 38 against the restoring force of the elastic member 4d. In the non-connected state, the restoring force vector 81d of the elastic member 4d acting on the first portion 513d approximately coincides with the reference line 82d connecting the first portion 513d and the second portion 514d. Thus, the restoring force of the elastic member 4d and the reaction force developed against the restoring force by the operating section 5d are balanced.

[0194] Accordingly, neither the clockwise rotation moment described above nor a counterclockwise rotation moment acts on the rotator 57d. Thus, even if the operator moves his/her fingertip or the like off the actuator 52d (i.e., in the state in which the operator does not apply any force to the operating section 5d), the circumferential position (i.e., rotational position) of the operating section 5d is stably maintained in the non-connected state illustrated in Fig. 38. The elastic member 4d is also stably maintained in the non-connected state (i.e., stopped tentatively). The non-connected state illustrated in Fig. 38 is a tentative stopped state in which the elastic member 4d is tentatively stopped in a bent position. At this time, the electric-cable receiver 574d of the operating section 5d is located on the path of insertion of an electric cable, which will be described later.

[0195] In the non-connected state, the actuator 52d of the operating section 5d is in contact with a projection provided on the guide face 27d of the case 2d. This restricts the movement of the operating section 5d so as to prevent further counterclockwise rotation of the operating section 5d. In the connector 1d, the operating section 5d includes only one first portion 513d that the restoring force of the elastic member 4d acts on, and only one second portion 514d that develops a reaction force against the restoring force. This simplifies the structure of the connector 1d.

[0196] In the connector 1d, the operating section 5d may be further rotated in the counterclockwise direction from the rotational position illustrated in Fig. 38, and the position of the operating section 5d may be maintained in a state in which the elastic member 4d is further bent, as approximately in the connector 1 illustrated in Fig. 14. This structure may be implemented by, for example, reducing the inclination of the guide face 27d of the case 2d illustrated in Fig. 38 (i.e., by approximating the guide face to a horizontal surface). In this case, the restoring force vector 81d slightly deviates to the left from the reference line 82d, and a counterclockwise rotation moment acts on the rotator 57d. That is, the elastic member 4d exerts the force of rotating the operating section 5d counterclockwise on the rotator 57d. However, the counterclockwise rotation of the operating section 5d is restricted by the actuator 52d that is in contact with the case 2d. Moreover, the elastic member 4d does not exert the force of rotating the operating section 5d clockwise and returning the operating section 5d to the initial state. Accordingly, the position (i.e., rotational position) of the operating section 5d is stably maintained, and the shape of the elastic member 4d separated from the terminal 3d is stably maintained.

[0197] When the connector 1d enters the non-connected state, as illustrated in Fig. 39, the electric cable 91 is inserted from the insertion hole 21d of the case 2d into the case 2d in a predetermined direction of insertion and placed between the terminal 3d and the elastic member 4d in the non-connected state. The direction of insertion of the electric cable 91 into the case 2d is a diagonal direction inclined to the up-down direction and the right-left direction. The electric cable 91 is the same in, for example, type and diameter as the electric cable 91 described above.

[0198] The tip end of the electric cable 91 comes in direct contact with the electric-cable receiver 574d of the operating section 5d in the case 2d. In the example illustrated in Fig. 39, the right side surface of the electric-cable receiver 574d serves as a receiving face 575d that comes in direct contact with the tip end of the electric cable 91 and that expands from the tip end to the surroundings. The receiving face 575d is located on the inner side of the elastic member 4d in the non-connected state in the direction of insertion of the electric cable 91 and expands to the surrounding in a direction that is approximately perpendicular to the direction of insertion. Note that the receiving face 575d does not necessarily have to be a surface perpendicular to the direction of insertion.

[0199] The electric cable 91, with the tip end in contact with the receiving face 575d of the electric-cable receiver 574d, is moved to the inner side in the direction of insertion. Accordingly, the force is directly transmitted from the electric cable 91 to the operating section 5d. Then, the receiving face 575d is pushed to the inner side in the direction of insertion, so that the operating section 5d is slightly moved from the position indicated by the dashed double-dotted line to the left (i.e., to the inner side in the direction of insertion of the electric cable 91) as illustrated in Fig. 40. Accordingly, the restoring force vector 81d deviates to the right in Fig. 40 from the reference line 82d, and the restoring force of the elastic member 4d produces a clockwise rotation moment on the rotator 57d. As a result, the operating section 5d is further rotated clockwise, and the elastic member 4d is restored from the non-connected state.

[0200] Then, as illustrated in Fig. 41, the elastic member 4d transitions to the connected state in which the electric cable 91 is sandwiched between the terminal 3d and the elastic member 4d, and the electric cable 91 and the terminal 3d are electrically and mechanically connected to each other. In other words, the electric cable 91, after inserted into the connector 1d, is automatically connected to the connector 1d (i.e., without the operator operating the operating section 5d using a tool other than the electric cable 91 or his/her fingers). For example, the operator may recognize this transition to the connected state by, for example, vibrations or sounds generated when the electric cable 91 is pressed against the terminal 3d by the movable portion 43d of the elastic member 4d. The vibrations or sounds may be generated by, for example, a collision of two members that are any of the elastic member 4d, the electric cable 91, the terminal 3d, the operating section 5d, and the case 2d. The connector 1d may employ any of various structures that facilitate the generation of the vibrations or sounds or that amplify the vibrations or sounds.

[0201] When the connector 1d is in the connected state, the position of the actuator 52d of the operating section 5d differs from the position of the actuator 52d when the connector 1d is in the non-connected state. Thus, the operator is able to easily recognize the transition of the connector 1d from the non-connected state to the connected state by visually recognizing the position of the actuator 52d. The operator is also able to easily recognize the initial state of the connector 1d by visually recognizing the position of the actuator 52d in the same manner as described above. That is, the actuator 52d of the operating section 5d serves as a visually recognizable identifier that indicates the state of the elastic member 4d.

[0202] In the case of removing the electric cable 91 from the connector 1d, for example, the operator may push down the actuator 52d of the operating section 5d with his/her fingertip or a tool such as a minus driver. Accordingly, the operating section 5d is rotated counterclockwise in Fig. 41. When the operating section 5d is rotated to the non-connected state illustrated in Fig. 39, the restoring force vector 81d (see Fig. 38) approximately coincides with the reference line 82d as described above, and the elastic member 4d is maintained in the non-connected state in which the elastic member 4d is separated above from the electric cable 91. This releases the holding of the electric cable 91 by the elastic member 4d and the terminal 3d. The operator is able to easily remove the electric cable 91 from the connector 1d by pulling out the electric cable 91 from the insertion hole 21d.

[0203] As described above, the connector 1d for connecting the electric cable 91 includes the case 2d, the conductive terminal 3d, the elastic member 4d, and the operating section 5d. The terminal 3d is fixed to the case 2d. The elastic member 4d is attached to the case 2d and presses the electric cable 91 against the terminal 3d by the restoring force to hold the electric cable 91. The operating section 5d applies a force to the elastic member 4d to bend the elastic member 4d from the initial state to the non-connected state and to maintain the elastic member 4d in the non-connected state. The operating section 5d includes the first portion 513d that the restoring force of the elastic member 4d acts on, and the second portion 514d that develops a reaction force against the restoring force. The vector of the restoring force is regarded as the restoring force vector 81d, and the straight line connecting the first portion 513d and the second portion 514d is regarded as the reference line 82d.

[0204] When the elastic member 4d is in the non-connected state, the restoring force vector 81d approximately coincides with the reference line 82d, and the above restoring force and the above reaction force are balanced. Accordingly, the position of the operating section 5d is maintained, and the elastic member 4d is maintained in the non-connected state. When the position of the operating section 5d is changed and the restoring force vector 81d deviates from the reference line 82d while the electric cable 91 is inserted between the terminal 3d and the elastic member 4d in the non-connected state, the elastic member 4d is restored from the non-connected state by the above restoring force and transitions to the connected state in which the electric cable 91 is sandwiched between the terminal 3d and the elastic member 4d.

[0205] The connector 1d with the structure described above eliminates the need to provide other structures such as a stepped portion for locking the operating section 5d in the non-connected state or a state releaser for releasing the locking of the operating section 5d. This simplifies the structure of the connector 1d. Besides, it is possible to prevent the occurrence of problems such as locking failures due to wear on the stepped portion or any other reasons and to increase the life of the connector 1d, unlike in the case where the operating section 5d is locked in the stepped portion or the like of the case 2d.

[0206] As described above, in the connector 1d, it is preferable that the position of the operating section 5d is maintained even if the elastic member 4d is further bent

in the non-connected state. At this time, the direction of the force on the rotator 57d produced by the restoring force of the elastic member 4d is opposite to the direction of the force that returns the operating section 5d to the connected state and the initial state. Accordingly, it is possible to more stably maintain the shape of the elastic member 4d in the state in which the elastic member 4d is separated from the terminal 3d.

[0207] In the connector 1d, it is preferable that the operating section 5d includes the approximately disk-shaped or columnar rotator 57d that has the notch 571d in part of its circumference and the projection 572d in another part of its circumference. The case 2d includes the concave operating-section placement part 26d that makes part of the approximately cylindrical surface of the inner surface 261d. The rotator 57d is placed on the operating-section placement part 26d and comes in contact with the elastic member 4d at part of the notch 571d (in the example described above, the notch protrusion 573d) serving as the first portion 513d and in contact with the inner surface 261d of the operating-section placement part 26d at the projection 572d serving as the second portion 514d. Preferably, when the elastic member 4d transitions to the non-connected state, the rotator 57d is rotated in a first rotation direction (in the example described above, the counterclockwise direction) to bend the elastic member 4d, and when the restoring force vector 81d approximately coincides with the reference line 82d, the rotational position of the rotator 57d is maintained, and the elastic member 4d is maintained in the non-connected state. Preferably, in the case of connecting the electric cable 91, the rotator 57d is moved to the inner side in the direction of insertion of the electric cable 91 (in the example described above, leftward in Fig. 40) to deviate the restoring force vector 81d from the reference line 82d and to rotate the rotator 57d in a second rotation direction opposite to the above first rotation direction by the restoring force to cause the elastic member 4d to transition from the non-connected state to the connected state. Accordingly, the transition of the elastic member 4d to the non-connected state, the state maintenance of the elastic member 4d in the non-connected state, and the transition of the elastic member 4d from the non-connected state to the connected state can be achieved with a simple structure.

[0208] In the case of connecting the electric cable 91 to the connector 1d described above, the force is directly transmitted from the inserted electric cable 91 to the operating section 5d so as to move the rotator 57d to the inner side in the direction of insertion of the electric cable 91 and to deviate the restoring force vector 81d from the reference line 82d, but the present embodiment is not limited to this example. For example, the force may be directly transmitted from the inserted electric cable 91 to the operating section 5d so as to move the rotator 57d to the inner side in the direction of insertion of the electric cable 91. That is, in the case of connecting the electric cable 91 to the connector 1d, it is preferable that the force is directly or indirectly transmitted from the inserted electric cable 91 to the operating section 5d so as to move the rotator 57d to the inner side in the direction of insertion of the electric cable 91 and to deviate the restoring force vector 81d from the reference line 82d. This achieve automatic connection of the electric cable 91 by only a simple operation such as inserting the electric cable 91 and facilitates the connection of the electric cable 91 to the connector 1d.

[0209] As described above, in the case of connecting the electric cable 91, it is preferable that the inserted electric cable 91 comes in direct contact with the operating section 5d to change the position of the operating section 5d. In this case, because the force of pushing in the electric cable 91 is easily transmitted to the operating section 5d, it is possible to easily achieve automatic connection of the electric cable 91. Besides, since there is no need to provide the elastic member 4b with a portion that comes in contact with the electric cable 91, it is possible to simplify the shape of the elastic member 4d.

[0210] As described above, it is preferable that the operating section 5d includes the electric-cable receiver 574d that comes in direct contact with the tip end of the electric cable 91. It is also preferable that the electric-cable receiver 574d has the receiving face 575d that expands from the tip end of the electric cable 91 to the surroundings. This allows the force of pushing in the electric cable 91 to be efficiently transmitted to the operating section 5d.

[0211] In the connector 1d, the movable portion 43d of the elastic member 4d serves as an electric-cable contact part that comes in direct contact with the electric cable 91 in the connected state. Preferably, the travel path of the electric-cable contact part does not overlap with the motion space of the operating section 5d at least when the elastic member 4d transitions from the non-connected state to the connected state. This prevents the electric-cable contact part of the elastic member 4d from coming in contact with the operating section 5d and inhibiting the movement of the operating section 5d.

[0212] In the connector 1d, it is preferable that part of the operating section 5d (in the example described above, the actuator 52d) projects from the case 2d. This enables the operator to easily operate the operating section 5d by touching the actuator 52d with, for example, his/her fingertip.

[0213] It is preferable that the connector 1d includes a visually recognizable identifier (in the example described above, the actuator 52d) that indicates the state of the elastic member 4d. This allows easy and speedy recognition of the state of the elastic member 4d.

[0214] The actuator 52d may be configured to project from the case 2d when the elastic member 4d is in the non-connected state and to be located inside the case 2d when the elastic member 4d is in the connected state. In this case, it is possible to easily operate the operating section 5d without using any tool such as a minus driver in the non-connected state. It is also possible to prevent

the occurrence of operating errors on the operating section 5d in the connected state. Moreover, it is possible to easily and speedily recognize whether the elastic member 4d is in the non-connected state, by visually recognizing whether the actuator 52d projects from the case 2d.

[0215] In the connector 1d, it is preferable that the elastic member 4d is a plate spring. This further simplifies the structure of the connector 1d.

[0216] The connectors 1 and 1a to 1d described above may be modified in various ways.

[0217] For example, in the connectors 1 and 1a to 1d, the elastic members 4 and 4a to 4d are not limited to plate springs and may be any other type of springs having a different structure (e.g., helical springs).

[0218] In the connector 1, the actuator 52 of the operating section 5 functions as the identifier as described above, but the other portion of the operating section 5 or any other portion other than the operating section 5 may be used as the visually recognizable identifier that indicates the state of the elastic member 4. The same also applies to the connectors 1a to 1d, and any other portion different from those described in the above examples may be used as the identifier. Note that the identifier may be omitted from the connectors 1 and 1a to 1d.

[0219] In the connector 1,the connection of the electric cable 91 does not necessarily have to be implemented by the automatic connection described above in approximately the same manner as in the connector 1a illustrated in Fig. 22, and may be implemented by, for example, the operator touching and moving the operating section 5 with, for example, a tool or his/her fingertip. Specifically, the operator may slightly push the actuator 52 of the operating section 5 on the right side in Fig. 9 to the left with his/her fingertip, so that the restoring force vector 81 deviates to the left from the reference line 82 and the restoring force of the elastic member 4 produces a clockwise rotation moment on the cam 51 as illustrated in Fig. 10. As a result, even if the operator does not apply any further force to the actuator 52, the operating section 5 rotates clockwise and the connector 1 transitions to the connected state illustrated in Fig. 12.

[0220] Almost the same also applies to the connector 1b, and the operator may slightly deform the elastic member 4b illustrated in Fig. 27 by touching the elastic member 4b with, for example, a tool or his/her fingertip, so that the operating section 5b is rotated clockwise from the non-connected state illustrated in Fig. 27 and transitions to the connected state illustrated in Fig. 29. Almost the same also applies to the connector 1c, and the operator may slightly rotate the releaser 6c illustrated in Fig. 33 by touching the releaser 6c with, for example, a tool or his/her fingertip, so that the operating section 5c is moved to the right from the non-connected state illustrated in Fig. 33 and transitions to the connected state illustrated in Fig. 35. Almost the same also applies to the connector 1d, and the operator may slightly move the operating section 5d illustrated in Fig. 39 to the left by touching the operating section 5d with, for example, a tool or his/her fingertip, so that the operating section 5d is rotated clockwise from the non-connected state illustrated in Fig. 39 and transitions to the connected state illustrated in Fig. 41.

[0221] In the connector 1, the operating section 5 does not necessarily have to project from the case 2, and the operating section 5 as a whole may be located inside the case 2. The same applies to the connectors 1a to 1d.

[0222] In the connector 1, the travel path of the electric-cable contact part 45 of the elastic member 4 may overlap with the motion space of the operating section 5 in the thickness direction. The elastic member 4 does not necessarily have to come in direct contact with the electric cable 91 in the connected state, and may come in indirect contact with the electric cable 91 via, for example, any other member. The same applies to the connectors 1a to 1d.

[0223] In the connector 1, the shape of the receiving face 531 of the electric-cable receiver 53 may be modified in various ways. The electric cable 91 inserted in the case 2 does not necessarily have to use its tip end to come in contact with the operating section 5, and may use any other portion to come in contact with the operating section 5 as in the connector 1a. The electric cable 91 does not necessarily have to come in direct contact with the operating section 5, and may come in indirect contact with the operating section 5 via any other member such as the elastic member 4 and change the position of the operating section 5 as in the connector 1b. Note that the operating section 5 may omit the electric-cable receiver 53. The same applies to the electric-cable receiver 44b of the connector 1b and the electric-cable receiver 574d of the connector 1d.

[0224] In the connector 1, the rotation direction of the operating section 5 during transition from the initial state to the non-connected state and the rotation direction of the operating section 5 during transition from the non-connected state to the connected state do not necessarily have to be opposite directions, and may be the same direction. Moreover, the operating section 5 does not necessarily have to rotate during transition from the non-connected state to the connected state, and for example, the operating section 5 may slide sideway to cause the elastic member 4 to transition from the non-connected state to the connected state as in the connector 1c.

[0225] The connectors 1 and 1a to 1d described above may be used to connect electric cables to various devices. For example, the connector 1 may be used in, for example, a relay socket or an operation switch.

[0226] The configurations of the preferred embodiments and the variations described above may be appropriately combined as long as there are no mutual inconsistencies.

[0227] While the invention has been shown and described in detail, the foregoing description is in all aspects illustrative and not restrictive. It is therefore to be understood that numerous modifications and variations can be

devised without departing from the scope of the invention.

REFERENCE SIGNS LIST

[0228]

1, 1a to 1d connector
2, 2a to 2d case
3, 3a to 3d terminal
4, 4a to 4d elastic member
5, 5a to 5d operating section
24, 24a, 24b rotating shaft
25c guide face
26d operating-section placement part
261d inner surface (of operating-section placement part)
44b electric-cable receiver
45 electric-cable contact part
46b releaser
51, 51a, 51b cam
52 actuator
53, 574d electric-cable receiver
54, 54a, 54b bearing
55a identifier
56c advancing/retracting part
57d notch
572d projection
81, 81a to 81d restoring force vector
82, 82a to 82d reference line
91 electric cable
431b receiving face
513, 513a to 513d first portion
514, 514a to 514d second portion
531, 575d receiving face

Claims

1. A connector for connecting an electric cable, comprising:

a case;
a conductive terminal fixed to said case;
an elastic member that is attached to said case and that presses an electric cable against said terminal by restoring force to sandwich said electric cable between said terminal and said elastic member; and
an operating section that applies a force to said elastic member to bend said elastic member from an initial state to a non-connected state and to maintain said elastic member in said non-connected state,
wherein said operating section includes:

a first portion that said restoring force of said elastic member acts on; and
a second portion that develops a reaction force against said restoring force,
where a vector of said restoring force is regarded as a restoring force vector, and a straight line connecting said first portion and said second portion is regarded as a reference line,
when said elastic member is in said non-connected state, said restoring force vector approximately coincides with said reference line, and said restoring force and said reaction force are balanced to maintain a position of said operating section and to maintain said elastic member in said non-connected state, and
when the position of said operating section is changed and said restoring force vector deviates from said reference line while said electric cable is inserted between said terminal and said elastic member in said non-connected state, said elastic member is restored from said non-connected state by said restoring force and transitions to a connected state in which said electric cable is sandwiched between said terminal and said elastic member.

2. The connector according to claim 1, wherein
the position of said operating section is maintained even in a state in which said elastic member is further bent in said non-connected state.

3. The connector according to claim 1 or 2, wherein

said operating section includes a cam that rotates about a rotating shaft,
said cam comes in contact with said elastic member at said first portion and comes in contact with said rotating shaft at a bearing that serves as said second portion, and
when said elastic member transitions to said non-connected state, said cam rotates to increase a distance between said first portion and said rotating shaft and to bend said elastic member, and when said restoring force vector approximately coincides with said reference line, a rotational position of said operating section is maintained and said elastic member is maintained in said non-connected state.

4. The connector according to claim 3, wherein
when said electric cable is connected to said connector, a force is directly or indirectly transmitted from said electric cable inserted to said operating section to change the position of said operating section and to deviate said restoring force vector from said reference line.

5. The connector according to claim 4, wherein
when said electric cable is connected to said connector, said electric cable inserted comes in direct contact with said operating section to change the position of said operating section.

6. The connector according to claim 5, wherein

said operating section includes an electric-cable receiver that comes in direct contact with a tip end of said electric cable, and
said electric-cable receiver has a receiving face that expands from said tip end of said electric cable to a surrounding.

7. The connector according to claim 4, wherein
when said electric cable is connected to said connector, said electric cable inserted comes in direct contact with said elastic member and deforms said elastic member to apply a force to said operating section via said elastic member and to change the position of said operating section.

8. The connector according to claim 7, wherein
said elastic member includes:

an electric-cable receiver that comes in direct contact with a tip end of said electric cable; and
a releaser that extends from said electric-cable receiver toward said operating section,
said electric-cable receiver has a receiving face that expands from said tip end of said electric cable to a surrounding, and
when said receiving face is pushed by said electric cable toward an inner side in a direction of insertion of said electric cable, said elastic member becomes deformed, and said releaser comes in contact with said operating section to apply a force of rotating said cam to said operating section.

9. The connector according to claim 1 or 2, wherein

said case has a guide face that extends linearly,
said elastic member extends along said guide face,
said operating section includes an advancing/retracting part that is located between said elastic member and said guide face and that moves linearly in a predetermined advancing and retracting direction while coming in contact with said elastic member at said first portion and in contact with said guide face at said second portion,
a distance between said elastic member and said guide face decreases from one side to the other side in said advancing and retracting direction,
when said elastic member transitions to said non-connected state, said advancing/retracting part moves from said one side to said other side in said advancing and retracting direction to bend said elastic member, and when said elastic member becomes approximately parallel to said guide face, and said restoring force vector approximately coincides with said reference line in a position in which said elastic member comes in contact with said first portion, a position of said operating section in said advancing and retracting direction is maintained and said elastic member is maintained in said non-connected state, and
when said electric cable is connected to said connector, said operating section moves from said other side to said one side in said advancing and retracting direction to deviate said restoring force vector from said reference line and to effect a transition of said elastic member from said non-connected state to said connected state by said restoring force.

10. The connector according to claim 9, wherein
when said electric cable is connected to said connector, a force is directly or indirectly transmitted from said electric cable inserted to said operating section to move said operating section from said other side to said one side in said advancing and retracting direction and to deviate said restoring force vector from said reference line.

11. The connector according to claim 1 or 2, wherein

said operating section includes an approximately disk-like or columnar rotator that has a notch in part of a circumference thereof and a projection in another part of the circumference,
said case includes a concave operating-section placement part having an inner surface that forms part of an approximately cylindrical surface,
said rotator is placed on said operating-section placement part to come in contact with said elastic member at said first portion that forms part of said notch and to come in contact with said inner surface of said operating-section placement part at said second portion that serves as said projection,
when said elastic member transitions to said non-connected state, said rotator rotates in a first rotation direction to bend said elastic member, and when said restoring force vector approximately coincides with said reference line, a rotational position of said rotator is maintained and said elastic member is maintained in said non-connected state, and
when said electric cable is connected to said

connector, said rotator is moved to an inner side in a direction of insertion of said electric cable to deviate said restoring force vector from said reference line, and when said rotator is rotated in a second rotation direction opposite to said first rotation direction by said restoring force, said elastic member transitions from said non-connected state to said connected state.

12. The connector according to claim 11, wherein
when said electric cable is connected to said connector, a force is directly or indirectly transmitted from said electric cable inserted to said operating section to move said rotator to an inner side in the direction of insertion of said electric cable and to deviate said restoring force vector from said reference line.

13. The connector according to any one of claims 1 to 12, wherein

said elastic member includes an electric-cable contact part that comes in direct contact with said electric cable in said connected state, and
a travel path of said electric-cable contact part does not overlap with a motion space of said operating section at least when said elastic member transitions from said non-connected state to said connected state.

14. The connector according to any one of claims 1 to 13, wherein
part of said operating section projects from said case.

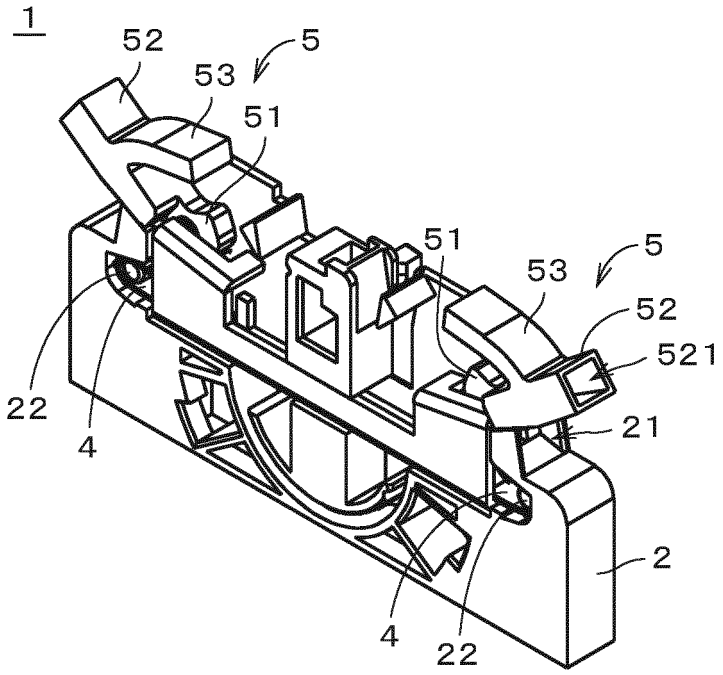
15. The connector according to any one of claims 1 to 14, wherein

when said elastic member is in said non-connected state, part of said operating section projects from said case, and
when said elastic member is in said connected state, said part of said operating section is located inside said case.

16. The connector according to any one of claims 1 to 15, further comprising:
a visually recognizable identifier that indicates a state of said elastic member.

17. The connector according to any one of claims 1 to 16, wherein
said elastic member is a plate spring.

Fig. 1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22

Fig. 2

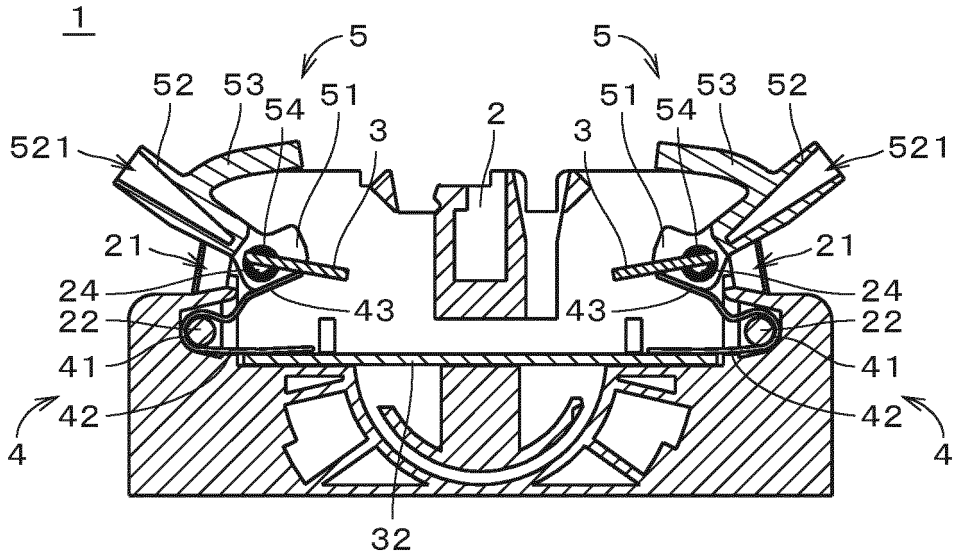
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Fig. 3

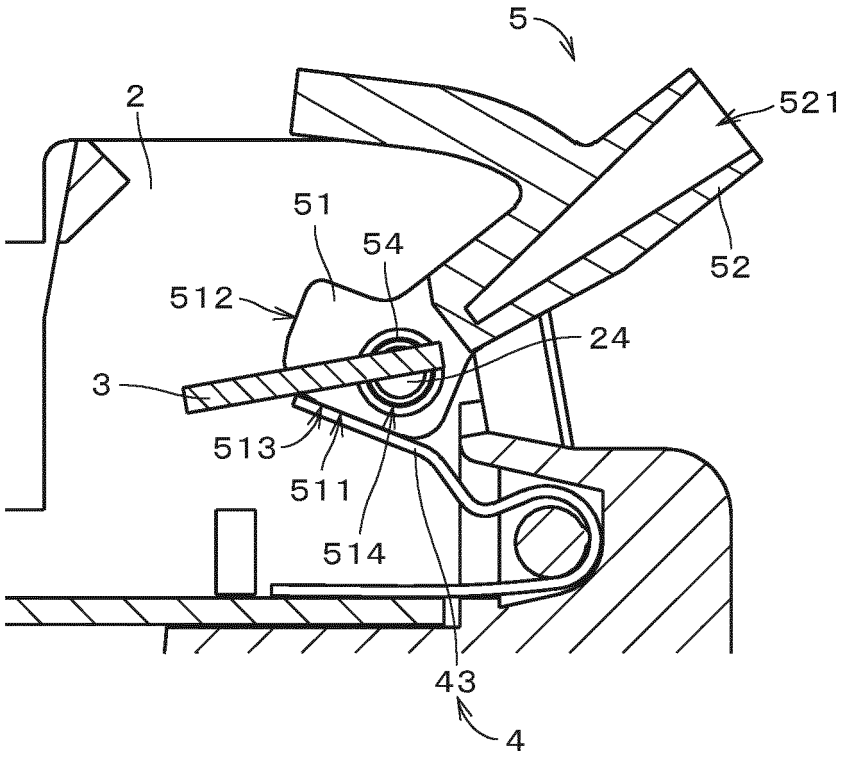
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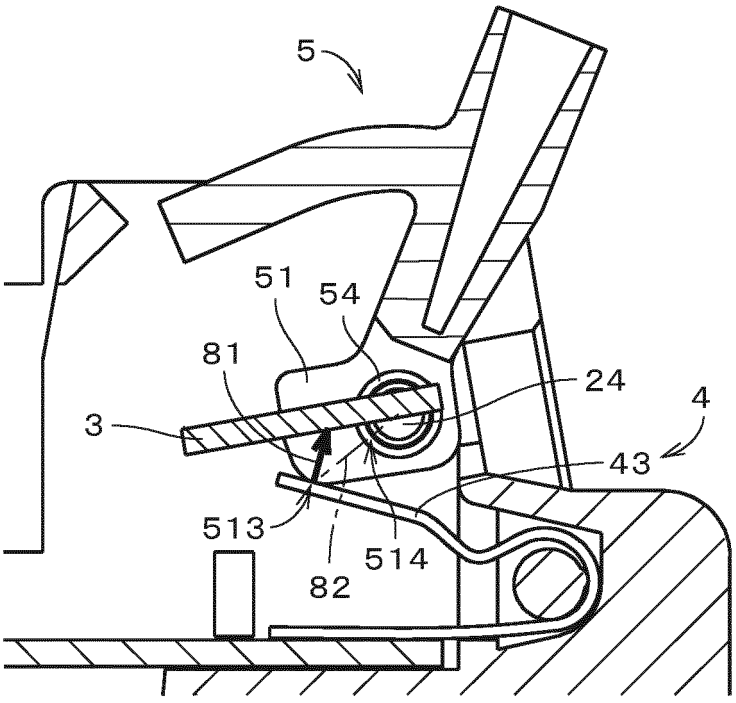
Fig. 4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3
43
513
514
82

Fig. 5

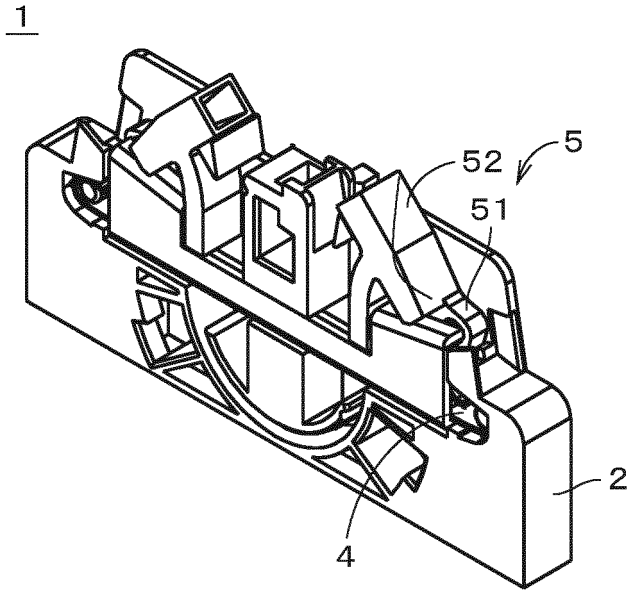


Fig. 6

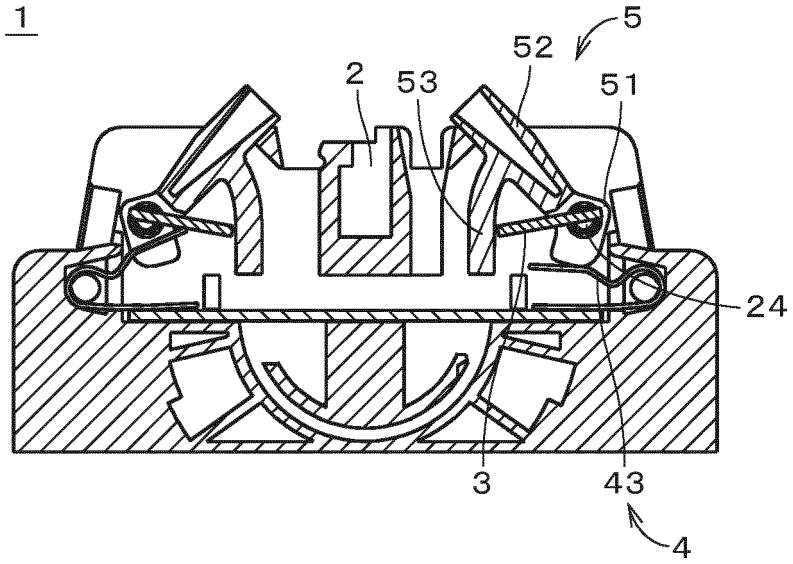
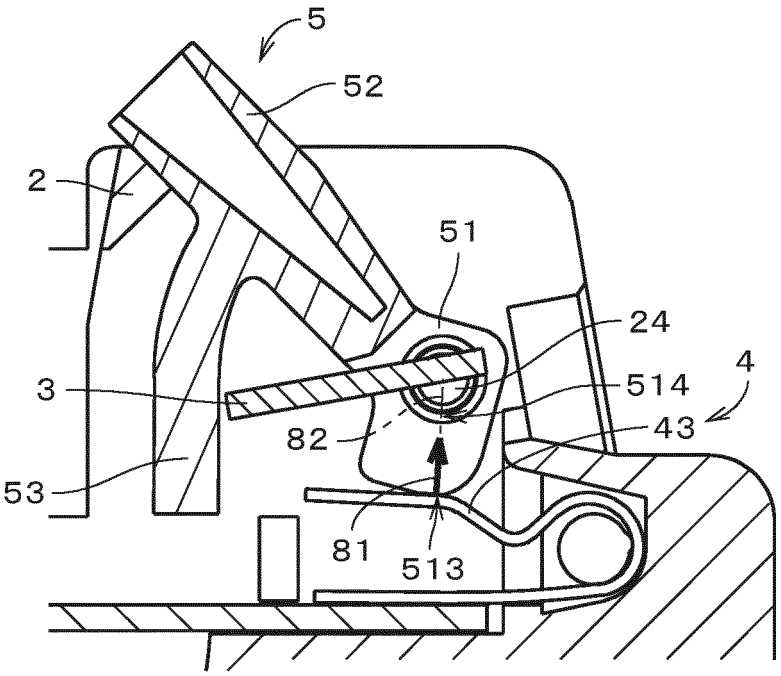


Fig. 7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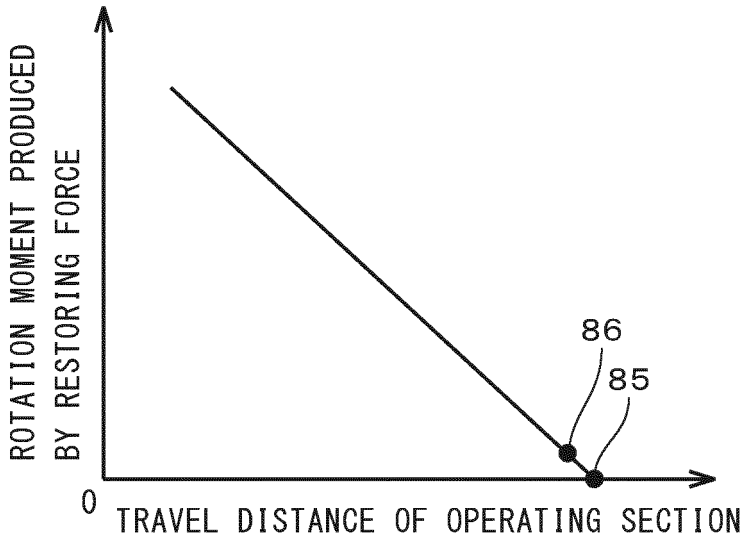
53
81
513

Fig. 8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86
85
0
TRAVEL DISTANCE OF OPERATING SECTION

Fig. 9

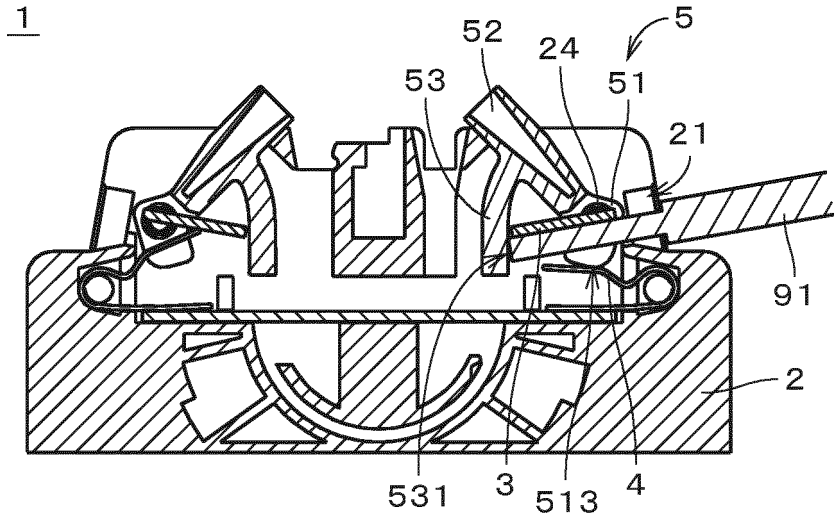


Fig. 10

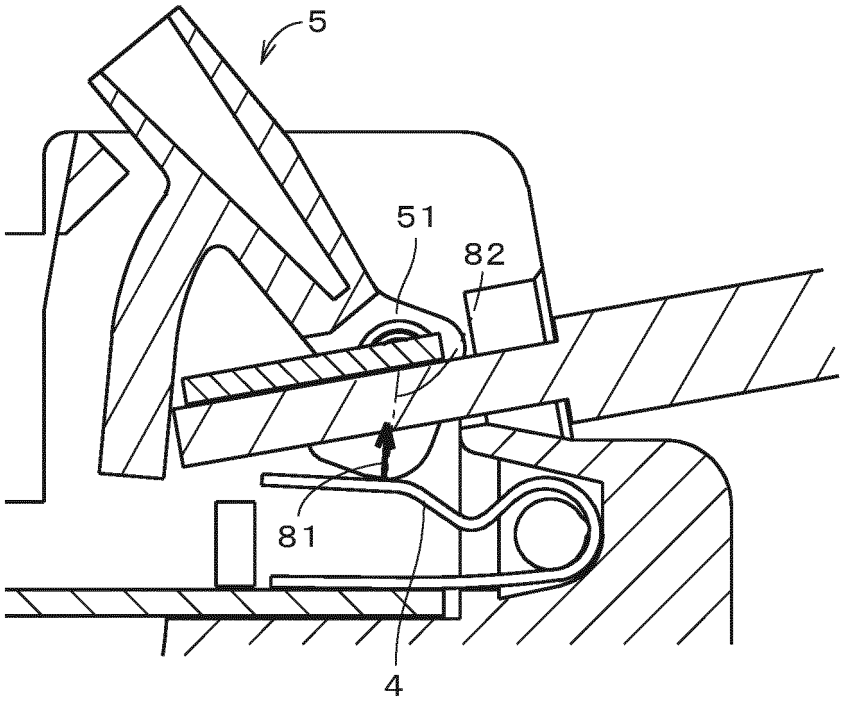


Fig. 11

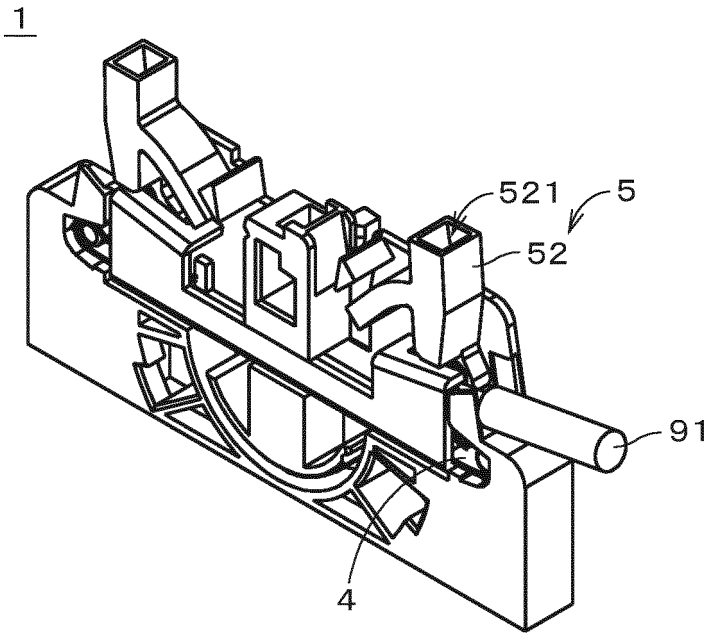


Fig. 12

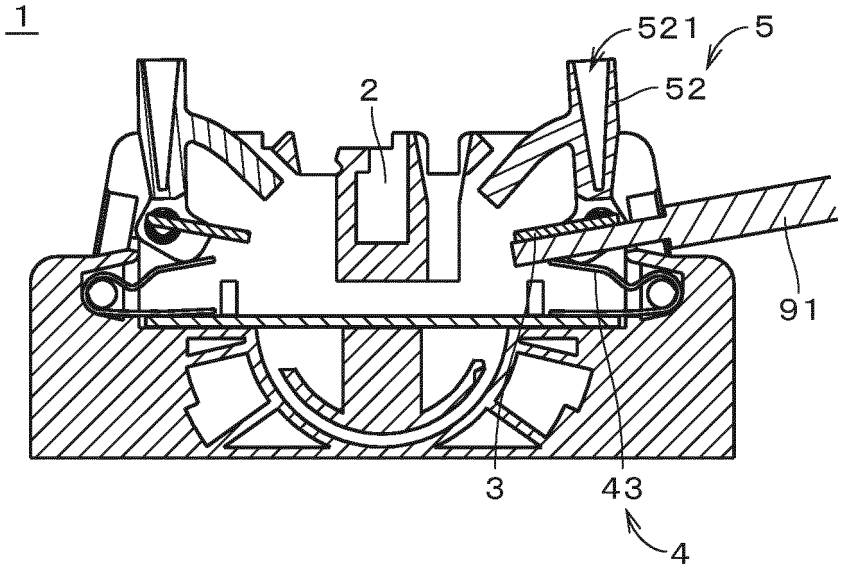


Fig. 13

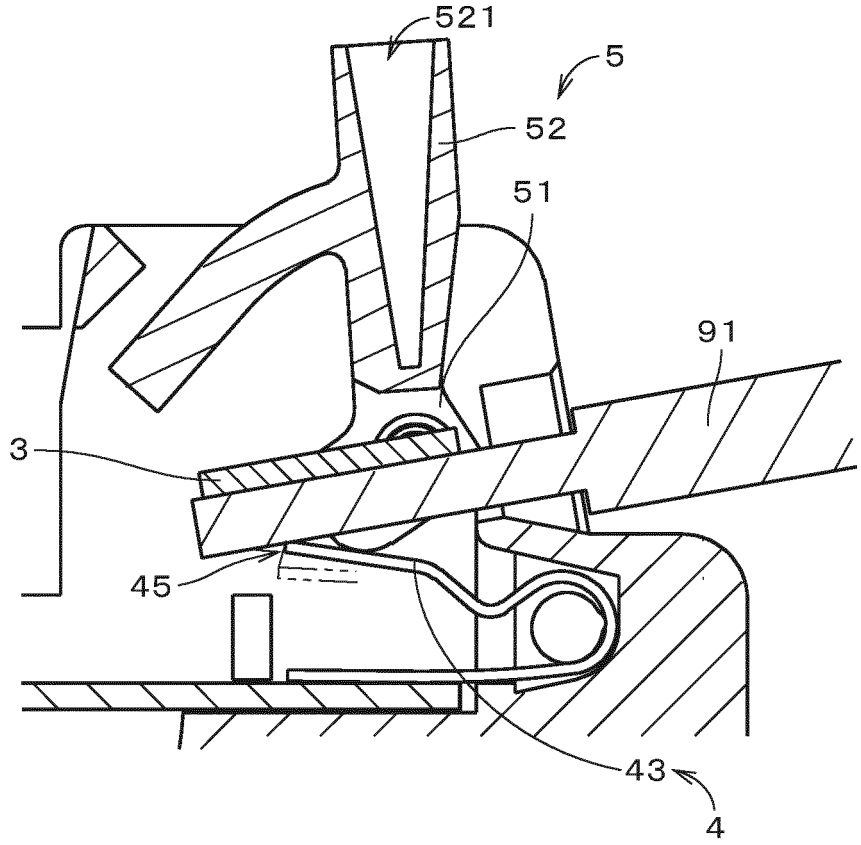


Fig. 14

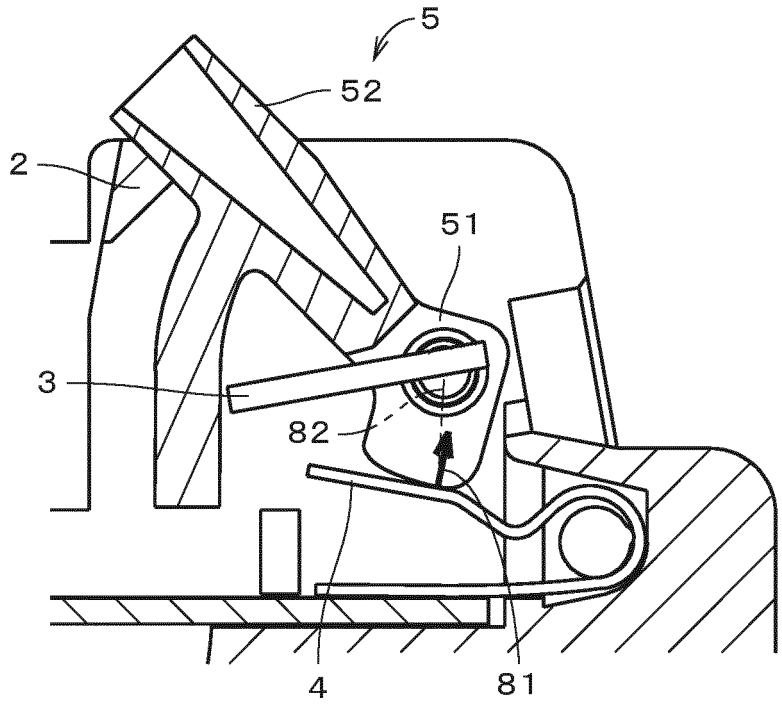
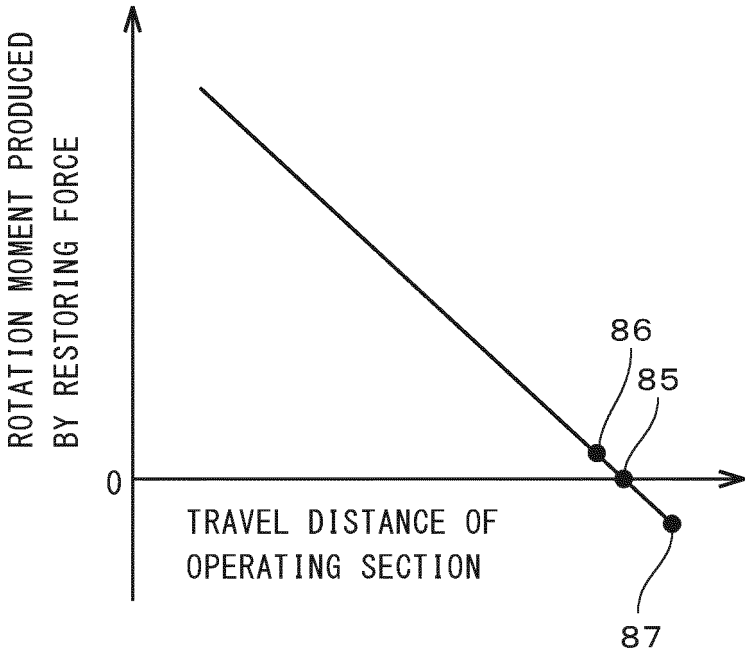


Fig. 15


ROTATION MOMENT PRODUCED BY RESTORING FORCE
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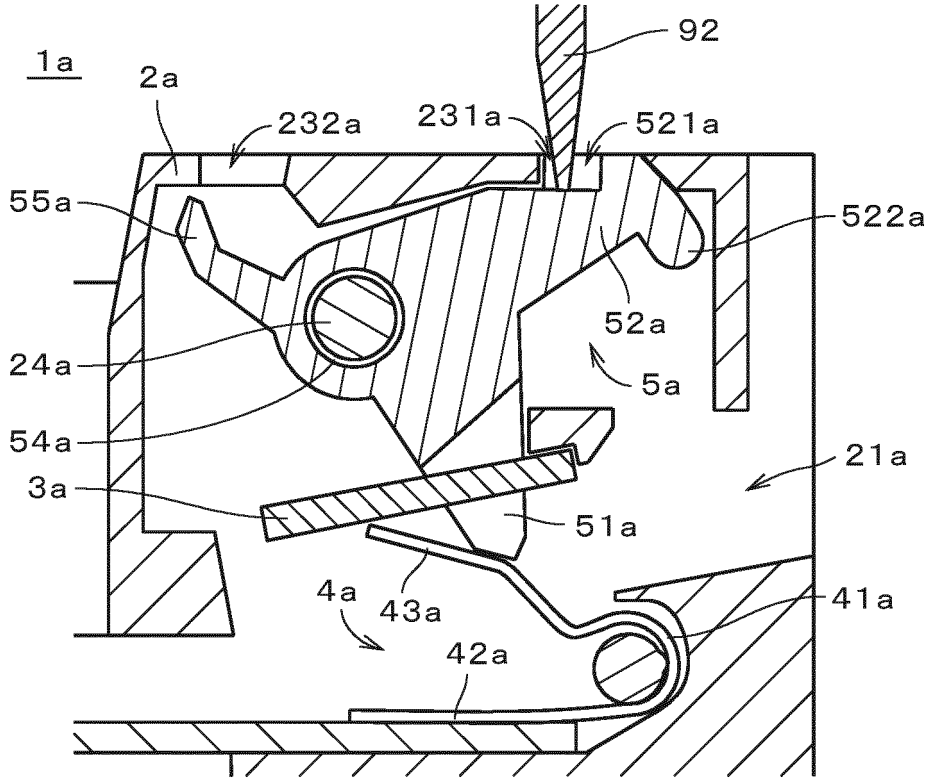
TRAVEL DISTANCE OF OPERATING SECTION
86
85
87

Fig. 16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92
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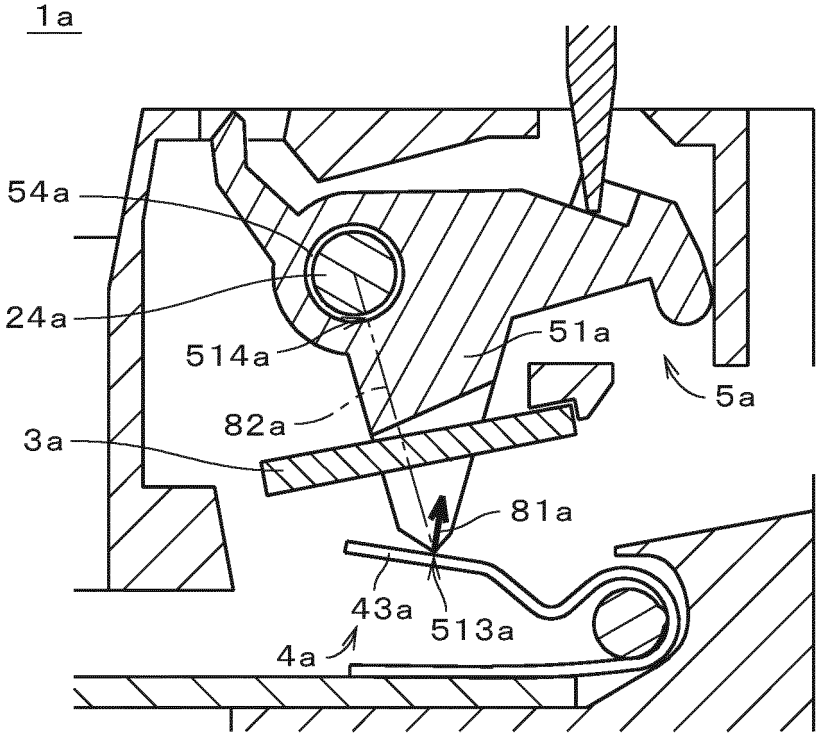
4a
43a
41a
42a

Fig. 17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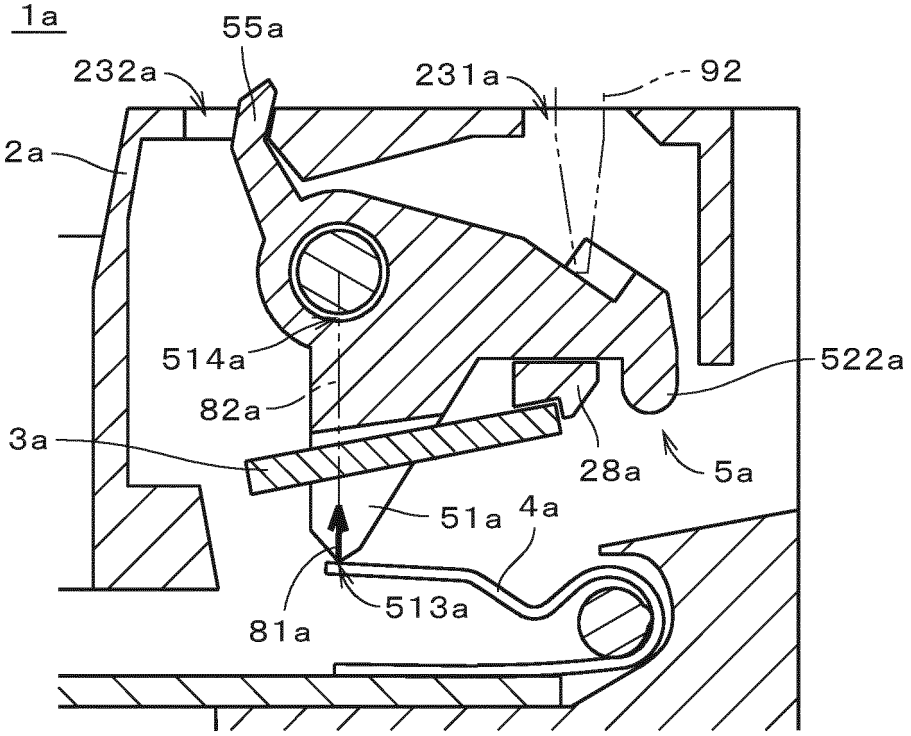
43a
513a
4a

Fig. 18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82a
3a
28a
5a
51a
4a
513a
81a

Fig. 19

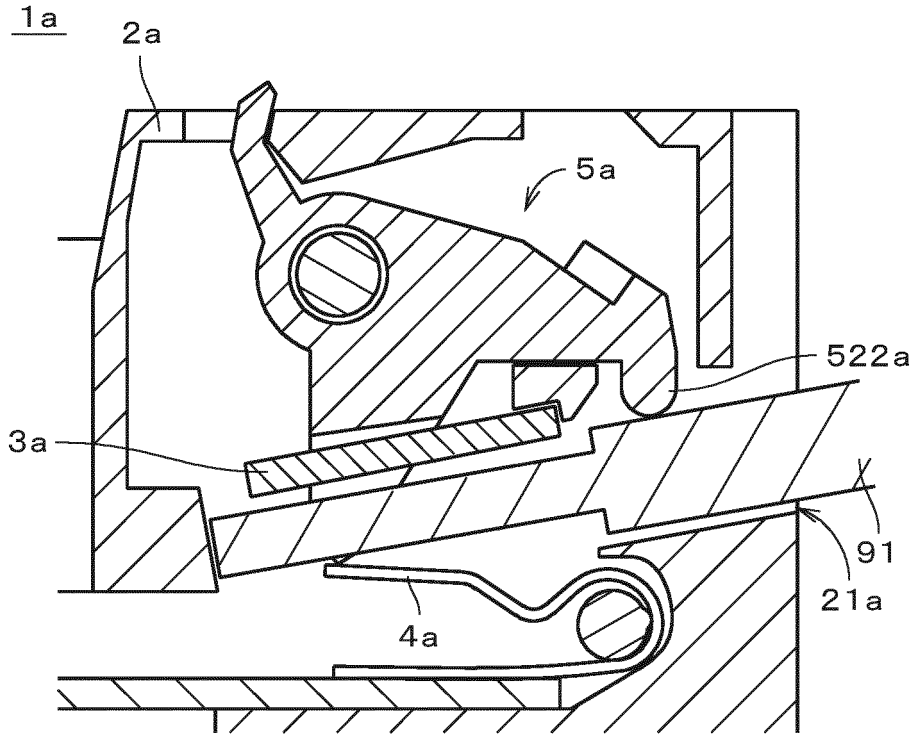


Fig. 20

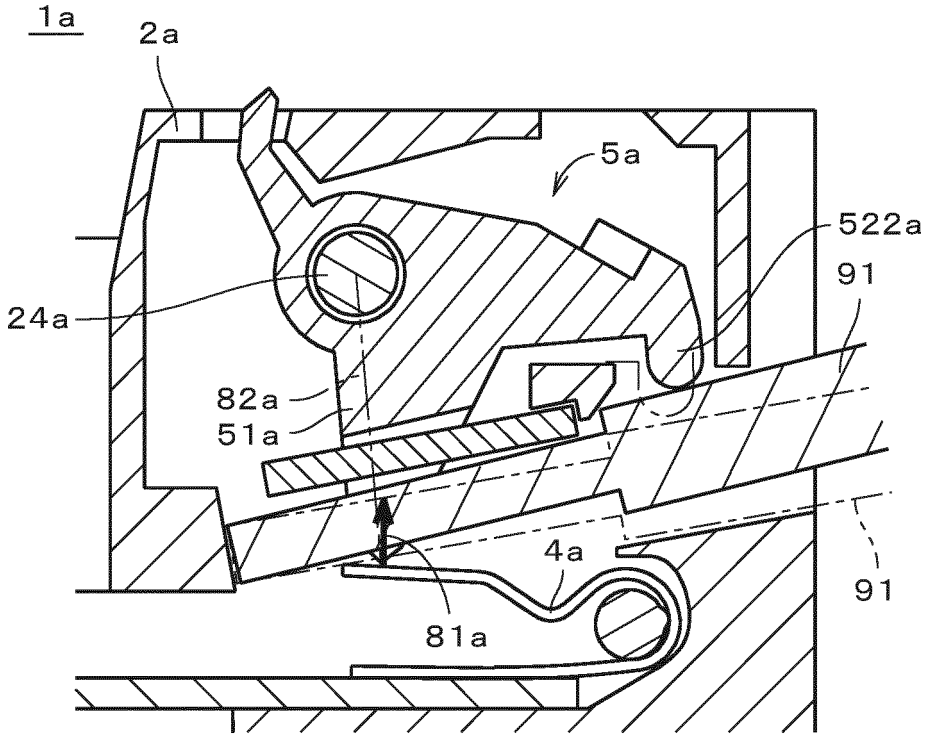
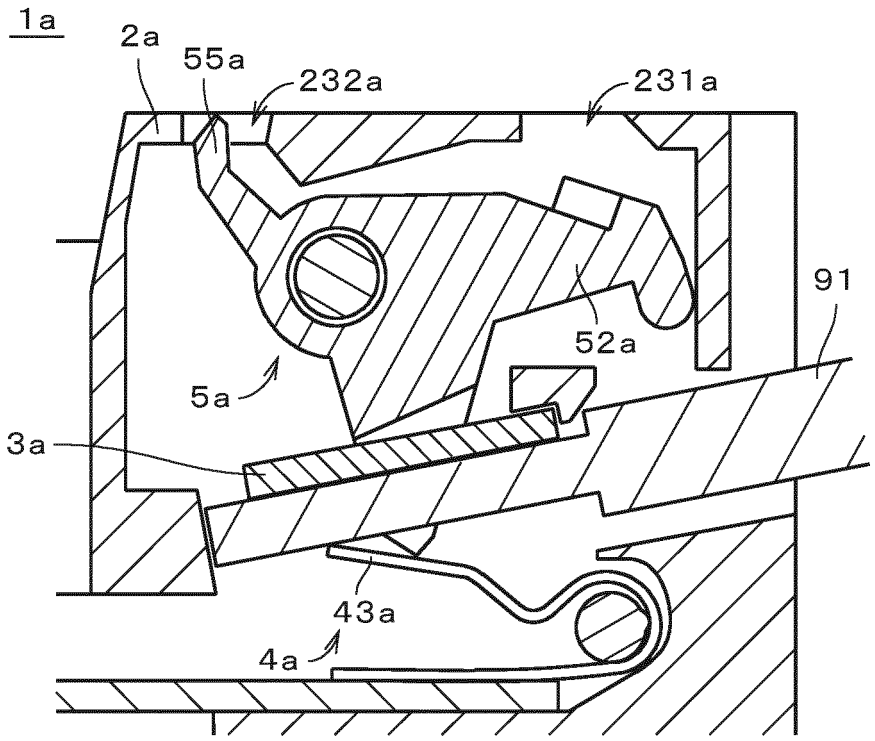


Fig. 21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232a
231a
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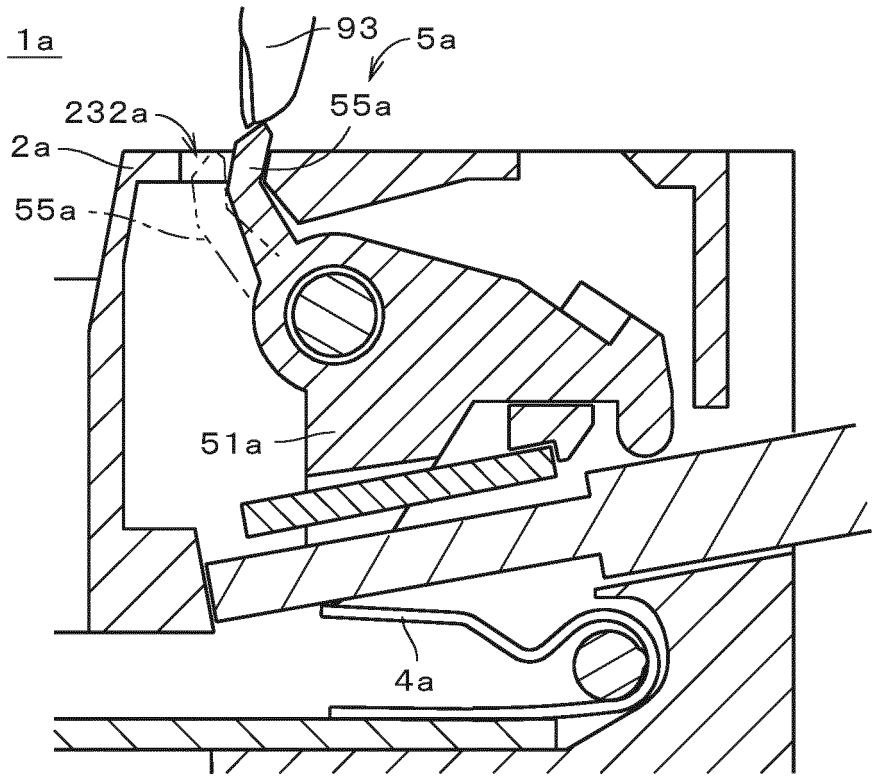
52a
5a
3a
43a
4a

Fig. 22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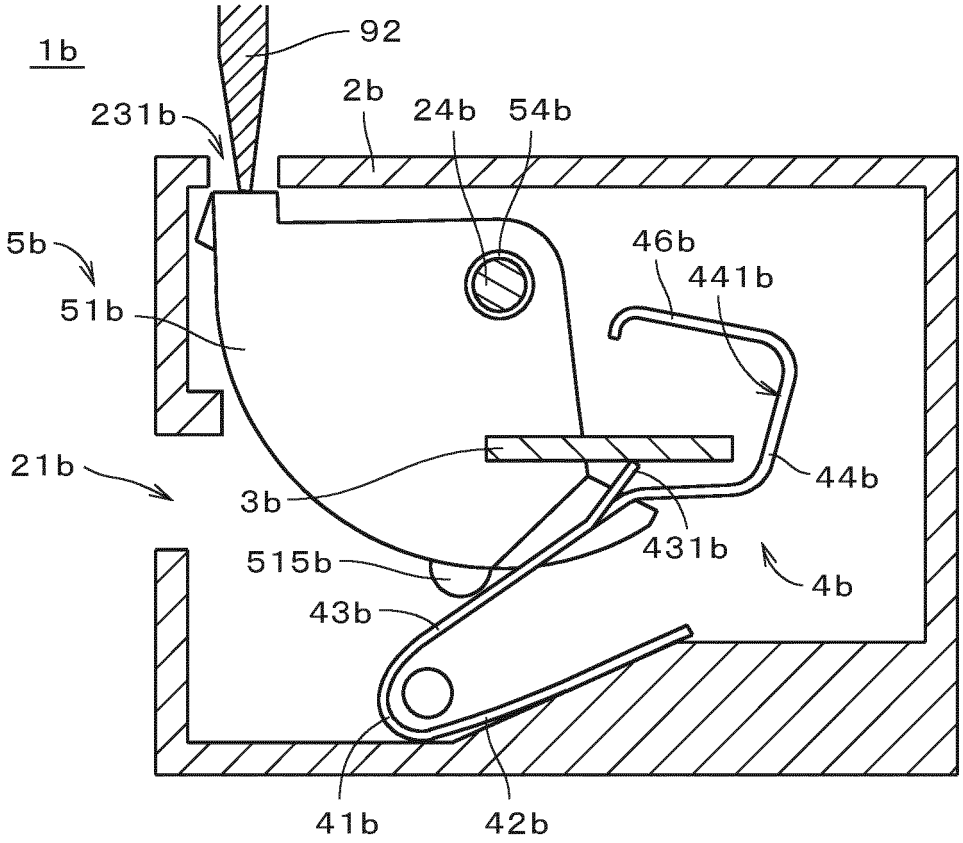
55a
232a
2a
55a
51a
4a

Fig. 23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231b
2b
24b
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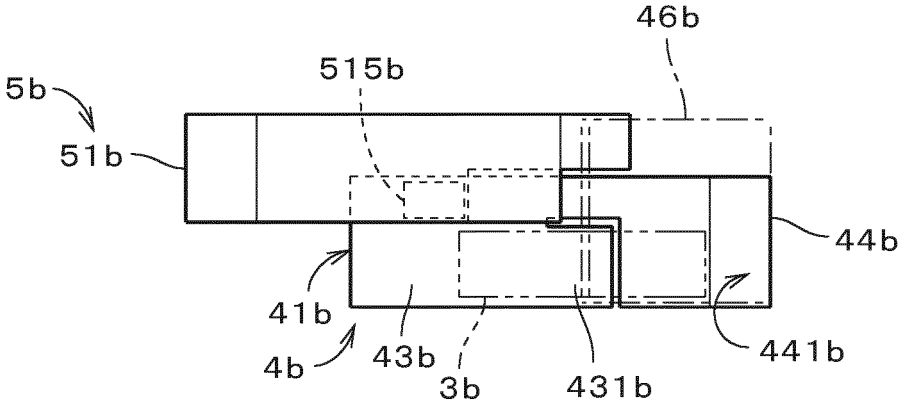
3b
44b
431b
515b
4b
43b
41b
42b

Fig. 24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41b
4b
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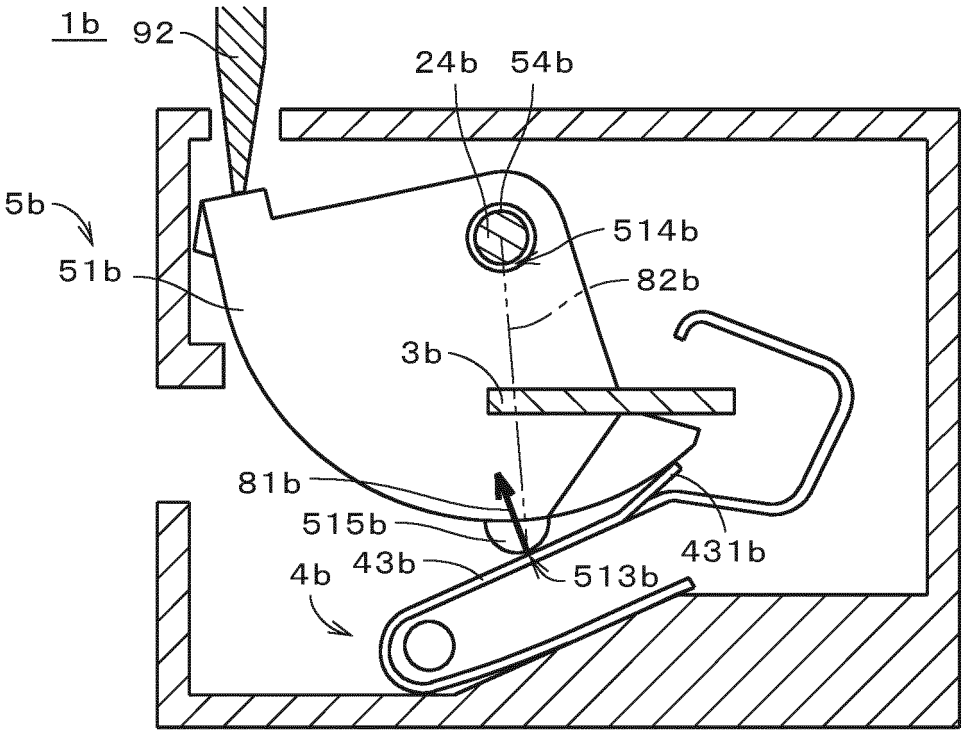
431b
441b

Fig. 25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3b
81b
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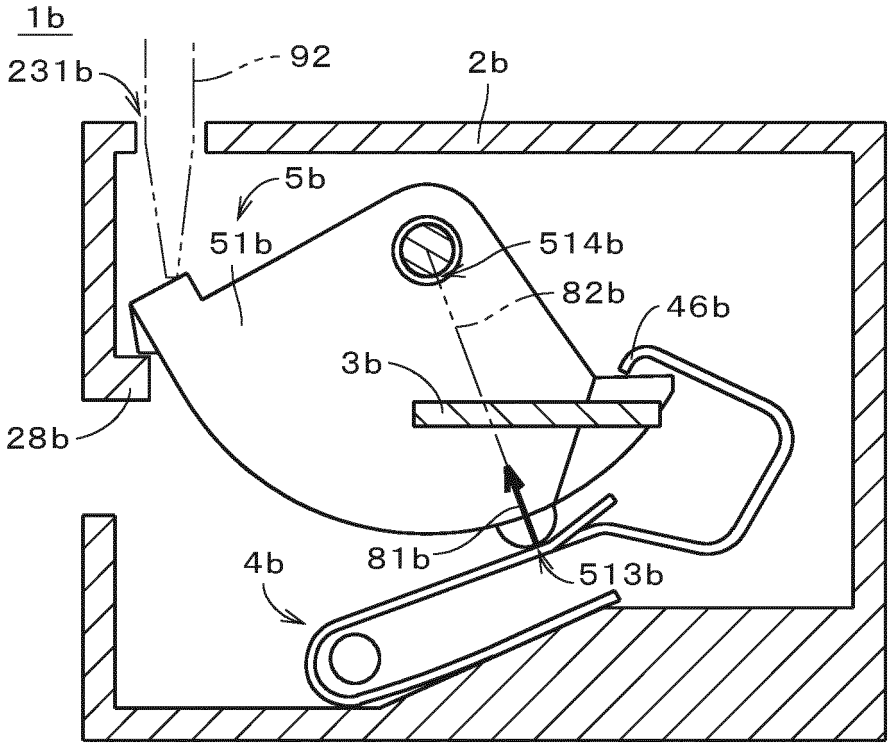
4b
43b
513b

Fig. 26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2b
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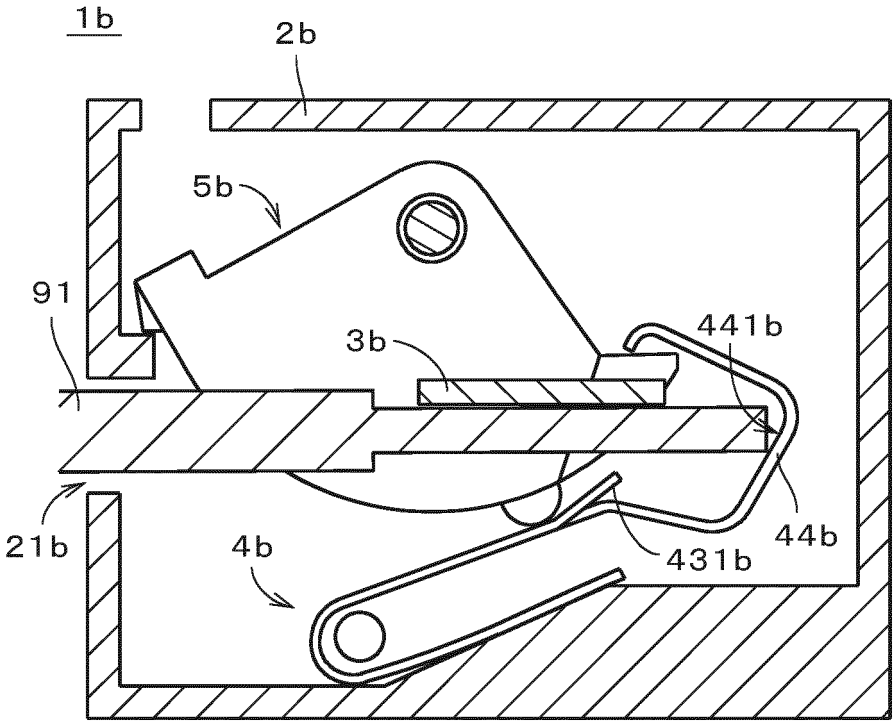
81b
513b

Fig. 27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3b
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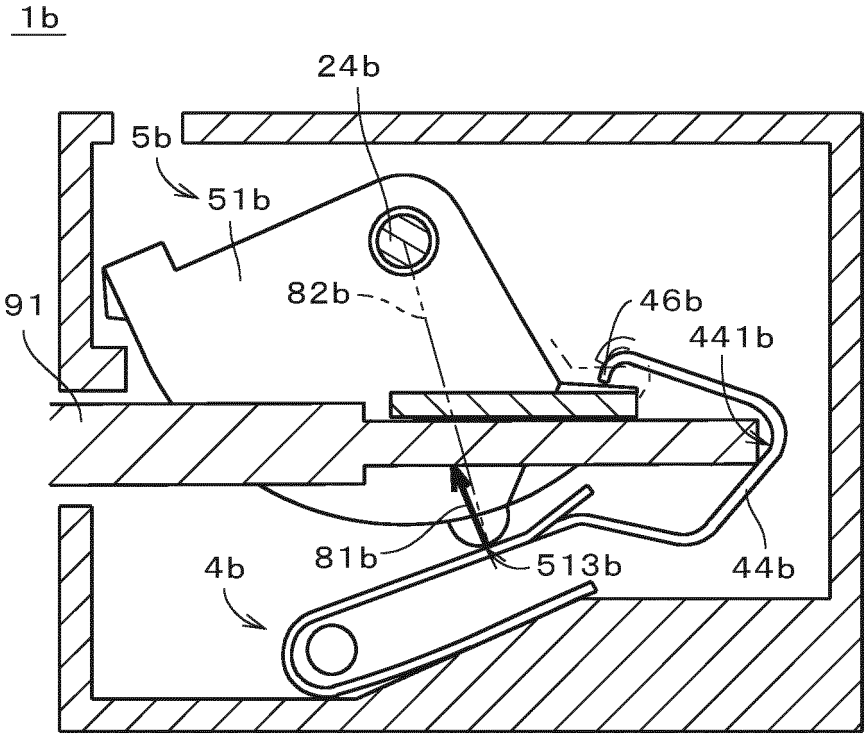
44b

Fig. 28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4b
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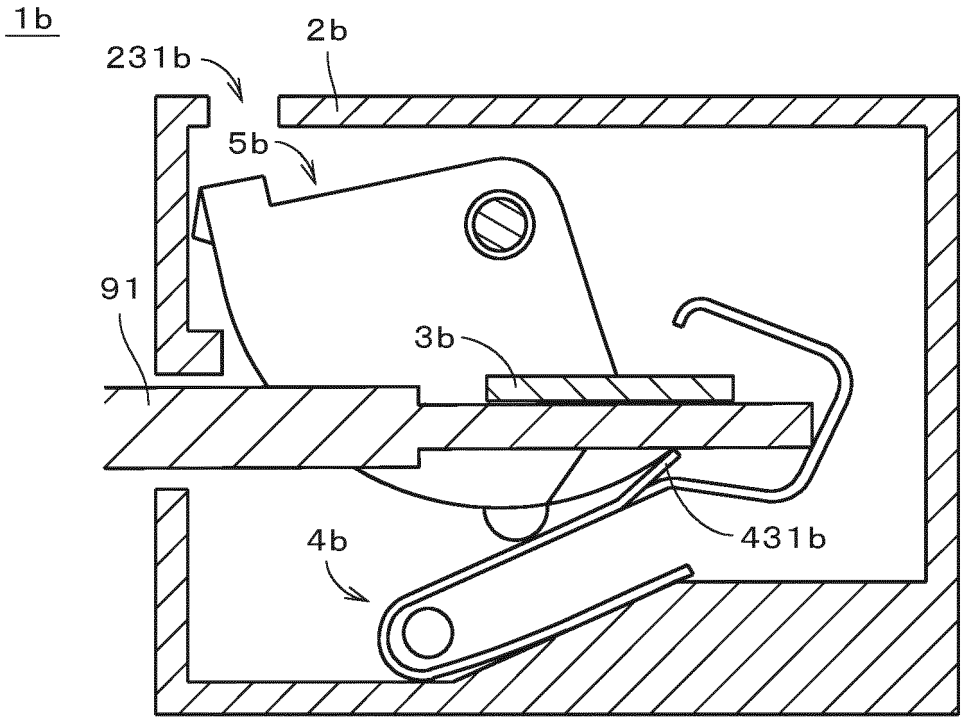
Fig. 29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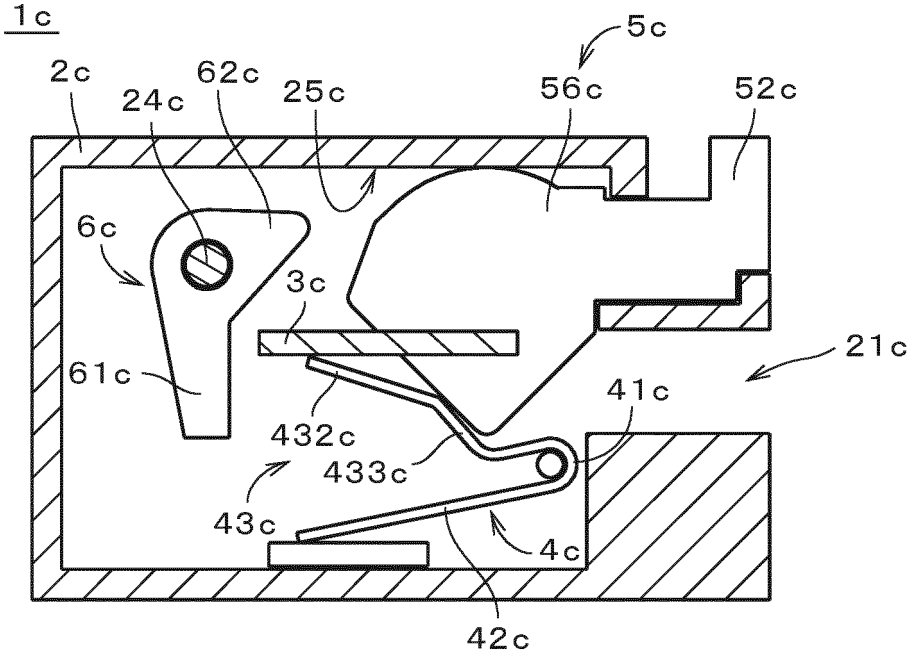
4b

Fig. 30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41c
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4c
42c

Fig. 31

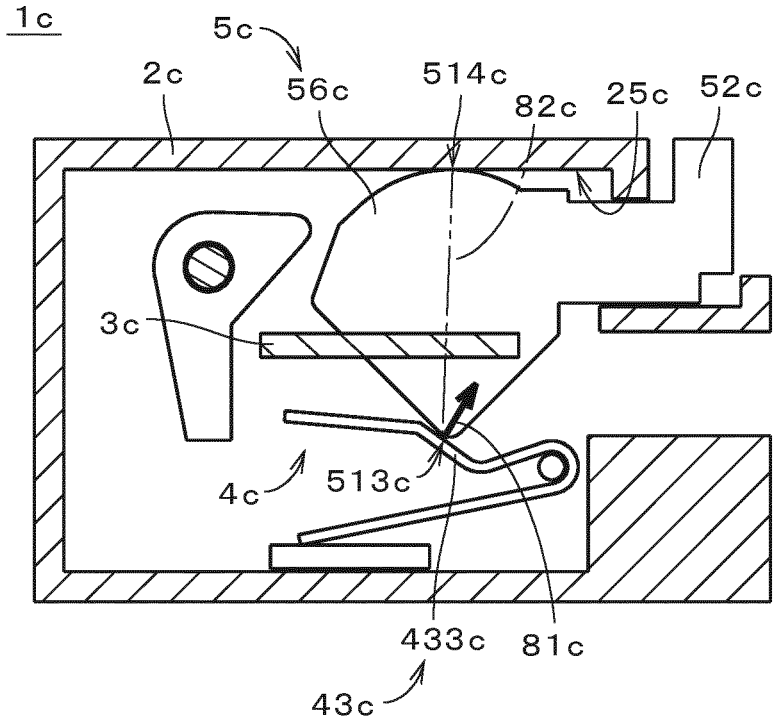
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Fig. 32

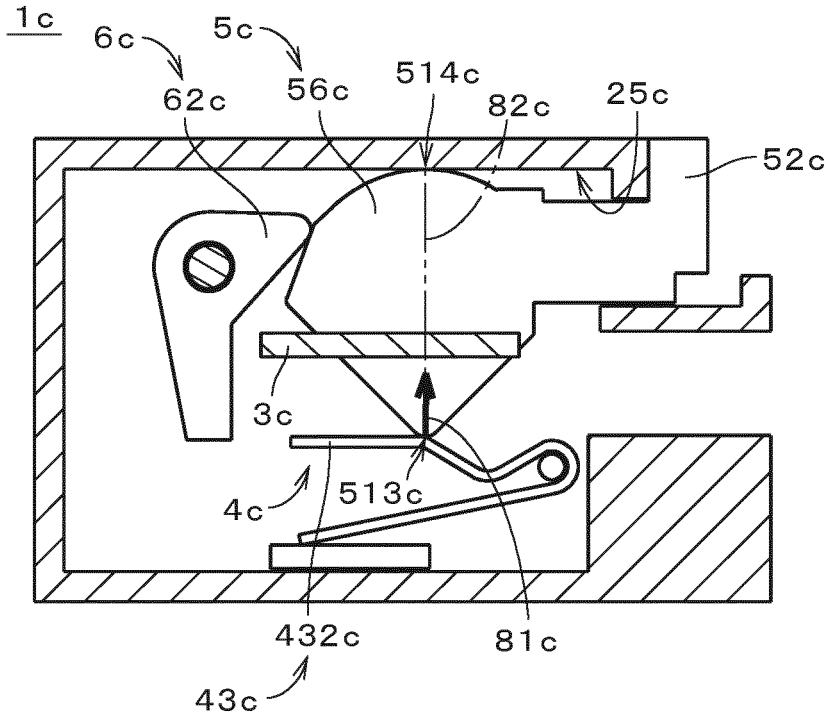
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Fig. 33

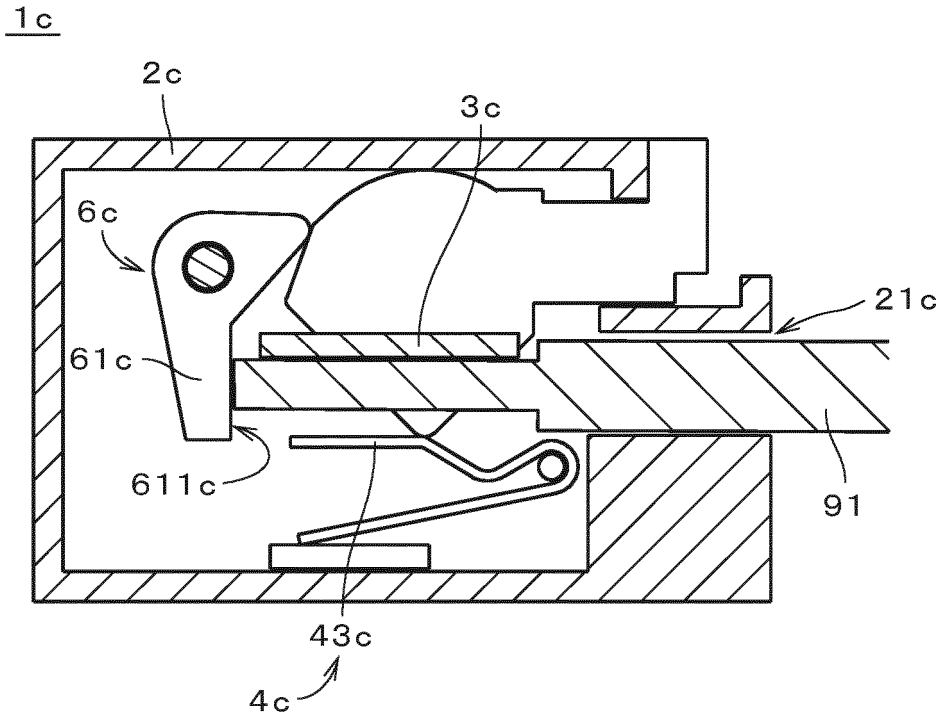
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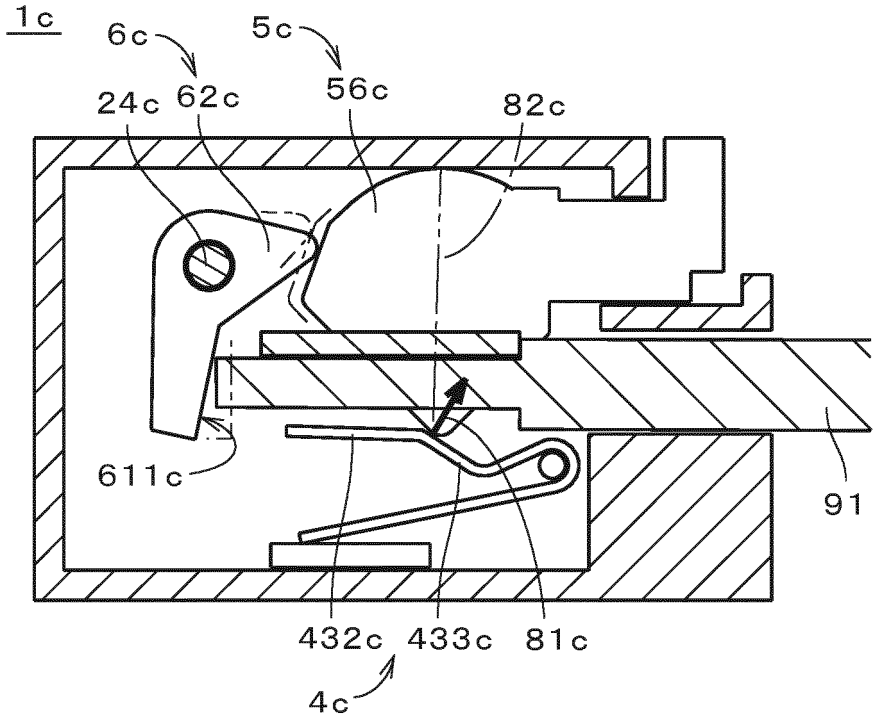
Fig. 34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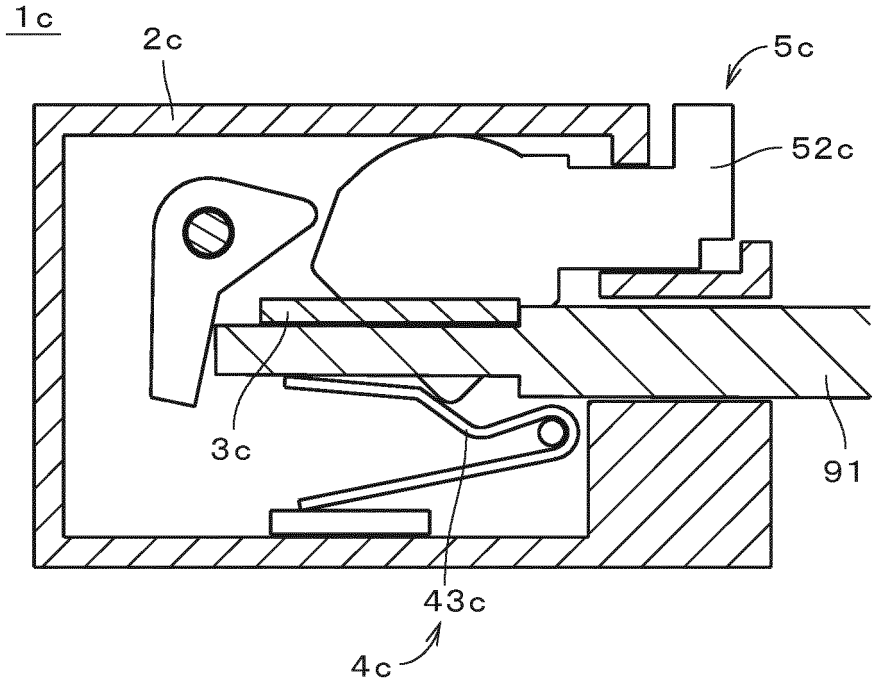
81c
4c

Fig. 35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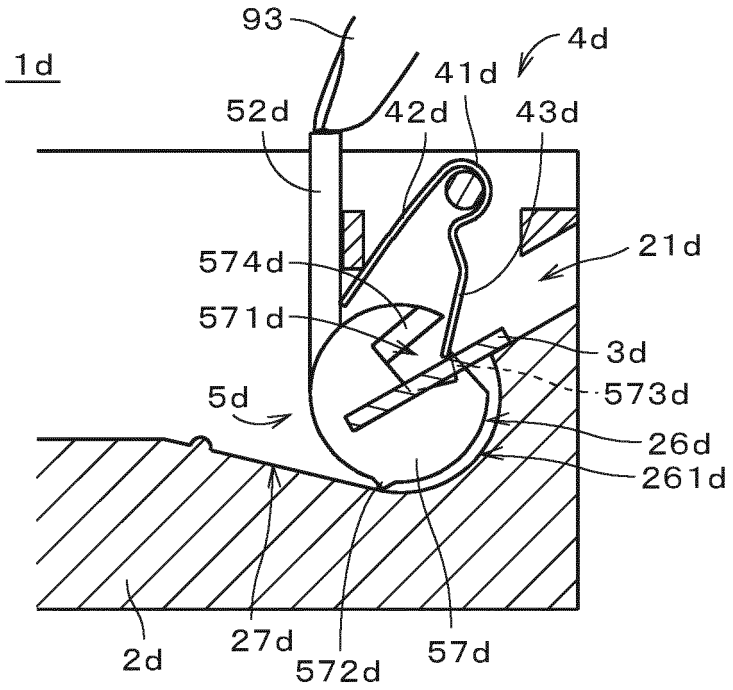
43c
4c

Fig. 36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571d
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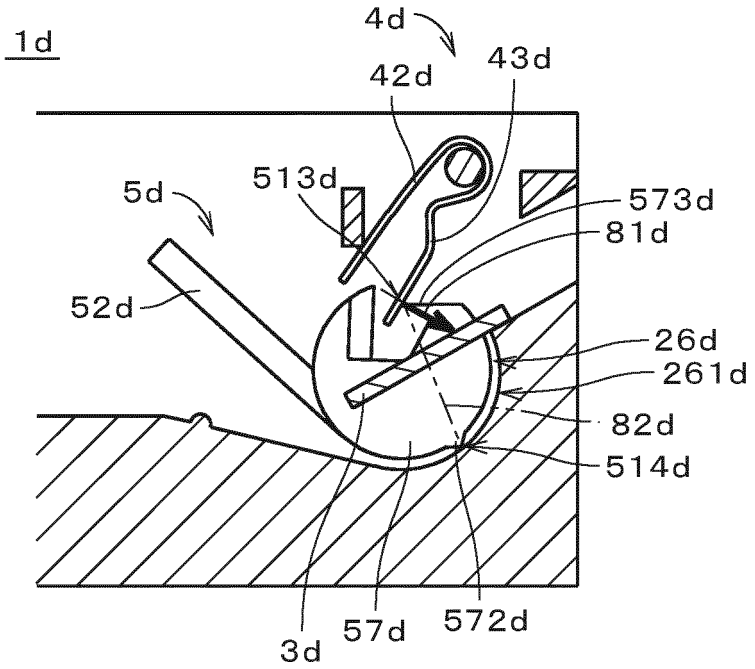
573d
5d
26d
261d
2d
27d
572d
57d

Fig. 37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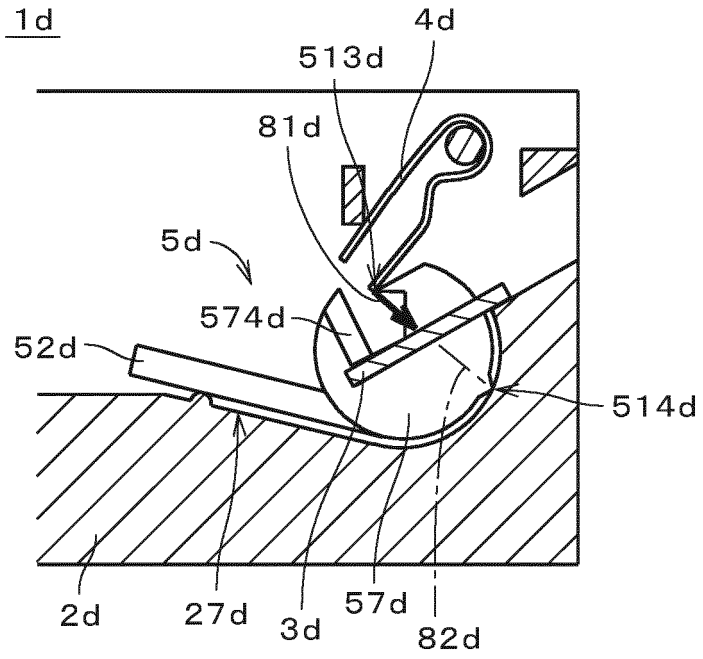
82d
514d
3d
57d
572d

Fig. 38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574d
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514d
2d
27d
3d
57d
82d

Fig. 39

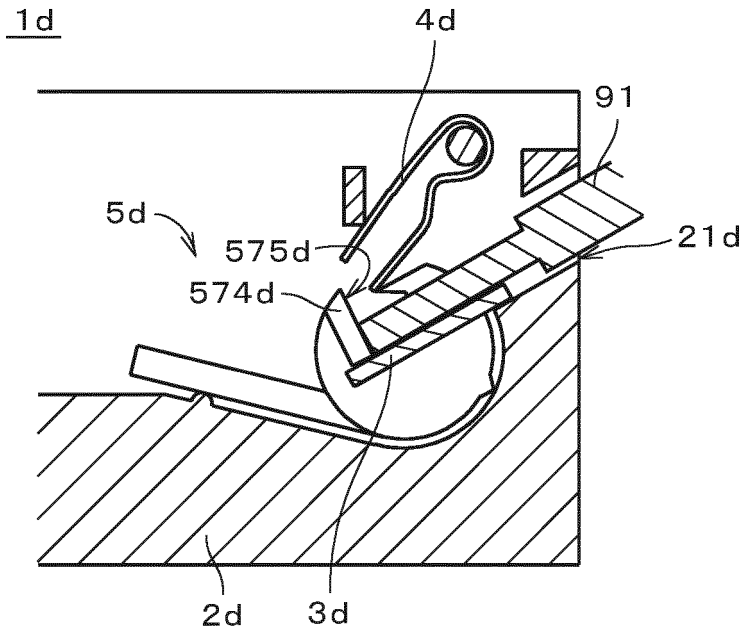


Fig. 40

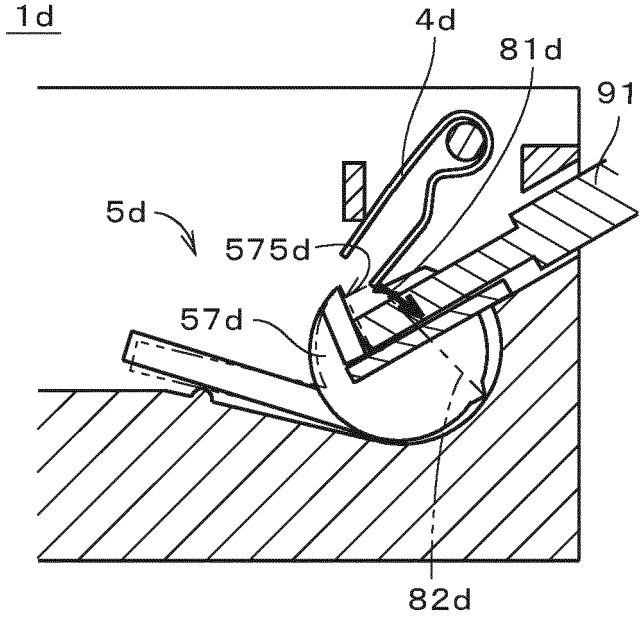
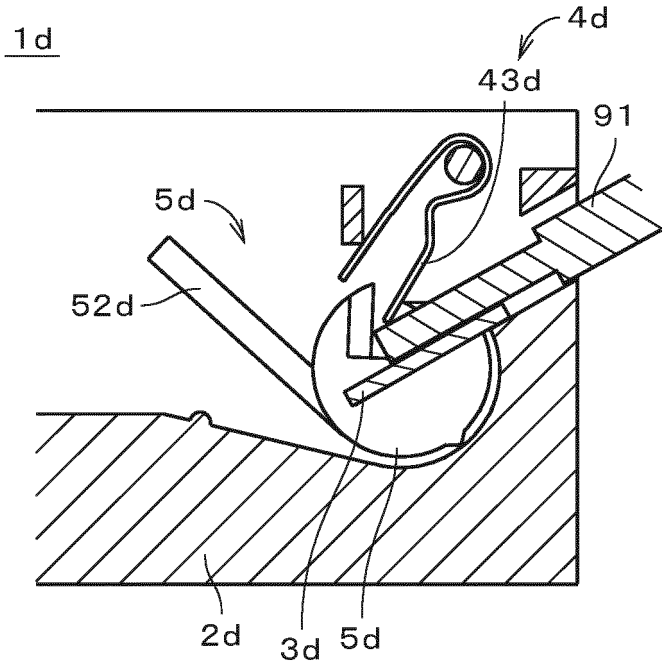


Fig. 41



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2021/026103

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. H01R4/48(2006.01)i
FI: H01R4/48 A, H01R4/48 C

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int. Cl. H01R4/48

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

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2021
Registered utility model specifications of Japan	1996-2021
Published registered utility model applications of Japan	1994-2021

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2020-017515 A (FUJIKON KK) 30 January 2020 (2020-01-30), paragraphs [0038]-[0079], fig. 3-12	1, 14, 15, 16, 17
A		2-13
Y	JP 2017-216250 A (VIRGO VERWALTUNGS GMBH) 07 December 2017 (2017-12-07), paragraphs [0020]-[0056], fig. 1-12	1, 14, 15, 16, 17
Y	JP 2001-135372 A (YAMAHA CORP.) 18 May 2001 (2001-05-18), paragraphs [0016]-[0047], fig. 1-7	16, 17

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
02.09.2021	14.09.2021

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2021/026103

Patent Documents referred to in the Report	Publication Date	Patent Family	Publication Date
JP 2020-017515 A	30.01.2020	WO 2020/013338 A1	
JP 2017-216250 A	07.12.2017	US 2013/0157520 A1 paragraphs [0038]-[0082], fig. 1-12	
		WO 2013/087619 A1	
		EP 3125372 A1	
		CN 103199350 A	
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Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2020122599 A **[0002]**
- JP 2020169408 A **[0002]**
- JP 4202125 B **[0004]**
- JP 6675004 B **[0006]**