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(54) **ELECTRICAL CONNECTOR**

(57) In a connector (10), a lever (300) and sliders (400) are attached to a housing (200). The lever (300) is rotatable between an initial position and a mated position. The sliders (400) are movable between a front-end position and a rear-end position.

The lever (300) has pinion portions (330). The sliders (400) have rack portions (410). The pinion portions (330) and the rack portions (410) are engaged with each other. Turning the lever (300) moves the sliders (400) between the rear-end position and the front-end position. When the lever (300) is in the mated position, a regulating portion (234) regulates a regulated portion (314) to limit movement of the lever (300). Press mechanisms (340) apply force to the lever (300) to press the regulated portion (314) against the regulating portion (234). Retain mechanisms (340) retain the sliders (400) in the front-end position.

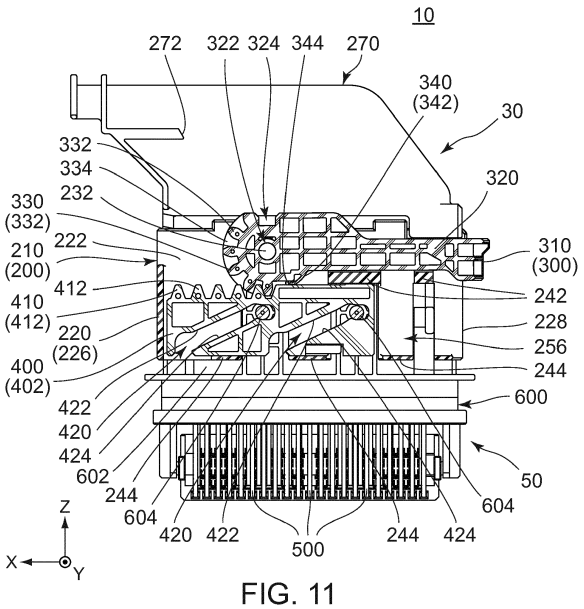

FIG. 11

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Description

BACKGROUND OF THE INVENTION:

[0001] This invention relates to a connector, in particular, to a connector which is changeable, by turning a lever, between a mated state that the connector is mated with a mating connector and a removable state that the connector is removable from the mating connector.

[0002] Referring to Fig. 22, a connector assembly 90 disclosed in JPA 2015-122182 (Patent Literature 1) has a connector 900 and a mating connector 950. The connector 900 has a housing 910, a cover 920, a lever 930 and sliders 940. The cover 920 is attached to the housing 910. The lever 930 is attached to the cover 920 to be rotatable within a predetermined range. The sliders 940 are accommodated in the housing 910 at least in part to be movable in a front-rear direction. The lever 930 and the sliders 940 are combined with each other to be interlocked with each other. In detail, the lever 930 and the sliders 940 are combined so that turning the lever 930 in a rotational direction moves the sliders 940 in the front-rear direction.

[0003] As understood from Fig. 22, the sliders 940 are formed with a plurality of cam grooves 942 (one of them is shown in Fig. 22). On the other hand, the mating connector 950 is formed with a plurality of bosses 952 (three of them are shown in Fig. 22). The cam grooves 942 correspond to the bosses 952, respectively. In order to mate the connector 900 with the mating connector 950, the bosses 952 of the mating connector 950 are inserted into the cam grooves 942 of the sliders 940. In such a state, turning the lever 930 in a predetermined direction along the rotational direction moves the sliders 940 in one of two directions along the front-rear direction and makes the cam grooves 942 move the bosses 952 upward. Accordingly, the mating connector 950 is drawn toward the connector 900 and mated with the connector 900. Moreover, turning the lever 930 in an opposite direction opposite to the predetermined direction along the rotational direction moves the sliders 940 in the other direction along the front-rear direction and moves the bosses 952 downward. Accordingly, the mating connector 950 is pushed in a direction away from the connector 900 and becomes removable from the connector 900.

[0004] In a connector used in a condition that it receives vibration, any part of the connector can be worn down by rubbing against neighboring parts thereof when the part is rattled by the vibration. The wear of the part causes malfunction of the connector, furthermore, causes malfunction of a product using the connector. Accordingly, it is necessary to prevent the part from being rattled. Patent Literature 1, however, shows nothing to prevent the part from being rattled.

SUMMARY OF THE INVENTION:

[0005] It is an object of the present invention to provide a connector which is provided with a mechanism for preventing a part from being rattled.

[0006] One aspect of the present invention provides a connector which is mateable with and removable from a mating connector in an up-down direction. The mating connector comprises a force receiving portion. The connector comprises a housing, a lever, a slider, a press mechanism, and a retain mechanism. The housing is provided with a regulating portion. The lever is attached to the housing to be rotatable between an initial position and a mated position. The lever is provided with a regulated portion. The slider is attached to the housing to be movable between a front end position and a rear end position in a front-rear direction orthogonal to the up-down direction. The lever has a pinion portion having a plurality of teeth. The slider has a force transmission portion and a rack portion having a plurality of teeth. The pinion portion and the rack portion translate turn of the lever into front-rear-direction movement of the slider by engaging with each other. According to the front-rear-direction movement of the slider, the force transmission portion transmits up-down-direction force to the force receiving portion of the mating connector to move relatively the mating connector against the connector in the up-down direction. When the lever turns from the initial position to the mated position, the slider is moved from the rear end position to the front end position in the front-rear direction. When the slider is moved from the rear end position to the front end position, the connector comes into a mated state that the connector is mated with the mating connector. When the lever turns from the meted position to the initial position, the slider is moved from the front end position to the rear end position in the front-rear direction. When the slider is moved from the front end position to the rear end position, the connector comes into a removable state that the connector is removable from the mating connector. When the lever is in the mated position, the regulating portion regulates the regulated portion to limit movement of the lever toward the initial position. When the lever is in the mated position, the press mechanism applies force on the lever to press the regulated portion against the regulating portion. When the lever is in the mated position, the retain mechanism retains the slider in the front end position.

[0007] In the connector according to the present invention, when the lever is in the mated position, the regulating portion regulates the regulated portion to limit movement of the lever for the initial position while the press mechanism presses the regulated portion against the regulating portion to prevent the lever from being rattled. Moreover, when the lever is in the mated position, the retain mechanism retains the slider in the front-end position to prevent the slider from being rattled.

[0008] An appreciation of the objectives of the present invention and a more complete understanding of its structure may be had by studying the following description of the preferred embodiment and by referring to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS:

[0009]

Fig. 1 is a perspective view showing a connector assembly according to a first embodiment of the present invention. A connector and a mating connector are not yet mated with each other.
Fig. 2 is a side view showing the connector assembly of Fig. 1.
Fig. 3 is a bottom view showing the connector assembly of Fig. 1.
Fig. 4 is a bottom view showing the connector included in the connector assembly of Fig. 1.
Fig. 5 is a cross-sectional view showing the connector assembly of Fig. 3, taken along A-A line.
Fig. 6 is a cross-sectional view showing the connector assembly of Fig. 3, taken along B-B line.
Fig. 7 is another perspective view showing the connector assembly according to the first embodiment of the present invention. The connector and the mating connector are in a mated state.
Fig. 8 is a side view showing the connector assembly of Fig. 7.
Fig. 9 is a bottom view showing the connector assembly of Fig. 7.
Fig. 10 is a bottom view showing the connector included in the connector assembly of Fig. 7.
Fig. 11 is a cross-sectional view showing the connector assembly of Fig. 9, taken along C-C line.
Fig. 12 is a cross-sectional view showing the connector assembly of Fig. 9, taken along D-D line.
Fig. 13 is a perspective view showing a lever used in the connector included in the connector assembly of Fig. 1. A longitudinal direction of arm portions coincides with a front-rear direction. Ends of the arm portions are directed forward.
Fig. 14 is another perspective view showing the lever of Fig. 13.
Fig. 15 is a side view showing the lever of Fig. 13. A part of the lever is enlarged to be shown.
Fig. 16 is a front view showing the lever of Fig. 13.
Fig. 17 is a plan view showing the lever of Fig. 13.
Fig. 18 is a perspective view showing one of a pair of sliders used in the connector included in the connector assembly of Fig. 1. The other slider is formed in a mirror symmetrical shape of the one.
Fig. 19 is another perspective view showing the slider of Fig. 18.
Fig. 20 is a side view showing an outer side surface, oriented outward in a right-left direction, of the slider of Fig. 18.
Fig. 21 is a side view showing an inner side surface, oriented inward in the right-left direction, of the slider of Fig. 20.
Fig. 22 is a perspective view showing a connector assembly disclosed in Patent Literature 1. A connector and a mating connector are not yet mated with each other.

[0010] While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof are shown by way of example in the drawings and will herein be described in detail. It should be understood, however, that the drawings and detailed description thereto are not intended to limit the invention to the particular form disclosed, but on the contrary, the intention is to cover all modifications, equivalents and alternatives falling within the spirit and scope of the present invention as defined by the appended claims.

DESCRIPTION OF PREFERRED EMBODIMENTS:

[First embodiment]

[0011] Referring to Figs. 1, 2, 5 to 8, 11 and 12, a connector assembly 10 according to a first embodiment of the present invention has a connector 30 and a mating connector 50. The connector 30 is mateable with and removable from the mating connector 50 along an up-down direction. In the present embodiment, the connector 30 is a socket connector while the mating connector 50 is a pin connector. Moreover, in the present embodiment, the up-down direction is a Z-direction. A positive Z-direction is upward while a negative Z-direction is downward.

[0012] Referring to Figs. 1 to 3, 5 to 9, 11 and 12, the mating connector 50 has a plurality of mating contacts 500 and a mating housing 600 which holds the mating contacts 500. As shown in Figs. 1, 2, 5 and 11, the mating housing 600 is provided with a plurality of camshafts (force receiving portions) 604. As understood from Figs. 1, 2, 5 and 11, in the present embodiment, the mating housing 600 has two side surfaces 602 positioned in a right-left direction. Each of the side surfaces 602 is provided with two camshafts 604 which protrude outward therefrom in the right-left direction. The two camshafts 604 provided on each of the side surfaces 602 are arranged apart from each other in a front-rear direction. One of the camshafts 604 formed on one of the side surfaces 602 and one of the camshafts 604 formed on the other of the side surfaces 602 make one pair. The mating housing 600 of the present embodiment has two pairs of the camshafts 604. The camshafts 604 making one pair are identical with each other when seen along the right-left direction. In the present embodiment, the front-rear direction is an X-direction orthogonal to the up-down direction. A positive X-direction is forward while a negative X-direction is rearward. Moreover, in the present embodiment, the right-left direction is a Y-direction orthogonal to both of the up-down direction and the front-rear direction.

[0013] As understood from Figs. 1, 4 to 6, and 10 to 12, the connector 30 is provided with a plurality of contacts 100, a housing 200, a lever 300 and a pair of sliders 400 (402, 404). In addition, as described later, the con-

nector 30 is provided with a press mechanism and a retain mechanism (spring portions 340).

[0014] As shown in Figs. 1 to 12, the housing 200 has a housing body 210 and a cover 270. As understood from Figs. 1, 2, 4 to 6, 10 and 12, the housing body 210 has a contact holding portion 212 and a wall portion 220. The contact holding portion 212 holds the contacts 100. The wall portion 220 surrounds a periphery of the contact holding portion 212. As shown in Figs. 1 to 12, the cover 270 is attached to an upper part of the housing body 210 and opens frontward. As shown in Figs. 1, 2, 5, 7, 8 and 11, the cover 270 is provided with stoppers 272 which protrude outward therefrom in the right-left direction.

[0015] As understood from Figs. 1, 2, 4 to 6 and 10 to 12, the contact holding portion 212 of the housing body 210 has an approximately rectangular-parallelepiped shape which is long in the front-rear direction. As shown in Figs. 1, 4, 6, 10 and 12, the contact holding portion 212 is provided with a plurality of holding holes 214 which hold the contacts 100, respectively. The holding holes 214 are arranged to correspond to arrangement of the mating contacts 500 of the mating connector 50. As shown in Figs. 6 and 12, the holding holes 214 pierce the contact holding portion 212 in the up-down direction. The contacts 100 held in the holding holes 214 are connected with wirings (not shown), respectively. The wirings are routed out upward of the contact holding portion 212 and led forward by the cover 270.

[0016] Referring to Figs. 1 to 12, the wall portion 220 of the housing body 210 has a pair of inner sidewalls 222, a pair of outer sidewalls 224, a front wall 226 and a rear wall 228. The inner sidewalls 222 are located outward of the contact holding portion 212 in the right-left direction. The outer sidewalls 224 are located outward of the inner sidewalls 222 in the right-left direction. Each of the inner sidewalls 222 and the outer sidewall 224 adjacent thereto are disposed at a predetermined interval. The front wall 226 is positioned forward of the contact holding portion 212 and connects the inner sidewalls 222 and the outer sidewalls 224 to one another at their front ends. The rear wall 228 is positioned rearward of the contact holding portion 212 and connects the inner sidewalls 222 to each other at their rear ends. Moreover, as shown in Figs. 5 and 11, the housing body 210 further has upper guide portions 242 and lower guide portions 244. Each of the upper guide portions 242 and the lower guide portions 244 connects each of the inner sidewall 222 and the outer sidewall 224 adjacent thereto to each other.

[0017] As understood from Figs. 6 and 12, each of the front wall 226 and the rear wall 228 is connected to the contact holding portion 212 in an upper side upper than a middle of the contact holding portion 212 in the up-down direction. Similarly, the inner sidewalls 222 are connected to the contact holding portion 212. As understood from Figs 1, 4, 6 and 10, a receiving portion 252 is formed between the contact holding portion 212 and surrounding walls, i.e. the inner sidewalls 222, the front wall 226 and the rear wall 228, and is positioned below connecting parts between the contact holding portion 212 and the surrounding walls. The receiving portion 252 receives a mating housing 600 of the mating connector 50 in part when the connector 30 is mated with the mating connector 50.

[0018] As understood from Figs. 1, 5 and 11, between each of the inner sidewalls 222 and the outer sidewall 224 adjacent thereto, a lever accommodation portion 254 and a slider accommodation portion 256 are formed. The lever accommodation portion 254 rotatably accommodates the lever 300 in part. The slider accommodation portion 256 accommodates the slider 400 (402 or 404) in part to allow the slider 400 to be movable in the front-rear direction. The lever accommodation portion 254 and the slider accommodation portion 256 communicate with each other in the up-down direction except for some parts. The upper guide portions 242 partition the lever accommodation portion 254 from the slider accommodation portion 256 in part. The lower guide portions 244 define a bottom of the slider accommodation portion 256. The upper guide portions 242 and the lower guide portions 244 guide front-rear-direction movement of the slider 400 accommodated in the slider accommodation portion 256. The inner sidewalls 222 are further provided with rotational shafts 232 protruding outward therefrom in the right-left direction. The rotational shafts 232 are positioned in the lever accommodation portions 254. As shown in Figs. 1 and 12, the rear wall 228 is provided with a lock portion (a regulating portion) 234. The lock portion 234 protrudes rearward from the rear wall 228.

[0019] In the present embodiment, the inner sidewalls 222, the outer sidewalls 224, the front wall 226, the rear wall 228, the upper guide portions 242 and the lower guide portions 244 are formed integrally with one another. Specifically, they are integrally molded using a resin (a first resin). This is for reducing the number of parts, simplifying manufacturing process and reducing manufacturing costs. The wall portion 220 may be molded integrally with at least a part of the contact holding portion 212 using common material.

[0020] As shown in Figs. 1 to 4, the lever 300 has an operation portion 310 and a pair of arm portions 320. The operation portion 310 extends in the right-left direction. The arm portions 320 extend from both ends of the operation portion 310 in a direction orthogonal to the right-left direction. As shown in Figs. 13 to 15, each of the arm portions 320 is formed with a shaft hole 322 in a vicinity of an end of the arm portion 320. The shaft hole 322 pierces the arm portion 320 in the right-left direction. Moreover, as shown in Figs. 13, 14 and 17, the arm portions 320 have inner surfaces facing each other in the right-left direction. Each of the inner surfaces of the arm portions 320 is formed with a guide groove 324 extending from an edge of the arm portion 320 to the shaft hole 322. The guide grooves 324 extend in a direction orthogonal to an extending direction (a longitudinal direction) of the arm portions 320. In other words, the guide grooves 324 extend in the up-down direction when the longitudinal

direction of the arm portions 320 coincides with the front-rear direction. The guide grooves 324 guide rotational shafts 232 provided to the housing 200 to the shaft holes 322 upon attaching the lever 300 to the housing 200. The shaft holes 322 receive the rotational shafts 232 so that the lever 300 is rotatably attached to the housing 200.

[0021] As understood from Figs. 1, 2, 5 to 12, in a state that the lever 300 is attached to the housing 200, the lever 300 is rotatable about the rotational shafts 232. In detail, the lever 300 of the present embodiment is rotatable between an initial position shown in Figs. 1, 2, 5 and 6 and a mated position shown in Figs. 7 to 12. The lever 300 is partly accommodated in the lever accommodation portions 254 in a state that the lever 300 is attached to the housing 200. As understood from Figs. 1, 2, 7 and 8, the ends of the arm portions 320 are always positioned in the lever accommodation portions 254. When the lever 300 is positioned in the mated position, a ratio of parts of the arm portions 320 that are accommodated in the lever accommodation portion 254 becomes maximum. The operation portion 310 is always positioned outside the lever accommodation portions 254.

[0022] As understood from Figs. 1, 2 and 5, when the lever 300 is positioned in the initial position, trying to turn the lever 300 in a direction away from the mated position makes the arm portions 320 be brought into abutment with the stoppers 272. Then, the lever 300 cannot be turned further. Moreover, as understood from Fig. 11, when the lever 300 is positioned in the mated position, trying to turn the lever 300 in a direction away from the initial position makes the arm portions 320 be brought in to abutment with the upper guide portions 242. Then, the lever 300 cannot be turned further.

[0023] As understood from Figs. 5, 11 and 13 to 17, each of the arm portions 320 further has a pinion portion 330. The pinion portion 330 has a plurality of teeth 332. The teeth 332 are arranged to surround partly a periphery of the shaft hole 322 when seen along the right-left direction. The arm portion 320 further has a plate-like member 334. The plate-like member 334 connects the teeth 332 of the pinion portion 330 to one another to reinforce the teeth 332. The plate-like member 334 is provided on one of side surfaces of the pinion portion 330. In other words, the plate-like members 334 of the arm portions 320 are located inward of two sets of the teeth 332 in the right-left direction.

[0024] As shown in Figs. 2, 5, 11, and 13 to 15, each of the arm portions 320 is provided with the spring portion 340. In the present embodiment, the spring portion 340 functions as both of the press mechanism and the retain mechanism. As shown in Fig. 11, when the lever 300 is positioned in the mated position, the lever 300 has a middle and a front end in the front-rear direction between which the spring portion 340 is positioned. In other words, the spring portion 340 is positioned between the middle and the front end of the lever 300 in the front-rear direction. In detail, when the lever 300 is positioned in the mated position, the spring portion 340 is positioned below the arm portion 320 and rearward of the pinion portion 330. Moreover, as shown in Figs. 13 and 14, the spring portion 340 is positioned on a plane (an XZ plane) same as a plane on which the pinion portion 330 is located. As shown partially enlarged in Fig. 15, in a state that a longitudinal direction of the lever 300 coincides with the front-rear direction, the spring portion 340 diagonally extends frontward and downward from a base (a root or a start point) 342 thereof and then extends frontward to a tip 344 thereof. As understood from Figs. 11 and 15, a shaft center of the rotational shaft 232 and the tip 344 of the spring portion 340 define a first distance L1 therebetween. The shaft center of the rotational shaft 232 and the base 342 of the spring portion 340 define a second distance L2 therebetween. The shaft center of the rotational shaft 232 and a tip of any one of the teeth 332 of the pinion portion 330 define a third distance L3 therebetween. The first distance L1 is equal to or shorter than the second distance L2 ($L1 \leq L2$). Moreover, the first distance L1 is equal to or shorter than the third distance L3 ($L1 \leq L3$). In addition, as understood from Figs. 2 and 8, the tip 344 of the spring portion 340 is always hidden behind a part of the housing 200, i.e. the outer sidewall 224, when seen along the right-left direction. All these conditions about the tip 344 of the spring portion 340 are for protecting the tip 344 of the spring portion 340.

[0025] In the present embodiment, the operation portion 310, the arm portions 320, the pinion portions 330, the plate-like members 334 and the spring portions 340 are integrally formed. Specifically, they are integrally molded using a resin (a second resin). This is for reducing the number of parts, simplifying manufacturing process and reducing manufacturing costs. The second resin may be same as or different from the first resin. In the present embodiment, the lever 300 is partly reduced in thickness to reduce weight thereof. Accordingly, the lever 300 has a lattice pattern on a surface thereof.

[0026] As shown in Figs. 6, 10, 12, 14, 16 and 17, the operation portion 310 is provided with a supporting portion 312 and a locked portion (a regulated portion) 314 supported by the supporting portion 312. The supporting portion 312 and the locked portion 314 are positioned in a middle of the operation portion 310 in the right-left direction. The locked portion 314 protrudes from a surface of the supporting portion 312 in a direction of the ends of the arm portions 320. As shown in Fig. 12, when the lever 300 is positioned in the mated position, the locked portion 314 is caught by the lock portion 234 provided to the housing 200. Accordingly, the lock portion 234 regulates the locked portion 314 to limit movement (turn), directed to the initial position, of the lever 300. As understood from Fig. 12, the locked portion 314 is movable at least in the front-rear direction due to resilient deformation of the supporting portion 312 when the lever 300 is positioned in the mated position. In other words, the supporting portion 312 supports the locked portion 314 so that the locked portion 314 is movable at least in the front-rear direction when the lever 300 is positioned in the mat-

ed position. Accordingly, when regulation of the locked portion 314 by the lock portion 234 is released by operating the supporting portion 312, the lever 300 is allowed to turn (move) to the initial position. At this time, an end 316 of the supporting portion 312 functions as a releasing portion which releases the regulation of the regulated portion (the locked portion 314) by the regulating portion (the lock portion 234).

[0027] As shown in Figs. 5, 11, and 18 to 21, each of the sliders 400 has an approximately rectangular-flat-plate shape when seen along the right-left direction. The slider 400 has an inner side surface oriented inward of the connector 30 in the right-left direction. The inner side surface of the slider 400 is formed with a plurality of cam grooves (force transmission portions) 420. In the present embodiment, the slider 400 is formed with two cam grooves 420. It should be noted that the cam grooves 420 may pierce the slider 400 in the right-left direction. The two cam grooves 420 correspond to the two camshafts 604 provided on any one of the side surfaces 602 of the mating housing 600 of the mating connector 50. One of the cam grooves 420 of one slider 402 and one of the cam grooves 420 of the other slider 404 form one pair. The connector 30 of the present embodiment has two pairs of the cam grooves 420. The cam grooves 420 of each of the sliders 400 are arranged apart from each other in the front-rear direction. Each of the cam grooves 420 opens downward at one end (a lower end) thereof. The cam groove 420 extends upward from the one end, and then diagonally extends rearward and upward, and further extends rearward. As described later, the cam grooves 420 transmit up-down-direction force to the camshafts 604 of the mating connector 50 according to the front-rear-direction movement of the sliders 400 to move the mating connector 50 in the up-down direction against the connector 30.

[0028] As shown in Figs. 5, 11, 19 and 21, each of the sliders 400 further has a rack portion 410. The rack portion 410 has a plurality of teeth 412 arranged along the front-rear direction. The slider 400 further has a plate-like member 414 connecting the teeth 412 of the rack portion 410 to one another to reinforce the teeth 412. The plate-like member 414 is provided on an outer-side surface of the teeth 412 in the right-left direction. The rack portion 410 is formed in a vicinity of an upper-front end of the slider 400. In the present embodiment, the slider 400 is integrally formed with the rack portion 410 and the plate-like member 414. Specifically, the slider 400 is integrally molded using a resin (a third resin). This is for reducing the number of parts, simplifying manufacturing process and reducing manufacturing costs. In addition, the third resin may be same as at least one of the first resin and the second resin or different from both of the first resin and the second resin.

[0029] As understood from Figs. 5 and 11, the sliders 400 (402, 404) are attached to the housing 200 to be movable between a front-end position shown in Fig. 11 and a rear-end position shown in Fig. 5. One slider 402 and the other slider 404 are positioned to be identical with each other when seen along the right-left direction. Moreover, the rack portions 410 of the sliders 400 engage with the pinion portions 330 of the lever 300, respectively. The rack portions 410 and the pinion portions 330 engage with each other so that the turn of the lever 300 is translated to the front-rear-direction movement of the sliders 400. The sliders 400 are positioned in the rear-end position when the lever 300 is positioned in the initial position. On the other hand, the sliders 400 are positioned in the front-end position when the lever 300 is positioned in the mated position. Accordingly, when the lever 300 turns from the initial position to the mated position, the sliders 400 are moved from the rear-end position to the front-end position in the front-rear direction. Inversely, when the lever 300 turns from the mated position to the initial position, the sliders 400 are moved from the front-end position to the rear-end position in the front-rear direction. The sliders 400 are always positioned in the slider accommodation portions 256 between the front-end position and the rear-end position. In other words, each of the sliders 400 is always hidden by a part of the housing 200, especially any one of the outer sidewalls 224, when seen along the right-left direction.

[0030] As shown in Figs 4 and 5, in a state that the lever 300 is in the initial position or that the sliders 400 are in the rear-end position, the lower end of each of the cam grooves 420 is positioned between two of the lower guide portions 244 which are adjacent to each other in the front-rear direction when seen along the up-down direction. In the state, the cam grooves 420 can receive the camshafts 604 of the mating connector 50. In other words, the connector 30 is in a mateable state that the connector 30 is mateable with the mating housing 600. As understood from Fig. 5, when the mating housing 600 of the mating connector 50 is inserted partly into the receiving portion 252 of the connector 30 which is in the mateable state, the camshafts 604 of the mating connector 50 go into the cam grooves 420. Then, the camshafts 604 of the mating connector 50 are brought into contact with upper walls 422 of the cam grooves 420 and stop at a mating start position.

[0031] As understood from Figs. 5 and 11, when the camshafts 604 of the mating connector 50 are positioned in the mating start position of the cam grooves 420, turning the lever 300 from the initial position to the mated position allows the sliders 400 to be moved from the rear-end position to the front-end position according to the turn of the lever 300. According to forward movement of the sliders 400, lower walls 424 of the cam grooves 420 push the camshafts 604 diagonally upward. Since the mating housing 600 of the mating connector 50 is partly received by the receiving portion 252 of the connector 30, neither the mating connector 50 nor the camshafts 604 can be moved forward. Consequently, the camshafts 604 pushed by the lower walls 424 of the cam grooves 420 are moved upward. In other words, upward force is transmitted from the cam grooves 420 to the camshafts

604. When the camshafts 604 receive the upward force from the cam grooves 420, the mating connector 50 is pulled up toward the connector 30. When the lever 300 reaches the mated position, the sliders 400 are moved to the front-end position. When the sliders 400 reach the front-end position, the camshafts 604 reach the mated position in the cam grooves 420 so that the connector 30 and the mating connector 50 come into a mated state. At this time, as shown in Fig. 12, the contacts 100 and the mating contacts 500 come into contact with one another to be electrically connected to one another.

[0032] When the lever 300 is turned toward the mated position from the initial position, the spring portions 340 are brought into abutment with the sliders 400 and resiliently deformed as understood from Fig. 11. When the lever 300 is in the mated position, the spring portions 340 are in a state that they are resiliently deformed. Reaction force of the spring portions 340 works to move the lever 300 and the sliders 400 away from each other. In other words, the spring portions 340 apply, to the lever 300, force of a direction directed toward the initial position from the mated position. Consequently, as understood from Fig. 12, the locked portion 314 is pressed against the lock portion 234. As a result, the lever 300 is prevented from being rattled. Thus, in the present embodiment, the spring portions 340 function as the press mechanism which apply force to the lever 300 to press the regulated portion (the locked portion 314) against the regulating portion (the lock portion 234) when the lever 300 is in the mated state.

[0033] Moreover, as understood from Fig. 11, the spring portions 340 apply downward force to the sliders 400 to press the sliders 400 against the lower guide portions 244. As a result, frictional force between the sliders 400 and the lower guide portions 244 is increased, and the sliders 400 are retained in the front-end position. Thus, in the present embodiment, the spring portions 340 also function as the retain mechanism which press the sliders 400 against the lower guide portions 244 to retain the sliders 400 in the front-end position when the lever 300 is in the mated state.

[0034] It should be noted that the spring portions 340 may be provided to the sliders 400 though the spring portions 340 are provided to the lever 300 in the present embodiment. However, considering the front-rear-direction movement of the sliders 400, each of the spring portions 340 except for a part (a point of action) thereof must be positioned inward of an outer shape of the slider 400 to which the spring portion 340 is provided. Accordingly, providing the spring portion 340 to the slider 400 causes increasing the slider 400 in size. Therefore, it is preferable that the spring portions 340 are provided to the lever 300. In the present embodiment, the spring portions 340 have a cantilever structure. However, the present invention is not limited thereto. For example, the spring portions 340 may have a double-supported beam structure. Furthermore, in the present embodiment, the spring portion 340 serves as both the press mechanism and the retain mechanism, and the press mechanism and the retain mechanism are unified. However, the present invention is not limited thereto. The press mechanism and the retain mechanism may be provided as distinct bodies separated from each other. In such a case, each of the press mechanism and the retain mechanism may be provided to any one of the housing 200, the lever 300 and the slider 400. Moreover, each of the press mechanism and the retain mechanism may not be something that uses large resilient deformation like the spring portion 340. For example, each of the press mechanism and the retain mechanism may be a protrusion which can apply force to the lever 300 or the slider 400. In such a case, a direction in which each of the press mechanism and the retain mechanism acts is not limited to the up-down direction but may be the right-left direction.

[0035] When the connector 30 and the mating connector 50 are in the mated state that the connector 30 and the mating connector 50 are mated with each other, as understood from Figs. 11 and 5, turning the lever 300 toward the initial position from the mated position moves the sliders 400 rearward toward the rear-end position from the front-end position. As the sliders 400 are moved rearward, the upper walls 422 of the cam grooves 420 push the camshafts 604 diagonally downward. Since the mating connector 50 cannot be also moved rearward in this time, the camshafts 604 pushed by the upper walls 422 of the cam grooves 420 are moved downward. In other words, downward force is transmitted from the cam grooves 420 to the camshafts 604. Hence, the mating connector 50 is pushed downward in a direction away from the connector 30. When the lever 300 reaches the initial position, the sliders 400 are moved to the rear-end position. When the sliders 400 reach the rear-end position, the camshafts 604 reach the mating start position in the cam grooves 420. At this time, the contacts 100 and the mating contacts 500 are separated from each other. Thus, the mating connector 50 comes into a removable state (the mateable state) that the mating connector 50 is removable form the connector 30. Then, the connector 30 can be easily removed from the mating connector 50.

[0036] Although the specific explanation about the present invention is made above referring to the embodiments, the present invention is not limited thereto but susceptible of various modifications and alternative forms. For example, though the regulating portion (the lock portion 234) and the regulated portion (the locked portion 314) are provided to the rear wall 228 and the operation portion 310, respectively, in the aforementioned embodiment, the regulating portion may be provided on either the inner sidewall 222 or the outer sidewall 224 while the regulated portion may be provided to the arm portion 320. However, in such a case, considering a balance of force applied to the lever 300, it is desirable that a plurality of the regulated portions is provided to the pair of the arm portions 320 to be arranged symmetrically. Accordingly, providing the regulated portions on the arm

portions 320 complicates structure of the connector 30 and releasing operation thereof. Therefore, like the present embodiment, it is desirable to provide the regulated portion in the middle of the operation portion 310 in the right-left direction.

[0037] Although the releasing portion (the end 316 of the supporting portion 312) is provided to the lever 300 in the aforementioned embodiment, the releasing portion may be provided to the housing 200. In such a case, the regulated portion (the locked portion 314) may be directly provided to the operation portion 310 without being supported by the supporting portion 312, and the regulating portion (the lock portion 234) may be supported by the supporting portion to be provided to the rear wall 228.

[0038] Furthermore, though rotational shafts 232 are provided to the housing 200 while the shaft holes 322 and the guide grooves 324 are provided to the lever 300 in the aforementioned embodiment, the shaft holes 322 and the guide grooves 324 may be provided to the housing 200 while the rotational shafts (shafts) 232 may be provided to the lever 300. Also in this case, the guide grooves 324 guide the rotational shafts 232 into the shaft holes 322 when the lever 300 is attached to the housing 200.

[0039] In addition, though the cam grooves 420 are provided to the connector 30 while the camshafts 604 are provided to the mating connector 50 in the aforementioned embodiment, the camshafts 604 may be provided to the connector 30 while the cam grooves 420 may be provided to the mating connector 50.

[0040] While there has been described what is believed to be the preferred embodiment of the invention, those skilled in the art will recognize that other and further modifications may be made thereto without departing from the spirit of the invention, and it is intended to claim all such embodiments that fall within the true scope of the invention.

Claims

1. A connector mateable with and removable from a mating connector in an up-down direction, wherein:

the mating connector comprises a force receiving portion;
the connector comprises a housing, a lever, a slider, a press mechanism, and a retain mechanism;
the housing is provided with a regulating portion;
the lever is attached to the housing to be rotatable between an initial position and a mated position;
the lever is provided with a regulated portion;
the slider is attached to the housing to be movable between a front end position and a rear end position in a front-rear direction orthogonal to the up-down direction;
the lever has a pinion portion having a plurality of teeth;
the slider has a force transmission portion and a rack portion having a plurality of teeth;
the pinion portion and the rack portion translate turn of the lever into front-rear-direction movement of the slider by engaging with each other;
according to the front-rear-direction movement of the slider, the force transmission portion transmits up-down-direction force to the force receiving portion of the mating connector to move relatively the mating connector against the connector in the up-down direction;
when the lever turns from the initial position to the mated position, the slider is moved from the rear end position to the front end position in the front-rear direction;
when the slider is moved from the rear end position to the front end position, the connector comes into a mated state that the connector is mated with the mating connector;
when the lever turns from the meted position to the initial position, the slider is moved from the front end position to the rear end position in the front-rear direction;
when the slider is moved from the front end position to the rear end position, the connector comes into a removable state that the connector is removable from the mating connector;
when the lever is in the mated position, the regulating portion regulates the regulated portion to limit movement of the lever toward the initial position;
when the lever is in the mated position, the press mechanism applies force on the lever to press the regulated portion against the regulating portion; and
when the lever is in the mated position, the retain mechanism retains the slider in the front end position.

2. The connector as recited in claim 1, wherein:

the press mechanism and retain mechanism are formed integrally with each other;
the housing is provided with an upper guide portion and a lower guide portion which guide movement of the slider;
when the lever is in the mated position, the retain mechanism presses the slider against the lower guide portion to retain the slider in the front end position.

3. The connector as recited in claim 2, wherein:

the press mechanism and the retain mechanism are provided as a spring portion; and
the spring portion is formed on either the slider

or the lever.

4. The connector as recited in claim 3, wherein the spring portion is formed on the lever.

5. The connector as recited in claim 4, wherein:

the lever turns around a shaft;
the shaft has a shaft center;
the spring portion has a tip and a base;
the shaft center of the shaft and the tip of the spring portion define a first distance therebetween;
the shaft center of the shaft and the base of the spring portion define a second distance therebetween; and
the first distance is equal to or shorter than the second distance.

6. The connector as recited in claim 5, wherein:

the teeth of the pinion portion have tips;
the shaft center of the shaft and each of the tips of the teeth of the pinion portion define a third distance therebetween; and
the first distance is equal to or shorter than the third distance.

7. The connector as recited in claim 5 or 6, wherein:

when seen along a right-left direction orthogonal to both of the up-down direction and the front-rear direction, the tip of the spring portion is always hidden behind a part of the housing.

8. The connector as recited in any one of claims 4 to 7, wherein the pinion portion is positioned on a plane same as a plane on that the spring portion is located.

9. The connector as recited in any one of claims 4 to 8, wherein the spring portion is formed integrally with the lever.

10. The connector as recited in any one of claims 1 to 9; wherein:

when the lever is in the mated position, the lever has a middle and a front end in the front-rear direction between which the retain mechanism is positioned.

11. The connector as recited in any one of claims 1 to 10, wherein:

the lever is provided with a releasing portion which releases regulation of the regulated portion caused by the regulating portion; and
the releasing portion is positioned in a middle of the lever in a right-left direction orthogonal to both of the up-down direction and the front-rear direction.

12. The connector as recited in any one of claims 1 to 10, wherein:

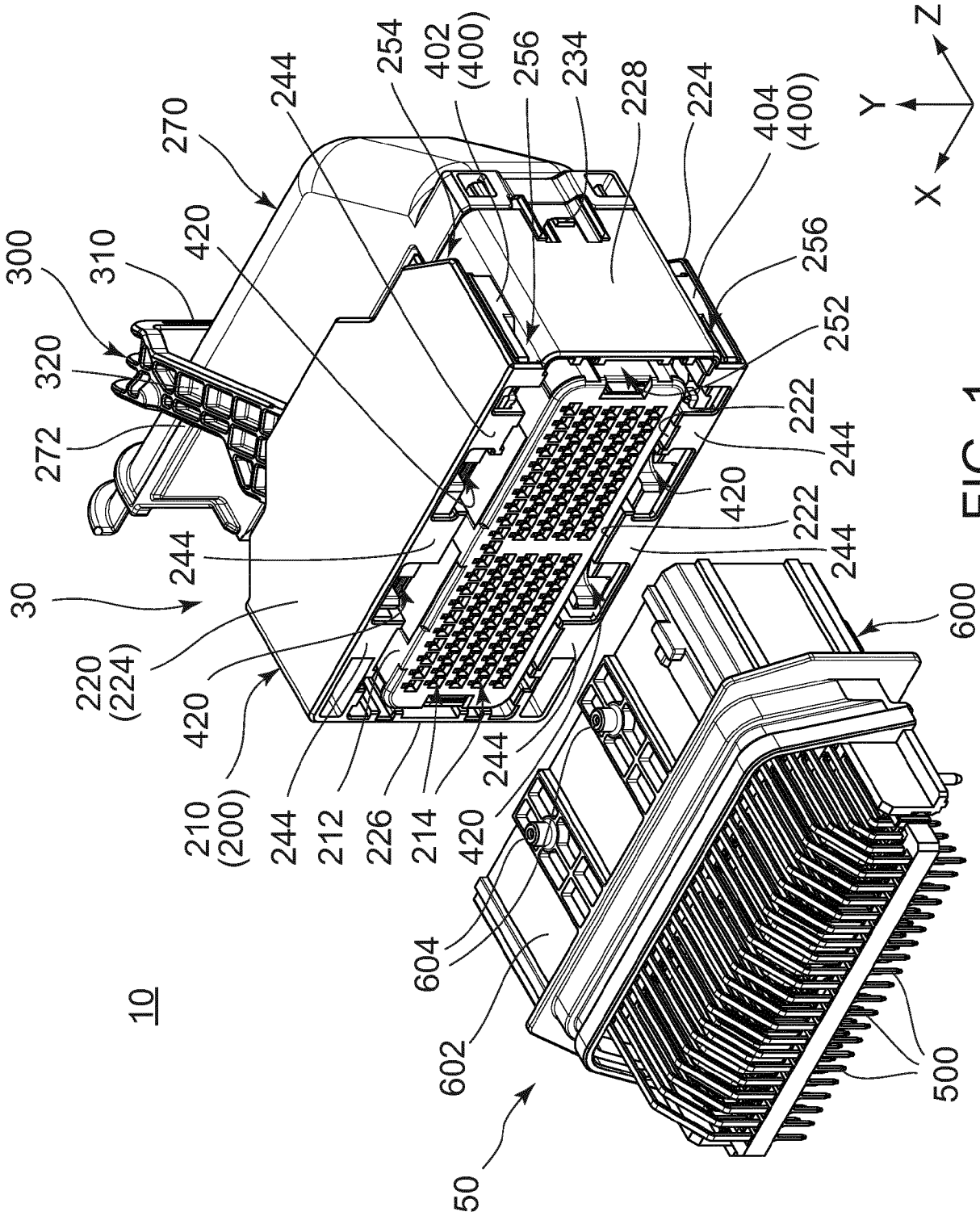
the housing is provided with a releasing portion which releases regulation of the regulated portion caused by the regulating portion; and
the releasing portion is positioned in a middle of the housing in a right-left direction orthogonal to both of the up-down direction and the front-rear direction.

13. The connector as recited in any one of claims 1 to 12, wherein:

the connector has a pair of the sliders, and
the pair of the sliders has two pairs of the force transmission portions.

14. The connector as recited in any one of claims 1 to 13, wherein:

the housing has a housing body and a cover; and
the lever and the slider are attached to the housing body.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222
FIG. 1

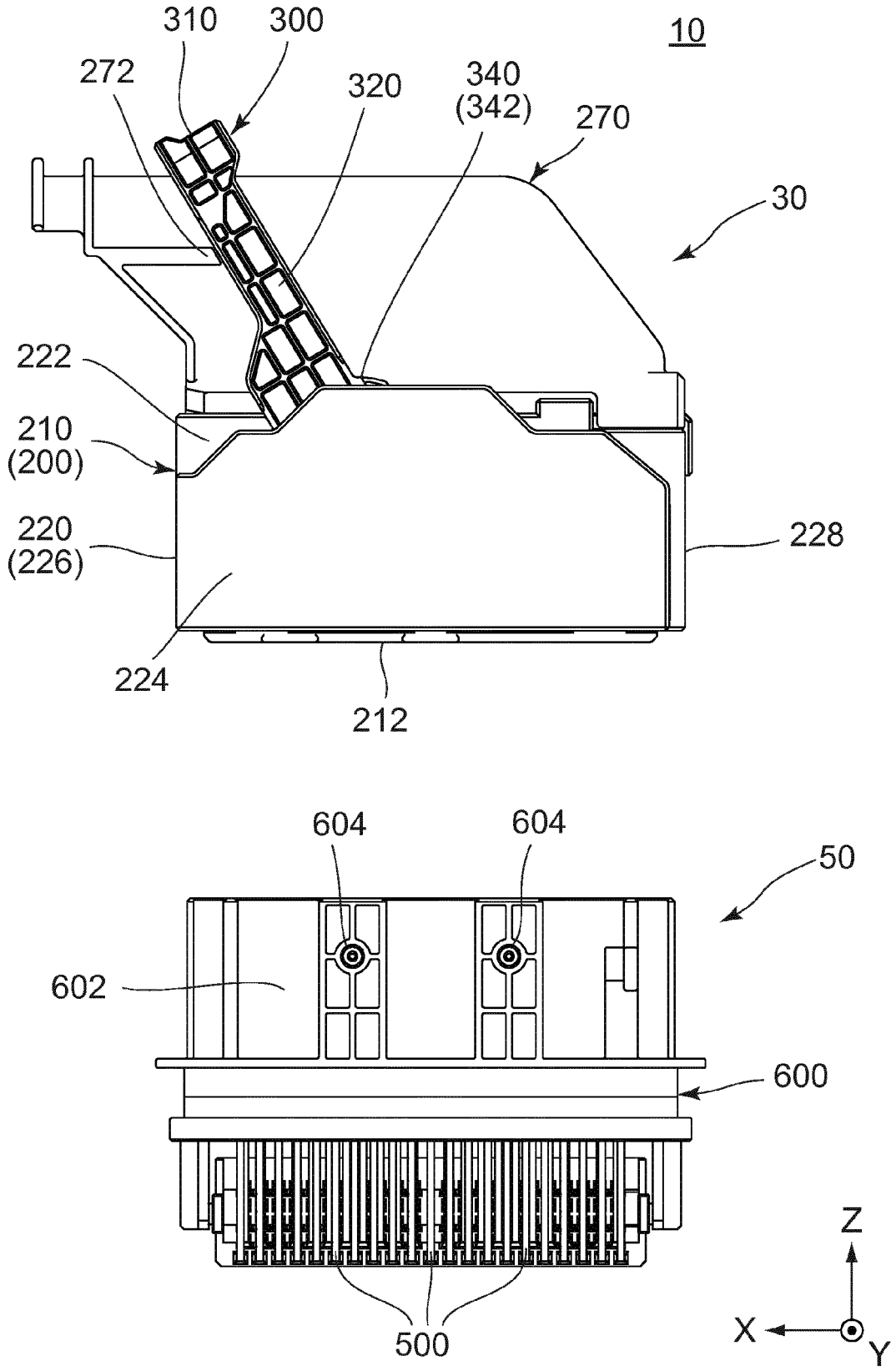
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FIG. 2

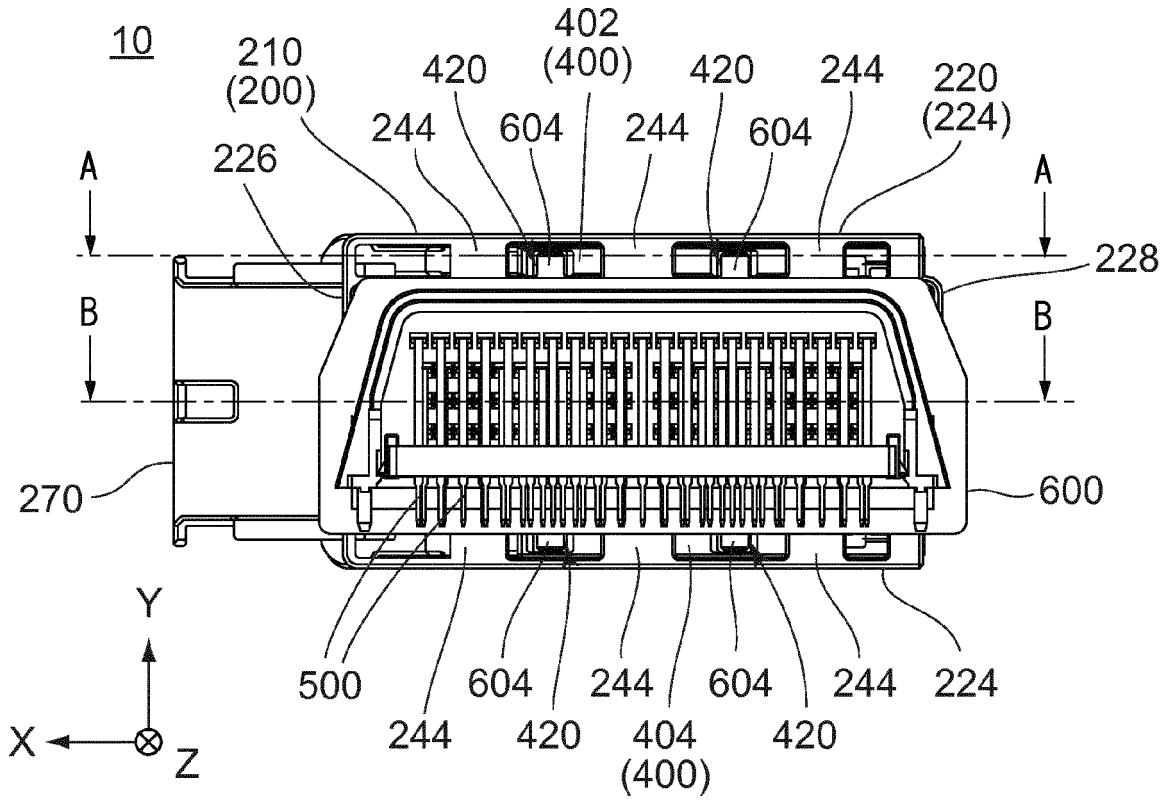
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FIG. 3

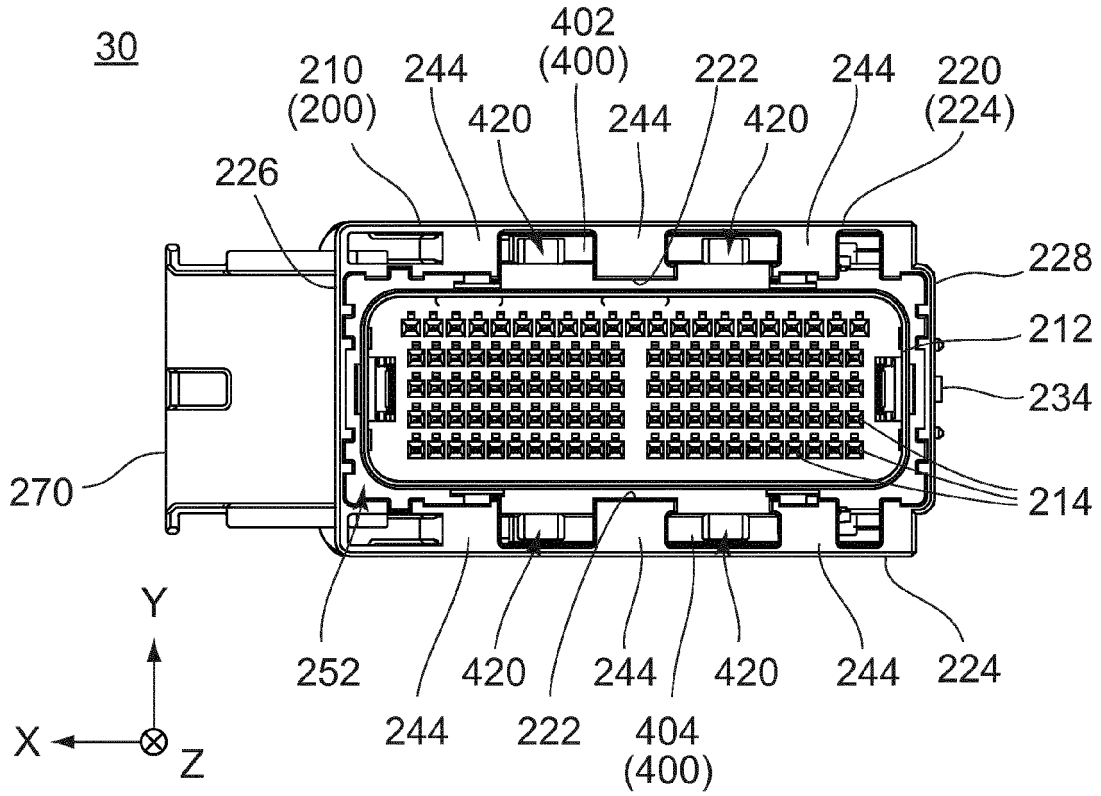
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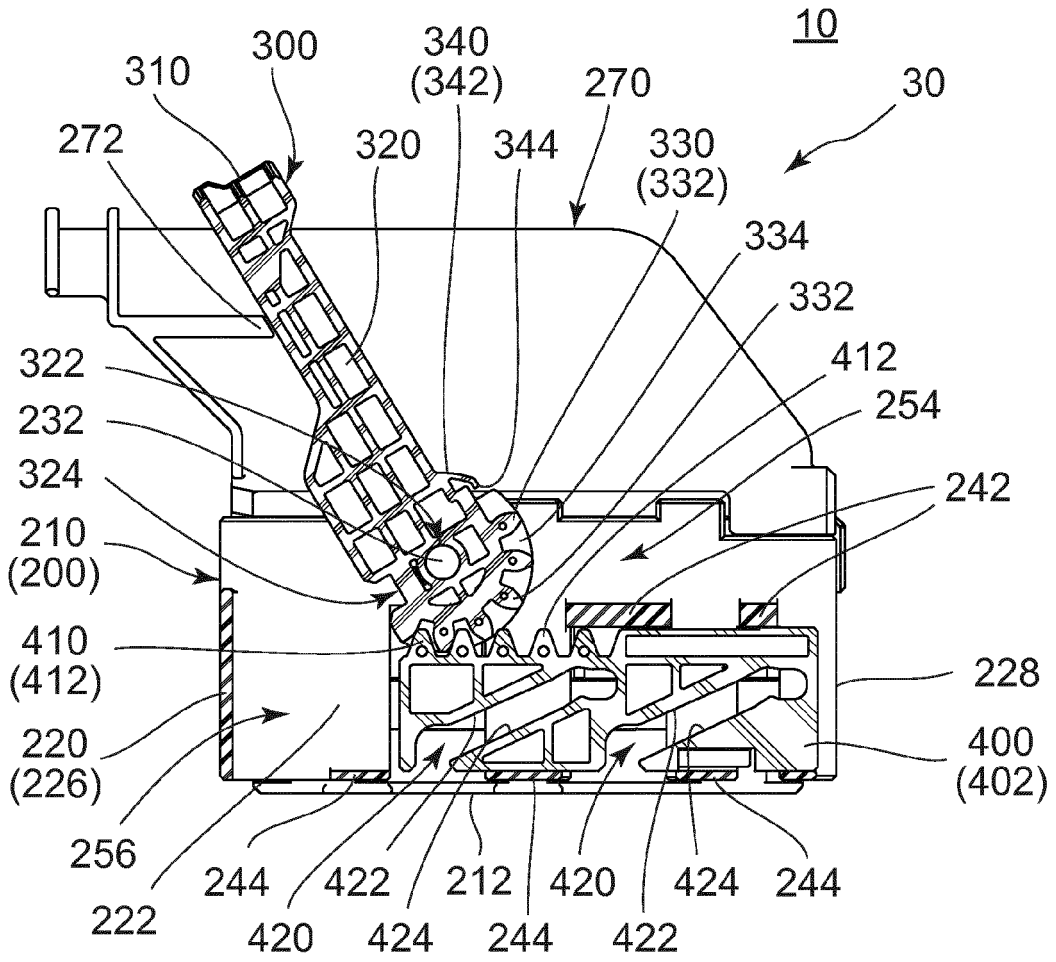
FIG. 4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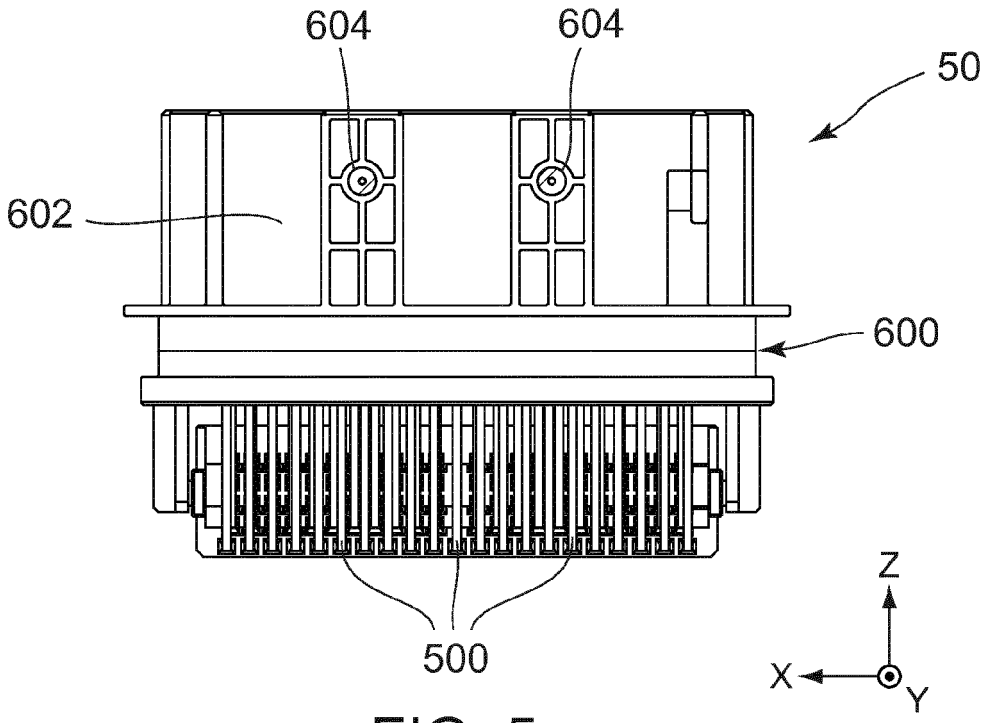
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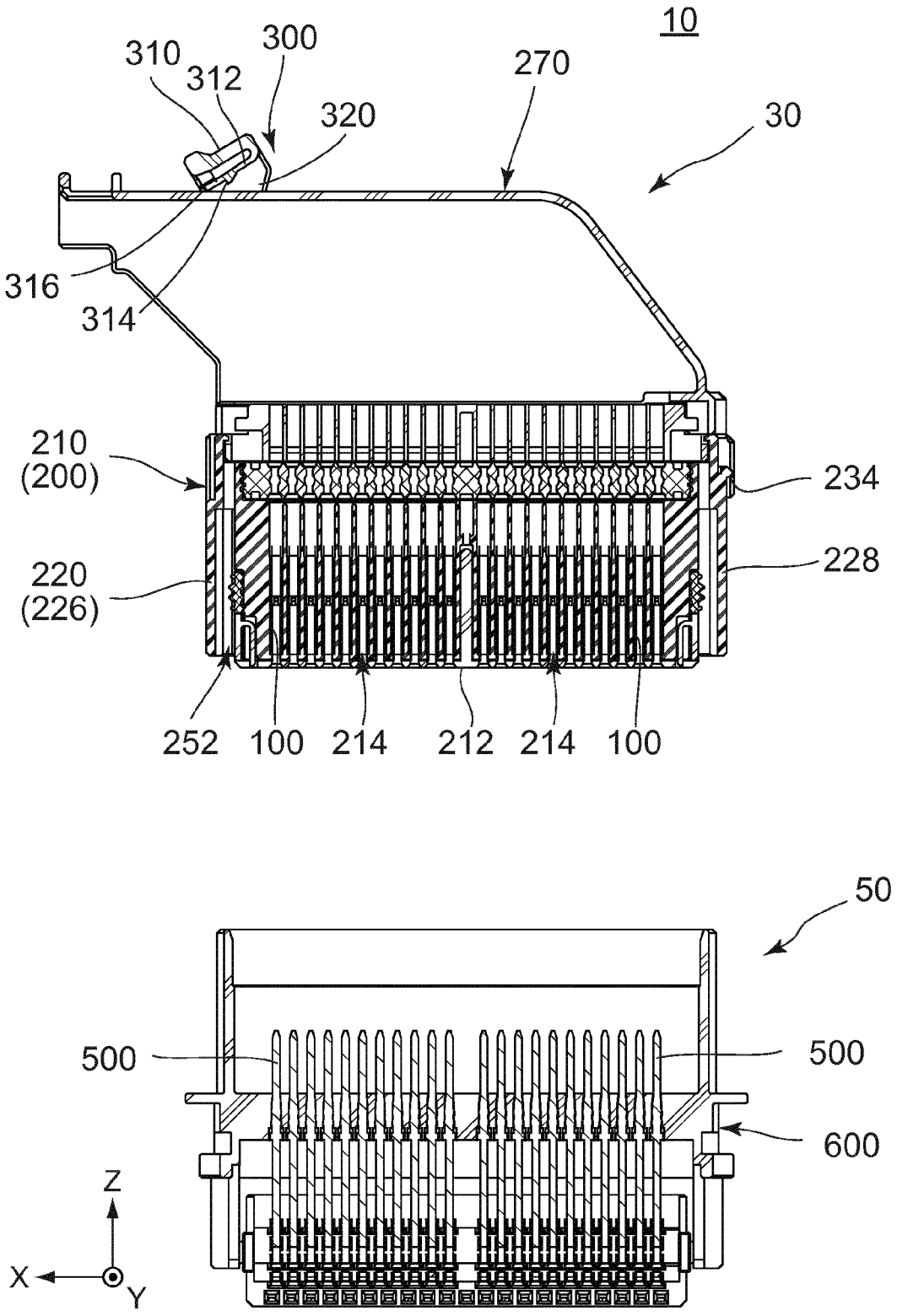
FIG. 5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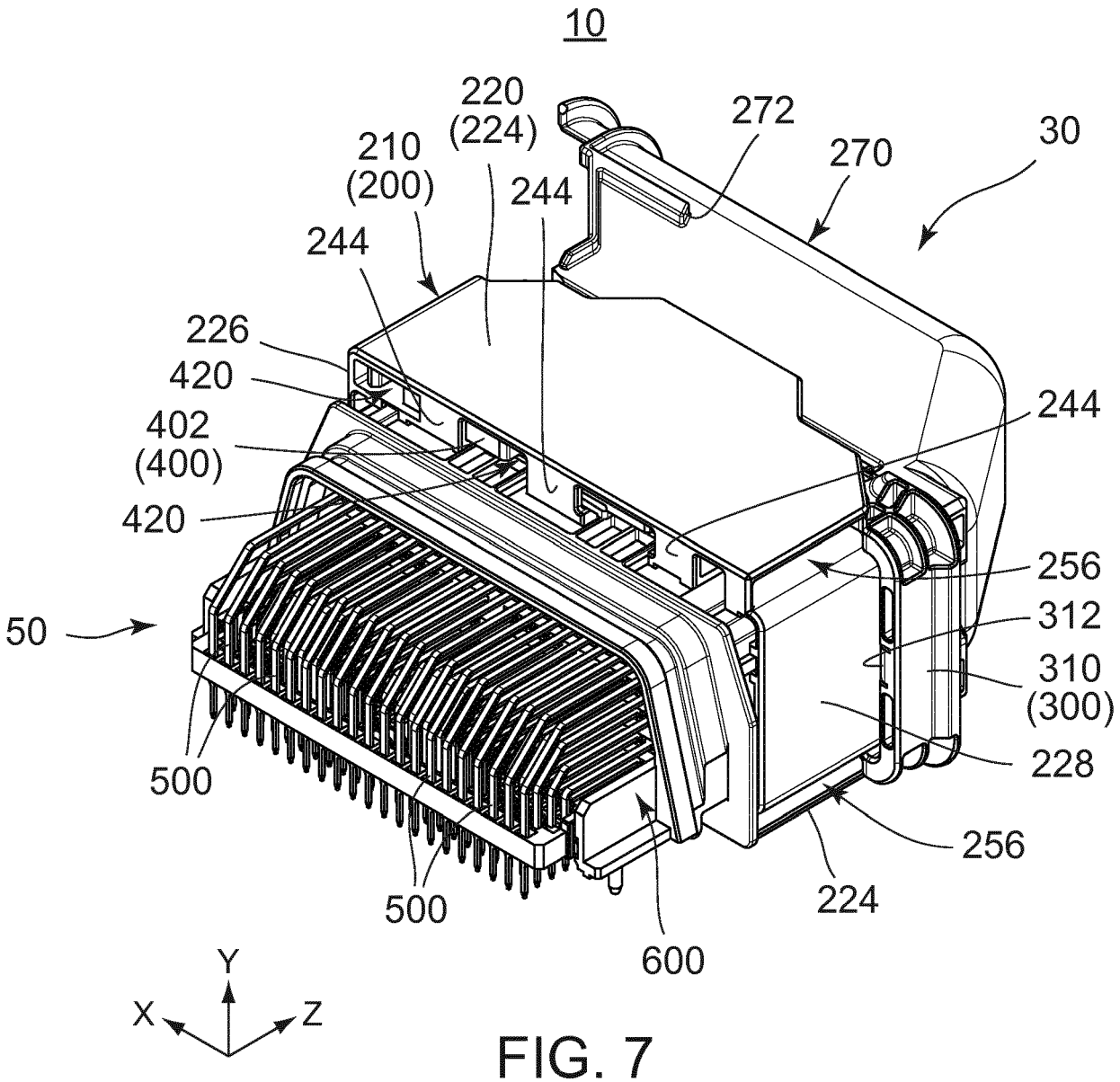
Y

FIG. 6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Z

FIG. 7

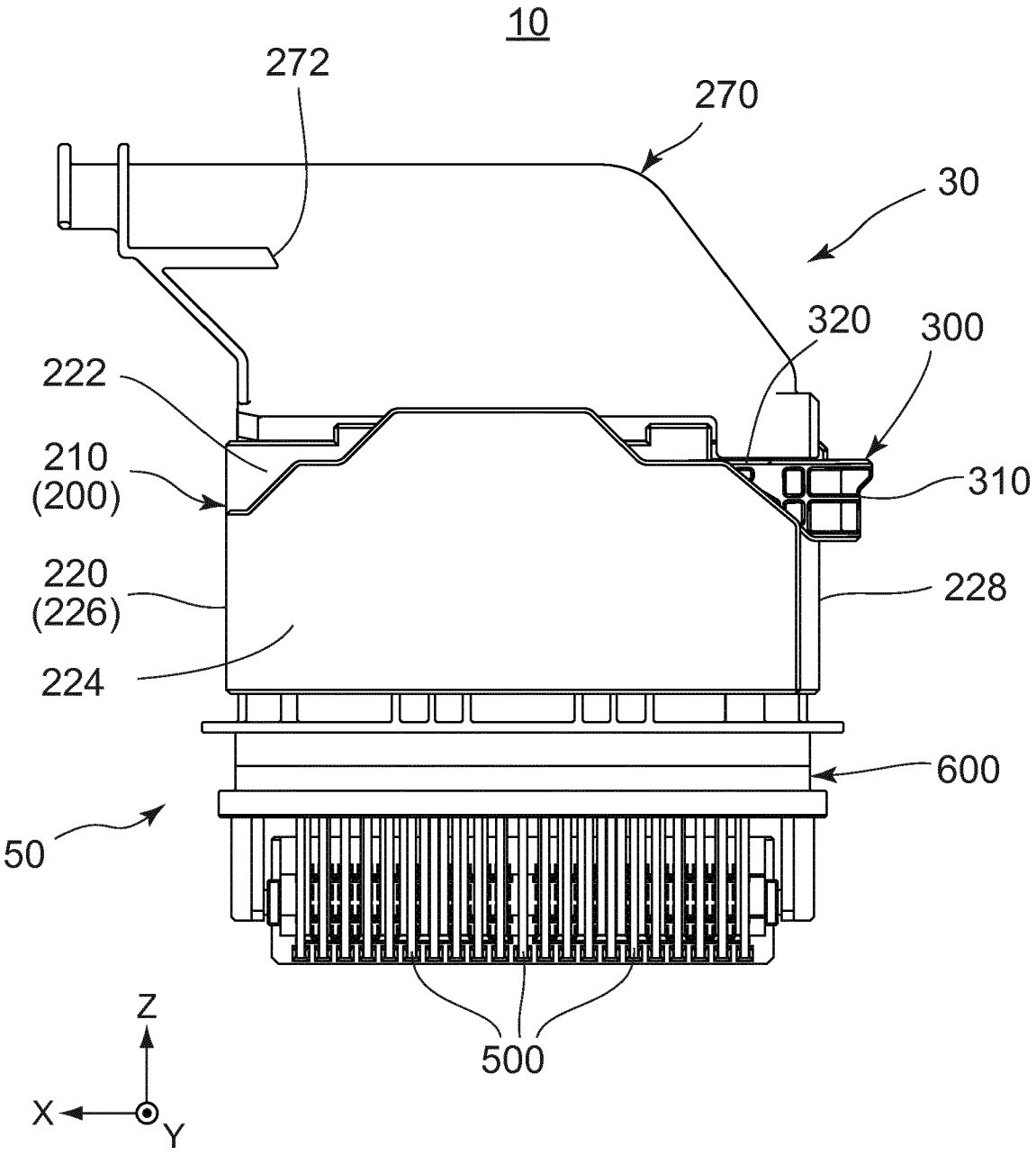
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FIG. 8

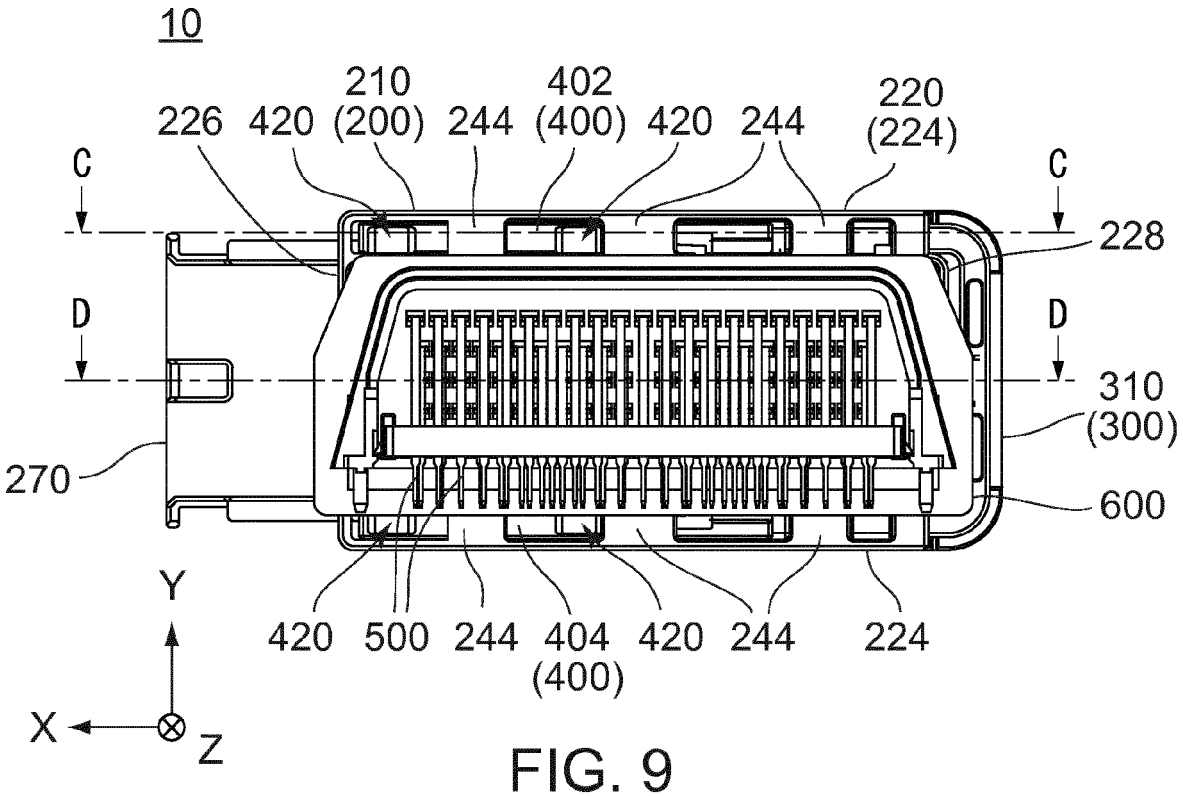
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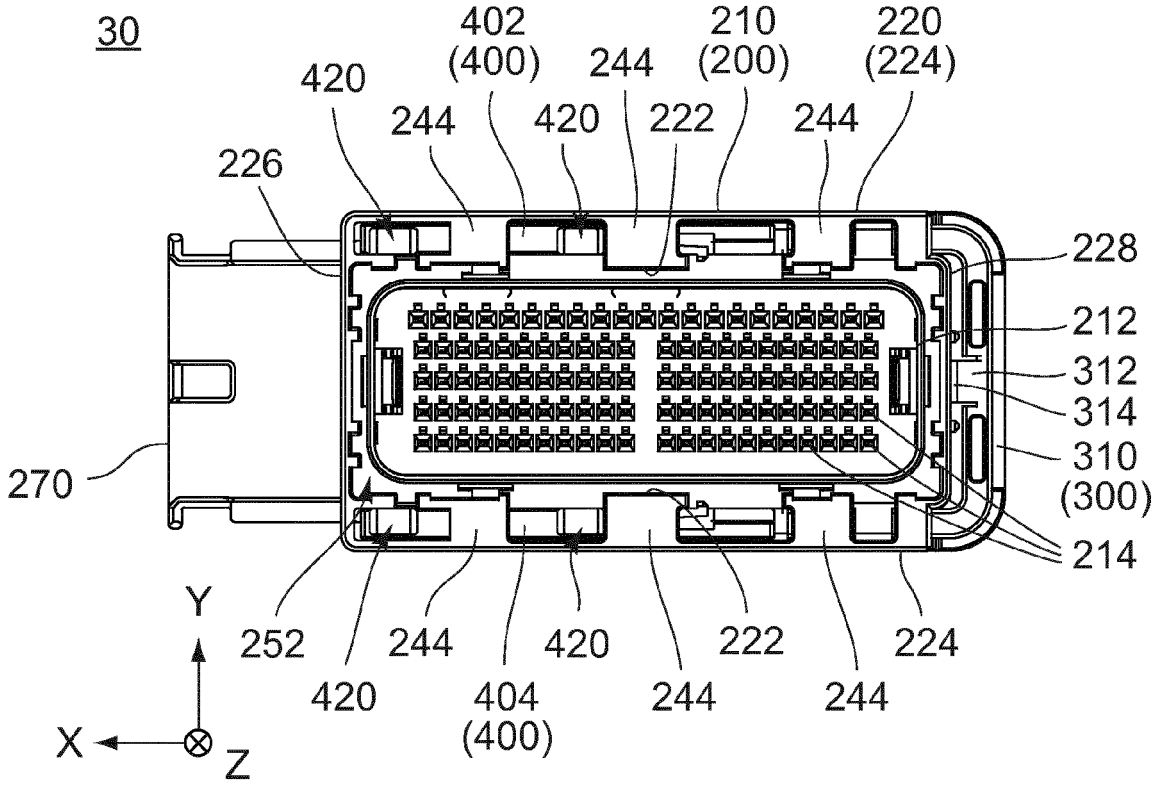
FIG. 9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Z

FIG. 10

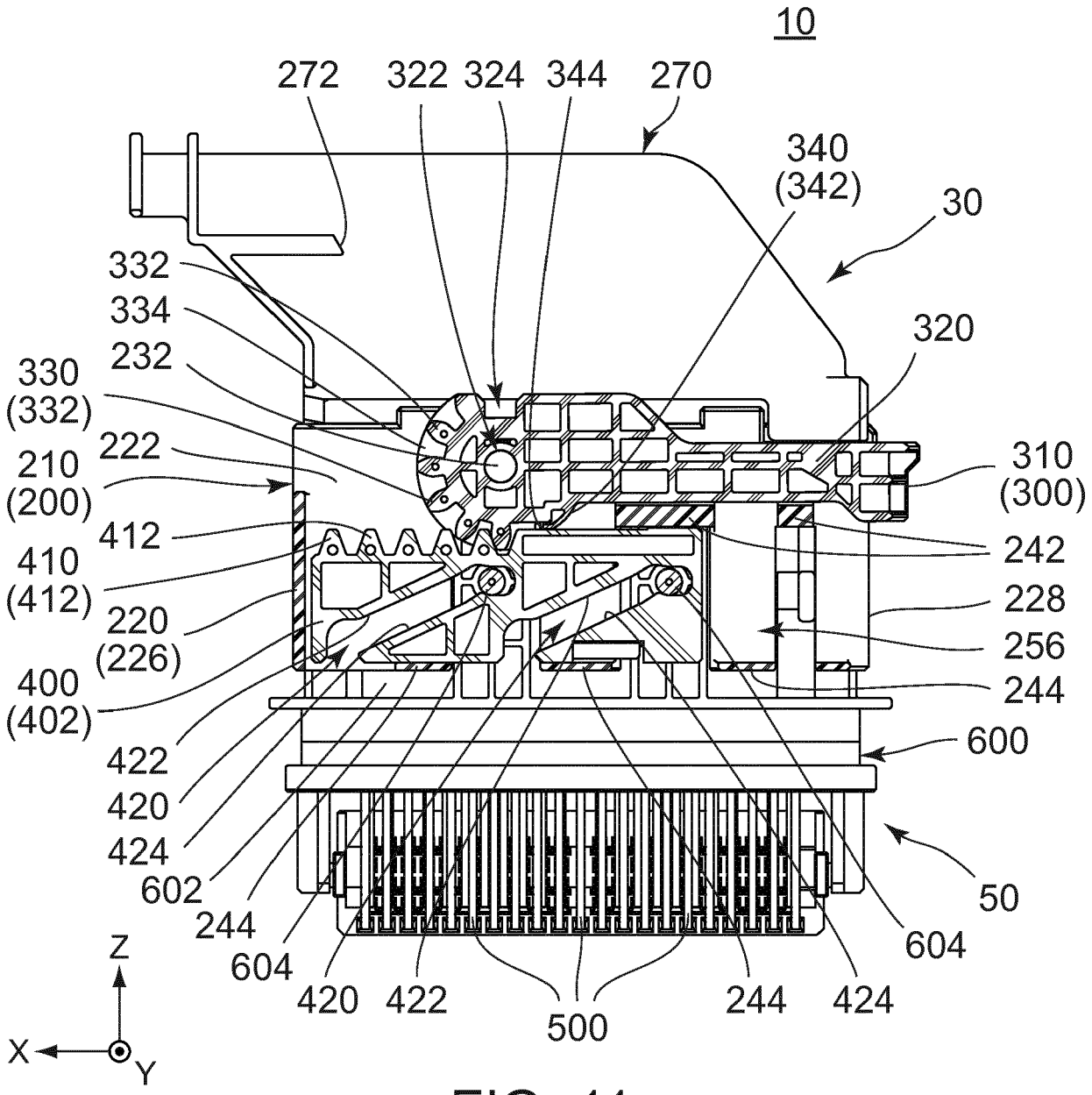
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FIG. 11

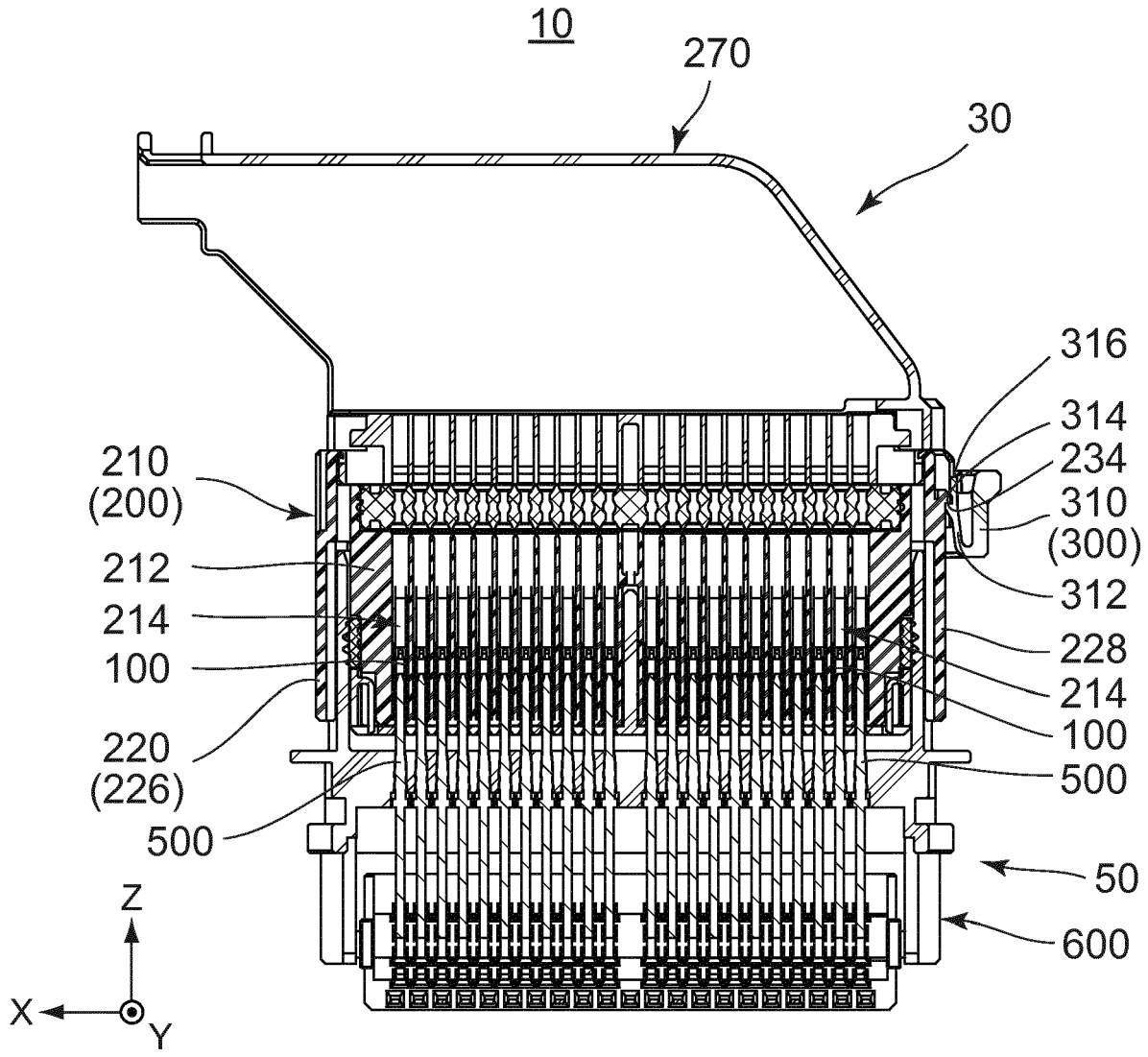
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FIG. 12

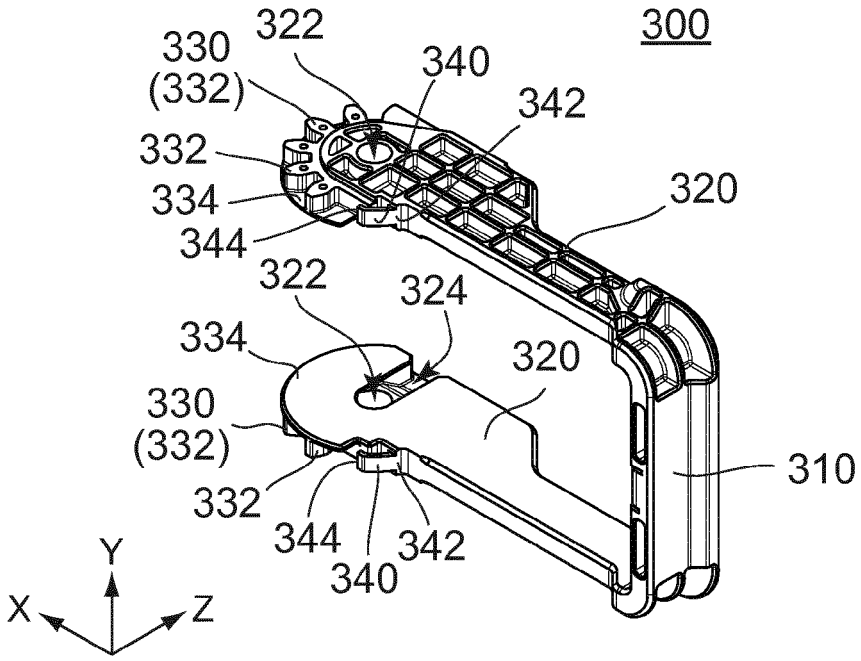
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FIG. 13

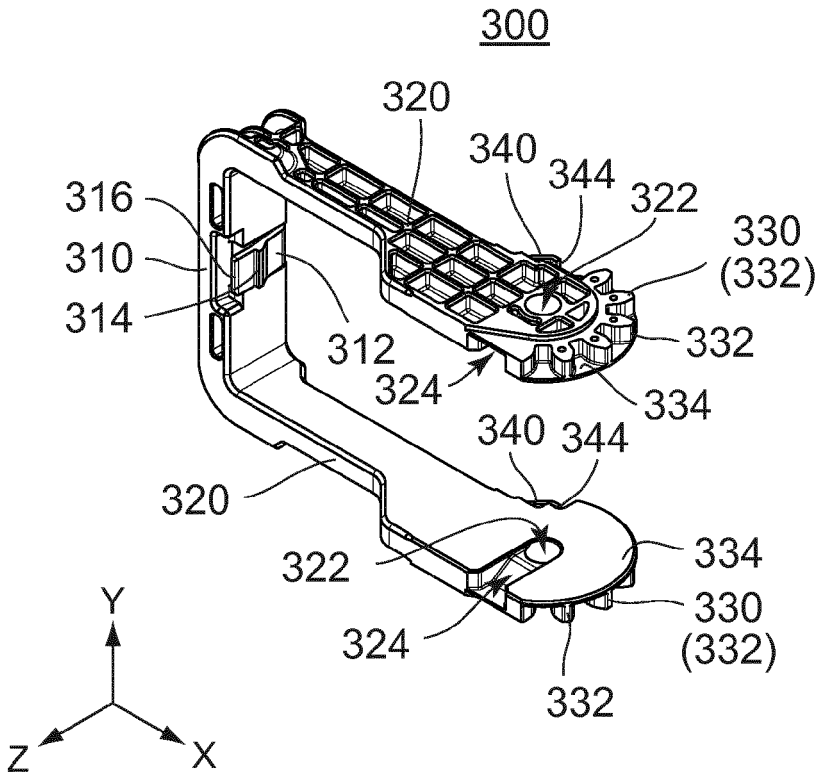
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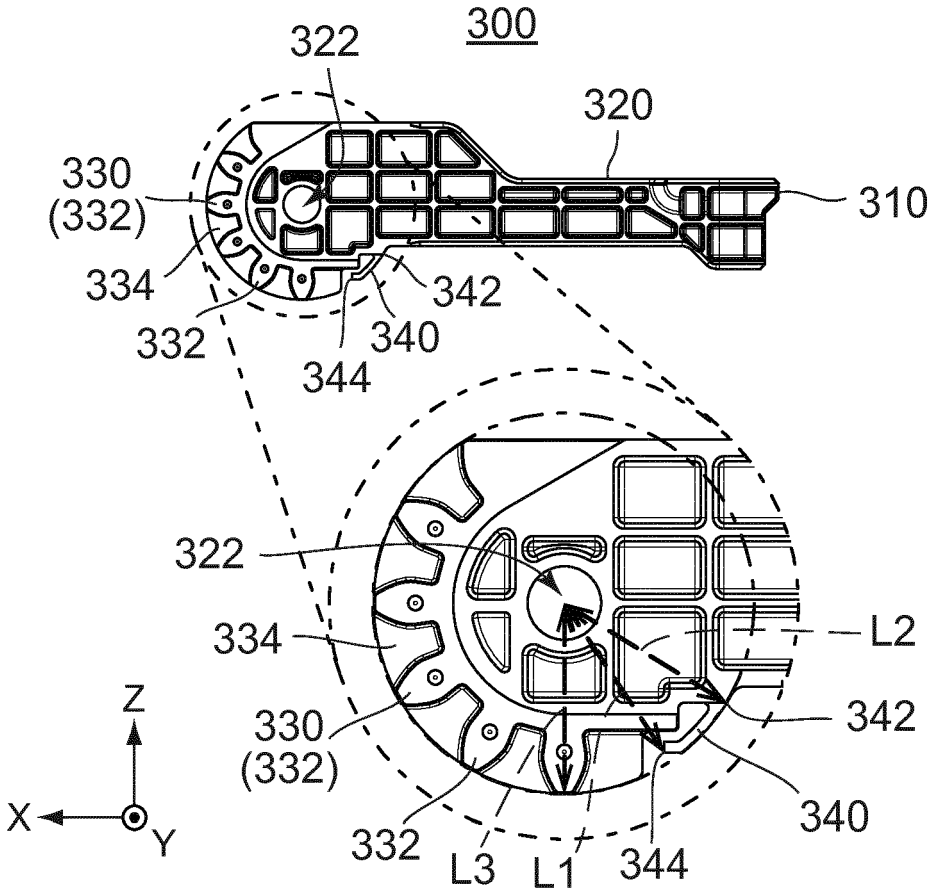
FIG. 14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L3
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Y

FIG. 15

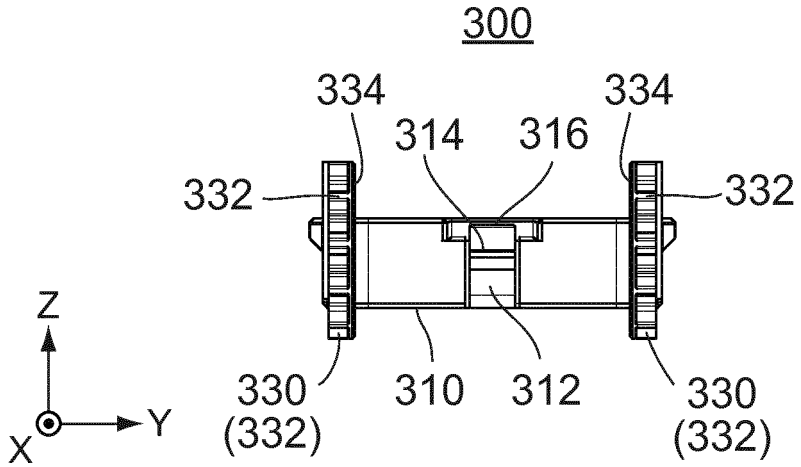
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FIG. 16

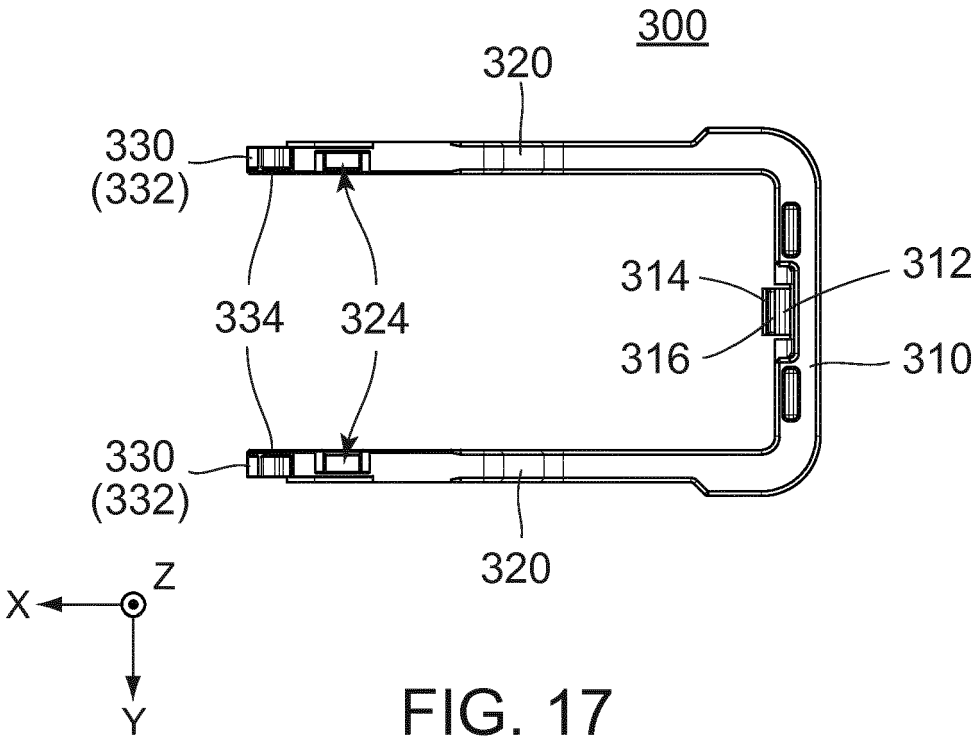
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FIG. 17

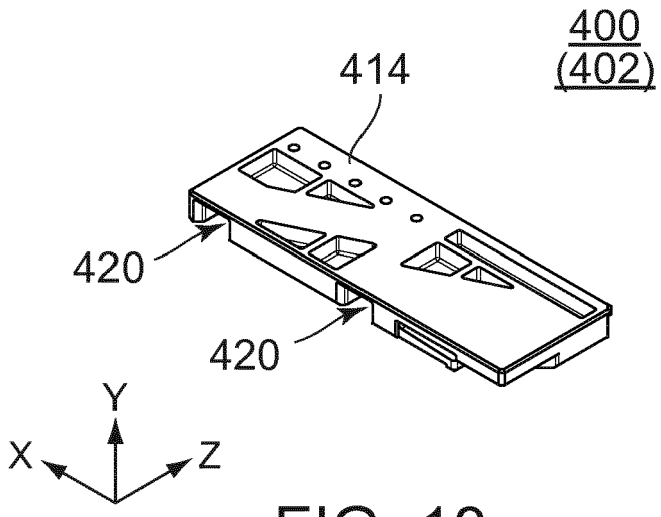
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FIG. 18

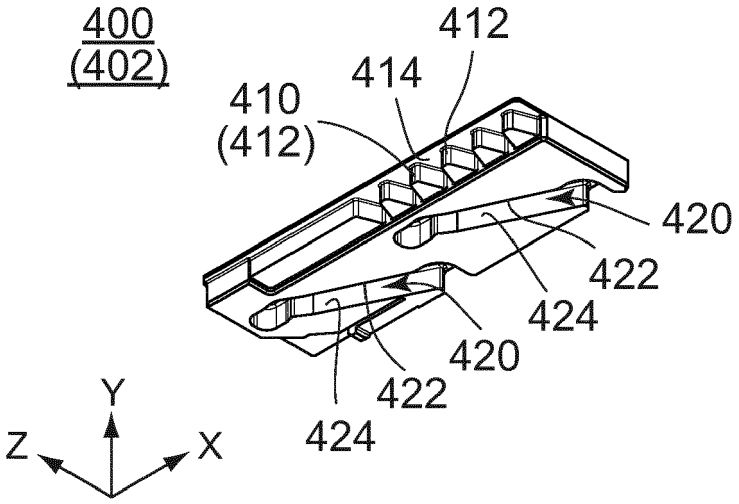
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FIG. 19

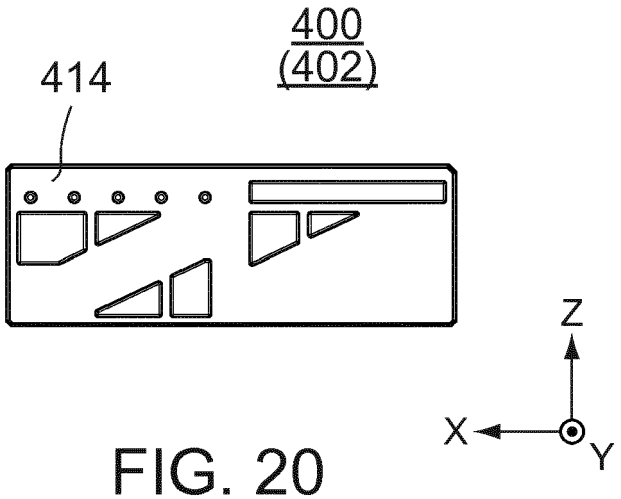
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FIG. 20

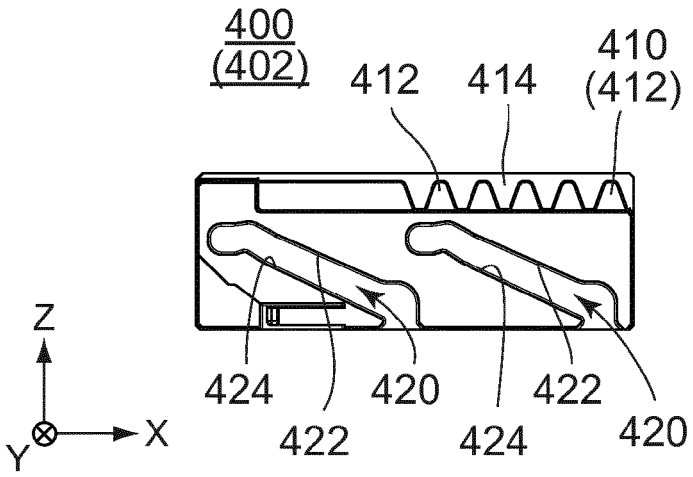
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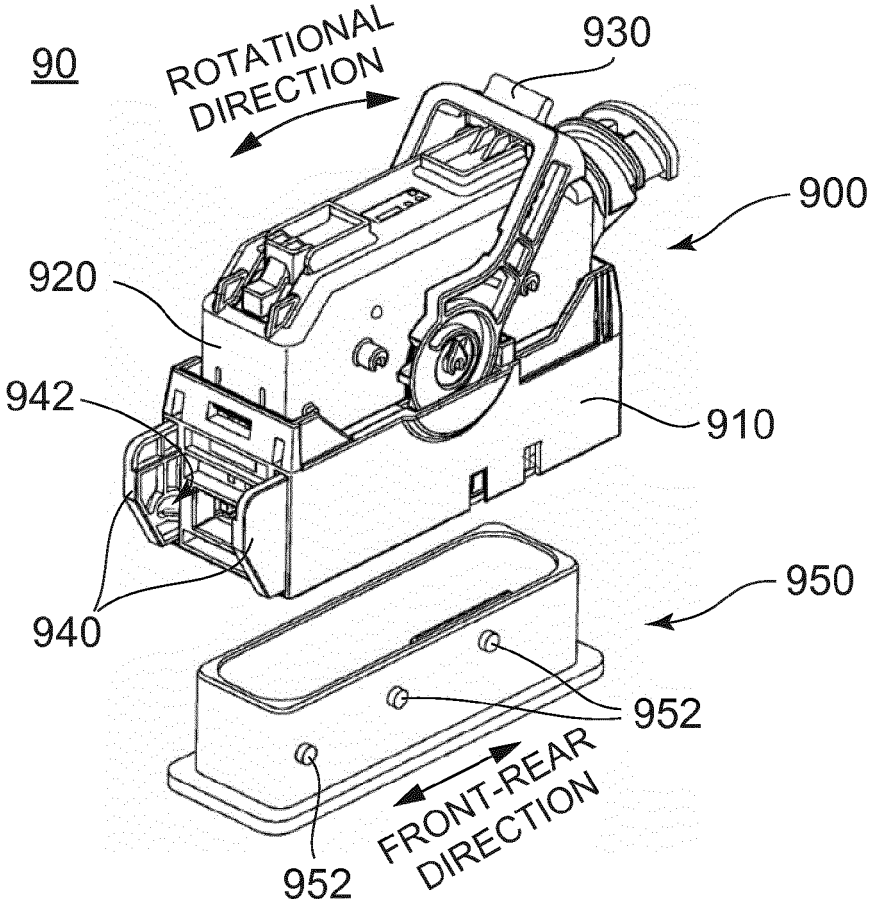
FIG. 21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FRONT-REAR DIRECTION

FIG. 22

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 17 15 9798

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X A	US 2014/134862 A1 (ITOU MASATOSHI [JP] ET AL) 15 May 2014 (2014-05-15) * columns 43,61-66; figures 1,4,13-16 *	1,10-14 2-9	INV. H01R13/629
A	WO 2006/087097 A1 (FRAMATOME CONNECTORS INT [FR]; CIRIELLO TOMMASINO [IT]; STELLA GIOVANN) 24 August 2006 (2006-08-24) * pages 6,7; figure 1 *	1-14	
A	WO 02/078126 A2 (FRAMATOME CONNECTORS INC [FR]; STELLA GIANNI [IT]; PIZZARELLI ROCCO [I) 3 October 2002 (2002-10-03) * the whole document *	1-14	
A	US 2011/034049 A1 (SHISHIKURA SEIJI [JP] ET AL) 10 February 2011 (2011-02-10) * figures 1,9,10 *	1-14	
A	JP 2012 015055 A (SUMITOMO WIRING SYSTEMS) 19 January 2012 (2012-01-19) * figures 1,3 *	1-14	TECHNICAL FIELDS SEARCHED (IPC)
A	JP 2006 331991 A (TYCO ELECTRONICS AMP KK) 7 December 2006 (2006-12-07) * the whole document *	1-14	H01R

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	14 July 2017	Vautrin, Florent

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