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(54) **ELECTRICAL CONNECTOR**

(57) A connector (10) includes a lever (200) and a slider (300). The lever (200) has a pinion portion (230) and a pressed portion (233). The slider (300) has a rack portion (314) and a press portion (317). The pinion portion (230) and the rack portion (314) are engaged with each other to translate turn of the lever (200) to front-rear direction movement of the slider (300). The press portion (317) is visible when only the slider (300) is seen from the front thereof along a front-rear direction. When the lever (200) is positioned in a first position, moving the slider (300) forward makes the press portion (317) press the pressed portion (233) to turn the lever (200) toward a second position. Thus, the pinion portion (230) and the rack portion (314) are engaged with each other.

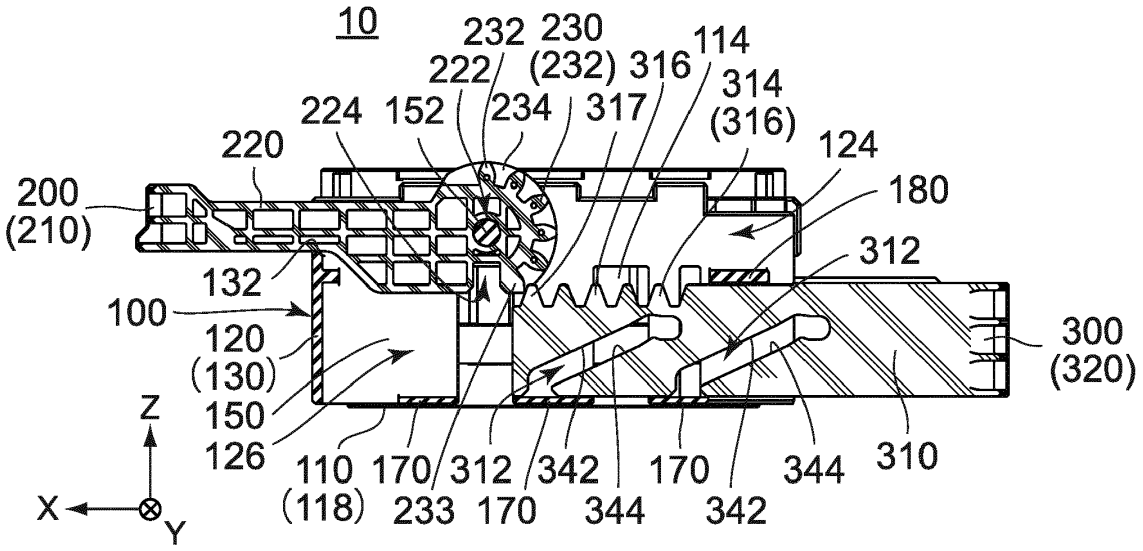

FIG. 8

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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 Figs. 16 and 17, a connector 900 disclosed in JPA2015-122182 (Patent Literature 1) 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. 17, the sliders 940 are formed with a plurality of cam grooves 942 (one of them is shown in Fig. 17). On the other hand, a mating connector 950 is formed with a plurality of bosses 952. The cam grooves 942 correspond to the bosses 952, respectively. When the connector 900 is mated 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 this state, turning the lever 930 in a predetermined direction along the rotational direction moves the sliders 940 in one direction of the front-rear direction and makes the cam grooves 942 move the bosses 952 upward. Thus, the mating connector 950 is drawn toward the connector 900 and mated with the connector 900. Furthermore, 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 of the front-rear direction and moves the bosses 952 downward. Thus, the mating connector 950 is pushed in a direction away from the connector 900 and becomes removable from the connector 900.

SUMMARY OF THE INVENTION:

[0004] In the connector 900 disclosed in Patent Literature 1, the lever 930 is attached to the cover 920 while the sliders 940 are accommodated in the housing 910. Accordingly, attaching the cover 920 to the housing 910 must be executed so that the lever 930 and the sliders 940 are correctly interlocked with each other. Therefore, the connector 900 described in Patent Literature 1 requires that the cover 920 has a structure to maintain the lever 930 in a predetermined lever position and that the housing 910 has a structure to accommodate the sliders 940 in predetermined slider positions. However, in a case where those structures do not correspond to each other with high accuracy, the lever 930 and the sliders 940 cannot be interlocked with each other when the cover 920 is attached to the housing 910. Accordingly, the connector 900 has a possibility that the lever 930 cannot be turned.

[0005] Therefore, it is an object of the present invention to provide a connector having a structure that allows the lever and the slider to be interlocked with each other easily and certainly.

[0006] An aspect of the present invention provides a first connector which is mateable with and removable from a mating connector along an up-down direction. The connector is attached with a cover when used. The mating connector comprises a force receiving portion. The connector comprises a housing, a lever and a slider. The lever is attached to the housing to be rotatable between a first position and a second position in a state before the cover is attached to the housing. The slider is attached to the housing to be movable in a front-rear direction orthogonal to the up-down direction. The lever has a pinion portion and a pressed portion. The pinion portion has a plurality of teeth. The slider has a rack portion, a press portion and a force transmission portion. The rack portion has 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 mutually engaging. The press portion is visible when the slider as a single body is seen from a front thereof along the front-rear direction. The press portion presses the pressed portion to turn the lever toward the second position when the slider is moved forward in the front-rear direction provided that the lever is positioned in the first position. The force transmission portion transmits up-down direction force to the force receiving portion of the mating connector according to the front-rear direction movement of the slider. The lever is regulated by the cover in a state that the cover is attached to the housing so as not to be rotatable toward the first position from a third position positioned between the first position and the second position but to be rotatable between the third position and the second position. When the lever is turned from the third position to the second position, the slider is moved forward in the front-rear direction, and the force transmission portion moves the force receiving portion of the mating connector upward in the up-down direction, and thereby the connector and the mating connector are brought into a mated state. When the lever is turned from the second position to the third position, the slider is moved rearward in the front-rear direction, and the force transmission portion moves the force receiving portion of the mating connector downward in the up-down direction, and thereby the connector and the mating connector are brought into a removable state.

[0007] When the lever is positioned in the first position, moving the slider forward in the front-rear direction makes the press portion of the slider press the pressed portion to turn the lever toward the second position. As a result of this, a relative position between the lever and the slider is decided to be able to engage easily and ap-

propriately the pinion portion of the lever and the rack portion of the slider with each other. Thus, the relationship that the lever and the slider are interlocked with each other is easily and certainly achieved.

[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 an exploded perspective view showing a connector according a first embodiment of the present invention. A cover is not shown in the figure.
Fig. 2 is an exploded bottom plan view showing the connector of Fig. 1.
Fig. 3 is an exploded cross-sectional view showing the connector of Fig. 2, taken along A-A line.
Fig. 4 is an exploded cross-sectional view showing the connector of Fig. 2, taken along B-B line.
Fig. 5 is another exploded perspective view showing the connector of Fig. 1. A lever is attached to a housing and positioned in a first position. The cover is not shown in the figure.
Fig. 6 is a perspective view showing the connector of Fig. 1. The lever is attached to the housing and positioned in the first position. A slider is inserted in the housing in part and positioned in a pressing start position. The cover is not shown in the figure.
Fig. 7 is a bottom plan view showing the connector of Fig. 6.
Fig. 8 is a cross-sectional view showing the connector of Fig. 7, taken along C-C line.
Fig. 9 is another perspective view showing the connector of Fig. 6. The lever is positioned in a second position. The slider is positioned in a mated position. The cover is not shown in the figure.
Fig. 10 is a bottom plan view showing the connector of Fig. 9.
Fig. 11 is a cross-sectional view showing the connector of Fig. 10, taken along D-D line.
Fig. 12 is another perspective view showing the connector of Fig. 9. The housing is attached with the cover.
Fig. 13 is another perspective view showing the connector of Fig. 12. The lever is positioned in a third position. The slider is positioned in a removable position.
Fig. 14 is a bottom plan view showing the connector of Fig. 13.
Fig. 15 is a cross-sectional view showing the connector of Fig. 14, taken along E-E line.
Fig. 16 is an exploded perspective view showing a connector disclosed in Patent Literature 1.
Fig. 17 is a perspective view showing the connector and a mating connector which are disclosed in Patent Literature 1.

[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 to 3, a connector 10 according to a first embodiment of the present invention is provided with a housing 100, a lever 200 and a slider 300. The connector 10 further has a plurality of contacts not shown. The connector 10 is a connector that is mateable with and removable from a mating connector, which is not shown, along an up-down direction. As shown in Figs. 12 to 15, the connector 10 is attached with a cover 400 when used. 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] As understood from Figs 1 and 2, the housing 100 has a contact holding portion 110 and a wall portion 120 surrounding a periphery of the contact holding portion 110. As understood from Figs. 1 to 4, the contact holding portion 110 has an approximately rectangular parallelepiped shape which is long in a front-rear direction orthogonal to the up-down direction. In the present embodiment, the front-rear direction is an X-direction. A positive X-direction is forward while a negative X-direction is rearward. As shown in Figs. 1, 2 and 4, the contact holding portion 110 is further provided with a plurality of holding holes 112. As shown in Fig. 4, the holding holes 112 pierce the contact holding portion 110 and open in both of an upper surface 116 and a lower surface 118 of the contact holding portion 110. The holding holes 112 are used for holding the contacts not shown. In detail, the contacts are held in the holding holes 112 of the contact holding portion 110, respectively. The contacts are connected with wirings not shown, respectively. The wirings are routed upward from above the upper surface 116 of the contact holding portion 110. The contacts are visible from under the lower surface 118 of the contact holding portion 110. In the present embodiment, the connector 10 is a socket connector.

[0013] As understood from Figs. 1 to 4, the wall portion 120 has a front wall 130, a rear wall 140, a pair of inner sidewalls 150 and a pair of outer sidewalls 160. The wall portion 120 further has a plurality of bottom plates 170 and a plurality of connection portions 180. The front wall

130 covers a front surface 113 of the contact holding portion 110 and connects front ends of the inner sidewalls 150 and front ends of the outer sidewalls 160 with one another. The rear wall 140 covers a back surface 115 of the contact holding portion 110 and connects rear ends of the inner sidewalls 150 with each other. The inner sidewalls 150 cover side surfaces 114 of the contact holding portion 110 at least in part. As shown in Figs. 2 to 4, each of the inner sidewalls 150 is provided with a rotational shaft 152 protruding outward in a right-left direction orthogonal to both of the front-rear direction and the up-down direction. In the present embodiment, the right-left direction is a Y-direction. As shown in Fig. 4, the outer sidewalls 160 are located apart from and outward of the inner sidewalls 150 in the right-left direction. The outer sidewalls 160 cover not only the inner sidewalls 150 but also the side surfaces 114 of the contact holding portion 110 in part.

[0014] As understood from Fig. 4, the pair of the inner sidewalls 150 is connected to the contact holding portion 110 at an upper side than a middle of the contact holding portion 110 in the up-down direction. Similarly, the front wall 130 and the rear wall 140 are connected to the contact holding portion 110. As understood from Figs 1, 2 and 4, a receiving portion 122 is formed between the contact holding portion 110 and the surrounding walls, i. e. the front wall 130, the rear wall 140 and the pair of the inner sidewalls 150, and is positioned below connecting parts between the contact holding portion 110 and surrounding walls. The receiving portion 122 receives a mating housing (not shown) of the mating connector in part when the connector is mated with the mating connector. As understood from Figs. 1 to 4, between the inner sidewalls 150 and the outer sidewalls 160, lever accommodation portions 124 and slider accommodation portions 126 are formed. Each of the lever accommodation portions 124 accommodates the lever 200 in part so that the lever 200 is rotatable. Each of the slider accommodation portions 126 accommodates the slider 300 in part so that the slider 300 is movable in the front-rear direction. The lever accommodation portions 124 and the slider accommodation portions 126 communicate with each other in the up-down direction except for some parts.

[0015] As understood from Figs. 1, 2 and 4, each of the bottom plates 170 connects a lower end of the inner sidewall 150 to a lower end of the outer sidewall 160 adjacent thereto. As understood from Figs. 1 to 4, the bottom plates 170 function as guides when the slider 300 accommodated in the slider accommodation portions 126 in part is moved in the front-rear direction. As understood from Figs. 1, 3 and 4, each of the connection portions 180 is located on a boundary between the lever accommodation portion 124 and the slider accommodation portion 126 and connects between the inner sidewall 150 and the outer sidewall 160 which are adjacent to each other. The connection portions 180 function as guides together with the bottom plates 170 when the slider 300 accommodated in the slider accommodation portions 126 in part is moved in the front-rear direction.

[0016] The front wall 130, the rear wall 140, the inner sidewalls 150, the outer sidewalls 160, the bottom plates 170 and the connection portions 180 are integrally molded using a resin (a third resin). This is for reducing the number of parts, simplifying the manufacturing process and reducing a manufacturing cost. The wall portion 120 may be molded integrally with at least a part of the contact holding portion 110 using a common material. As shown in Fig. 4, the wall portion 120 is molded integrally with a part of the contact holding portion 110 using a common material in the present embodiment. It should be noted that the contact holding portion 110 consists of three parts made of three different materials, respectively. The three parts forming the contact holding portion 110 are stacked on one another in the up-down direction and integrated.

[0017] As shown in Figs. 1 to 4, the lever 200 has an operation portion 210 and a pair of arm portions 220. The operation portion 210 extends in the right-left direction. The arm portions 220 extend from both ends of the operation portion 210 in a direction orthogonal to the right-left direction. As understood from Figs. 1 and 3, the lever 200 is partly reduced in thickness to reduce weight thereof in the present embodiment. Accordingly, the lever 200 has a lattice pattern on a surface thereof.

[0018] As shown in Figs. 1, 3 and 4, each of the arm portions 220 is formed with a shaft hole 222 piercing the arm portion 220 in the right-left direction at a vicinity of an end of the arm portion 220. Furthermore, each of the arm portions 220 is formed with a guide groove 224 extending from an edge of the arm portion 220 to the shaft hole 222 in an inner surface thereof in the right-left direction. The guide grooves 224 extend in a direction orthogonal to the extending direction of the arm portions 220. In other words, the guide grooves 224 extend in the up-down direction when the arm portions 220 extend in the front-rear direction. The guide grooves 224 guide the rotational shafts 152 provided to the housing 100 to the shaft holes 222 upon attaching of the lever 200 to the housing 100.

[0019] As understood from Figs. 1, 2 and 4, each of the arm portions 220 further has a pinion portion 230 having a plurality of teeth 232. The teeth 232 are arranged to surround partly a periphery of the shaft hole 222 when seen along the right-left direction. As mentioned later, one of the teeth 232 functions as a pressed portion 233. As shown in Figs. 1 and 3, each of the arm portions 220 further has a plate-like member 234 connecting the teeth 232 of the pinion portion 230 to one another to reinforce the teeth 232. The plate-like member 234 is provided on one of side surfaces of the pinion portion 230. In other words, the plate-like members 234 are located inward of two sets of the teeth 232 in the right-left direction. The operation portion 210, the arm portions 220, the pinion portions 230 and the plate-like members 234 are integrally molded using a resin (a first resin). This is for reducing the number of parts, simplifying the manufacturing process and reducing a manufacturing cost. The first res-

in may be same as or different from the third resin.

[0020] As shown in Figs. 1 to 4, the slider 300 has a pair of side plate portions 310 and a connection plate portion 320. The side plate portions 310 extend in the front-rear direction. The connection plate portion 320 connects rear ends of the side plate portions 310 to each other. As shown in Fig. 1, the slider 300 is partly reduced in thickness to reduce weight thereof in the present embodiment. Accordingly, the slider 300 has a lattice pattern on a surface thereof.

[0021] As shown in Figs. 1 to 3, the slider 300 is provided with two pairs of cam grooves (force transmission portions) 312 in the side plate portions 310 thereof. One of the pairs of the cam grooves 312 and the other pair of the cam grooves 312 are located apart from each other in the front-rear direction. In other words, each of the side plate portions 310 is formed with two of the cam grooves 312 which belong to different pairs and are apart from each other in the front-rear direction. Each of the cam grooves 312 opens downward at one end (a lower end) thereof. The cam groove 312 extends upward from the one end, then diagonally extends rearward and upward and further extends rearward. In the present embodiment, the cam groove 312 pierces the side plate portion 310 in the right-left direction except for a part (a lower end portion) of the side plate portion 310. However, the cam groove 312 may be closed at a side located outside of the slider 300 in the right-left direction. In other words, the cam groove 312 may be a groove having a bottom.

[0022] As shown in Figs. 1 and 3, each of the side plate portions 310 further has a rack portion 314 having a plurality of teeth 316 arranged along the front-rear direction. The side plate portion 310 further has a plate-like member 318 connecting the teeth 316 of the rack portion 314 to one another to reinforce the teeth 316. The plate-like members 318 are provided on outside surfaces of two sets of the teeth 316 in the right-left direction. The rack portion 314 is formed in a vicinity of an upper front end of the side plate portion 310. When the slider 300 as a single body is seen from the front thereof, the tooth 316 positioned in the most forward position is visible. As mentioned later, the tooth 316 positioned in the most forward position functions as a press portion 317. The side plate portions 310, the connection plate portion 320, the rack portions 314 and the plate-like members 318 are integrally molded using a resin (a second resin). This is for reducing the number of parts, simplifying the manufacturing process and reducing a manufacturing cost. The second resin may be same as at least one of the first resin and the third resin or may be different from both of the first resin and the third resin.

[0023] Next, the description will be made for assembling the connector 10. At first, the lever 200 is attached to the housing 100 as shown in Fig. 5. In detail, the rotational shafts 152 of the housing 100 are inserted into the guide grooves 224 of the lever 200 from one end of the guide grooves 224, and the lever 200 is pressed toward the housing 100. At this time, it is desirable that the lever 200 takes a position so that the arm portions 220 extend in the front-rear direction. This is because it becomes easy to attach the lever 200 to the housing 100 since the guide grooves 224 extend in the up-down direction. When the lever 200 is pressed toward housing 100, the rotational shafts 152 are guided by the guide grooves 224 and inserted into the shaft holes 222. With reference to Fig. 4, each of the guide grooves 224 is provided with a slope portion 226. The slope portion 226 is formed so that the guide groove 224 becomes shallower towards the shaft hole 222. Consequently, upon attaching the lever 200 to the housing 100, the rotational shafts 152 enlarge gradually the arm portions 220 of the lever 200 in the right-left direction and thereby deforming elastically the lever 200 and the housing 100. As a result, the rotational shafts 152 are inserted in the shaft holes 222. Once the rotational shafts 152 are inserted into the shaft holes 222, the lever 200 and the housing 100 return to original shapes. Accordingly, the rotational shafts 152 cannot come out from the shaft holes 222 easily.

[0024] As understood from Figs. 8 and 11, in a state that the lever 200 is attached to the housing 100, the lever 200 is rotatable about the rotational shafts 152 between a first position and a second position. As shown in Fig. 8, the first position is a position where the arm portions 220 extends along the front-rear direction approximately and the operation portion 210 is positioned forward. As shown in Fig. 11, the second position is a position where the arm portions 220 extend along the front-rear direction approximately and the operation portion 210 is positioned rearward. When the lever 200 is positioned in the first position, the arm portion 220 is supported by the front wall 130. In other words, the front wall 130 of the housing 100 is formed with a stopper 132 to stop the lever 200 in the first position. The stopper 132 is molded integrally with at least a part of the housing 100 (the wall portion 120). This is for reducing the number of parts. On the other hand, when the lever 200 is positioned in the second position, front edges of the side plate portions 310 of the slider 300 are brought into abutment with the front wall 130. Thus, in a state that the cover 400 is not attached to the housing 100 yet, the lever 200 is attached to the housing 100 to be rotatable between the first position and the second position. When the lever 200 is positioned in the second position, the guide grooves 224 extend in the up-down direction and open upward. Accordingly, in this state, the lever 200 cannot be detached from the housing 100. Moreover, the operation portion 210 is formed with a hook 212 to maintain the lever 200 in the second position. On the other hand, the housing 100 is formed with a stop portion 142 corresponding to the hook 212. When the lever 200 is positioned in the second position, the hook 212 is caught in the stop portion 142. Unless the hook 212 is operated, the lever 200 cannot turn toward the first position from the second position.

[0025] Next, as shown in Figs. 6 to 8, the side plate portions 310 of the slider 300 are inserted into the slider

accommodation portions 126 of the housing 100 in a state that the lever 200 is positioned in the first position. The side plate portions 310 of the slider 300 are inserted forward from behind the housing 100. At this time, the bottom plates 170 and the connection portions 180 serves as guides to guide the side plate portions 310. In a state that the side plate portions 310 are partly accommodated in the slider accommodation portions 126, when the slider 300 is moved forward in the front-rear direction, the tooth 316 positioned in the most forward position among the teeth 316 (the press portion 317) of each of the rack portions 314 is brought into abutment with the tooth 232 nearest to the guide groove 224 among the teeth 232 (the pressed portion 233) of each of the pinion portions 230 as shown in Fig. 8. At this time, the slider 300 is in a pressing start position. In other words, the tooth 316 positioned in the most forward position among the teeth 316 of each of the rack portions 314 functions as the press portion 317, and the tooth 232 nearest to the guide groove 224 among the teeth 232 of each of the pinion portions 230 functions as the pressed portion 233. Thus, the slider 300 has the press portions 317 while the lever 200 has the pressed portions 233 in the present embodiment.

[0026] As understood from Fig. 8, when the slider 300 positioned in the pressing start position is further moved forward, the press portions 317 press the pressed portion 233 to turn the lever 200 toward the second position. Consequently, the rack portions 314 and the pinion portions 230 are engaged with each other to bring a state that the lever 200 and the slider 300 can be interlocked with each other. In that state, turning the lever 200 moves the slider 300 in the front-rear direction and, on the other hand, moving the slider 300 in the front-rear direction turns the lever 200. Thus, in the present embodiment, by merely inserting the slider 300 into the slider accommodation portions 126 of the housing 100 when the lever 200 is positioned in the first position, relative positions of the lever 200 and the slider 300 are defined so that the rack portions 314 and the pinion portions 230 can be appropriately engaged with each other. In other words, the pinion portions 230 of the lever 200 and the rack portions 314 of the slider 300 are engaged with each other and thereby forming a relation that turn of the lever 200 and front-rear direction movement of the slider 300 are exchanged with each other. In this manner, the slider 300 is attached to the housing 100 to be movable in the front-rear direction.

[0027] In the present embodiment, one of the teeth 316 forming the rack portion 314 is used as the press portion 317 while one of the teeth 232 forming the pinion portion 230 is used as the pressed portion 233. This is because shapes of the lever 200 and the slider 300 are simplified and their design and manufacturing are facilitated. The present invention, however, is not limited thereto. The press portion 317 may be provided separately from the teeth 316 of the rack portion 314. Similarly, the pressed portion 233 may be provided separately from the teeth 232 of the pinion portion 230. In such a case, the shapes of the press portion 317 and the pressed portion 233 may be freely decided. For example, each of the press portion 317 and the pressed portion 233 may be rectangular in shape when seen along the light-left direction. Furthermore, an interval between the press portion 317 and the tooth 316 of the rack portion 314 adjacent to the press portion 317 may be different from an interval between the teeth 316 of the rack portion 314 adjacent to each other. Similarly, an interval between the pressed portion 233 and the tooth 232 of the pinion portion 230 adjacent to the pressed portion 233 may be different from an interval between the teeth 232 of the pinion portion 230 adjacent to each other. At any rate, the press portion 317 and the pressed portion 233 may be any portions provided that when the lever 200 is in the first position, moving the slider 300 forward makes the press portion 317 press the pressed portion 233 to turn the lever 200 toward the second position and to define the relative positions of the lever 200 and the slider 300. For that purpose, the press portion 317 is provided in the slider 300 to be visible when the slider 300 as a single body is seen from forward along the front-rear direction. It should be noted that the defined relative positions are necessary to allow the rack portion 314 and the pinion portion 230 to be appropriately engaged with each other.

[0028] Next, the lever 200 is put in the second position as shown in Figs. 9 and 11. This situation can be achieved by either moving the slider 300 more forward or turning the lever 200 to the second position after the lever 200 and the slider 300 are changed into the state that they are interlocked with each other. Since the side plate portion 310 of the slider 300 is brought into abutment with the front wall 130 of the housing 100, the lever 200 is stopped in the second position. At this time, the slider 300 is positioned in a mated position.

[0029] Subsequently, as shown in Fig. 12, the cover 400 is attached to the housing 100. The cover 400 is attached to an upper part of the housing 100 to lead wires (not shown) forward. The cover 400 is attached to the housing 100 by moving the cover 400 forward from behind the housing 100. The cover 400 protrudes forward of the housing 100 in part in the state that the cover 400 is attached to the housing 100. As understood from Fig. 13, a rotatable range of the lever 200 is limited by the cover 400 attached to the housing 100. In detail, in a state that the cover 400 is attached to the housing 100, the turn of the lever 200 toward the first position is limited to a position (a third position) where the arm portions 220 are brought into abutment with the regulation portions 402. In other words, in the state that the cover 400 is attached, the lever 200 is regulated so as not to be rotatable toward the first position from the third position positioned between the first position and the second position. This is because the arm portions 220 are brought into abutment with the regulation portions 402 and the lever 200 cannot be turned even if it is intended to be turned toward the first position. In this state, the lever 200

is rotatable between the third position and the second position. The cover 400 (or the regulation portions 402) regulates the turn of the lever 200 from the third position to the first position, and thereby the lever 200 is prevented from coming into contact with the wires connected to the connector 10. In the present embodiment, "the third position" represents not a specified point but a predetermined range. That is, "the third position" includes a range from a position, where the arm portions 220 are brought into abutment with the regulation portions 402, to a position where the arm portions 220 are slightly apart from the regulation portions 402 as shown in Fig. 15. In detail, "the third position" represents a rotatable range of the lever 200 that allows the cam grooves 312 of the connector 10 receive cam shafts (force receiving portion, not shown) of the mating connector. In addition, though the regulation portions 402 are provided to be brought into abutment with the arm portions 220 of the lever 200 in the present embodiment, the regulation portions 402 may be provided to be brought into abutment with the operation portion 210.

[0030] As shown in Figs. 13 to 15, in a state that the lever 200 is positioned in the third position, a lower end of each of the cam grooves 312 is positioned between adjacent two of the bottom plates 170 when seen along the up-down direction. In this state, the cam grooves 312 can receive the cam shafts (not shown) of the mating connector. In other words, the connector 10 is in a mateable state (or removable state) that the connector 10 is mateable with the mating connector (not shown). When the mating housing (not shown) of the mating connector is partly inserted into the receiving portion 122 of the connector 10 which is in the mateable state, the cam shafts of the mating connector are inserted into the cam grooves 312. Then the cam shafts of the mating connector are brought into abutment with upper walls 342 of the cam grooves 312 and stopped in mating start positions.

[0031] As understood from Figs. 11 to 15, when the cam shafts (not shown) of the mating connector are positioned in the mating start positions of the cam grooves 312, turning the lever 200 toward the second position moves the slider 300 forward according to the turn of the lever 200. Then, lower walls 344 of the cam grooves 312 push the cam shafts diagonally upward as the slider 300 is moved forward. The mating housing of the mating connector is received by the receiving portion 122 of the connector 10 in part. Accordingly, the mating connector cannot be moved forward. Also, the cam shafts cannot be moved forward. As a result, the cam shafts pushed by the lower walls 344 of the cam grooves 312 are moved upward. In other words, upward force is transmitted from the cam grooves 312 to the cam shafts. When the cam shafts receive the upward force from the cam grooves 312, the mating connector is pulled up toward the connector 10. When the lever 200 reaches the second position, the cam shafts reach the other ends of the cam grooves 312, and the connector 10 and the mating connector are brought into the mated state.

[0032] Conversely, when the connector 10 and the mating connector (not shown) are in the mated state that they are mated with each other, turning the lever 200 toward the third position from the second position moves the slider 300 rearward as understood from Figs. 11 and 15. As the slider 300 is moved rearward, the upper walls 342 of the cam grooves 312 push the cam shafts (not shown) diagonally downward. At this time, the mating connector cannot be moved rearward. Accordingly, the cam shafts pushed by the upper walls 342 of the cam grooves 312 are moved downward. In other words, downward force is transmitted from the cam grooves 312 to the cam shafts. Thus, the mating connector is pushed down in a direction away from the connector 10. When the lever 200 reaches the third position, the cam shafts reach the mating start positions of the cam grooves 312. In this manner, the mating connector is brought into the removable state (or the mateable state) that the mating connector is removable from the connector 10. Thus, the connector 10 can easily be removed from the mating connector.

[0033] Although the specific explanation about the present invention is made above referring to the embodiments, the present invention is not limited thereto but susceptible to various modifications and alternative forms. For example, though the housing 100 is provided with the rotational shafts 152 while the lever 200 is provided with the shaft holes 222 and the guide grooves 224 in the aforementioned embodiment, the housing 100 may be provided with shaft holes and guide grooves while the lever 200 may be provided with rotational shafts. In such a case, the guide grooves also function to guide the rotational shafts to the shaft holes upon attaching the lever 200 to the housing 100. Furthermore, in a case where the guide grooves are provided in the housing 100, the guide grooves extend in the up-down direction and open upward. In the aforementioned embodiment, the connector 10 is provided with the cam grooves 312 while the mating connector is provided with the cam shafts (not shown). However, the connector 10 may be provided with cam shafts while the mating connector may be provided with cam grooves.

[0034] 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 along an up-down direction, the connector being attached with a cover when used, wherein:

the mating connector comprises a force receiving portion;
the connector comprises a housing, a lever and a slider;
the lever is attached to the housing to be rotatable between a first position and a second position in a state before the cover is attached to the housing;
the slider is attached to the housing to be movable in a front-rear direction orthogonal to the up-down direction;
the lever has a pinion portion and a pressed portion;
the pinion portion has a plurality of teeth;
the slider has a rack portion, a press portion and a force transmission portion;
the rack portion has 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 mutually engaging;
the press portion is visible when the slider as a single body is seen from a front thereof along the front-rear direction;
the press portion presses the pressed portion to turn the lever toward the second position when the slider is moved forward in the front-rear direction provided that the lever is positioned in the first position;
the force transmission portion transmits up-down direction force to the force receiving portion of the mating connector according to the front-rear direction movement of the slider;
the lever is regulated by the cover in a state that the cover is attached to the housing so as not to be rotatable toward the first position from a third position positioned between the first position and the second position but to be rotatable between the third position and the second position;
when the lever is turned from the third position to the second position, the slider is moved forward in the front-rear direction, and the force transmission portion moves the force receiving portion of the mating connector upward in the up-down direction, and thereby the connector and the mating connector are brought into a mated state; and
when the lever is turned from the second position to the third position, the slider is moved rearward in the front-rear direction, and the force transmission portion moves the force receiving portion of the mating connector downward in the up-down direction, and thereby the connector and the mating connector are brought into a removable state.

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

the pressed portion is one of the teeth of the pinion portion; and
the press portion is one of the teeth of the rack portion.

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

the pinion portion is molded integrally with the lever using first resin; and
the rack portion is molded integrally with the slider using second resin.

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

the pinon portion has a side surface;
the connector further comprises a plate-like member provided on the side surface of the pinion portion and connecting the teeth of the pinion portion to one another;
the pinion portion and the plate-like member are molded integrally with the lever using the first resin.

5. The connector as recited in any one of claims 1 to 4, wherein the housing is provided with a stopper to stop the lever in the first position.

6. The connector as recited in claim 5, wherein the stopper is molded integrally with the housing using a third resin.

7. The connector as recited in any one of claims 1 to 6, wherein:

the slider has a pair of side plate portions;
the side plate portions are provided with two pairs of the force transmission portions; and
one of the pairs of the force transmission portions and a remaining one of the pairs of the force transmission portions are located apart from each other in the front-rear direction.

8. The connector as recited in any one of claims 1 to 7, wherein:

the force receiving portion is a cam shaft; and
the force transmission portion is a cam groove which received the cam shaft upon mating of the connector with the mating connector.

9. The connector as recited in any one of claims 1 to 8, wherein:

one of the lever and the housing is provided with a rotational shaft;
a remaining one of the lever and the housing is provided with a bearing hole and a guide groove;
the bearing hole receives the rotational shaft

when the lever is attached to the housing;
the guide groove guides the rotational shaft to the bearing hole when attaching the lever to the housing;
in a case where the guide groove is provided in the housing, the guide groove extends in the up-down direction and opens upward; and
in another case where the guide groove is provided in the lever, the guide groove extends in the up-down direction and opens upward provided that the lever is positioned in the second position.

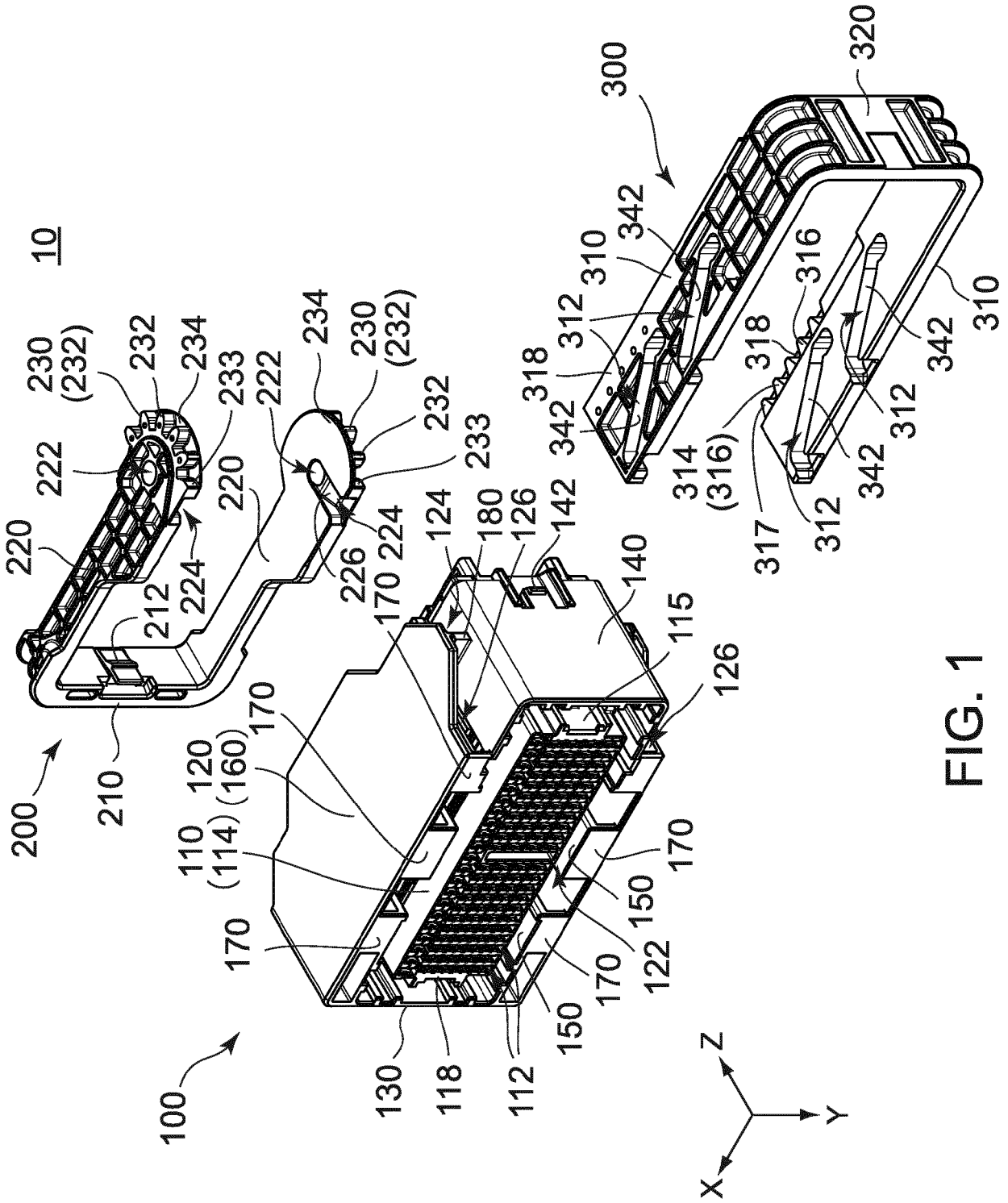
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FIG. 1

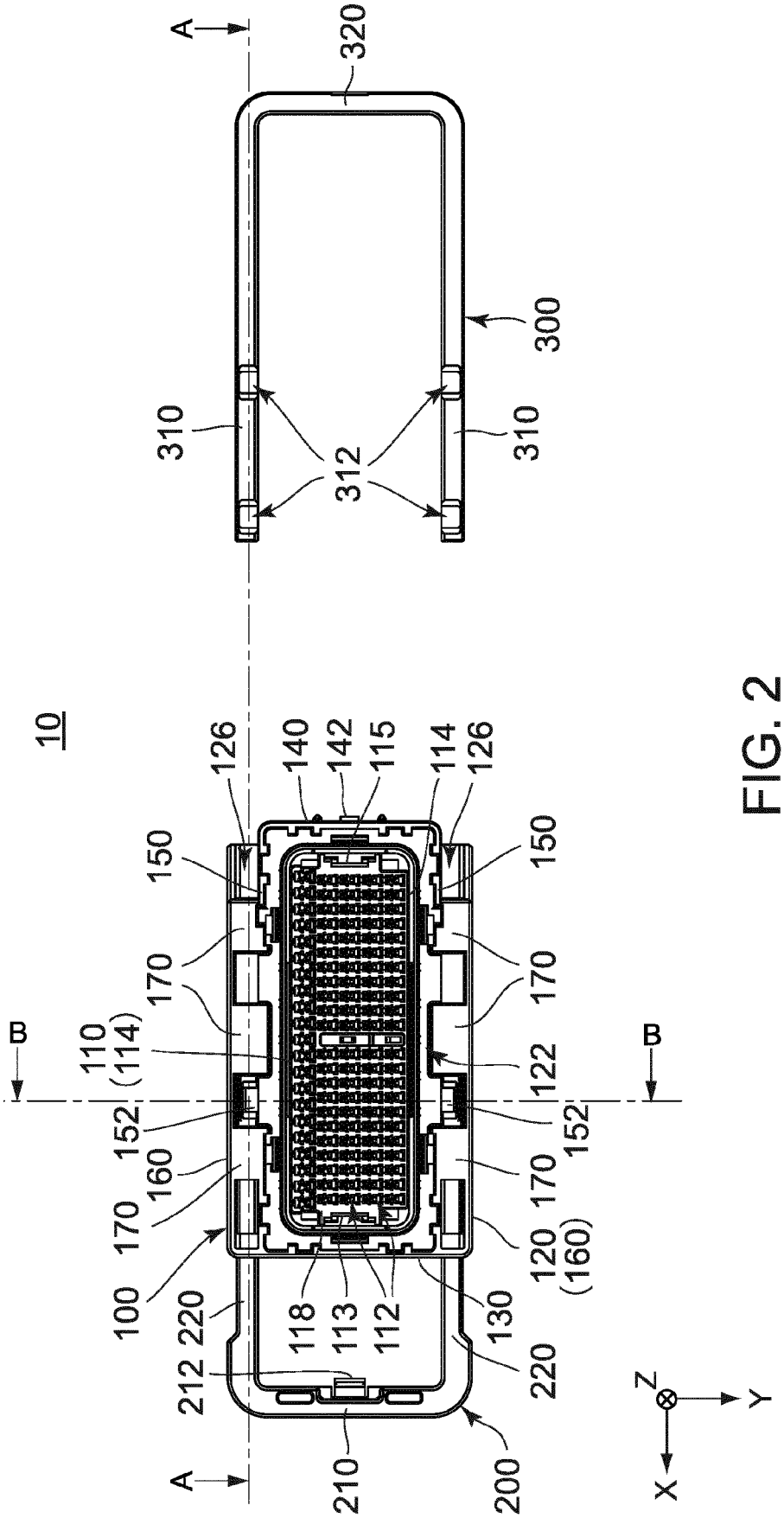
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FIG. 2

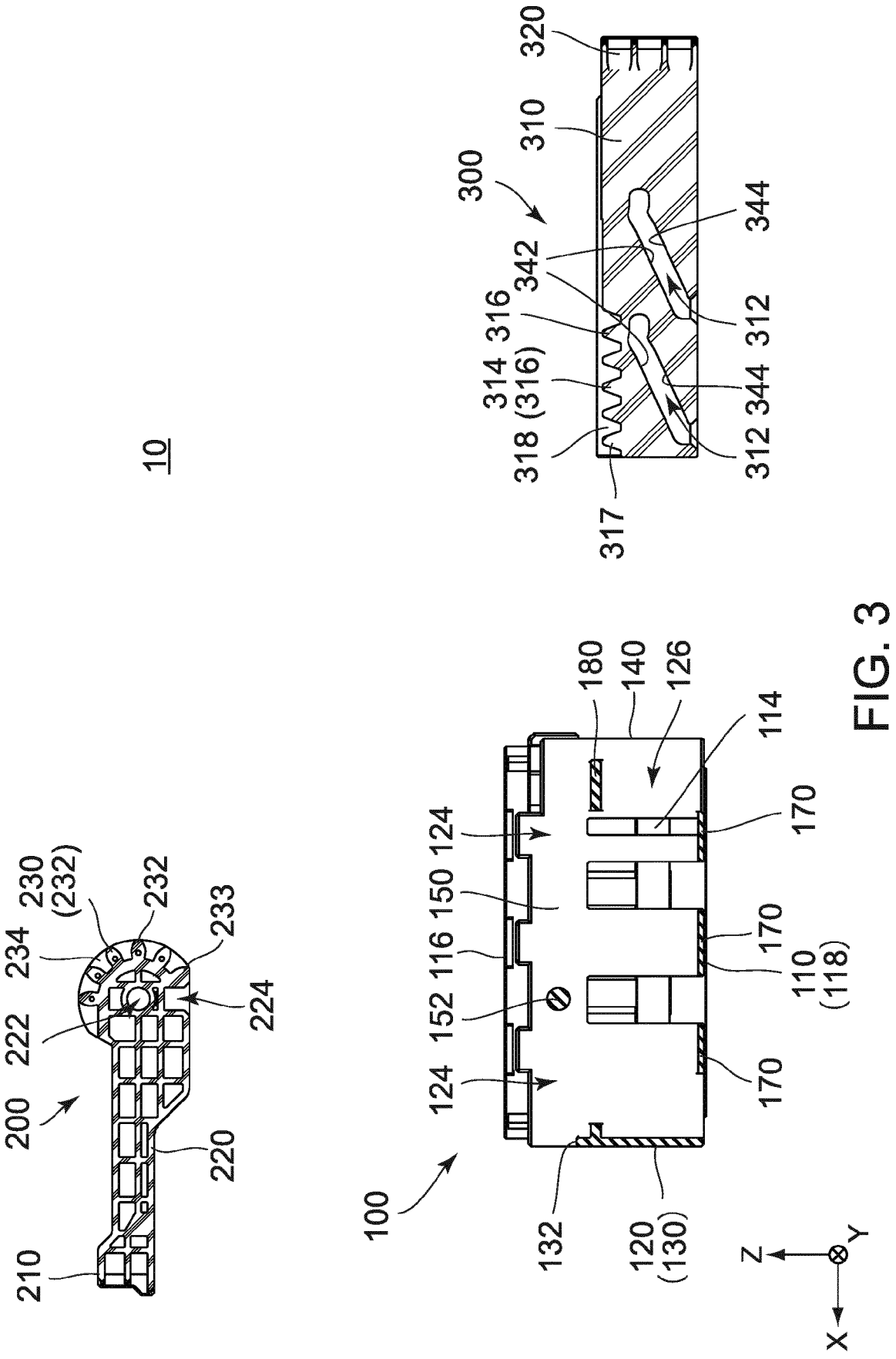
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FIG. 3

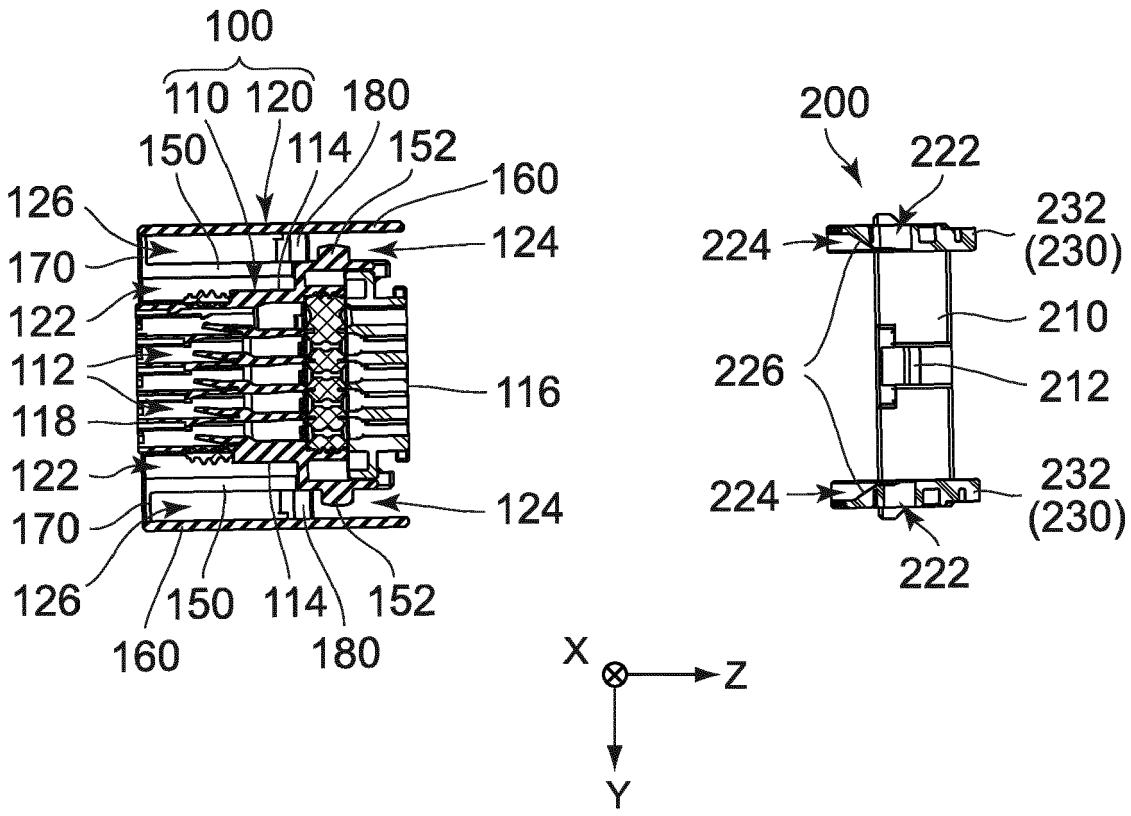
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FIG. 4

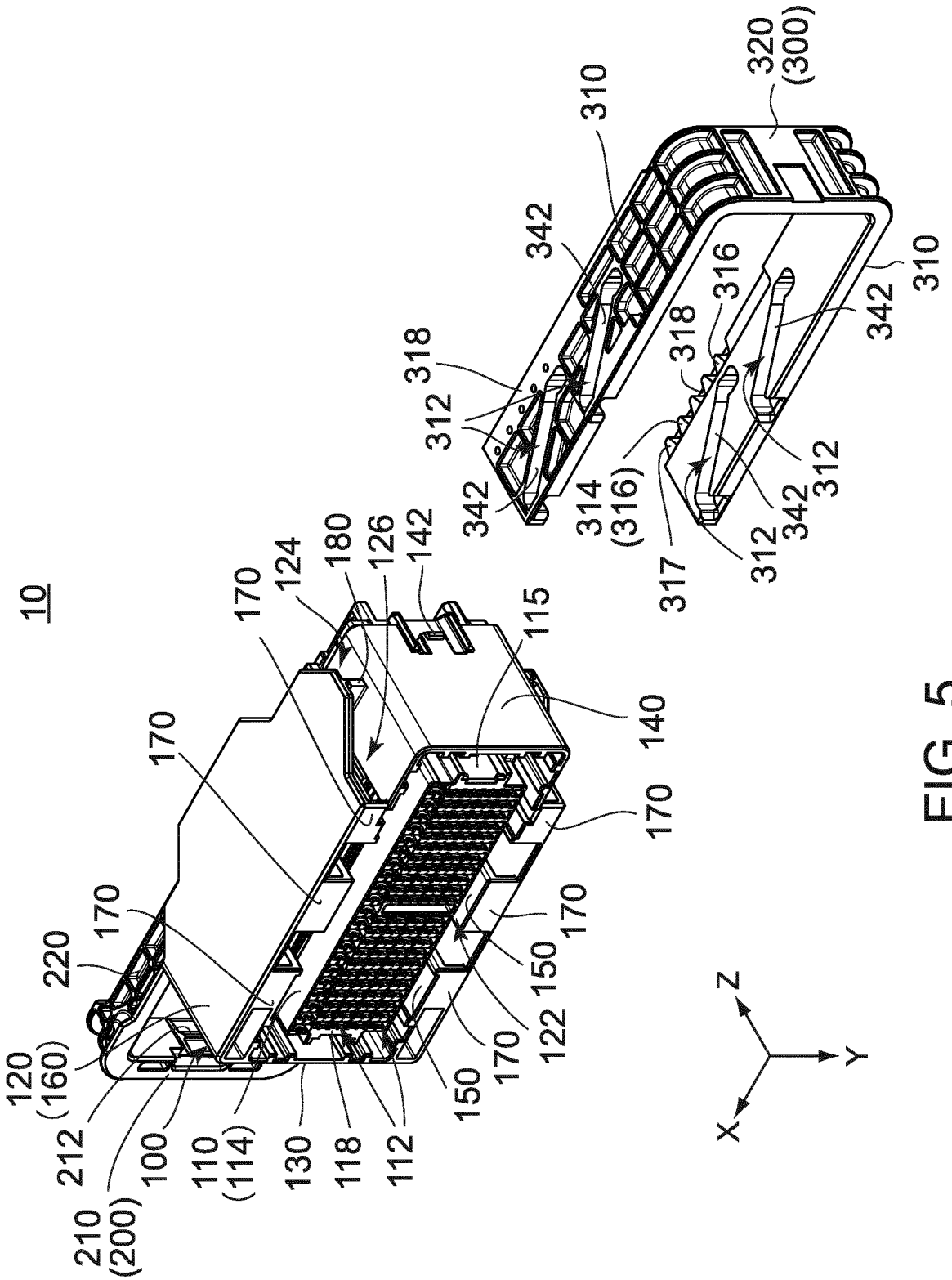
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FIG. 5

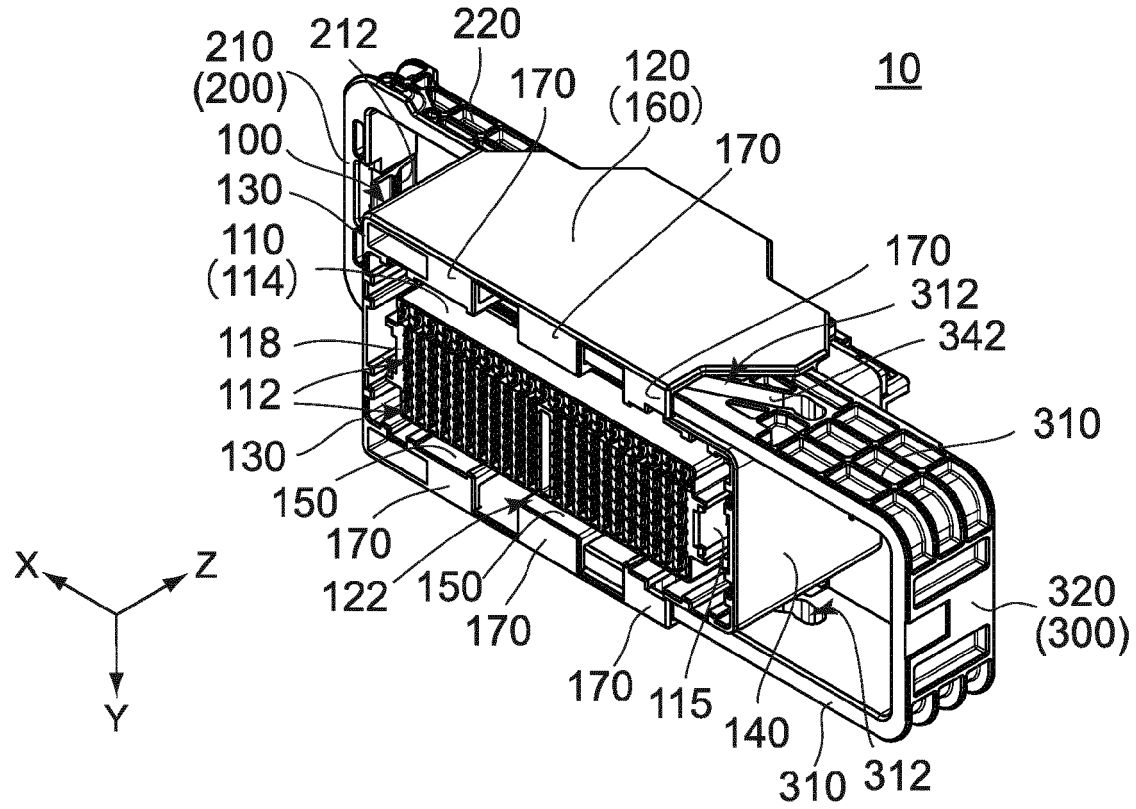
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FIG. 6

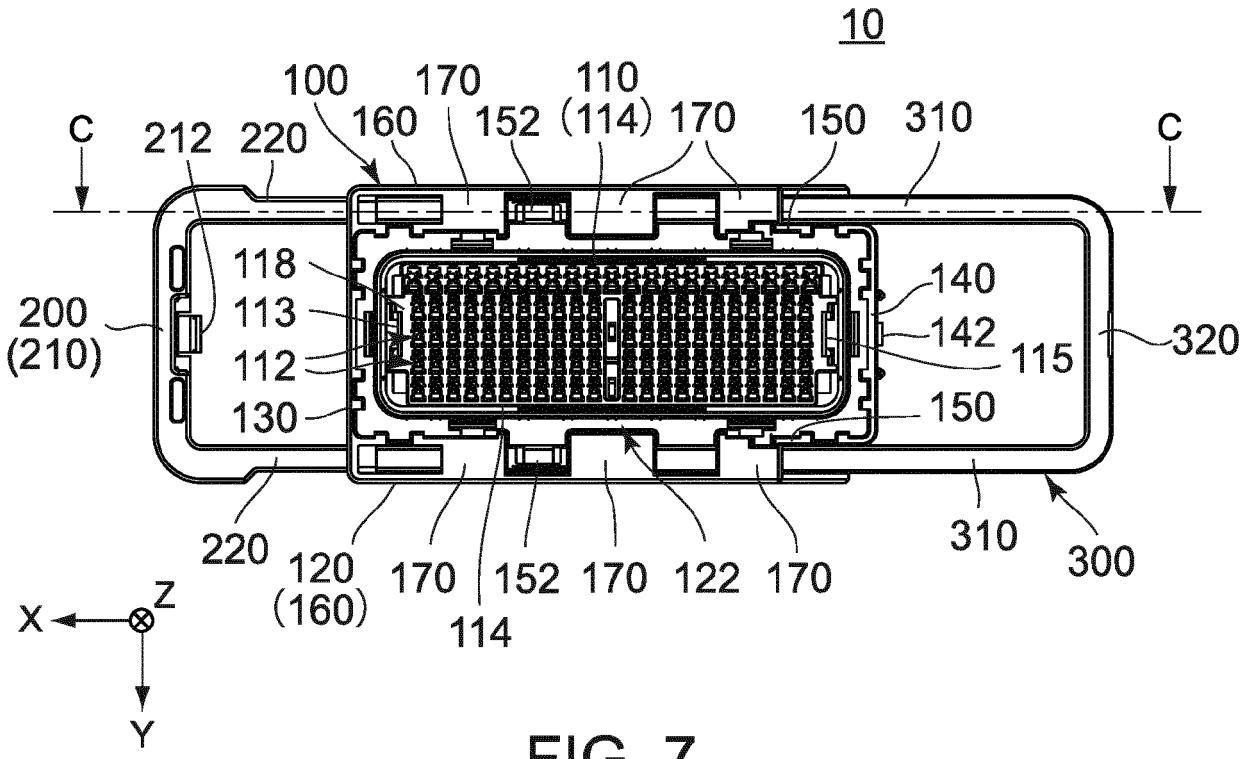
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FIG. 7

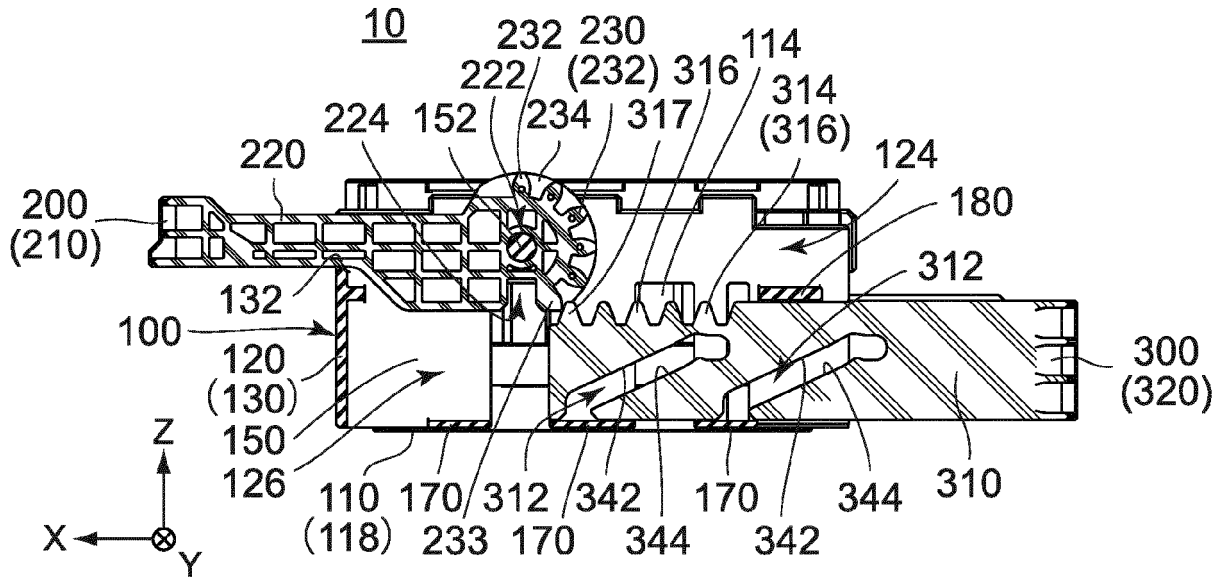
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FIG. 8

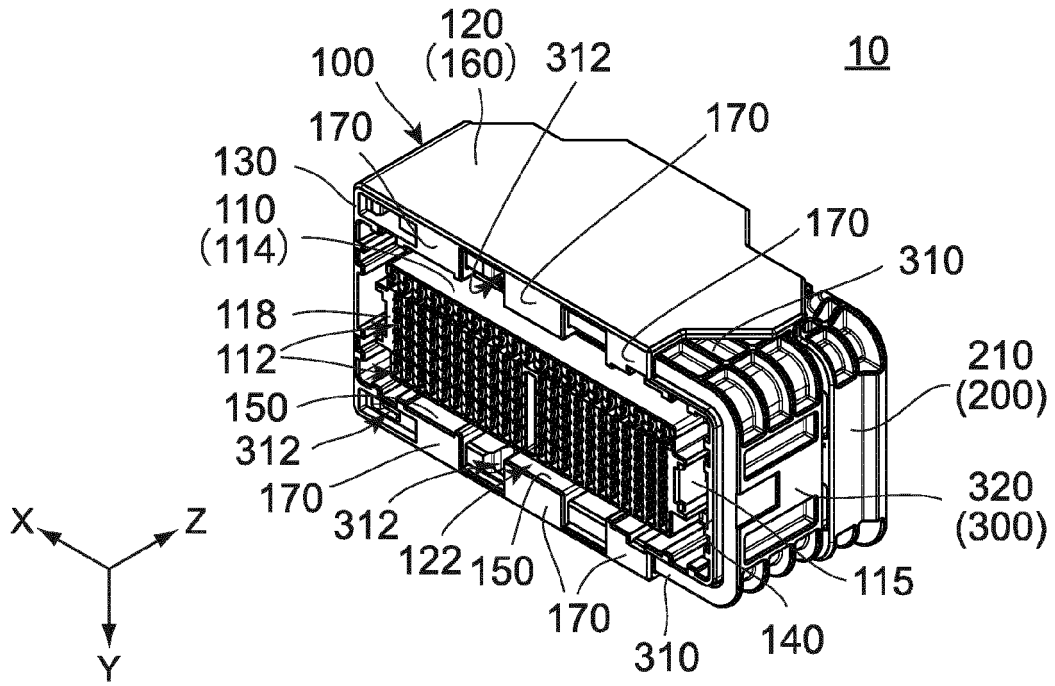
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FIG. 9

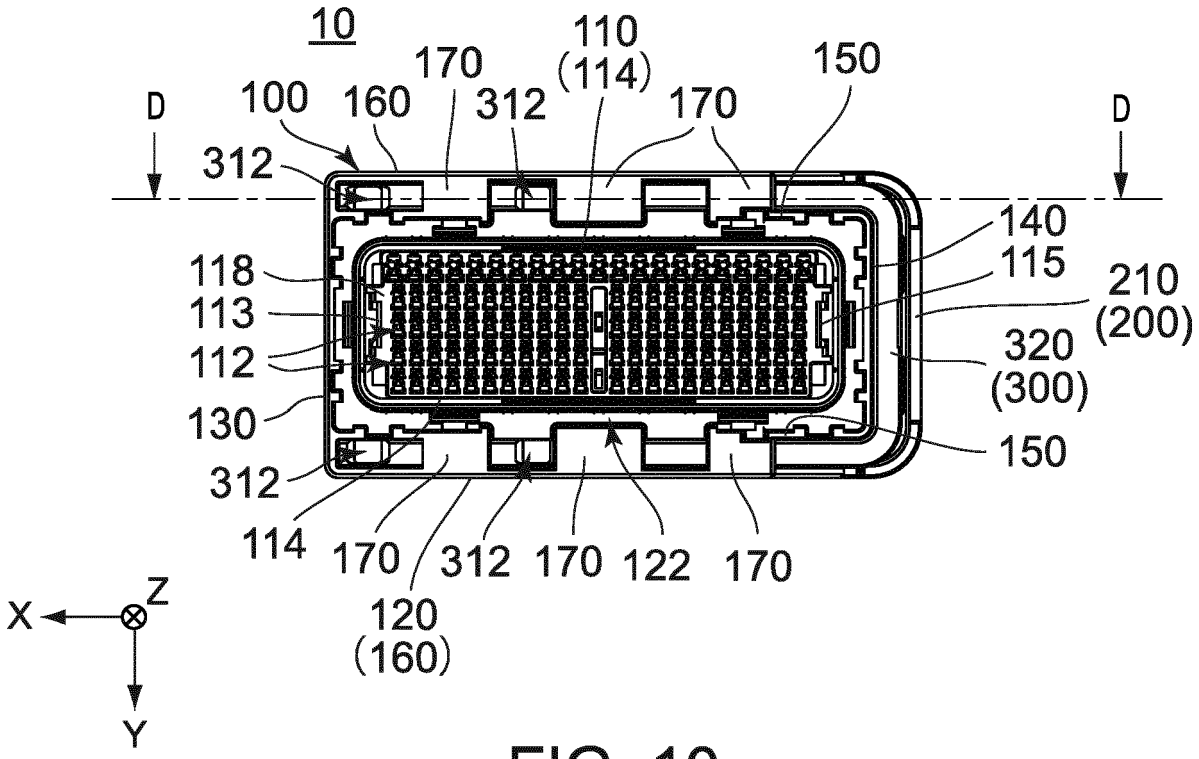
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FIG. 10

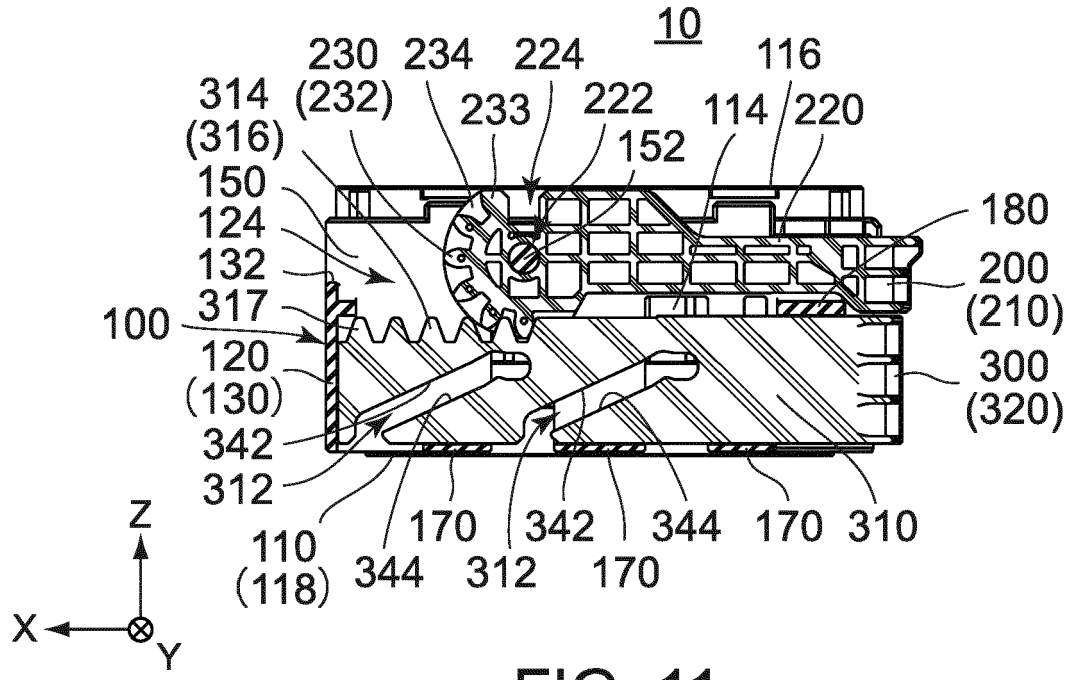
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FIG. 11

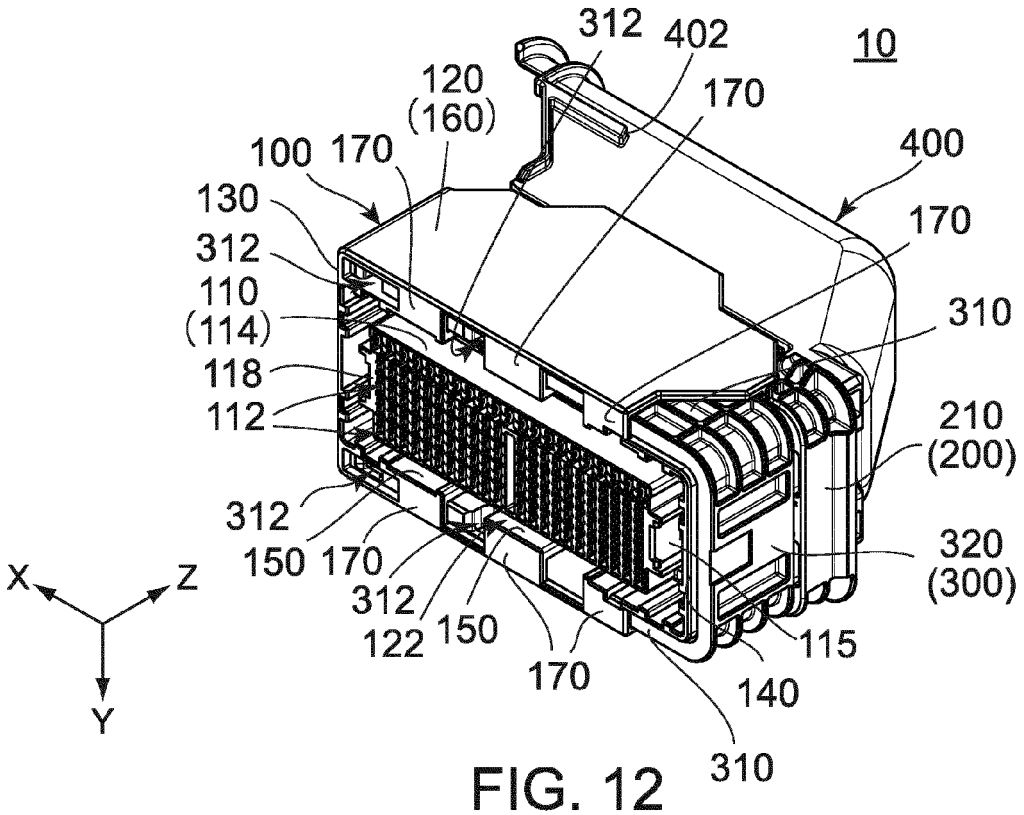
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FIG. 12

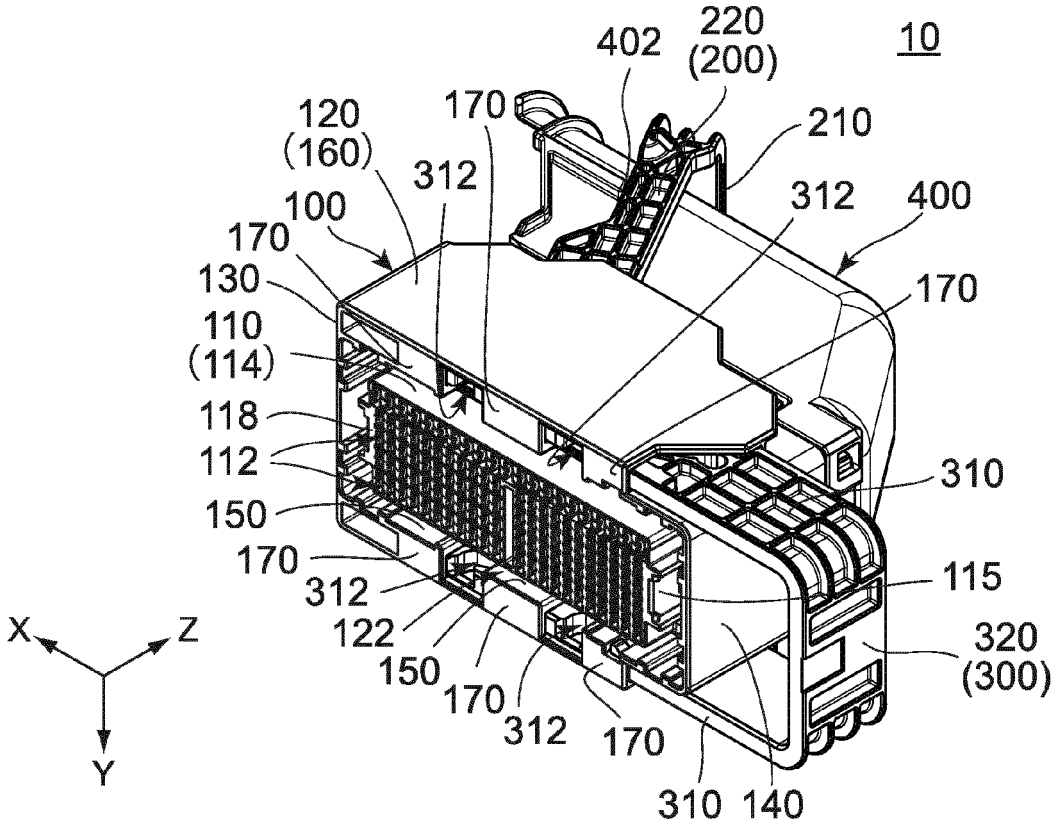
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FIG. 13

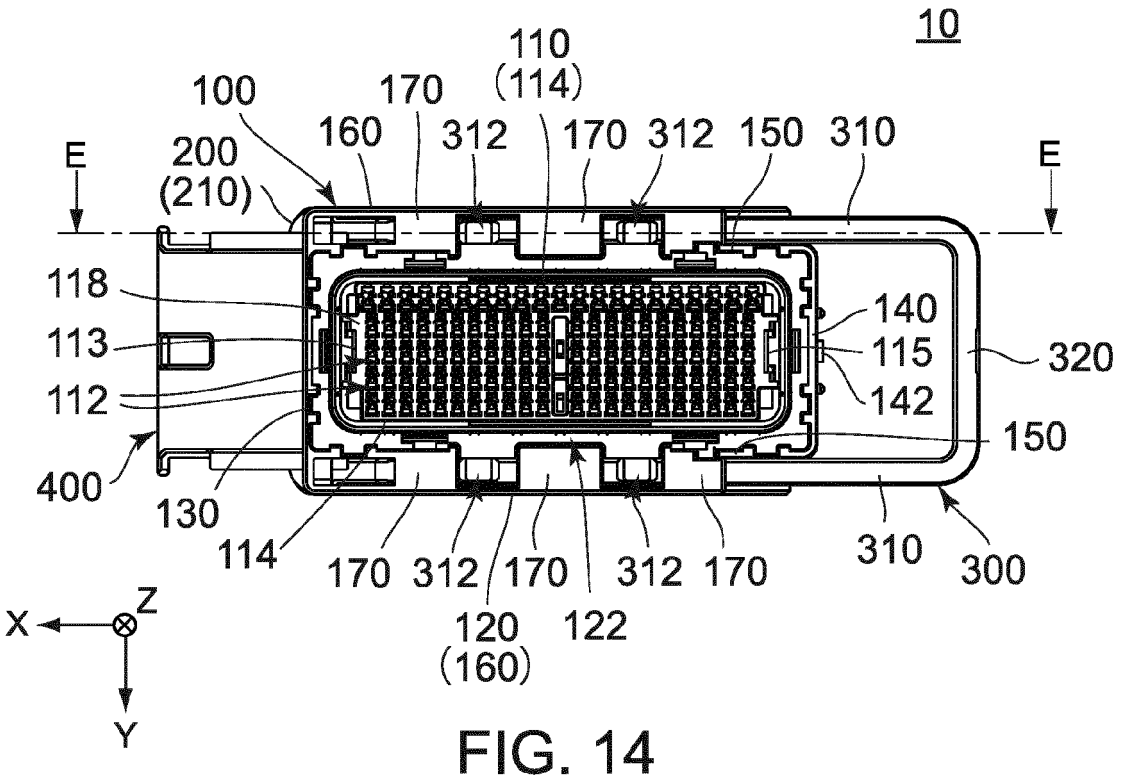
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FIG. 14

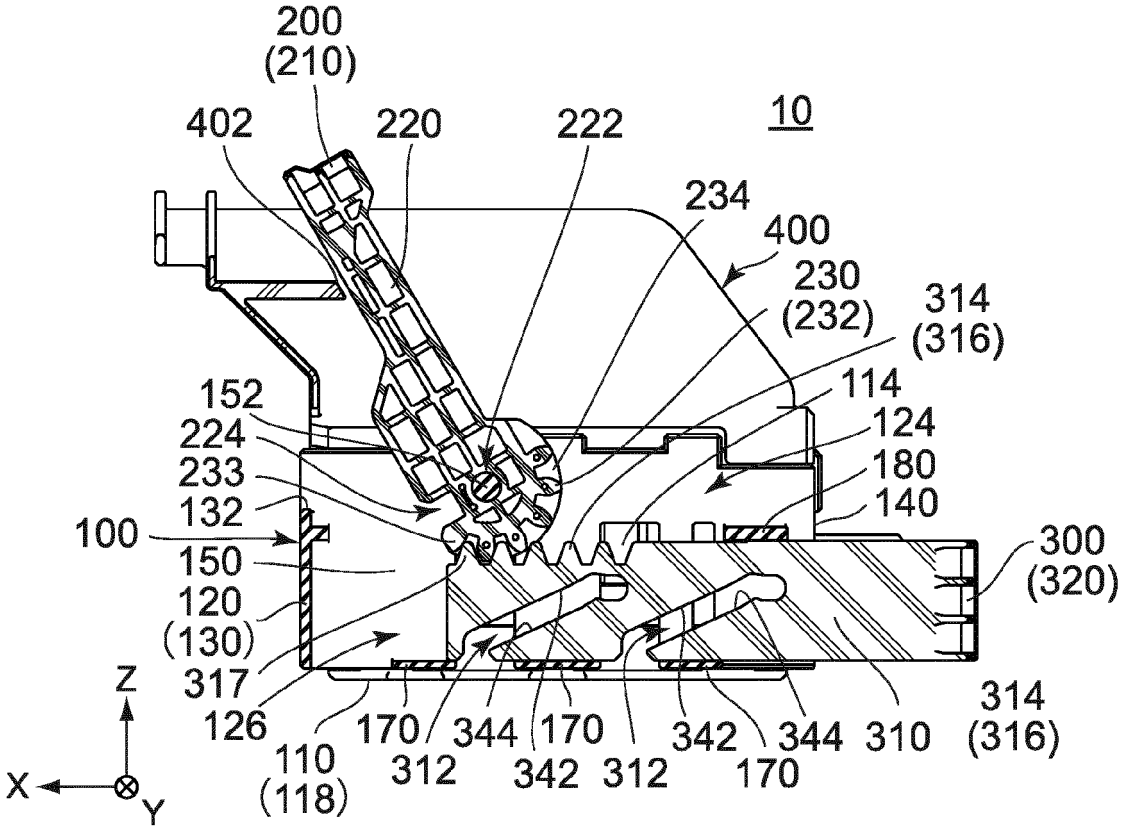
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FIG. 15

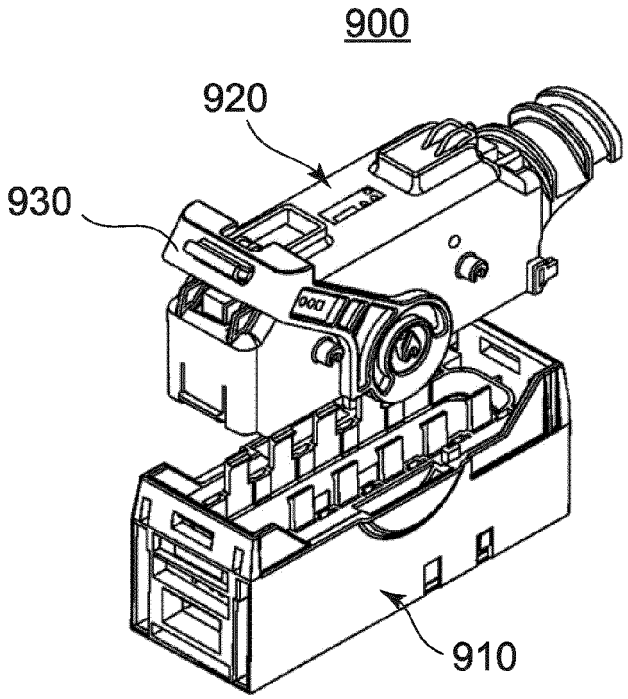
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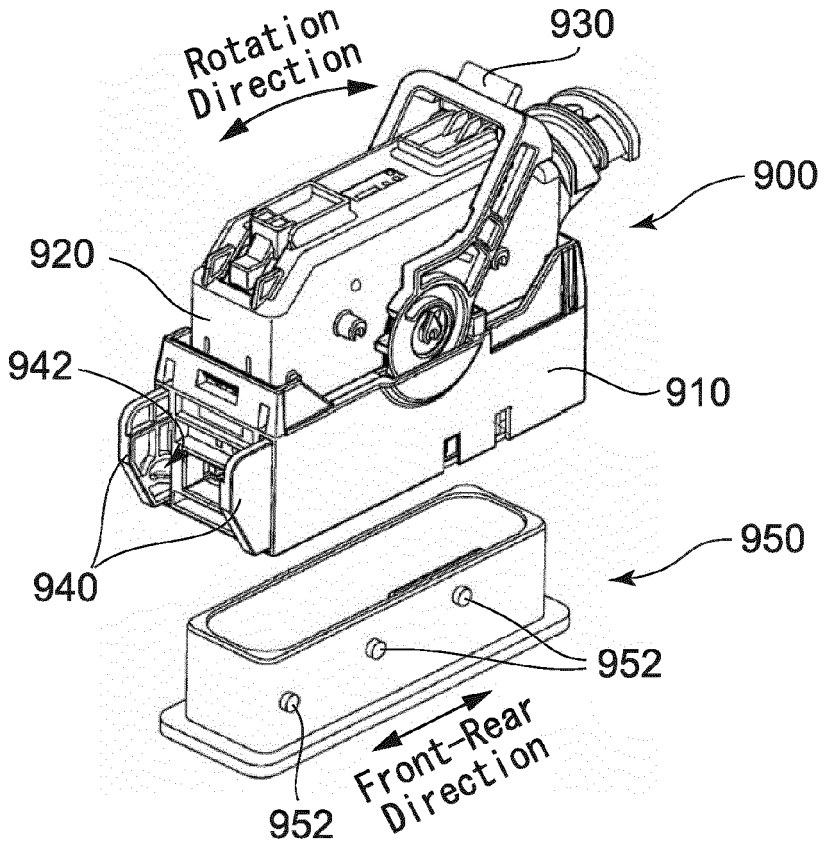
FIG. 16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Front-Rear Direction

FIG. 17

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EUROPEAN SEARCH REPORT

Application Number
EP 17 15 6870

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 Y	JP 2006 331991 A (TYCO ELECTRONICS AMP KK) 7 December 2006 (2006-12-07) * abstract; figures 1-9 *	1-8 9	INV. H01R13/629
X	EP 0 655 799 A1 (MOLEX INC [US]) 31 May 1995 (1995-05-31) * column 4 - column 7; figures 1-13 *	1-4	
Y	US 2003/017026 A1 (TACHI HIDESHI [JP]) 23 January 2003 (2003-01-23) * paragraph [0049]; figures 1,2 *	9	
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			TECHNICAL FIELDS SEARCHED (IPC) H01R

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	25 July 2017	Vautrin, Florent

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25-07-2017

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