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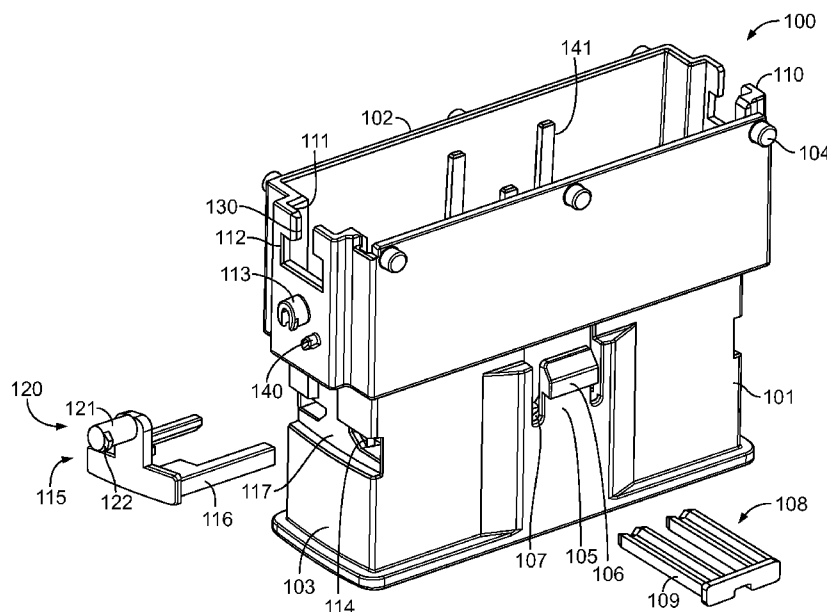


Fig. 1

(57) Abstract: The present invention relates to a first connector housing (100) and a second connector housing (300) for an electrical connector assembly. The first connector housing (100) includes a first engaging member (104) and a second engaging member (112) and at least one pivot means (113) for supporting a third engaging member (210, 220). The engaging members (104, 112, 210, 220) of the first connector housing (100) are adapted to be mated with corresponding engaging members (304, 411, 511) of a complementary second connector housing (300) and are adapted to interlock the first connector housing (100) to the complementary second connector housing (300). The first connector housing (100) can be engaged with the complementary second connector housing (300) by using at least one of the engaging members (104, 112, 210, 220).

SECTIONING CONNECTOR

The invention relates to an electrical connector assembly including a housing for
5 socket contacts and a complementary housing for plug contacts, wherein a first connector
housing comprises a plurality of engaging means for engaging corresponding engaging means
of a complementary second connector housing.

Electrical connectors typically include a socket housing and a plug housing which are
adapted to be engaged so as to connect corresponding electrical contacts. The insertion force
10 needed to connect the two housings depends on the number of contacts included in the
housings. Further, depending on the number of contacts and on their specific use, connectors
of the type described above are normally engaged according to different designs so as to
increase the stability of the connector assembly.

For instance, if the number of contacts is limited, if the force required for connecting
15 the connector assembly is small and if the connector is easily accessible, it is possible to
connect the plug and socket housing by direct insertion. In this case, the plug housing is
inserted into the socket housing without the help of additional means and the two housings
are kept in their final position by latch projections. On the other hand, in the case that the
electrical connector assembly contains a large number of contacts and a large insertion force
20 is required, the housings are engaged with the help of actuation means so as to overcome the
friction between the mating contacts. Such connectors may be also used in cases where one
of the housings is fixed and not easily accessible so that direct insertion becomes more
difficult.

A common design for a connector of this type provides a connector assembly wherein
25 the mating plug and socket connector housings are engaged using a lever. A connector
assembly which includes an actuating lever is described in the European patent EP 0 977 324
B1. This document describes a connector including two housings wherein one housing
pivotally supports a lever adapted to connect the mating housings by rotating to a final
position. Another example of an electrical connector assembly actuated by a lever is
30 described in the documents US 2002/0022391 A1 and WO 2008/062389 A2.

A further design for a connector assembly that is often used in the automotive sector
is provided with an actuation slide means as described in EP 1 396 910 A1. According to this
document, an actuation slide means is arranged on the moveable housing of a connector

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assembly and is displaceable in a direction transverse to the direction of engagement of the two housings. Accordingly, the moveable housing is moved towards a fixed housing by displacing the slide means transversely with respect to the direction of movement of the moveable housing. A similar arrangement is also described in the United States patent
5 5,618,194.

However, each of the connector arrangements described above is especially designed for a particular use. The design allowing direct insertion of the plug housing into the socket housing is indeed useful if the available space is limited but can only be used if the connector can be easily reached by the user and if its configuration allows the user to grab the moveable
10 housing for connecting and disconnecting the contacts. Further, such a design is preferably used when the number of contacts in the connector is limited. On the other hand, designs including the lever or the actuation slide means are very practical when only a small portion of the moveable housing of the connector can be reached by the user, making it difficult to grab the moveable housing for extraction. Further, these designs are preferred in the case
15 that the plug and socket housings include a large number of contacts.

Since each connector design is optimized for a specific application, it is not possible to use the same electrical connector assembly for different applications according to the customer needs or wishes.

Therefore, the problem underlying the present invention is to provide a modular
20 connector with a versatile and flexible design wherein standard connector housings are adapted to be engaged according to different mating designs, so that the connector can be used for different applications and in different sectors according to the user needs and wishes.

This object is solved by the subject matter of the independent claims. Advantageous embodiments of the present invention are subject matter of the dependent claims.

25 A first connector housing for use in an electrical connector assembly includes a first and a second engaging member arranged on the walls of the first connector housing. Further, at least one pivot means is arranged on at least one of the walls of the first connector housing so as to support a third engaging member for pivot movement. Each of said engaging members is adapted to be mated with a corresponding engaging member on a complementary
30 second connector housing and is adapted to lock the two mating housings when the contacts are connected. Since the first connector housing can be engaged with the second connector housing by using at least one of the engaging means according to the user's needs, it is

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possible to choose the engaging design which is more appropriate to the particular application. The electrical connector assembly including the plug and socket housings according to the invention is particularly advantageous compared to the usual electrical connectors. Indeed, while the housings of standard electrical connectors are adapted to be
5 mated according to one standard design only, the connector housing according to the present invention is adapted to be engaged according to all the most common mating designs, thereby being more flexible.

According to a preferred embodiment of the first connector housing, the first engaging means includes at least two guiding elements adapted to be engaged with
10 corresponding cam profiles of an actuation slide means for moving the complementary second connector housing towards the first connector housing when the actuation slide means is moved to a final position. The engaging means may comprise one or more guide pins.

The first connector housing may be further provided with one or more locking
15 openings arranged on the walls of the first connector housing. Said openings are adapted to receive at least one locking bolt included in the second connector housing so as to firmly interlock the first and second connector housings when the first connector housing and the complementary second connector housing are completely connected.

Furthermore, an actuation lever may be mounted on the pivot means arranged on the
20 walls of the first connector housing as an example of third engaging member. This allows to provide a contact housing which can be connected with its mating housing using a frontal actuation lever. The actuation lever may include a first and a second lever portions adapted to be supported by the pivot means arranged on opposing walls of the first connector housing and joined by a bridge element. The possibility of applying an engaging lever to the first
25 connector housing allows to have a mating design which is particularly stable and adapted to engage an electrical connector including a large number of contacts. In order to allow engagement with a second contact housing, the actuation lever may include at least one first guide groove. Said guide groove is adapted to engage a corresponding first engaging pivot included in the complementary second connector housing. This has the effect that, when the
30 lever is pivoted to its final position, the second housing is driven into the first housing so as to fully connect the contacts in both the first and second housings of the electrical connector.

The first and second lever portions may further include at least one second guide

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groove adapted to engage a corresponding second engaging pivot included in the first connector housing for pulling the first connector housing into the complementary second connector housing in a direction along the mating direction of the electrical connector. The second engaging pivot is vertically aligned with the first engaging pivot included in the complementary second connector housing. Since the second engaging pivot of the first
5 connector housing and the first engaging pivot of the second connector housing are positioned above each other and engage the first and second guide grooves, a rotation of the actuating lever towards a front face of the first housing will pull the first connector housing and the complementary second connector housing together so as to reduce the tolerance
10 chain for the terminal contact overlap. Further, since the first and second engaging pivots are firmly closed by the first and second guide grooves of the actuating lever, once the lever is in its final position the system is very stable against external forces that could open the connection by accident.

In a further embodiment, one of the walls of the first connector housing includes a
15 resilient latch member which may be engaged with a mating latch member of the bridge element of the actuating lever. This allows to fix the first connector housing to the complementary second connector housing, thereby avoiding that the contacts in the housings are accidentally disconnected.

The first connector housing may further include contact receiving cavities for
20 receiving power and signal contacts, wherein said contact receiving cavities are symmetrically disposed with respect to one of the middle axis of a face of the first connector housing. Since the contact receiving cavities are disposed symmetrically, the available space in the connector housing can be better organized and the overall dimensions of the housing can be reduced while the number of contacts is increased.

25 The contacts are generally signal contacts and power contacts and, in a particular embodiment, are fixed to the first connector housing by means of at least one power contact lock and at least one signal contact lock. Said contact locks are adapted to be inserted in corresponding receiving holes formed on the walls of the housing.

In a further development of the embodiment, the second engaging pivot of the first
30 housing can be formed on a contact lock. If the contact lock is adapted to be inserted in a wall of the first housing in a vertical position with respect to the first engaging pivot of the complementary second connector housing, the second engaging pivot can be vertically

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aligned with the first engaging pivot included in the complementary second connector housing, thereby increasing the stability of the system when the actuating lever is in its final position. Further, since the actuating lever can be rotated to its final position only if the contact lock including the second engaging pivot is correctly and completely inserted in the corresponding receiving holes, situations in which the first housing is connected to the second housing while the contacts are not firmly interlocked to the first housing are avoided. Again, once the engaging lever is in its final position, it will secure the contact locks of the first housing in their position so as to avoid accidental side wards movement of the same.

In order to facilitate the insertion of the complementary second housing into the first housing, the first housing may exhibit two opposing recesses on the inner face of at least two of the walls of the first connector housing. Said recesses are adapted to receive corresponding protrusions formed on the complementary second housing.

According to the present invention, a second connector housing is given which includes a first, a second and a third engaging means. The second and third engaging means for the second connector housing can be interchangeably mounted on walls of the second housing. Each of the above mentioned engaging means can be engaged with a corresponding engaging means arranged on a complementary first connector housing. The second connector housing is finally adapted to be engaged with a first connector housing by using at least one of said engaging means. This has the advantage that the user can employ, depending on the available space and the overall design, the same connector housing in a plurality of situations which require a different engaging design.

In an embodiment, the second connector housing comprises an actuation slide means. Two guide grooves are respectively included on two opposing sides of the actuation slide means for engaging with corresponding engaging means of the complementary second connector housing. Further, at least two cam profiles are included in two opposing walls of the actuation slide means and extend in a direction transverse to a direction of mating of the electrical connector.

The guide grooves are adapted to be engaged with guide profiles of the second housing and the at least two cam profiles are adapted to be engaged with a corresponding guide pin on the first housing. In this way, the first housing is moved towards the second housing when the actuation slide means is moved to its final position. According to this solution, the connector can be locked by sliding the actuation slide means along the

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connector in a direction transverse to the mating direction of the electrical connector. This provides the advantage that a large force can be applied to the housings so as to easily connect electrical connectors including a high number of contacts. Furthermore, this solution also has the advantage that the space needed for actuating the slide means is reduced
5 compared with the space needed for actuating an engaging lever.

In a further development of the embodiment, the at least one first and second guide profiles of the second housing exhibit at least one resilient latch member which operate with at least one corresponding mating latch member on the actuation slide means for locking said actuation slide means in a final position. This allows to increase the stability of the whole
10 electrical connector assembly and to avoid that the contacts in the housings can be accidentally disconnected.

In a further embodiment, the second engaging means for the second connector housing is adapted to be inserted in at least one second socket receiving hole formed on at least one of the walls of the second connector housing. The second engaging means for the
15 second connector housing includes at least one locking bolt adapted to be engaged with the locking opening of the complementary first connector housing. This mating configuration is relatively simple and space saving and is particularly useful when the contact cavities of the connector housings are only partially occupied and a low tolerance chain for the terminal overlap is required. Accordingly, the overall dimensions of the housing can be reduced and
20 connection can be obtained by direct insertion of the second housing into the first housing.

On the other hand, if the third engaging means for the second connector housing including the first engaging pivot is adapted to be inserted in at least one second socket receiving hole formed on at least one wall of the second connector housing, the second housing may be connected to the first housing by means of an actuating lever. The first
25 engaging pivot is adapted to be engaged with corresponding guide grooves formed in the first and second lever portion of the engaging lever and, once the connection between the two counter-parts is established, the second connector housing can be moved towards the complementary first connector housing by rotating the engaging lever to its final position. This mating design can be used if a relatively large force is needed in order to connect the
30 contacts in the housings and if a high tolerance chain for the terminal overlap is required.

Also, the second housing includes contact receiving cavities for receiving power and signal contacts. Said contact receiving cavities are symmetrically disposed with respect to one

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of the middle axis of a connector face of the second connector housing. Since the contact receiving cavities are disposed symmetrically, the available space in the connector housing can be better organized and the overall dimensions of the housing can be reduced while the number of contacts is increased.

5 In a further development, the contacts may be fixed to the second connector housing by the second or third engaging means. The second connector housing may further include at least one additional receiving hole for receiving at least one additional contact lock for fixing the contacts in the second connector housing.

 The second and third engaging means of the second connector housing may
10 advantageously have a protrusion adapted to slide into the recesses of at least two walls of the complementary first connector housing for guiding the insertion into said complementary first connector housing.

 An electrical connector according to the present invention comprises the first and second housings described above. Since the two housings of the electrical connector
15 according to the invention are provided with a plurality of engaging means, it is possible to use said electrical connector in different situations by using at least one of the provided engaging members. This can be done without modifying the design of the connector and without having to purchase additional components.

 The accompanying drawings are incorporated into and form a part of the specification
20 for the purpose of explaining the principles of the invention. The drawings are not to be construed as limiting the invention to only the illustrated and described examples of how the invention can be made and used. Further, features and advantages will become apparent from the following and more particular description of the invention as illustrated in the accompanying drawings.

25 FIG. 1 shows a perspective view of a plug housing assembly according to the present invention;

 FIG 2 shows a perspective view of an alternative polarization of a plug housing assembly according to the invention;

 FIG. 3 shows an engaging lever for use with the plug housings of figures 1 and 2;

30 Fig. 4 shows an alternative design for an engaging lever which can be used with the plug housing of the present invention;

 FIG. 5 shows a perspective view of a socket housing assembly according to the

invention;

FIG. 6 shows a perspective view of an alternative polarization of a socket housing assembly according to the invention;

FIG. 7 shows a perspective view of an electrical connector assembly according to a
5 direct insertion mating design;

FIG. 8 shows a perspective view of a completely interlocked electrical connector assembly according to a direct insertion mating design;

FIG. 9 shows a perspective view of an electrical connector assembly using a lever mating design according to a first embodiment;

10 FIG. 10 shows a perspective view of a completely interlocked electrical connector assembly using a lever mating design according to the first embodiment;

FIG. 11 shows an electrical connector using an engaging lever mating design according to a second embodiment;

15 FIG. 12 shows a perspective view of a completely interlocked electrical connector assembly using a lever mating design according to the second embodiment;

FIG. 13 shows a transparent perspective view of a completely interlocked electrical connector assembly using a lever mating design according to the second embodiment;

FIG. 14 shows a perspective view of an electrical connector assembly using a lever mating design according to the second embodiment, wherein the connector contacts are not
20 correctly fixed to the plug housing;

FIG. 15 shows a perspective view of the electrical connector assembly using an actuation slide means mating design;

FIG. 16 shows a further perspective view of completely interlocked electrical connector assembly using an actuation slide means mating design;

25 FIG. 17 shows a top view of the face of the electrical connector according to a preferred embodiment of the invention.

Figure 1 shows in a perspective view a plug housing 100 for use in an electrical connector according to the present invention.

30 The plug housing 100 is an example of a first connector housing of an electrical connector assembly. It has a box-shaped form and includes a first wall and a second wall opposing to each other joined by a third and a fourth opposing walls. The first wall can be identified as front wall 101, while the second wall defines the rear wall 102. The third and

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fourth walls define the side walls 103 of the plug housing 100.

A plurality of guiding pins 104 having a cylindrical shape is arranged on the external face of the front and rear walls 101 and 102. The guiding pins 104, which are an example of first engaging means for the plug housing 100, project from the front and rear walls 101 and 102 and are arranged in a row extending in a direction perpendicular to a mating direction of the electrical connector. Figure 1 shows the plug housing 100 including three guiding pins 104. However, the plug housing 100 may include a higher number of guiding pins 104.

Alternatively only one guiding pin 104 may be arranged on the front and rear walls 101 and 102 of the plug housing 100. In the latter case the guiding pin 104 may have an elongated shape extending in the direction perpendicular to the mating direction of the electrical connector.

The front wall 101 of the plug housing 100 generally faces the user when the electrical connector assembly is mounted, and shows on its external surface, a resilient latch member 105 having an arrow-shaped latch portion 106. Moreover, both the front and rear walls 101 and 102 further include first plug receiving openings 107, which are adapted to receive respective prongs 109 of a U-shaped signal contact lock 108 having the function of fixing signal contacts to the plug housing 100. Although in figure 1 the contact lock 108 is depicted facing the front wall 101 of the plug housing 100, it is adapted to be inserted through the plug receiving openings 107 formed on the rear face 102 of the plug housing (see also figure 11).

Each of the side walls 103 shows a protrusion 110 forming in the inner side of the plug housing 100 two opposing recesses 111. On the external face of each protrusion 110 are arranged a locking opening 112 and a pivot 113. The locking opening 112 is positioned in a vertical position above the pivot 113 and may be used as second engaging means for the plug housing 100. Each of the protrusions 110 further exhibits a narrow inserting channel 130 formed above the locking opening 112 and extending from the locking opening 112 to the edge of the protrusion 110. Moreover, the protrusions 110 on both side walls 103 of the plug housing 100 further include an auxiliary curved pivot member 140.

Again, on each of the two side walls 103 of the plug housing 100 are formed second plug receiving openings 114 for receiving and guiding two L-shaped prongs 116 of a power contact lock 115. The contact lock 115 has a T-shaped base adapted to be placed in a corresponding T-shaped slot 117 molded on the side wall 103 of the plug housing 100 and

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vertically aligned below the protrusion 110. In this embodiment, the T-shaped base of the contact lock 115 is inserted in the T-shaped slot 117 so that the main tee of the base of the contact lock 115 extends from the cross tee of the base of the contact lock 115 towards the protrusion 110 along the mating direction of the electrical connector. On the main tee of the

5 T-shaped base of the power contact lock 115 is formed a cam portion 120 having a cylindrical body 121 on top of which a semicircular head 122 is formed. The cam portion 120 is an example of second engaging pivot. Alternatively, the base of the power contact lock may have a rectangular shape (not shown) and may not include the cam portion 120.

According to a further design, the cam portion 120 may be integrally formed on both side
10 walls 103 of the plug housing 100 in the space between the base of the contact lock and an edge of the protrusion 110 facing the contact lock with rectangular shape.

On the inner face of the front and rear wall 101 and 102 of the plug housing 100 are formed two elongated protrusions 141 functioning as guiding portions which extend along the mating direction of the electrical connector assembly. The guiding portions 141 have the
15 function of facilitating and guiding the insertion of a mating element into the plug housing 100. The position of the two guiding portions 141 can be chosen according to several designs or polarizations. An alternative plug housing 100 according to a different polarization is depicted in figure 2.

Although figures 1 and 2 describe a preferred embodiment including the guiding
20 portions 141 and the curved pivot member 140, the plug housings of figures 1 and 2 may also be designed without the guiding portions 141 and the curved pivot member 140. In a further embodiment, the protrusions 110 may not include the inserting channel 130.

Figure 3 shows an actuation lever 210 which is used as third engaging means for the plug housing 100. According to figure 3, the actuation lever 210 includes two arms or lever
25 portions 211 joined together by a lever bridge 212. The two arms 211 of the lever 210 respectively include a pivot receiving opening 213 for receiving the pivot 113 arranged on the plug housing 100. By means of said pivot receiving opening 213, the lever 210 can be fixed to the plug housing 100 and rotated so as to bring the lever bridge 212 in a position adjacent to the front face 101 of the plug housing 100. Each of the lever portions 211 further includes
30 a curved pivot groove 217 adapted to receive the auxiliary curved pivot member 140 formed on the side wall 103 of the plug housing 100 and having the function of stabilizing the actuation lever 210 while pivoting. Moreover, each of the arms 211 of the lever 210 includes

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a curved guide groove 214 which is an example of a first guide groove. Said curved guide groove 214 has an aperture 215 on the side of the lever portion 211 closer to the lever bridge 212, and by means of the aperture 215, a projection can be inserted into the curved guide groove 214 while the actuation lever 210 is rotated. The lever bridge 212 extends between
5 the two lever arms 211 and exhibit a grip portion 216 at the center, which can be utilized by the user to hold the lever while rotating it with respect to the axis formed by the lever pivots 113. The grip portion 216 may also be used as a mating latch member for locking the actuating lever 210 to the plug housing 100 by means of the resilient latch member 105 of the plug housing 100.

10 Figure 4 shows an alternative actuation lever 220. The parts of the actuation lever 220 which are in common with the actuation lever 210 will be indicated with the same reference signs and will not be described in the following description. According to figure 4, improved lever portions 221 for the actuation lever 220 may include a cam profile 218 which can be seen as a second guide groove. The cam profile 218 exhibits on its walls two slots 219
15 extending along the whole length of the cam profile 218 and is adapted to engage the cam portions 120 when the actuating lever 220 is pivoted in a final position. The cam profile slots 219 are adapted to be engaged with the head 122 of the cam portion 120 so as to increase the stability of the system when the actuation lever 220 is locked to the resilient latch member 105 of the housing 100.

20 Although in these particular examples the actuation levers 210 and 220 respectively include two arms 211 and 221 and are adapted to engage with two pivots 113 arranged on both side walls 103 of the plug housing 100, it may be possible to design the actuating lever 210 or 220 including only one arm 211 or 221.

In figure 5, a socket housing 300 is depicted as an example of a second connector
25 housing. The socket housing 300 has a box-shaped form and includes a first and a second wall opposing to each other joined by a third and fourth opposing walls. The first wall can be identified as front wall 301 and corresponds to the front wall 101 of the plug housing 100, while the second wall defines the rear wall 302 and corresponds to the rear wall 102 of the plug housing 100. The third and fourth walls define the side walls 303 of the socket housing
30 300. The shape and the dimension of the socket housing 300 may be such that the socket housing 300 can be inserted in the plug housing 100 described in figure 1. The front and rear walls 301 and 302 of the socket housing 300 respectively exhibit a T-shaped guiding rail 304.

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The guiding rails 304 are guide profiles projecting from the front and rear walls 301 and 302 of the socket housing 300 and are an example of first engaging means for the socket housing 300. Each of the guiding rails 304 may be formed on the socket housing 300 and projects from the front and rear walls 301 and 302 of the socket housing 300 so as to form two control channels 305 extending along the complete length of the front and rear wall 301 and 302. Moreover, the guiding rails 304 of the socket housing 300 include two socket resilient latch portions 312 that can be resiliently moved in the direction of mating of the electrical connector, and two socket locking spikes 313 projecting from each guiding rail 304 in a direction perpendicular to the front and rear wall 301 and 302 of the socket housing 300.

The control channels 305 allow to easily apply a sliding member 600 to the socket housing 300. The sliding member 600 is an example of actuation slide means and has a U-shaped design. It comprises a basis 610, which is adapted to match a side wall 303 of the socket housing 300 and can be used as handling part. The actuation slide means 600 further comprises two parallel flat legs 620, which extend away from the basis 610. The two flat legs 620 show, on their inner face, a first control means in the form of a guide groove or control slot 621 that extends along the direction of mating of the actuation slide means 600, and three second control means in the form of cam profiles or control grooves 622 extending in a direction transversal to the mating direction of the actuation slide means 600. Once the actuation slide means 600 has been guided in a final position by means of the guiding rails 304, it can be secured in the final position by means of the resilient latch portions 312 and the locking spikes 313.

On the front and rear walls 301 and 302 of the socket housing 300 is further formed a socket slit 306 extending from the edge of the front and rear walls 301 and 302 opposing a face 700 of the socket housing 300 and oriented in the mating direction of the electrical connector. The front and rear walls 301 and 302 further exhibit first socket receiving openings 307 for receiving and guiding the two prongs 109 of the U-shaped signal contact lock 108. The socket slit 306 and the first socket receiving openings 307 are arranged so as to form a T-shaped slot. On each side wall 303 of the socket housing 300 are further formed trapezoidal receiving openings or second socket receiving openings 309. Two trapezoidal profiles 310 including a latch projection 311 are further molded on the front and rear walls 301 and 302 of the socket housing 300 in correspondence of four vertices opposing to the face 700 of the socket housing 300. Further, on the front and rear walls 301 and 302 of the

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socket housing 300 are formed two inserting slits 308. The inserting slits 308 are used as counter-part of the guiding portions 141 of the plug housing 100 and are adapted to receive the guiding rails 141 for guiding the insertion of the socket housing 300 into the plug housing 100 when the electrical connector is connected.

5 The socket housing 300 further includes a first socket power contact lock 400, which is an example of a second engaging means for the socket housing 300. The body of the first socket power contact lock 400 has a rectangular shape and exhibit a protrusion 410 on top of which two locking bolts 411 are formed. The rectangular protrusion 410 has the function of engaging the corresponding recess 111 formed on the inner side of the plug connector
10 housing 100 so as to guide the insertion of the socket connector housing 300 into the plug housing 100. The first socket power contact lock 400 further exhibits two fixing prongs 412 and two trapezoidal projections 420 extending in the direction across the mating direction of the electrical connector. Two first socket power contact locks 400 can be applied to the side walls 303 of the socket housing 300 by inserting their prongs 412 into the corresponding
15 second socket receiving openings 309 formed on the side walls 303 of the socket connector housing 300. The prongs 412 of the first socket power contact lock 400 also have the function of locking power contacts (not shown) of the socket housing 300. Once the prongs 412 of the first socket power contact lock 400 are completely inserted into the second socket receiving openings 309, the trapezoidal projections 420 mate the two corresponding
20 trapezoidal profiles 310 molded in the front and rear walls 301 and 302, and may be further locked to the socket connector housing 300 by inserting the socket latch projection 311 into corresponding latch counterparts 421.

 Further, the socket housing 300 of the electrical connector according to the invention may also include a second socket power contact lock 500 as an example of third engaging
25 means for the socket housing 300. The second socket power contact lock 500 is based on the design of the first socket power contact lock 400, wherein on a protrusion 510 of the second socket power contact lock 500 is formed an engaging pivot 511 in correspondence to the fixing prongs 512. Said engaging pivot 511 is an example of first engaging pivot. Parts of the second socket power contact lock 500 such as fixing prongs 512 and trapezoidal projections
30 520, which have the same function of the similar parts of the first socket power contact lock 400 will not be described in detail.

Figure 6 shows an example of an alternative design for the socket housing 300

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adapted to mate the plug housing 100 of figure 2. The parts of the socket housing 300 of figure 6 which are common with the socket housing 300 of figure 5 will be indicated with the same reference signs and will not be described in the following. According to this embodiment, the inserting slits 308 are formed in different positions of the front and rear walls 301 and 302 of the socket housing 300. Alternatively, although this is not shown in the figures, the socket housing 300 may also have a design which does not include the inserting slits 308.

The first socket power contact lock 400 and the second socket power contact lock 500 may be alternatively inserted in the second socket receiving openings 309 so as to connect the plug housing 100 with the socket housing 300 according to different mating designs. In the following, examples of possible mating designs will be described in relation to figures 7 to 16. Further, reference will be made to the plug housing 100 and the socket housing 300 of figures 1 and 5. However, the following description can refer to the alternative plug housing 100 and socket housing 300 depicted in figures 2 and 6.

Figure 7 shows a perspective view of an electrical connector wherein the socket connector housing 300 can be fixed to the plug housing 100 by means of the above-described first socket power contact locks 400. In this example, the signal contacts (not shown) in the socket housing 300 are locked to the socket housing 300 by means of a signal contact lock 108 inserted into the first socket receiving openings 308. According to this design, the electrical connector is connected by directly inserting the socket housing 300 into the plug housing 100 along the direction 10, which is the mating direction of the electrical connector assembly. When the first socket contact lock 400 is used, the bolts 411 formed on the rectangular protrusion 410 slide into the recess 111 of the plug housing 100 and lock the socket housing 300 to the plug housing 100 by interlocking the corresponding locking opening 112 formed on the side wall 103 of the plug housing 100. According to this embodiment, the power contact lock 115 with the T-shaped basis including the cam portion 120 may be replaced by a U-shaped power contact lock 1151 with rectangular basis, which can be inserted in a corresponding rectangular slot formed on both side walls 103 of the plug housing 100.

Figure 8 shows a perspective view of the completely connected electrical connector. From this figure it can be clearly seen how the locking bolts 411 of the first socket power contact lock 400 firmly interlock the locking opening 112 formed on the side walls 103 of the

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first connector housing 100.

A perspective view of the electrical connector using the actuation lever 210 is shown in figure 9. The pivot receiving openings 213 and the curved pivot grooves 217 of the actuating lever 210 are respectively engaged with the pivots 113 and with the auxiliary
5 curved pivot members 140 of the plug housing 100. In this embodiment, the power contacts on the plug housing 100 are fixed by means of the U-shaped power contact locks 1151.

Similarly, the signal contacts are fixed to the plug housing 100 by means of the signal contact lock 108 inserted into the corresponding receiving holes 107 formed on the rear wall 102 of the plug housing 100. In Figure 9 the socket connector housing 300 is partially inserted into
10 the plug housing 100 and the actuation lever 210 is partially engaged with its counterpart on the socket housing 300. The counterpart of the actuation lever 210 is the engaging pivot 511 on the second socket power contact lock 500. The engaging pivot 511 is inserted into the curved guide groove 214 of the actuating lever 210 through the aperture 215 and from this starting position, the actuation lever 210 can be rotated along the direction 20 towards a final
15 position so as to completely lock the plug housing 100 with the socket housing 300. When the socket housing 300 and the plug housing 100 are pulled together, the engaging pivot 511 formed on the second socket power contact lock 500 slides into the locking opening 112 through the inserting channel 130, formed on the protrusions 110 of the side walls 303 of the socket housing 300. Since the actuation lever 210 locks with pivots on the second socket
20 power contact locks 500 on both sides of the socket connector housing 300, the connector is pulled to a final position by means of said second socket power contact locks 500, thereby reducing the tolerance chain for the terminal overlap.

Figure 10 shows an embodiment of the present invention according to the actuating lever design of figure 9 wherein the actuation lever 210 is locked in its final position. From
25 the figure, it is possible to see how the resilient latch member 105 of the plug housing 100 locks the actuation lever 210 by engaging the grip portion 216 with its arrow-shaped latch portion 106.

An embodiment of the electrical connector actuated by the actuating lever 220 is depicted in figure 11. As already described with reference to figures 9 and 10, the counterpart
30 of the actuation lever 220 is the engaging pivot 511 on the second socket power contact lock 500. The engaging pivot 511 is adapted to be inserted into the curved guide groove 214 of the actuating lever 220. Additionally, the cam profile 218 of the actuation lever 220 is

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adapted to engage the cam portion 120 of the power contact lock 115 of the plug housing 100. When the actuating lever 220 is rotated to its final position along the direction 20, the engaging pivots 511 on both side walls 303 of the socket housing 300 slide into the curved guide grooves 214 of the actuating lever 220. Similarly, the cam portions 120 of the power
5 contact locks 115 slide into the cam profiles 218 of the actuation lever 220. Accordingly, the actuation lever 220 pulls the plug housing 100 and the socket housing 300 together by means of the engaging pivots 511 on the second socket power contact lock 500 and the cam portions 120 on the power contact locks 115. This solution allows to further reduce the tolerance chains for the terminal contact overlap. When the socket housing 300 and the plug
10 housing 100 are pulled together, the engaging pivot 511 slides through the inserting channel 130 until it is completely inserted into the locking opening 112. Once in its final position, the actuation lever 220 also keeps the power contact locks 115 in position, thereby avoiding that the power contact locks 115 are unintentionally moved from the final position.

Figure 12 shows a transparent perspective view of the fully connected electrical
15 connector using the actuation lever 220. From this figure it is possible to see the relative position of the first engaging pivot 511 and the cam portion 120. According to this embodiment, the engaging pivot 511 of the socket housing 300 and the cam portion 120 of the plug housing 100 are vertically aligned, thereby being in line with the locking force. Since the actuating lever 220 cooperates with the engaging pivots 511 on the socket connector
20 housing 300 and the engaging pivots or cam portions 120 on the plug housing 100 and the pivots 511 and 120 are vertically aligned and in line with the locking force, the stability of the fully connected connector can be increased. This avoids that an external force may open the actuation lever 220 once it is locked to the resilient latch member 105 on the front wall 101 of the plug housing 100. Further, it is also evident from the figure how the engaging pivot
25 511 and the cam portion 120 respectively mate the first guide groove 214 and the cam profile 218 of the actuating lever 220. An example of a fully connected connector assembly using the actuation lever 220 is further shown in figure 13.

Figure 14 illustrates a situation in which the power contact lock 115 is not completely inserted into the plug housing 100. The use of the power contact lock 115 in combination
30 with the actuation lever 220 provides the further advantage that, when the contact lock 115 is not completely inserted into the corresponding receiving openings 107 of the plug housing 100, the actuation lever 220 cannot reach its final position, and a situation wherein the

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electrical connector is connected while the power contacts of the plug housing 100 are not fixed to the housing itself is avoided.

Figure 15 shows the electrical connector according to the invention, wherein the connection is actuated by an actuation slide means 600. When connecting the electrical connector assembly, the legs 620 of actuation slide means 600 can be pushed along the front and rear walls of the connector. The control slots 621 integrally molded on the inner side of each leg 620 of the actuation slide means 600 will engage the corresponding guiding rails 304 formed on the socket housing 300. At the same time, the first of the three control grooves 622 molded on the inner face of each leg 620 of the actuation slide means 600 will mate the first guiding pin 104 of the plug housing 100. When the actuating slide means 600 is pushed to its final position, the second and third control grooves 622 will mate the corresponding second and third guiding pins 104 on the plug housing 100, thereby causing the plug housing 100 to move towards the socket housing 300 in the direction of mating of the electrical connector until the contacts in the plug housing 100 are fully connected with the contacts in the socket housing 300.

The actuation slide means 600 can be further releasably latched in an end position by means of the two resilient latch portions 312 formed on the guiding rails 304 and the two locking spikes 313. The resilient latch portions 312 on the guiding rails 304 will move towards the plug housing 100 when the actuation slide means 600 is engaged with the guiding rail 304 so as to allow the actuation slide means 600 to slide into its final position. Once the actuation slide means 600 is in its final position, the resilient latch portions 312 of the guiding rails 304 will resiliently return to their original position, thereby locking the actuation slide means 600 in its final position. Further, the locking spikes 313 provided on the guiding rails 304 contribute to increase the stability of the fully connected connector. In figure 15, the socket connector housing 300 includes the second socket power contact locks 500 but it may alternatively include the first socket power contact locks 400. If the first socket power contact locks 400 are used, the locking bolts 411 will fit into the locking openings 112 on the side walls 103 of the plug housing 100 when the actuation slide means 600 is in its final position, thereby increasing the stability of the connector. An example of an electrical connector fully connected by means of an actuation slide means 600 is shown in figure 16.

Figure 17 shows a top view of a face 700 of the electrical connector according to the

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invention. From this figure, it is possible to see the disposition of cavities for receiving contacts. In a particular embodiment of the present invention, the electrical connector is designed for receiving 30 contacts. Accordingly, 20 contact cavities 710 adapted to receive 20 signal contacts (not shown) are disposed in a central position of the connector face 700 and are arranged on five rows. The 20 signal contacts can support a wire with a section between 0.35 and 1.5 mm². On the right and left sides of the signal contacts receiving cavities 710 are disposed two groups of four AMP MCP (multiple contact point) contact receiving cavities 720, which are an example of first power contact cavities. Two further AMP MCP contact receiving cavities 721 are respectively disposed on the right and left sides of the two groups of 4 AMP MCP contact receiving cavities 720 and are an example of second power contact cavities. As apparent from figure 17, all the terminal cavities are symmetrically disposed with respect to one of a middle axis 701 of the electrical connector. This disposition allows to organize the available space in the connector face 700, thereby reducing the dimensions of the connector itself. Indeed, the electrical connector according to the invention can receive a 30-way connection and its overall dimension is essentially the same as the dimension of a 20-way connector of the same type.

According to the present invention, a new electrical connector is provided, which can be connected using a plurality of mating designs according to the user needs and the available space. The invention uses a standard housing design for socket and plug housings, on which it is possible to assemble different engaging means like a lever and a slide keeping the same housing configuration. In the case that the customer uses the connector in a contact depopulated version, the same housing design can be used for a direct insertion connection.

Since the electrical connector according to the invention can be connected using different standard mating designs, the customer can use the same product for different applications, without having to implement substantial modifications to the connector assembly and without having to purchase additional elements. In other words, the connector assembly according to the invention has the advantage that a standardization at the customer production side can be obtained, thereby causing a reduction of the investments.

Furthermore, since the electrical connector according to the invention can replace a plurality of standard connectors currently used in the industrial production, e.g. in the automotive sector, this provides the further advantage of simplifying the management of the part numbers. Indeed, the electrical connector according to the present invention, which is

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associated with only one part number, replaces a plurality of standard connectors, each of which is associated with one part number.

Claims

1. A first connector housing (100) for use in an electrical connector assembly, said first connector housing (100) comprising:

a first and a second engaging means for the first connector housing arranged on walls
5 (101, 102, 103) of said first connector housing (100),

at least one pivot means (113) arranged on at least one of the walls (101, 102, 103) of the first connector housing (100) for pivotally mounting a third engaging means for the first connector housing,

wherein each of the engaging means for the first connector housing (100) is adapted
10 to be respectively engaged with a corresponding engaging means arranged on a complementary second connector housing (300), and

wherein said first connector housing (100) is adapted to be engaged with the complementary second connector housing (300) by using at least one of said engaging means.
- 15 2. The first connector housing (100) of claim 1, wherein the first engaging means includes at least two guiding elements (104) adapted to be engaged with corresponding cam profiles (622) of an actuation slide means (600) for moving the complementary second connector housing (300) towards the first connector housing (100) when the actuation slide means (600) is moved to a final position.
- 20 3. The first connector housing (100) of claim 1 or 2, wherein the second engaging means for the first connector housing (100) comprises at least one locking opening (112) adapted to receive at least one locking bolt (411) included in the complementary second connector housing (300).
- 25 4. The first connector housing (100) of any one of claims 1 to 3, wherein the third engaging means for the first connector housing (100) is an actuation lever (210, 220) including a first and a second lever portion (211, 221) joined by a bridge element (212), said first and second lever portions (211, 221) being respectively supported by

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two pivot means (113) arranged on opposing walls of said first connector housing (100).

5. The first connector housing (100) of claim 4, wherein the first and second lever portions (211, 221) respectively comprise at least one first guide groove (214) adapted to engage a corresponding first engaging pivot (511) included in the complementary second connector housing (300), for moving the complementary second connector housing (300) towards the first connector housing (100) when the actuation lever (210, 220) is rotated to a final position.

6. The first connector housing (100) of claim 4 or 5, wherein the first and second lever portions (211, 221) further include at least one second guide groove (218) adapted to engage a corresponding second engaging pivot (120) for moving the first connector housing (100) towards the complementary second connector housing (300) when the actuation lever (210, 220) is rotated to a final position, said second engaging pivot (120) being arranged on at least one wall (101, 102, 103) of said first connector housing (100) and vertically aligned with the first engaging pivot (511) included in the complementary second connector housing (300).

7. The first connector housing (100) according to any one of claims 4 to 6, wherein one wall (101, 102, 103) of the first connector housing (100) includes at least one resilient latch member (105) and the bridge element (212) comprises at least one mating latch member (216), said at least one mating latch member (216) being adapted to be engaged with the at least one resilient latch member (105) when the actuation lever (210, 220) is in a final position.

8. The first connector housing (100) according to any one of claims 1 to 7, further including contact receiving cavities (710, 720, 721) for receiving power and signal contacts, wherein said contact receiving cavities (710, 720, 721) are symmetrically disposed with respect to one of the middle axis (701) of a connector face (700) of the first connector housing (100).

9. The first connector housing (100) according to any one of claims 1 to 8, further including first receiving openings (114) for receiving at least one power contact lock (115) and second receiving openings (107) for receiving at least one signal contact

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lock (108) for respectively fixing power and signal contacts to the first connector housing (100),

wherein at least one contact lock (115) of the first connector housing (100) is adapted to be inserted in a wall (101, 102, 103) in a vertical position with respect to the first engaging pivot (511), and

the at least one second engaging pivot (120) is formed on said contact lock (115) and vertically aligned with the first engaging pivot (511) included in the complementary second connector housing (300).

10. The first connector housing (100) according to any one of claims 1 to 9, wherein the inner face of at least two walls (101, 102, 103) exhibit two opposing recesses (111) for guiding the insertion of the complementary second connector housing (300).

11. A second connector housing (300) for use in an electrical connector assembly, said second connector housing (300) comprising:

a first engaging means for the second connector housing,

second and third engaging means for the second connector housing (400, 500) interchangeably applicable to at least one wall (301, 302, 303) of the second connector housing (300), wherein

each of said first, second and third engaging means for the second connector housing (400, 500) is adapted to be respectively engaged with a corresponding engaging means arranged on a complementary first connector housing (100), and

said second connector housing (300) is adapted to be engaged to the complementary first connector housing (100) by using at least one of said engaging means.

12. The second connector housing (300) of claim 11, further including the actuation slide means (600), said actuation slide means (600) comprising:

at least two guide grooves (621) respectively included in two opposing walls (620) of the actuation slide means (600) for engaging with corresponding engaging means of the second connector housing (300), and

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at least two cam profiles (622) included on two opposing walls (620) of the actuation slide means (600) and extending in a direction transverse to a direction of mating of the electrical connector, said at least two cam profiles (622) being adapted to engage the at least two guiding elements (104) of the complementary first connector housing (100) for moving said second connector housing (300) towards the complementary first connector housing (100) when the actuation slide means (600) is moved to a final position.

13. The second connector housing (300) of claim 11 or 12, wherein the first engaging means for the second connector housing (300) includes at least a first and a second guide profile (304) respectively projecting from two opposing walls (301, 302, 303) of the second connector housing (300) and extending in a direction across the direction of mating of the electrical connector, and

wherein said guide profiles (304) are adapted to engage the at least two guide grooves (621) of the actuation slide means (600) and exhibit at least one resilient latch portion (312) adapted to cooperate with at least one corresponding mating latch portion on the actuation slide means (600) for locking said actuation slide means (600) in a final position.

14. The second connector housing (300) according to any one of claims 11 to 13,

wherein the second engaging means for the second connector housing (400) is adapted to be inserted in second receiving holes (309) formed on at least one wall (301, 302, 303) of the second connector housing (300), said second engaging means for the second connector housing (400) further including the at least one locking bolt (411) adapted to be engaged with the locking opening (112) of the complementary first connector housing (100); or

wherein the third engaging means (500) for the second connector housing (300) is adapted to be inserted in second receiving holes (309) formed on at least one wall (301, 302, 303) of the second connector housing (300), and

wherein said third engaging means (500) for the second connector housing (300) comprises the first engaging pivot (511) adapted to be engaged with the

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corresponding guide grooves (214) formed in the first and second lever portion (211) of the actuation lever (210, 220) for moving the second connector housing (300) towards the complementary first connector housing (100) when the actuation lever (210, 220) is rotated to a final position.

5 15. The second connector housing (300) of one of claims 11 to 14, further including contact receiving cavities (710, 720, 721) for receiving power and signal contacts, wherein the contact receiving cavities (710, 720, 721) are symmetrically disposed with respect to one of the middle axis (701) of a connector face (700) of the second connector housing (300),

10 wherein the second or third engaging means (400, 500) for the second connector housing (300) are further adapted to fix the contacts in the second connector housing (300); and

15 said second connector housing (300) further includes first receiving holes (307) for receiving at least one additional contact lock (109) for fixing the contacts in the second connector housing (300).

16. The second connector housing (300) of any one of claims 11 to 15, wherein the second and third engaging means (400, 500) have a protrusion (410, 510) adapted to slide into the recesses (111) of at least two walls (101, 102, 103) of the complementary first connector housing (100) for guiding the insertion into said complementary first connector housing (100).

20 17. An electrical connector assembly comprising the first connector housing (100) according to any one of claims 1 to 10 and the second connector housing (300) according to any one of claims 11 to 16, wherein the first connector housing (100) is adapted to be engaged with the second connector housing (300) by at least a pair of
25 the plurality of engaging means (112, 210, 220, 304, 400, 500).

* * * * *

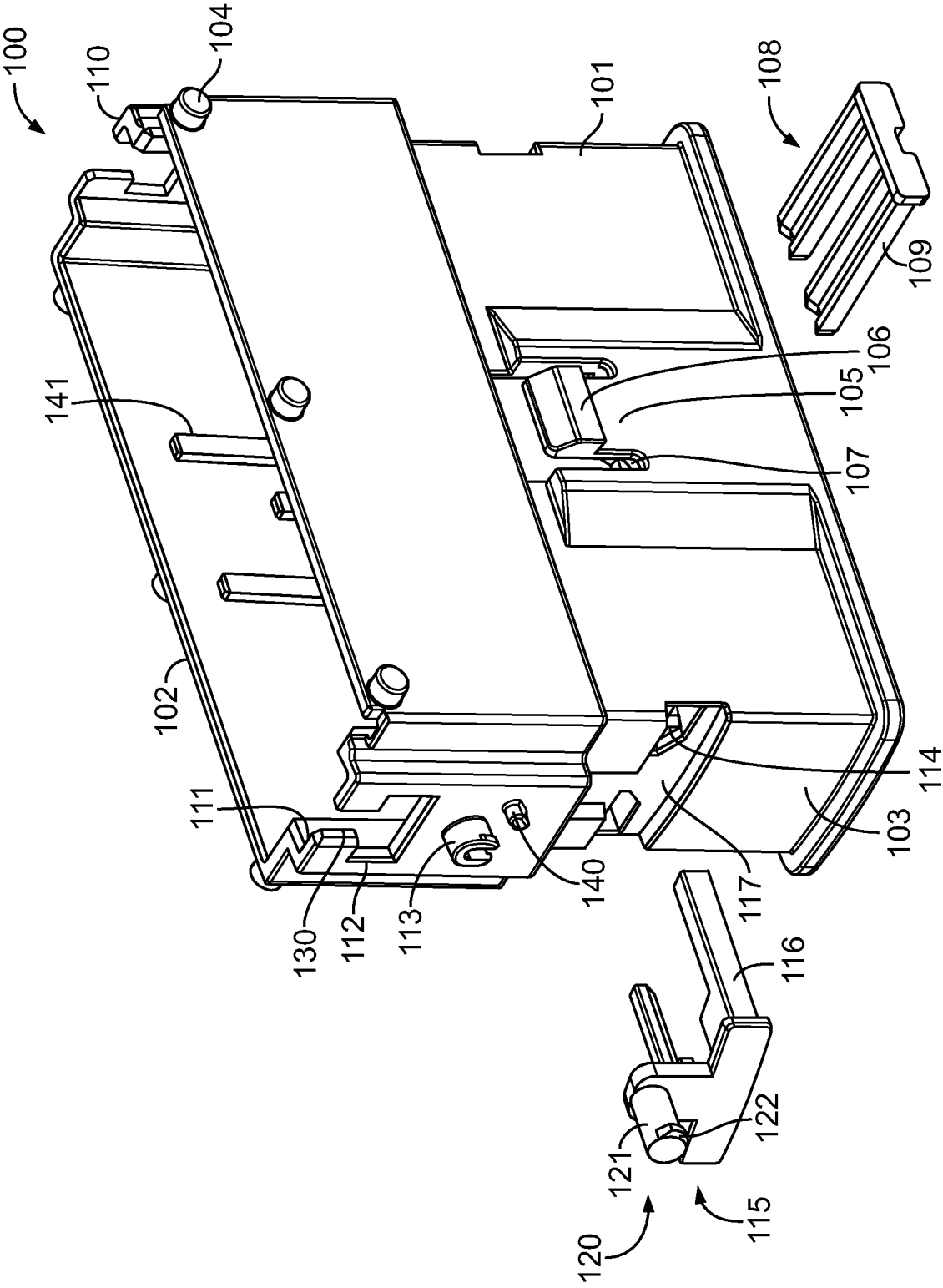


Fig. 1

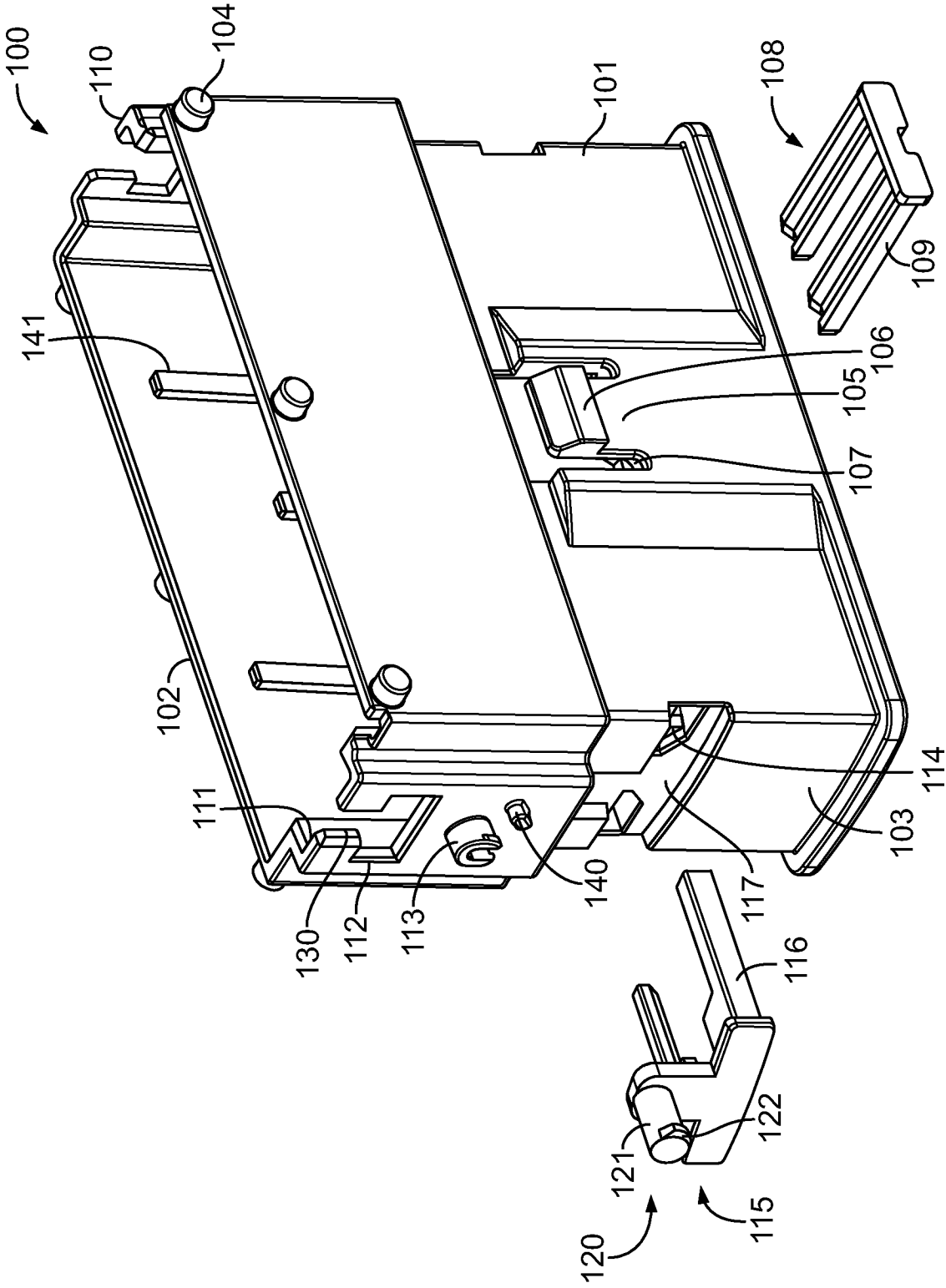


Fig. 2

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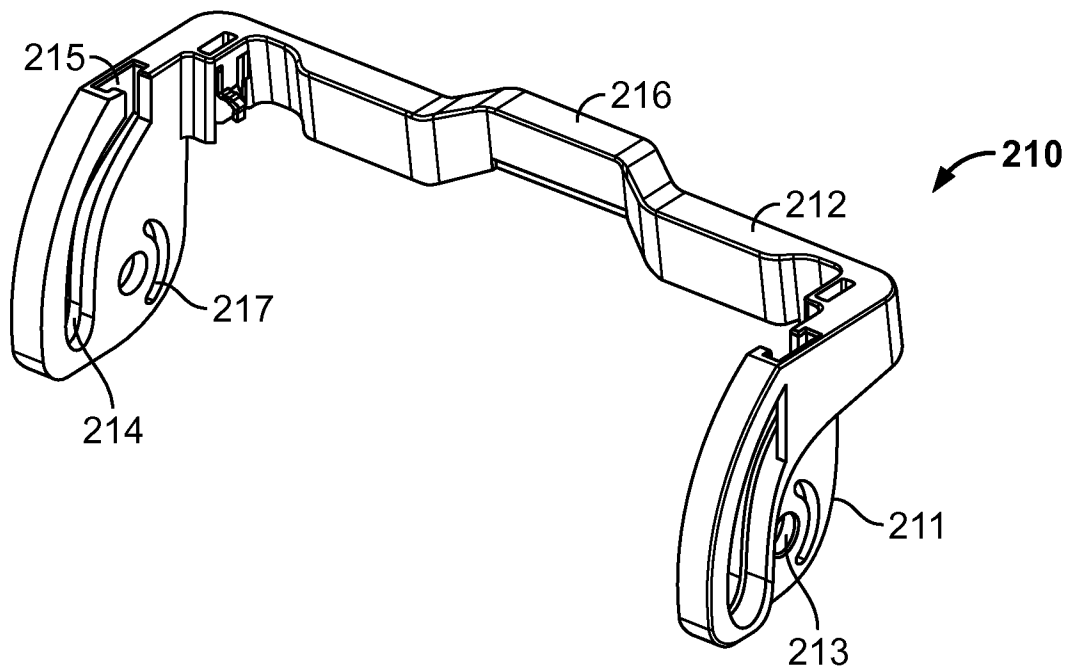


Fig. 3

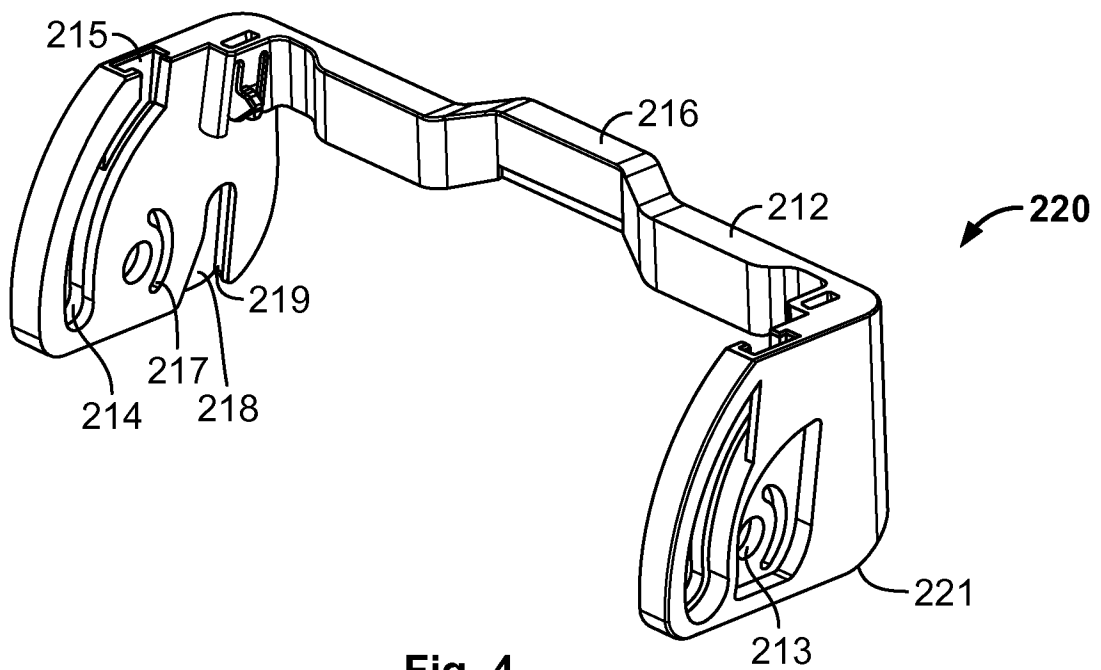


Fig. 4

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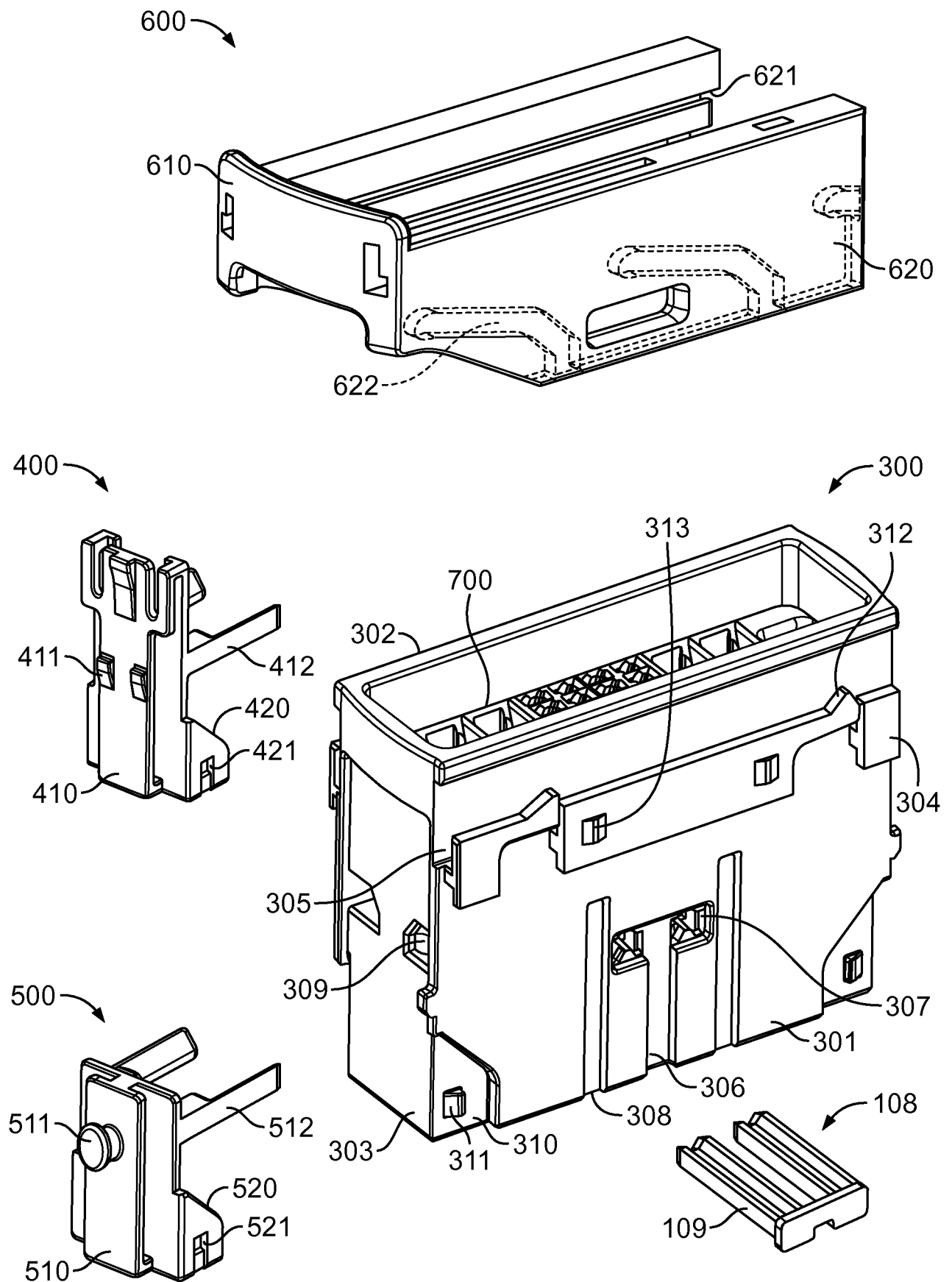


Fig. 5

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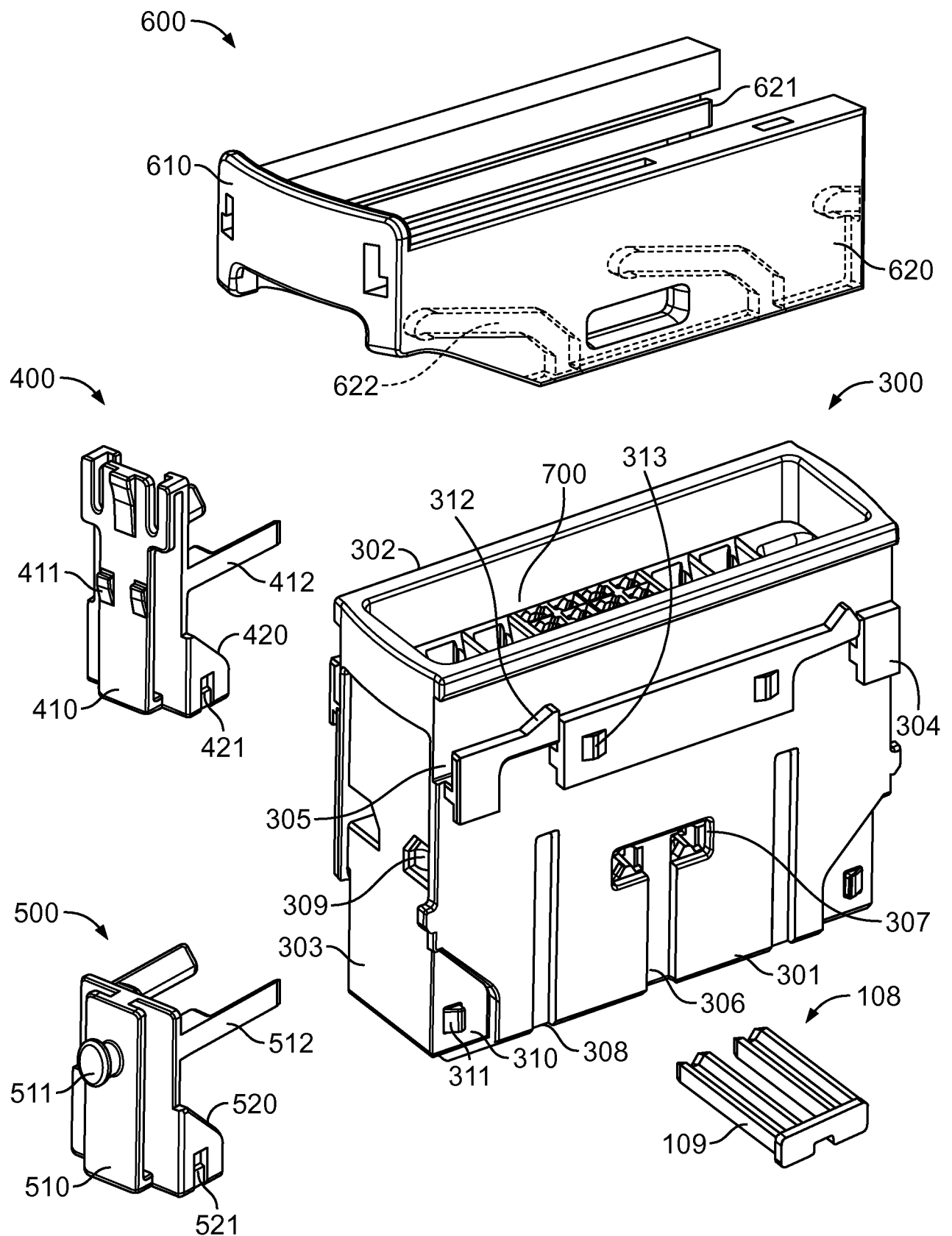


Fig. 6

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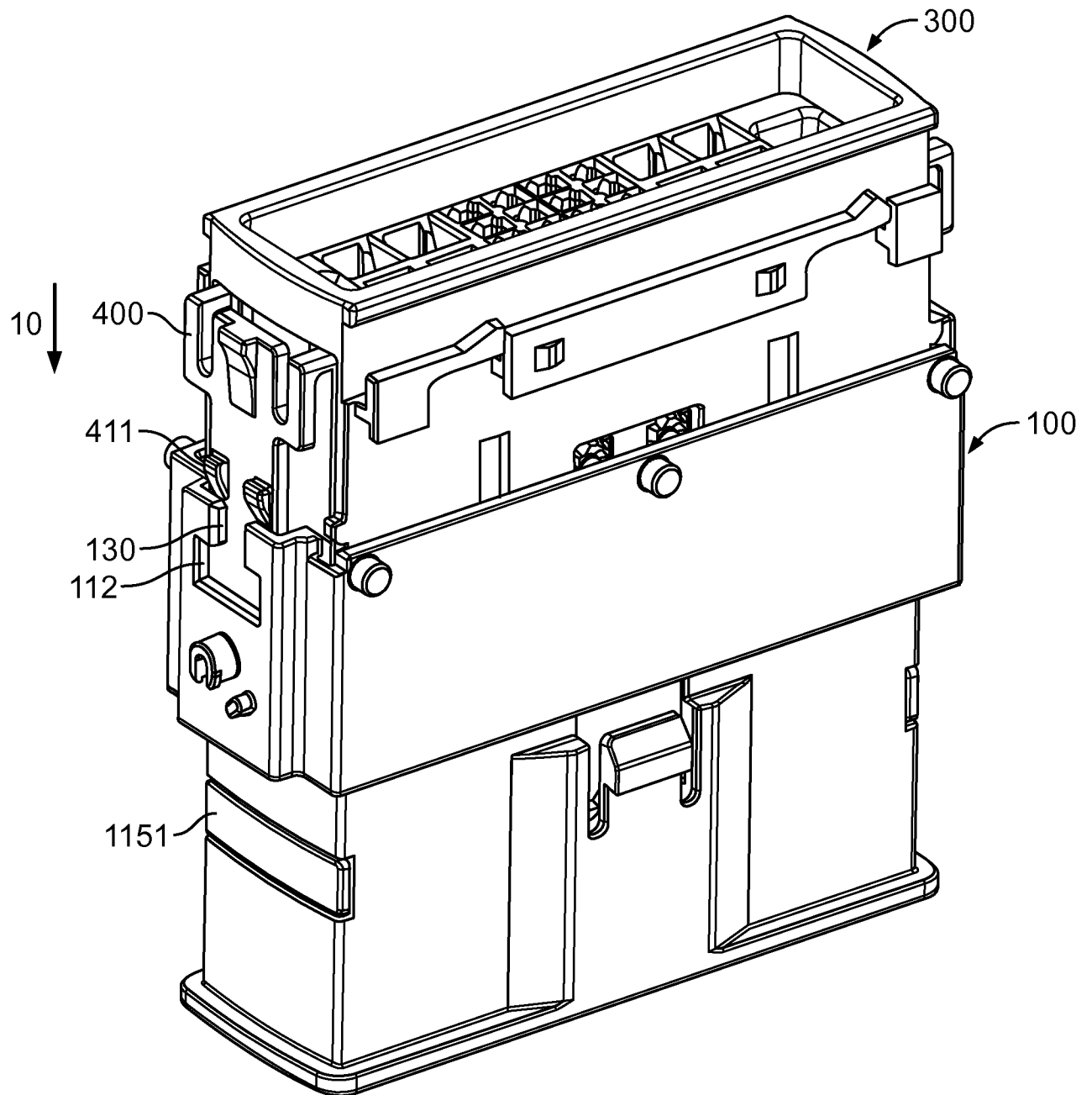


Fig. 7

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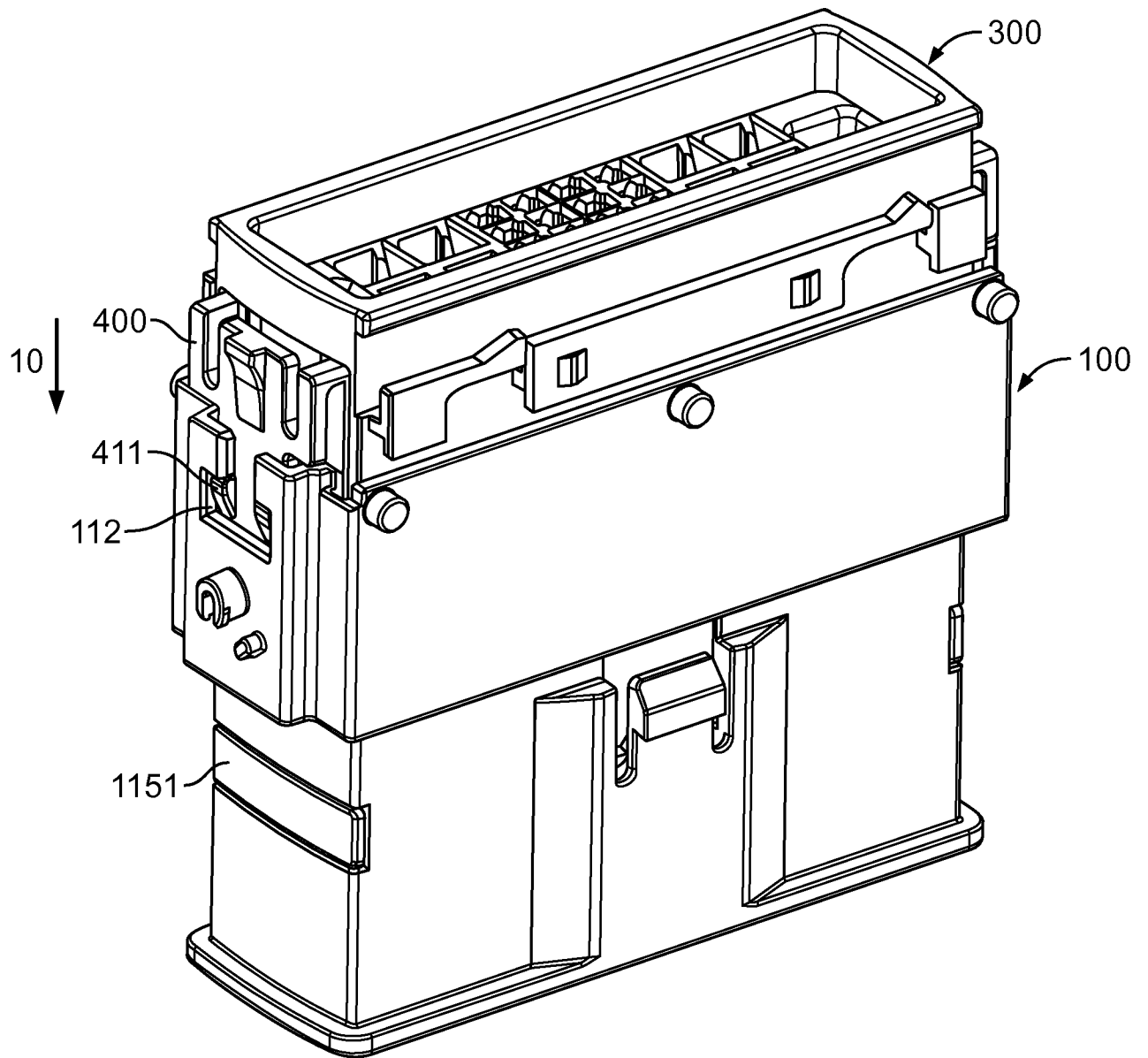


Fig. 8

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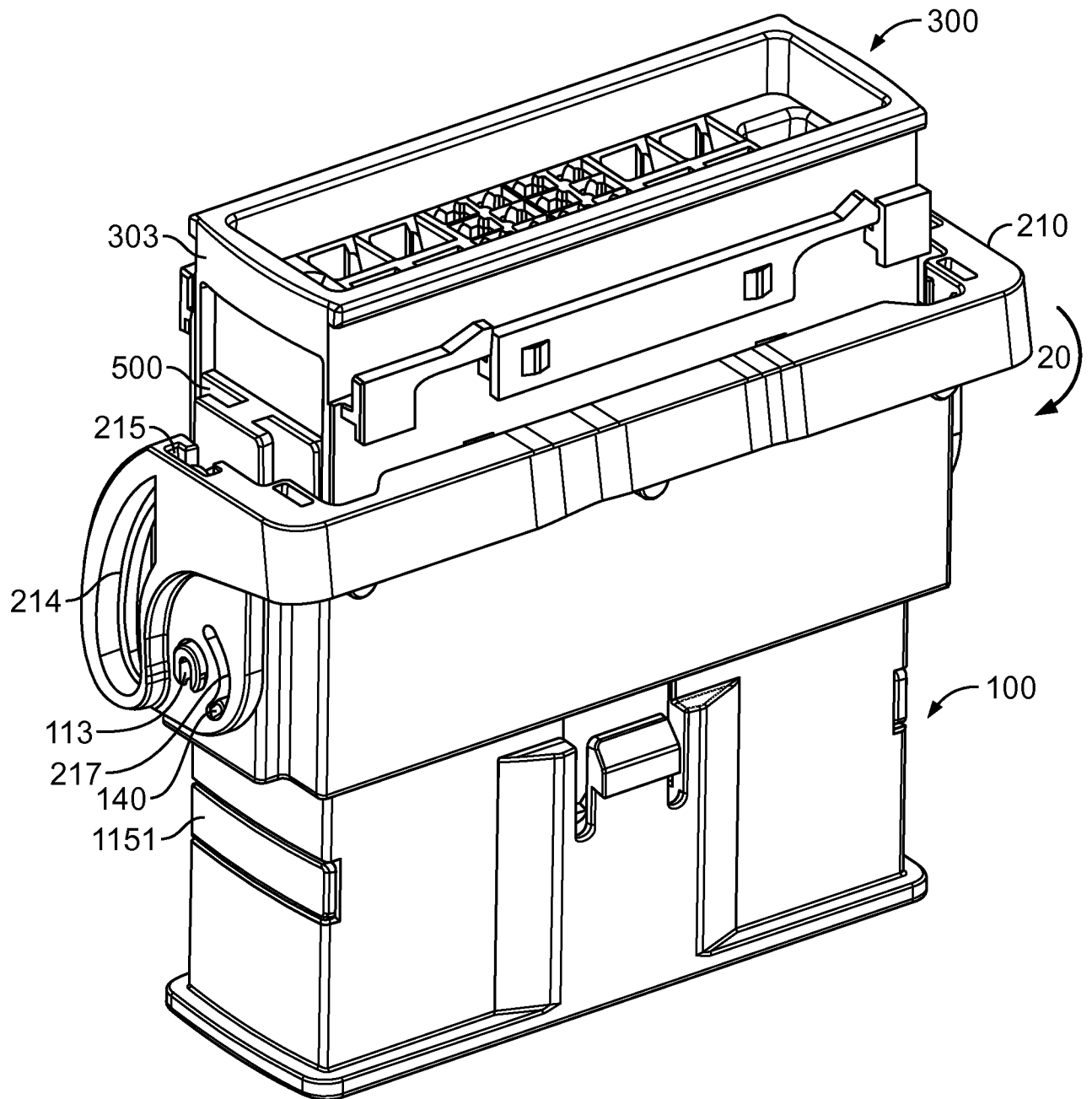


Fig. 9

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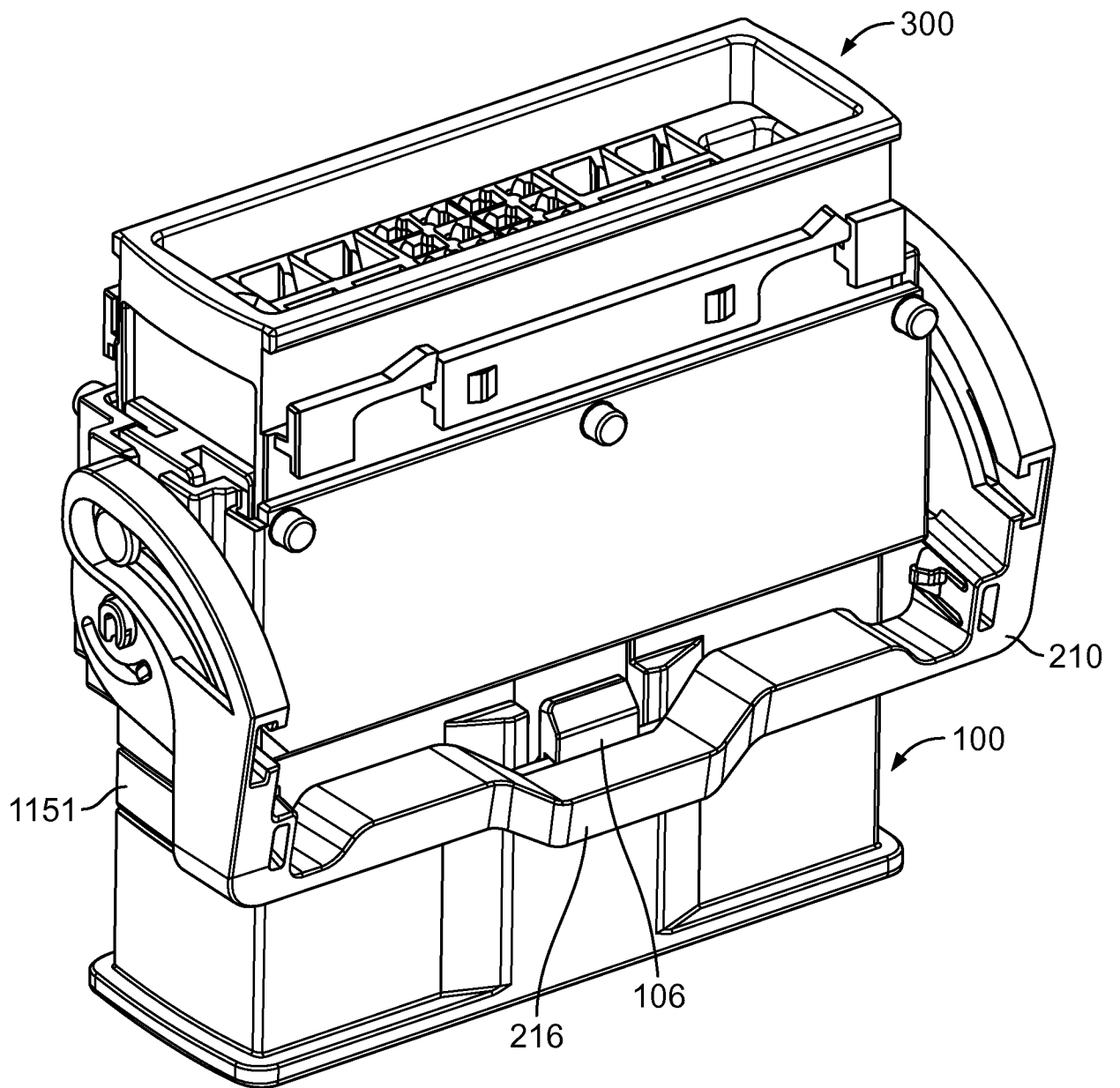


Fig. 10

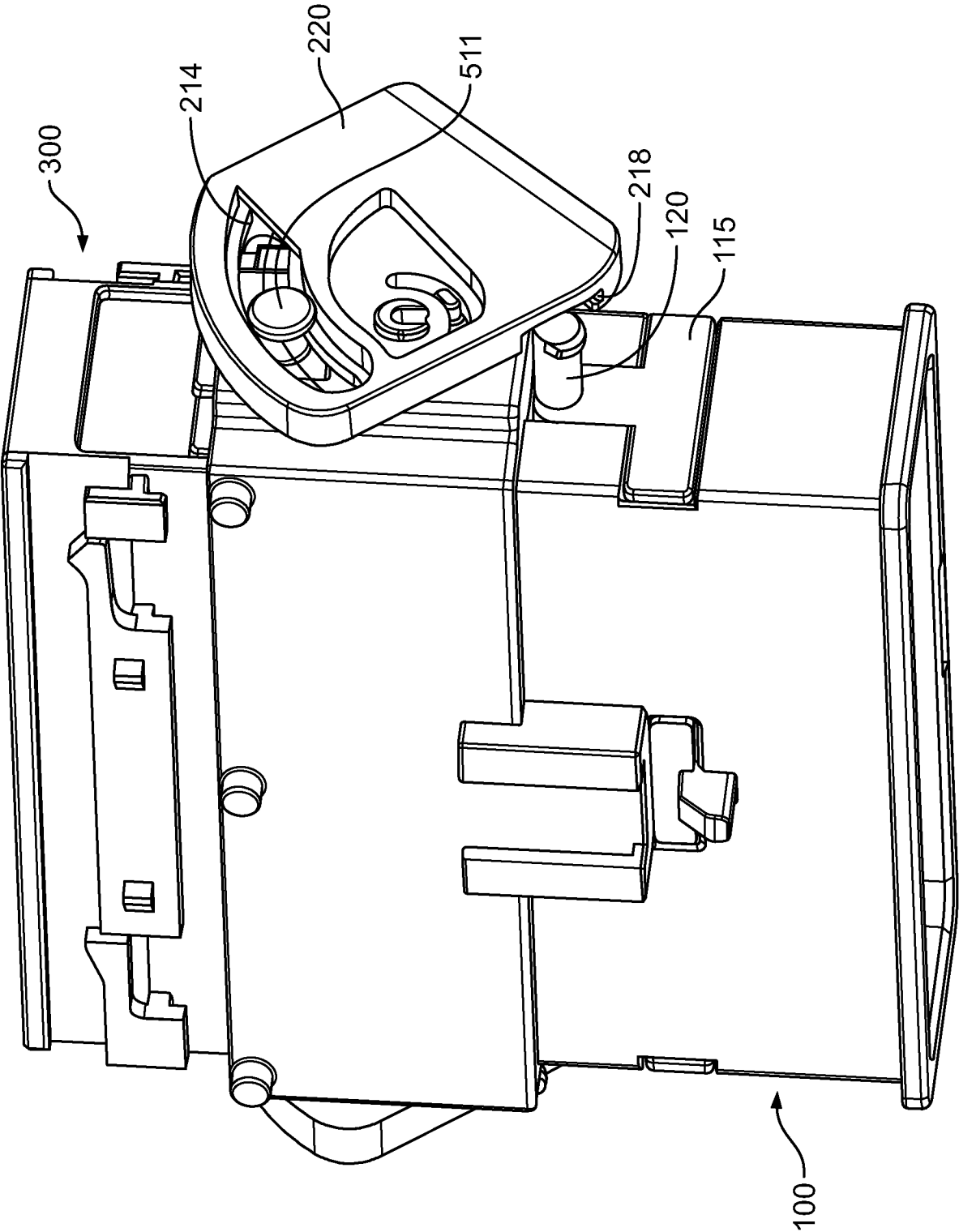


Fig. 11

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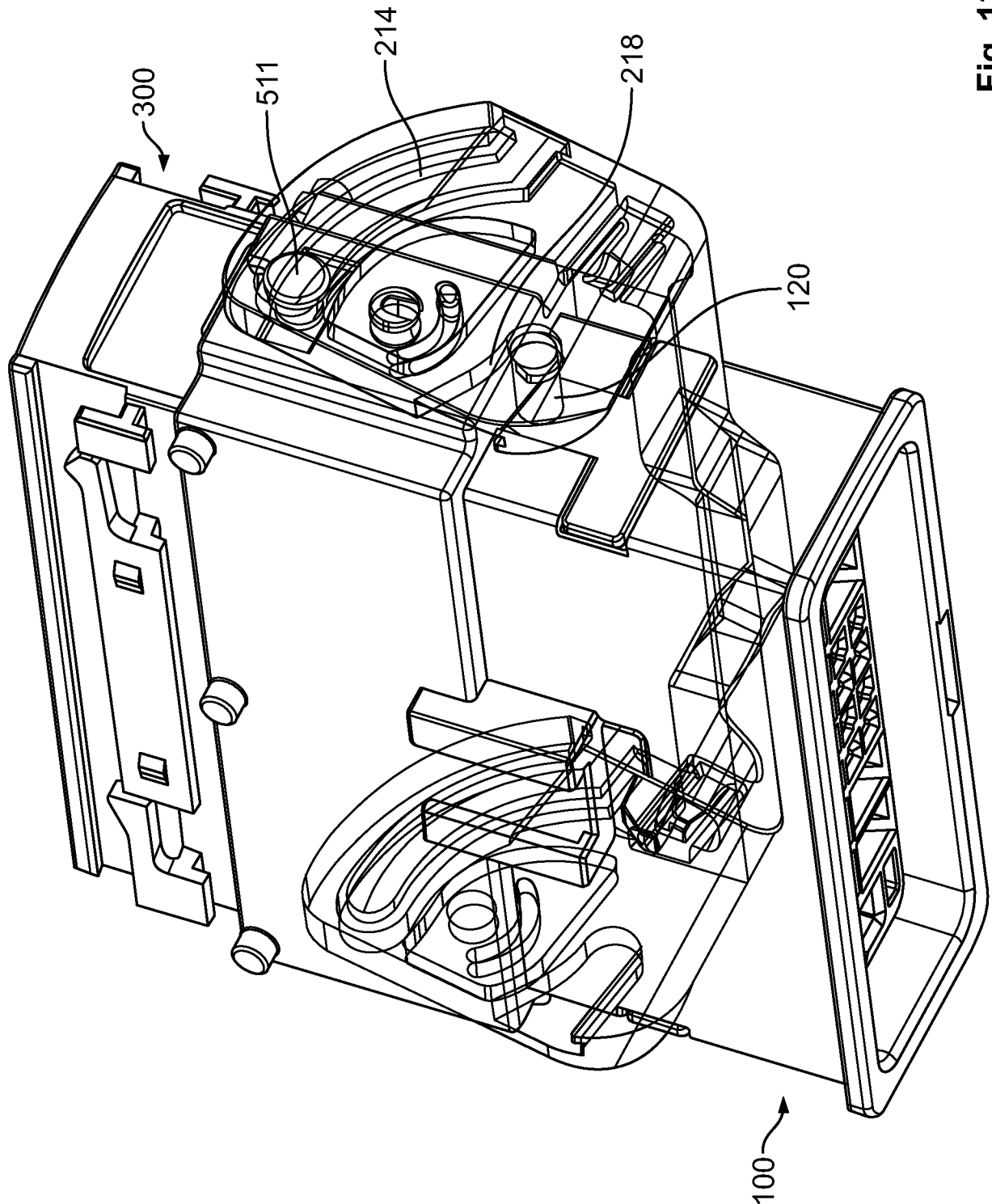


Fig. 12

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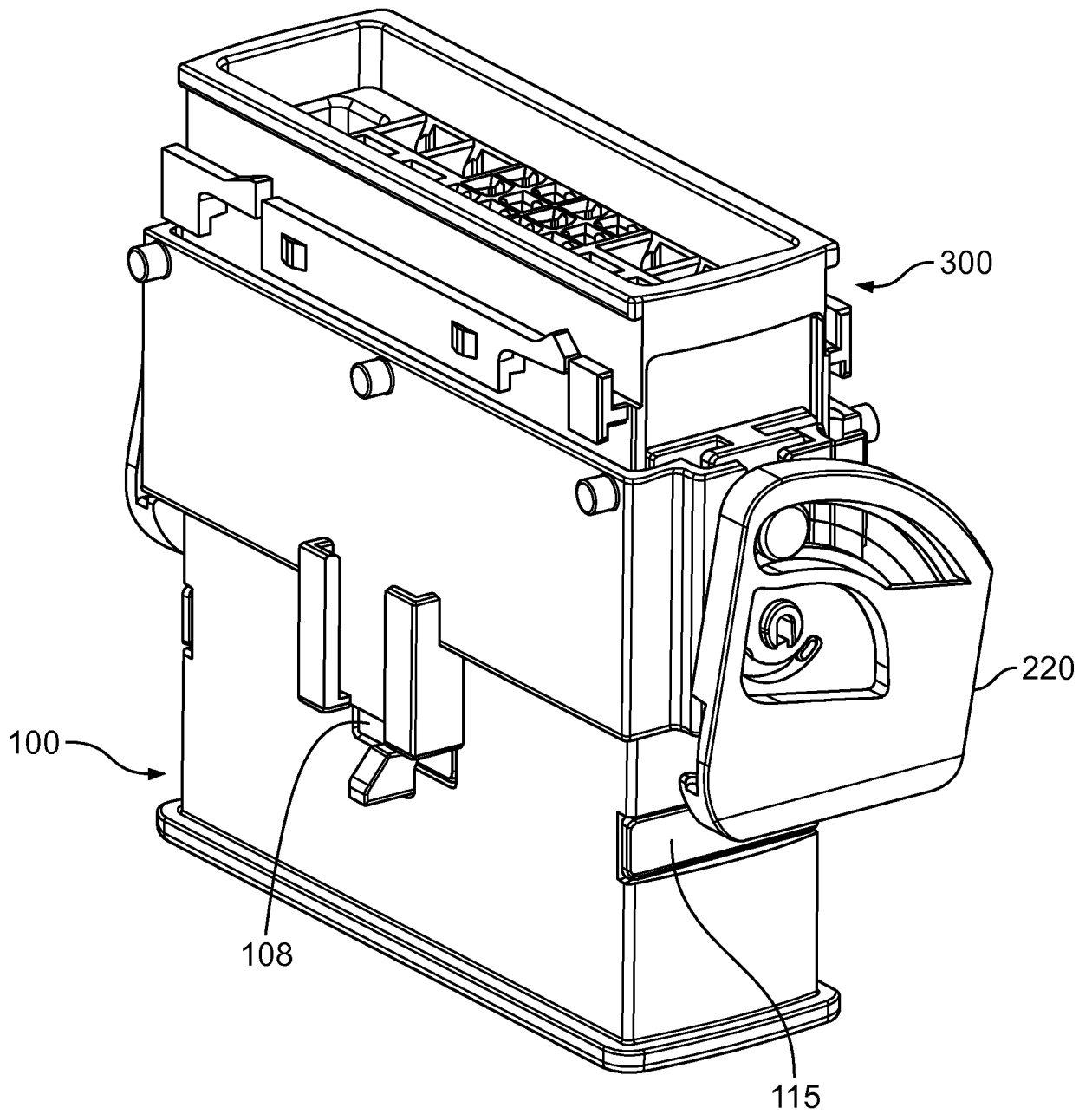


Fig. 13

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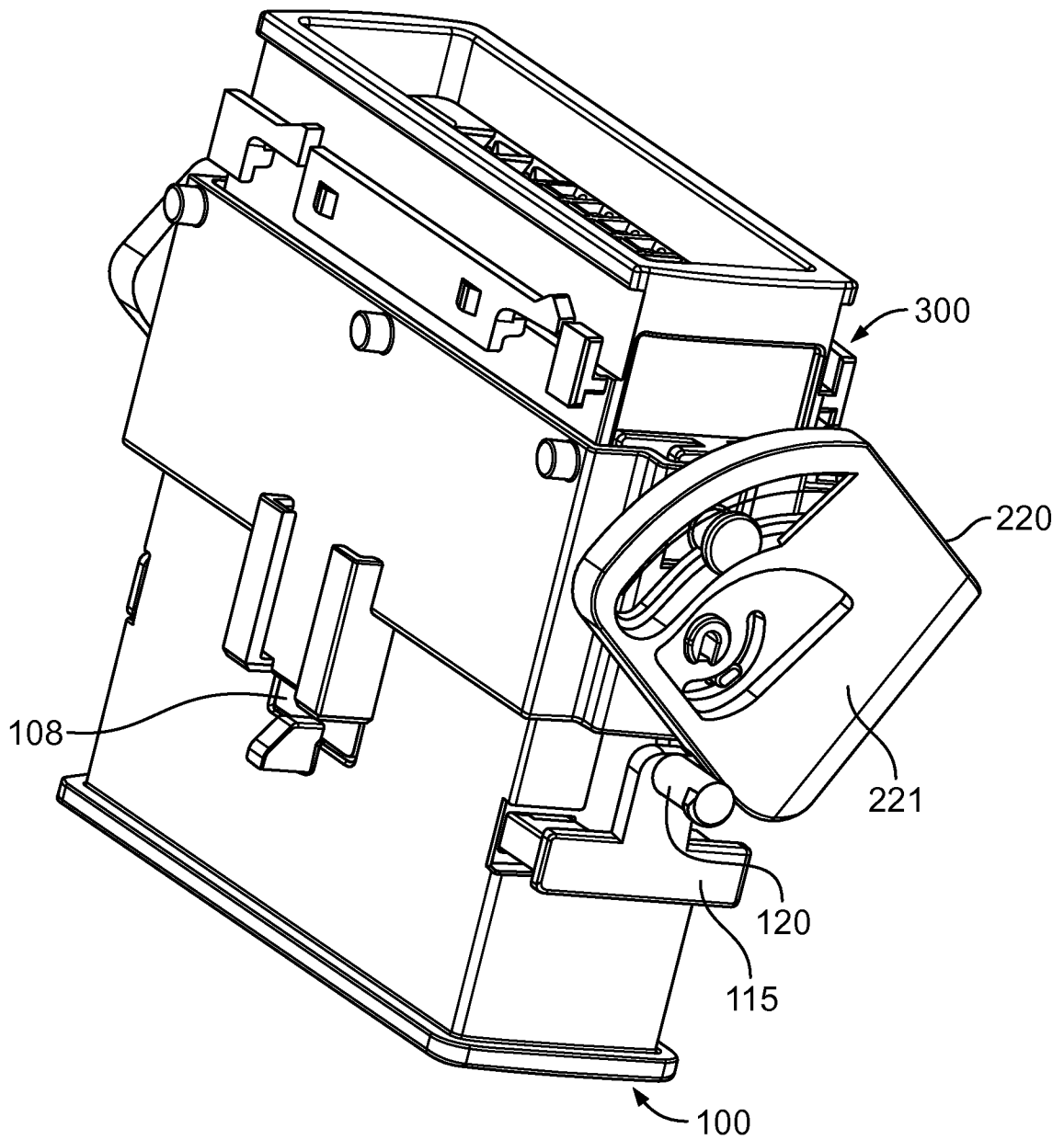


Fig.14

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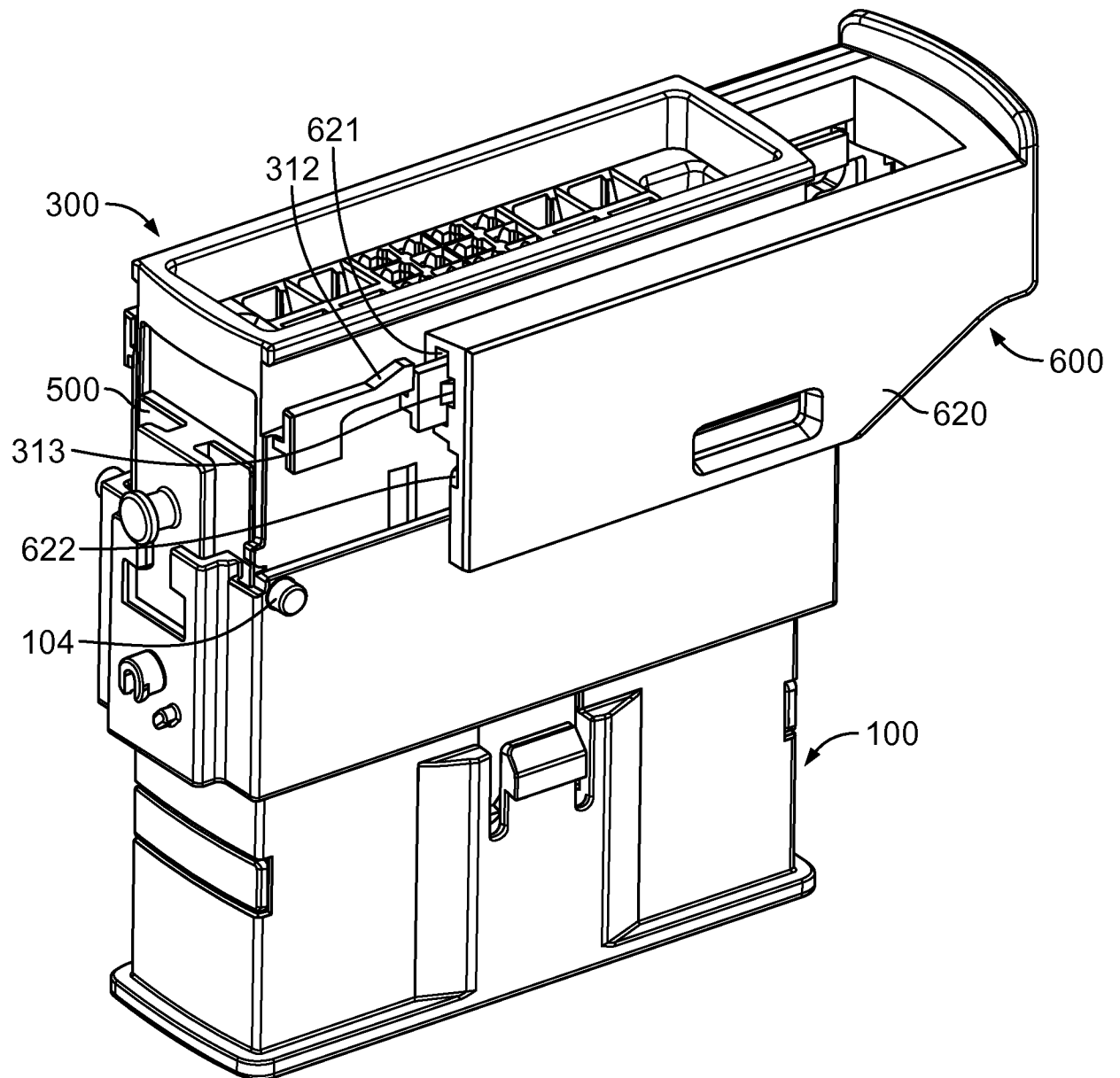


Fig. 15

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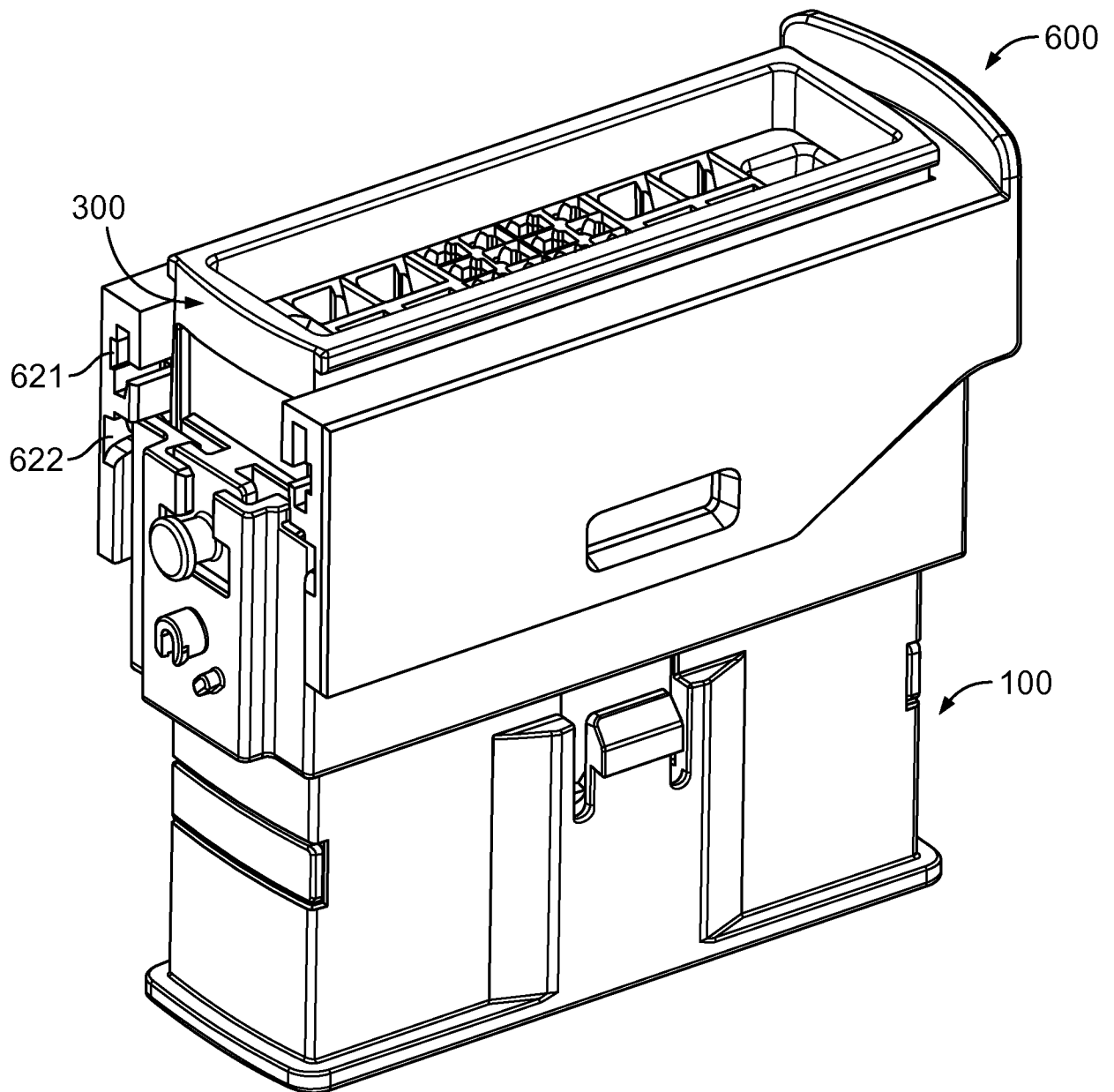


Fig. 16

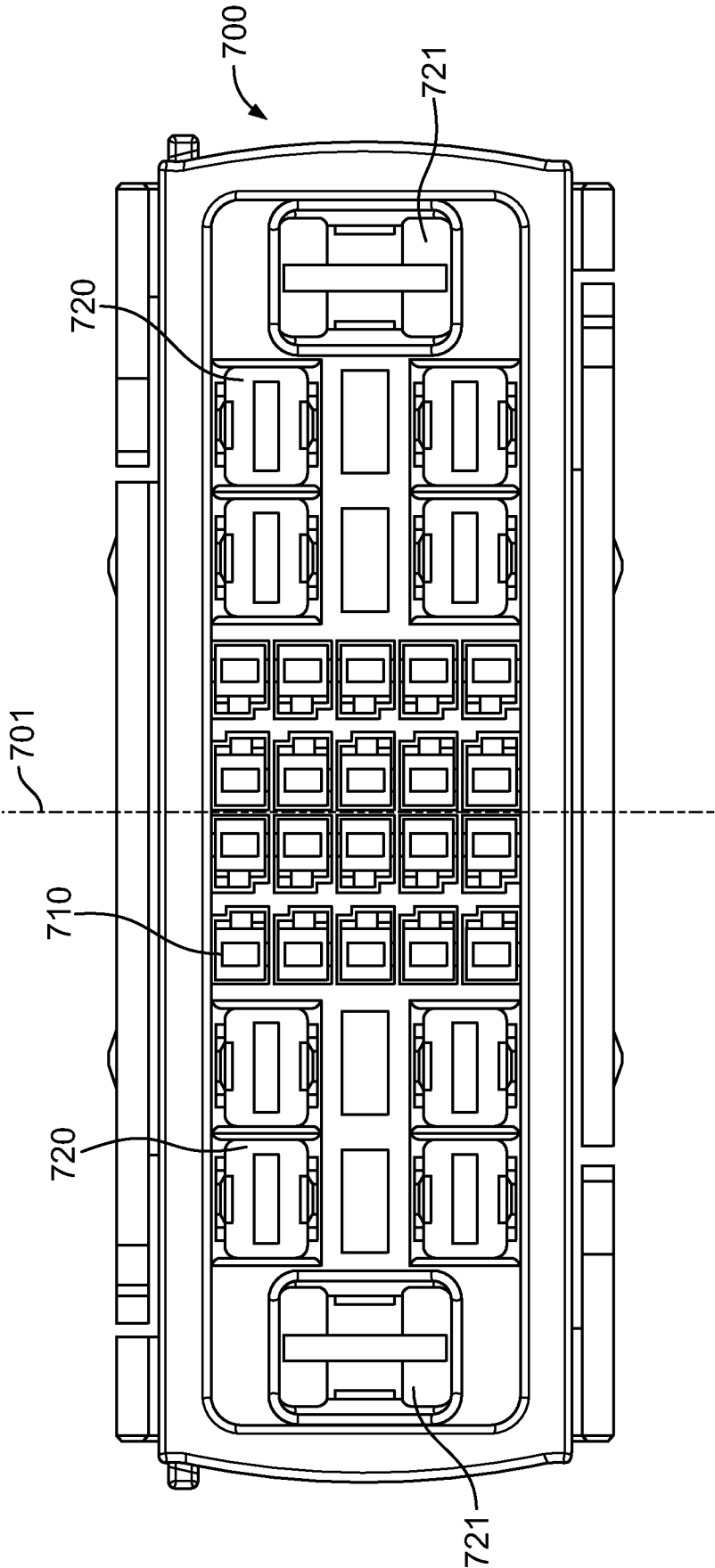


Fig. 17

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2009/065307

A. CLASSIFICATION OF SUBJECT MATTER

INV. H01R13/629 H01R13/627

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H01R

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

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

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X	US 6 558 176 B1 (MARTIN GALEN M [US] ET AL) 6 May 2003 (2003-05-06) the whole document	1-10
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☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

11 February 2010

Date of mailing of the international search report

18/02/2010

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2009/065307

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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