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(54) **FLANGE CONNECTION FOR VACUUM PUMPS**

(57) A flange connection for mounting vacuum pumps comprising an upper body configured to receive at least two stators that create pump chambers in which respective rotors are to be housed. The flange connection further comprises a lower body configured to receive a motor of each vacuum pump, at least one inlet port for sucking air from a device where pressure is aimed to be lowered and at least one duct housed in the flange con-

nection that is in fluid communication with the at least one inlet port. The upper body further comprises a respective inlet hole fluidly communicable with each pump chamber and being in fluid communication with the at least one duct. The at least one duct comprises flow control means configured to selectively let air pass from the at least one inlet port towards at least one of the pump chambers.

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Description

TECHNICAL FIELD

[0001] This invention belongs to the field of vacuum systems for the automotive industry, preferably for brake boosters. More particularly, it refers to flange connections for vacuum pumps comprising a rotor with one or more vanes inserted in it, the rotor being contained in a stator where subspaces are created between the vane or vanes, the stator walls and the rotor when the rotor is moved.

STATE OF THE ART

[0002] Brake boosters are components used in braking systems in motor vehicles to provide assistance to the driver by decreasing the braking effort the driver has to make to brake the vehicle. The brake boosters amplify/boost the mechanical effort of the brake pedal by using vacuum from a vacuum chamber providing a greater braking force.

[0003] Vacuum pumps are devices that remove fluid molecules, e.g., gas molecules such as air molecules, from a sealed volume in order to leave behind a partial vacuum. These vacuum pumps usually integrate a rotor housed inside a housing such that, when the rotor rotates, the vanes of the rotor transports the fluid load from the inlet of the housing to an outlet (exhaust) of the same housing creating an area of low pressure.

[0004] Pump arrangements are known and used to generate high or ultra-high vacuums for the braking systems. The vacuum in the vacuum chamber of the brake boosters may be generated by these vacuum pumps. Vacuum pump arrangements with vacuum pumps connected in series or parallel are known. These known arrangements have the disadvantage that the required pressure or vacuum pressure is established only relatively slowly and/or a relatively large pump capacity is required.

[0005] Vacuum pump arrangements are normally formed by one single vacuum pump and exceptionally by two vacuum pumps which are independent from each other and that are connected to each other by vacuum lines. Depending on if the vacuum pumps are connected in series or in parallel, these vacuum lines may be designed as external direct connections between the vacuum pumps or as external bypasses, respectively. These external vacuum lines make the vacuum pump arrangement design more complex and less reliable since the vacuum lines and their connections to the vacuum pumps may provoke vacuum losses due to vacuum leaks.

[0006] Besides, vacuum pump arrangements for brake boosters are critical elements in terms of user's safety since the braking of the vehicle, in the event of the failure of the vacuum pump arrangements, may be seriously compromised.

DESCRIPTION OF THE INVENTION

[0007] The invention provides a solution for the mentioned problems by means of a flange connection for vacuum pumps according to claim 1. Preferred embodiments of the invention are defined in dependent claims.

[0008] A first aspect of the invention relates to a flange connection for mounting a plurality of vacuum pumps, i.e., two or more vacuum pumps. The plurality of vacuum pumps mounted on the flange connection may be operated individually or in combination based on the vacuum requirements of the device to which these vacuum pumps are to provide vacuum. The flange connection comprises an upper body and a lower body. For example, the upper body may comprise an upper wall and an upper side wall surrounding the outer edge of the upper wall. Alternatively, the upper body may be only an upper wall configured to act as a cover for the lower body. The upper surface of the upper body is configured to receive a stator of each one of the vacuum pumps that are to be mounted on the flange connection. Each stator creates, with the upper body, the pump chamber of the corresponding vacuum pump. A rotor is to be housed in each pump chamber. For example, the rotors may be circular rotors or elliptical rotors, among other types of rotors, with at least one slot and at least one vane, each vane being at least partially introduced in the at least one slot of the rotor. In turn, the lower body may further comprise a bottom wall and a lower side wall surrounding the outer edge of the bottom wall. The lower surface of the lower body is configured to receive a motor of each one of the vacuum pumps. For example, the motors may be electric motors. The upper body and the lower body, and more specifically, the respective upper wall and the bottom wall, of the flange connection have respective openings through which respective drive shafts of the motors are insertable such that these drive shafts are to drive the rotors located into the pump chambers.

[0009] The flange connection also comprises at least one inlet port for sucking air from the device where pressure is aimed to be lowered, e.g., from a vacuum chamber of a brake booster the flange connection is connected to or from an intermediate vacuum tank from which the brake boosters and other subsystems of the vehicle, such as the A/C system, etc., may receive the vacuum. The flange connection may have one or more inlet ports for sucking air from the same device or for sucking air from different devices. The flange connection also comprises at least one duct housed in the flange connection that is in fluid communication with the at least one inlet port. By way of example, the flange connection may have one duct fluidly communicating the one or more inlet ports with all the vacuum pumps of the assembly or may have more than one duct, each duct for fluidly communicating at least one inlet port with one or more vacuum pumps of the plurality of vacuum pumps of the assembly. For example, the inlet ports may be inlet tubes or inlet openings, etc.

[0010] The upper body also comprises at least one inlet hole fluidly communicable with each pump chamber and that is in fluid communication with the at least one duct. In turn, the at least one duct comprises flow control means configured to selectively let air pass from the at least one inlet port towards at least one of the pump chambers of the respective vacuum pumps (forward air-flow). These fluid control means are also configured to prevent the passage of air in the opposite direction (reverse airflow).

[0011] In some embodiments, the upper body of the flange connection further comprises at least one outlet hole located in correspondence with each one of the pump chambers, such that these outlet holes are fluidly communicable with the corresponding pump chambers. In turn, the upper body and the lower body define an intermediate chamber in which air exiting the pump chambers through the outlet holes enters. In addition, the flange connection may comprise at least one outlet port through which air located in the intermediate chamber exits the flange connection. Thus, the at least one outlet port may be fluidly communicated with the intermediate chamber such that compressed air exiting the pump chambers of the vacuum pumps being operated at that moment via the respective outlet holes enters in the intermediate chamber and then exits the flange connection via the outlet ports. Alternatively, the outlet ports may be directly located in the stators such that compressed air directly exits the vacuum pumps via said outlet ports without previously entering into the flange connection. For example, the outlet ports may be outlet tubes or outlet openings, etc.

[0012] In some embodiments, the flow control means are configured to let air pass from the at least one inlet port towards at least one of the pump chambers based on operation of the corresponding vacuum pumps. Therefore, the flow control means will only let airflow to pass towards those pump chambers of the vacuum pumps which are operative in a particular moment.

[0013] In some embodiments, the flow control means are at least one Non-Return Valve (NRV) configured to open, letting airflow to pass, when the pressure at the inlet of the non-return valve (upstream side of the NRV in fluid communication with the device where pressure is aimed to be lowered) is higher than the pressure at the outlet of the non-return valve (downstream side of the NRV in fluid communication with the vacuum chamber) and to close, preventing air from flowing in the opposite direction, when the pressure at the outlet of the non-return valve is equal or higher than the pressure at the inlet of the non-return valve. Operation of the rotor of a particular vacuum pump generates a pressure reduction, i.e., a partial vacuum, at the outlet (downstream side of the NRV) of the non-return valve interposed between the corresponding pump chamber and the device to which the vacuum pump is providing vacuum. Then a pressure difference will be created between the inlet and outlet of the NRV. This pressure difference between the inlet and

the outlet of the non-return valve provokes the opening of the non-return valve allowing air to pass towards the pump chamber of that particular vacuum pump. Based on the structural characteristics of the non-return valves, this pressure difference between the inlet and the outlet will have to be higher or lower in order to open or close the non-return valve.

[0014] In some other embodiments, the flow control means may be switch valves, bypass valves or electronic valves, among other types of valves, which are capable of selectively let air pass from the device to which vacuum is to be provided towards the corresponding vacuum pumps. For example, there could be one single valve to control the air flowing towards all the vacuum pumps coupled to the flange connection or there could be one respective valve to control the air flowing towards each vacuum pump.

[0015] In some embodiments, the flange connection may comprise one non-return valve located in a portion of the at least one duct between the at least one inlet port and each one of the inlet holes. Thus, each non-return valve may be configured to control airflow from the at least one inlet port towards the pump chamber the corresponding inlet hole is fluidly communicable to.

[0016] Alternatively, all these valves, i.e., the non-return valves, switch valves, bypass valves or electronic valves, among other types of valves, instead of being located into the ducts in the flange connection, may be located into the inlet ports of the flange connection or in the vacuum lines that fluidly communicate the vacuum pumps with the device where pressure is aimed to be lowered.

[0017] In some embodiments, the flange connection comprises an inlet portion that comprises at least a portion of the duct. As used herein, the inlet portion may refer to an element that may attachable to the flange connection or that may be integral part of the flange connection. Moreover, the inlet portion may fully integrate the duct or may integrate part of the duct while the rest of the duct may be integrated into flange connection, e.g., into the upper or lower body of the flange connection.

[0018] In some embodiments, the inlet portion may be coupled to the lower surface of the upper wall and to a portion of the upper side wall of the upper body in correspondence with the at least one inlet port. The inlet portion may integrate the duct that may be in fluid communication with the at least one inlet port and with the inlet holes in the upper wall of the upper body by interposition of respective expansion chambers. This inlet portion may be an integral part of the flange connection.

[0019] In some embodiments, the inlet portion may be removably attached to the lower surface of the upper wall of the upper body in correspondence with the at least one inlet port. The inlet portion, that is an element independent from the upper and lower bodies, may comprise the at least one duct, inlet openings in correspondence with the at least one inlet port and which are in fluid communication with the at least one duct, expansion cham-

bers in correspondence with the inlet holes in the upper wall of the upper body and in fluid communication with the at least one duct and means for attaching the inlet portion to the lower surface of the upper body, e.g., screw elements. Moreover, the inlet portion may comprise respective seal gaskets surrounding the inlet openings and the expansion chambers to ensure that there are no vacuum leaks in these connection areas. In such embodiments, the flange connection may comprise guiding means, e.g., pins extending from the lower surface of the upper wall and a guide passageway in the inlet portion to receive the guide pin, to facilitate the positioning of the inlet portion relative to the flange connection. Other guiding means could also be used.

[0020] In some embodiments, the inlet portion may be attached to a lower surface of the upper wall and to a portion of the upper side wall in correspondence with the at least one inlet port. In turn, the duct may comprise a tube having inlet openings to communicate with the at least one inlet port, duct portions located in the inlet portion wherein each duct portion is in fluid communication with a respective inlet hole via corresponding expansion chambers and with an end of the tube. In such embodiments, the flange connection may have one non-return valve located in each duct portion of the inlet portion. In such embodiments, the inlet portion may be an integral part of the flange connection while the tube may be an element external to the inlet portion and connectable to the inlet portion.

[0021] In some embodiments, the inlet portion may comprise an upper portion coupled to the lower surface of the upper wall and located in correspondence with the at least one inlet port and a lower portion removably attached to the upper portion. For example, the upper portion and the lower portion of the inlet portion may be symmetrical to each other. In such embodiments, the upper portion may be an integral part of the flange connection while the lower portion may be an independent element removably attachable to the upper portion.

[0022] In some embodiments, both, the upper portion and the lower portion of the inlet portion comprise an inlet recess in correspondence with the at least one inlet port and grooves that define the at least one duct. The grooves communicate the inlet recesses, and thus the at least one inlet port, with the inlet holes through respective expansion chambers. The inlet portion may further comprise means for attaching the lower portion to the upper portion such as screw elements or similar. Moreover, the inlet portion may comprise respective seal gaskets surrounding the inlet recesses and the grooves to ensure that no vacuum leaks in these contact areas can be produced. In such embodiments, the upper portion and the lower portion of the inlet portion may comprise guiding means to facilitate the positioning of the lower portion relative to the upper portion. For example, the upper portion may comprise guiding pins that fits within guide passageways in the lower portion or have a particular geometry that fits with the geometry of the lower

portion.

[0023] In some embodiments, the upper body may comprise a plurality of mounting brackets coupled to the upper side wall, the mounting brackets having recesses to house rubber mounts. The rubber mounts may be inserted into recesses of the mounting brackets together with sleeve elements to be assembled in the mounting brackets. These mounting brackets allow the flange connection to be coupled to the structure of the vehicle inside its engine compartment. Alternatively, the lower body may comprise the mounting brackets.

[0024] In some embodiments, the inlet portion may be coupled to the lower surface of the upper wall and to a portion of the upper side wall of the upper body in correspondence with the at least one inlet port. The upper body may be a substantially planar upper wall configured to act as a cover for the lower body. The inlet portion may integrate the duct for which the upper body may act as a cover too. This inlet portion may be an integral part of the flange connection or may be an independent piece coupleable, e.g., by screws, to the lower body. The inlet portion may comprise seal gaskets surrounding the duct in order to ensure that no vacuum leaks between the duct and the upper body are produced. In some embodiments, the flange connection may comprise a mounting portion on which an Electronic Computing Unit (ECU) is to be coupled. The mounting portion may be attached to the flange portion by fastening pieces such as mounting brackets, clamps, etc. For example, the mounting portion may be coupled to at least one mounting bracket of the upper body, and more preferably to two mounting brackets. As used herein the ECU may refer to any combination of hardware and software logic for controlling operation of the vacuum pumps coupled to the flange connection. The ECU may further implement a combination of hardware and software logic for controlling other components in the vehicle such as actuators of the engine, the anti-lock braking system (ABS) or the A/C system of the vehicle, among other subsystems.

[0025] A second aspect of the invention relates to a vacuum assembly that comprises a flange connection as previously described and at least two vacuum pumps. The stators of the at least two vacuum pumps are coupled to the upper surface of the upper wall to create respective pump chambers in which corresponding rotors of the vacuum pumps are housed. Moreover, the motor of each vacuum pump is coupled to the lower surface of the bottom wall of the lower body and the respective drive shafts of the motors are inserted into the openings of the upper wall and the bottom wall to drive the rotors in the pump chambers.

[0026] The flange connection for vacuum pumps presents several advantages and/or differences compared with previous devices. It provides a compact solution that allows installing the vacuum pumps in residual spaces of the engine compartment using the available space in the vehicle in a more efficient manner. The shape and geometry of the flange connection may be

different depending on the space availability and the arrangement of the rest of the elements in the engine compartment of the vehicle. In addition, the intermediate chamber in which the air compressed in the pump chambers enters before exiting the flange connection via the outlet ports significantly simplifies the arrangement design and reduce the number of components for fluidly communicate the vacuum pumps. It also avoids using vacuum lines, such as hoses and pipes, and their corresponding connections that may provoke vacuum losses that may compromise safety and reliability of the braking system. The flange connection is also low-cost incurring and facilitates installation into the vehicle. It also allows designing redundant vacuum systems with two or more vacuum pumps that guarantees that there will be at least one vacuum pump available at any time.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] To complete the description and in order to provide for a better understanding of the invention, a set of drawings is provided. Said drawings form an integral part of the description and illustrate an embodiment of the invention, which should not be interpreted as restricting the scope of the invention, but just as an example of how the invention can be carried out.

[0028] The drawings, where like reference numerals designate like structural elements, comprise the following figures:

Figures 1A and 1B show different perspective views of an example vacuum assembly comprising two vacuum pumps and a flange connection.

Figure 2 shows a perspective view of an example lower body of the flange connection of the vacuum assembly of Figure 1.

Figures 3A, 3B and 3C show different views of a first example upper body of a flange connection.

Figures 4A, 4B, 4C and 4D show different views of a second example upper body of a flange connection.

Figures 5A, 5B and 5C show different views of a third example upper body of a flange connection.

Figures 6A, 6B, 6C and 6D show different views of a fourth example upper body of a flange connection.

Figure 7 shows an upper perspective view of a fifth example upper body of a flange connection.

Figure 8 shows a perspective view of a vacuum assembly with the upper body of figure 7.

Figures 9A-9D show different views of another example of vacuum assembly comprising two vacuum pumps and a flange connection with a flat upper body.

DETAILED DESCRIPTION OF THE INVENTION

[0029] Figures 1A and 1B show different perspective views of an example vacuum assembly 100 comprising

two vacuum pumps 102,103 and a flange connection 101. In particular, figure 1A shows an upper front perspective view of the vacuum assembly 100 and figure 1B shows a lower front perspective view of the vacuum assembly 100. It should be understood that the vacuum assembly 100 depicted in Figure 1 may include additional components and that some of the components described herein may be removed and/or modified without departing from a scope of the vacuum assembly 100.

[0030] The vacuum assembly 100 is formed by two vacuum pumps 102-103 which are mounted on the flange connection 101. These two vacuum pumps 102-103 can be operated individually or simultaneously, providing the individual or combined vacuum generation capability to the vacuum chamber of the brake booster (not shown) to which they are connected. Each vacuum pump 102-103 comprises a pump chamber defined by the flange connection 101 that acts as the base of the pump chambers and a respective stator 105. The stators 105 are attached to the flange connection 101 by screw elements 106. The pump chambers house a respective rotor (not shown), e.g., a circular or elliptical rotor. These rotors comprise at least one slot and at least one vane being at least partially introduced in the slot of the rotor.

[0031] Each vacuum pump 102-103 also comprises a respective motor 107, e.g., an electric motor, having a drive shaft (not shown in this figure) to drive the corresponding rotors. The flange connection 101 is positioned between the pump chambers and the motors 107. The flange connection 101 comprises an upper body 108 and a lower body 109 that define an intermediate chamber (not shown in this figure). The upper body 108 has an upper wall 110 which defines the base of the pump chambers and an upper side wall 111 surrounding the upper wall 110 and the lower body 109 has a bottom wall 112 and a lower side wall 113 surrounding the bottom wall 112.

[0032] The flange connection 101 also comprises one inlet tube 114 for sucking air from the vacuum chamber of the brake booster. The inlet tube 114 is in fluid communication with at least one vacuum connection of the brake booster through a vacuum line, e.g., a pipe or hose. In some other embodiments, the flange connection 101 may have more than one inlet tubes for sucking air from the brake booster. The inlet tube 114 is coupled to the upper side wall 111 of the flange connection 101 and is in fluid communication with the inlet holes (not shown) of the pump chambers through at least one duct (not shown) housed at least partially in the intermediate chamber of the flange connection 101. The inlet holes are placed in the area of the upper wall 110 of the upper body 108 which constitutes the bases of the pump chambers. In some other embodiments, the inlet tube 114 may be coupled to the lower side wall 113 of the lower body 109.

[0033] The flange connection 101 further comprises one outlet tube 115 in fluid communication with respective outlet holes (not shown) of the pump chambers. The

outlet tube 115 is fluidly communicated with the intermediate chamber defined in the flange connection 101. The intermediate chamber damps compressed air exiting the pump chambers of the corresponding vacuum pumps 102-103 through the outlet holes (not shown in this figure) located in the areas of the upper wall 110 of the upper body 108 which constitutes the base of the respective pump chambers. While the example flange connection 101 in figures 1A and 1B shows one outlet tube 115, the flange connection 101 may comprise two outlet tubes with one outlet tubes in fluid communication with each pump chamber of the respective vacuum pumps 102-103.

[0034] The flange connection 101 further comprises three mounting brackets 116a-c with recesses 117 in which rubber mounts 118 are respectively inserted. Specifically, the flange connection 101 has a first mounting bracket 116a and a second mounting bracket 116b located at both sides of the inlet tube 114 and a third mounting bracket 116c located at the opposite edge of the flange connection 101 and in correspondence with the inlet tube 114. The rubber mounts 118 are inserted into recesses 117 of the mounting brackets 116a-c together with sleeve elements 119 to be assembled in the mounting brackets 116a-c. These sleeve elements 119 are to insert screws, bolts or similar, to couple the flange connection 101 to the structure of the vehicle on which it is to be mounted.

[0035] Moreover, the upper body 108 and the lower body 109 contact to each other via the free edges of the upper side wall 111 and lower side wall 113, respectively, and may have a seal gasket between these free edges of the upper side wall 111 and lower side wall 113 in order to avoid vacuum leaks. The upper body 108 and the lower body 109 are coupled to each other with screws 120. The covers 121 for the motors 107 are an integral portion of the lower body 109 while the outer casing of the motors 107 is coupled to the respective covers 121 by screws 122.

[0036] Figure 2 shows a perspective view of an example lower body 209 of the flange connection of the vacuum assembly of Figure 1. It should be understood that the lower body 209 depicted in Figure 2 may include additional components and that some of the components described herein may be removed and/or modified without departing from a scope of the lower body 209.

[0037] In such example, the lower body 209 comprises the bottom wall 212 and the lower side wall 213. The lower body 209 of the flange connection has a substantially elliptical shape (although the lower body may have any other shape) with two openings 223 substantially located in the focus of the ellipse. The two openings 223 are to allow the respective drive shafts 224 of the motors 207 to pass through to drive the corresponding rotors. The upper wall of the upper body of the flange connection will also have these two openings in corresponding locations.

[0038] The bottom wall 212 has openings 225 that

communicate the outlet tube 215 with the intermediate chamber 226 that, in turn, is in fluid communication with the outlet hole or holes (not shown in this figure) of the pump chambers. In this way, the air compressed in the pump chambers exits through the respective outlet holes and enters in the intermediate chamber 226 exiting the flange connection via the opening 225 towards the outlet tube 215. In some other embodiments, the flange connection may not have the intermediate chamber and the outlet tubes may be directly attached to the stators of the vacuum pumps.

[0039] Figures 3A, 3B and 3C show different views of a first example upper body 308 of a flange connection. In particular, figure 3A shows an upper front perspective view of the example upper body 308, figure 3B shows a lower front perspective view of the example upper body 308 and figure 3C shows a lower plan view of the example upper body 308 along X-X cut plane. It should be understood that the upper body 308 depicted in Figures 3A-C may include additional components and that some of the components described herein may be removed and/or modified without departing from a scope of the upper body 308.

[0040] The upper body 308 of the flange connection has the upper wall 310 and the upper side wall 311. The upper body 308 has a substantially elliptical shape (although the upper body may have any other shape) with two openings 327 substantially located in the focus of the ellipse. The two openings 327 are to allow the respective drive shafts of the motors (not shown in this figure) to pass through to drive the corresponding rotors. The upper body 308 also integrates the three mounting brackets 316a-c with the recesses 317 in which the rubber mounts are to be inserted.

[0041] The upper body 308 comprises the inlet tube 314 for sucking air from the vacuum chamber of a brake booster or from any other vacuum tank or device (not shown). The inlet tube 314 is coupled to the upper side wall 311 of the upper body 308 and is in fluid communication with the inlet holes 328 of the two pump chambers (not shown), through the duct 329 housed at least partially in the intermediate chamber 326. While in figure 3B the duct 329 is entirely housed in the upper body 308, in some other embodiments the duct 329 may be partially housed in the upper body 308 and partially housed in the lower body of the flange connection.

[0042] The upper body 308 further comprises outlet holes 330 that are in fluid communication with their respective pump chambers and with the intermediate chamber 326. Preferably, the intermediate chamber 326 is placed beneath and facing the outlet holes 330 such that the outlet holes 330 open directly in this intermediate chamber 326. The inlet holes 328, the openings 327 and the outlet holes 330 are all located in correspondence with the respective pump chambers.

[0043] The upper body 308 also comprises an inlet portion 331 attached to the lower surface of the upper wall 310 and to a portion of the upper side wall 311 in corre-

spondence with the inlet tube 314. The inlet portion 331 integrates the duct 329 that is in fluid communication with the inlet tube 314 and with the inlet holes 328. This inlet portion 331 is an integral part of the upper body 308. The inlet portion 331 further comprises a respective expansion chamber 332 in correspondence with the inlet holes 328 such that the duct 329 communicates with the expansion chambers 332 and the expansion chambers 332 communicate with the inlet holes 328.

[0044] The duct 329 comprises a first non-return valve 333a located in a portion of the duct 329 between the inlet tube 314 and the first inlet hole 328 and a second non-return valve 333b located in a portion of the duct 329 between the inlet tube 314 and the second inlet hole 328, the first non-return valve 333a to let airflow pass from the inlet tube 314 towards the first pump chamber and prevent airflow in the opposite direction and the second non-return valve 333b to let airflow pass from the inlet tube 314 towards the second pump chamber and prevent airflow in the opposite direction.

[0045] Figures 4A, 4B, 4C and 4D show different views of a second example upper body 408 of a flange connection. In particular, figure 4A shows an upper front perspective view of the example upper body 408, figure 4B shows an exploded perspective view of the example upper body 408, figure 4C shows a lower plan view of the example upper body 408 along X-X cut plane and figure 4D shows a perspective view of the inlet portion 431. It should be understood that the upper body 408 depicted in Figures 4A-D may include additional components and that some of the components described herein may be removed and/or modified without departing from a scope of the upper body 408.

[0046] The upper body 408 of the flange connection has the upper wall 410 and the upper side wall 411. The upper body 408 has a substantially elliptical shape (although the upper body may have any other shape) with two openings 427 substantially located in the focus of the ellipse. The two openings 427 are to allow the respective drive shafts of the motors (not shown in this figure) to pass through to drive the corresponding rotors. The upper body 408 also integrates the three mounting brackets 416a-c with the recesses 417 in which the rubber mounts are to be inserted.

[0047] The upper body 408 comprises the inlet tube 414 that is connected to the upper side wall 411 of the upper body 408 and that is in fluid communication with the inlet holes 428 of the two pump chambers (not shown), through the duct 429 housed at least partially in the inlet portion 431.

[0048] The upper body 408 further comprises outlet holes 430 that are in fluid communication with their respective pump chambers and with the intermediate chamber 426. The inlet holes 428, the openings 427 and the outlet holes 430 are all located in correspondence with the respective pump chambers.

[0049] The upper body 408 also comprises the inlet portion 431 that is attachable to the lower surface of the

upper wall 410 and located in correspondence with the inlet tube 414. Although figure 4 shows a particular example in which the inlet portion is attachable to the upper body, in some other examples, the inlet portion may be attachable to the lower body of the flange connection. The inlet portion 431, that is an element independent from the upper body 408, comprises the duct 429, an inlet opening 434 in correspondence with the inlet tube 414 and that is in fluid communication with the duct 429, respective expansion chambers 432 with openings 435 in correspondence with the inlet holes 428 in the upper wall 410 of the upper body 408 and which are in fluid communication with the duct 429, and screws 436 to attach the inlet portion 431 to the upper wall 410 of the upper body 408.

[0050] The inlet portion 431 further comprises a respective expansion chambers 432 in correspondence with the each one of the inlet holes 428 such that the duct 429 communicates with the expansion chambers 432 and the expansion chambers 432 communicate with the inlet holes 428. Moreover, the inlet portion 431 may comprise respective seal gaskets surrounding the inlet opening 434 and the openings 435 of the expansion chambers 432 to ensure that there are no vacuum leaks in these connection areas. The upper body 408 may comprise guide pins extending from the lower surface of the upper wall 410 and corresponding guide passageways in the inlet portion 431 to receive the guide pins that may facilitate the positioning of the inlet portion 431 relative to the upper body 408. In addition, the geometry of the inlet portion 431 may fit within the geometry of the upper body 408 such that the inlet portion 431 can be easily and properly positioned relative to the upper body 408.

[0051] The duct 429 comprises a first non-return valve 433a located in a portion of the duct 429 between the inlet tube 414 and the first inlet hole 428 and a second non-return valve 433b located in a portion of the duct 429 between the inlet tube 414 and the second inlet hole 428, the first non-return valve 433a to control airflow from the inlet tube 414 towards the first pump chamber and the second non-return valve 433b to control airflow from the inlet tube 414 towards the second pump chamber.

[0052] Figures 5A, 5B and 5C show different views of a third example upper body 508 of a flange connection. In particular, figure 5A shows an upper front perspective view of the example upper body 508, figure 5B shows an exploded perspective view of the example upper body 508 and figure 5C shows a lower plan view of the example upper body 508 along X-X cut plane. It should be understood that the upper body 508 depicted in Figures 5A-C may include additional components and that some of the components described herein may be removed and/or modified without departing from a scope of the upper body 508.

[0053] The upper body 508 has the upper wall 510 and the upper side wall 511 and a substantially elliptical shape (although the upper body may have any other shape) with two openings 527 substantially located in the focus

of the ellipse. The two openings 527 are to allow the respective drive shafts of the motors (not shown in this figure) to pass through to drive the corresponding rotors. The upper body 508 also integrates the three mounting brackets 516a-c with the recesses 517 in which the rubber mounts are to be inserted.

[0054] The upper body 508 comprises the inlet tube 514 that is connected to the upper side wall 511 of the upper body 508 and is in fluid communication with the inlet holes 528 of the two pump chambers (not shown), through the duct housed at least partially in the intermediate chamber 526. In such example, the duct is formed by the tube 537 and the duct portions 538a-b.

[0055] The upper body 508 further comprises outlet holes 530 that are in fluid communication with their respective pump chambers and with the intermediate chamber 526. The inlet holes 528, the openings 527 and the outlet holes 530 are all located in correspondence with the respective pump chambers.

[0056] The upper body 508 also comprises an inlet portion 531 attached to a lower surface of the upper wall 510 and to a portion of the upper side wall 511 in correspondence with the inlet tube 514. The inlet portion 531 is an integral part of the upper body 508. In turn, the duct, that is partially housed in the inlet portion 531, is formed by a tube 537 external to the inlet portion 531 and a first duct portion 538a and a second duct portion 538b housed in the inlet portion 531. Thus, the inlet portion 531 is an integral portion of the upper body 508 while the tube 537 is an element external to the inlet portion 531 and connectable to the inlet portion 531. A central portion of the tube 537 is in fluid communication with the inlet tube 514 through an opening while one of the ends of the tube 537 is connected to the first duct portion 538a and the opposite end of the tube 537 is connected to the second duct portion 538b. In turn, the first duct portion 538a is in fluid communication with the first inlet hole 528 by interposition of an expansion chamber 532 and the second duct portion 538b is in fluid communication with the second inlet hole 528 by interposition of another expansion chamber 532.

[0057] In such embodiment, the inlet portion 531 also has a first non-return valve 533a located in the first duct portion 538a and a second non-return valve 533b located in the second duct portion 538b, the first non-return valve 533a to let airflow to pass from the inlet tube 514 to the first pump chamber and prevent airflow in the opposite direction and the second non-return valve 533b to let airflow to pass from the inlet tube 514 to the second pump chamber and prevent airflow in the opposite direction. Alternatively, the non-return valves 533a-b may be mounted in the tube 537 and located in proximity to its ends.

[0058] Figures 6A, 6B, 6C and 6D show different views of a fourth example upper body 608 of a flange connection. In particular, figure 6A shows an upper front perspective view of the example upper body 608, figure 6B shows an exploded perspective view of the example up-

per body 608, figure 6C shows a lower plan view of the example upper body 608 along X-X cut plane and figure 6D shows a perspective view of the inlet portion 629b. It should be understood that the upper body 608 depicted in Figures 6A-D may include additional components and that some of the components described herein may be removed and/or modified without departing from a scope of the upper body 608.

[0059] The upper body 608 of the flange connection has the upper wall 610 and the upper side wall 611. The upper body 608 has a substantially elliptical shape (although the upper body may have any other shape) with two openings 627 substantially located in the focus of the ellipse. The two openings 627 are to allow the respective drive shafts of the motors (not shown in this figure) to pass through to drive the corresponding rotors. The upper body 608 also integrates the three mounting brackets 616a-c with the recesses 617 in which the rubber mounts are to be inserted.

[0060] The upper body 608 comprises the inlet tube 614 that is connected to the upper side wall 611 of the upper body 608 and that is in fluid communication with the inlet holes 628 of the two pump chambers (not shown), through the duct 629 housed at least partially in the inlet portion 631a-b.

[0061] The upper body 608 further comprises outlet holes 630 that are in fluid communication with their respective pump chambers and with the intermediate chamber 626. The inlet holes 628, the openings 627 and the outlet holes 630 are all located in correspondence with the respective pump chambers.

[0062] In such example, the upper body 608 also comprises an upper inlet portion 631a attached to the lower surface of the upper wall 610 in correspondence with the inlet tube 614 and a lower inlet portion 631b attachable to the upper inlet portion 631a. While the upper inlet portion 631a is an integral part of the upper body 608, the lower inlet portion 631b is an element independent from the upper body 608 and attachable to it. While in this embodiment the inlet portion is formed by an upper inlet portion 631a and a lower inlet portion 631b, in some other embodiments the inlet portion may be one single portion attachable to the upper body 608 as shown in Figure 4 or to the lower body. The upper inlet portion 631a comprises a first inlet recess 639a on a lower surface of the upper inlet portion 631a and in correspondence with the inlet tube 614 and an upper groove 640a on the lower surface of the upper inlet portion 631a. In turn, the lower inlet portion 631b comprises a second inlet recess 639b on an upper surface of the lower inlet portion 631b and in correspondence with the inlet tube 614 and a lower groove 640b on the upper surface of the lower inlet portion 631a. The first inlet recess 639a and the second inlet recess 639b define the inlet opening 634 of the inlet portion while the first inlet recess 639a, the second inlet recess 639b, the upper groove 640a and the lower groove 640b form the duct 629.

[0063] The grooves 640a-b communicate the opening

634, and thus the inlet tube 614, with the first inlet hole 628 and the second inlet hole 628 in the upper wall 610 of the upper body 608 via respective expansion chambers 632. Moreover, the upper and lower inlet portions 631a-b may comprise respective seal gaskets surrounding the inlet opening 634 and the openings 635 of the expansion chambers 632 to ensure that there are no vacuum leaks in these connection areas. Besides, there could be an additional sealing gasket located in the contact area between the upper inlet portion 631a and lower inlet portion 631b.

[0064] In some examples, the upper body 608 may comprise guide pins extending from the lower surface of the upper wall 610 or in the upper inlet portion 631a itself and lower inlet portion 631b may have a shape adapted to receive said guide pins to facilitate the positioning of the lower inlet portion 631b relative to the upper inlet portion 631a.

[0065] The grooves 640a-b comprise respective recesses 641 to house a first non-return valve 633a located in a portion of the duct 629 between the inlet tube 614 and the first inlet hole 628 and a second non-return valve 633b located in a portion of the duct 629 between the inlet tube 614 and the second inlet hole 628, the first non-return valve 633a to let airflow to pass from the inlet tube 614 towards the first pump chamber and prevent airflow in the opposite direction and the second non-return valve 633b to let airflow to pass from the inlet tube 614 towards the second pump chamber and prevent airflow in the opposite direction.

[0066] Figure 7 shows an upper perspective view of a fifth example upper body 708 of a flange connection. It should be understood that the upper body 708 depicted in Figure 7 may include additional components and that some of the components described herein may be removed and/or modified without departing from a scope of the upper body 708.

[0067] The upper body 708 has the upper wall 710 and the upper side wall 711. The upper body 708 has two openings 727 that allow the respective drive shafts of the motors (not shown in this figure) to pass through to drive the corresponding rotors.

[0068] The upper body 708 comprises the inlet tube 714 for sucking air from the brake booster (not shown). The inlet tube 714 is connected to the upper side wall 711 of the upper body 708 and is in fluid communication with the inlet holes 728 of the two pump chambers (not shown).

[0069] The upper body 708 further comprises outlet holes 730 that are in fluid communication with their respective pump chambers and with the intermediate chamber 726. The inlet holes 728, the openings 727 and the outlet holes 730 are all located in correspondence with the respective pump chambers.

[0070] The embodiment of upper body 708 shown in figure 7 may substantially correspond to any of the upper bodies shown in figures 3-6 but comprising four mounting brackets 716a-d with recesses 717 in which rubber

mounts are to be inserted. These mounting brackets 716a-d are respectively located into the corners of the upper body 708.

[0071] Figure 8 shows an upper perspective view of a vacuum assembly 800 with the upper body of figure 7. It should be understood that the vacuum assembly 800 depicted in figure 8 may include additional components and that some of the components described herein may be removed and/or modified without departing from a scope of the vacuum assembly 800.

[0072] The upper body 808 comprises four mounting brackets 816a-d with recesses 817 in which rubber mounts 818 are inserted. These mounting brackets 816a-d are respectively located into the corners of the upper body 808. Specifically, the flange connection 801 has two mounting brackets 816a-b located at both sides of the inlet tube 814 and other two mounting brackets 816c-d at the opposite corners of the flange connection 801. The rubber mounts 818 are fixed to the mounting brackets 816a-d by sleeve elements 819 which are also used to couple the flange portion in the vehicle.

[0073] The flange connection 801 further comprises a mounting portion 842 on which an ECU 843 is to be coupled. The mounting portion 842 is attached to mounting brackets 816c-d by the corresponding sleeves 819. The electronics of the ECU 843 is within a casing 844 and has a connector 845 to connect the electronic components of the ECU 843 to the electric motors 807 of the vacuum pumps 802-803, to sensors in the brake booster, to the battery of the vehicle and to some other sensors and devices within the vehicle. Alternatively, the ECU may be mounted directly in the flange connection, for example in the upper body of the flange connection, by screws or similar without interposition of a mounting portion or similar.

[0074] Although the ECU is shown mounted on the flange connection of Figure 8, the ECU could be also mounted on any one of the embodiments shown in Figures 1 to 7 and 9.

[0075] Figures 9A-9D show different views of another example of vacuum assembly 900 comprising two vacuum pumps 902-903 and a flange connection 901 with a flat upper body 908. It should be understood that the vacuum assembly 800 depicted in figure 8 may include additional components and that some of the components described herein may be removed and/or modified without departing from a scope of the vacuum assembly 800.

[0076] Figure 9A shows an upper perspective view of the vacuum assembly 900. The lower body 909, that is formed by the bottom wall 912 and the lower side wall 913, comprises four mounting brackets 916a-d with recesses 917 in which rubber mounts 918 are inserted. The upper body 908 is flat wall that acts as a cover for the lower body 909. In particular, the dimensions of the upper body 908 are such that correspond with the upper surface of the lower body 909 not including the mounting brackets 916a-d. The upper body 908 is attached to the lower body by the screws 946.

[0077] Figure 9B shows an upper perspective view of the vacuum assembly 900 of Figure 9A without the upper body 908 and the stators 905. The lower body 909 integrates an inlet portion 931 that may be an integral part of the lower body 909 or that may be removably attached to the lower body 909. In such example, the inlet portion 931 is coupled to the upper surface of the bottom wall 912 and to a portion of the lower side wall 913 in correspondence with the inlet tube 914. The inlet portion 931 has a groove 948 that with the upper body 908 define the duct 929 that is in fluid communication with the inlet tube 914 and with the inlet holes 928. The inlet portion 931 further comprises a respective expansion chamber 932 in correspondence with the inlet holes 928 such that the duct 929 communicates with the expansion chambers 932 and the expansion chambers 932 communicate with the inlet holes 928.

[0078] The inlet portion 931 further comprises a seal gasket 947 located in correspondence with its outer edge such that when the upper body 908 is screwed on the lower body 909, the pressure exerted by the lower surface of the upper body 908 on the gasket 947 ensures that there will be no vacuum leaks between the upper body 908 and the lower body 909.

[0079] The groove 948 comprise respective recesses 949 to house a first non-return valve 933a located in a portion of the duct 929 between the inlet tube 914 and the first inlet hole 928 and a second non-return valve 933b located in a portion of the duct 929 between the inlet tube 914 and the second inlet hole 928, the first non-return valve 933a to let airflow to pass from the inlet tube 914 towards the first pump chamber and prevent airflow in the opposite direction and the second non-return valve 933b to let airflow to pass from the inlet tube 914 towards the second pump chamber and prevent airflow in the opposite direction.

[0080] Figure 9C shows top view of the lower body 909 of Figure 9B, and Figure 9D shows an upper perspective of the upper body 908 of Figure 9A. The upper body 908 and the lower body 909 define the intermediate chamber 926 in which air compressed in the pump chambers enters via the outlet holes 930 and exits the flange connection 900 through the respective outlet tube 915. The inlet holes 928, the openings 927 for the rotor shafts and the outlet holes 930 are all located in correspondence with the respective pump chambers.

[0081] While the embodiments shown in figures 1 to 9 show the mounting brackets located in specific positions of the upper body, these mounting brackets may be located in different positions and in a different number in the flange connection.

[0082] In addition, while the embodiments shown in figures 1 to 9 show a flange connection for two vacuum pumps and with a substantially oval shape, the number of vacuum pumps mounted on the flange connection may be higher and the shape of the flange connection may be any other shape whose design could be based on the vacuum requirements of the vehicle, and thus on the

number and size of the vacuum pumps mounted on the flange connection, and the space requirements of the vehicle.

[0083] The upper bodies shown in figures 3 to 8 may be also combined with the lower body shown in figure 2 to create the intermediate chamber. Alternatively, these upper bodies may be combined with other lower bodies wherein the respective upper side walls and lower side walls match to each other to define an intermediate chamber.

[0084] In this text, the term "comprises" and its derivations (such as "comprising", etc.) should not be understood in an excluding sense, that is, these terms should not be interpreted as excluding the possibility that what is described and defined may include further elements, steps, etc. It will also be understood that, although the terms first, second, third, etc. may be used herein to describe various elements, these elements should not be limited by these terms, as these terms are only used to distinguish one element from another unless stated otherwise or the context indicates otherwise. The term "another," as used herein, is defined as at least a second or more. The term "coupled," as used herein, is defined as connected, whether directly without any intervening elements or indirectly with at least one intervening elements, unless otherwise indicated. Two elements can be coupled mechanically, electrically, or communicatively linked through a communication channel, pathway, network, or system.

[0085] The invention is obviously not limited to the specific embodiments described herein, but also encompasses any variations that may be considered by any person skilled in the art (for example, as regards the choice of materials, dimensions, components, configuration, etc.), within the general scope of the invention as defined in the claims.

Claims

1. A flange connection (101) for mounting vacuum pumps (102,103), comprising:

an upper body (108) configured to receive at least two stators (105), each stator (105) being configured to create a pump chamber in which a respective rotor is to be housed, and each stator (105) corresponding to a particular vacuum pump (102,103);

a lower body (109) configured to receive a motor (107) of each vacuum pump (102,103), wherein the upper body (108) and the lower body (109) have openings (223) through which respective drive shafts (224) of the motors (107) are insertable, the drive shafts (224) to drive the rotors in the pump chambers;

at least one inlet port (114) for sucking air from a device where pressure is aimed to be lowered;

- and
 at least one duct (329) housed in the flange connection (101) that is in fluid communication with the at least one inlet port (114);
 wherein the upper body (108) further comprises a respective inlet hole (328) fluidly communicable with each pump chamber, the inlet holes (328) being in fluid communication with the at least one duct (329); and
 wherein the at least one duct (329) comprises flow control means configured to selectively let air pass from the at least one inlet port towards at least one of the pump chambers.
2. The flange connection (101) according to claim 1, wherein the upper body (108) comprises a respective outlet hole (330) located in correspondence with each pump chamber, each outlet hole (330) being fluidly communicable with the corresponding pump chamber, and wherein the upper body (108) and the lower body (109) define an intermediate chamber (226) in which air exiting the pump chambers through the outlet holes (330) enters.
 3. The flange connection (101) according to claim 2, comprising at least one outlet port (115) through which air that has entered in the intermediate chamber (226) from the pump chambers exits the flange connection (101).
 4. The flange connection (101) according to any one of the preceding claims, wherein the flow control means are configured to let air pass from the at least one inlet port (114) towards at least one of the pump chambers based on operation of the corresponding vacuum pumps (102, 103).
 5. The flange connection (101) according to any one of the preceding claims, wherein the flow control means are at least one non-return valve (333a, 333b) configured to open when the pressure at the inlet of the non-return valve (333a, 333b) is higher than the pressure at the outlet of the non-return valve (333a, 333b).
 6. The flange connection (101) according to claim 5, comprising one non-return valve (333) located in a portion of the at least one duct (329) between the at least one inlet port (114) and each one of the inlet holes (328), each non-return valve (333) to control airflow from the at least inlet port (114) towards the pump chamber the corresponding inlet hole (328) is fluidly communicable to.
 7. The flange connection (301) according to any one of the preceding claims, comprising an inlet portion (331) that comprises at least a portion of the duct (329).
 8. The flange connection (301) according to claim 7, wherein the inlet portion (331) is coupled to a lower surface of an upper wall (310) of the upper body (308) and to a portion of an upper side wall (311) of the upper body (308) in correspondence with the at least one inlet port (314), the inlet portion (331) comprising the at least one duct (329) that is in fluid communication with the at least one inlet port (314) and with the inlet holes (328) in the upper wall (310) of the upper body (308) by interposition of respective expansion chambers (332).
 9. The flange connection (401) according to claim 7, wherein the inlet portion (431) is removably attached to a lower surface of an upper wall (410) of the upper body (408) in correspondence with the at least one inlet port (414), the inlet portion (431) comprising:
 - the at least one duct (429);
 - inlet openings (434) in correspondence with the at least one inlet port (414) and in fluid communication with the at least one duct (429);
 - expansion chambers (432) in correspondence with the inlet holes (428) in the upper wall (410) and in fluid communication with the at least one duct (429); and
 - means for attaching the inlet portion (431) to the lower surface of the upper wall (410).
 10. The flange connection (501) according to claim 7, wherein the inlet portion (531) is coupled to a lower surface of an upper wall (510) of the upper body (508) and to a portion of an upper side wall (511) of the upper body (508) in correspondence with the at least one inlet port (514), wherein the duct (529) comprises:
 - a tube (537) having inlet openings to communicate with the at least one inlet port (514); and
 - duct portions (538a, 538b) in the inlet portion (531), each duct portion (538a, 538b) being in fluid communication with a respective inlet hole (528) via a corresponding expansion chamber (532) and with an end of the tube (537).
 11. The flange connection (501) according to claim 10, wherein there is one non-return valve (533a, 5331b) located in each duct portion (538a, 538b) of the duct (529).
 12. The flange connection (601) according to claim 7, wherein the inlet portion (631) comprises an upper portion (631a) coupled to a lower surface of an upper wall (610) of the upper body (608) and located in correspondence with the at least one inlet port (614) and a lower portion (631b) removably attached to the upper portion (631b).

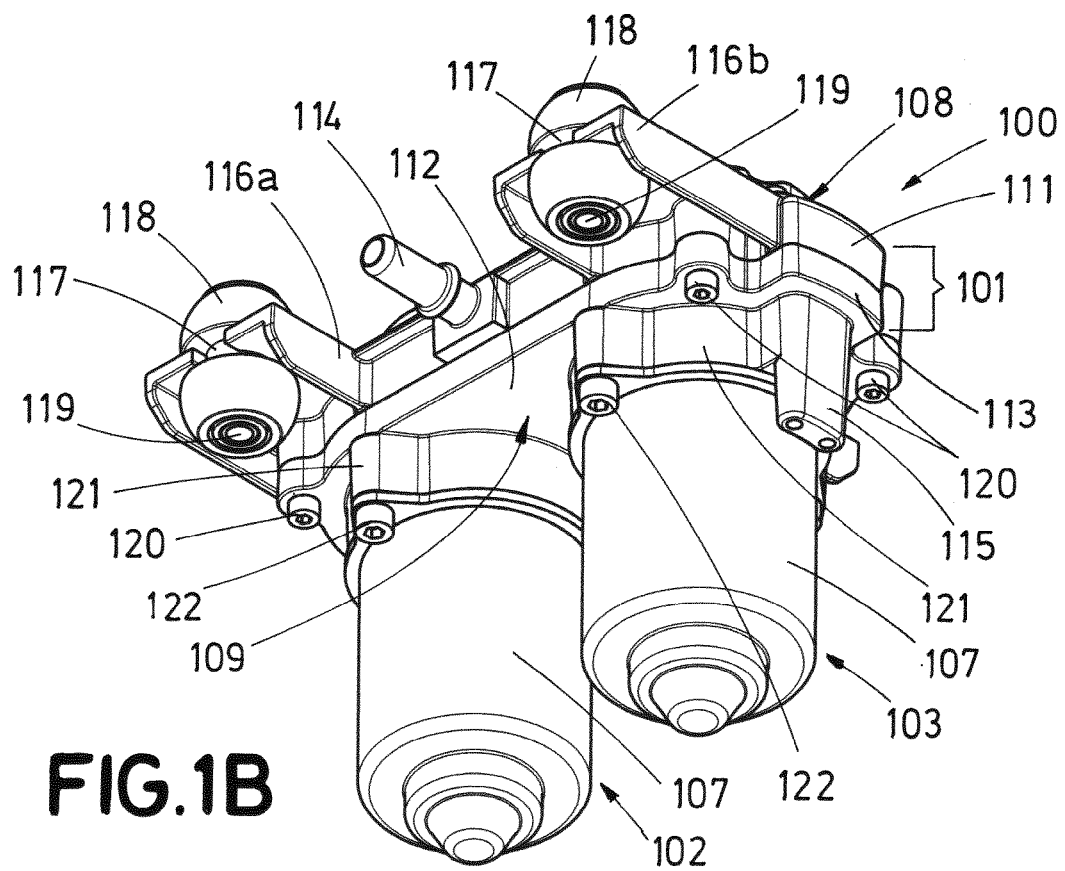
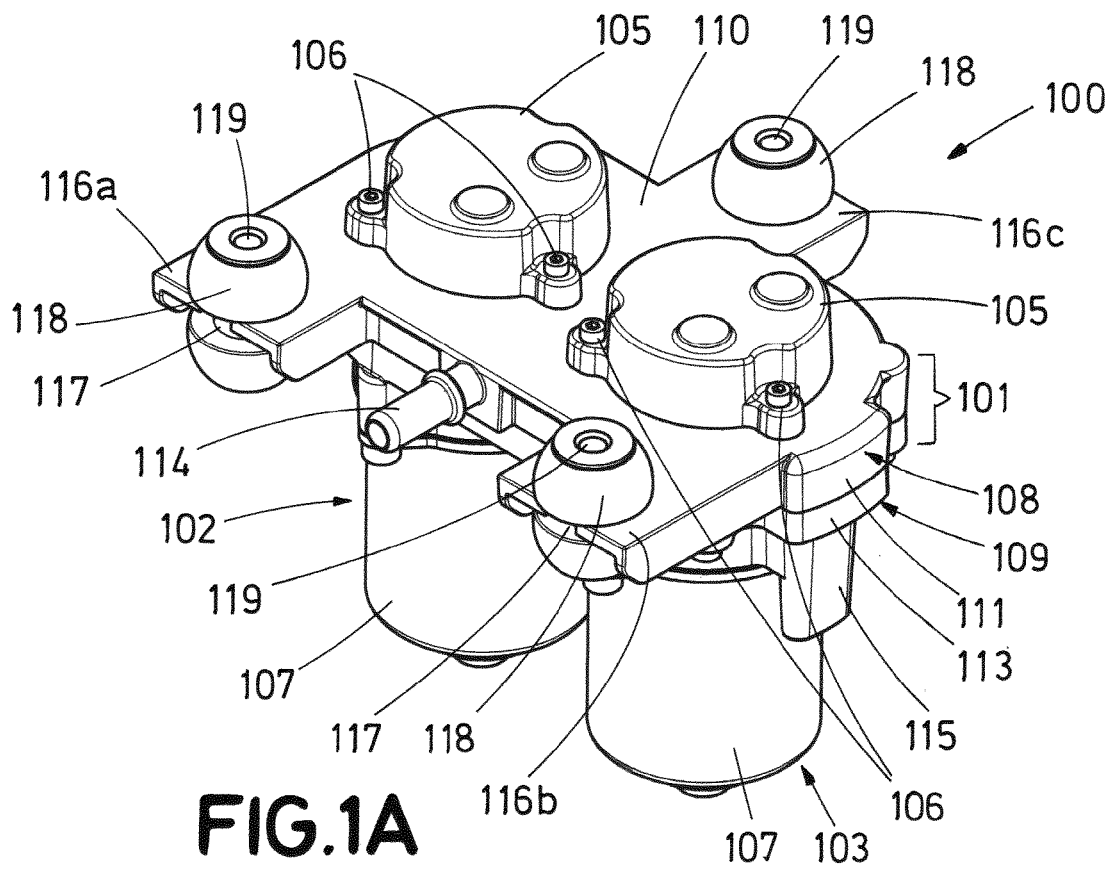
13. The flange connection (601) according to claim 12, wherein the upper portion (631a) and the lower portion (631b) comprise, respectively:

an inlet recess (639a,639b) in correspondence with the at least one inlet port (614);
grooves (640a,640b) defining the at least one duct (629) and wherein the grooves (640a,640b) communicate the inlet recess (639a,639b) with the inlet holes (628) through respective expansion chambers (632); and
means for attaching the lower portion (631b) to the upper portion (631a).

14. The flange connection (801) according to any one of the preceding claims, comprising a mounting portion (842) on which an Electronic Computing Unit (843) is to be coupled, the mounting portion (842) being attached to the flange connection.

15. A vacuum assembly comprising:

a flange connection as described in any one of claims 1 to 14; and
at least two vacuum pumps (102,103);
wherein the stators (105) of the at least two vacuum pumps (102,103) are coupled to the upper surface of the upper wall (110) to create a respective pump chamber in which a corresponding rotor is housed; and
wherein the motor (107) of each vacuum pump (102,103) is coupled to the lower surface of the bottom wall (112) and the respective drive shafts (224) of the motors (107) are inserted into the openings (223) of the upper wall (110) and the bottom wall (112) to drive the rotors in the pump chambers.



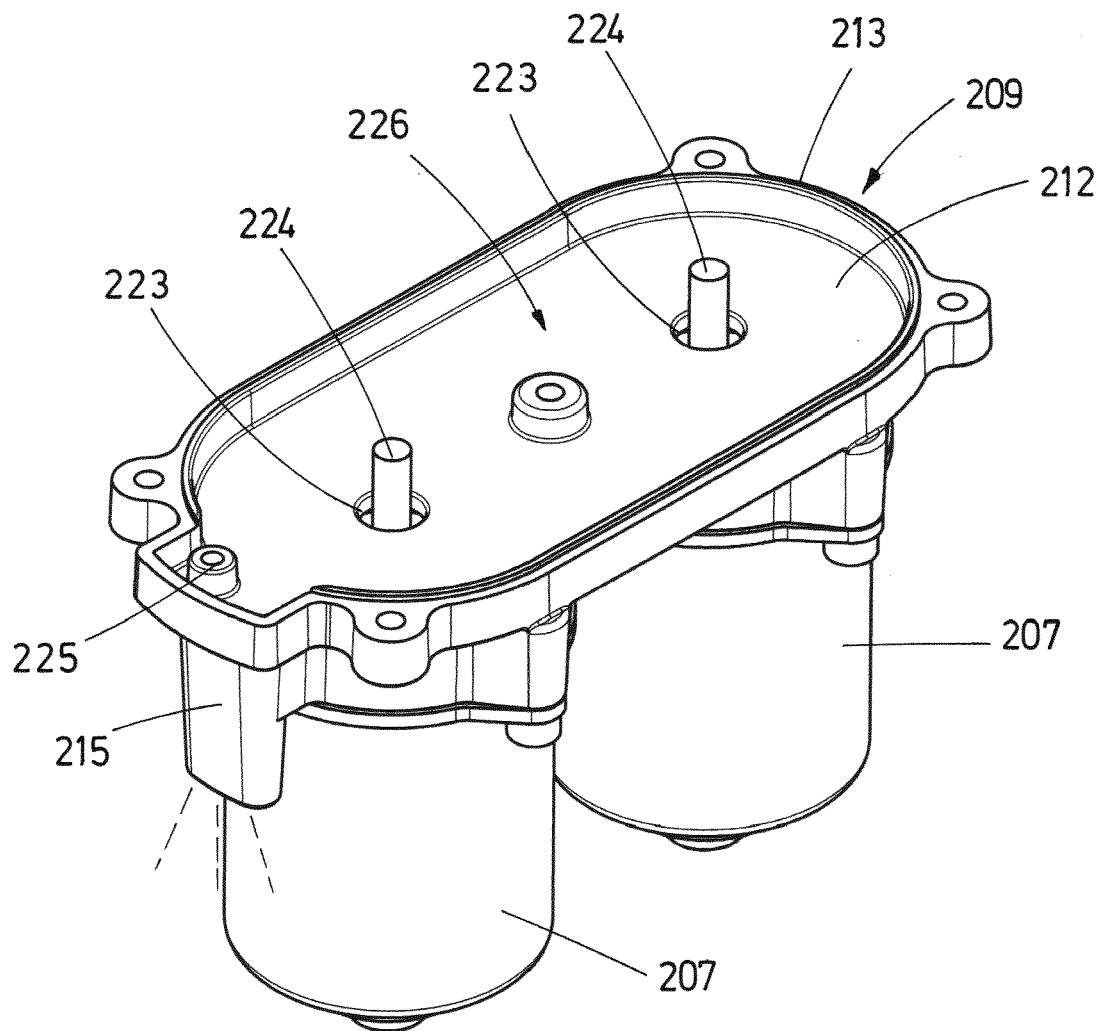


FIG.2

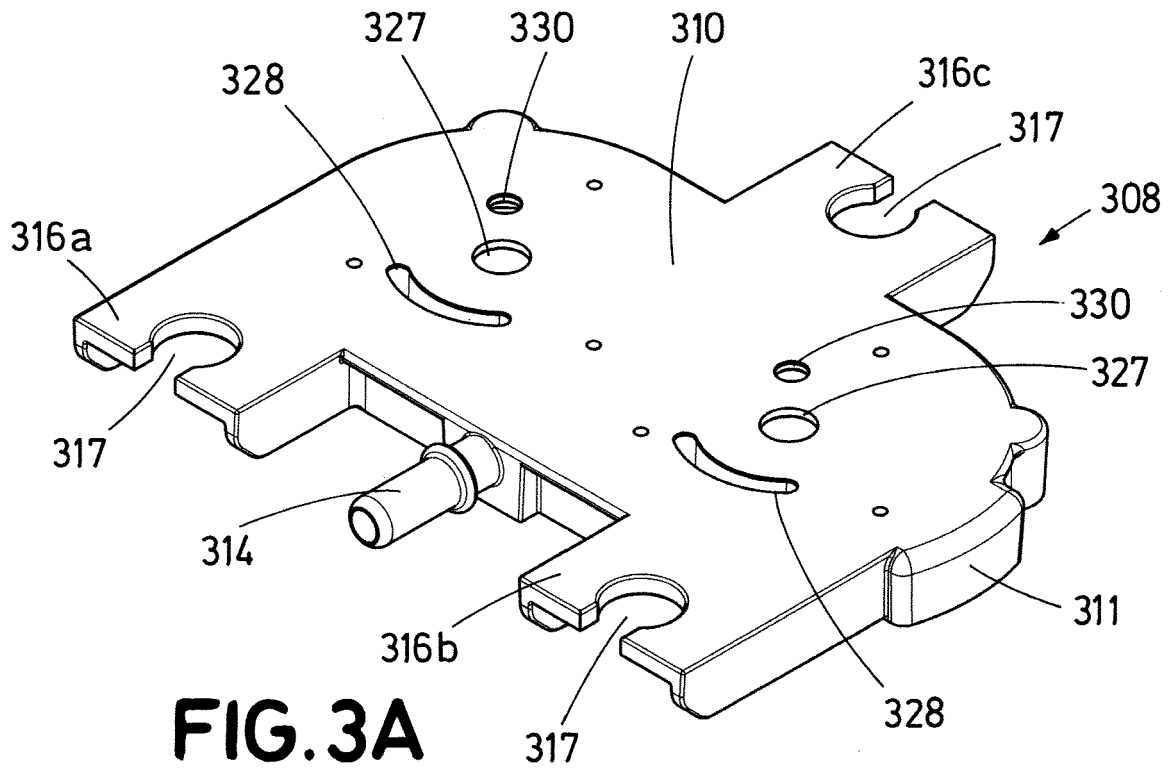


FIG. 3A

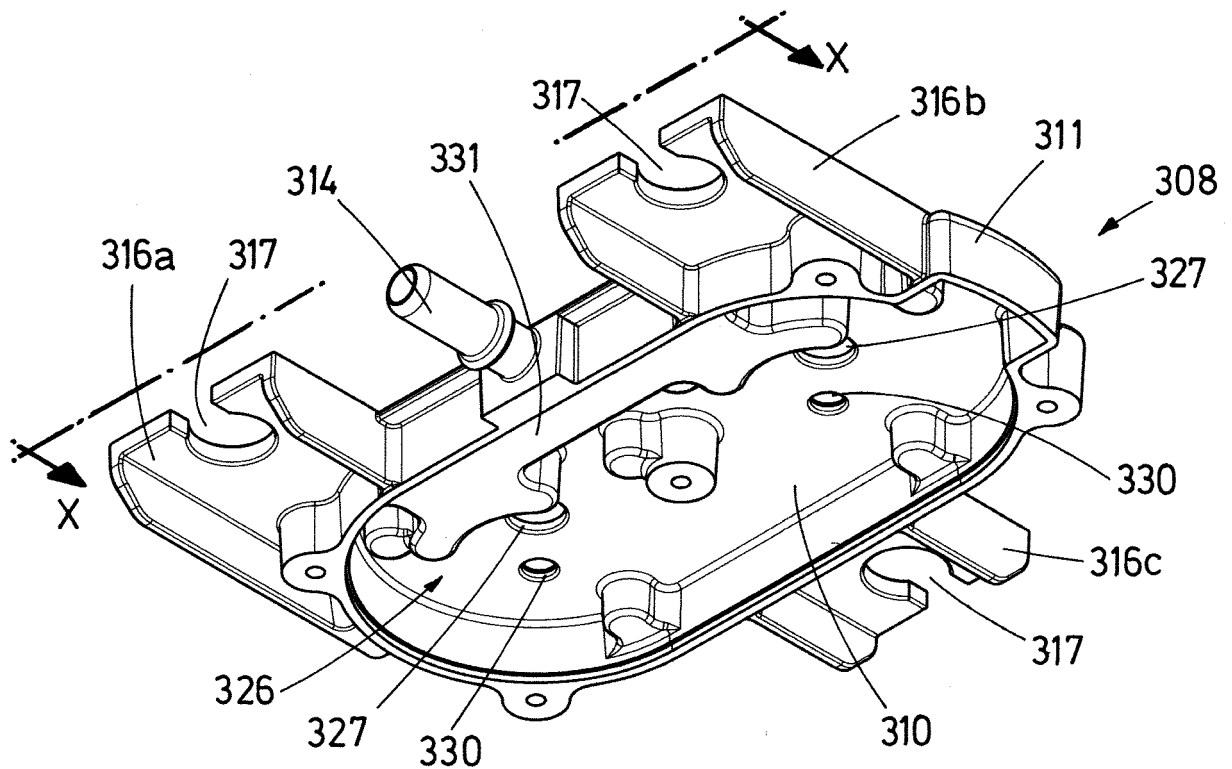


FIG. 3B

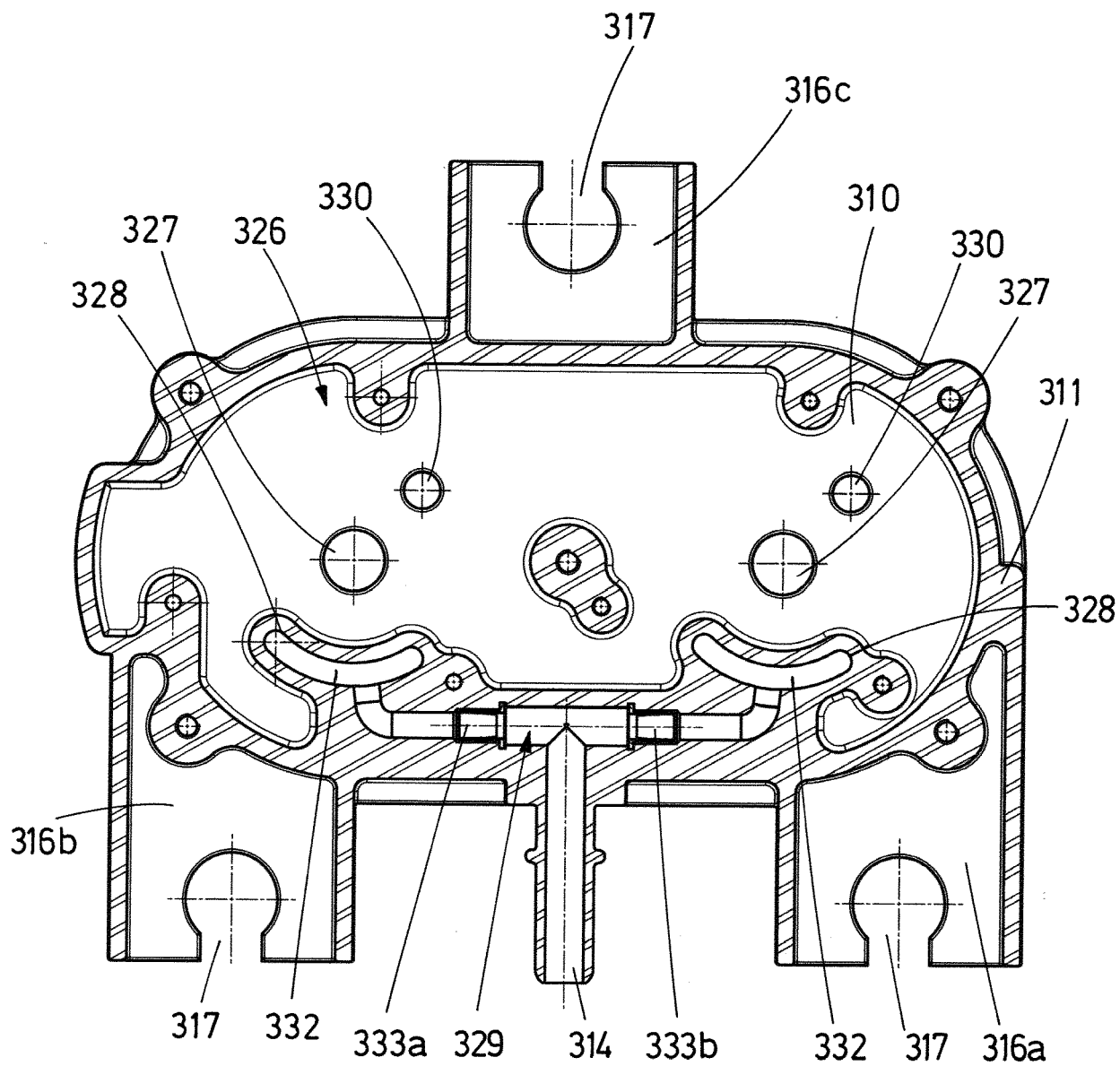


FIG.3C

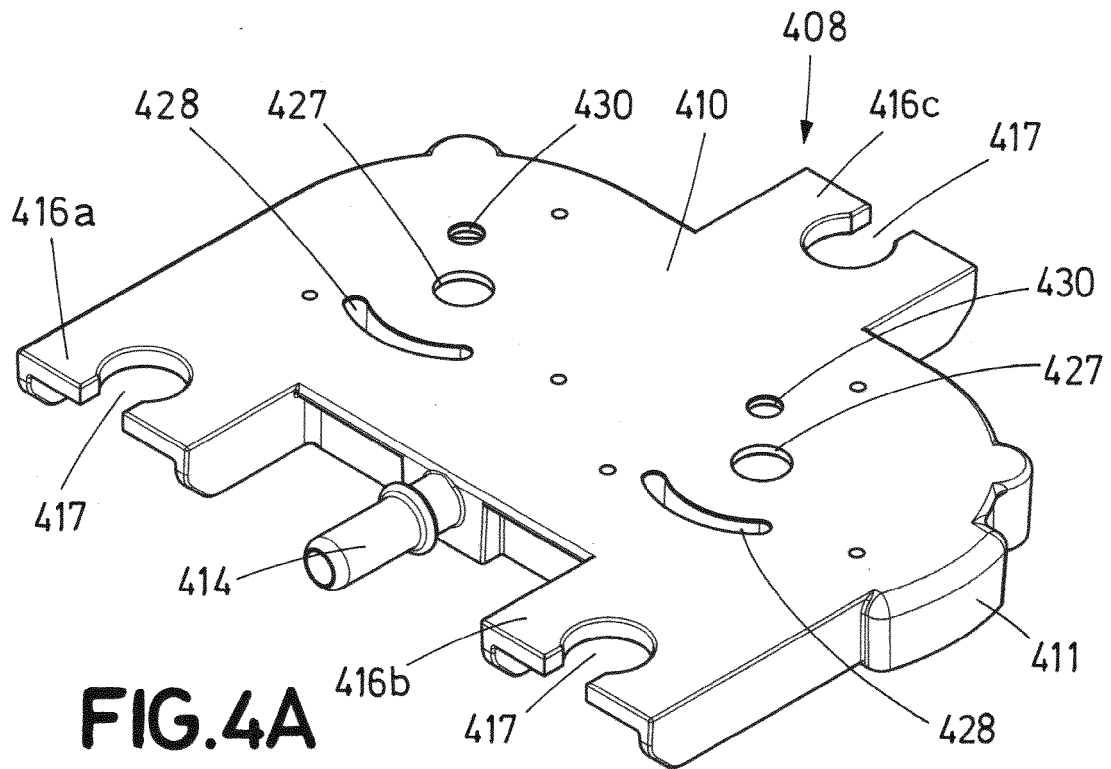


FIG. 4A

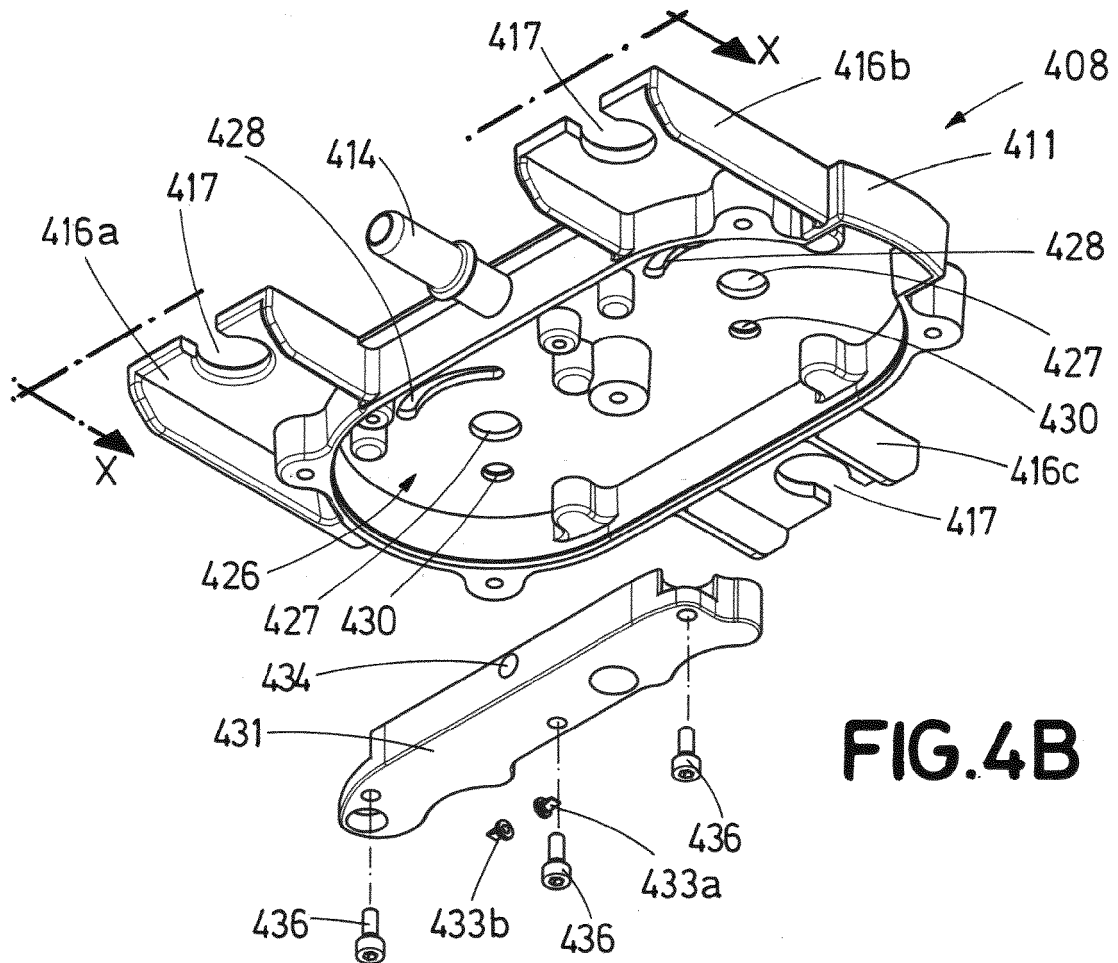


FIG. 4B

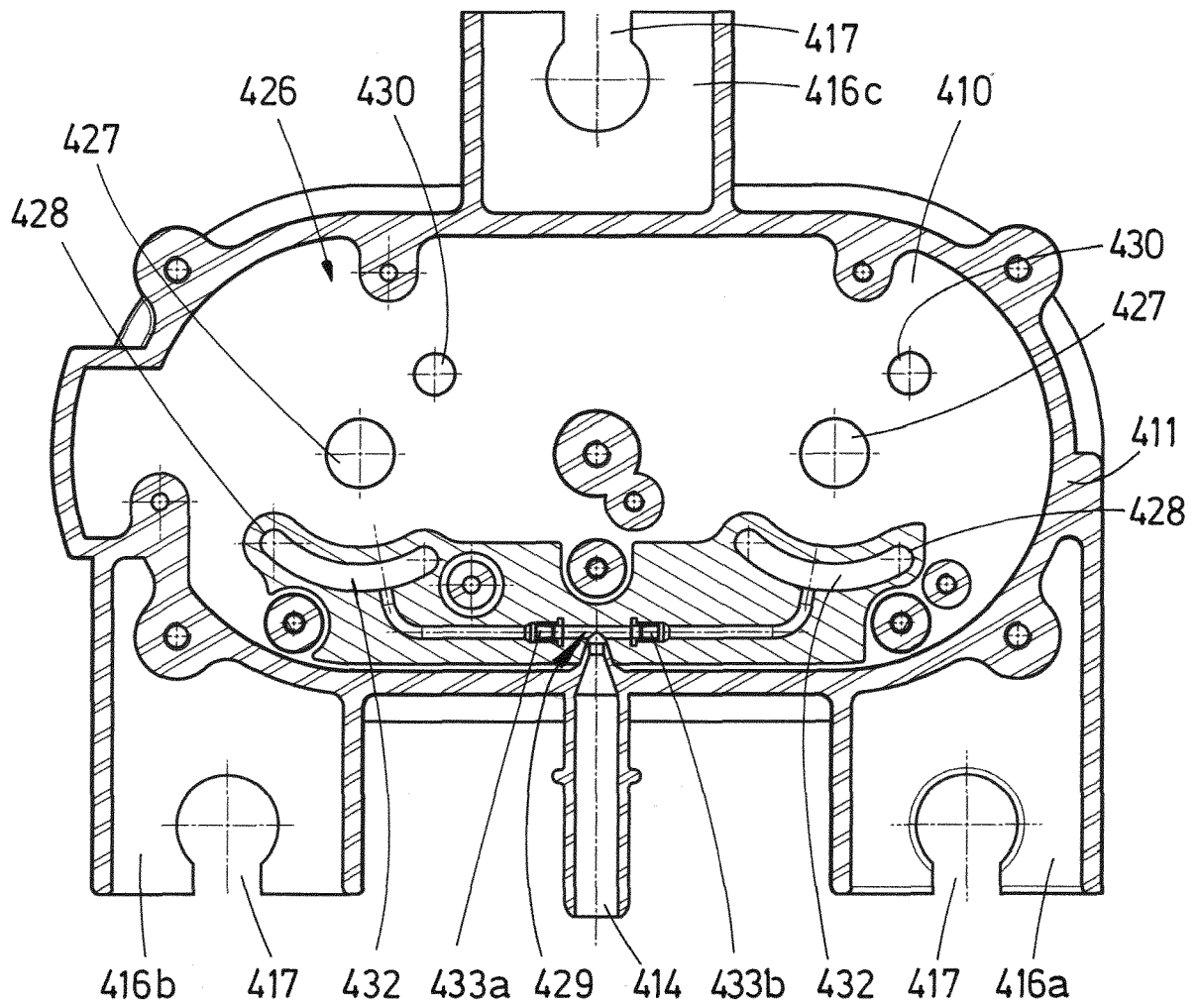


FIG. 4C

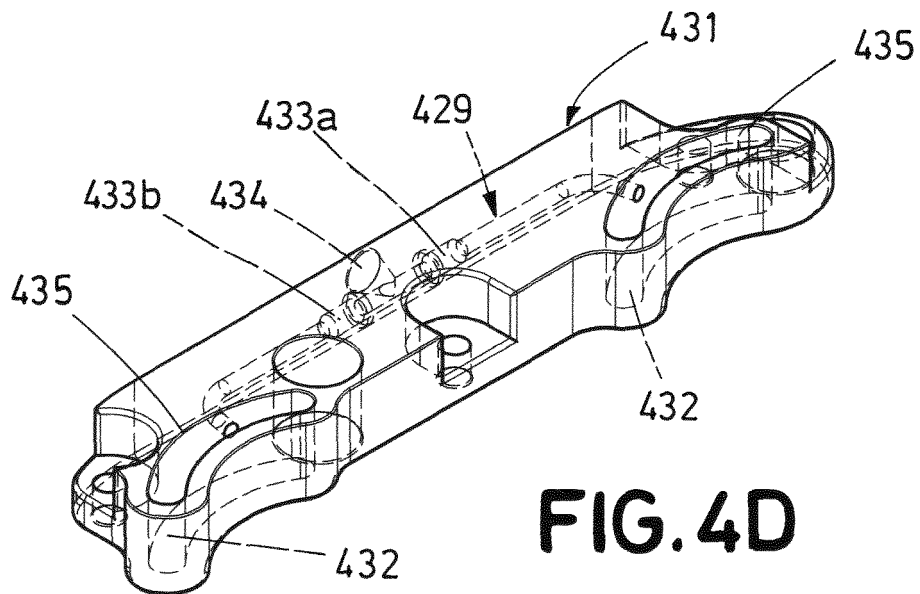


FIG. 4D

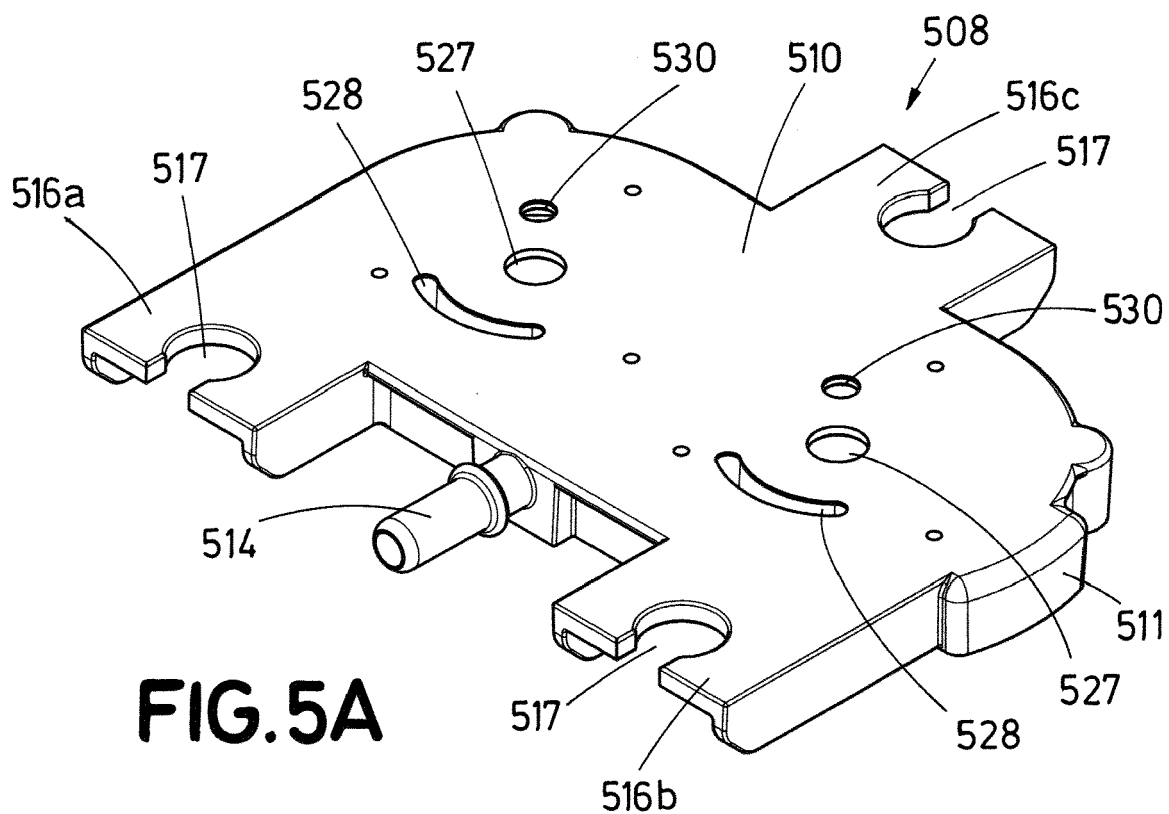


FIG. 5A

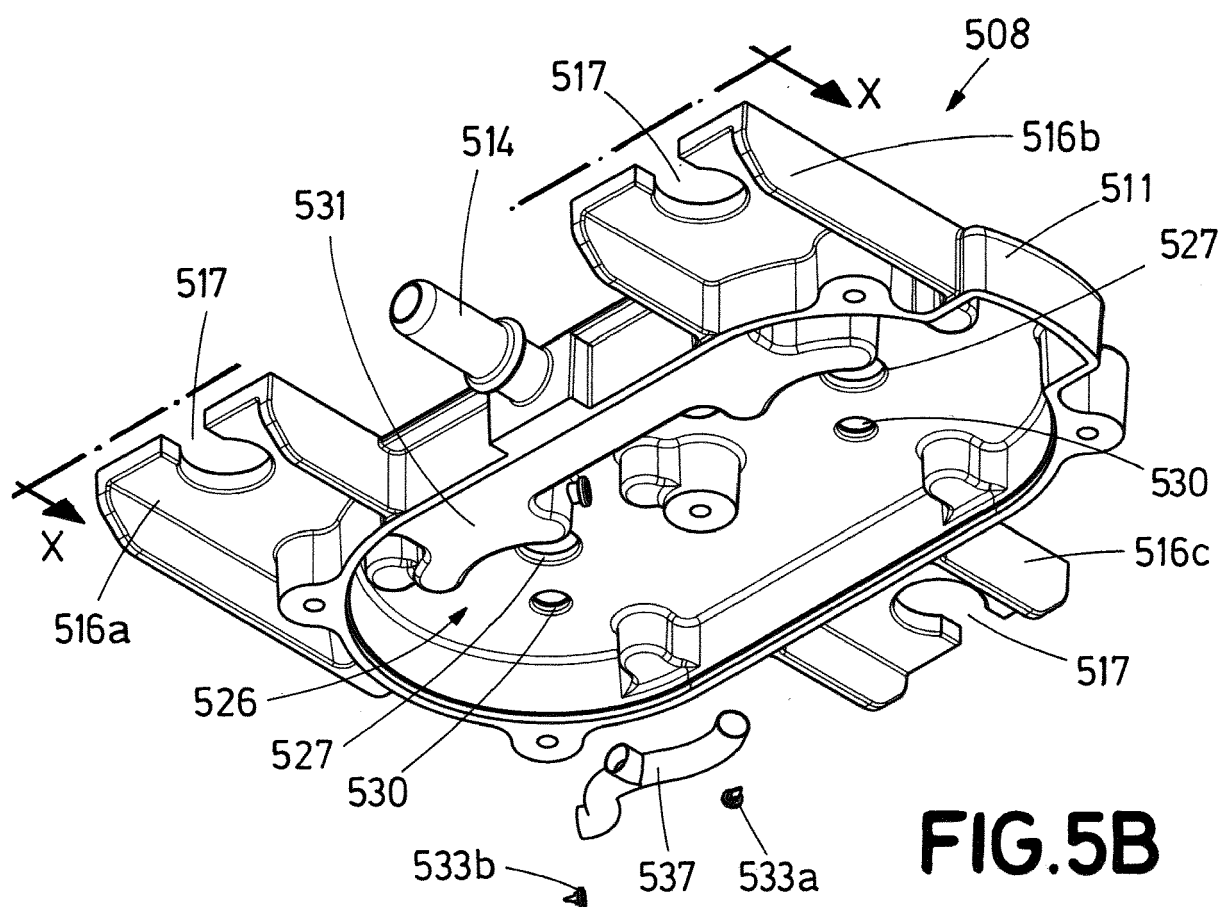


FIG. 5B

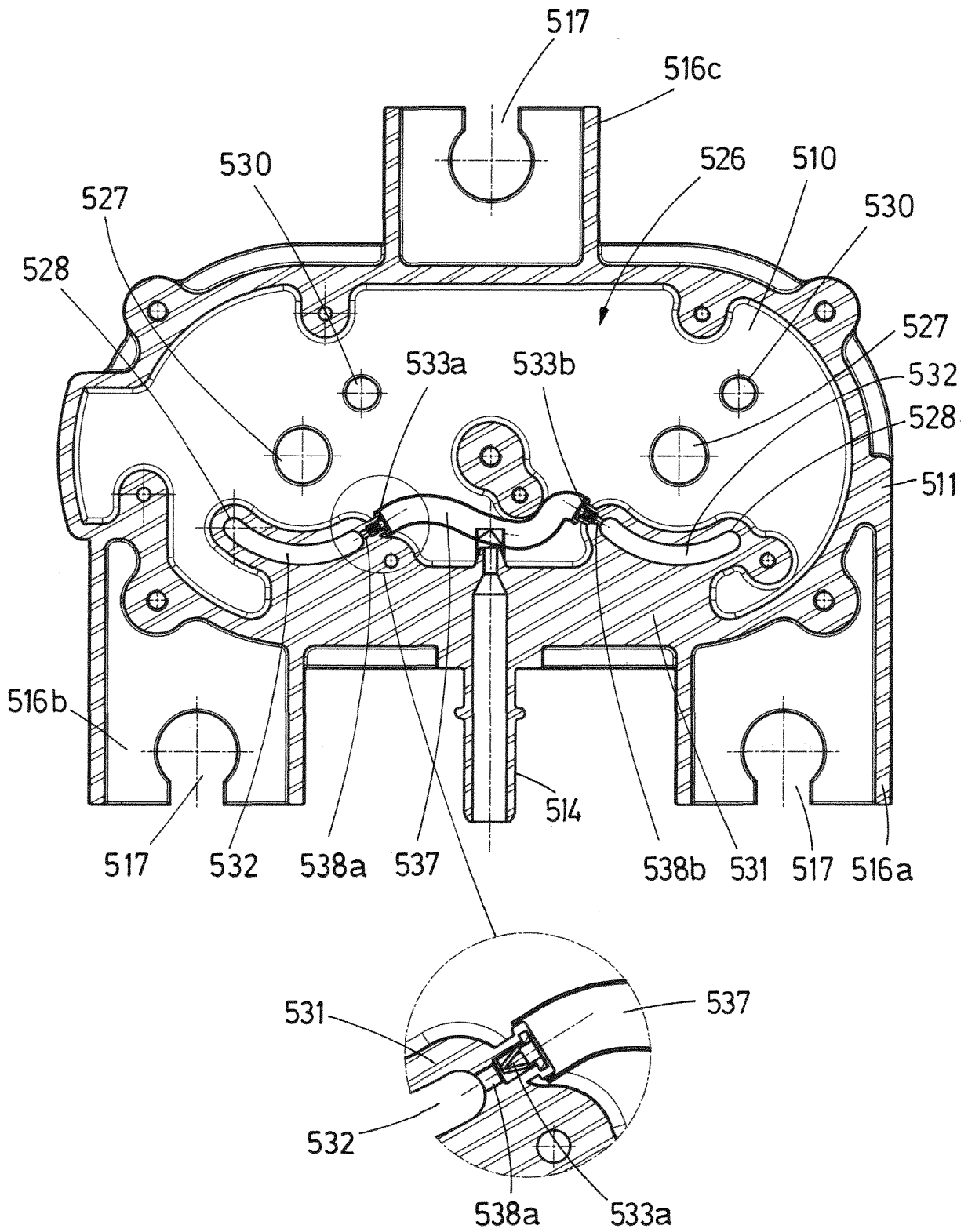


FIG.5C

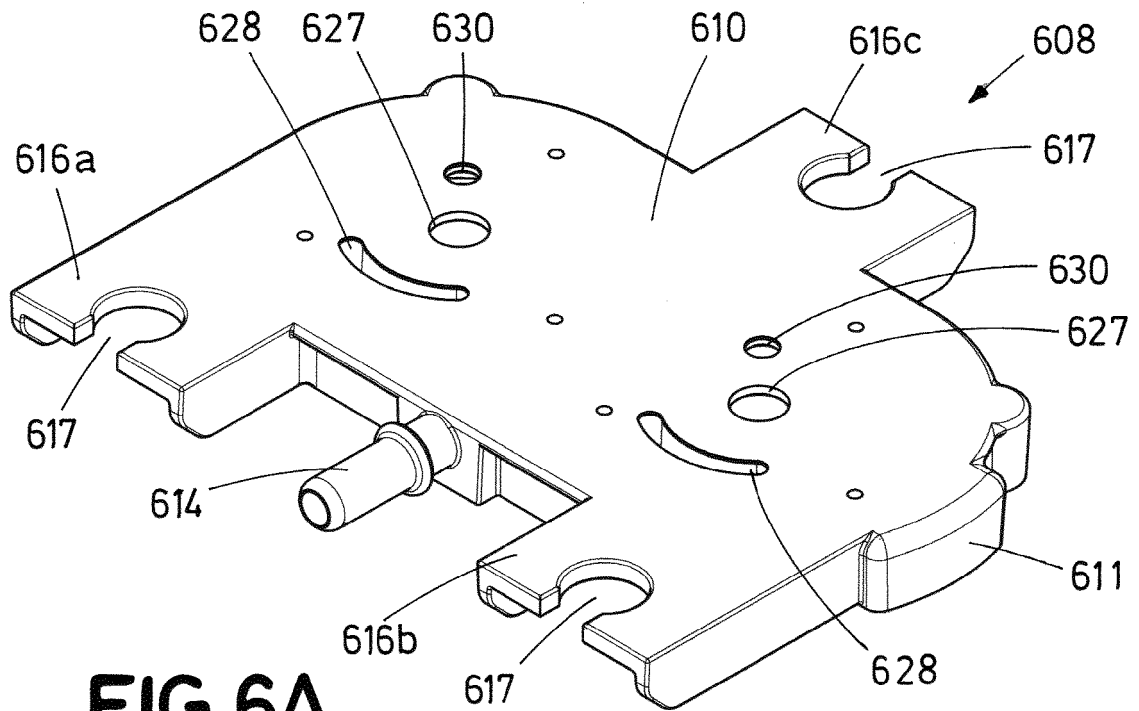


FIG. 6A

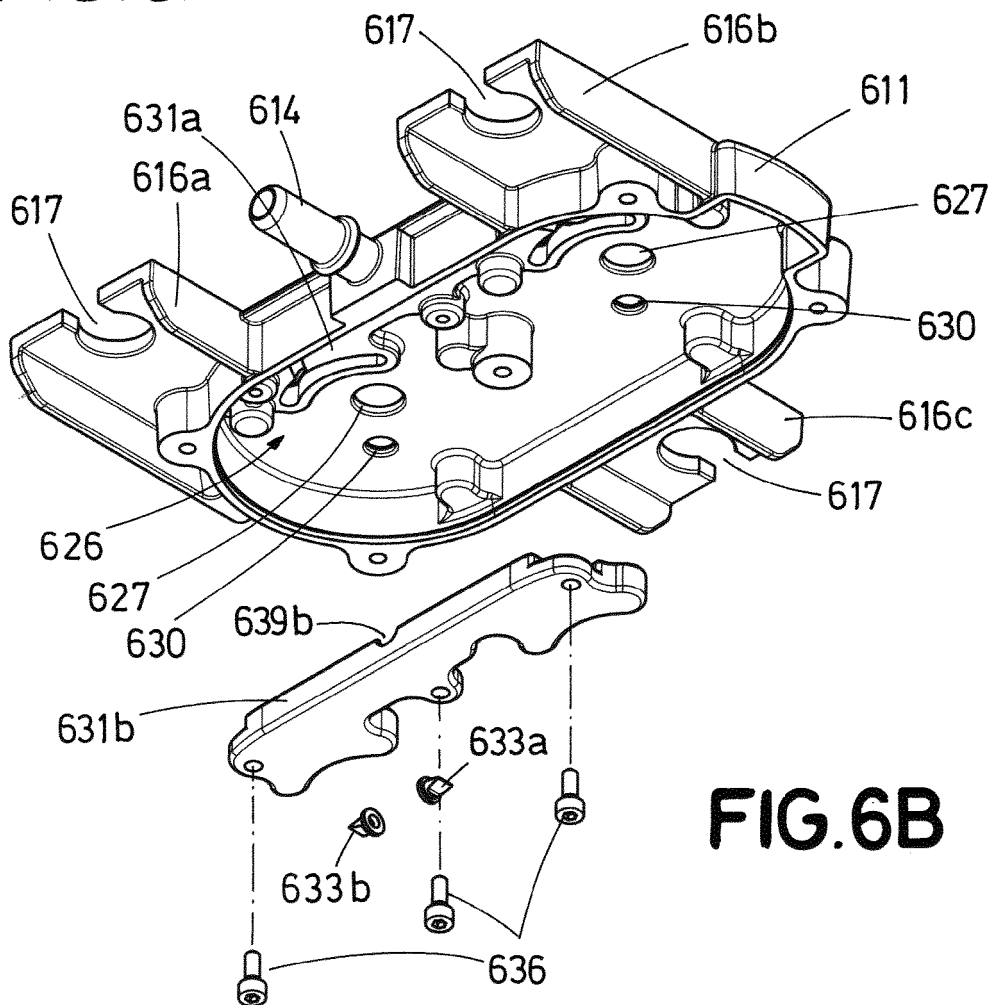


FIG. 6B

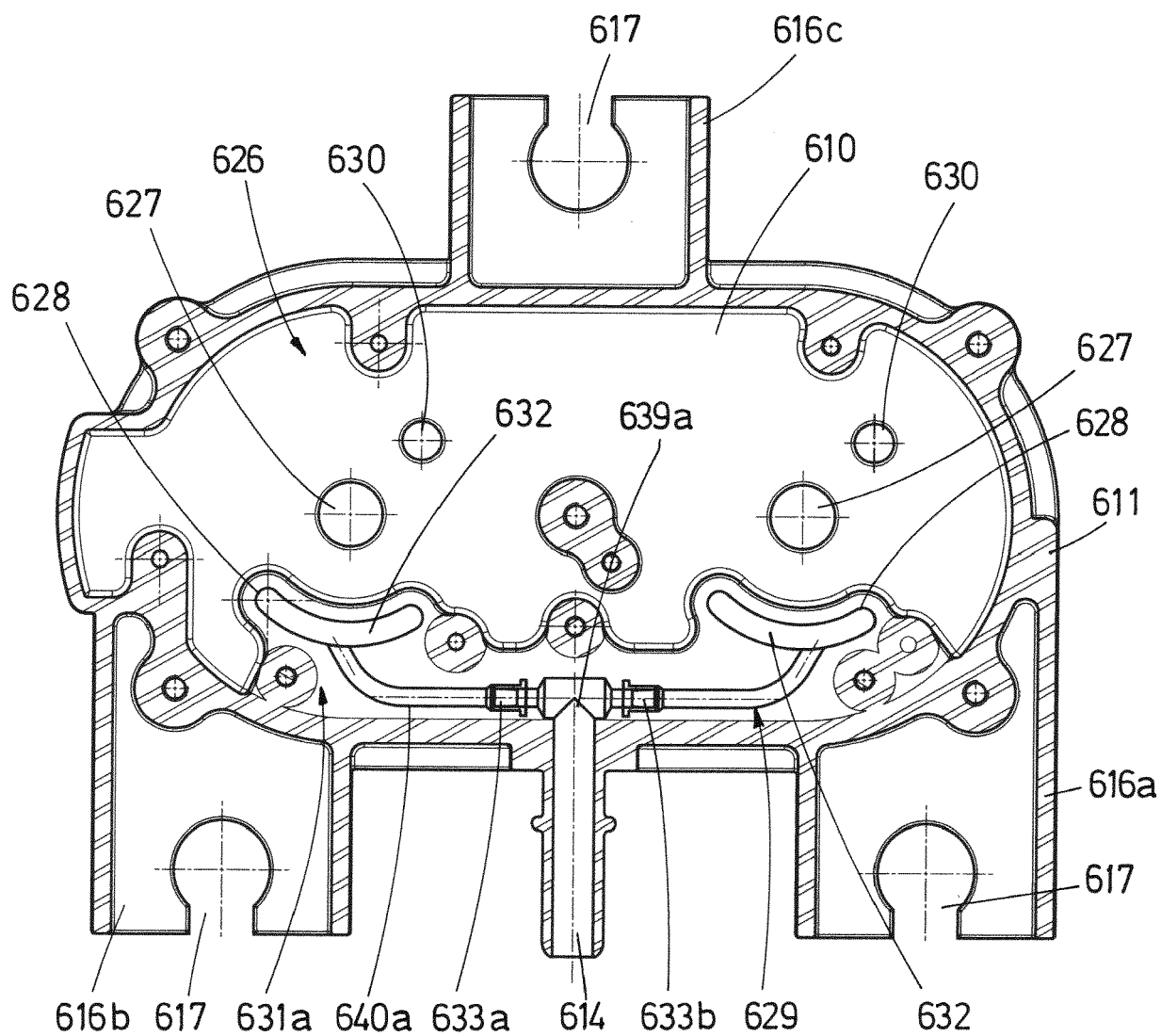


FIG. 6C

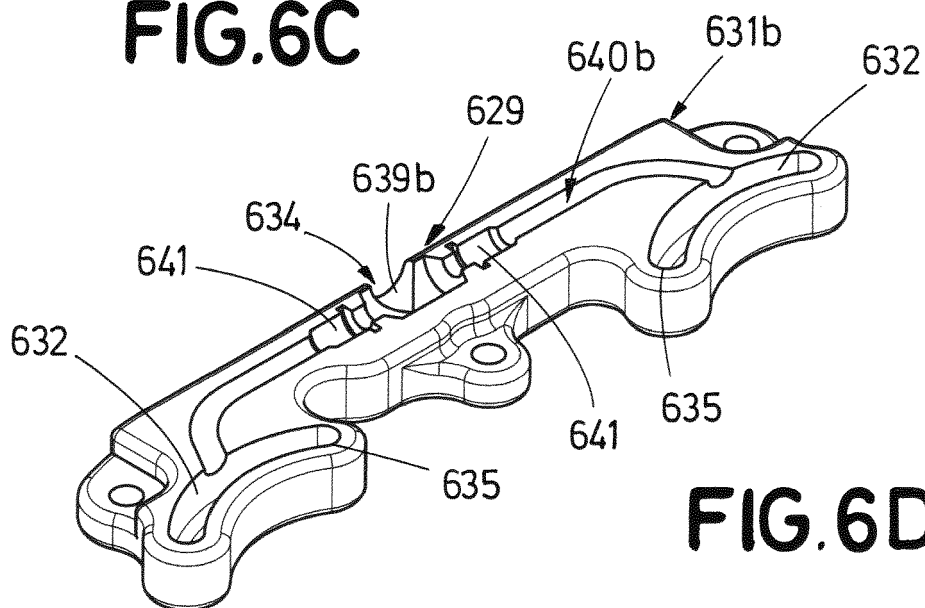


FIG. 6D

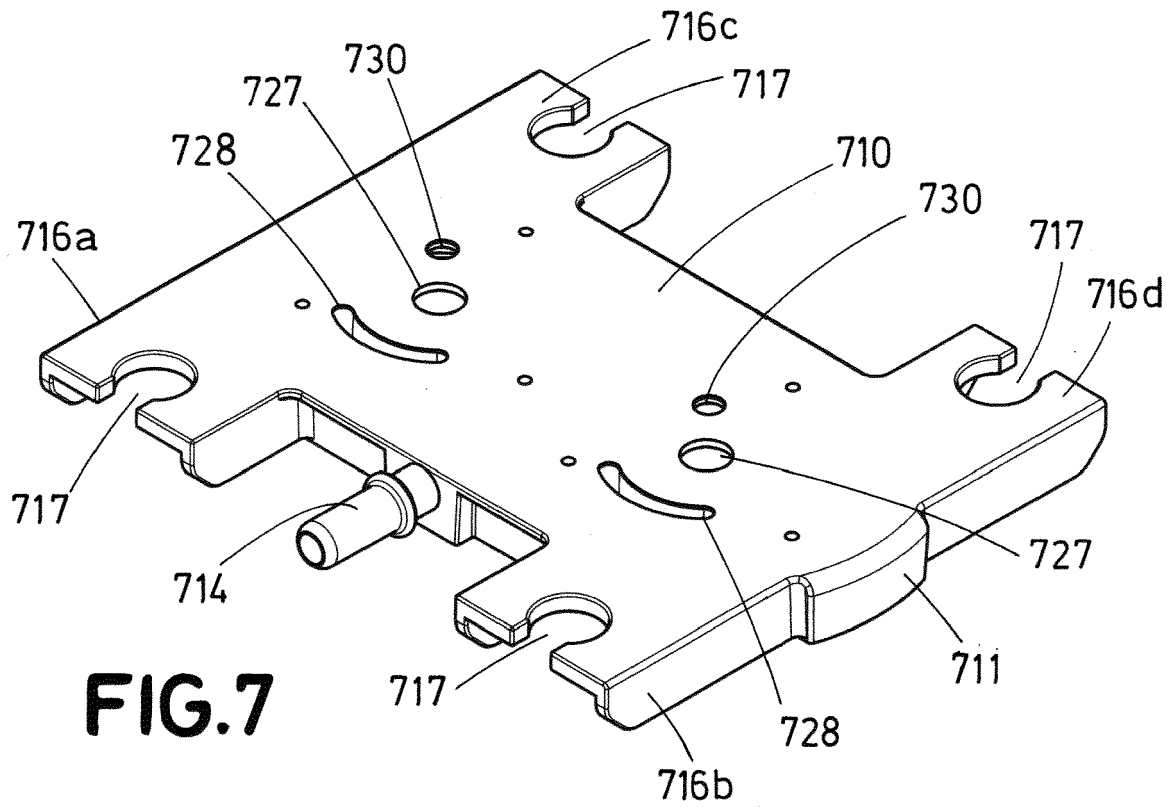


FIG. 7

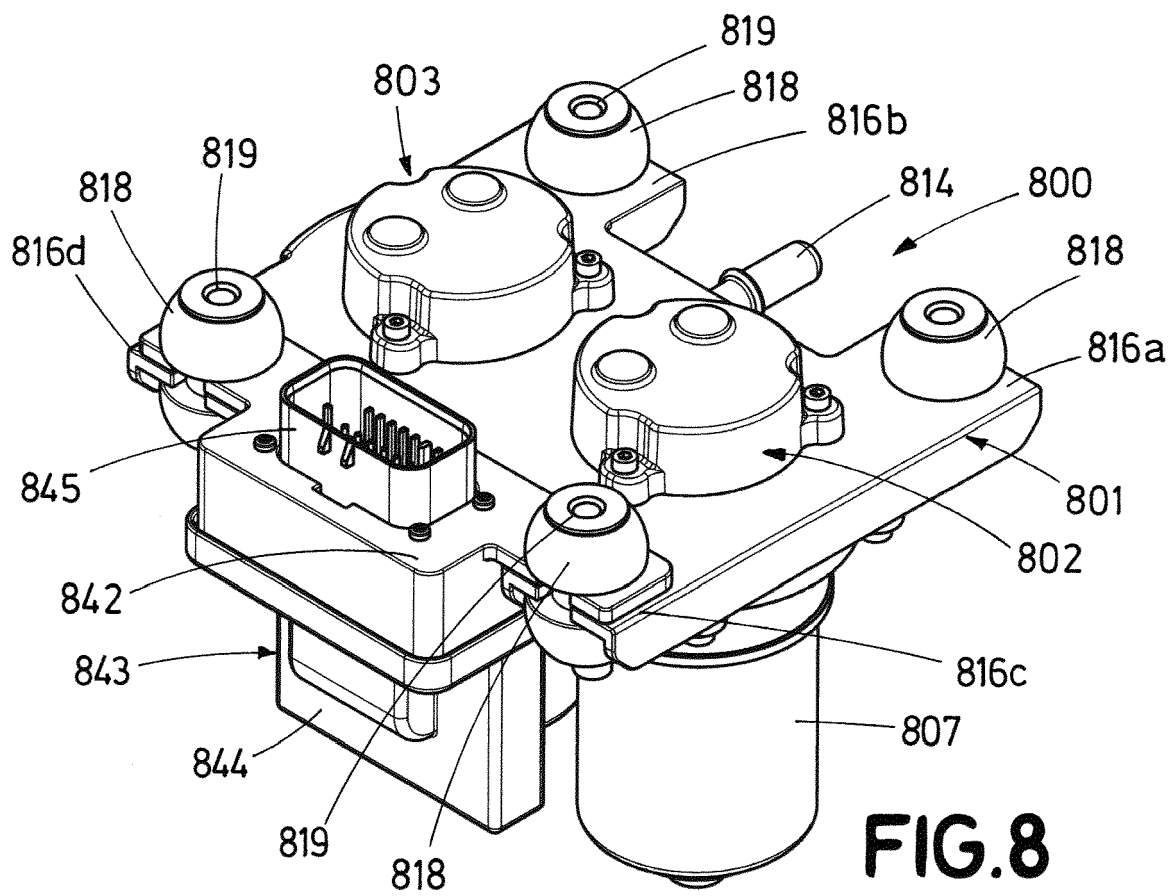


FIG. 8

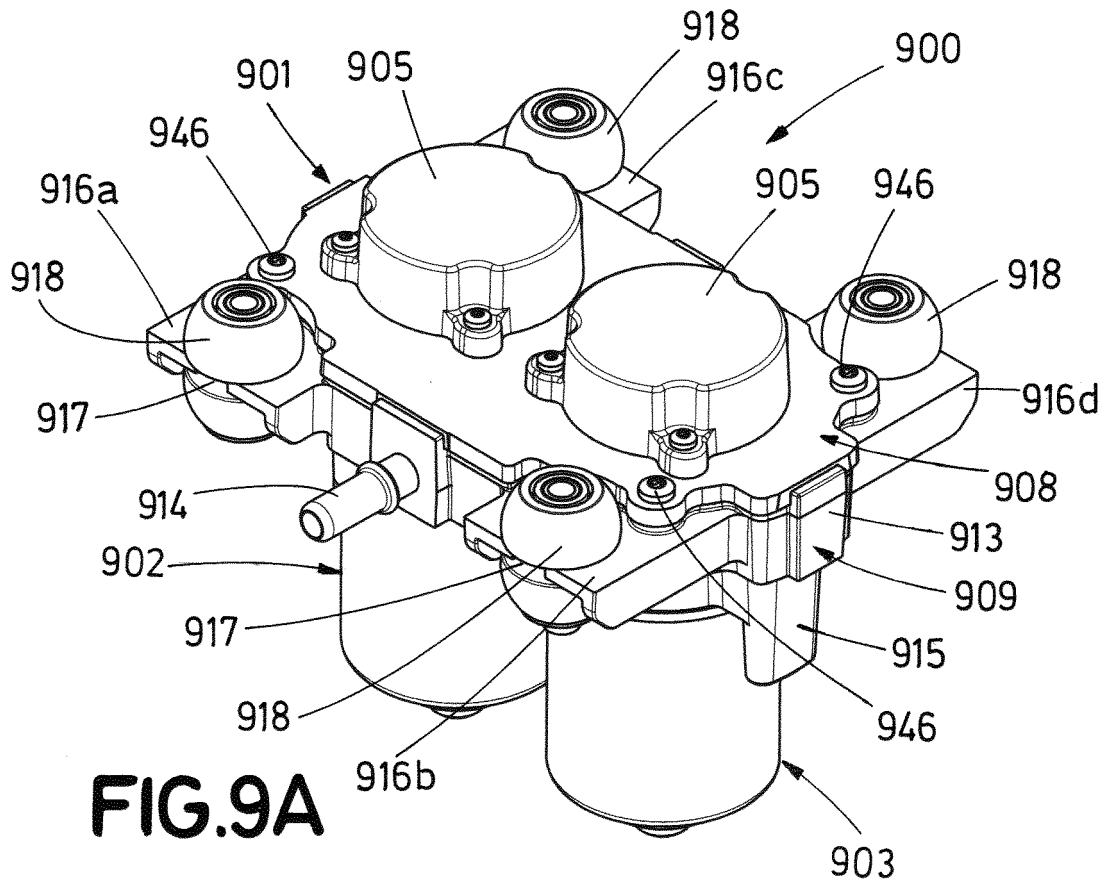


FIG. 9A

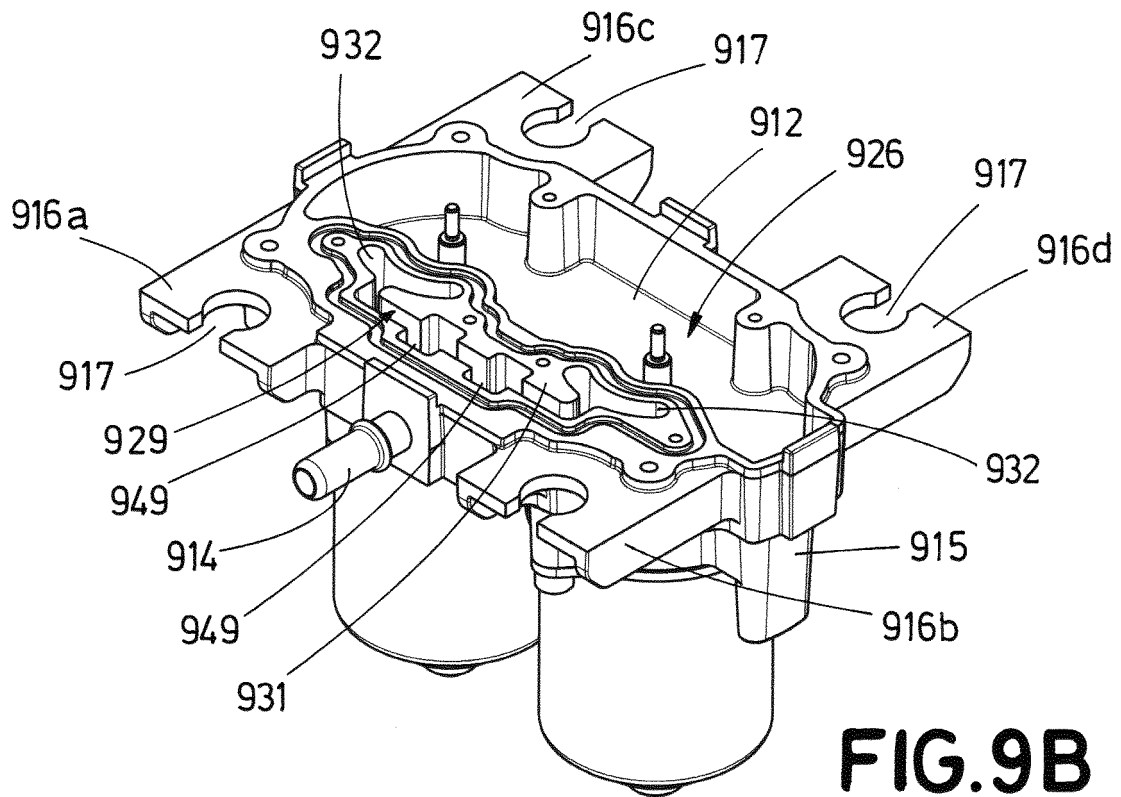


FIG. 9B

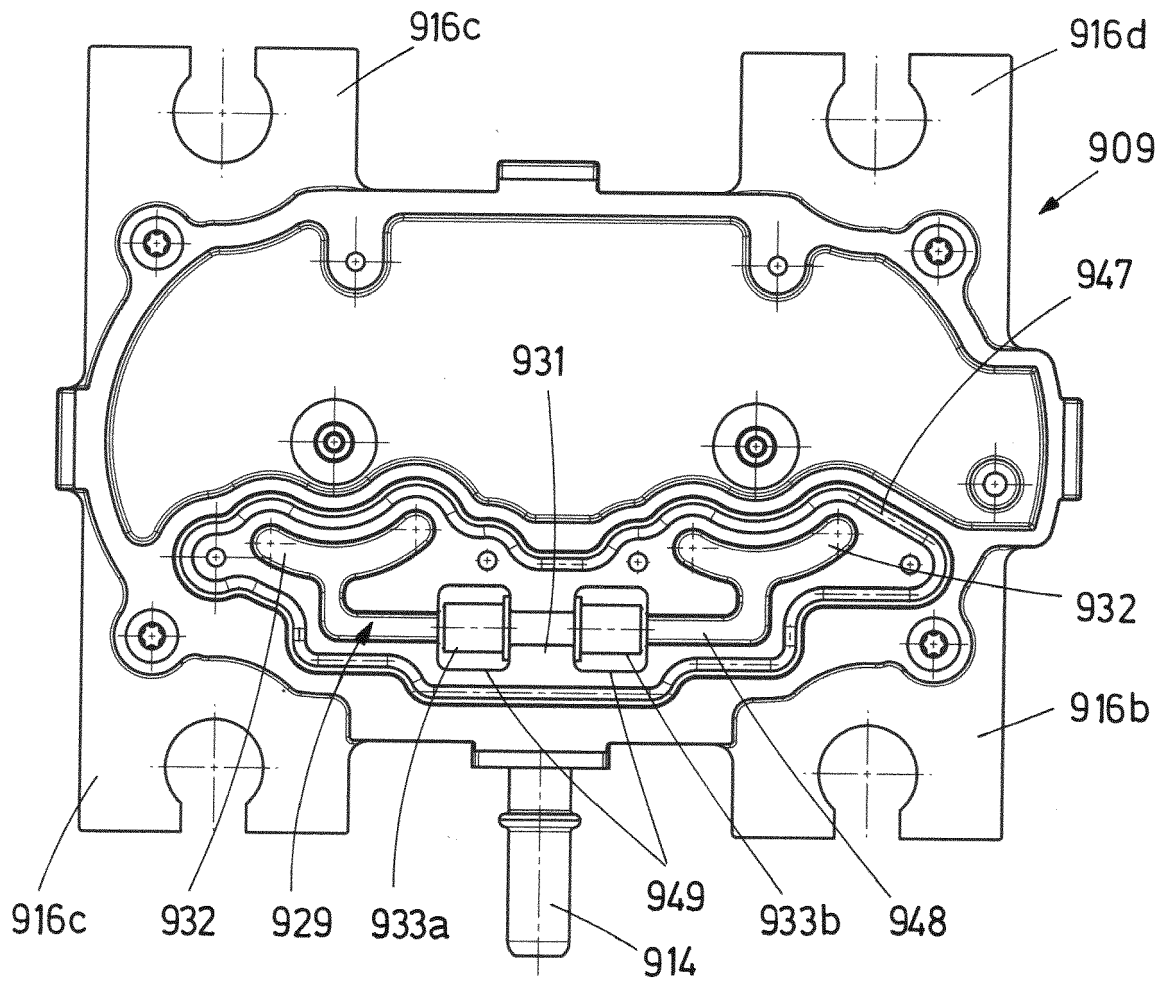


FIG. 9C

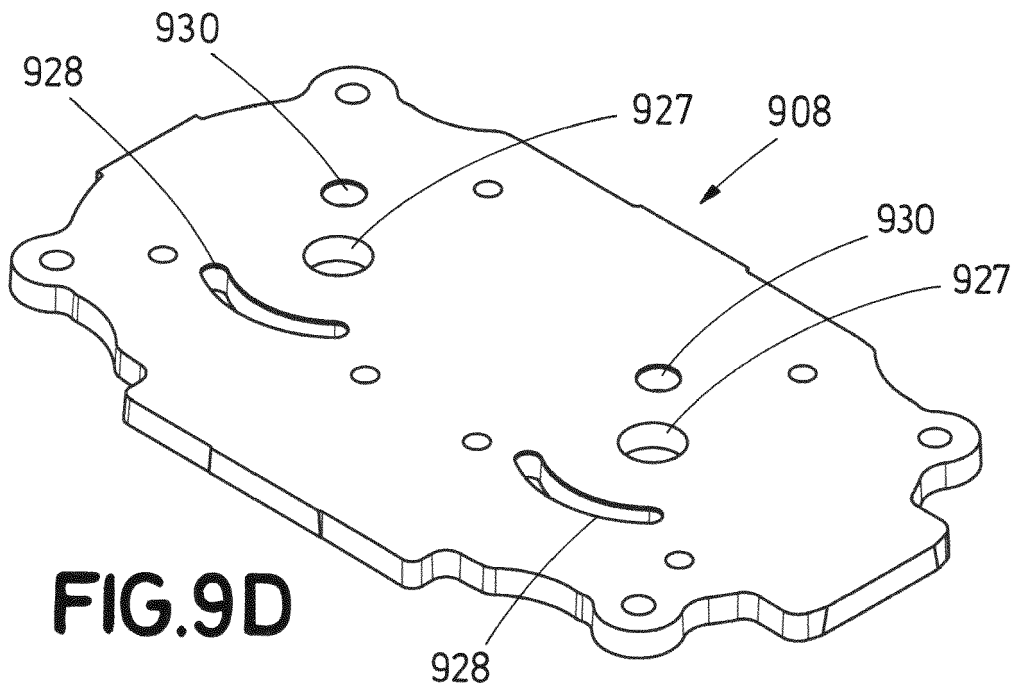


FIG. 9D



EUROPEAN SEARCH REPORT

Application Number
EP 20 38 2106

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	CN 206 035 815 U (HANGZHOU SIKETE ELECTROMECHANICAL CO LTD) 22 March 2017 (2017-03-22) * abstract * * figures 1-3,7 *	1-15	INV. F01C21/00 F04C23/00 F04C25/02 F04C28/02 F04C29/12
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A	CN 110 466 490 A (UNIV SHANDONG TECHNOLOGY) 19 November 2019 (2019-11-19) * abstract * * figures 1,2 *	1-15	TECHNICAL FIELDS SEARCHED (IPC) F01C F04C B60T
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 5 August 2020	Examiner Sbresny, Heiko
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 20 38 2106

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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05-08-2020

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