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(71) Applicant: **ZF CV Systems Europe BV**
1170 Brussels (BE)

(72) Inventor: **KOZLOWSKI, Bartosz**
51-669 Wroclaw (PL)

(74) Representative: **Rabe, Dirk-Heinrich et al**
ZF CV Systems Hannover GmbH
Am Lindener Hafen 21
30453 Hannover (DE)

(54) **ACTUATION PEDAL, HYDRAULIC SYSTEM, PNEUMATIC SYSTEM, VEHICLE, METHOD OF ASSEMBLING AN ACTUATION PEDAL**

(57) The invention relates to an actuation pedal (100) comprising a pedal lever (140) rotatable in a housing (110); a stop bar (180), which is detachably fixed to the housing (110) and arranged to limit the lever rotation (RL) of the pedal lever (140), the stop bar (180) comprising a stop feature (182) adapted to interfere with a lever hook (142) fixed to the pedal lever (140), defining an end stop (SE) of the lever rotation (RL); a push rod (160), arranged to contact the pedal lever (140) on a pedal end (162) and a piston (120) on an opposing piston end (164), wherein the push rod (160) is adapted to transform the lever rotation (RL) into an actuation translation (TA) for a piston (120), wherein the piston (120) is adapted to build up a pressure (P) on a medium (122, 124) upon receiving the actuation translation (TA).

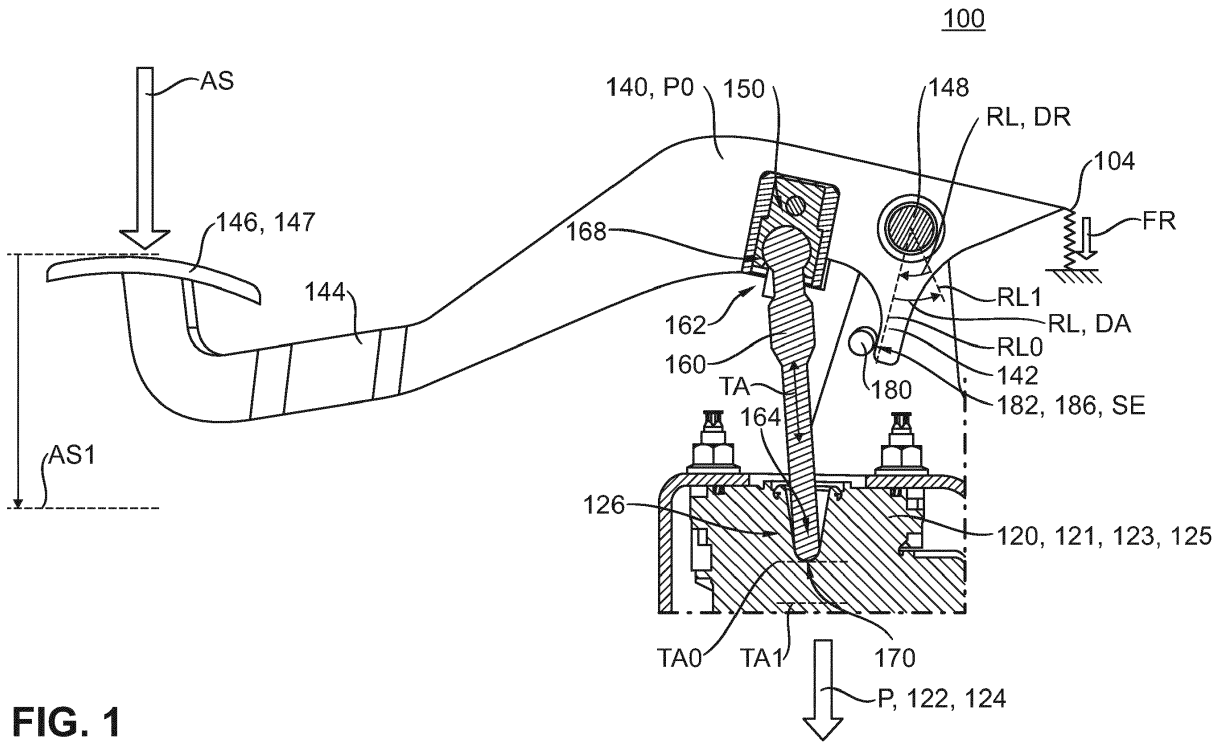

FIG. 1

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Description

[0001] The invention relates to an actuation pedal according to the preamble of claim 1.

[0002] Actuation pedals, in particular hydraulic and/or a pneumatic actuation pedals for a vehicle, are generally well known. Such actuation pedals serve to transform a mechanical actuation signal, in particular provided by a foot of a human operator, into an actuation translation, in particular on a hydraulic or a pneumatic piston, for building up a pressure on a fluidic medium and in turn actuate a hydraulic or a pneumatic system. To achieve this, actuation pedal comprises a pedal lever, which is adapted to transform the mechanical actuation signal into a lever rotation, wherein the lever rotation is transformed into the actuation translation by a push rod connected to the pedal lever.

[0003] A pedal lever particularly makes use of a leverage effect when transforming the mechanical actuation signal into the actuation translation. The lever rotation - in particular when moving in a retracting direction after the release of a mechanical actuation signal - is limited by a stop, such as a stop bar.

[0004] However, the assembly and the function of an actuation pedal can still be improved. The assembly of the components of the actuation pedal still requires a relatively high amount of manual effort, in order for the actuation pedal to fulfill the requirements with respect to function, reliability and comfort. It is therefore desirable to address at least one of the above problems. Actuation pedals should be improved with respect to their reliability as well as to their manufacturing and assembly friendliness.

[0005] In accordance with a first aspect of the invention, an actuation pedal is proposed according to claim 1. An actuation pedal is proposed for a hydraulic system or a pneumatic system of a vehicle, in particular a commercial vehicle, comprising:

- a pedal lever, which is held rotatable in a housing, adapted to receive a mechanical actuation signal and transform the mechanical actuation signal into a lever rotation,
- a stop bar, which is detachably fixed to the housing and is arranged and adapted to limit the lever rotation of the pedal lever, wherein
- the stop bar comprises a stop feature, which is adapted to interfere with a lever hook fixed to the pedal lever, the stop feature having a feature position and defining an end stop of the lever rotation at the feature position,
- a push rod, arranged to contact the pedal lever on a pedal end and a piston on an opposing piston end of the push rod, wherein the push rod is adapted to transform the lever rotation into an actuation translation for a piston, wherein
- the piston is adapted to build up a pressure on a pneumatic medium or a hydraulic medium upon receiving the actuation translation.

[0006] In accordance with the invention,

- the stop bar comprises an adjustable fixation feature, adapted to engage with a mounting feature of the housing in at least a first fixation position and a second fixation position, wherein
- the first fixation position provides a first feature position of the stop feature and the second fixation position provides a second feature position of the stop feature different from the first feature position.

[0007] According to the invention, it was specifically recognized that a stop means such as a stop bar is generally advantageous for limiting the lever rotation of an actuation pedal. Through such stop, it is ensured that an initial position of the pedal lever and in particular of an attached actuation section, is reliably reached by an operator at an expected position after every actuation. Consequently, the human operator can rely on a constant initial position of the actuation pedal.

[0008] The invention includes the finding, that the assembly of an actuation pedal is relatively time-consuming, since the mechanism comprising the pedal lever, the push rod and the piston need to be adjusted to ensure a reliable function, yet to prevent a too large clearance between components, in particular when the pedal lever of the actuation pedal is in its initial position. Hence, the adjustment in particular shall result in a clearance small enough to ensure a reliable and effective actuation, yet allow for a specified clearance to prevent a constant actuation of the brake, in particular in the initial position.

[0009] In contrast to prior art approaches - where such adjustment is achieved via an effort- and time-consuming length adjustment of the push rod - the invention includes the finding that, by varying a feature position of a stop feature, and adjustment of said mechanism can be achieved with significantly less effort. In prior art approaches, the procedure of adjusting the length of the push rod is in particular time consuming, as there is limited access to the push rod and two tools have to be used simultaneously by the assembly worker.

[0010] According to the invention, it was specifically recognized, that - although the initial position of the pedal lever is changed by the adjustment of the feature position - such change is not critical to the reliable function of the actuation pedal, since it is minimal (in particular in the range of a few millimeters) and furthermore it is permanent.

[0011] The feature position can be conveniently set by the adjustable fixation feature of the stop bar, namely by engaging the adjustable fixation feature with the mounting feature of the housing when the stop feature is at a

desired feature position.

[0012] According to the concept of the invention, different fixation positions of the adjustable fixation feature result in different feature positions of the stop feature. If the adjustable fixation feature is fixed in a first fixation position, a first feature position will be provided. For changing the feature position of the stop feature, in particular to minimize free play and/or to set a specified axial clearance in the mechanism of the actuation pedal, the adjustable fixation feature can be brought into a second fixation position, which will provide a second feature position. In particular, the adjustment movement is a rotational movement, in particular around a bar axis of the stop bar.

[0013] Such adjustment of the feature position with an adjustable fixation feature enables an assembly worker to precisely and reliably set an initial position of the pedal lever - in particular such that a specified axial clearance is present between the components of said mechanism, in particular between the push rod and the piston- under relatively little manual effort. Such specified axial clearance is in particular greater than 0 mm, for example between 0.2 mm and 0.8 mm.

[0014] Further embodiments of the invention can be found in the dependent claims and show particular advantageous possibilities to realize above described concept in light of the object of the invention and regarding further advantages.

[0015] In particular, the actuation pedal is a hydraulic clutch actuation pedal or a hydraulic brake actuation pedal or a pneumatic brake actuation pedal. In other embodiments, the actuation pedal is an electronic clutch actuation pedal or an electronic brake actuation pedal, in particular of a drive-by-wire system of a vehicle.

[0016] In particular, the adjustable fixation feature is adapted such that an adjustment of the feature position results in a specified axial clearance greater than 0 mm, preferably between 0.1 mm and 2 mm, more preferably between 0.2 mm and 0.8 mm.

[0017] An embodiment suggests that the adjustable fixation feature is adapted to engage with the mounting feature by means of a positive locking. A positive locking in particular is achieved by a protrusion on one locking partner interfering with a recess on the other locking partner such that a relative movement between the two locking partners is inhibited. In particular, the adjustable fixation feature comprises one or more protrusions adapted to engage with one or more recesses of the mounting feature in a positive locking manner.

[0018] In accordance with a further embodiment, it is proposed that the fixation feature comprises a disc with one or more radial protrusions, adapted to engage with one or more radial recesses of the mounting feature. In embodiments, the one or more protrusions can be radial protrusions and/or can have a triangle shape and/or can be are arranged equally around the circumference of the adjustable fixation feature, in particular resulting in a star-shaped geometry of the adjustable fixation feature. In embodiments, the recesses as well can be radial recesses and/or can have a triangle shape and/or can be arranged equally around the inner circumference of the mounting feature, in particular resulting in a star-shaped geometry of the mounting feature. In other embodiments, the protrusions are axial protrusions, in particular of the adjustable fixation feature, adapted to engage with axial recesses, in particular of the mounting feature, in a positive locking.

[0019] In a further embodiment, the stop feature is a cam. A cam in particular is a body axially protruding along the bar axis, with a radial extension varying in dependence of the angle. In particular, one angular section of the cam has a continuously increasing and subsequently decreasing radial extension compared to the remaining angular section. Also other shapes of cams are possible, that are adapted such that the rotation of the cam along with the stop bar upon adjustment of the fixation position results in a change of the feature position.

[0020] In particular, the cam is a cylindrical section with a cylinder axis, which is parallel and offset by a cam offset to a bar axis of the stop bar. Such cylindrical section arranged eccentric to the bar axis has the advantage of - in contrast to other cam shapes such as a solid cam - increasing the range of achievable feature positions by additionally allowing a negative displacement of the feature position. For example, the feature position and thus, the end stop of the lever rotation, can be located on the bar axis or even beyond, depending on the amount of the cam offset. In other embodiments of the invention, the cam and the stop bar are formed as one integral part, in particular such that the cam is formed to the - in particular cylindrically shaped - stop bar.

[0021] In accordance with a further embodiment, it is proposed that the push rod is one integral part. An embodiment with an integrally designed push rod is advantageously possible due to the adjustment of the initial position of the pedal lever by means of the stop bar, according to the concept of the invention. In particular, an actuation pedal according to the first aspect of the invention is not depending on a length adjustment of the push rod, in particular because unwanted clearances between one or more of the components pedal lever and/or push rod and/or piston can be removed by adjusting the feature position of the stop feature. Also, a drawback of a length-adjustable push rod is that the length can change over time, in particular when a nut or counter nut loosens. Therefore, in an embodiment with an integrally designed push rod, the accidental loosening of screws or nut of a length adjustment mechanism is advantageously avoided.

[0022] An embodiment suggests that the lever end of the push rod comprises a spherical joint. Such spherical joint enables an effective transformation from a lever rotation to an actuation translation. Also, other constructive solutions, such as a hinge or other sort of the bearing, can be applied.

[0023] In particular, the actuation pedal is a hydraulic

actuation pedal comprising a hydraulic piston. In other embodiments, the actuation pedal is a pneumatic actuation pedal comprising a pneumatic piston. In yet other embodiments, the actuation pedal is an electronic actuation pedal comprising an electronic piston with a position sensor, wherein the position sensor is adapted to determine the position of the pedal and/or of the push rod, in particular to determine an actuation translation.

[0024] According to a second aspect of the invention, a hydraulic system for a vehicle is proposed, comprising a hydraulic clutch and/or a hydraulic brake system, and further comprising an actuation pedal according to the first aspect of the invention.

[0025] According to a third aspect of the invention, a pneumatic system for a vehicle is proposed, comprising a pneumatic brake system and an actuation pedal according to the first aspect of the invention.

[0026] According to a fourth aspect of the invention, a vehicle, in particular a commercial vehicle, is proposed comprising a hydraulic system according to the second aspect of the invention and/or a pneumatic system according to the third aspect of the invention and/or an actuation pedal according to the first aspect of the invention.

[0027] According to a fifth aspect of the invention, a method of assembling an actuation pedal according to the first aspect of the invention is proposed, comprising the steps:

- Inserting of the push rod into the piston and/or inserting of the push rod into the rod bearing,
- Mounting of the pedal lever to the housing,
- Inserting of the stop bar, wherein the feature position of the stop feature is adjusted by choosing a fixation position,
- Fixing of the stop bar.

[0028] In a further embodiment of the method, the fixation position is chosen such that a clearance gap between the stop feature and the lever hook is minimized.

[0029] In a further embodiment of the method, the method can comprise the step:

- inserting the rod bearing into the pedal lever, in particular prior to the inserting of the push rod into the rod bearing.

[0030] The hydraulic system according to the second aspect of the invention, a pneumatic system according to the third aspect of the invention, the vehicle according to the fourth aspect of the invention and the method according to the fifth aspect of the invention particularly benefit from the advantages of the an actuation pedal according to the first aspect of the invention. In particular, the method of assembling an actuation pedal is improved due to the characteristic features of the actuation pedal according to the first aspect of the invention.

[0031] The aspects of the disclosure may be best understood from the following detailed description taken in conjunction with the accompanying figures. The figures are schematic and simplified for clarity, and they just show details to improve the understanding of the claims, while other details are left out. Throughout, the same reference numerals are used for identical or corresponding parts. The individual features of each aspect may each be combined with any or all features of the other aspects. These and other aspects, features and/or technical effect will be apparent from and elucidated with reference to the illustrations described hereinafter which show in:

Fig. 1 a cross-sectional view of an actuation pedal 100 according to the invention,
Fig. 2 a perspective view of a stop bar 180,
Fig. 3 a perspective view of a housing 110,
Fig. 4 a schematic cross-sectional drawing of an adjustable fixation feature 184 and a corresponding mounting feature 112,
Fig. 5 a perspective view of an actuation pedal 100 in its assembled condition, and in
Fig. 6 a schematic drawing of a vehicle 1000 comprising an actuation pedal 100.

[0032] Fig. 1 shows a cross-sectional view of an actuation pedal 100 with a piston 120 and a pedal lever 140. The piston 120 in particular can be a hydraulic piston 123 adapted to exert a pressure P on a hydraulic medium 124, such as oil. In other embodiments, the piston 120 can be a pneumatic piston 121 adapted to exert a pressure P on a pneumatic medium 122, such as air or the like gas. In other embodiments, the piston 120 can be an electronic piston 125, in particular with a position sensor, wherein the position sensor is adapted to determine the position of the pedal lever 140 and/or of the push rod 160, in particular to determine an actuation translation TA. The signal of such position sensor can in particular serve as an input for a drive-by-wire, in particular brake-by-wire, system.

[0033] The pedal lever 140 is held rotatable in a pivot bearing 148, with a main lever section 144 extending from said pivot bearing 148 towards an actuation section 146. In particular, the actuation section 146 can be a foot pedal 147.

[0034] The pedal lever 140 further comprises a rod bearing 150, adapted to accommodate a push rod 160. The rod bearing 150 is arranged between the actuation section 146 and the pivot bearing 148, preferably closer towards the pivot bearing 148 as to increase the leverage effect for facilitating the actuation of the piston 120 by a human operator. The push rod 160 serves as a mechanical connection between the pedal lever 140 and the piston 120 and is adapted to transform the lever rotation RL of the pedal lever 140 into an actuation translation TA for the piston 120.

[0035] The push rod 160 is held at a lever end 162 in the rod bearing 150 of the pedal lever 140. In particular, the rod bearing 140 allows for a certain degree of pivoting

of the lever end 162, to enable the transformation of the rotational lever rotation RL into the translational actuation translation TA. In particular, the lever end 162 comprises a spherical joint 168.

[0036] On a second, opposing end, the push rod 160 comprises a piston end 164. The piston end 164 is held in a rod mount 126 of the piston 120. Analogously to the rod bearing 150, the rod mount 126 allows for a certain degree of pivoting of the piston end 164. In particular, the piston end 164 is spherically shaped and the rod mount 126 is accordingly dome-shaped to accommodate the piston end 164.

[0037] In particular, the push rod 160 is formed as one integral part.

[0038] The actuation pedal 100 and its pedal lever 140 are shown here in an initial position P0, in which no mechanical actuation signal AS is acting upon the actuation section 146. In the shown initial position P0, also the lever rotation RL is in a corresponding initial lever rotation RL0, resulting in an initial actuation translation TA0.

[0039] Upon applying a mechanical actuation signal AS to the actuation section 146, in particular by pressing down the foot pedal 147 by a foot of a human operator, the pedal lever 140 rotates around the pivot bearing 148 in a lever rotation RL. The lever rotation RL has an actuation direction DA.

[0040] As an example, a first actuation signal AS1 is indicated in Fig. 1, resulting in a first lever rotation RL1, which in turn results in a first actuation translation TA1.

[0041] The actuation pedal 100 further comprises a retracting spring 104, which is schematically shown in Fig. 1. The retracting spring 104 is adapted to exert a retracting force FR to rotate back the pedal lever 140 in a retracting direction DR into its initial position PI after the mechanical actuation signal AS has been released from the actuation section 146.

[0042] The lever rotation RL of the pedal lever 140 in the retracting direction DR is limited by a stop feature 182 of a stop bar 180, which serves as an end stop AS for the pedal lever 140 by interfering with a pedal hook 142, which is integrally connected to the pedal lever 140.

[0043] The position of the stop feature 182 therefore defines the position of the end stop SE and thus of the range of the lever rotation RL. Therefore, by modifying a feature position 186 of the stop feature 182, the range of the lever rotation RL can be adjusted. In particular, the feature position 186 of the stop feature 182 can preferably be adjusted such that when no mechanical actuation signal AS is acting upon the pedal lever 140 - and the pedal lever 140 is in its initial position P0 - the push rod 160 is held with a relatively small, specified clearance 170 between the actuation pedal 100 and the piston 120. In particular, the specified clearance 170 is between 0.2 mm and 0.8 mm. More preferably, the feature position 186 is chosen such that the piston 120 is not actuated and therefore is in its initial actuation translation TA0 when the pedal lever 140 is in its initial position P0. In particular, the adjustable fixation feature 184 is adapted and/or the feature position 186 is chosen such that the retracting spring 104 is held under a, in particular relatively small, tension when the pedal lever 140 is in its initial position P0.

[0044] Fig. 2 and Fig. 3 further illustrate the concept of the invention by showing in detail a stop bar 180 (Fig. 2) as well as an excerpt of the housing 110 (Fig. 3). The stop bar 180 is of principally cylindrical shape and extends along a bar axis 198. The stop bar 180 comprises in its approximate axial center a stop feature 182 in the form of a cam 192, which here is formed as a cylindrical section 194. The cylindrical section 194 extends along a cylinder axis 196, which is parallel to the bar axis 198 and offset to said bar axis 198 by a cam offset OC.

[0045] The stop bar 180 comprises at least one, in particular on at least one axial end, here at an adjustment end 204, an adjustable fixation feature 184. The adjustable fixation feature 184 comprises a circular disc 188 with at least one radial protrusion 190. In particular, the disc 188 comprises a number of radial protrusions 190, which are distributed equally around its outer circumference.

[0046] In particular, the stop bar comprises at its axially opposing, mounting end 202 a mounting thread 206, which is not shown here. The housing 110 comprises two bearing ears 118, each in turn comprising a pivot bearing 148 for accommodating the pedal lever 140.

[0047] Each bearing ear 118 further comprises a stop bar orifice 119, which is adapted for accommodating the stop bar 180. A first stop bar orifice 119.1 is formed as a cylindrical through hole with a diameter slightly greater than a bar core diameter 200, in particular for accommodating the mounting end 202 of the stop bar 180 in a clearance fit. A second stop bar orifice 119.2 comprises a cylindrical through hole and a mounting feature 112. The cylindrical through hole of the second stop bar orifice 119.2 can have a larger diameter than the diameter of the first stop bar orifice 119.1, in particular such that the stop bar 180, including the stop feature 182 can pass through it during assembly. The mounting feature 112 here is formed as a hollow cylindrical space 117 with at least one radial recess 116. In particular the mounting feature 112 comprises a number of radial recesses 116, which are distributed equally around the inner circumference of the hollow cylindrical space 117.

[0048] In particular, the number of radial protrusions 190 is equal to the number of radial recesses 116.

[0049] The size and arrangement of radial protrusions 190 corresponds to the size and arrangement of radial recesses 116 so that the adjustable fixation feature 184 can be accommodated in the mounting feature 112 in a positive locking manner. This means, that the engaging of at least one radial protrusion 190 with at least one mounting feature 112 inhibits a rotational movement of the stop bar 180 around its bar axis 198, relative to the housing 110.

[0050] This concept is further described in Fig. 4, which shows a schematic cross-sectional drawing of an adjust-

able fixation feature 184 locked in a corresponding mounting feature 112 by means of a positive lock PL. The mounting feature 112 comprises a cylindrical hole with an amount of triangle-shaped radial recesses 116, equally distributed on its inner circumference. The mounting feature 112 comprises an amount of twelve radial recesses 116. The adjustable fixation feature 184 comprises a cylindrical disc 188 with an amount of triangle-shaped radial protrusions 190 equally distributed on its outer circumference. The adjustable fixation feature 184 comprises an amount of twelve radial protrusions 190, corresponding to the amount of radial recesses 116.

[0051] In other embodiments, the number of radial protrusions 190 may not be equal to the number of radial recesses 116, but smaller or greater. For example, only one radial protrusion 190 would be sufficient to establish a positive locking PL and inhibit a rotational movement of the adjustable fixation feature 184 and the stop bar 180. In other embodiments, protrusions and recesses may extend axially, that is in the direction of the bar axis 198, instead of radially, and thereby realizing a positive locking between the adjustable fixation feature 184 and the mounting feature 112.

[0052] Due to the eccentric arrangement of the stop feature 182, that is the offset of the stop feature 182 by a cam offset OC from the bar axis 198, an adjustment A of the adjustable fixation feature 184 will result in a different feature position 186 of the stop feature 182 and consequently, in a different end stop SE for the lever hook 142 of the pedal lever 140.

[0053] In Fig. 4, a first feature position 186.1 and a second feature position 186.2 of the stop feature 182 are shown as an example. In the first example, the adjustable fixation feature 184 is inserted into to the mounting feature 112 such that it is in a first fixation position 114.1. Consequently, the stop feature 182 is in its first feature position 186.1 and forms a first end stop SE1 for the lever hook 142.

[0054] For adjusting the feature position 186, an adjustment A can be made. This might in particular be required, when after a lever rotation RL in the retracting direction DR, upon a contact of the lever hook 142 with the stop feature 182, the push rod 160 has no axial contact with the piston 120 anymore and an axial clearance between the push rod 160 and the piston 120 is present that is larger than the desired specified axial clearance 170. Such unwanted large axial clearance results in a relatively long distance which the actuation pedal needs to be pressed down before an actuation of the piston 120 is effected, which in turn can result in unfavorable operation conditions and decreased comfort of the driver. In order to prevent the situation of unwanted large axial clearance, the stop feature 182 is shifted towards the direction of the lever hook 142 by an adjustment A, thus further limiting the movement range of the lever rotation RL. The feature position 186 and the end stop SE are interrelated in that the feature position 186 describes the center, in particular the cylinder axis 196, of the stop feature 182, wherein the end stop SE describes the resulting point of contact of the stop feature 182 in said feature position 186 with the lever hook 142.

[0055] The adjustment A comprises the steps of axially pulling the stop bar 180 out of the housing 110 to an extent that the adjustable fixation feature 184 is not engaging with the mounting feature 112 anymore, then rotating the stop bar 180 around the bar axis 198 until a desired feature position 186 is reached, and subsequently pushing the stop bar 180 back into the housing 110 so as to engage the adjustable fixation feature 184 with the mounting feature 112 in a new fixation position 114.

[0056] Here, the adjustable fixation feature 184 is adjusted to a second fixation position 114.2 by the smallest possible increment, that is that each radial protrusion 190 engages with the neighboring radial recess 116 of the previously engaged radial recess 116. Given the number of twelve radial recesses 116 in the example shown here, the smallest possible adjustment angle is 30°. With an increase of radial recesses 116 and/or radial protrusions 190, the smallest possible adjustment angle can be decreased in order to allow for a more accurate adjustment of the feature position 186. For example the amount of radial recesses 116 and/or radial protrusions 190 can be 30, in particular an amount of 30 radial recesses 116 and an amount of 30 corresponding radial protrusions 190. By designing a stop bar 180 with an increased cam offset OC, it is possible to allow for a greater range of possible feature positions 186. The range of possible feature positions 186 is approximately twice the amount of the cam offset OC (which would be reached by rotating the stop bar 180 by 180° from one lateral extremum of the feature position to the opposing extremum).

[0057] After the adjustment A, the feature position 186 has changed to a second feature position 186.2, resulting in a second end stop SE2, which further limits the range of the lever rotation RL. If the desired stop position 186 has been reached, in particular if the desired, specified axial clearance 170 is present in the initial position P0 of the pedal lever 140, the stop bar 180 can be fixed to the housing 110, in particular by a mounting a mounting nut 208 to a mounting thread 206, as shown in Fig. 5.

[0058] Fig. 5 shows an excerpt of a perspective view of an actuation pedal 100. The pedal lever 140 is rotatably mounted via a lever shaft 152 to a pivot bearing 148 of the housing 110. The lever shaft 152 is axially secured to the housing 110 by a headless screw 210. The retracting spring 104 is connected to the housing 110 on one side, and to the pedal lever 140 on its other side. The stop bar 180 is inserted into the housing 110, with the adjustable fixation feature 184 engaging with the mounting feature 112.

[0059] Fig. 6 shows a vehicle 1000 in the form of a commercial vehicle 1002, comprising a pneumatic system 702, in particular with a pneumatic brake system 710. Optionally or additionally, the vehicle 1000 can comprise a hydraulic system 704 with a hydraulic brake system 708. Optionally or additionally, the hydraulic system

704 can comprise a hydraulic clutch 706.

[0060] Optionally or additionally, the vehicle 1000 can comprise an electronic system 712, in particular with an electronic brake system 714. The electronic system 712 can in particular be formed as a drive-by-wire, in particular brake-by-wire, system.

The pneumatic system 702 and/or the hydraulic system 704 and/or the electronic system 712 can be actuated via an actuation pedal 100 according to the concept of the invention. The vehicle 1000 comprises four wheels 730, two of which are shown in Fig. 6. A disc brake 720 is assigned to each wheel 730. Each disc brake 720 can be actuated by a brake actuator 722, wherein the brake actuator 722 in turn can be actuated via the actuation pedal 100. Likewise, the hydraulic clutch 706 can be actuated via the actuation pedal 100.

List of reference signs (part of the description)

[0061]

100	actuation pedal
104	retracting spring
110	housing
112	mounting feature
114	fixation position
114.1, 114.2	first, second fixation position
116	radial recess of the mounting feature
117	hollow cylindrical space
118	bearing web
119	stop bar orifice
119.1, 119.2	first, second stop bar orifice
120	piston
121	pneumatic piston
122	pneumatic medium
123	hydraulic piston
124	hydraulic medium
125	electronic piston
126	rod mount
140	pedal lever
142	lever hook
144	main lever section
146	actuation section
147	foot pedal
148	pivot bearing
150	rod bearing
152	lever shaft
160	push rod
162	first, pedal end of the push rod
164	opposing, piston end of the push rod
166	integral part, integral push rod
168	spherical joint of the push rod
170	axial clearance, specified axial clearance
180	stop bar
182	stop feature
184	adjustable fixation feature
186	feature position
186.1, 186.2	first, second feature position
188	disc of the adjustable fixation feature
190	radial protrusion of the adjustable fixation feature
192	cam
194	cylindrical section
196	cylinder axis
198	bar axis
200	bar core diameter
202	mounting end
204	adjustment end
206	mounting thread
208	mounting nut
210	headless screw
702	pneumatic system
704	hydraulic system
706	hydraulic clutch
708	hydraulic brake system
710	pneumatic brake system
712	electronic system
714	electronic brake system
720	disc brake
722	brake actuator
730	wheel
1000	vehicle
1002	commercial vehicle
A	adjustment
AS	mechanical actuation signal
DA	actuation direction
DR	retracting direction
FR	retracting force
OC	cam offset
P	pressure
P0	initial position of the actuation pedal
PI	initial position
PL	positive locking
RL	lever rotation
RL0	initial lever rotation
RL1	first lever rotation
SE	end stop of the lever rotation
TA	actuation translation
TA0	initial actuation translation
TA1	first actuation translation

Claims

1. Actuation pedal (100) for a hydraulic system (704) or a pneumatic system (702) of a vehicle (1000), in particular a commercial vehicle (1002), comprising:

- a pedal lever (140), which is held rotatable in a housing (110), adapted to receive a mechanical actuation signal (AS) and transform the mechanical actuation signal (AS) into a lever rotation (RL),
- a stop bar (180), which is detachably fixed to the housing (110) and is arranged and adapted

to limit the lever rotation (RL) of the pedal lever (140), wherein
- the stop bar (180) comprises a stop feature (182), which is adapted to interfere with a lever hook (142) fixed to the pedal lever (140), the stop feature (182) having a feature position (186, 186.1, 186.2) and defining an end stop (SE) of the lever rotation (RL) at the feature position (186, 186.1, 186.2),
- a push rod (160), arranged to contact the pedal lever (140) on a pedal end (162) and a piston (120) on an opposing piston end (164) of the push rod (160), wherein the push rod (160) is adapted to transform the lever rotation (RL) into an actuation translation (TA) for the piston (120), wherein
- the piston (120) is adapted to build up a pressure (P) on a pneumatic medium (122) or a hydraulic medium (124) upon receiving the actuation translation (TA),
characterized in that
- the stop bar (180) comprises an adjustable fixation feature (184), adapted to engage with a mounting feature (112) of the housing (110) in at least a first fixation position (114.1) and a second fixation position (114.2), wherein
- the first fixation position (114.1) provides a first feature position (186.1) of the stop feature (182) and the second fixation position (114.2) provides a second feature position (186.2) of the stop feature (182) different from the first feature position (186.1).

2. Actuation pedal (100) according to claim 1, **characterized in that** the adjustable fixation feature (184) is adapted to engage with the mounting feature (112) by means of a positive locking (PL).

3. Actuation pedal (100) according to claim 2, **characterized in that** the fixation feature (184) comprises a disc (188) with one or more radial protrusions (190), adapted to engage with one or more radial recesses (116) of the mounting feature (112).

4. Actuation pedal (100) according to one of the preceding claims, **characterized in that** the stop feature (182) is a cam (192).

5. Actuation pedal (100) according to claim 4, **characterized in that** the cam (192) is a cylindrical section (194) with a cylinder axis (196), which is parallel and offset by a cam offset (OC) to a bar axis (198) of the stop bar (180).

6. Actuation pedal (100) according to one of the preceding claims, **characterized in that** the push rod (160) is one integral part (166).

7. Actuation pedal (100) according to claim 6, **characterized in that** the lever end (162) of the push rod (160) comprises a spherical joint (168).

8. Hydraulic system (704) for a vehicle (1000), comprising a hydraulic clutch (706) and/or a hydraulic brake system (708), and further comprising an actuation pedal (100) according to one of the claims 1 to 7.

9. Pneumatic system (702) for a vehicle (1000), comprising a pneumatic brake system (710) and an actuation pedal (100) according to one of the claims 1 to 7.

10. Vehicle (1000), in particular a commercial vehicle (1002), comprising a hydraulic system (704) according to claim 8 and/or a pneumatic system (702) according to claim 9 and/or an actuation pedal (100) according to one of the claims 1 to 7.

11. Method of assembling an actuation pedal (100) according to one of the claims 1 to 7, comprising the steps:

- Inserting of the push rod (160) into the piston (120) and/or inserting of the push rod (160) into the rod bearing (150),
- Mounting of the pedal lever (140) to the housing (110),
- Inserting of the stop bar (180), wherein the feature position (186, 186.1, 186.2) of the stop feature (182) is adjusted by choosing a fixation position (114, 114.1, 114.2),
- Fixing of the stop bar (180).

12. Method according to claim 11, **characterized in that** the fixation position (114, 114.1, 114.2) is chosen such that a clearance gap (200) between the stop feature (182) and the lever hook (142) is minimized.

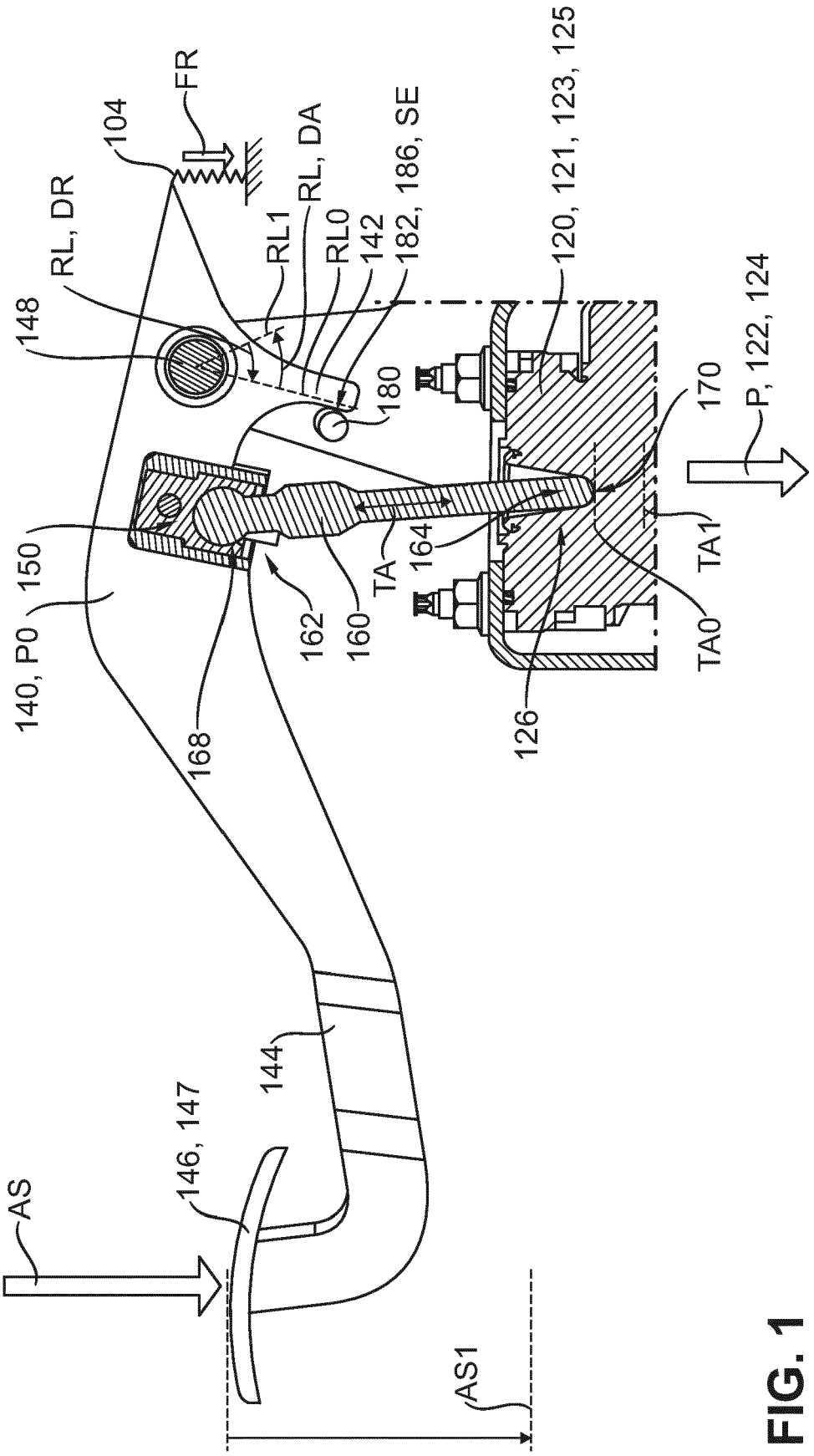

100
148
RL, DR
104
FR
RL1
RL, DA
RL0
142
182, 186, SE
120, 121, 123, 125
180
170
P, 122, 124
150
140, P0
162
160
TA
164
TA1
TA0
168
126
144
146, 147
AS
AS1

FIG. 1

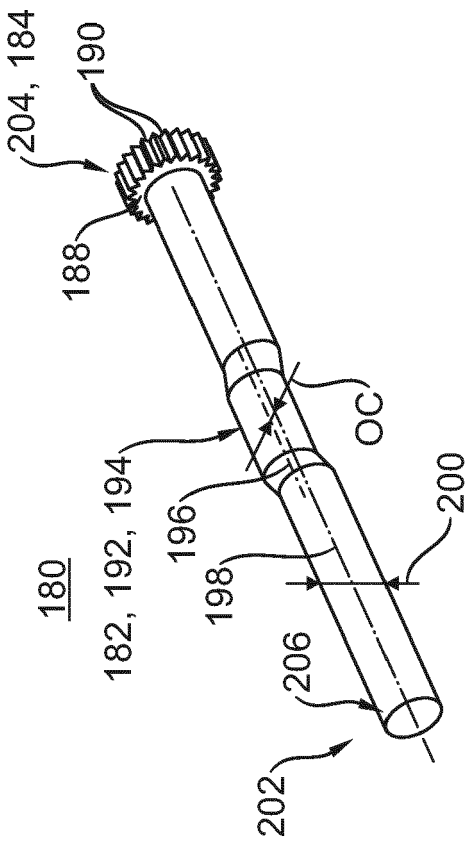


FIG. 2

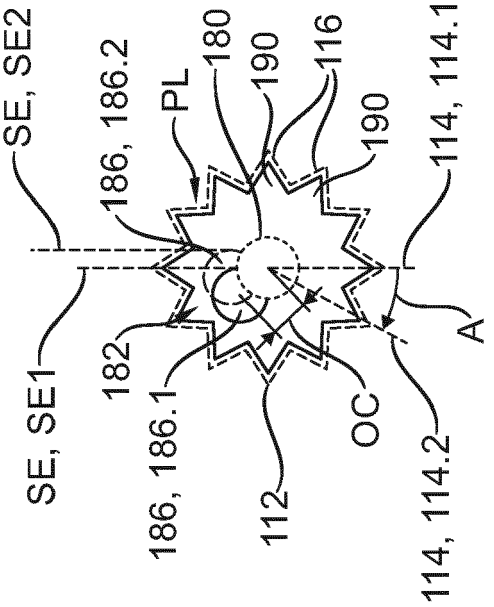


FIG. 4

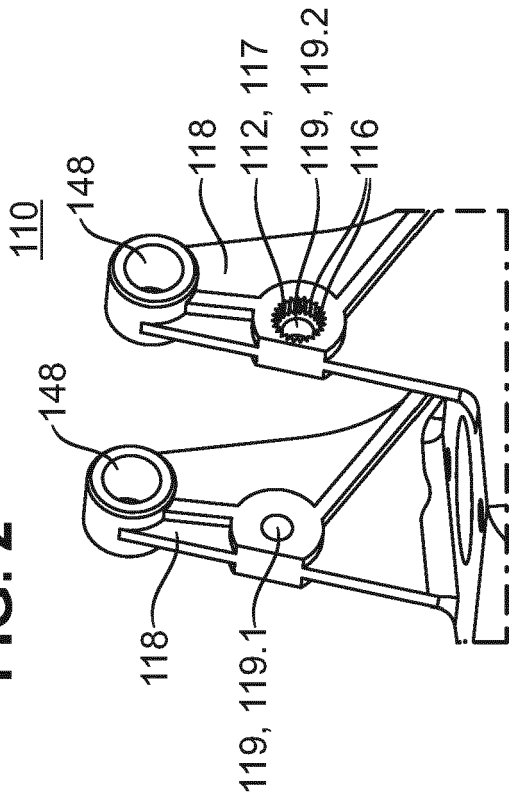
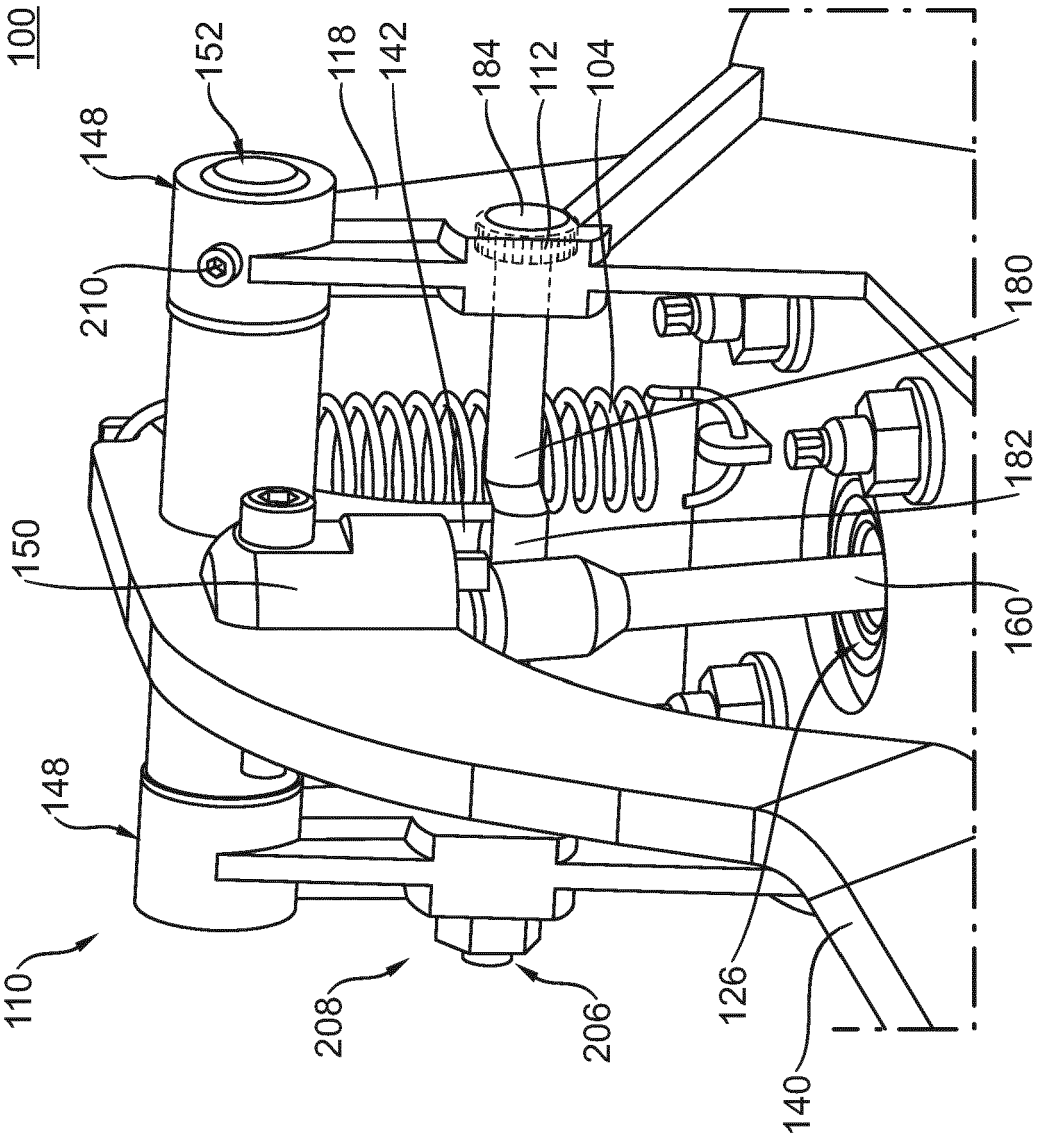


FIG. 3


100
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180
182
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160
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110
208
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140

FIG. 5

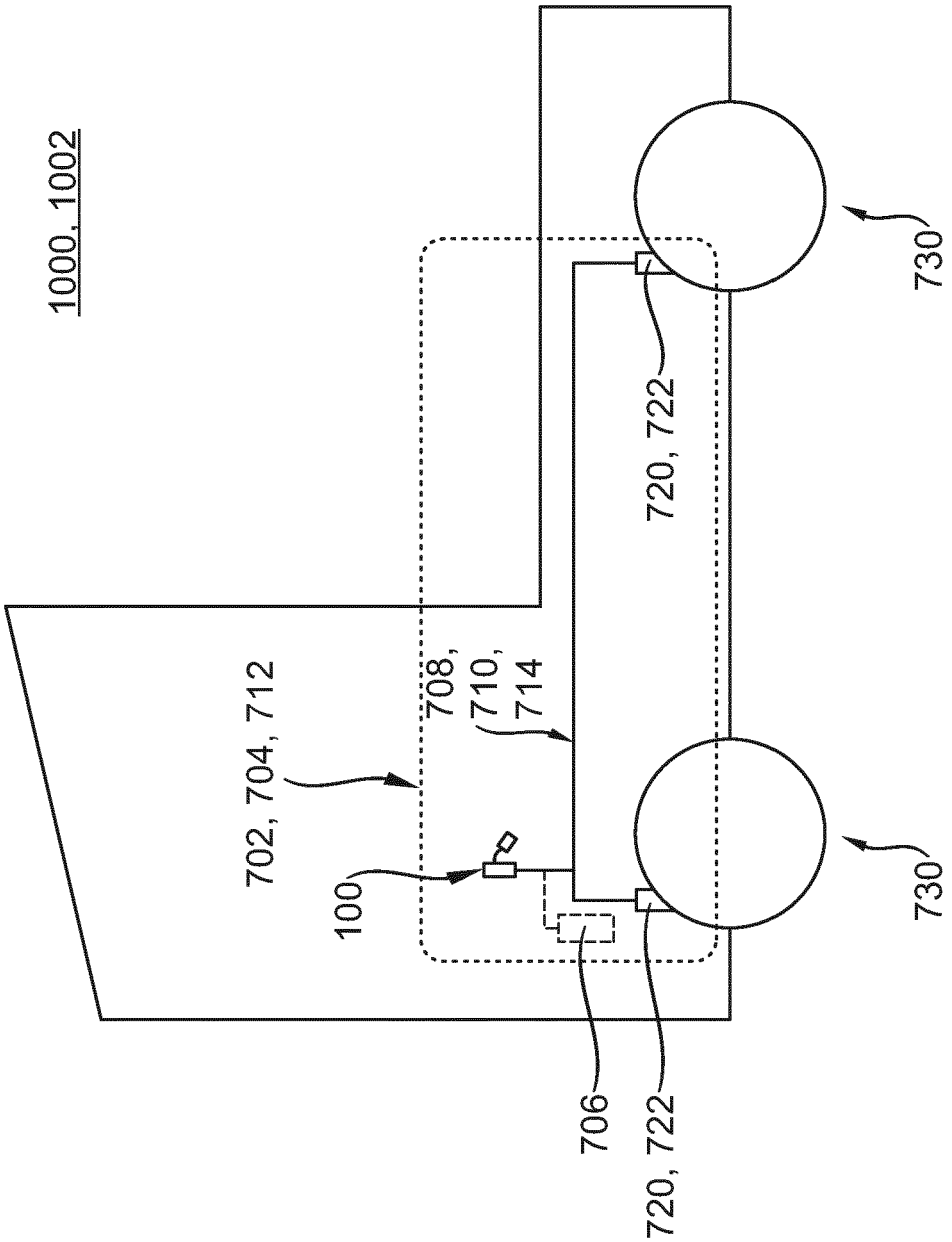
1000, 1002
730
720, 722
708, 710, 714
702, 704, 712
100
706
720, 722
730

FIG. 6

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EUROPEAN SEARCH REPORT

Application Number
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B60T

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	24 March 2021	Rossatto, Cédric

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24-03-2021

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