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Description

The invention relates to a quick changer according to the preamble of claim 1. The invention also relates to a quick-change system having such a quick changer and a dedicated adapter.

Such quick-changers are used for simple and easy changing of different attachments on building machines. Using such a quick changer, for example tilt buckets, grab buckets, shears, compressors, magnets, hydraulic hammers or other attachments may be coupled or uncoupled in a few seconds and with a high safety standard from a driver's cabin, for example on a boom of a digger.

A generic quick changer is known from US 6 379 075 B1. The latter has a support which has on one side, first receivers for holding a first coupling element provided on an attachment and on the other side, second receivers having a locking element movable between a release position and a locking position for releasable holding of a second coupling element. The locking element is configured as a linearly movable hook slider which may be displaced between an open position and closed position. A display rod, which is drawn into a housing in the closed position of the hook slider and projects with respect to the housing in the open position of the hook slider, is attached to the hook slider. Indeed the position of the hook slider may be monitored by such a display arrangement, however it cannot be checked by the display arrangement whether correct engagement of the coupling element has taken place on the hook slider.

Furthermore, a visible display element for a quick changer is known from WO 2016/153360 A1. The display element is thus visible during locking of a coupling element by a locking element provided therefor, wherein the locking element is located in the locking position.

An actuating indicator for coupling devices is known from DE 10 2015 009 491 A1 and a coupling device for attaching a working tool to a boom is known from DE 20 2006 018 263 U1.

The object of the invention is to provide a quick changer of the type mentioned in the introduction and a quick-change system having such a quick changer which facilitate improved monitoring of proper locking.

This object is achieved by a quick changer having the features of claim 1 and by a quick-change system having the features of claim 11. Expedient designs and advantageous developments of the invention are indicated in the sub-claims.

In the quick changer, the mechanical display device has an arrangement to display lack of engagement of the second coupling element to the second receivers. Correct locking is thus only displayed when the second coupling element is also located in its position intended for correct locking. For monitoring and display of proper locking, thus not only the position of the at least one locking element, but also the position of the second coupling element is included. Monitoring may thus be improved and safety increased.

The arrangement for display of lack of engagement of the second coupling element to the second receivers comprises a display element movable between a locking position and an unlocking position and a coupling gear to move the display element into the locking position during movement of the at least one locking element into the coupling position and for rearward movement of the display element into the unlocking position during a movement of the at least one locking element going beyond the coupling position.

In a first design of the invention, the coupling gear has a control lever pivotable about a hinge on the support and which is connected to the display element via a hinge rod and a linearly movable rod. The control lever preferably has a control cam and a recess. The linearly movable rod is expediently displaceably guided in a guide and resiliently pretensioned.

The control lever may be rotatable by a cylinder for displacement of the at least one locking element via an actuating arrangement. In a low-friction design, the actuating arrangement may be a lever with a ball bearing.

In a design which can be seen particularly well for the operator, the display element may be a gate arranged pivotably on a housing and which is movable between a raised locking

position and a lowered unlocking position via a linearly displaceable rod. However, the display element may also be a bolt movable between a moved-in position and moved-out position or a further suitable display element.

In a further design of the invention, the coupling gear may have a carriage displaceable at right-angles to the display element and connected to the latter via a toothed drive and an actuating element releasably connected to the carriage. The carriage may be connected releasably to the actuating element, for example via a pivotable control lever. The toothed drive may comprise a lever rotatable by a toothed wheel, an idler wheel meshing with the toothed wheel and a toothed rack meshing with the idler wheel on the carriage.

The invention additionally relates to a quick-change system having a quick changer described above and an adapter which can be coupled to the quick changer.

Further features and advantages of the invention can be seen from the following description of a preferred exemplary embodiment using the drawing. The following are shown:

Figure 1 a partly sectioned side view of a quick-change system having a quick changer and an adapter in a coupling position;

Figure 2 a perspective view of the quick changer from Figure 1 in a change position;

Figure 3 an enlarged detailed view A from Figure 2;

Figure 4 an enlarged detailed view B from Figure 3;

Figure 5 a partly sectioned side view of the quick-change system from Figure 1 in a change position;

Figure 6 the quick changer in the change position from Figure 5;

Figure 7 a partly sectioned side view of the quick-change system from Figure 1 in a coupling position;

Figure 8 the quick changer in the coupling position from Figure 7;

Figure 9 a partly sectioned side view of the quick-change system from Figure 1 in an unlocked first position;

Figure 10 the quick changer in the position from Figure 9;

Figure 11 a partly sectioned side view of the quick-change system from Figure 1 in an unlocked second position;

Figure 12 the quick changer in the position from Figure 11;

Figure 13 a second exemplary embodiment of a quick-change system in a coupling position;

Figure 14 a display device of the quick-change system from Figure 13 in the coupling position;

Figure 15 the quick-change system from Figure 13 in a locked position;

Figure 16 the display device of the quick-change system from Figure 13 in the locked position;

Figure 17 the quick-change system from Figure 13 in an unlocked position and

Figure 18 the display device of the quick-change system from Figure 13 in the unlocked position.

Figure 1 shows a quick-change system consisting of a quick changer 1 and a dedicated adapter 2 for simple and easy changing of different attachments on building machines, in particular diggers. Using such a quick changer, for example tilt buckets, grab buckets, shears, magnets, compressors, hydraulic hammers or other mechanical or hydraulic attachments may be coupled or uncoupled simply and easily from a driver's cabin on a boom or another attachment part of a digger or other building vehicle.

The adapter 2 which can be attached to an attachment has a base plate 3 and two side cheeks 4 parallel to one another, between which a first bolt-like coupling element 5 and a second bolt-like coupling element 6 spaced therefrom at a predetermined distance are arranged for releasable connection to the quick changer 1. The two bolt-like coupling elements 5 and 6 may be inserted in corresponding bores in the side cheeks 4 and fixed there.

The quick changer 1 shown also in Figure 2 in one perspective has a support 7 configured as a welded part or cast part, which has on one side, first receivers 8 open at the front for receiving and holding the first bolt-like coupling element 5 and on the other side, second receivers 9 open at the bottom with a locking element 10 shown in Figure 1 for receiving and holding the second bolt-like coupling element 6.

In the exemplary embodiment shown, the quick changer 1 has on the one side of the support 7, two receivers 8 spaced from one another for the first coupling element 5 and on the other side, two receivers 9 for the second coupling element 6. The first receivers 8 open at the front are configured like a claw or like a fork. The second receivers 9 open at the bottom have a curved lower bearing surface 11 to support the second bolt-like coupling element 6. The support 9 has on its upper side, two side parts 12 parallel to one another, in which continuous openings 13 for attachment bolts not shown are provided for attachment of the quick changer 1 to a boom of a digger or a connection part of another building vehicle.

The quick changer 1 has in the design shown also two locking elements 10 configured as locking bolts which are displaceably guided according to Figure 1 in guide bores 14 of the support 7 and can be displaced together by an in plan view H-shaped cylinder 15 hydraulically between a moved-in release position shown in Figure 5 for releasing or coupling an attachment and a locking position shown in Figure 7. In the locking position of Figure 7, the second receivers 9 open at the bottom are closed on the underside by the locking elements 10 arranged in the guide bores 14 so that the second bolt-like coupling element 6 is gripped underneath by the locking elements 10.

In order to couple an attachment with the aid of the quick changer 1, the quick changer 1 usually arranged on a boom of a digger is initially moved so that a first coupling element 5 arranged, for example on an adapter or on the attachment, is moved into the claw-like or fork-like receivers 8 on the one side of the quick changer 1. Then the quick changer 1 with

still retracted locking bolts 10 is pivoted about the first bolt-like coupling element 5 so that the second coupling element 6 on the adapter or attachment comes to rest on the bearing surfaces 11 of the receivers 9 open at the bottom on the other side of the quick changer 1. Subsequently, the locking elements 10 displaceably arranged in the guide bores 14 in the support 7 of the quick changer 1 may be moved out hydraulically so that the second bolt-like coupling element 6 is gripped underneath by the two locking elements 10 on the quick changer 1 and the attachment is thus held on the quick changer 1.

Furthermore, a mechanical display device 16 to monitor proper locking is provided on the quick changer 1. As can be seen particularly from Figures 3 and 4, the mechanical display device 16 has an arrangement for signalling lack of engagement of the second coupling element 6 to the second receivers 9. The arrangement for signalling lack of engagement of the second coupling element 6 to the second receivers 9 has a display element 17 movable between a locking position and an unlocking position and a coupling gear, by means of which the display element 17 is moved initially into the locking position during a movement of the locking elements 10 into the coupling position. However, if the locking elements 10, due to a coupling element 5 not engaging properly, are moved beyond the coupling position, the display element 17 is moved back again into the unlocking position via the coupling gear. Hence, a signal may be sent to the operator that in spite of actuation of the locking elements 10, proper locking has not taken place.

In the exemplary embodiment shown, the display element 17 is a gate arranged pivotably on a housing 18 and which can be moved by a linearly displaceable rod 19 via a bolt 20 guided within the housing 18 between a raised locking position shown in Figure 1 and a lowered unlocking position shown in Figure 5. In the locking position shown in Figure 1, the bolt 20 projects with respect to the housing 19 and raises the gate-like display element 17. In the unlocking position, the bolt 20 on the other hand is drawn into the housing 18 and the gate-like display element 17 is closed. Hence, it can be seen visually from the outside and in particular also well from a driver's cabin whether the quick changer 1 is properly locked. The display of the locking position and unlocking position may however also be effected only by the bolt 20 without the gate.

As can be seen particularly from Figure 3, the coupling gear configured for connection between the cylinder 15 and the display element 17 has a control lever 22 arranged

pivotably about a hinge 21 on the support 7 and which is connected to the linearly movable rod 19 via a hinge rod 23. The control lever 22 pivotable about the hinge 21 has on the one arm a control cam 24 and a recess 25. On the other arm of the control lever 22 is hinged the one end of the hinge rod 23. The other end of the hinge rod 23 is connected in hinged manner to the linearly movable rod 19 to move the display element 17. The linearly movable rod 19 is displaceably guided via a guide 26 attached to the cylinder 15 and is pressed into the unlocking position shown in Figure 3 by a spring arranged within a bushing 27. The guide 26 is configured in the design shown as a doubly bent sheet metal part. By rotating the plate-like control lever 22, the rod 19 is moved linearly via the hinge rod 23. Rotation of the control lever 22 is effected by the cylinder 15 provided to displace the two locking elements 10 via a lever 28 with a ball bearing 29 arranged thereon. The ball bearing 29 is configured for engagement on the control cam 24 and the recess 25 of the control lever 22.

The mode of operation of the display device 16 described above is illustrated below using Figures 5 to 12.

In the change position shown in Figures 5 and 6, the two locking elements 10 are located in a retracted release position. In this position, the ball bearing 29 according to Figure 6 is spaced from the control cam 24 of the control lever 22 and the control lever 22 is pressed into the starting position shown by the spring-loaded rod 19 via the hinge rod 23. The rod 19 is in a retracted position, whereby the gate-like display element 17 is located in an unlocking position gated at the bottom. Hence, a signal is sent to the operator that the quick changer 1 is located in a change position. In the change position shown in Figure 5 with drawn-in locking elements 10, the quick changer 1 on the front side may be lowered so that the second coupling element 6 comes to rest on the lower bearing surface 11 of the receivers 9.

If the second coupling element 6 according to Figure 7 comes to rest on the lower bearing surface 11 of the receivers 9, the two bolt-like locking elements 10, which have on their front ends a round section 30 adapted to the outer contour of the coupling element 6 to rest on the outer side of the bolt-like coupling element 6, may be moved out by the common cylinder 15 and move into the coupling position shown in Figure 7. In this coupling

position, the coupling element 6 is gripped underneath by the two bolt-like locking elements 10 and the adapter 2 is locked securely on the quick changer 1.

If the two locking elements 10 with correctly coupled adapter 2 are moved by the cylinder 15 from their retracted release position into the coupling position shown in Figure 7, the lever 28 attached to the cylinder 15 with a ball bearing 29 according to Figure 8 moves onto the control cam 24 of the control lever 22 so that the control lever 22 is rotated about the hinge 21 and the gate-like display element 17 is moved into the raised locking position via the hinge lever 23 and the linearly movable rod 19. In the locking position of Figure 8, the bolt 20 projects with respect to the housing 18 and the gate-like display element 17 is raised. Hence, a signal is sent to the operator that the adapter 2 is properly coupled to the quick changer 1 and locked. The coupling gear is designed such that the ball bearing 29 comes to rest on the outermost edge of the control cam 24 at the transition to the recess 25 in the locking position shown in Figure 8.

Provided the bolt-like locking elements 10 according to Figure 9, due to lack of engagement of the coupling element 6 to the receivers 9, move beyond the coupling position shown in Figure 8 and move out further as far as the stop of the cylinder 15 on an edge 31 of the support 7, the ball bearing 29 according to Figure 10 moves beyond the outermost edge of the control cam 24 and engages in the recess 25 of the control lever 22, whereby the control lever 22 impacted by the spring-loaded rod 19 via the hinge rod 23 moves back into the starting position. The bolt 20 on the front end of the rod 19 is thus also drawn back into the housing 18 and the gate-like display element 17 moved into the lowered unlocking position. This is a signal for the operator that the adapter 2 is not properly locked on the quick changer 1 in spite of moved-out locking elements 10.

Also a position shown in Figure 11 with non-proper engagement of the coupling element 6 is displayed. If moving-out of the two locking elements 10 is blocked by the incorrectly engaging coupling element 6, the ball bearing 29 according to Figure 12 also remains spaced from the control cam 24 of the control lever 22 and the control lever 22 is pressed into the starting position shown by the spring-loaded rod 19 via the hinge rod 23. The bolt 20 on the front end of the rod 19 is thus located in a position retracted into the housing 18 and the gate-like display element 17 is in the lowered unlocking position. Hence, it is displayed to the operator that the quick changer 1 is not correctly locked.

Figures 13 to 18 show a further exemplary embodiment of a quick-change system having a quick changer 1 and a dedicated adapter 2. Also in this design, a mechanical display device 16 is provided on the quick changer 1 to monitor proper locking. The mechanical display device 16 used in this design has a display element 17 configured here as a bolt and is displaceably arranged within a housing 18 between a locking position and an unlocking position. In the locking position shown in Figure 16, the bolt-like locking element 17 projects laterally with respect to the housing 18, whereas the locking element 17 is drawn into the housing 18 in an unlocking position shown in Figures 14 and 18. During a movement of the locking elements 10 into the release position or coupling position, the display element 17 is also moved initially into the locking position via a coupling gear in this design. However, if the locking elements 10, due to a coupling element 5 not engaging properly, move out beyond the coupling position, the display element 17 is moved back again here too into the unlocking position via the coupling gear. Hence, a signal may be sent to the operator that in spite of actuation of the locking elements 10, proper locking has not taken place.

As can be seen from Figures 14 and 16, the bolt-like display element 17 displaceably guided within the housing 18 can be moved by a lever 33 arranged pivotably about a rotational axis 32 within the housing 18. Hence, the lever 33 pivotable about the rotational axis 32 with its lever arm 34 is connected in hinged manner to the bolt-like display element 17 via a transverse pin 35. Rotation of the lever 33 is effected via a toothed wheel 36 firmly connected to the latter, which toothed wheel 36 is engaged via an idler wheel 37 with a toothed rack 38 on a carriage 39 displaceable at right-angles to the display element 17 within the housing 18. By displacing the carriage 39, the display element 17 can thus be displaced between the drawn-in position shown in Figure 14 and the moved-out position shown in Figure 16. Due to a spring arrangement not shown here, the carriage 39 is impacted so that the display element 17 is drawn into the housing 18 under the force of the spring arrangement.

A rod-like actuating element 40 arranged at right-angles to the display element 17 and projecting from the housing 18 is displaceably guided in the carriage 39. Furthermore, a double-arm control lever 42 pivotable about an axis 41 is arranged on the carriage 39. The carriage 39 is connected releasably to the rod-like actuating element 40 via the control lever

42 rotatable about the axis 41. The control lever 42 thus has on its one lever arm, a projection 43 for engagement in a groove 44 of the actuating element 40 and on its other end, a control slope 45 for engagement with an inclined control surface 46 on the housing 18. The control lever 42 is impacted by a spring not shown here so that the projection 43 is pressed in the direction of the actuating rod 40. The actuating rod 40 is connected to the cylinder 15 via a linkage 47 and a mounting 48.

In the design shown in Figures 13 to 18, the display arrangement 16 operates as follows:

In the change position shown in Figures 13 and 14, the cylinder 15 occupies the position shown in Figure 13 and the locking elements 10 are located in a retracted release position. The rod-like actuating element 40 connected to the cylinder 15 via a linkage 47 and a mounting 48 and the carriage 39 coupled to the latter via the control lever 42 are located in a starting position shown in Figure 14. In this starting position of the carriage 39, the display element 17 connected to the carriage 39 via the toothed rack 38, the idler wheel 37, the toothed wheel 36 and the lever 33 is drawn into the housing 18. Hence, a signal is sent to the operator that the quick changer 1 is located in a change position. In this change position, the quick changer 1 may be coupled on its rear end to the first coupling element 5 of the adapter 2 via the first receivers 8 and then lowered on the front side so that the second coupling element 6 comes to rest on the lower bearing surface 11 of the receivers 9.

If then the cylinder 15 according to Figure 15 is displaced in the direction of the second coupling element 6 and the locking elements 10 thus moved couple in proper manner in the adapter 2, the carriage 39 is displaced by the actuating element 40 coupled to it via the control lever 42 from the starting position shown in Figure 14 into a locking position shown in Figure 16. In the locking position of the carriage 39 shown in Figure 16, the control lever 42 is located in its not yet pivoted coupling position. By displacing the carriage into the locking position, the display element 17 is moved into a locking position projecting with respect to the housing 18 via the toothed rack 38, the idler wheel 37, the toothed wheel 36 and the lever 33. Hence, a signal is sent to the operator that the adapter 2 is properly coupled to the quick changer 1 and locked.

Provided the bolt-like locking elements 10 according to Figure 9, due to lack of engagement of the coupling element 6 to the receivers 9, move out beyond the coupling position shown

in Figure 8 and move out further as far as the stop of the cylinder 15 on one edge 31 of the support 7, the carriage 39 is also moved further in the direction of the inclined control surface 46 on the housing 18. The control lever 42 is thus pivoted via the control slope 45 so that the projection 43 comes out of engagement with the groove 44 on the actuating element 40 and there is no longer locking between the carriage 39 and the actuating element 40. The carriage 39 resiliently pretensioned in the direction of the starting position is then pressed into its starting position via the spring arrangement, wherein the display element 17 is drawn back into the housing 18. This is a signal for the operator that the adapter 2 is not properly locked on the quick changer 1 in spite of moved-out locking elements 10. If the quick changer 1 is opened, the cylinder 15 moves back again and locking between the resiliently pretensioned control lever 32 and the actuating element 40 is activated again to connect carriage 39 and actuating element 40. The mechanics are then again ready for the next actuation of the quick changer.

Reference number list

1	Quick changer
2	Adapter
3	Base plate
4	Side cheek
5	First coupling element
6	Second coupling element
7	Support
8	First receiver
9	Second receiver
10	Locking element
11	Bearing surface
12	Side part
13	Opening
14	Guide bore
15	Cylinder
16	Display device
17	Display element
18	Housing
19	Rod
20	Bolt
21	Hinge
22	Control lever
23	Hinge rod
24	Control cam
25	Recess
26	Guide
27	Bushing
28	Lever
29	Ball bearing
30	Round section
31	Edge

32	Rotational axis
33	Lever
34	Lever arm
35	Transverse pin
36	Toothed wheel
37	Idler wheel
38	Toothed rack
39	Carriage
40	Actuating element
41	Axis
42	Control lever
43	Projection
44	Groove
45	Control slope
46	Control surface
47	Linkage
48	Mounting

Patentkrav

1. Hurtigskifter (1) til at skifte et påmonteret apparat på en byggemaskine, som har et bæreelement (7), på en side af bæreelementet (7) første anbragte optagselementer (8) til optag af et første koblingselement (5), på den anden side af bæreelementet (7) yderligere anbragte optagselementer (9) med mindst et låseelement (10), der kan bevæges mellem en frigørelsesposition til til- eller frakobling af det påmonterede apparat og en koblingsposition til at holde det påmonterede apparat på hurtigskifteren (1), til optag af et yderligere koblingselement (6), og en mekanisk visningsanordning (16) til kontrol af låsningen, hvor den mekaniske visningsanordning omfatter en indretning (17, 19, 22, 23, 39, 40) til visning af manglende indgreb af det andet koblingselement (6) på de yderligere optag (9) med et visningselement (17), som kan bevæges mellem en låseposition og en oplåsningssposition, og en koblingsmekanisme (19, 22, 23; 39, 40) til bevægelse af visningselementet (17) til låsepositionen ved bevægelse af det mindst ene låseelement (10) til koblingspositionen og til returbevægelse af visningselementet (17) til oplåsningsspositionen ved en bevægelse af det mindst ene låseelement (10) ud over koblingspositionen, **kendetegnet ved, at** koblingsmekanismen (19, 22, 23, 39, 40) omfatter et styrehåndtag (22), der kan dreje om et led (21) på bæreelementet (7) og er forbundet med visningselementet (17) via en hængselstang (23) og en lineært bevægelig stang (19), eller har en slæde (39), som kan flyttes vinkelret på visningselementet (17) og er forbundet med dette via et tanddrev (36, 37, 38), og et betjeningsselement (40), som er aftageligt forbundet med slæden (39).
2. Hurtigskifter (1) ifølge krav 1, **kendetegnet ved, at** styrehåndtaget (22) har en styreknast (24) og en fordybning (25).
3. Hurtigskifter (1) ifølge krav 2, **kendetegnet ved, at** styreknasten (24) og fordybningen (25) er anbragt på en arm af styrehåndtaget (22) og hængselstangen (23) på den anden arm af styrehåndtaget (23).
4. Hurtigskifter (1) ifølge et af kravene 1 til 3, **kendetegnet ved, at** styrehåndtaget (22) kan drejes med en cylinder (15) til forskydning af det mindst ene låseelement (10) via en betjeningsindretning (28, 29).
5. Hurtigskifter (1) ifølge krav 4, **kendetegnet ved, at** betjeningsindretningen (28, 29) er dannet af et håndtag (28) med et kugleleje (29).

6. Hurtigskifter (1) ifølge et af kravene 1 til 5, **kendetegnet ved, at** den lineært bevægelige stang (19) er ført forskydeligt i en føring (26) og forspændt fjedrende.

5 **7.** Hurtigskifter (1) ifølge et af kravene 1 til 6, **kendetegnet ved, at** visningselementet (17) er en klap anbragt drejeligt på et hus (18), som via den lineært bevægelige stang (19) er bevægelig mellem en løftet låseposition og en sænket oplåspositionsposition.

10 **8.** Hurtigskifter ifølge krav 1, **kendetegnet ved, at** slæden (39) er aftageligt forbundet med betjeningsselementet (40) via et drejeligt styrehåndtag (42).

15 **9.** Hurtigskifter ifølge krav 8, **kendetegnet ved, at** det toarmede styrehåndtag (42), drejeligt anbragt omkring en akse (41) på slæden (39), har en næse (43) på sin ene håndtagsarm til indgreb i en not (44) på betjeningsselementet (40) og en styrekant (45) på sin anden styrearm til indgreb med en skrå styreflade (46) på et hus (18).

20 **10.** Hurtigskifter ifølge et af kravene 1, 8 eller 9, **kendetegnet ved, at** tanddrevet (36, 37, 38) har et håndtag (33), der kan drejes ved hjælp af et tandhjul (36), et mellemhjul (37), der griber ind i tandhjulet (36), og en tandstang (38), der griber ind i mellemhjulet (37) på slæden (39).

25 **11.** Hurtigskiftesystem med en hurtigskifter (1) og en adapter (2), som kan kobles med hurtigskifteren (1), **kendetegnet ved, at** hurtigskifteren (1) er udført ifølge et af kravene 1 til 10.

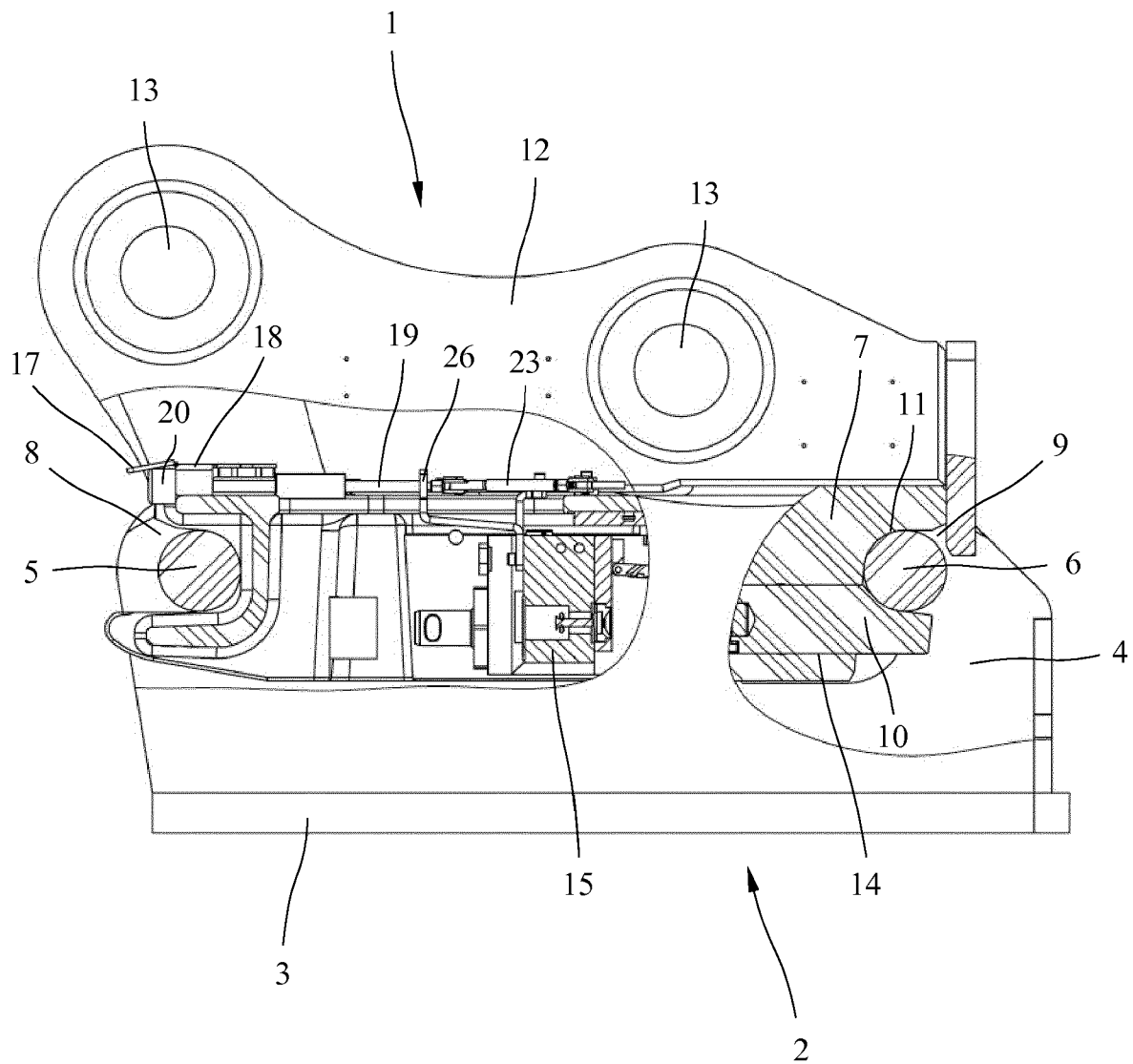
Fig. 1

Fig. 2

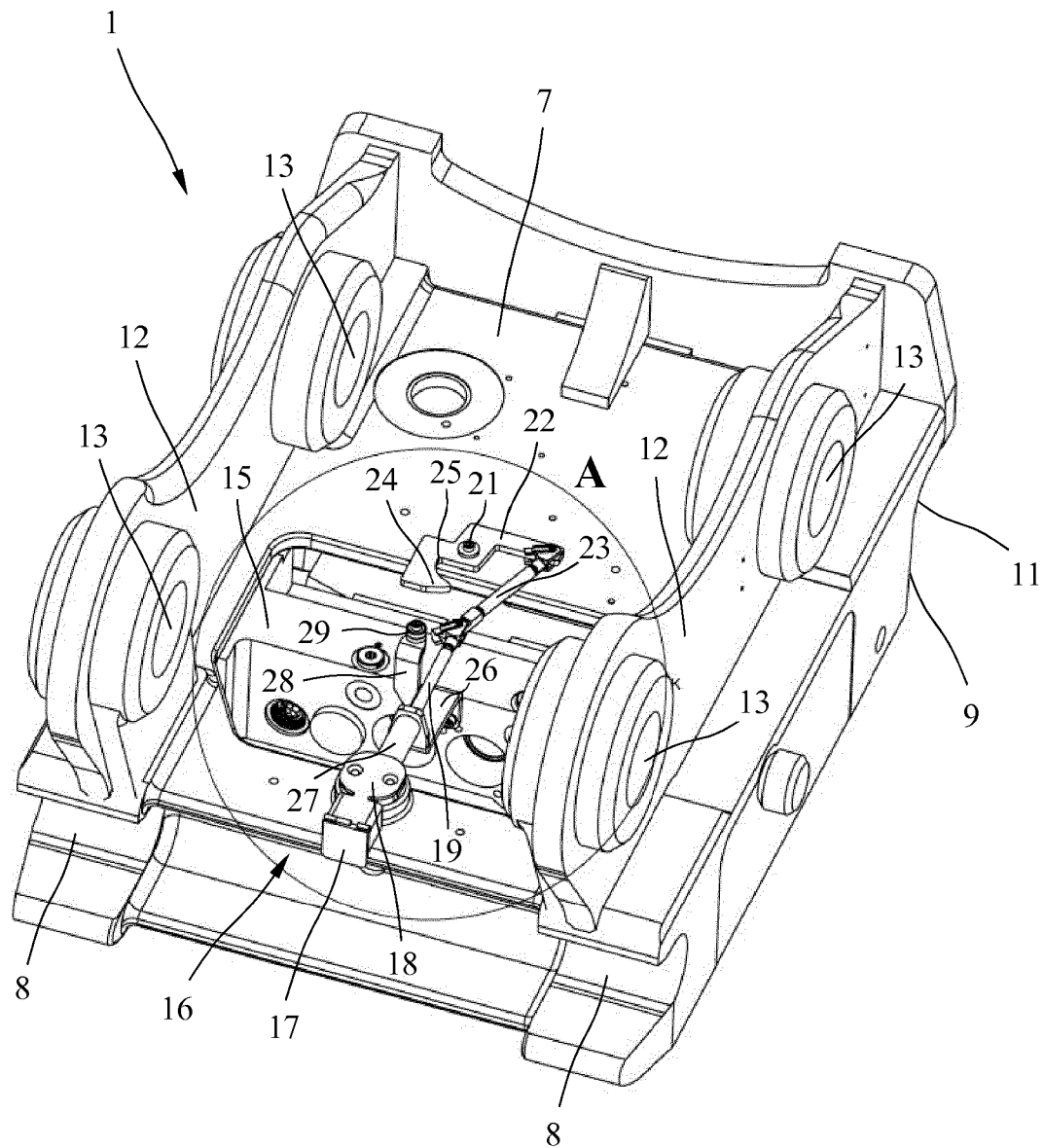


Fig. 3

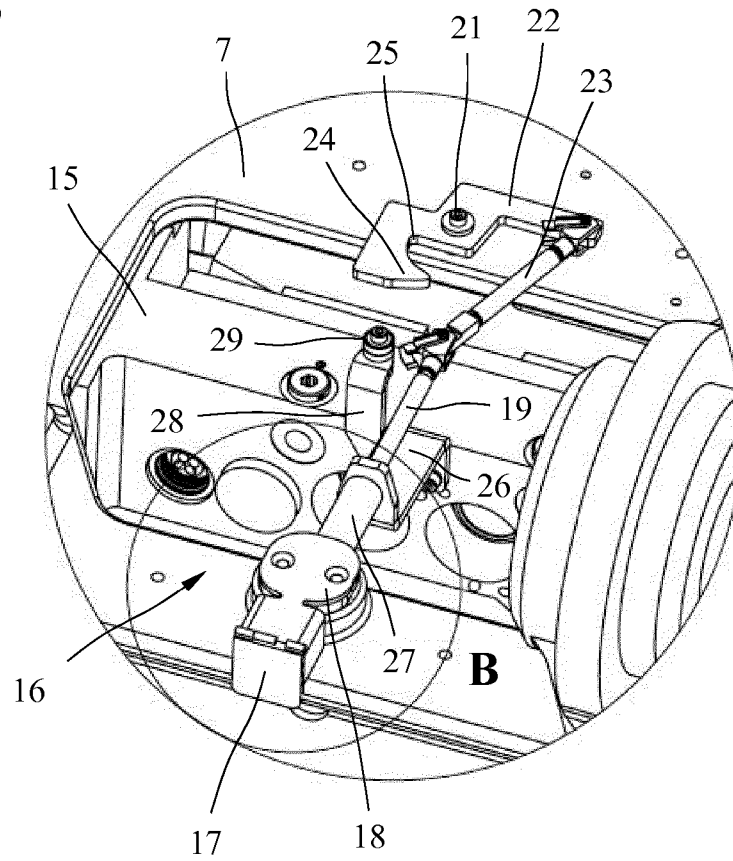


Fig. 4

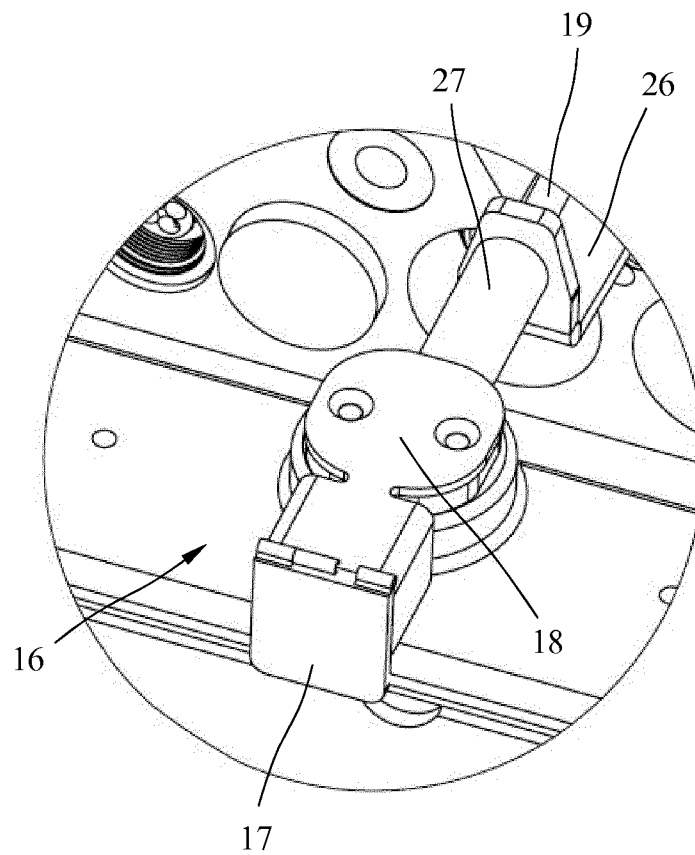


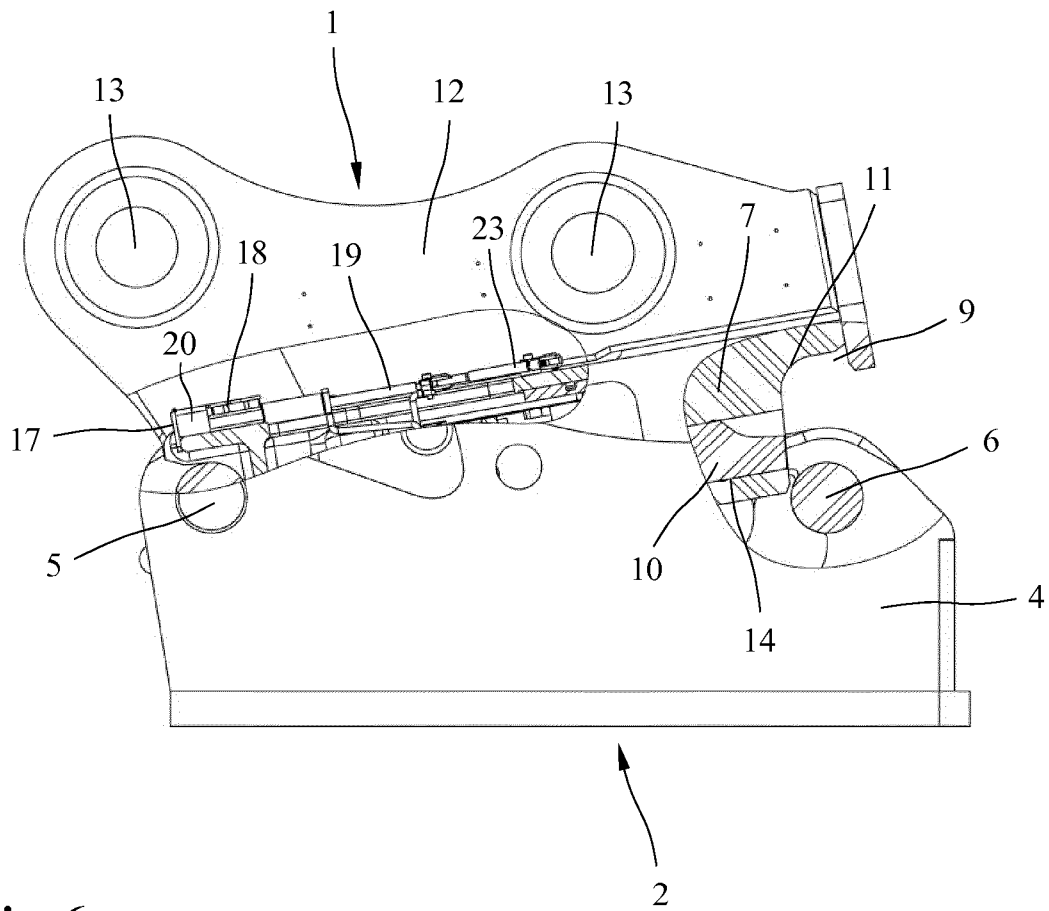
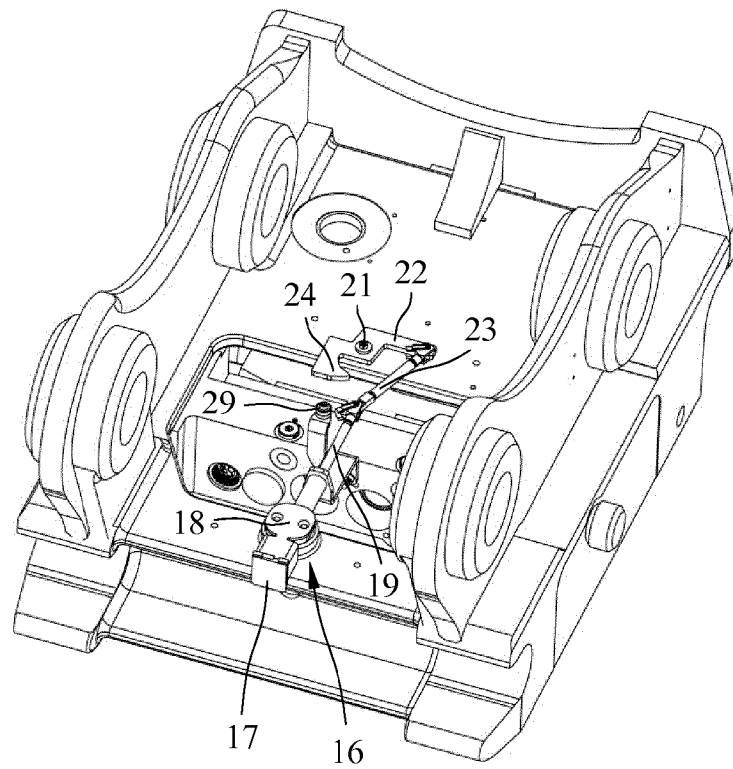
Fig. 5**Fig. 6**

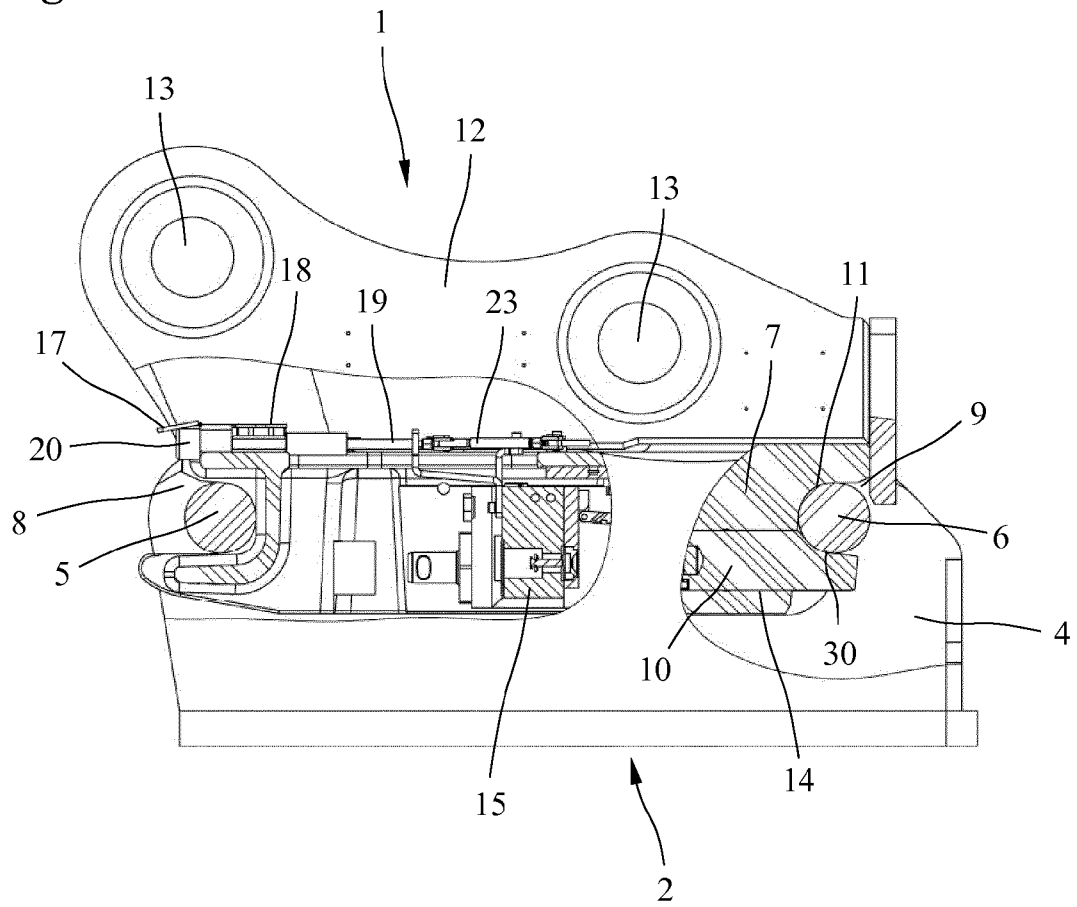
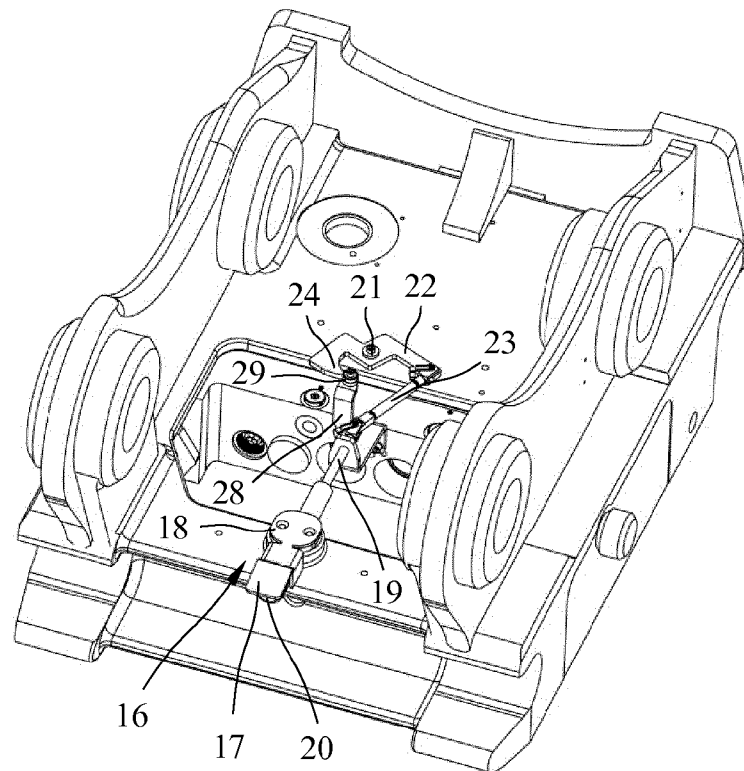
Fig. 7**Fig. 8**

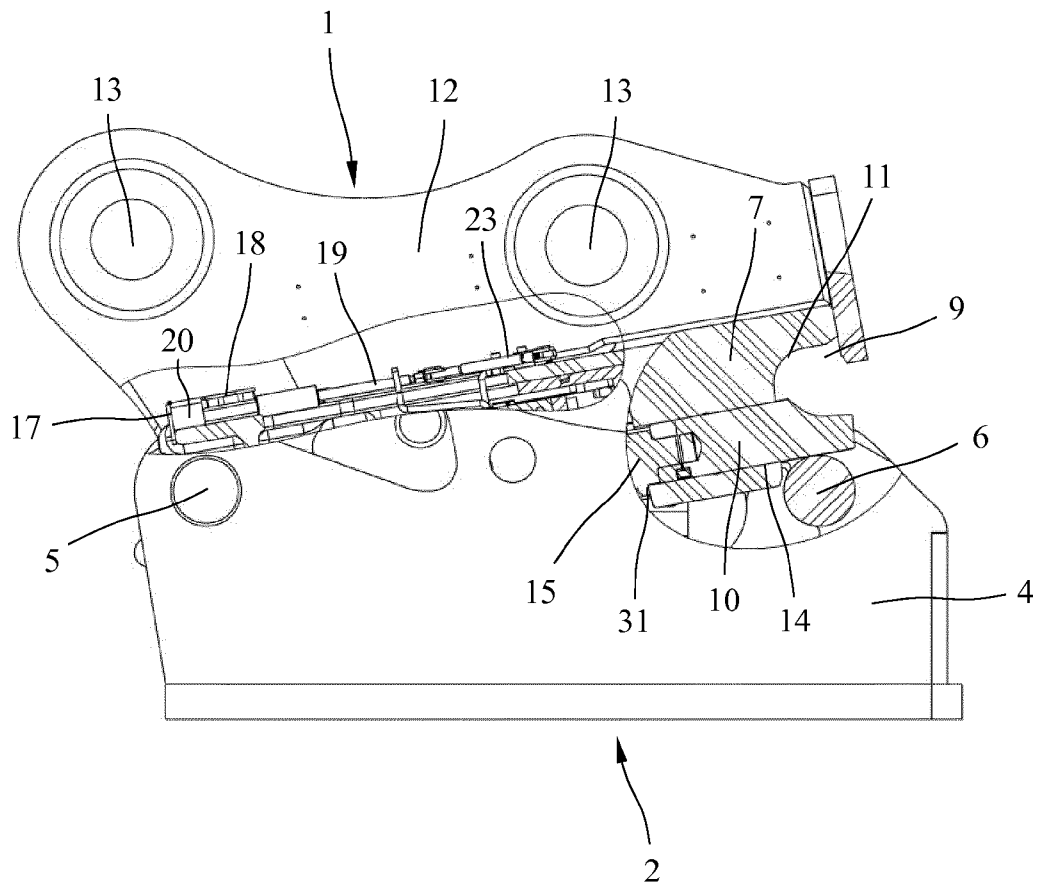
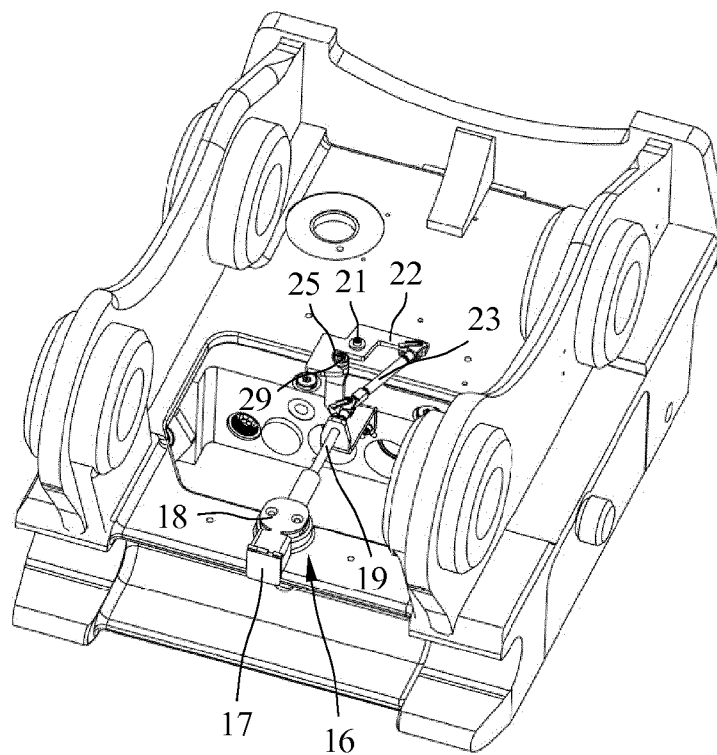
Fig. 9**Fig. 10**

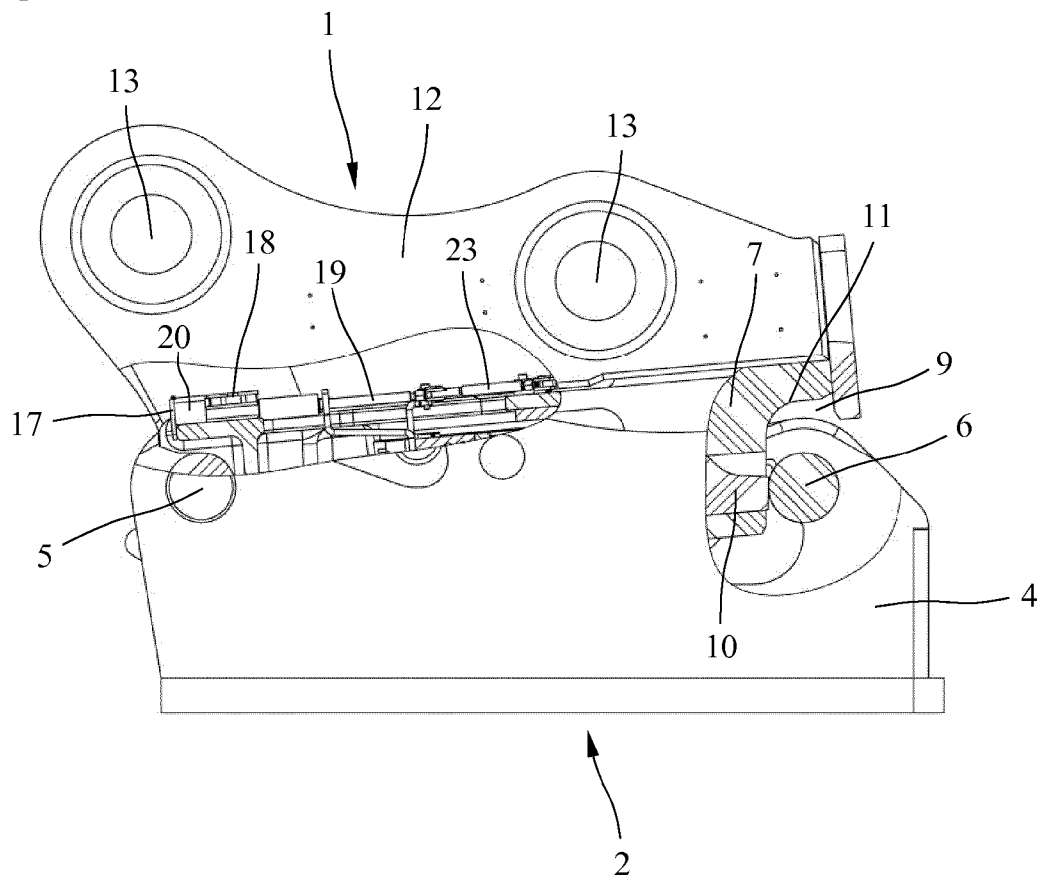
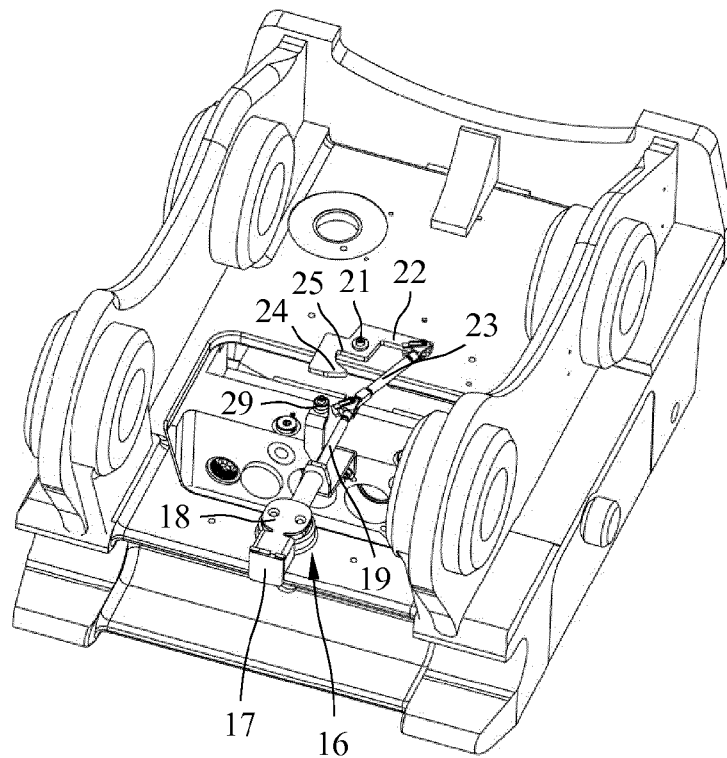
Fig. 11**Fig. 12**

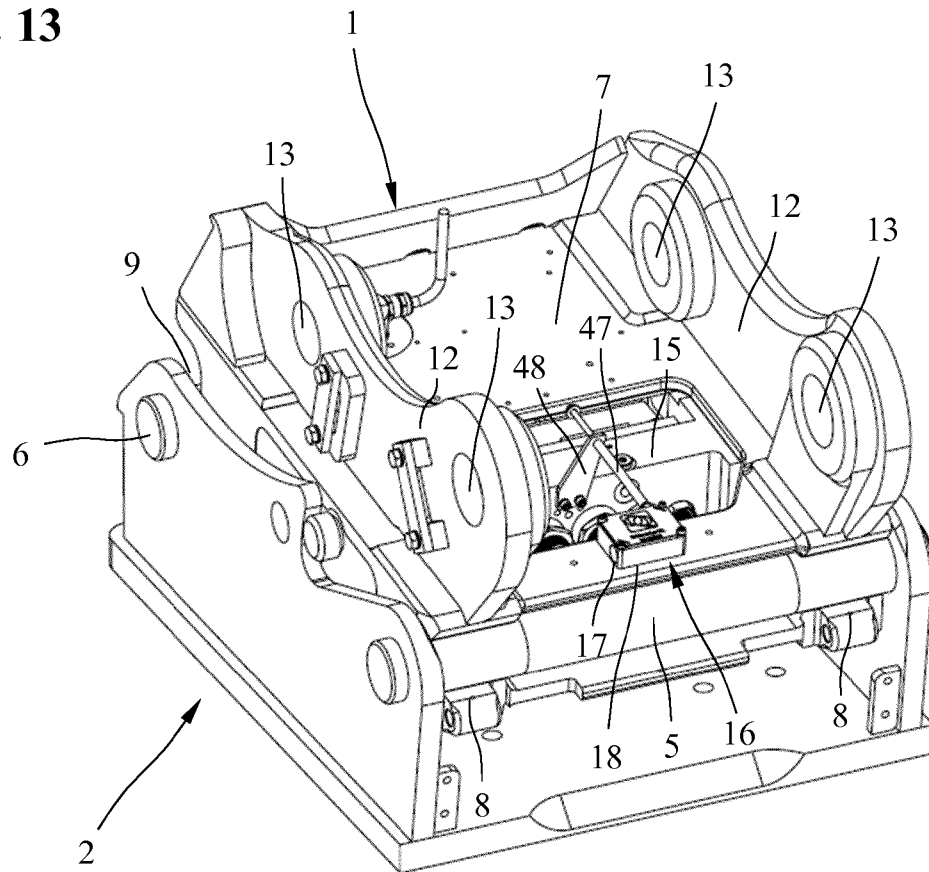
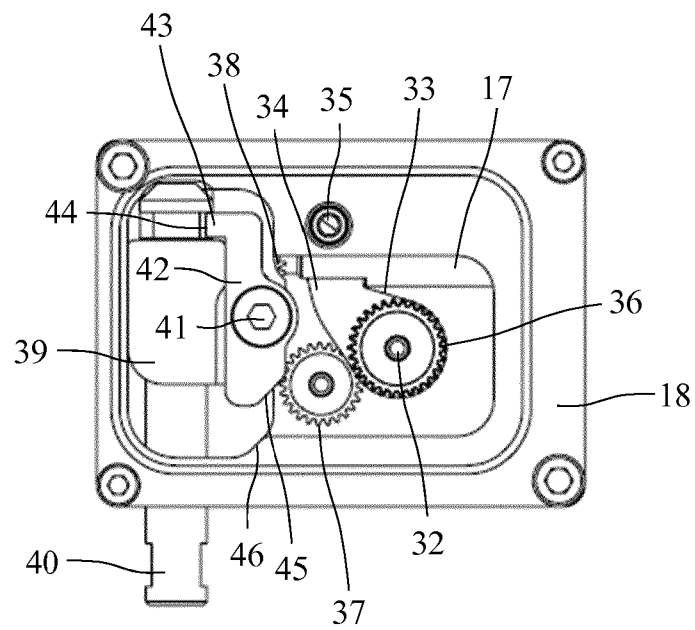
Fig. 13**Fig. 14**

Fig. 15

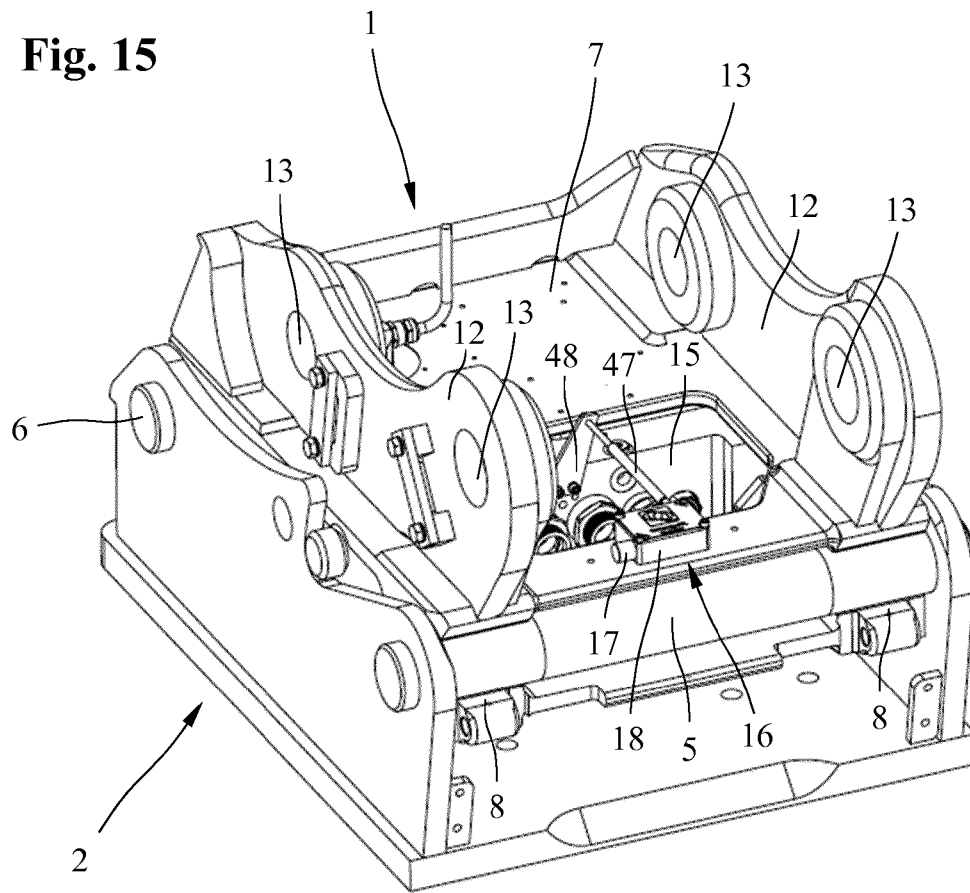


Fig. 16

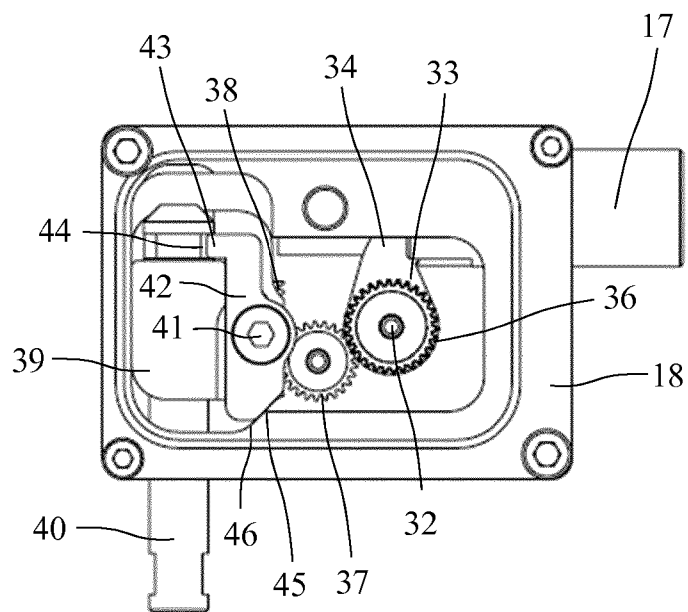
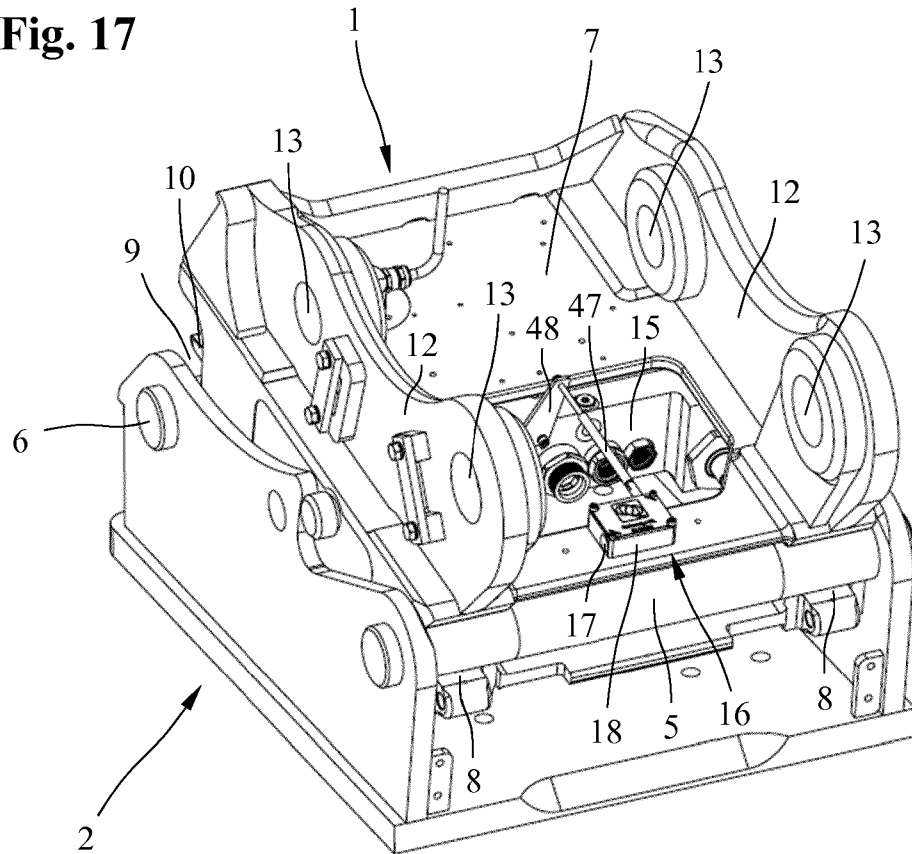


Fig. 17**Fig. 18**