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(54) AN ENGINE BRAKE ASSEMBLY

(57) An engine brake rocker arm assembly (RA) including a rocker arm (11) arranged to rock in response to a cam supported by a cam shaft in order to press down at least an exhaust valve, a shaft (20) slidingly arranged in an end of the rocker arm, having a first end provided of an interface (16, 21) towards said exhaust valve and a second end, opposite to the first one, provided of a travel stop (24), the shaft being supported by a castellation capsule (1) comprising castellation members (30, 40, 50) including frontal teeth suitable to mesh reciprocally, wherein the rocker arm includes a seat (90) defining a cylinder and said travel stop defining a piston with an intermediate chamber arranged to be filled of oil in order to maintain the travel stop spaced from the rocker arm.

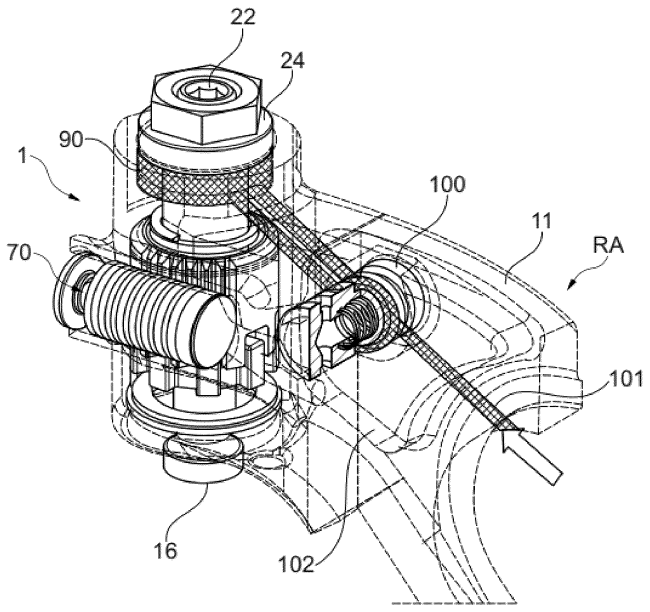

Fig. 3a

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Description

Field of the invention

[0001] The present invention relates to the field of engine brake actuation systems, in the field of medium and heavy-duty vehicles.

Description of the prior art

[0002] Compression engine brakes can be used as auxiliary brakes, in addition to wheel brakes, on relatively large vehicles, for example trucks, powered by heavy or medium duty diesel engines. During engine brake operation, the engine is not fueled and a compression engine braking system is arranged, to provide an additional opening of an engine cylinder's exhaust valve when the piston in that cylinder is near a top-dead-center position of its compression stroke so that compressed air can be released through the exhaust valve. This causes that the air trapped in the cylinder cannot return the compression energy accumulated during compression. Thus, the engine works as an air compressor and the torque consumed slows the vehicle.

[0003] In a typical valve train assembly used with a compression engine brake, the exhaust valve is actuated by a rocker arm which engages the exhaust valve by means of a valve bridge. The rocker arm rocks in response to a cam on a rotating cam shaft and presses down on the valve bridge which in turn presses down on the exhaust valves to open them.

[0004] In several rocker arm assembly, an oil circuit pressurizes a mechanism which pushes selectively an exhaust valve during engine brake.

[0005] EATON INTELLIGENT POWER LTD has developed several solutions, commercially available on the market.

[0006] The Eaton® solution is mainly based on a castellation assembly as disclosed in WO2022248082A1 and WO2019133658. Here an actuator is arranged to rotate a first castellation member in such a way that its axial teeth face the axial teeth of a second castellation member or the valleys between the teeth.

[0007] The first castellation is rotatably mounted on a castellation shaft 20 slidingly associated with the rocker arm.

[0008] In the first case, the two castellation members develop the maximal extension of the shaft so as to activate the exhaust valve, while in the second case, the second castellation collapses in the first one.

[0009] In the last period, EATON developed a new solution disclosed in US11428127B2. Here there are three castellation members mounted on a shaft.

[0010] The third castellation member biases the first and second castellation members apart. The engine brake rocker arm assembly selectively opens first and second exhaust valves and includes an exhaust rocker arm configured to rotate about the rocker shaft, an engine brake capsule assembly movable between a locked position configured to perform an engine braking operation, and an unlocked position that does not perform the engine braking operation, and a hydraulically controlled actuator assembly configured to selectively move the engine brake capsule assembly between the first and second configurations.

[0011] The actuator assembly includes a pin arranged to rotate the first castellation member of the engine brake capsule assembly. In the fired condition, namely when the engine brake operation is deactivated, the castellation shaft is configured to slide within the lash adjustment screw. Figures 1a and 1b of the prior art, corresponding to figures 3a and 3b of US11428127B2, disclose two configurations of the castellation shaft with respect to the rocker arm.

[0012] Here the engine brake capsule can be affixed to the same rocker arm operating the valve bridges as disclosed in WO2019133658, or can be affixed to a secondary rocker arm as in WO2021164950.

[0013] Here, the main problem is in the fact that the nut arranged to adjust the position of the shaft, often named as travel stop, impacts on the seat of the capsule in each swinging operation of the rocker arm in the fired condition.

[0014] These impacts produce noise and lead to the damaging of the assembly rocker/capsule.

[0015] Therefore, it is possible to summarize the present context as an engine brake capsule assembly comprising at least two castellation members provided with axial teeth. One of the castellation members is arranged to rotate in such a way the axial teeth face the axial teeth of the other castellation member or the corresponding valleys. Therefore, the two possible configurations are "tooth-to-tooth" or "tooth-to-valley".

[0016] An actuator is arranged to tangentially contact and rotate the rotating castellation member to control the angular position of it with respect to the other castellation member. The castellation members are arranged on a shaft provided of a nut of the lash adjustment screw. In fired operating conditions, the nut alternately departs and approaches the rocker arm, due to the fact that the castellation capsule can collapse. This alternate movement leads to producing impacts, noise and damages. US11428127B2 and WO2021164950 are herewith included by reference.

Summary of the invention

[0017] The main object of the present invention is to overcome the above problems/drawbacks in the solution proposed and commercialized by EATON®.

[0018] The main principle of the invention is the realization of an hydraulic actuator where its cylinder is defined by a seat realized in the rocker arm and the travel stop of the shaft defines the piston of the hydraulic actuator, such that the actuator chamber is between the seat and the travel stop.

[0019] In the following this actuator chamber or cylinder is named as "raising chamber", because it forces the shaft dedicated to the exhaust valve to maintain a retracted configuration with respect to the exhaust valve.

[0020] An oil channel is arranged in the rocker arm to continuously fill the actuator chamber in "normal operation", namely when the engine is fired or dragged but it is not in engine brake operation.

[0021] A piston valve is arranged on the channel arranged to assume a first configuration, released, when the engine is in normal operation, such that the oil freely reached the actuator chamber and an active condition, pushed, in such a way to connect the actuator chamber with the outside and to interrupt the hydraulic connection of the oil channel with the raising chamber.

[0022] Preferably, the piston valve is supplied by the same oil channel implemented to activate the hydraulically controlled actuator assembly configured to selectively move the engine brake capsule assembly between the first and second configuration. Advantageously, when the engine brake operation is switched on, the hydraulic actuator arranged to operate on the castellation and the piston valve are simultaneously subjected to an activation pressure, the first leading the castellation to assuming the extended position and the second leading to empting the raised chamber. As described in the following the empting of the raised chamber is an essential condition for permitting the rotation of one castellation member under the force exerted by the hydraulic actuator.

[0023] It should be considered that the valvetrain is arranged in a closed compartment defined in the overhead of the engine and that the oil supplied to the valvetrain flows to the oil sump, from where a pump withdraws the oil and pumps it in the main gallery connected hydraulically with the valvetrain and, in particular, within the rocker arm supporting the brake capsule.

[0024] While the engine is in normal operation, the oil flows through the rocker arm to reach the raising chamber, but while the engine brake operation is activated a dedicated oil channel is pressurized to activate the above hydraulic actuator and the piston valve.

[0025] These and further objects are achieved by means of the attached claims, which describe preferred embodiments of the invention, forming an integral part of the present description.

Brief description of the drawings

[0026] The invention will become fully clear from the following detailed description, given by way of a mere exemplifying and non limiting example, to be read with reference to the attached drawing figures, wherein:

- Figs. 1a and 1b of the prior art disclose an example of brake, switchable, capsule from EATON® in two opposites conditions while the engine is operated not in braking mode, namely it is fired or dragged;
- Fig. 2 discloses a perspective view of an example of rocker arm supporting a brake, switchable, capsule;
- Figs. 3a - 3b disclose a perspective view of a portion of a valvetrain, with transparent portions, according to different operating conditions;
- Fig. 4 discloses a longitudinal section of section of the rocker arm according to Figs. 3a - 3b;
- Fig. 5 discloses a cross-section of rocker arm of the previous figures with transparent portions.

[0027] The same reference numerals and letters in the figures designate the same or functionally equivalent parts. According to the present invention, the term "second element" does not imply the presence of a "first element", first, second, etc.. are used only for improving the clarity of the description and they should not be interpreted in a limiting way.

Detailed description of the preferred embodiments

[0028] As disclosed above, the present invention aims at solving the impacts between the nut of the lash adjustment screw, also named "travel stop", against the upper portion of the rocker arm.

[0029] In FIGS. 1A and 1B, a first castellation device 1 constitutes a mechanical capsule comprising an annular shroud 80 coupled to a rack 75 of an actuator 70. This mechanical capsule can be drop-in assembled in a capsule bore 17 (see fig. 2). A bore end 171 comprises a lash bore 172 through hole through which the shaft 20 can slide. Rocker arm 11 is shown to comprise the capsule bore 17 with a positioning washer 18 and snap ring 19 to hold the castellation device 1 within. Return spring 60 and the castellation members 30, 50, 40 can be dropped into capsule bore 17, with shaft 20 threaded therethrough. Washer 18 and snap ring 19, or other locking device such as a set screw, pressed bushing, among others, prevents the castellation device 1 from falling out of the capsule bore 17. Washer 18 or snap ring 19 or other locking device can serve as a travel limit for shaft 20, as by obstructing the travel of press foot 21 or e-foot 16.

[0030] A bias spring 60 is disposed between the second castellation member and the third castellation member and is configured to bias the second castellation member away from the third castellation member such that the castellation capsule assumes an extended configuration.

[0031] A lash sleeve 23, or lash adjustment screw 24 is fitted or fixed, as by threading or press-fitting, to the end 22 of shaft 20. Lash sleeve 23 can be positioned on shaft 20 to control the lash of the castellation device 1. A travel stop 24 is arranged to catch on the lash bore 172 or bore end 171. Shaft 20 comprises a press foot 21 configured to press on a valve stem, valve bridge, other rocker arm, or other valvetrain component, to realize the compressed air release of the engine brake operation. An e-foot (elephant foot) arrangement 16 can also be accomplished on the shaft 20 as by attaching the appropriate

socket arrangement to the shaft 20.

[0032] When the castellation members are collapsed, in the tooth-to-valley configuration, the shaft 20 is free to slide within the bore. In particular, when the rocker arm tries to push down the stem of the exhaust valve, the spring of the exhaust valve is more rigid than the spring 60 of the castellation capsule 1, therefore, the castellation capsule collapses and the shaft 20 slides axially within the capsule in response to the approaching of the rocker arm to the exhaust valve stem as clear from the comparison of figures 1a and 1b.

[0033] In contrast, when the castellation members are extended, in the tooth-to-tooth configuration, the e-foot is forced to depart from the rocker arm, thus the approaching movement of the rocker arm is such to push down the exhaust valve stem as disclosed in figure 1a.

[0034] The rack 75 of an actuator 70 is coupled to one of the castellation members.

[0035] The actuator 70 defines "rack and pinion" type arrangement such as an axial movement of the actuator forces one of the castellation members to rotate. Being the EATON product already on the market and well disclosed in several patents, no further details are needed.

[0036] With reference to figures 3a and 3b an example of the present invention is disclosed.

[0037] A cylinder of a hydraulic actuator is defined on the top of the bore within the rocker arm. A cylindrical seat 90 is defined in the rocker arm, arranged to receive the travel stop 24, such that the travel stop defines the piston of the hydraulic actuator.

[0038] The chamber defined between the seat and the travel stop, named raising chamber, is suitable to be filled of oil forcing the travel stop to depart from the seat, against the effect of the spring 60.

[0039] The outcome is that the interface 16 of the shaft intended to contact the stem of the exhaust valve in engine brake operation does not contact such stem during normal operation.

[0040] A first oil channel 101 is arranged within the rocker arm to fill the raising chamber. This first oil chamber is continuously connected with the engine oil main gallery.

[0041] A piston valve 100, in engine brake operation, is arranged to

- interrupt the oil flow through the first oil channel,
- put in communication the raising chamber 90 with the outside, in order to permit the oil outflow under the action of the spring 60.

[0042] The piston valve 100 is preferably arranged directly within the body of the rocker arm 11.

[0043] When the solenoid valve is ON due to the activation of the engine brake operation, the portion of the first oil channel between the piston valve and the raising chamber 90 remains unpressurized.

[0044] The piston valve 100 is commanded through a dedicated second oil channel 102. This oil channel can be controlled through a solenoid valve (not disclosed).

[0045] More in particular the same second oil channel 102 is arranged to supply pressure both to the piston valve 100 and to the hydraulic actuator 70, which is arranged to rotate one of the castellation members to assume the above extended/collapsed configurations.

[0046] It should be noted that when the solenoid valve pressurizes the second oil channel 102, the castellation capsule can assume the extended condition only after the emptying the raising chamber 90. Then the hydraulic actuator 70 can force one of the castellation members to rotate, locking the capsule in the extended condition. Indeed, the spring 60 should be able to disengage the teeth of the castellation members in order to permit to the hydraulic actuator to lead the castellation device to assume the tooth-to-tooth configuration.

[0047] Thus, a minimum delay can be appreciated in the activation of the engine brake operation, however, this is negligible, overall in comparison with the advantages obtained thanks to the present invention.

[0048] Many changes, modifications, variations and other uses and applications of the subject invention will become apparent to those skilled in the art after considering the specification and the accompanying drawings which disclose preferred embodiments thereof as described in the appended claims.

[0049] The features disclosed in the prior art background are introduced only in order to better understand the invention and not as a declaration about the existence of known prior art. In addition, said features define the context of the present invention, thus such features shall be considered in common with the detailed description.

[0050] Further implementation details will not be described, as the man skilled in the art is able to carry out the invention starting from the teaching of the above description.

Claims

1. An engine brake rocker arm assembly (RA) including a

- a rocker arm (11) arranged to rock in response to a cam supported by a cam shaft in order to press down at least an exhaust valve,
- a shaft (20) slidingly arranged in an end of the rocker arm, having a first end provided of an interface (16, 21) towards said exhaust valve and a second end, opposite to the first one, provided of a travel stop (24), the shaft being supported by a
- castellation capsule (1) comprising castellation members (30, 40, 50) including frontal teeth suitable to mesh reciprocally, such that the capsule is suitable to assume an extended configuration and a collapsed configuration respectively according to a tooth-to-tooth or tooth-to-

valley meshing, under the action of
- an actuator (70) suitable to rotate at least a member of the castellation capsule with respect to another in such a way to force the castellation capsule in said extended or permitting the collapsed condition,
- a resilient element (60) arranged to bias the castellation members away from each other,
Wherein the rocker arm includes

+ a seat (90), complimentary with the travel stop (24), arranged in such a way that the seat defines a cylinder and the travel stop(24) defines a piston reciprocating the cylinder so as to define a hydraulic actuator, and
+ a first oil channel (101) arranged within the rocker arm to fill the cylinder (90) with hydraulic oil and
+ a piston valve (100) arranged to

. interrupt an oil flow through the first oil channel,
. put in communication the cylinder with the outside, in order to permit the oil outflow under the action of the resilient element (60),

+ a second oil channel (102) arranged within the rocker arm to actuate the piston valve.

2. Assembly according to according to claim 1, wherein said piston valve (100) is arranged directly within the body of the rocker arm (11) .

3. Assembly according to claim 1 or 2, wherein said second oil channel (102) is arranged to control the actuation of the piston valve (100) and also of the actuator (70).

4. Assembly according to claim 3, wherein said second oil channel (102) is arranged to be supplied of hydraulic oil by a solenoid valve as a response of an activation of the engine brake operation.

5. Internal combustion engine comprising an engine brake system including the assembly of anyone of the previous claims 1 - 4.

6. Truck including a combustion engine according to claim 5.

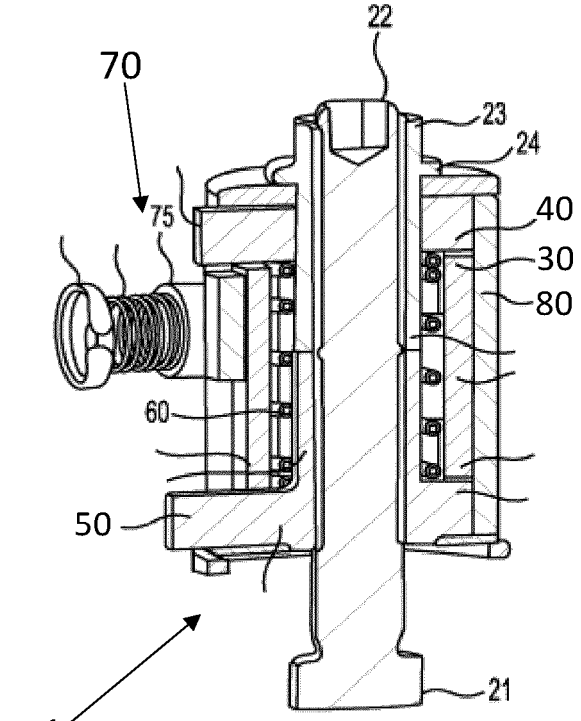

Fig. 1a (Prior Art)

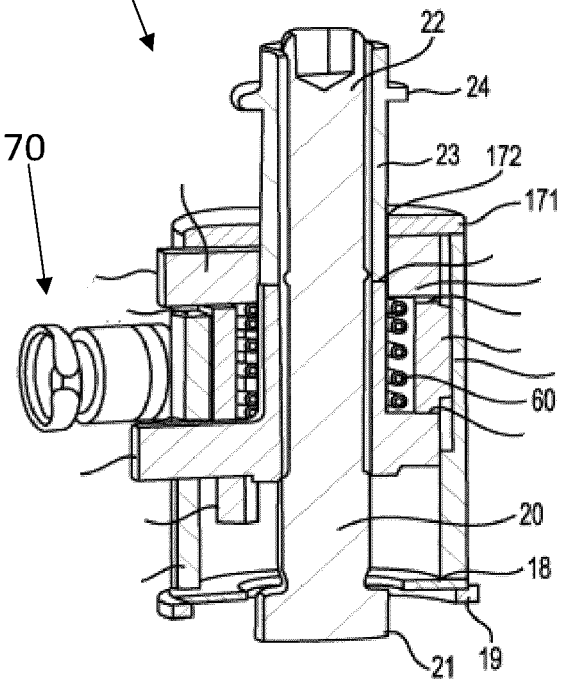

Fig. 1b (Prior Art)

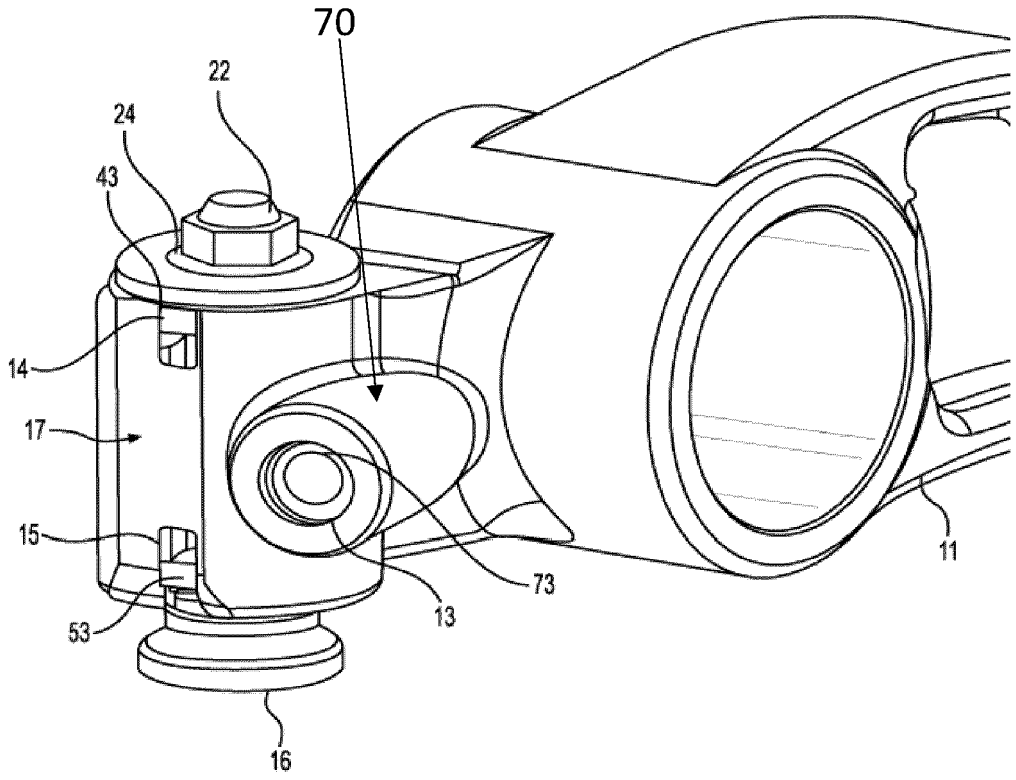

Fig. 2 (Prior Art)

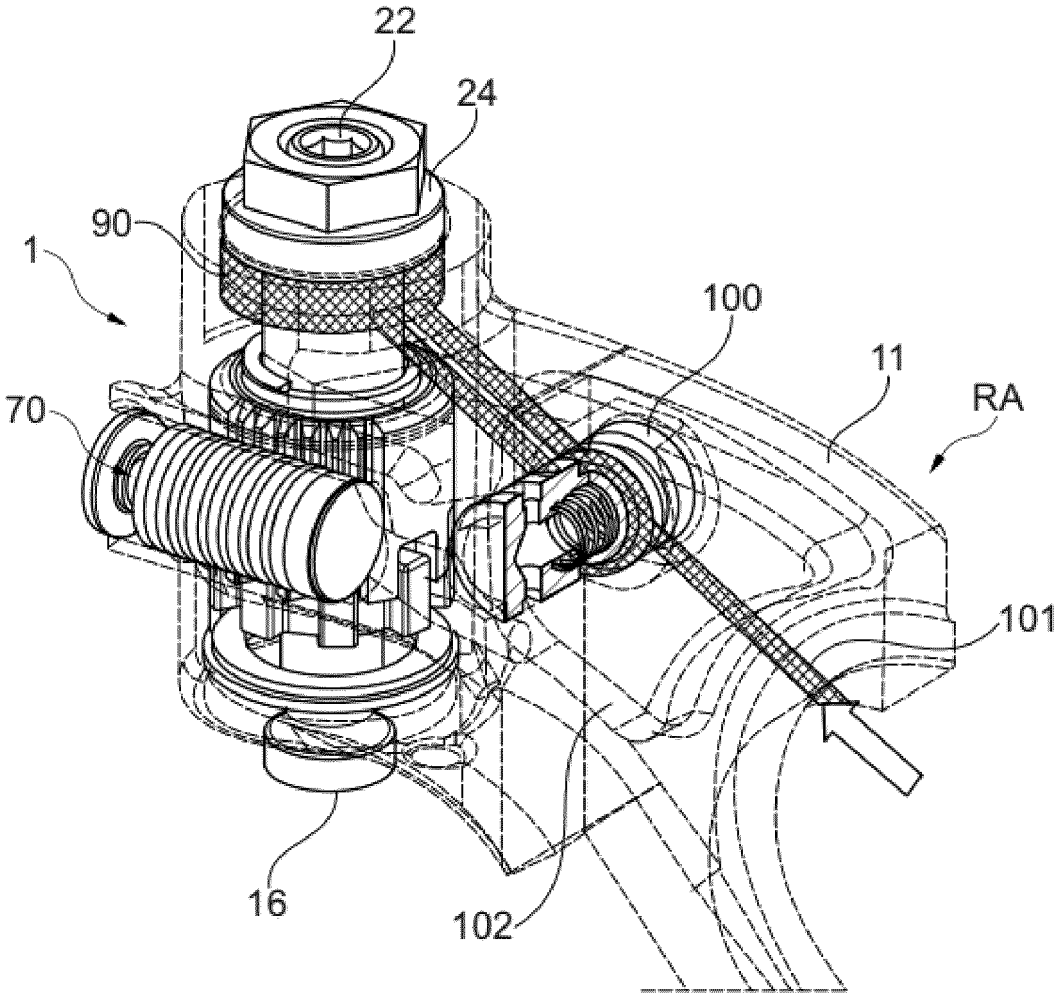

Fig. 3a

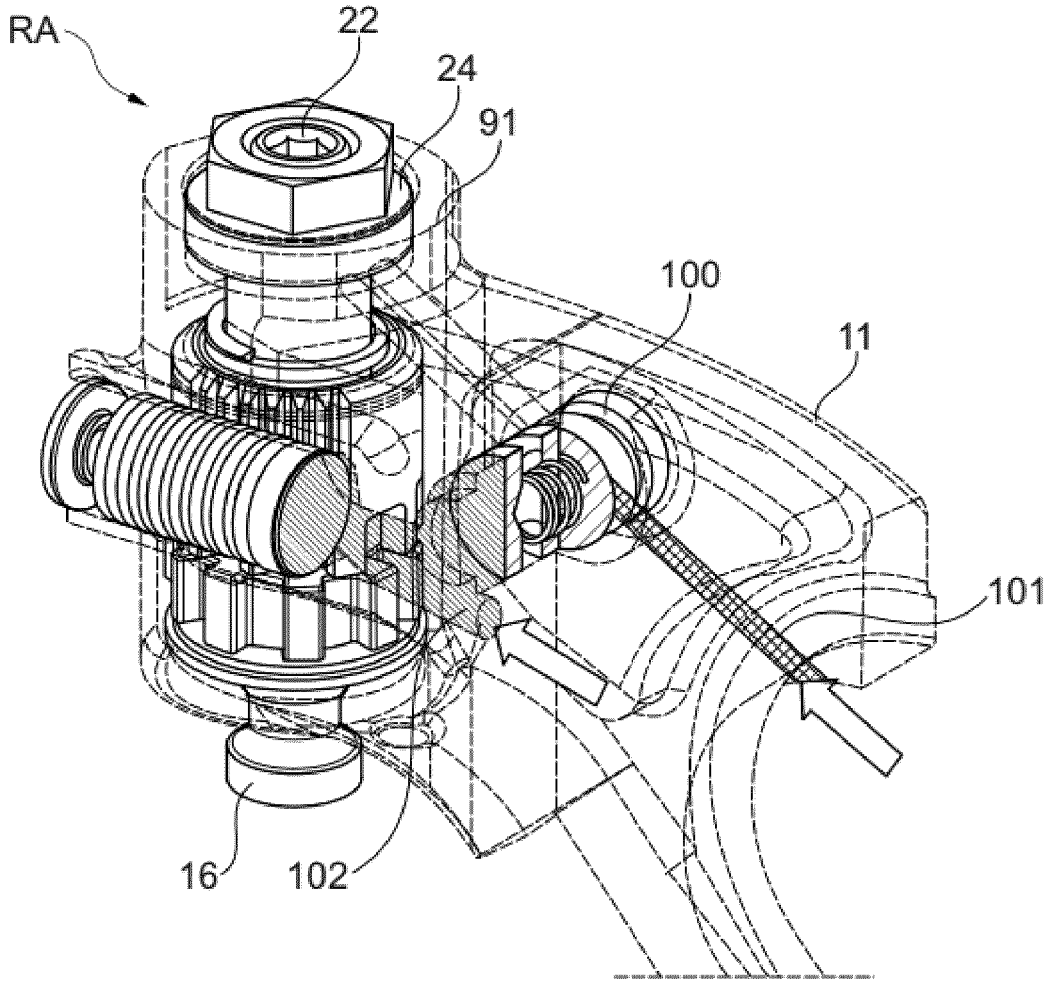

Fig. 3b

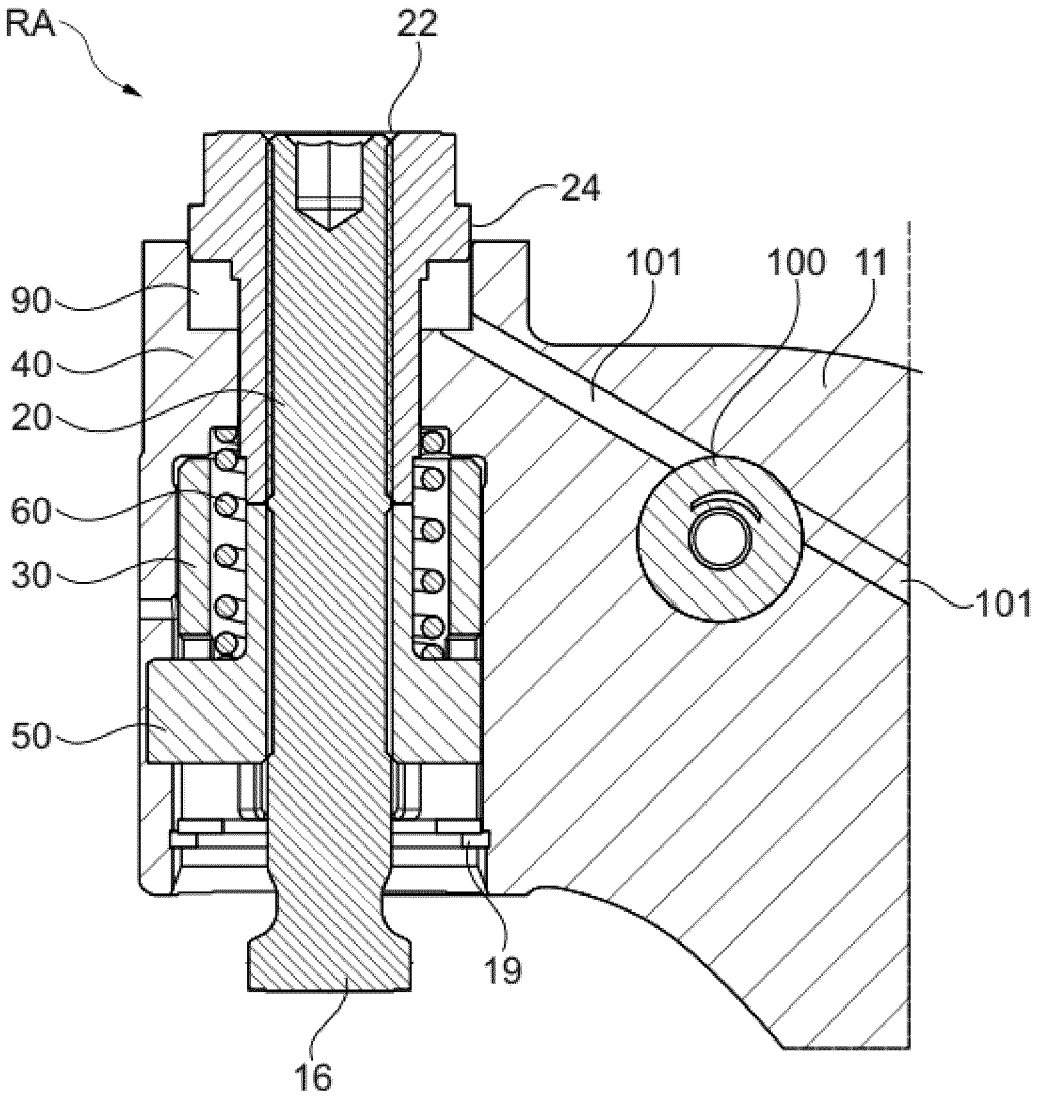

Fig. 4

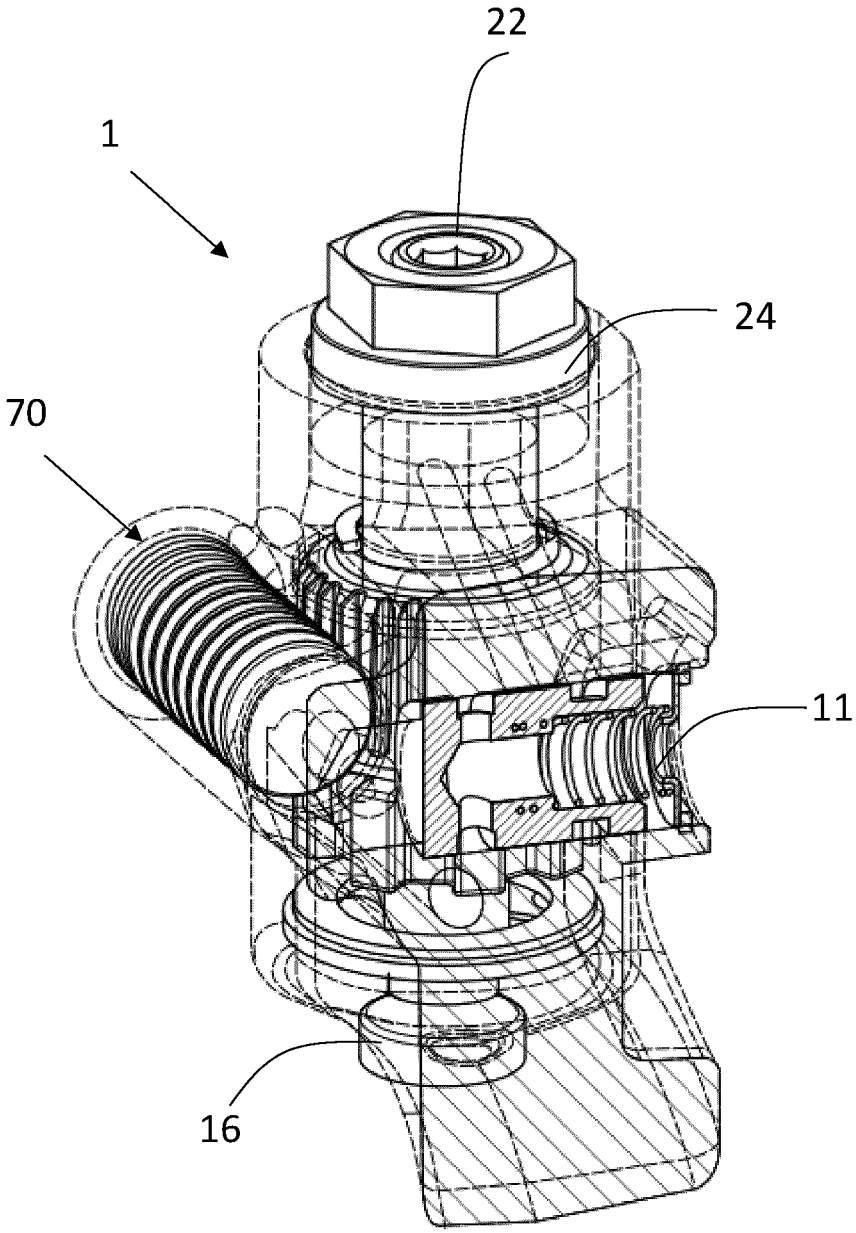

Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 24 20 6429

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A	WO 2019/133658 A1 (EATON INTELLIGENT POWER LTD [IE]) 4 July 2019 (2019-07-04) * abstract * * figure 3 * * paragraph [0048] - paragraph [0051] * * paragraph [0066] - paragraph [0073] *	1-6	
A	DE 696 30 000 T2 (CATERPILLAR INC [US]) 22 July 2004 (2004-07-22) * abstract * * figure 12 * * figures 8-11 * * paragraph [0055] - paragraph [0060] *	1-6	

TECHNICAL FIELDS SEARCHED (IPC)

F01L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	14 February 2025	Kämper, Fabian

CATEGORY OF CITED DOCUMENTS

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