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(54) **LEAKAGE DETECTION ARRANGEMENT**

LECKAGEDETEKTIONSANORDNUNG

AGENCEMENT DE DÉTECTION DE FUITE

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(73) Proprietor: **Wärtsilä Finland Oy**
65100 Vaasa (FI)

(72) Inventor: **CAVRESSI, Franco**
FI-65100 Vaasa (FI)

(74) Representative: **Berggren Oy, Helsinki & Oulu**
P.O. Box 16
Eteläinen Rautatiekatu 10A
00101 Helsinki (FI)

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Description

Technical field of the invention

[0001] The present invention relates to a leakage detection arrangement for detecting a leakage in a fuel injection system of an internal combustion engine in accordance with the preamble of claim 1.

Background of the invention

[0002] In fuel injection systems of internal combustion engines the pressures can be very high, even up to 3000 bar. A leakage in a fuel injection system causes a serious hazard both due to the high pressure of the fuel and the fire risk. For increasing the safety of the fuel injection systems, fuel pipes and other components of the fuel injection systems are often provided with double walls. An inner wall delimits an inner pipe, inside which the fuel flows. A leakage channel is formed between the inner wall and an outer wall. The leakage channel is normally free of fuel, but in case of a leaking inner pipe, the leakage channel can receive the leaking fuel. For safety reasons, it is important that a leakage can be detected and repaired quickly. Different leakage detection arrangements for detecting the presence of fuel in a leakage channel are known. One known method for detecting leakages is to provide a leakage channel with an indicator pin, which is visible to the outside of the leakage channel and normally in a retracted position, as disclosed in GB2060800A. When the leakage channel fills with fuel, the pressure inside the leakage channel pushes the indicator pin to a protruding position, which indicates that the inner pipe is leaking. The leakage can thus be visually detected. Because of the vibrations of engines during operation, the indicator pin is usually provided with a snap ring or some other retaining element, which prevents unintentional movement of the pin, but allows movement of the pin in case the force applied to the pin by the leaking fuel exceeds a certain threshold value. When a leakage is detected, the cause of the leakage has to be removed and the indicator pin needs to be set back to the retracted position.

[0003] A problem with the known indicator pin arrangements is that in order to set the pin back to its retracted position, it has to be removed for getting the snap ring into the correct position. This is undesirable especially in case the engine is operated using methanol or some other toxic fuel.

Summary of the invention

[0004] The object of the present invention is to provide an improved leakage detection arrangement for detecting a leakage in a fuel injection system of an internal combustion engine. The arrangement comprises a fluid chamber that can be arranged in fluid communication with a leakage channel that is configured to receive fuel from a leaking component of the fuel injection system, an indicator element having a retracted position and a protruding position, the indicator element being configured to move due to fuel pressure in the fluid chamber from the retracted position to the protruding position thus indicating a leakage in the fuel injection system, and a retaining element, which is arranged around the indicator element and configured to keep the indicator element in the retracted position and allow movement of the indicator element to the protruding position when the force applied to the indicator element by the fuel pressure in the fluid chamber exceeds a predetermined threshold. The characterizing features of the arrangement according to the invention are given in the characterizing part of claim 1.

[0005] According to the invention, the arrangement is provided with a groove which is arranged in a part surrounding the indicator element and which is configured to accommodate the retaining element.

[0006] Because of the groove, the retaining element can be held in the same position during movement of the indicator element. After detecting and repairing a leakage, the indicator element can thus be easily returned to the retracted position without dismounting any parts of the leakage detection arrangement. This prevents spilling of fuel from the fluid chamber. This is beneficial especially in case the fuel injection system contains methanol or some other toxic fuel.

[0007] According to an embodiment of the invention, the groove is arranged in a removable holding element, which allows mounting and dismounting of the indicator element. The holding element can be, for instance, a nut. A removable holding element allows removal of the indicator element when needed, for instance for replacing seals of the leakage detection arrangement.

[0008] According to an embodiment of the invention, the holding element comprises a bore through which the indicator element protrudes and one end of the bore is provided with a section that tapers towards the inside of the holding element. The tapered section of the bore allows easy mounting of the retaining element.

[0009] According to the invention, the indicator element comprises a groove, which surrounds the outer circumference of the indicator element and which is configured to accommodate the retaining element when the indicator element is in the retracted position. Because of the groove, there is a clear threshold force that is required for moving the indicator element from the retracted position to the protruding position. The functioning of the retaining element could also be based on friction, but in that case the indicator element could adopt intermediate positions between the retracted position and the protruding position, which is not desirable.

[0010] According to an embodiment of the invention, the leading end of the indicator element in the direction from the retracted position towards the protruding position tapers towards said end. The tapered end of the indicator element allows progressive expansion of the re-

taining element when the indicator element is mounted, which makes the assembling of the leakage detection arrangement easier.

[0011] According to an embodiment of the invention, the retaining element is a snap ring.

Brief description of the drawings

[0012] Embodiments of the invention are described below in more detail with reference to the accompanying drawings, in which

Fig. 1 shows a cross-sectional view of a connection piece that is used for connecting three fuel pipes of a fuel injection system to each other, the connection piece comprising a leakage detection arrangement according to an embodiment of the invention,

Fig. 2 shows an indicator element of the leakage detection arrangement of Fig. 1, and

Fig. 3 shows a holding element of the leakage detection arrangement of Fig. 1.

Description of embodiments of the invention

[0013] In figure 1 is shown a cross-sectional view of a connection piece 11, which can be used for connecting three fuel pipes of a fuel injection system to each other. In figure 1, only one fuel pipe 4 is shown. The connection piece 11 forms part of a fuel injection system of an internal combustion engine. The engine is a large piston engine, such as a main or an auxiliary engine of a ship or an engine that is used at a power plant for producing electricity. The fuel injection system is configured to inject liquid fuel, such as light fuel oil, marine diesel oil or methanol into the cylinders of the engine. The fuel injection system can be, for instance, a common rail fuel injection system. The fuel pipes 4 are high-pressure pipes that can supply fuel for instance from a high-pressure pump to fuel injectors. Each fuel pipe 4 has a double-wall construction. The pressurized fuel is conveyed in an inner pipe and a leakage channel is formed between the inner pipe and an outer pipe. In case there is a leakage in the inner pipe, the leaking fuel is received by the leakage channel.

[0014] The connection piece 11 is provided with a leakage detection arrangement according to an embodiment of the invention. The leakage detection arrangement comprises a fluid chamber 1, which is in fluid communication with a leakage channel 2, 3. The connection piece 11 of figure 1 comprises a first leakage channel 2 and a second leakage channel 3. Each leakage channel 2, 3 of the connection piece 11 is in fluid communication with a leakage channel of a fuel pipe 4. The fuel leaking from a fuel pipe 4 is thus received by a leakage channel 2, 3 of the connection piece 11. In the embodiment of figure 1, each fuel pipe 4 can be connected to an own leakage channel 2, 3. This makes it easier to locate a leakage. However, several components of the fuel injection system could also be connected to a common leakage channel 2, 3.

[0015] The leakage detection arrangement further comprises an indicator element 5. The indicator element 5 is a part, which is movable in the direction of its longitudinal axis. The indicator element 5 has a first position and a second position. The first position is a retracted position and the second position is a protruding position. When the leakage detection arrangement is assembled, the indicator element 5 is put in the retracted position. The indicator element 5 is configured to move from the retracted position to the protruding position due to fuel pressure in the fluid chamber 1. When leaking fuel flows via a leakage channel 2, 3 to the fluid chamber 1, the fuel pressure in the fluid chamber 1 pushes the indicator element 5 to the protruding position. The position of the indicator element 5 can be perceived from the outside of the leakage detection arrangement, and a leakage can thus be visually detected. The leakage detection arrangement could also be provided with a sensor that monitors the position of the indicator element 5, which would allow automatic leakage monitoring. The fuel injection system can be provided with a plurality of leakage detection arrangements. By connecting a leakage detection arrangement only to one or a few leakage channels, the leakages can be easily located.

[0016] The indicator element 5 has a first end and a second end. The first end of the indicator element 5 comprises a piston having a piston surface 12, onto which the pressure in the fluid chamber 1 is applied. The piston surface 12 delimits the fluid chamber 1. An elongated stem 15 is connected to the piston of the indicator element 5. The indicator element 5 comprises a first sealing groove 13 and a second sealing groove 14. The sealing grooves 13, 14 are circumferential grooves that are arranged close to the first end of the indicator element 5. Each of the sealing grooves 13, 14 accommodates an O-ring 16, 17. When the indicator element 5 is in the retracted position, the O-rings 16, 17 are on opposite sides of a drain line 18, which is perpendicular to the longitudinal direction of the indicator element 5. When the indicator element 5 is in the retracted position, the O-ring 16 located in the first sealing groove 13 prevents flow from the leakage channel 2, 3 into the drain line 18. The O-ring 17 of the second sealing groove 14 prevents outflow from the drain line 18 past the indicator element 5. In the protruding position of the indicator element 5, flow from the leakage channel 2, 3 into the drain line 18 is allowed.

[0017] The leakage detection arrangement comprises a holding element 8, which limits the movement of the indicator element 5. The holding element 8 allows the movement of the indicator element 5 between the retracted position and the protruding position, but prevents the indicator element 5 from falling out of the connection piece 11. In the embodiment of the figures, the holding

element is a nut 8, which can be attached to the connection piece 11 by means of threads. However, the holding element 8 could also be a plate or a block or a similar part, which is attached to the connection piece 11 for instance by means of bolts. The holding element 8 comprises a bore 10, which can receive the stem 15 of the indicator element 5. In figure 1, both indicator elements 5 are in the retracted position. In the retracted position, the second end of the indicator element 5 does not protrude out of the holding element 8. In the protruding position, the second end protrudes out of the holding element 8 so that it can be easily detected from the outside of the connection piece 11 that the indicator element 5 is in the protruding position. It is possible that the indicator element 5 protrudes out of the holding element 8 also in the retracted position. In that case, the stem 15 of the indicator element 5 can be provided with a marking which clearly indicates whether the indicator element 5 is in the retracted or in the protruding position.

[0018] Due to the vibrations of the engine, the O-rings 16, 17 that are arranged in the sealing grooves 13, 14 of the indicator element 5 cannot hold the indicator element 5 reliably in the retracted position. To prevent the indicator element 5 from moving accidentally from the retracted position to the protruding position and to avoid false alarms, the leakage detection arrangement is provided with a retaining element 6. The retaining element 6 is engaged with both the indicator element 5 and the holding element 8 and configured to keep the indicator element 5 in the retracted position, unless a longitudinal force applied to the indicator element 5 exceeds a predetermined threshold value. The normal vibrations of the engine do thus not move the indicator element 5, but when the fuel pressure in the fluid chamber 1 is sufficient, the indicator element 5 can move from the retracted position to the protruding position.

[0019] The retaining element 6 is a resilient annular member, such as a snap ring. When the retaining element 6 is not compressed or stretched, the outer diameter of the retaining element 6 is greater than the diameter of the bore 10 of the holding element 8 and the inner diameter of the retaining element 6 is smaller than the diameter of the bore 10. The indicator element 5 is provided with a groove 9 for receiving the retaining element 6. The groove 9 encircles the stem 15 of the indicator element 5. The cross-sectional shape of the groove 9 is rounded. The cross-section of the groove 9 can be, for instance, a semicircle. The depth of the groove 9 is less than half of the thickness of the retaining element 6 in the radial direction. The shape and the size of the groove 9 allow the retaining element 6 to move out of the groove 9 when a sufficient axial force is exerted on it. Also the holding element 8 is provided with a groove 7 for accommodating the retaining element 6. The depth of the groove 7 of the holding element 8 is at least the same as the thickness of the retaining element 6 in the radial direction. The retaining element 6 can thus be received completely inside the groove 7 of the holding element 8.

[0020] When the indicator element 5 is in the retracted position as shown in figure 1, the retaining element 6 is engaged both with the groove 9 of the indicator element 5 and the groove 7 of the holding member 8. The retaining element 6 is in a slightly expanded state. When the indicator element 5 is pushed by the fuel pressure towards the protruding position and the force exerted by the fuel pressure exceeds the force that keeps the retaining element 6 in the groove 9 of the indicator element 5, the retaining element 6 jumps out of the groove 9 of the indicator element 5. The form locking between the retaining element 6 and the indicator element 5 is thus released and the indicator element 5 can move towards the protruding position. The groove 7 now receives the retaining element 6 completely.

[0021] When the leakage causing the movement of the indicator element 5 has been detected and repaired, the indicator element 5 needs to be put back to the retracted position. This can be done by simply pushing the indicator element 5 towards the retracted position. Since the groove 7 of the holding element 8 holds the retaining element 6, the retaining element 6 is not allowed to move together with the indicator element 5. When the indicator element 5 receives the position where the groove 9 of the indicator element 5 is aligned with the groove 7 of the holding element 8, the retaining element 6 is locked with the groove 9 of the indicator element 5. Due to the groove 7 of the holding element 8, resetting of the leakage detection arrangement is easy and does not require dismounting of any parts.

[0022] One end of the bore 10 of the holding member 8 is provided with a tapered section 10a, which tapers towards the inside of the holding member 8. The wider end of the tapered section 10a opens onto an outer surface of the holding member 8. The diameter of the tapered section 10a at the wider end is greater than the outer diameter of the retaining element 6. This facilitates the insertion of the retaining element 6 into the groove 7 of the holding element 8, since the retaining element 6 is gradually compressed when being inserted into the groove 7. In the embodiment of the figures, the tapered section 10a is arranged at that end of the bore 10, which faces the fluid chamber 1 of the leakage detection arrangement.

[0023] Also an end of the stem 15 of the indicator element 5 is tapered. The indicator element 5 thus tapers towards the second end of the indicator element 5. The indicator element 5 can therefore be easily inserted into the bore 10 of the holding element 8, since the stem 15 of the indicator element 5 gradually expands the retaining element 6 that has been inserted into the groove 7 of the holding element 8.

[0024] It will be appreciated by a person skilled in the art that the invention is not limited to the embodiments described above, but may vary within the scope of the appended claims. For instance, the leakage detection arrangement of the figures is arranged in a connection piece, but the leakage detection arrangement could also

be, for instance, a separate module, which can be connected to a leakage channel of a fuel pipe or some other component of a fuel injection system.

Claims

1. A leakage detection arrangement for detecting a leakage in a fuel injection system of an internal combustion engine, the arrangement comprising

   - a fluid chamber (1) that can be arranged in fluid communication with a leakage channel (2, 3) that is configured to receive fuel from a leaking component (4) of the fuel injection system,
   - an indicator element (5) having a retracted position and a protruding position, the indicator element (5) being configured to move due to fuel pressure in the fluid chamber (1) from the retracted position to the protruding position thus indicating a leakage in the fuel injection system, and
   - a retaining element (6), which is arranged around the indicator element (5) and is configured to keep the indicator element (5) in the retracted position and allow movement of the indicator element (5) to the protruding position when the force applied to the indicator element (5) by the fuel pressure in the fluid chamber (1) exceeds a predetermined threshold,

   characterized in that the arrangement is provided with a groove (7) which is arranged in a part (8) surrounding the indicator element (5) and which is configured to accommodate the retaining element (6), and that the indicator element (5) comprises a groove (9), which surrounds the outer circumference of the indicator element (5) and which is configured to accommodate the retaining element (6) when the indicator element (5) is in the retracted position.

2. An arrangement according to claim 1, wherein the groove (7) is arranged in a removable holding element (8), which allows mounting and dismounting of the indicator element (5).

3. An arrangement according to claim 2, wherein the holding element is a nut (8).

4. An arrangement according to claim 2 or 3, wherein the holding element (8) comprises a bore (10) through which the indicator element (5) protrudes and one end of the bore (10) is provided with a section (10a) that tapers towards the inside of the holding element (10).

5. An arrangement according to any of the preceding claims, wherein the leading end of the indicator element (5) in the direction from the retracted position towards the protruding position tapers towards said end.

6. An arrangement according to any of the preceding claims, wherein the retaining element (6) is a snap ring.

Patentansprüche

1. Leckerkennungsanordnung zum Erkennen eines Lecks in einem Kraftstoff-Einspritzsystem eines Verbrennungsmotors, wobei die Anordnung Folgendes umfasst:

   - eine Fluidkammer (1), die in Fluidverbindung mit einem Leckkanal (2, 3) angeordnet werden kann, der dafür konfiguriert ist, Kraftstoff von einer leckenden Komponente (4) des Kraftstoff-Einspritzsystems aufzunehmen,
   - ein Anzeigeelement (5), das eine zurückgezogene Position und eine hervorstehende Position aufweist, wobei das Anzeigeelement (5) dafür konfiguriert ist, sich infolge des Kraftstoffdrucks in der Fluidkammer (1) von der zurückgezogenen Position in die hervorstehende Position zu bewegen und damit ein Leck in dem Kraftstoff-Einspritzsystem anzuzeigen, und
   - ein Rückhalteelement (6), das um das Anzeigeelement (5) herum angeordnet und dafür konfiguriert ist, das Anzeigeelement (5) in der zurückgezogenen Position zu halten und die Bewegung des Anzeigeelements (5) in die hervorstehende Position zu ermöglichen, wenn die Kraft, die durch den Kraftstoffdruck in der Fluidkammer (1) auf das Anzeigeelement (5) ausgeübt wird, einen festgelegten Grenzwert übersteigt,

   dadurch gekennzeichnet, dass die Anordnung mit einer Rille (7) versehen ist, die in einem Teil (8) angeordnet ist, welches das Anzeigeelement (5) umgibt und das dafür konfiguriert ist, das Rückhalteelement (6) unterzubringen, und dadurch, dass das Anzeigeelement (5) eine Rille (9) umfasst, die den Außenumfang des Anzeigeelements (5) umgibt und dafür konfiguriert ist, das Rückhalteelement (6) unterzubringen, wenn sich das Anzeigeelement (5) in der zurückgezogenen Position befindet.

2. Anordnung nach Anspruch 1, wobei die Rille (7) in einem entnehmbaren Halteelement (8) angeordnet ist, das die Montage und die Demontage des Anzeigeelements (5) ermöglicht.

3. Anordnung nach Anspruch 2, wobei das Halteelement eine Mutter (8) ist.

4. Anordnung nach Anspruch 2 oder 3, wobei das Halteelement (8) eine Bohrung (10) umfasst, durch die das Anzeigeelement (5) hervorsteht, und wobei ein Ende der Bohrung (10) mit einem Abschnitt (10a) versehen ist, der sich hin zum Inneren des Halteelements (8) verjüngt.

5. Anordnung nach einem der vorhergehenden Ansprüche, wobei sich das vordere Ende des Anzeigeelements (5) in der Richtung von der zurückgezogenen Position hin zur hervorstehenden Position zu dem Ende hin verjüngt.

6. Anordnung nach einem der vorhergehenden Ansprüche, wobei das Rückhalteelement (6) ein Schnappring ist.

Revendications

1. Agencement de détection de fuite pour détecter une fuite dans un système d'injection de carburant d'un moteur à combustion interne, l'agencement comprenant

   - une chambre de fluide (1) qui peut être agencée en communication fluidique avec un canal de fuite (2, 3) qui est configuré pour recevoir du carburant d'un composant (4) fuyant du système d'injection de carburant,
   - un élément indicateur (5) ayant une position rétractée et une position en saillie, l'élément indicateur (5) étant configuré pour se déplacer, du fait de la pression du carburant dans la chambre de fluide (1), de la position rétractée à la position en saillie indiquant ainsi une fuite dans le système d'injection de carburant, et
   - un élément de retenue (6) qui est agencé autour de l'élément indicateur (5) et est configuré pour maintenir l'élément indicateur (5) dans la position rétractée et permettre le mouvement de l'élément indicateur (5) vers la position en saillie lorsque la force appliquée à l'élément indicateur (5) par la pression du carburant dans la chambre de fluide (1) dépasse un seuil prédéterminé,

   caractérisé en ce que l'agencement est doté d'une rainure (7) qui est agencée dans une partie (8) entourant l'élément indicateur (5) et qui est configurée pour recevoir l'élément de retenue (6), et que l'élément indicateur (5) comprend une rainure (9) qui entoure la circonférence extérieure de l'élément indicateur (5) et qui est configurée pour recevoir l'élément de retenue (6) lorsque l'élément indicateur (5) est dans la position rétractée.

2. Agencement selon la revendication 1, dans lequel la rainure (7) est agencée dans un élément de maintien (8) amovible qui permet le montage et le démontage de l'élément indicateur (5).

3. Agencement selon la revendication 2, dans lequel l'élément de maintien est un écrou (8).

4. Agencement selon la revendication 2 ou 3, dans lequel l'élément de maintien (8) comprend un alésage (10) à travers lequel l'élément indicateur (5) fait saillie et une extrémité de l'alésage (10) est dotée d'une section (10a) qui décroît en direction de l'intérieur de l'élément de maintien (8).

5. Agencement selon l'une quelconque des revendications précédentes, dans lequel l'extrémité avant de l'élément indicateur (5) dans la direction de la position rétractée vers la position en saillie décroît en direction de ladite extrémité.

6. Agencement selon l'une quelconque des revendications précédentes, dans lequel l'élément de retenue (6) est un circlip.

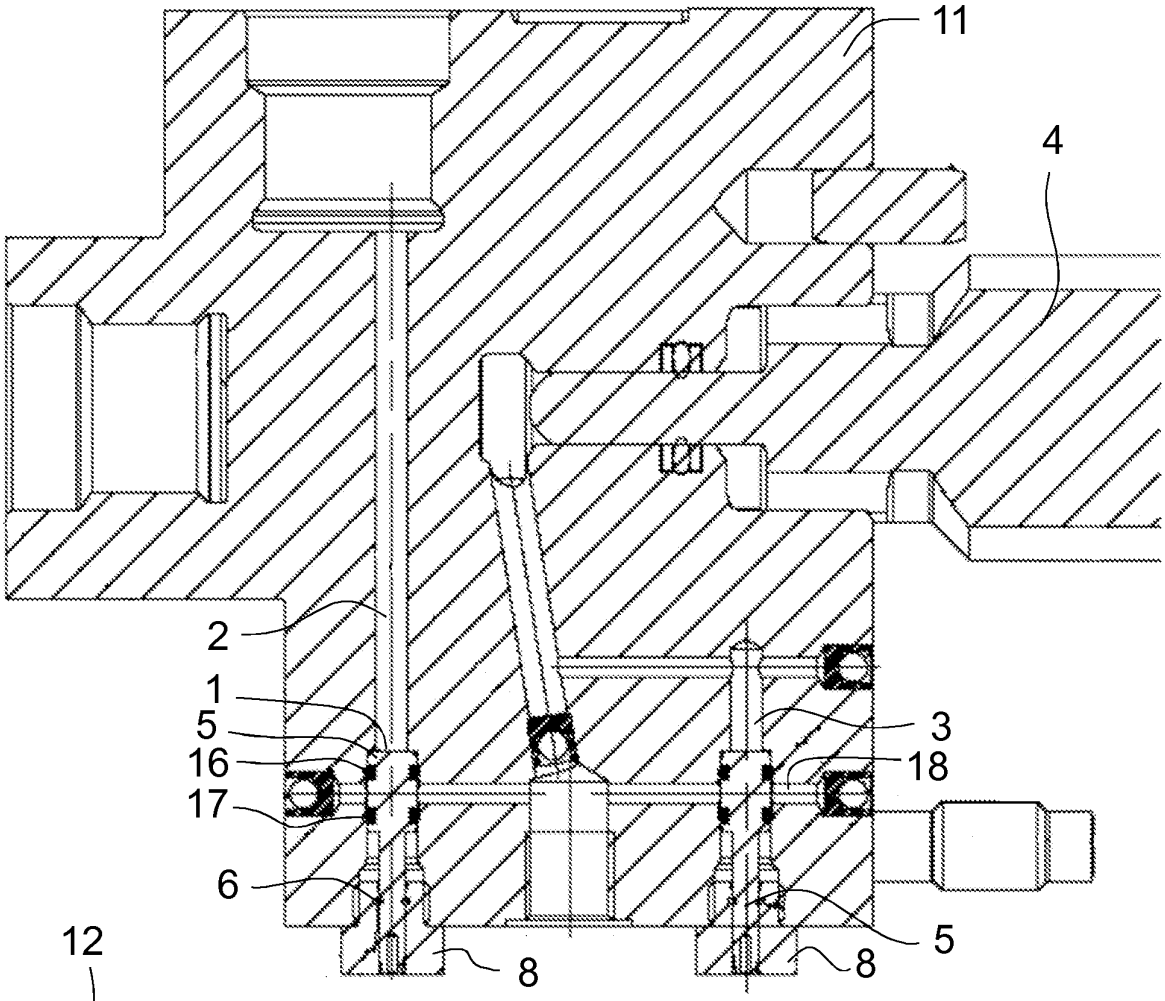

FIG. 1

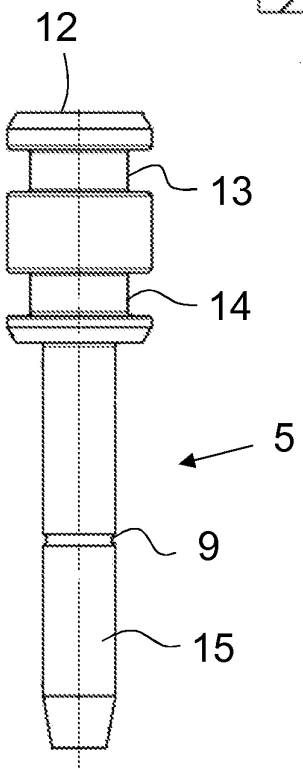

FIG. 2

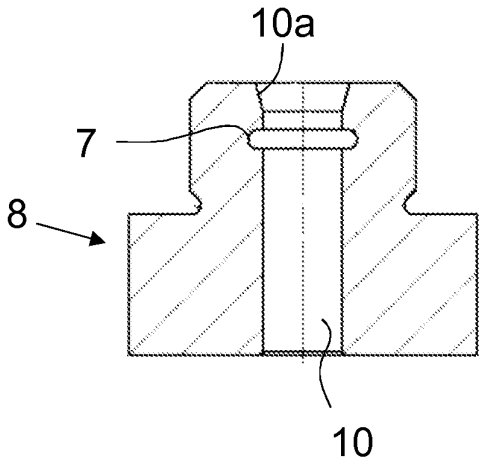

FIG. 3

REFERENCES CITED IN THE DESCRIPTION

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