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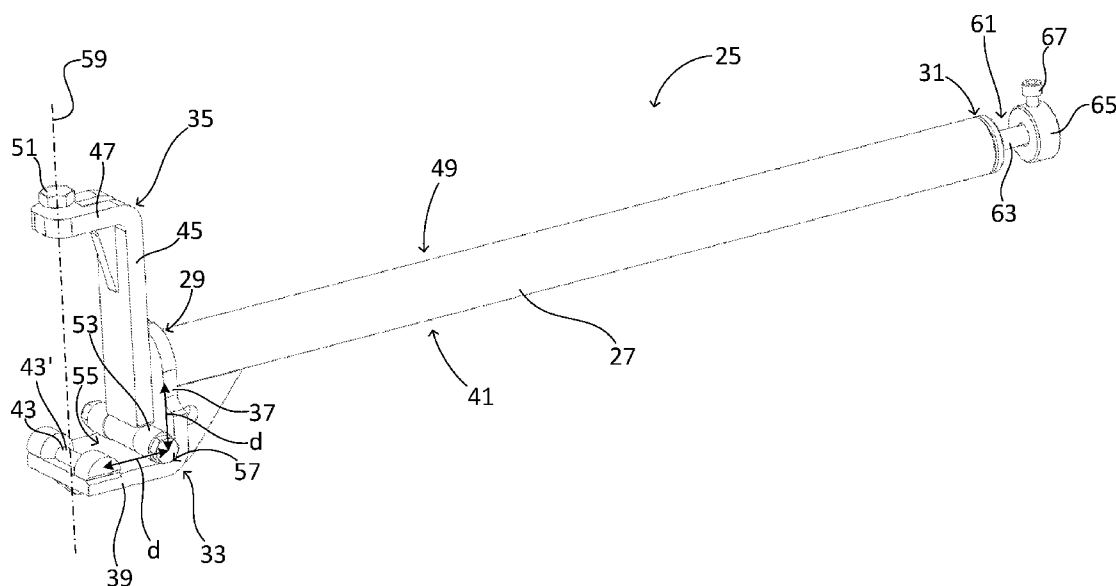


Fig. 2

(57) Abstract: The invention relates to a measuring device (25), for measuring play in a ball joint (1). The device (25) comprises an elongated arm member (27) having a first end (29) and a second end (31), a first clutch member (33) and a second clutch member (35). The first clutch member (33) having a first portion (37) and a second portion (39), said first portion (37) being attached to the first end (29) of the arm member (27), and said second portion (39) comprising a first connection element (43) arranged to engage a first side (7) of a ball joint (1). The second clutch member (35) having a first portion (45) and a second portion (47), the second portion (47) comprising a second connection element (51) arranged to engage a second side (21) of the ball joint (1). The first portion (45) of the second clutch member (35) is coupled to the first clutch member (33) by means of a hinged coupling (53), arranged at an inner surface (55) of the first clutch member (33), the first and second connection elements (43, 51) being movable towards each other so as

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to compress a ball joint (1), wherein a change in distance between the first portions (37, 45) of the first and the second clutch members (33, 35) corresponds to the amount of play in the ball joint (1). The invention also relates to a method for measuring play in a ball joint (1) by using such a measuring device (25).

MEASURING DEVICE AND METHOD FOR MEASURING PLAY IN A BALL JOINT

TECHNICAL FIELD

- 5 The invention relates to a measuring device and a method for measuring play in ball joints according to the appended claims.

BACKGROUND ART

- 10 Wheel suspension of vehicles often comprises ball joints as a means to achieve high mobility and flexibility with regards to the movement in joints. Ball joints may support compressive loads and tensile loads while still being rotationally movable about a rotational axis, giving rise to a very versatile joint in a mechanical structure suitable for a wheel suspension. Such a ball joint is typically threaded at one end and comprise a movable ball element at the other end, being seated within a housing. The ball element
- 15 is pressed against a seat provided with a bearing surface within said housing by means of a spring element or similar, wherein the ball element may be rotated in engagement with said bearing surface. The spring ensures that the ball element is always flush pressed against said bearing surface wherein the ball joint provides a reliable mechanical function which does not rattle within the housing due to increased
- 20 wear of the structure. If said spring element would not be present within the housing, the wear caused by the rotational movement of the joint and the mechanical loads applied to the joint would cause the contact surfaces of the ball joint to be exposed to mechanical wear until play would arise with the ball joint which would in turn cause the ball joint to rattle and not provide a stable joint. It is therefore desired to direct the wear
- 25 distinctly to the bearing surfaces wherein said bearing surfaces are designed to allow a certain amount of wear before the ball joint needs to be replaced

- However, such bearing surfaces must thus be regularly inspected and controlled so as to not go below a wear threshold set for the ball joint. When the ball joint is exposed to a wear above a certain limit, the ball joint must be replaced to guarantee the
- 30 mechanical stability and function of the ball joint and the mechanical structure. A

common way of inspecting ball joint is to arrange an indicator to the ball joint and then compressing the ball joint with a pair of tongue-and-groove pliers. The dial display of the indicator then indicates the present play within the ball joint. However, there are several drawbacks with such a procedure. Firstly, a pair of tongue-and-groove pliers may not always be guaranteed to align perfectly with correct direction the ball joint should be compressed, which may therefore lead to incorrect results of the measuring. Furthermore, as the measuring process requires several pieces of equipment and a rather complex setup, such a procedure becomes time consuming, especially if a large number of ball joints are to be inspected, which may be the case for a series of vehicles having wheel suspension with a large number of ball joints to inspect.

US 2012 0306478 (A1) discloses a hand held check fixture to indicate play in a pitch change link ball joint. The check fixture can include a first member for attachment to a first portion of the pitch chain link, a second member for attachment to a second portion of the pitch change link, and a gage to indicate movement of the first member relative the second member. The gage is adapted to indicate the clearance between a pitch change link ball bearing and a pitch change link knuckle in the axial and/or in the radial direction.

SUMMARY OF THE INVENTION

Despite prior art there is a need to develop a measuring device which is fast and easy to use when measuring play in a ball joint. There is also a need for such a measuring device which provides a high accuracy when used, which indicates play in a simple manner. Furthermore, there is a need for a method for measuring play in a ball joint, which method is fast and easy to use while still providing high accuracy results from the measurements.

An object of the invention is thus to provide a measuring device which is fast and easy to use. Another object is to provide a measuring device which provides reliable results having a high accuracy. An even further object of the invention is to provide a method which is fast and easy to use and provides reliable measurement results with high accuracy.

According to a first aspect of the invention a measuring device for measuring play is provided. The measuring device comprises an elongated arm member having a first end and a second end, a first clutch member and a second clutch member. The first clutch member being a first angled plate member having a first portion and a second portion, said first portion being fixedly coupled to the first end of the arm member, said second portion extending at a first side of the arm member, in a direction away from the first end of the arm member and comprising a first connection element arranged to engage a first side of a ball joint. The second clutch member being a second angled plate member having a first portion and a second portion, the second portion comprising a second connection element arranged to engage a second side of the ball joint. The first portion of the second clutch member is coupled to the first clutch member by means of a hinged coupling, arranged at an inner surface of the first clutch member. Thereby, the first and second connection elements are movable towards each other so as to compress a ball joint by displacing the second end of the arm member in a direction towards the first side of the arm member, wherein a change in distance between the first portions of the first and the second clutch members corresponds to the amount of play in the ball joint.

This has the advantage that a measuring device is provided, which measuring device is fast and easy to bring into engagement with a ball joint when a measurement is to be performed. The type of ball joints for which said measuring device is to be used is to be viewed as a ball joint comprising a housing having a seat provided with a bearing surface, which bearing surface is exposed to wear over time when the ball joint is in use. The housing further comprising a spring element or similar, which spring presses the ball element of the ball joint towards the bearing surface. The housing further comprises the first side of the ball joint, which is to be viewed as a lower outer surface of the housing. The ball element of the ball joint comprises an extending shaft having a threaded end portion, extending upwards from the housing, wherein the threaded end portion may be threaded to another mechanical element of the structure for which the ball joint is to act as a joint, for example a wheel suspension of a vehicle. The threaded end portion further comprises a second side of the ball joint, being the end surface of the end portion.

The measuring device is arranged to the ball joint by means of gripping the ball joint from opposite sides so that the first connection element engage the first side and the

second connection element engage the second side of the ball joint. The second end of the elongated arm member may thereafter be displaced in a direction towards the first side of the arm member. When the arm member is displaced in such a way, the hinged coupling of the second clutch member provides a pivoting of the positioning of the clutch member relative each other, wherein the first and second connection elements are brought closer to each other and as a result compress the ball joint. Such a compression of the ball joint directly relates to the amount of play in the ball joint, the play being a direct result of the amount of wear present in the bearing surface, wherein the compression of the ball joint thereby can be measured to evaluate the amount of wear present in the bearing surface of the ball joint.

The elongated arm member provides a fast and easy way to exert a large enough force to overcome the spring force of the spring and thus compress the ball joint for such a measurement, due to the elongated arm member functioning as a moment arm for the pivoting of the hinged coupling.

Thereby a measuring device is provided which has the advantage that a single piece of equipment can be used to perform a measurement of play in a ball joint in a very fast, easy and efficient manner. This is beneficial, especially for measuring play in a ball joint of wheel suspensions of vehicles. As some types of vehicles may have wheel suspensions comprising a large number of ball joints, an inspection of such a vehicle relating to checking all said ball joints for play and thus wear in their respective bearing surfaces will result in lot of saved time for performing said inspection.

According to another aspect of the invention the hinged coupling is arranged at an equal distance from the first end of the arm member and the first connection element of the second portion of the first clutch member.

This has the advantage that a change in distance between the first portion of the first clutch member and the first portion of the second clutch member will be equal to a change in distance between the first and the second connection elements. Thereby, by measuring the distance between the two first portions of the clutch members, the amount of compression of a ball joint can be evaluated in a simple and accurate way.

This is beneficial as the measuring device is fast and easy to use wherein reliable and accurate results are provided in a correspondingly fast and easy manner.

According to yet another aspect of the invention the device further comprises a displacement element, arranged partly within the arm member, extending from the second end to a hole in the first clutch member so as to engage a back surface of the second clutch member. The displacement element, when operated at the second end of the arm member, is arranged to engage the second clutch member by means of a longitudinal displacement of the adjustment element.

This has the advantage that the distance between the first portion of the first clutch member and the first portion of the second clutch member easily may be measured by means of a specified movement of the displacement element within the arm member.

The displacement member may further also be used as a calibration device, wherein the displacement element is brought into engagement with the first portion of the second clutch member prior to a compression of a ball joint, so as to achieve a null value for the positioning of the displacement element. When a compression of said ball joint has been achieved, the displacement element may further be moved so as to cover the additional distance between the first portions of the first and the second clutch members due to the compression, wherein said additional distance directly relates to the compression of the ball joint. Said additional distance may thus be measured as a means to measure the amount of wear in the bearing surface of the ball joint in a fast and easy manner. The displacement element being arranged within the arm member further transfers the location for such a measurement to a convenient and easy to use location at the handle of the arm member.

According to a further aspect of the invention the displacement element comprises a threaded front portion, which is threaded to the hole in the first clutch member wherein the longitudinal displacement is controlled by means of a rotation of the displacement element.

This has the advantage that longitudinal displacement may be performed in a very controlled and precise manner by means of utilizing the direct relationship between the rotation of the displacement element and the corresponding longitudinal displacement. Smaller longitudinal displacements are thereby easier to perform and control as a short longitudinal displacement may be achieved by rotating the displacement element a certain angle, wherein said angle is easy to perform and observe.

According to an even further aspect of the invention the threaded front portion comprises a thread pitch which translates one full turn of the displacement element to a longitudinal displacement of 1 mm.

5 This has the advantage that ratio between the total number of complete turns of the displacement element is easily converted into distinct units of length for a corresponding longitudinal displacement of the displacement element. Thus, one full rotation of the displacement element equals a 1 mm longitudinal movement and so forth.

10 According to another aspect of the invention the displacement element further comprises an indication element, arranged at the second end of the arm member, which indication element is arranged to show the longitudinal displacement of the displacement element.

15 This has the advantage that said indication element is arranged to easily show/display the amount of longitudinal displacement of the displacement element. The measuring device is thereby provided with a clear and precise way for a user of the device to obtain the results of a performed measuring operation performed with the measuring device.

20 According to a yet another aspect of the invention the displacement element extends through the handle of the arm member, the indication element being in the form of a disc shaped element with a radially arranged marking arranged at an extending portion of the displacement element, wherein the disc shaped indication element shows the longitudinal displacement of the displacement element by means of the radial position of the marking.

25 This has the advantage that the disc shaped indication element will show the amount of rotation performed by means of the displacement element in a clear and easy to use manner. The radially arranged marking further emphasize this benefit of the feature as the angle of rotation is easy to track and observe by means of comparing the initial starting position of said marking with the achieved end position of said marking. The total angular displacement of the radially arranged marking can thereafter directly be
30 translated to the total amount of longitudinal displacement of the displacement element in a very fast and easy to perform manner.

According to a further aspect of the invention the displacement element is rotationally coupled to the handle of the arm member so that a rotation of the handle longitudinally displaces the adjustment element within the elongated arm member.

This has the advantage that the handle as a single mechanical element of the device may be used for several functions. The handle may be used for pulling and thereby pivoting the clutch members and thus compressing a ball joint, and also be used for calibration and movement of the displacement element. Thereby a compact and efficient measuring device is provided. The handle may further be provided with visual markers, such a raster incorporated into the surface of the handle to further serve as an indication element as well.

According to yet another aspect of the invention the first connection element of the first clutch member comprises a saddle shaped protrusion, arranged to engage the first side of a ball joint.

This has the advantage that the first connection element can fit to a variety of first surfaces of a ball joint, wherein said first surface of the ball joint can be fitted to a low point of the saddle shaped protrusion where it is firmly fitted for a compression of the ball joint.

According to a further aspect of the invention the second connection element of the second clutch member comprises an axially displaceable element, arranged to be axially displaced into engagement with the second side of a ball joint. The axially displaceable element may be a screw.

This has the advantage that the screw can be utilized to hold the ball joint securely in place between the first and second connection elements of the measuring device. The screw further can be used to calibrate the first and second clutch members to be aligned with the longitudinal extension of the ball joint. The ideal starting positions of the first and second clutch members relative the ball joint is to have the second portions of said clutch members as close to parallel with each other as possible, wherein the screw can be arranged to engage the second side of the ball joint while aiming for such an orientation. The screw can thereby be used to fit the measuring device to ball joints of different sizes and ensure accurate measuring results with the device. The type of ball joints for which the device is meant to be used for often

comprise a dowel hole, which is a cone formed recess. The tip of a screw therefore fits well in such a dowel hole.

According to an even further aspect of the invention a method for measuring wear in a ball joint is provided. The method is performed by using a measuring device

5 comprising an elongated arm member, a first clutch member having a first connection element, a second clutch member having an adjustable second connection element. The first clutch member being fixed to the arm member and the second clutch member being arranged to the first clutch member by means of a hinged coupling, arranged at an inner surface of the first clutch member. The device further comprises a
10 displacement element which is movable towards and away from a back surface of the second clutch member, and an indication element for showing the longitudinal displacement of the displacement element. The method comprising the steps of;
a) arranging the first connection element to a first side of a ball joint, b) arranging the second connection element to a second side of the ball joint, c) adjusting the second
15 connection element to provide a flush coupling between the measuring device and the ball joint, d) calibrating the displacement element to be in abutment with the back surface of the second clutch member, e) compressing the ball joint by displacing the arm member, f) displacing the displacement element to again be in abutment with the back surface of the second clutch member, and g) measuring the play of the ball joint
20 by means of reading the indication element.

This has the advantage that a fast and easy to use method is provided for measuring play in ball joints. A further advantage is that the method may be performed using a single piece of equipment which makes the method fast and easy to perform with regards to preparing and initiating the measuring. The elongated arm member provides
25 a fast and easy way for a user to exert a large enough force to overcome the spring force of a spring within the ball joint to compress the ball joint wherein the method is easy to perform. The method is beneficial to use for checking for play in ball joints of wheel suspensions for vehicles, especially for large vehicles with wheel suspensions having a large number of ball joints, wherein a large quantity of time is saved when
30 using the method for such vehicles.

According to another aspect of the invention step e) and f) are replaced with a step h), wherein step h) comprises compressing the ball joint by means of displacing the

displacement element towards the back surface of the second clutch member so as to achieve a pivoting of the clutch members relative each other.

This has the advantage that the results of the measuring operation are obtained during the compression of the ball joint directly, which provides a very fast and efficient
5 method for measuring play within a ball joint.

According to yet another aspect of the invention the displacement element further comprises a threaded front portion, which is threaded to a hole in the first clutch member, wherein any of the steps h) or i) is performed by a rotation of the displacement element.

- 10 This has the advantage that the compression of the ball joint may be performed in a very precise and controlled manner, as the compression is achieved by means of a rotational movement instead of, for example, a pulling motion exerted on the arm member.

15 BRIEF DESCRIPTION OF THE DRAWINGS

Below is a description of, as examples, preferred embodiments of the invention with reference to the enclosed drawings, in which:

Figure 1 schematically illustrates a ball joint for which the measuring device is to be used according to the invention,

- 20 Figure 2 schematically illustrates a perspective view of a measuring device according to the invention,

Figure 3 schematically illustrates a side view of measuring device according to the invention,

- 25 Figure 4 schematically illustrates a side view of measuring device according to the invention, and

Figure 5 shows a flowchart of a method for measuring play in a ball joint according to the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

Figure 1 schematically illustrates a ball joint 1 for which a measuring device (shown in figure 2-4) is to be used according to the invention. The ball joint 1 as presented in figure 1 is partly a cross sectional view so as to exhibit the interior of said ball joint in a clear manner. The ball joint 1 comprises a housing 3 having a laterally extending shaft 5 arranged thereto, said shaft 5 is to be used as one of the mechanical elements rotationally coupled by means of the ball joint 1. The housing 3 further comprises a first side 7, being a lower outside surface of the housing 3 and an interior, provided with a spring 9 and a bearing surface 11. The ball joint 1 further comprises a ball element 13, situated within the housing 3 and being pressed towards a contact surface region 15 of the bearing surface 11 by means of the spring 9. The ball element 13 is further joined with an extending shaft 17 having a threaded end portion 19. The end portion 19 further comprises a second side 21, being the end surface of the end portion 19. The end surface may be provided with an indentation, such as a dowel hole, which is shown with dotted lines in the figure. The extending shaft 17 is inserted into the second of the mechanical elements being rotationally coupled by means of the ball joint 1, wherein said coupling is fixated by means of a nut element 23. As the spring 9 is exerting a constant spring force to the ball element 13, the ball element 13 will over time wear down the contact surface region 15 of the bearing surface 11. However, as the spring force keeps the ball element 13 constantly pressed towards said contact surface region 15 the ball element 13 will remain securely in place within the housing 3 wherein the ball joint 1 provides its function in a reliable manner. When a certain amount of the bearing surface 11 has been worn out, the ball joint 1 must be discarded and replaced. Said certain amount of the bearing surface 11 is usually measured as a distance or play within the joint 1 which is detectable when the spring force is relieved. The allowed amount of such play within a ball joint 1 is dependent on the type of ball joint 1, but is generally in the region of parts of, to about a few millimetres. The size of the ball joint 1 shown in figure 1 may be viewed as roughly 10 cm in height as a rough estimate. However, the size of both the ball joint 1 and a measuring device for such a ball joint 1 may of course vary without deviating from the inventive concept of invention as described within the application.

Figure 2 schematically illustrates a perspective view of a measuring device 25 according to the invention. The measuring device 25, for measuring play in a ball joint,

such as for example the ball joint 1 shown in figure 1, comprises an elongated arm member 27 having a first end 29 and a second end 31. The second end 31 may be perceived as a handle, or may also be provided with an additional specific handle portion if desired. The measuring device 25 further comprises a first clutch member 33 and a second clutch member 35, arranged at the first end 29 of the arm member 27. The first clutch member 33 is in this embodiment a first right angled plate member having a first portion 37 and a second portion 39, said first portion 37 being attached to the first end 29 of the arm member 27. The first portion 37 extends perpendicular to an extending direction of the arm member 27, wherein the second portion 39 extends at a first side 41 of the arm member 27, in a direction away from the first end 29 of the arm member 27, parallel to the extending direction of the arm member 27. The second portion 39 further comprises a first connection element 43 arranged to engage the first side 7 of a ball joint 1, as shown in figure 1. The first connection element 43 comprises in this embodiment a saddle shaped protrusion 43', arranged to engage a recess of the first side 7 of the ball joint 1. Other shapes of said protrusion 43' are however also possible and may easily be modified to conform with different shapes and designs of ball joints, either by using other types of first connection elements or by using an additional adaptor element for example.

The second clutch member 35 is a second right angled plate member having a first portion 45 and a second portion 47. As depicted in figure 2, the first portion 45 extends parallel to the first portion 37 of the first clutch member 33, and the second portion 47 of the second clutch member 35 extends at a second side 49 of the arm member, in a direction away from the first end 29 of the arm member 27, parallel to an extending direction of the arm member 27. The second portion 47 comprises a second connection element 51 arranged to engage the second side 21 of the ball joint 1 as depicted in figure 1. The second connection element 51 of this embodiment is in the form of an axially displaceable element, such as a screw, arranged to be displaced into engagement with the second side 21 of the ball joint. The second connection element 51 being a screw allows for differences in size of ball joints 1 to be measured as well as the ability to securely fixate the measuring device to the ball joint 1 in a reliable manner. The axially displaceable element is provided with a pointed tip (seen in figure 3), which is arrangeable in a dowel hole at the second side 21 of the ball joint 1.

As shown in figure 2, the first portion 45 of the second clutch member 35 is arranged to the first clutch member 33 by means of a hinged coupling 53, arranged at an inner surface 55 of the first clutch member 33. More specifically the hinged coupling 53 is arranged at an inner corner 57 of the right angled first clutch member 33. The second clutch member 35 is thereby arranged in such a way that the second clutch member 35 can pivot about the hinged coupling 53, and being movable between the first portion 37 of the first clutch member 33 and the first connection element 43 of the second portion 39 of the first clutch member 33. The second portions 39, 47 of the first and second clutch members 33, 35, and the arrangement of the first and second connection elements 43, 51 respectively thereon are designed to position the first and second connection elements 43, 51 on a line 59 perpendicular to the extending direction of the arm member 27 when the clutch members 33, 35 are in the position shown in figure 2. Said relative positioning of the clutch members 33, 35 represents the preferable orientation of the clutch members 33, 35 when arranged to a ball joint but before a compression and thereafter a measurement of said ball joint 1 has been performed. The second connection element 51 in form of the screw may be used to align the two clutch members 33, 35 as close as possible to such an orientation prior to performing a measurement procedure with the device 25.

When using the measuring device 25 the second end 31 of the arm member is displaced towards the first side 41 of the arm member 27, which is downwards as shown in figure 2, wherein the first connection element 43 is moved towards the second connection element 51. Such a relative displacement of the connection elements 43, 51 relative each other thereby compresses the ball joint 1 to which the measuring device 25 is being used, wherein any present play within said ball joint 1 may be measured. As should be obvious, the first connection element 43 is in practice moved in an arch which originates from the hinged coupling 53. However, as the play in a ball joint 1 is so much smaller than the size of the measuring device 25, the relative upwards movement of the first connection element 43 may be approximated with a movement straight upwards for this type of application. As an example, the ball joint 1 might have a height in the range of about 10 to about 15 cm, wherein the threshold for the amount of play within such a ball joint 1 may be in the range of about 0.5 to about 2 mm depending on model and brand of the ball joint 1.

The hinged coupling 53 of this embodiment is furthermore arranged at an equal distance d from the first end 29 of the arm member 27 and the first connection element 43 of the second portion 39 of the first clutch member 33. By means of arranging the coupling 53 in such a way, the relative movement of the first connection element 43 during a compression of a ball joint 1 will be equal to the change in distance between the first portions 37, 45 of the first and second clutch members 33, 35. Said change in distance between the two first portions 37, 45 may thereby be utilized as a means to measure play within a ball joint 1 in a simple manner, when said ball joint 1 is compressed.

The measuring device 25 further comprises a displacement element 61 arranged partly within the arm member 27. Said displacement element 61 is in this embodiment shown extending with an extending portion 63 out of the second end 31 of the arm member 27. The displacement element 61 shown in figure 2 further comprises an indication element 65, which indication element 65 is arranged to show the longitudinal displacement of the displacement element 61. As the displacement element 61 is displaceable within the arm member 27, it may be used to measure the change in distance between the first portions 37, 45 of the first and second clutch members 33, 35 which change in distance corresponds to the measurement results when using the measuring device 25 on a ball joint 1. The indication element 65 shown in figure 2 is in the form of a disc shaped element with a radially arranged marking 67, such as a radially extending protrusion the indication element 65 being arranged at the extending portion 63 of the displacement element 61. The disc shaped indication element 65 may thereby be utilized to show the longitudinal displacement of the displacement element 61. The displacement element 61 and the indication element 65 will be explained in more detail with reference to figure 3.

As is stated, both the first and the second clutch members 33, 35 of this embodiment are right angled plate members. However, the angles of said plate members may have other values than right angles. Likewise, the direction of the first portion 37 of the first clutch member 33 may differ from being perpendicular as is shown with reference to the measuring device of figure 2. Both the first and the second clutch members 33, 35 may also be made with other shapes than plate members, such as shafts, beams, or a combination of such elements. To achieve a correct compression of a ball joint 1, the ball joint 1 should be compressed in a direction going as straight through a centre of

the ball joint 1 as possible. Modifications may thereby be made to the angles of the clutch members, the extending direction of the arm member and the positioning of the hinged coupling as long as the measuring device 25 provides the force applied to the ball joint 1 in said direction.

5 Figure 3 schematically illustrates a side view of measuring device 25 according to the invention. The measuring device 25 shown may be viewed as the same measuring device 25 shown in figure 2, but shown in a manner in which some details are shown more clearly. The main functionality and potential modification to individual features may however be perceived the same. In this view the displacement element 61 within
10 the arm member 27 is seen, depicted with a dotted line within the arm member 27. The displacement element 61 of this embodiment is extending from the second end 31 of the arm member 27 to a hole 69 in the first clutch member 33 so as to engage a back surface 71 of the second clutch member 35, wherein the displacement element 61, when operated at the second end 31 of the arm member 27, engages the back surface
15 71 of the second clutch member 35 by means of a longitudinal displacement of the displacement element 61. The displacement element 61 further comprises a threaded front portion 73, which is threaded to the hole 69 in the first clutch member 33 wherein the longitudinal displacement is controlled by means of a rotation of said displacement element 61. Thus, when the first and second connection elements 43, 51 are in
20 engagement with a ball joint 1 which is to be evaluated with regards to potential play within the joint 1, the displacement element 61 is rotated at the extending portion 63 at the second end 31 of the arm member 27 so as to position a rounded tip 75 of the front portion 73 of the displacement element 61 in contact with the back surface 71 of the second clutch member 35. The displacement element 61 is thereby calibrated for the
25 positioning of the clutch members 33, 35 relative each other. Furthermore, the displacement element 61 may also be used to achieve the displacement of the first and second clutch members 33, 35 relative each other. By means of rotating the displacement element 61 so that it is being longitudinally displacement towards the second clutch member 35, the first portion 37 of the first clutch member 33 will thus be
30 displaced away from the first portion 45 of the second clutch member 35 by means of said longitudinal displacement. Thereby a pivoting of the first and second clutch members is achieved by means of rotating the displacement element 61 instead of initiating said pivoting by displacing the arm member 27. This may be beneficial as a

means of compressing a ball joint 1 in a very controlled manner, as a rotating movement is easy to control and perform slowly by a user of the measuring device 25. Furthermore, if the spring force exerted by the spring 9 within the ball joint 1 is large, a rotating movement may be easier to use to provide a large enough force counteracting the spring force.

The indication element 65, in the form of the disc shaped element in this embodiment, may thereafter also be calibrated to align with a desired rotational position of the displacement element 61. The radially arranged marking 67 of the indication element 65 of this embodiment is a screw arranged in the disc shaped indication element 65.

Said screw may be loosened wherein the disc shaped indication element 65 may be rotated about the displacement element 61 until the screw is pointing in a desired direction, for example straight upwards. The screw is thereafter screwed into the disc shaped indication element 65 until the indication element is firmly coupled to the displacement element 61 again. The arm member 27 is thereafter displaced in a direction downwards according to the figure, wherein a compression of the ball joint 1 is achieved. As should be understood, said compression results in an upwards directed movement of the first connection element 43, said movement corresponding to existing play in the ball joint 1. The distance d between the hinged coupling 53 and the arm member 27 being the same equal distance d as the distance d between the hinged coupling 53 and the first connection element 43 results in a gap forming between the rounded tip 75 of the displacement element 61 and the back surface 71 of the second clutch member 35, said gap being the same size as the present play in a ball joint 1 when compressed. The distances d are defined as lengths of moment arms of the pivoting displacement for the hinged coupling 53, along the first and second portions 37, 39 of the first clutch member 33. While holding the ball joint in a compressed state, the displacement element 61 is thereafter rotated until the tip 75 of the displacement element 61 and the back surface 71 of the second clutch member 35 is in contact again. By tracking the number of rotations of the indication element 65 and relating said amount of rotation to a thread pitch of the threaded front portion 73 of the displacement element 61, the gap and thereby also play present within the ball joint may be measured.

The displacement element 61 of the measuring device 25 shown in figure 3 comprises a threaded front portion 73 comprising a thread pitch which translates one full turn of

the displacement element 61 to a longitudinal displacement of 1 mm. As should be obvious, a fast and simple to use scale is thereby obtained for the measuring device 25, wherein the total amount of full turns of the indication element directly translates to play in a ball joint expressed in millimetres. However, other thread pitches are of course also possible to use, wherein the thread pitch may be adapted for larger or smaller tolerances with regards to the measurement, or be adapted for inches for example. One full turn of the displacement element 61 could relate to $\frac{1}{2}$ millimetre, 2 millimetre or $\frac{1}{16}$ of an inch for example. Furthermore, the displacement element 61 may also be non-threaded at the front portion wherein the displacement element 61 is simply pushed into contact with the back surface 71 of the second clutch member 35 instead of being rotated. For such an embodiment the extending portion 63 of the displacement element 61 may be provided with a scale (not shown in figure 3) wherein the longitudinal displacement of the displacement element 61 may be read directly by means of said scale when the displacement element 61 is displaced in- or outwards relative the arm member 27.

Figure 4 schematically illustrates a side view of measuring device 25 according to the invention. The embodiment shown in figure 4 is similar to the one shown in figure 3 but with a few modifications. The measuring device 25 shown in figure 4 further comprises a handle portion 77 arranged at the second end 31 of the arm member 27, the handle portion 77 being rotationally movable relative the arm member 27. The displacement element 61 is according to this embodiment rotationally coupled to said handle portion 77 so that a rotation of the handle portion 77 longitudinally displaces the adjustment element 61 within the elongated arm member 27. The extending portion of the displacement element 61 as shown in figure 3 is thus not present in the embodiment depicted in figure 4. The coupling of the displacement element 61 to the handle portion 77 may be achieved by arranging a washer element 79 to the displacement element 61, wherein said washer element 79 is attached to the displacement element 61 but being freely longitudinally displaceable within the handle portion 77, in which radially protrusions 81 arranged at the washer element 79 may slide in grooves 83 arranged at the interior of said handle portion 77. The rotation of the handle portion 77 is thereby translated to the displacement element 61, wherein the rotating displacement element 61 in turn translates said rotation into longitudinal displacement within the arm member

27 by means of the threaded front portion 73 being threaded into or out of the threaded hole 69 of the first clutch member 33.

The arm member 27 shown in figure 4 further comprises an elongated hole 85 in the arm member 27 wherein the longitudinal displacement of the displacement element 61 may be observed via said hole 85. The displacement element 61 comprises an indication element 65 in the form of an additional washer element attached to the displacement element 61. A scale 89 is further arranged on the outside of the arm member 27 by means of a sliding attachment. Said scale 87 may thereby be slid longitudinally along the arm member 27 to calibrate the scale 87 relative a null position of the washer indication element 65, whereby after compression of a ball joint is achieved, the handle portion 77 is rotated to measure the gap between the first portion of the clutch members 33, 35 (as described above) wherein the indication element 65 relative the scale 87 provides the results of the measurement. The indication element may also be replaced with for example a radially placed scale on the arm member 27, in the vicinity of the handle portion 77. The handle portion 77 may in such a case be provided with a visible raster or another type of visual marker, wherein the rotation of the handle portion 77 is observed and used to measure a longitudinal displacement by means of combined the rotation applied with a known thread pitch, as described earlier.

Figure 5 shows a flowchart of a method for measuring play in a ball joint 1 according to the invention. The method is performed using a measuring device 25, such as a measuring device 25 described with reference to figures 2-4, for measuring play in a ball joint 1, as shown in figure 1. The measuring device 25 comprises an elongated arm member 27, a first clutch member 33 having a first connection element 43, and a second clutch member 35 having an adjustable second connection element 51. The first clutch member 33 is fixed to the arm member 27 and the second clutch member 35 is arranged to the first clutch member 33 by means of a hinged coupling 53, arranged at an inner surface 55 of the first clutch member 33. The device 25 further comprises a displacement element 61 which is movable towards and away from a back surface 71 of the second clutch member 35, said displacement element 61 being arranged partly within the arm member 27, and an indication element 65 for showing the longitudinal displacement of the displacement element 61. The method comprises the steps of; a) arranging the first connection element 43 to a first side 7 of a ball joint

1, b) arranging the second connection element 51 to a second side 21 of the ball joint 1, c) adjusting the second connection element 51 to provide a flush coupling between the measuring device 25 and the ball joint 1, d) calibrating the displacement element 61 to be in abutment with the back surface 71 of the second clutch member 35, e) 5 compressing the ball joint 1 by displacing the arm member 27, f) displacing the displacement element 61 to again be in abutment with the back surface 71 of the second clutch member 35, and g) measuring the play of the ball joint 1 by means of reading the indication element 65.

As should be obvious, the measuring device 25 used to perform the method as 10 described above may vary with regards to its features in similar manners as the different embodiments of the measuring device 25 described with reference to figures 2-4.

The method may further also be used by replacing the steps e) and f) with a step h), wherein step h) comprises compressing the ball joint by means of displacing the 15 displacement element 61 towards the back surface 71 of the second clutch member 35 so as to achieve a pivoting of the clutch members 33, 35 relative each other. Thereby the results of the measuring of present play in a ball joint 1 may be obtained simultaneously while performing the method. Furthermore, as the displacement element 61 of the measuring device 25 may comprise a threaded front portion 73, as 20 described with reference to figure 3, such a longitudinal displacement of the displacement element 61 may be performed with very high accuracy while at the same time immediately obtaining the results of the measuring of play in a ball joint by means of observing the rotational displacement of the displacement element 61 while the ball joint 1 is being compressed. This provides a very fast and easy to use method for 25 measuring play in ball joints 1.

As should be realized, the components and features specified above may within the framework of the invention be combined between the different embodiments specified.

CLAIMS

1. A measuring device (25), for measuring play in a ball joint (1), the device (25) comprising an elongated arm member (27) having a first end (29) and a second end (31), a first clutch member (33) and a second clutch member (35), the first clutch member (33) being a first angled plate member having a first portion (37) and a second portion (39), said first portion (37) being attached to the first end (29) of the arm member (27), said second portion (39) extending at a first side (41) of the arm member (27), in a direction away from the first end (29) of the arm member (27) and comprising a first connection element (43) arranged to engage a first side (7) of a ball joint (1), the second clutch member (35) being a second angled plate member having a first portion (45) and a second portion (47), the second portion (47) comprising a second connection element (51) arranged to engage a second side (21) of the ball joint (1),
- characterized in that** the first portion (45) of the second clutch member (35) is coupled to the first clutch member (33) by means of a hinged coupling (53), arranged at an inner surface (55) of the first clutch member (33), the first and second connection elements (43, 51) being movable towards each other so as to compress a ball joint (1) by displacing the second end (31) of the arm member (27) in a direction towards the first side (41) of the arm member (27), wherein a change in distance between the first portions (37, 45) of the first and the second clutch members (33, 35) corresponds to the amount of play in the ball joint (1).
2. The measuring device (25) according to claim 1, wherein the hinged coupling (53) is arranged at an equal distance (d) from the first end (29) of the arm member (27) and the first connection element (43) of the second portion (39) of the first clutch member (33).
3. The measuring device (25) according to any of the preceding claims, wherein the device (25) further comprises a displacement element (61), arranged partly within the arm member (27), extending from the second end (31) to a hole (69) in the first clutch member (33) so as to engage a back surface (71) of the second clutch member (35), wherein the displacement element (61), when operated at the second end (31) of the arm member (27), is arranged to engage the second clutch member (35) by means of a longitudinal displacement of the adjustment element (61).

4. The measuring device (25) according to claim 3, wherein the displacement element (61) comprises a threaded front portion (73), which is threaded to the hole (69) in the first clutch member (33) wherein the longitudinal displacement is controlled by means of a rotation of the displacement element (61).

5. The measuring device (25) according to claim 3, wherein the threaded front portion (73) comprises a thread pitch which translates one full turn of the displacement element (61) to a longitudinal displacement of 1 mm.

6. The measuring device (25) according to any of claims 3-5, wherein the displacement element (61) further comprises an indication element (65), arranged at the second end (31) of the arm member (27), which indication element (65) is arranged to show the longitudinal displacement of the displacement element (61).

7. The measuring device (25) according to any of claims 3-6, wherein the displacement element (61) extends through the second end (31) of the arm member (27), the indication element (65) being in the form of a disc shaped element with a radially arranged marking (67) arranged at an extending portion of the displacement element (61), wherein the disc shaped indication element (35) shows the longitudinal displacement of the displacement element (61) by means of the radial position of the marking (67).

8. The measuring device (25) according to any of claims 3-5, wherein the arm member (27) further comprises a handle portion (77) and the displacement element (61) is rotationally coupled to said handle portion (77) so that a rotation of the handle portion (77) longitudinally displaces the adjustment element (61) within the elongated arm member (27).

9. The measuring device (25) according to any of the preceding claims, wherein the first connection element (43) of the first clutch member (33) comprises a saddle shaped protrusion, arranged to engage the first side (7) of a ball joint (1).

10. The measuring device (25) according to any of the preceding claims, wherein the second connection element (51) of the second clutch member (35) comprises an axially displaceable element, arranged to be axially displaced into engagement with the second side (7) of a ball joint (1).

11. A method for measuring wear in a ball joint (1), by means of using a measuring device (25) comprising an elongated arm member (27), a first clutch member (33) having a first connection element (43), a second clutch member (35) having an adjustable second connection element (51), the first clutch member (33) being fixed to the arm member (27) and the second clutch member (35) being arranged to the first clutch member (33) by means of a hinged coupling (53), arranged at an inner surface (55) of the first clutch member (33), the device (25) further comprises a displacement element (61) which is movable towards and away from a back surface (71) of the second clutch member (35), and an indication element (65) for showing the longitudinal displacement of the displacement element (61), the method comprising the steps of;
- a) arranging the first connection element (43) to a first side (7) of a ball joint (1),
 - b) arranging the second connection element (51) to a second side (21) of the ball joint (1),
 - 15 c) adjusting the second connection element (51) to provide a flush coupling between the measuring device (25) and the ball joint (1),
 - d) calibrating the displacement element (61) to be in abutment with the back surface (71) of the second clutch member (35), comprising the steps of:
 - e) compressing the ball joint (1) by displacing the arm member (27),
 - 20 f) displacing the displacement element (61) to again be in abutment with the back surface (71) of the second clutch member (35), and
 - g) measuring the play of the ball joint (1) by means of reading the indication element (65); or
 - h) compressing the ball joint by means of displacing the displacement element (61) towards the back surface (71) of the second clutch member (35) so as to achieve a pivoting of the clutch members (33, 35) relative each other; and
 - 25 g) measuring the play of the ball joint (1) by means of reading the indication element (65).

12. The method according to claim 11 claim, wherein the displacement element (61) of the device (25) further comprises a threaded front portion (73), which is threaded to a hole (69) in the first clutch member (33), wherein any of the steps e) or h) is performed by means of a rotation of the displacement element (61).

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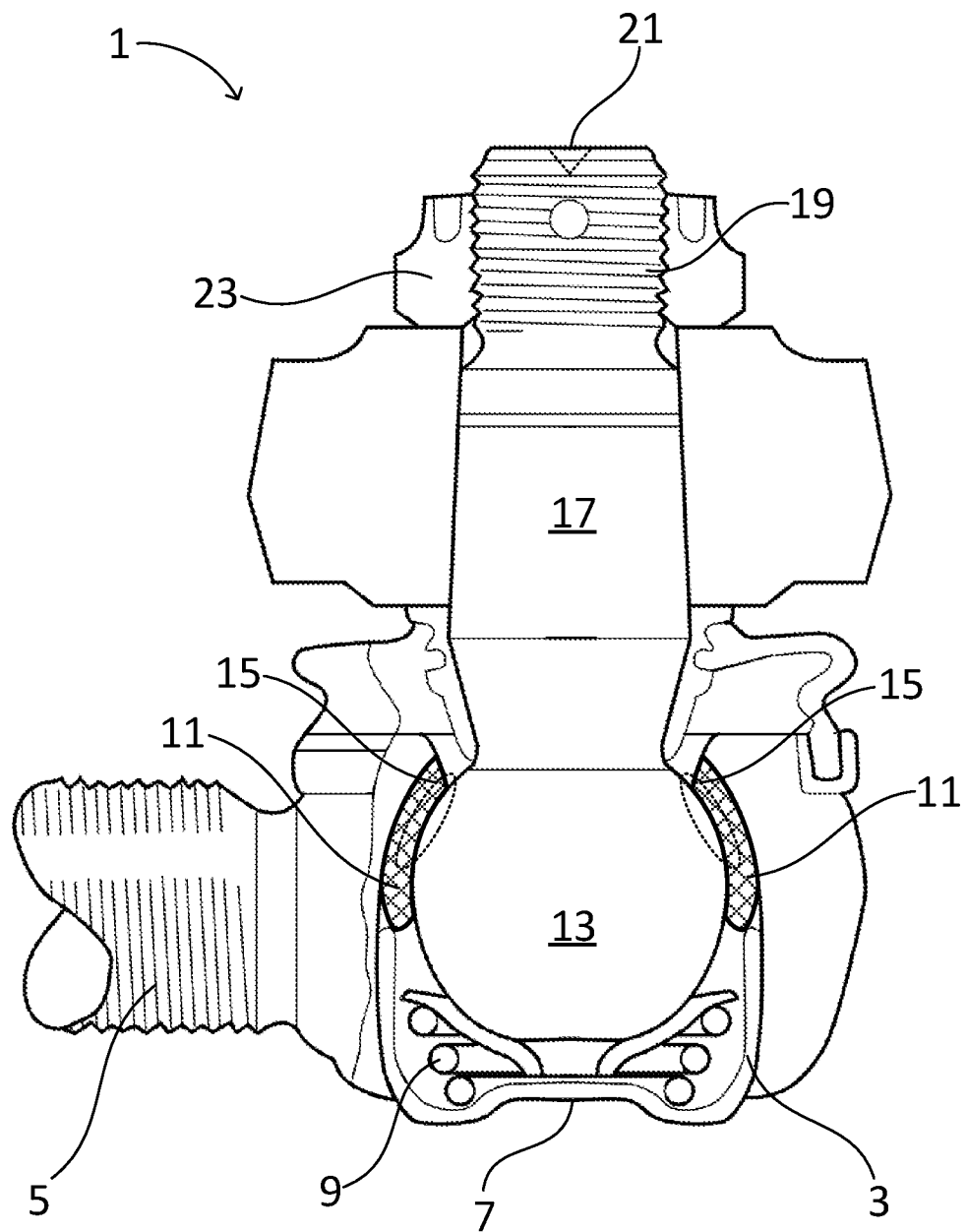


Fig. 1

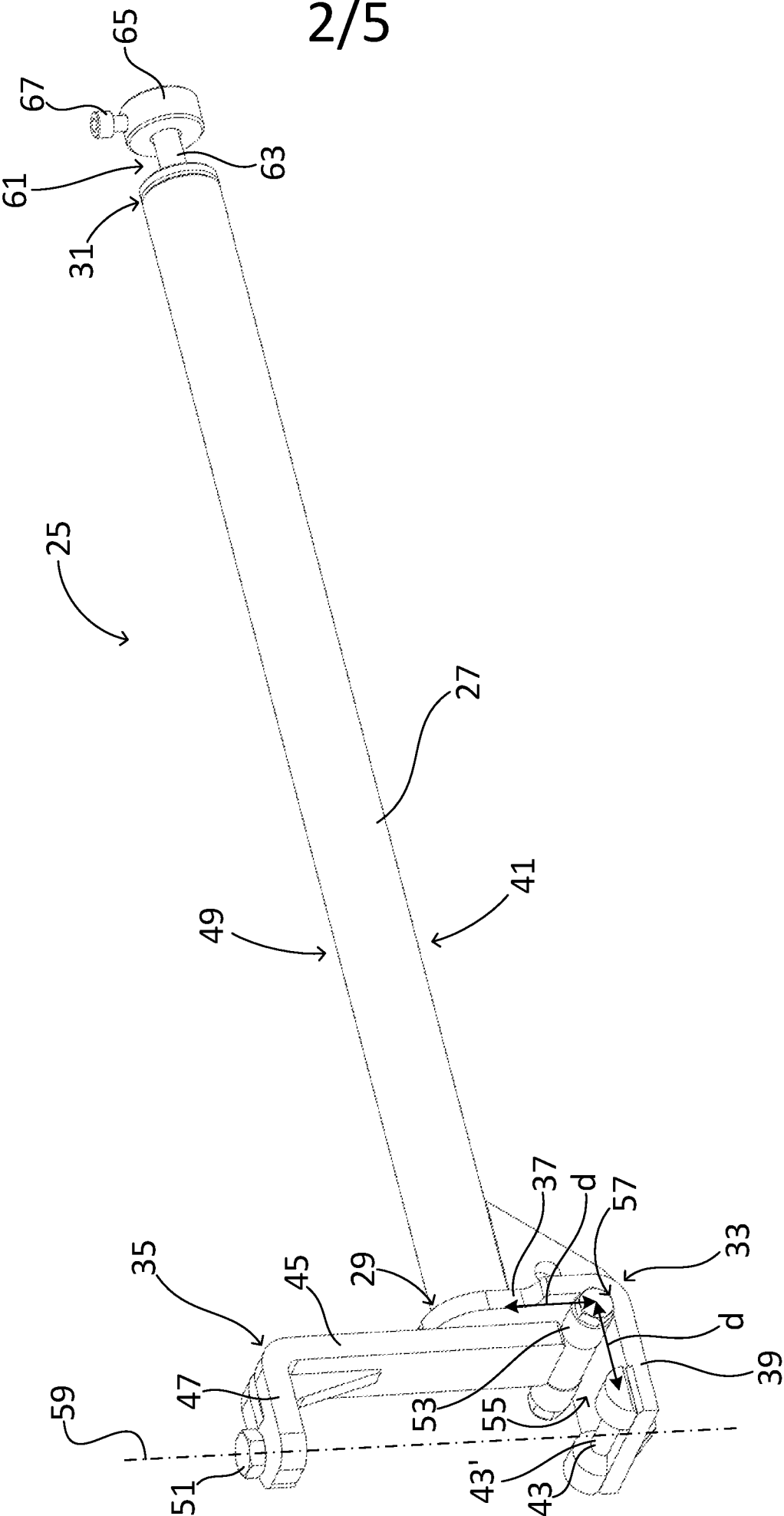
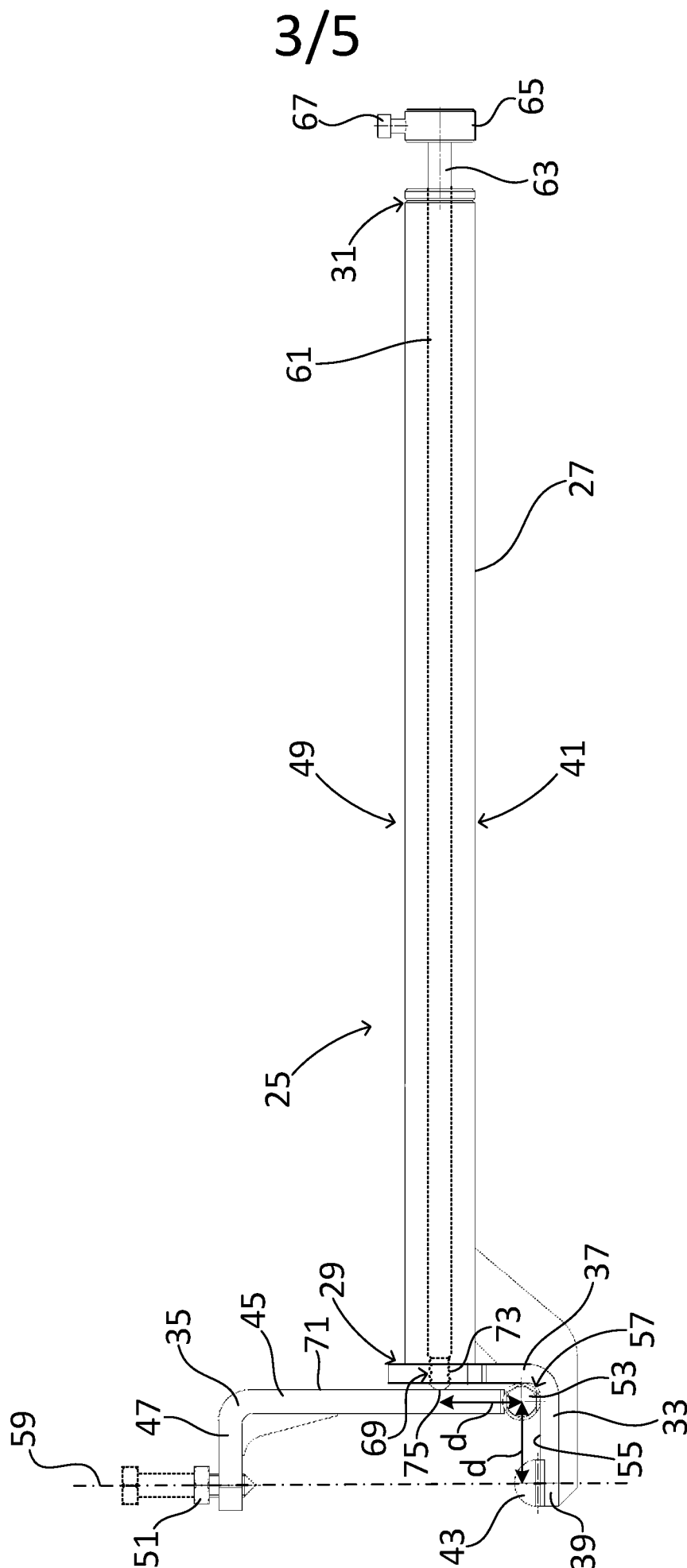
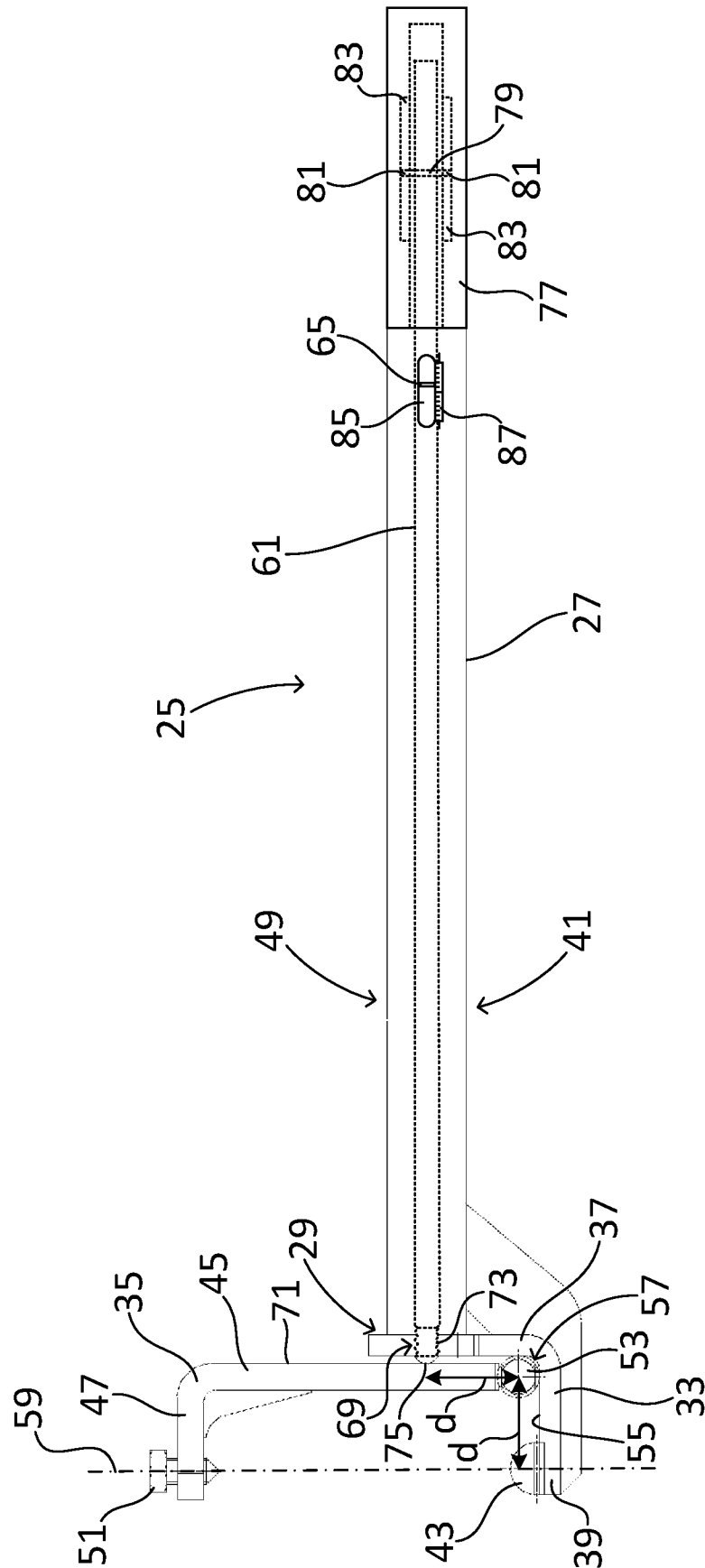


Fig. 2



Fi. 3

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Fib.

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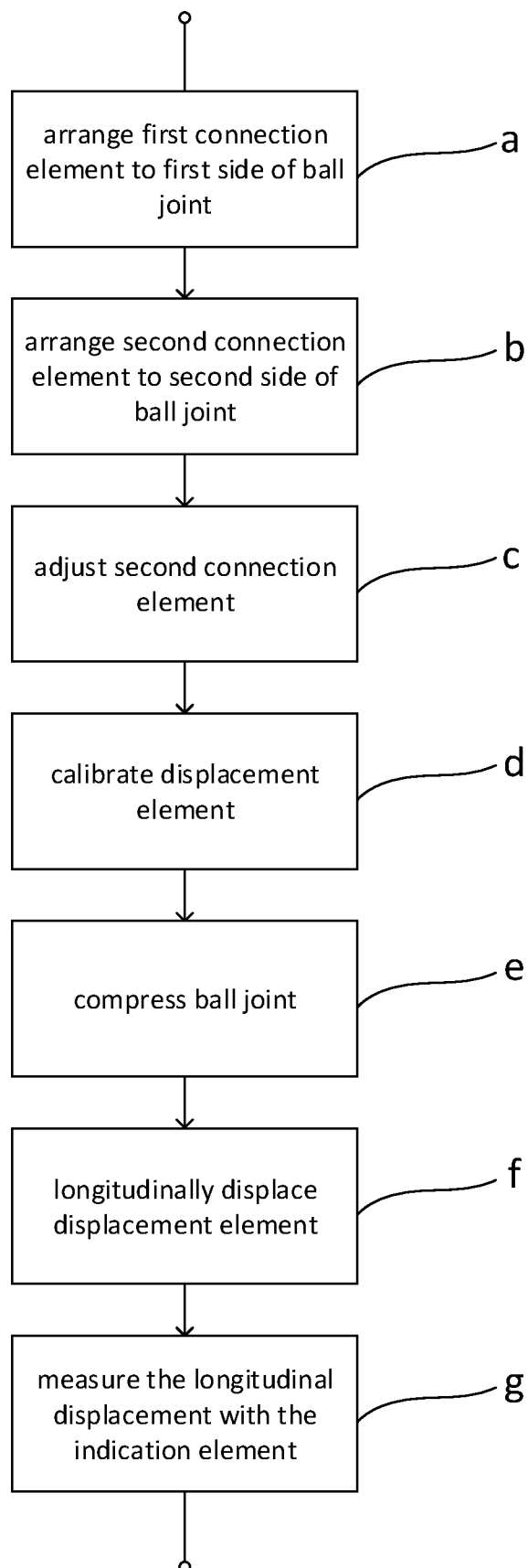


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2017/051130

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: G01B, G01M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, WPI data, COMPENDEX, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5101573 A (MILLS LOREN T ET AL), 7 April 1992 (1992-04-07); column 3, line 23 - column 4, line 14; figures --	1-12
A	US 20120306478 A1 (EMENAKER NICOLAS E ET AL), 6 December 2012 (2012-12-06); abstract; figure 1 --	1-12
A	US 3736665 A (LA MOREUX C), 5 June 1973 (1973-06-05); abstract; figure 1 --	1-12
A	DE 20219696 U (GREBENER HINRICH GEORG), 8 May 2003 (2003-05-08); abstract; figure 1 --	1-12

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 09-02-2018	Date of mailing of the international search report 09-02-2018
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2017/051130

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 10217612 A1 (BAYERISCHE MOTOREN WERKE AG), 6 November 2003 (2003-11-06); abstract; figures -- -----	1-12

Continuation of: second sheet

International Patent Classification (IPC)

G01B 5/14 (2006.01)

G01M 17/04 (2006.01)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/SE2017/051130

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