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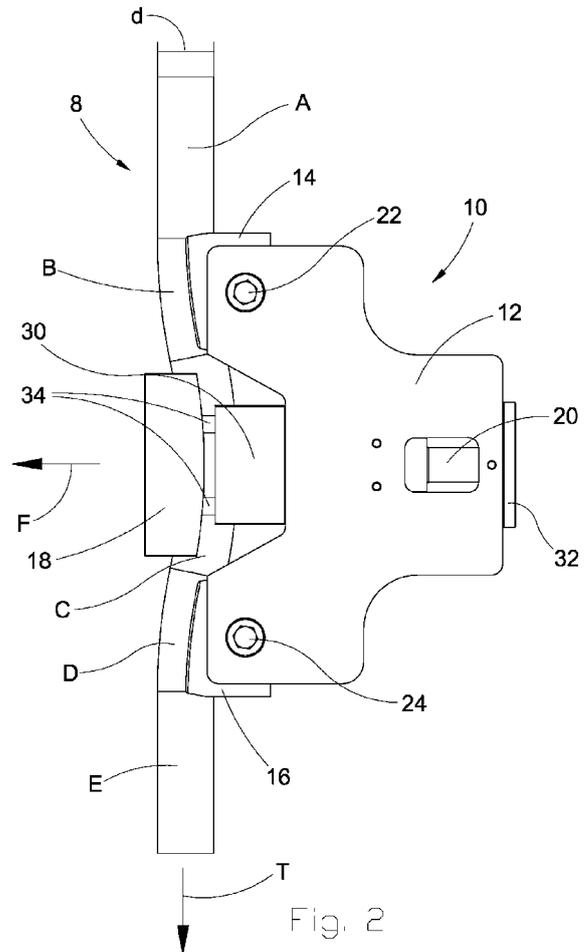
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(54) **Cable tension measuring device**

(57) A tensiometric device (10) for load limiting devices, couplable with a rope (8) having a diameter (d) in order to evaluate the tension (T) of the rope and comprising a block (12) on which a first contrast sector (14) and a second contrast sector (16) are connected respectively on the upper part and on the lower part of the block (12). A pin (20) is connected between the first contrast sector (14) and the second contrast sector (16) in the block (12) so as to translate and being coupled to elastic means and to sensor means for the measurement of the translation of the pin (20) on which a locking clamp (18) is fixed. Said rope (8) is deviated by the first contrast sector (14), the second contrast sector (16) and the locking clamp (18).



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Description

[0001] The present invention refers, in general, to a load limiting device applicable to a rope. More particularly, the present invention refers to a load limiting device comprising an electromechanical tensiometric system having elements of contact and fastening with the rope, said elements being adapted to reduce the tension of the elementary wires of the rope itself on maintaining the performance of the load limiting device unchanged.

[0002] As is known, the load limiting devices are, in general, installable on lifting apparatuses to prevent these apparatuses from lifting loads that exceed a predetermined weight threshold or exceed the nominal capacity load of a machine.

[0003] The market offers several types of load limiting devices, for instance pin load cells are utilized in which their pin replaces the pin of the fixed head or the pin of one of the return or compensation pulleys. Other types of load limiting devices utilize electronic systems which detect the variation of the supply current of the main motor of the winch or hoist dedicated to the lifting. Besides, tensiometric electromechanical devices are known to test the tension of one of the rope portions descending from the winch. Usually, these tensiometric devices are utilized on rope winches and hoists with at least a compensation pulley or a fixed head and more precisely, said tensiometric devices are installed on a stationary rope portion.

[0004] An electromechanical tensiometric device 100 according to the known art, as represented in Figure 1 in a cross-sectional view, is installed on a rope 102 and comprises two more external contrast pulleys 104, 106 and a central pin 108 with locking clamp 110, adapted also to keep the device in a fixed position on the rope portion.

[0005] The device imposes a deflection with a predetermined angle to the portion of rope 102 on which the device is installed by passing the rope 102 between the two more external contrast pulleys 104, 106 and the central pin 108 with locking clamp 110. The load applied to the rope 102 tends to make rectilinear again the rope portion included between the two contrast pulleys 104, 106 by drawing out the central pin 108 with clamp 110. The movement of the central pin 108 is contrasted by the action of a stack of cup springs (not represented in Figure 1) which are thus compressed or by the action of another elastic means having the same function. The compression deflection of the springs is thus proportional to the horizontal component of the force applied to the rope. A cursor with adjusting screw is fixed to the central pin 108 and acts on an electric precision microswitch (not represented in Figure 1). Once the springs have reached a determined deflection, the electric contact is lost in the microswitch which prevents the lifting operation since it is suitably connected with the control system of the machine.

[0006] The known electromechanical tensiometric de-

vices cause to the rope, which is usually made of steel, accentuated deviation angles in order to obtain a horizontal force which on the one side is small enough to use springs or other elastic means of small dimensions and on the other side is large enough to make negligible the force required to deflect the portion of rope again as the load diminishes.

[0007] Consequently, in the tensiometric devices, the rope is forced to assume bends with rather small radii of curvature on provoking unwished tensions in the rope itself.

[0008] More particularly, when a load is applied to the rope, the rope bends with a rather small radius of curvature over the two contrast pulleys 104, 106, as represented in Figure 1, and then, the rope comes out perfectly rectilinear in the portion denoted by the reference number 114. The rope elementary wires, opposed to the rope elementary wires in contact with the contrast pulleys and identified by ellipses denoted by the reference number 112 are therefore greatly stretched by the stress.

[0009] A similar behavior is found in the points of tangency of the rope coming out from the clamp 110 fixed to the central pin 108. In these points of tangency, the rope elementary wires identified by the ellipses denoted by the reference number 116 are stressed and stretched.

[0010] Said aspect discourages a utilization of this type of load limiting devices. In fact, although these load limiting devices are quite common, this type of devices often meet the distrust of the technicians who rarely choose to apply these devices on cranes working intensively.

[0011] An aim of the invention is to remove the above disadvantages and further ones by carrying out an electromechanical tensiometric device for load limiting devices in which although the device deflects the rope from its rectilinear portion, the device prevents the rope from bending with reduced angles of curvature.

[0012] A further aim of the invention is to carry out a tensiometric device which avoids the stretching of the elementary wires forming the rope.

[0013] Another aim of the invention is to carry out a tensiometric device that complies with safety standards for the ropes to be coupled with the tensiometric systems.

[0014] The aforesaid aims and further ones are reached according to the invention by a tensiometric device for load limiting devices, to be coupled with a rope having a diameter d to evaluate the tension and comprising a block on which a first contrast sector and a second contrast sector are connected on the upper part and on the lower part, respectively; a pin being connected between the first contrast sector and the second contrast sector in said block so as to translate and being coupled to elastic means and to sensor means for the measurement of the translation of the pin; a locking clamp being fixed on said pin. The rope is therefore deviated by the first contrast sector, the second contrast sector and the locking clamp so as to identify five consecutive sections of rope: a first rectilinear section having the function of fixed head, a second curvilinear section in contrast to the

first contrast sector, a third curvilinear section in contrast to the locking clamp, a fourth curvilinear section in contrast to the second contrast sector and a fifth rectilinear section.

[0015] In particular, the tensiometric device is characterized in that said first contrast sector comprises a surface in contact with the second section of the rope having a profile with a first diameter of curvature, that said second contrast sector comprises a surface in contact with the fourth section of rope having a profile with a second diameter of curvature, that said locking clamp comprises a surface in contact with the third section of the rope having a profile with a third diameter of curvature, and that the ratio between the first diameter of curvature of the first contrast sector and the diameter d of the rope is greater than 4, the ratio between the second diameter of curvature of the second contrast sector and the diameter of the rope is greater than 4, and the ratio between the third diameter of curvature of the locking clamp and the diameter d of the rope is greater than 4.

[0016] Thanks to this ratio between the diameters of curvature, the rope follows a profile with curvatures which do not have reduced radii of curvature which could cause unwished tensions in the rope and stretches in the elementary wires of the rope.

[0017] Advantageously, the tensiometric device according to the invention provides that the ratio between the first diameter of curvature of the first contrast sector and the diameter of the rope is greater than 11.2 and less than 18, that the ratio between the second diameter of curvature of the second contrast sector and the diameter of the rope is greater than 11.2 and less than 18, and that the ratio between the third diameter of curvature of the locking clamp and the diameter of the rope is greater than 11.2 and less than 18.

[0018] Indeed, there are no specific rules for the tensiometric systems to evaluate the allowable stress to be applied to a rope to which a tensiometric device is applied and therefore, it is necessary to refer to the technical rules concerning the ropes. In particular, the rule UNI-ISO 4308 Part I specifies, for each class of hoisting apparatuses, a minimal ratio between the diameter of the rope and the diameter of the main mechanical parts with which the rope is in contact. Accordingly, it is assumed that the rope portion interested by the presence of the tensiometric device is subjected to a mechanical stress comparable to that of the portions of rope going in and out of the compensation pulley of a winch.

[0019] In fact, in the tensiometric devices, the relevant portion of rope is not completely wended up on the contrast pulley, nor on the central pin, so that a rope is not completely wended up in the compensation pulley of a winch. At the same time, in both applications, the portion of rope in question is subjected to repeated and frequent flexions: in case of a pulley, the cause is the oscillation of the load while in case of a limiting device, the cause is the compression and decompression of the spring owing to the variations of the load applied to the hook.

[0020] An adoptable rule to be considered as reference provided that according to the class, the ratio between compensation pulley diameter and rope diameter must be included between 11.2 and 18.

5 [0021] Consequently, the tensiometric device for load limiting devices according to the invention complies with said adoptable rule of reference because the ratio between the first curvature diameter of the first contrast sector and the rope diameter, the ratio between the second curvature diameter of the second contrast sector and the rope diameter, and the ratio between the third curvature diameter of the locking clamp and the rope diameter are all included in the range of values provided for by said rule.

10 [0022] Advantageously, in the tensiometric device according to the invention, the curvature of the locking clamp may have an entering tangency angle which is substantially equal to the tangency angle of the curvature going out of the first contrast sector and the curvature of the locking clamp may have an outgoing tangency angle which is substantially equal to the tangency angle of the entering curvature of the second contrast sector. In this way, when going out of and entering the contrast sectors and going out of and entering the locking clamp, the rope

15 has no bends that are not accompanied by the same contrast sectors or by the locking clamp. [0023] Besides, the surface of contact of the first contrast sector with the rope, the surface of contact of the second contrast sector with the rope and the surface of contact of the locking clamp with the rope may have a concave shape to receive the rope without stressing the rope only in a single area when contacting the components of the tensiometric device.

20 [0024] Advantageously, the first contrast sector and the second contrast sector may be pivoted on the block so as to tilt and fit to whatever movement of the rope, in particular to the small movements.

25 [0025] In addition, the pin may comprise a head on which the locking clamp is fixed so that the third curvilinear section of the rope is received between the head and the locking clamp. This head may have a concave shape to receive the rope.

30 [0026] Further features and details of the invention could be better understood from the following specification, supplied as a non-limiting example, as well as from the accompanying drawings, wherein:

Fig. 1 is a schematic sectional side view of a tensiometric device for a load limiting device according to the known art, as previously described;

Fig. 2 is a side view of a tensiometric device according to the invention;

Fig. 3 is a rear view of the tensiometric device in Fig. 2;

35 Fig. 4 is a sectional side view of the tensiometric device in Fig. 2 according to the section plane Y in Fig. 3;

Fig. 5 is a sectional side view of the tensiometric

device in Fig. 2, according to the section plane W in Fig. 3.

[0027] With reference to the accompanying figures, number 10 denotes a tensiometric device for a load limiting device to be applied to a lifting equipment.

[0028] The tensiometric device 10 is coupled to a rope 8 to measure the tension of the rope and comprises a block 12 to which a first contrast sector 14, a locking clamp 18 and a second contrast sector 16 are coupled. In particular, the first contrast sector 14, the second contrast sector 16 and the locking clamp 18 force a portion of the rope 8 to a deviation on accompanying same. As visible in Figures 2 to 4, in the portion interested by the action of the tensiometric device 10, the rope may be ideally divided into five sections: a first section A, a second section B, a third section C, a fourth section D and a fifth section E.

[0029] The first section A is rectilinear and has a free end; this end may be fixed to a fixed element so that this end acts as a fixed head.

[0030] The third section C forms an arc of circle having diameter D_m as indicated in Figure 4 and is subjected to the action of the locking clamp 18 which forces the rope 8, in this section, to approach the block 12.

[0031] The second section B is subjected to the action of the first contrast sector 14 which guides the rope 8 according to a first curvature of diameter D_{s1} up to almost the mouth of the locking clamp 18.

[0032] Likewise, the fourth section D is subjected to the action of the second contrast sector 16 which guides the rope 8 according to a second curvature of diameter D_{s2} , equal to that of the first curvature, from the exit of the locking clamp 18 up to be arranged vertically on following the orientation of the fifth section E.

[0033] The rope 8 continues in a straight, as illustrated in the fifth section E, in order to be connected to other elements of the lifting equipment, such as a pulley of the hook block.

[0034] The first contrast sector 14 is fixed through a first screw 22 to the upper portion of the block 12 while the second contrast sector 16 is fixed through a second screw 24 to the lower portion of the block 12. Both screws 22, 24 act as pins since the first contrast sector 14 and the second contrast sector 16 are free to tilt.

[0035] As it appears from Figure 4, a cylindrical cavity 26 is obtained in the block 12 and a through hole 28 is obtained in the bottom of said cylindrical cavity.

[0036] A central pin 20 passes through the through hole 28 and is received in the cylindrical cavity 26 which is appropriately closed by a closing cap 32. The central pin 20 comprises a head 30 of a longer diameter than the through hole 28 so that the head abuts on the surface of the block 12, which surface is opposite to the cylindrical cavity 26.

[0037] One or more cup springs, not illustrated in the Figures, are received in the cylindrical cavity 26. These cup springs are opposed to a translation of the central

pin 20 in the direction indicated by the arrow F.

[0038] The locking clamp 18 is fixed by means of four screws 34 to the head 30 so that the third section C of the rope 8 is locked between the head 30 and the locking clamp 18.

[0039] When the tensiometric device is working, the rope 8 is stressed by a downward tension, indicated with the arrow T in the Figure 2 and 4. Owing to this tension T, the rope portion interested by the action of the tensiometric device 10 tends to dispose in a rectilinear way on displacing the locking clamp 18 according to the direction F. Consequently, both the first contrast sector 14 and the second contrast sector 16 settle by revolving slightly around the first screw 22 and the second screw 24, respectively and accommodate the new conformation of the rope 8.

[0040] According to the invention, the first contrast sector 14 has a concave shape to receive the cylindrical rope 8 and follows an arc-of-circle profile of diameter D_{s1} which guides the rope 8 in its second section B: in fact, the first contrast sector 14 receives the rope, which is perfectly vertical at the inlet, and accompanies the rope by guiding the rope in the curvature almost to the inlet of the locking clamp 18.

[0041] Likewise, the locking clamp 18 has a concave shape to receive the rope 8 and follows an arc-of-circle profile of diameter D_m which accompanies the rope 8 in its third section C; in particular, the curvature of the locking clamp 18 has an entering tangency angle which is substantially equal to the tangency angle going out of the first contrast sector 14, and has an outgoing tangency angle which is substantially equal to the entering tangency angle of the second contrast sector 16.

[0042] Like the first contrast sector 14, the second contrast sector 16 has a concave shape to receive the cylindrical rope 8 and follows an arc-of-circle profile of diameter D_{s2} which guides the rope 8 in its fourth section D: the second contrast sector 16 receives the entering rope with an inclination which is substantially equal to the inclination of the outgoing rope leaving the locking clamp 18 and accompanies the entering rope by guiding it in the curvature up to arrange same in a perfectly vertical direction as in the fifth section E.

[0043] The shape of first contrast sector 14, second contrast sector 16 and locking clamp 18 allows the rope 8 to be deflected in a guided way without sudden changes in curvature.

[0044] In addition, the diameter of curvature D_{s1} of the profile formed by the first curvature sector 14, the diameter of curvature D_{s2} of the profile formed by the second curvature sector 16 and the diameter of curvature D_m of the profile formed by the locking clamp 18 have a ratio to the diameter d of the rope 8 that is greater than 18. In this way, the UNI-ISO 4308 Rule, Part I, specifying, for each class of lifting equipment, a minimum ratio between the diameter of the main mechanical components with which the rope is in contact and the diameter of the rope itself when the rope portion interested by the presence

of the tensiometric device is subjected to a mechanical stress comparable to that to which the compensating pulley of a winch is subjected.

[0045] Accordingly, whether the rope 8 is in its rest position and is not subjected to particular tensions or whether the rope 8 is subjected to tensions, the tensiometric device 10 according to the invention allows that the rope 8 is always accompanied in its deviation without the formation of curvatures with small radii of curvature. In this way, it is possible to avoid both the formation of higher tensions than the admissible tensions and the consequent stretching of the elementary wires of the rope, in particular the wires opposite to those that are in contact with the contrast sectors and locking clamp.

[0046] It is evident how, instead of the two contrast pulleys in the systems of the known art, the device according to the invention comprises contrast sectors with a very large radius having a ratio that exceeds eighteen in the various configurations between the diameter of curvature of the contrast sector and the diameter of the rope. The shape of said contrast sectors allows to accompany the rope up to the end point of tangency where the prosecution of the rope develops in a perfectly rectilinear way.

[0047] Likewise, the locking clamp tends to maintain the stretch of tangency with the diverted rope as wide as possible in order to prevent the rope from swerving owing to the tension provoked by the load. In particular, the locking clamp is shaped in such a way as to accompany the rope up to the mouth of the contrast sector where the following reversing of the direction of deflection takes place. Also concerning the locking clamp, the ratio between the diameter of curvature and the diameter of the rope is greater than eighteen so that the above mentioned rule is complied with.

[0048] A technician of the sector can make changes or variants which are to be considered as included in the scope of protection of the present invention.

Claims

1. Tensiometric device (10) for load limiting devices apt to evaluate the tension (T) of a rope (8) coupled with said tensiometric device (10) and having a diameter (d), said tensiometric device (10) comprising a block (12) on which a first contrast sector (14) and a second contrast sector (16) are connected respectively on the upper part and on the lower part of the block (12); a pin (20) being connected between the first contrast sector (14) and the second contrast sector (16) in said block (12) so as to translate and being coupled to elastic means and to sensor means for the measurement of the translation of the pin (20); a locking clamp (18) being fixed on said pin (20); said rope (8) being deviated by the first contrast sector (14), the second contrast sector (16) and the locking clamp (18) so as to identify five consecutive sections of rope: a first rectilinear section (A) having the function of fixed end, a second curvilinear section (B) in contrast to the first contrast sector (14), a third curvilinear section (C) in contrast to the locking clamp (18), a fourth curvilinear section (D) in contrast to the second contrast sector (16) and a fifth rectilinear section (E); said tensiometric device being **characterized in that** said first contrast sector (14) comprises a surface in contact with the second section (B) of the rope (8) having a profile with a first diameter of curvature (Ds1), that said second contrast sector (16) comprises a surface in contact with the fourth section (D) of rope (8) having a profile with a second diameter of curvature (Ds2), that said locking clamp (18) comprises a surface in contact with the third section (C) of the rope (8) having a profile with a third diameter of curvature (Dm), and that the ratio between the first diameter of curvature (Ds1) of the first contrast sector (14) and the diameter (d) of the rope (8) is greater than 4, the ratio between the second diameter of curvature (Ds2) of the second contrast sector (16) and the diameter (d) of the rope (8) is greater than 4, and the ratio between the third diameter of curvature (Dm) of the locking clamp (18) and the diameter (d) of the rope (8) is greater than 4.
2. Tensiometric device (10) according to claim 1, wherein the ratio between the first diameter of curvature (Ds1) of the first contrast sector (14) and the diameter (d) of the rope (8) is included between 11.2 and 18, wherein the ratio between the second diameter of curvature (Ds2) of the second contrast sector (16) and the diameter (d) of the rope (8) is included between 11.2 and 18, and wherein the ratio between the third diameter of curvature (Dm) of the locking clamp (18) and the diameter (d) of the rope (8) is included between 11.2 and 18.
3. Tensiometric device (10) according to any of the preceding claims, wherein the curvature of the locking clamp (18) has an entering tangency angle which is substantially equal to the tangency angle of the curvature going out of the first contrast sector (14) and the curvature of the locking clamp (18) has an outgoing tangency angle which is substantially equal to the tangency angle of the entering curvature of the second contrast sector (16).
4. Tensiometric device (10) according to any of the preceding claims, wherein the surface of contact with the rope (8) of the first contrast sector (14) and/or the surface of contact with the rope (8) of the second contrast sector (16) and/or the surface of contact with the rope (8) of the locking clamp (18) have a concave shape to receive the rope (8).
5. Tensiometric device (10) according to any of the preceding claims, wherein the first contrast sector (14)

and the second contrast sector (16) are pivoted on the block (12).

6. Tensiometric device (10) according to any of the preceding claims, wherein the pin (20) comprises a head (30) on which the locking clamp (18) is fixed so that the third curvilinear section (C) of the rope (8) is received between the head (30) and the locking clamp (18).
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7. Tensiometric device (10) according to the preceding claim, wherein the head (30) has a concave shape to receive the rope (8).
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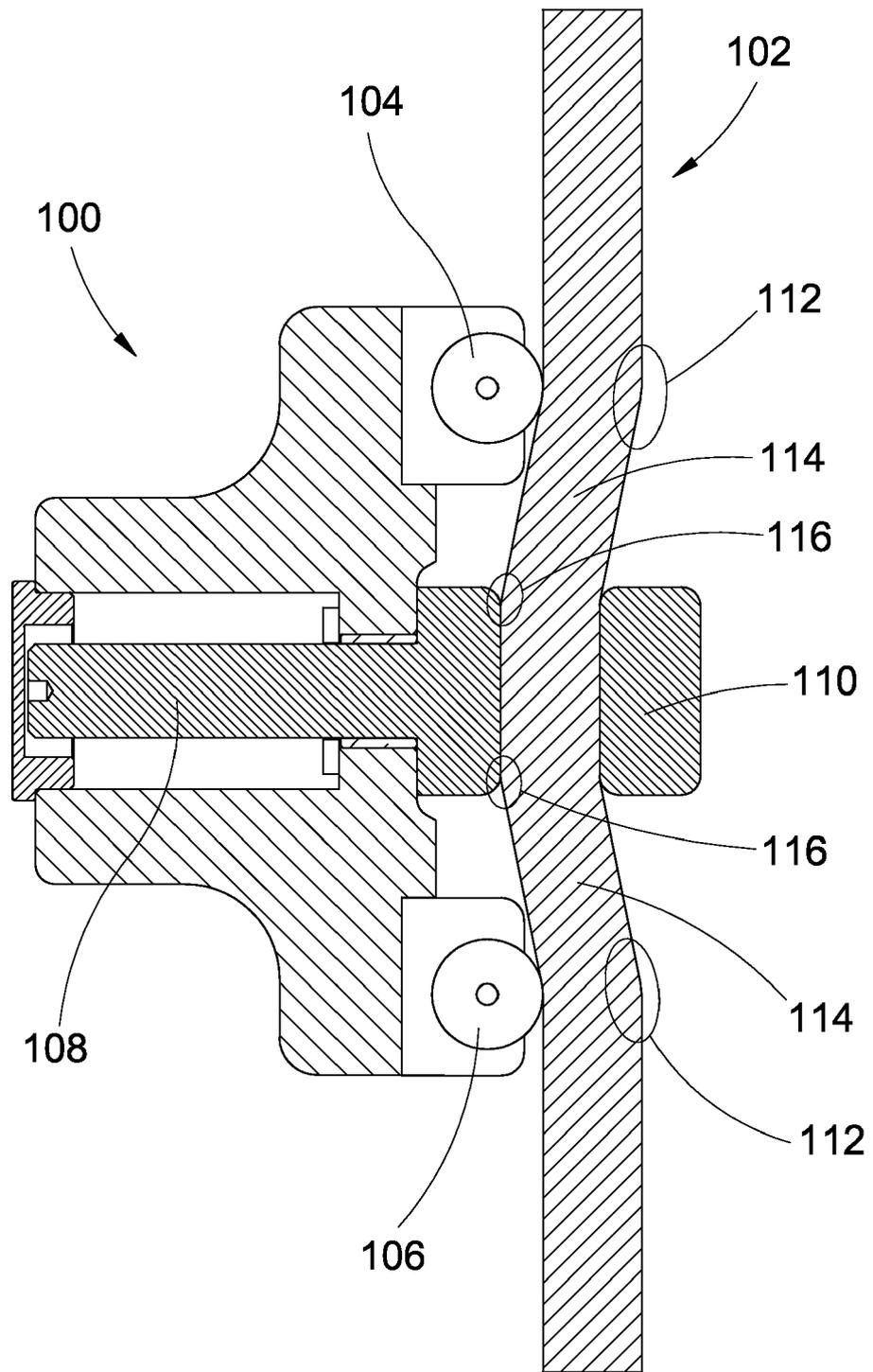
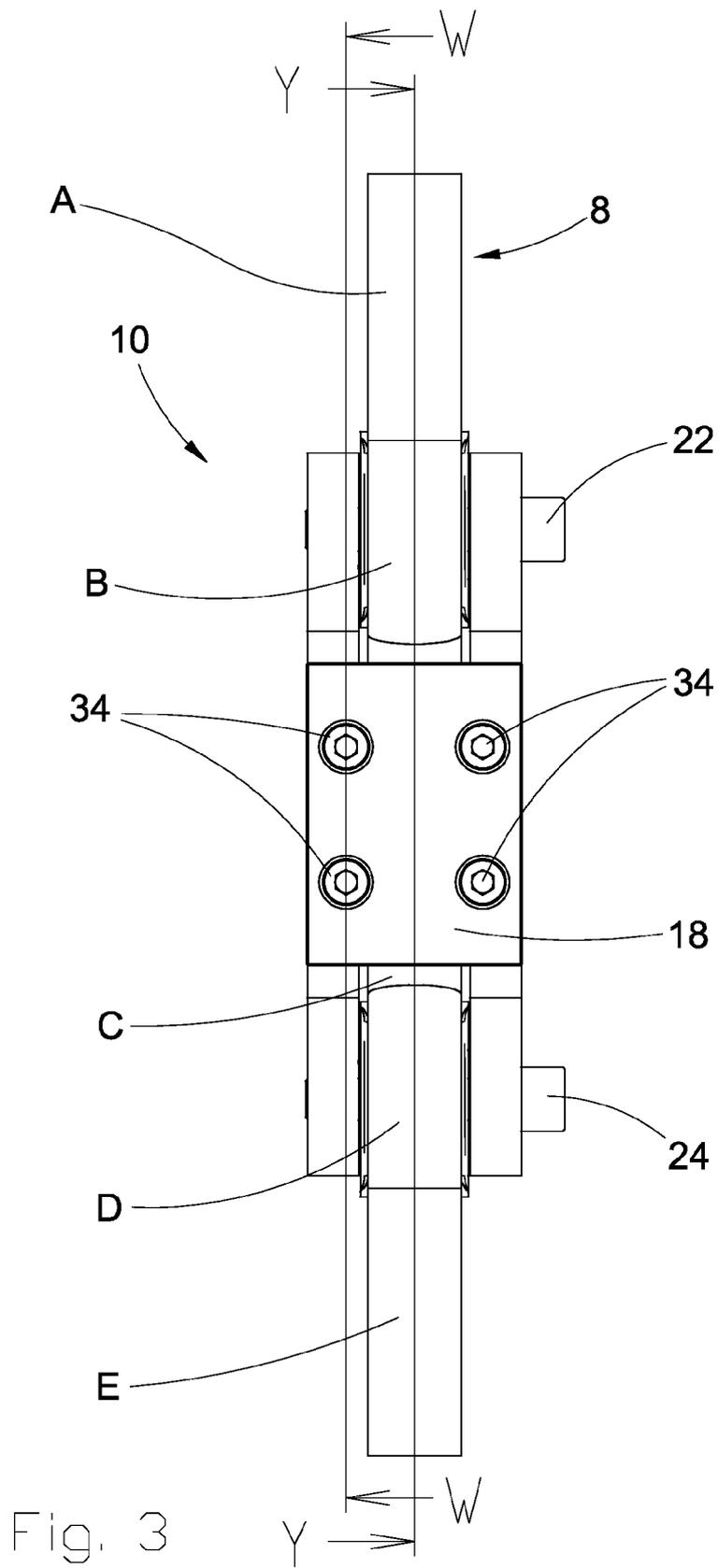
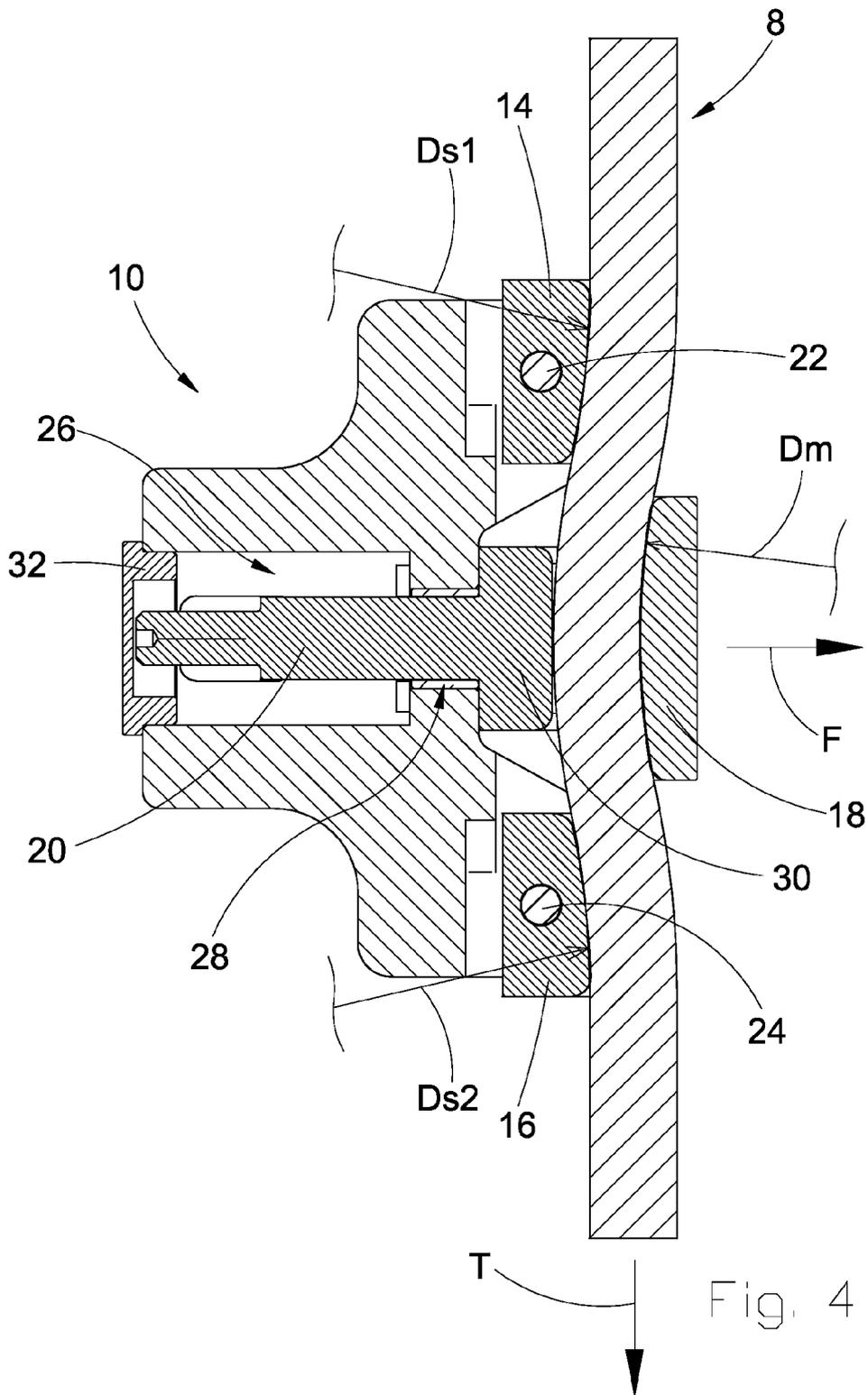


Fig. 1





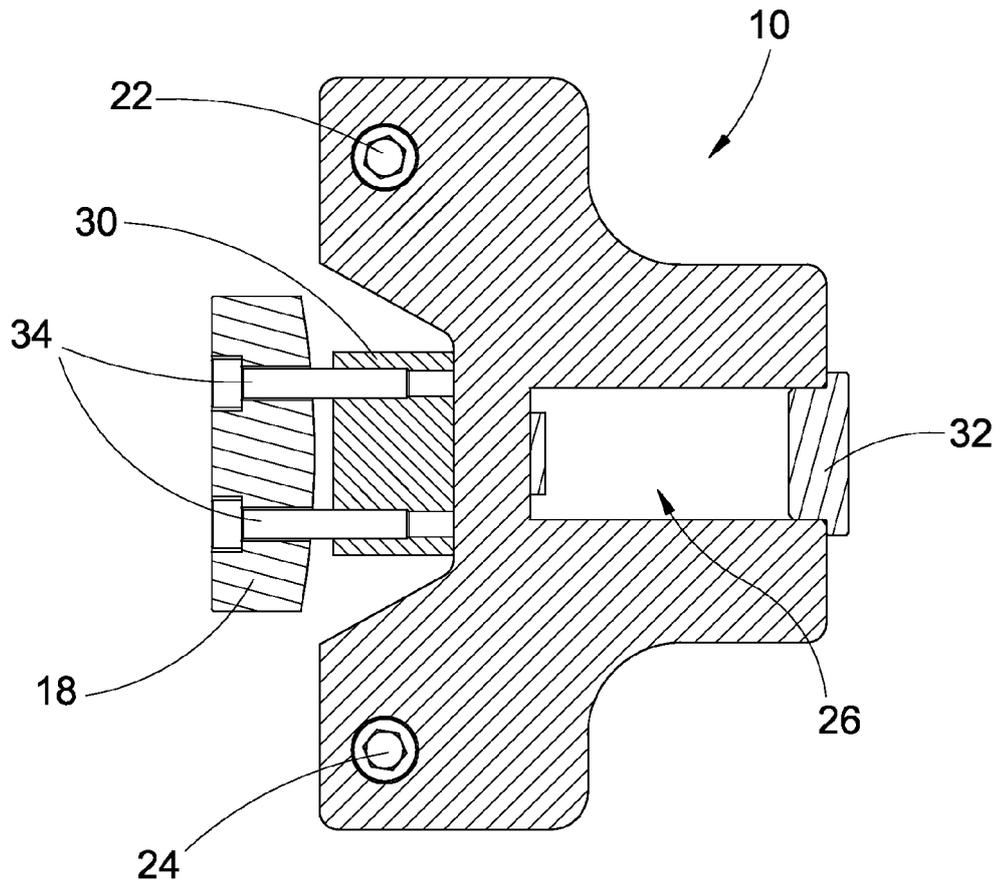


Fig. 5



EUROPEAN SEARCH REPORT

Application Number
EP 12 17 5124

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	DE 14 81 762 A1 (KOBAYASHI TOSHITA) 26 June 1969 (1969-06-26) * the whole document * -----	1-7	INV. B66D1/50
A	DE 37 02 073 A1 (PAUL POTT FA [DE]) 4 August 1988 (1988-08-04) * the whole document * -----	1-7	
			TECHNICAL FIELDS SEARCHED (IPC)
			B66D G01L
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		24 July 2012	Faymann, L
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 12 17 5124

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24-07-2012

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