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GB-A- 2 527 782
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US-A- 5 364 075

DESCRIPTION

FIELD OF INVENTION

[0001] The technical field of the present invention is directed to mooring apparatuses or systems for connecting a mooring line.

[0002] The present invention relates in particular to a method of configuring a mooring apparatus. The mooring line may be a mooring line for a vessel, an offshore structure, floating structure, an anchor, buoy or the like.

BACKGROUND TO INVENTION

[0003] Offshore structures, such as floating structures or platforms, may be moored by mooring lines, such as mooring chains. A tension may be applied to each of the mooring lines, for example, by the use of a tensioning apparatus. The application of tension may serve to moor the floating structure or platform in a desired position.

[0004] A mooring apparatus may require assembly before a tension is applied to the mooring line. Assembly may include direct or indirect connection of at least one mooring line to the structure to be moored and direct or indirect coupling of each mooring line to another structure, such as an anchor or pile located on the seabed.

[0005] The mooring lines, and in particular the ends of the mooring lines, may comprise chains. A connection between a vessel, anchor, or the like, to a chain which may, in use, be under tension, may be prone to stress and wear.

[0006] In an offshore environment, because of a relative movement between a vessel, a mooring line and an anchoring point, there may be a degree of movement at a connection between the mooring line and the vessel and/or anchoring point. Such movement may further stress and wear the mooring line and connection components. The relative movement may cause Out of Plane Bending (OPB) fatigue, which may exacerbate the wear of the mooring components.

[0007] The use of structures, such as lever arms and fairleads, to minimise the effects of OPB, is known. However, such structures may be large, heavy, expensive and difficult to install, operate and/or maintain.

[0008] Further, the installation and maintenance of such structures in an offshore or underwater environment may require high levels of skill, the use of divers, operators, and/or underwater Remotely Operated underwater Vehicles (ROVs), and may incur significant

expense and risk. An example of method of configuring a mooring apparatus is known from GB 2 512 312 A.

[0009] It is an object of the present invention to obviate or at least mitigate one or more problems in the prior art.

[0010] it is an object of the present invention to provide a technically simple and/or commercially more cost effective method of configuring a mooring apparatus than in the prior art.

SUMMARY OF INVENTION

[0011] According to the present invention, there is provided a method of configuring a mooring apparatus according to claim 1. There is provided a mooring apparatus comprising:

a socket comprising a pair of seats,

a connection member comprising a pair of trunnions arranged such that the connection member is rotatable about an axis defined by the pair of trunnions when the connection member is received in the socket, and

a positioning arrangement comprising a guide and configurable to seat the pair of trunnions on the pair of seats by a line connected to the connection member and extending around the guide,

the method further comprising:

connecting a first portion of a line to a line engaging apparatus disposed at a proximal portion of the connection member and extending the line around the guide; and

seating the pair of trunnions on the pair of seats while a distal portion of the connection member is connected to a mooring-line by applying a pulling force followed by a reduction in the pulling force to the line in a direction away from the guide.

[0012] The Applicant calls this apparatus a "Pull-In Uni-Joint".

[0013] The socket may comprise at least one seat, and optionally at least a portion of the at least one seat may be substantially U-shaped, hook-shaped or J-shaped.

[0014] The positioning arrangement may comprise a guide such as a sheave or a chain wheel, and optionally which a/the line extends around. The positioning arrangement may comprise a line engaging apparatus disposed on, connected to, and/or associated with, the connection member.

[0015] In use, the line may extend from the connection member and/or the line engaging apparatus around the guide.

[0016] The seat, or a base of the seat, or receiving portion or weight-bearing portion of the seat, may at least partially or substantially face toward, or may be oriented in the direction of, the guide.

[0017] The connection member may be for connecting, such as disconnectably connecting, to a mooring line. The connection member may be provided with an arrangement for connecting, such as disconnectably connecting, the apparatus to a mooring line.

[0018] Preferably the connection member may be removably retainable in the socket.

[0019] Preferably the connection member may be removably receivable in the socket.

[0020] Preferably the connection member may comprise a line engaging apparatus. In use, a first portion of a line may be connected to the line engaging apparatus.

[0021] The positioning arrangement may comprise the line. The guide may be a pulley, or a component of a pulley mechanism. In use, the line may extend from the connection member around the guide.

[0022] The pair of seats may be substantially hook-shaped.

[0023] A distal end of the connection member may be adapted for connecting the apparatus to a mooring line, or the like. In use, which may include positioning of the connection member, the mooring line may be under tension.

[0024] The line engaging apparatus may be positioned at a proximal end of the connection member.

[0025] The line may be a wire, a rope, a chain, or the like. In use, the line may extend around and/or about and/or through the positioning arrangement.

[0026] The socket may comprise at least one guide portion.

[0027] In use, a pulling force on a second portion of the line, the pulling force being in a direction away from the guide, may pull the first portion of the line towards the guide.

[0028] The pulling force may pull the connection member towards and/or into the socket and/or onto a guide portion. In use, a reduction in the pulling force on a second portion of the line, the pulling force being in a direction away from the guide, may move the connection member into the seat. The connection member may move towards the seat under the force of

gravity and/or under a force induced by a tension, such as a mooring tension in the mooring line. The connection member may move towards the seat along the guide portion.

[0029] The further pulling force may be applied by a support line, a lifting wire, a lifting line, a bridle, or the like.

[0030] The connection member may comprise a lever arm.

[0031] The at least one cylindrical projection may be adapted to fit and/or sit in the at least one seat. The at least one cylindrical projection may be retained by the at least one seat.

[0032] The apparatus may comprise a retaining pin. The retaining pin may be adapted to restrict movement of the connection member when the connection member is positioned on the at least one seat.

[0033] Each connection member may comprise at least one retaining member.

[0034] The connection member and/or the retaining member may comprise at least one shoulder or wing. The connection member or the retaining member may comprise a pair of shoulders or wings. The at least one shoulder or wing may be adapted to move around and/or rotate around or about an outer surface of the seat. The connection member may be adapted to be located in a retained position within and/or by the or each socket. In the retained position, the seat may be located between the at least one cylindrical projection and the at least one shoulder or wing.

[0035] The apparatus may be adapted for connection to, or mounting on or in, a structure. The structure may be a floating structure, a vessel or the like. The structure may be an anchor, a pile, such as a suction pile, gravity anchor, or the like.

[0036] In use, such as during installation and/or stowage and/or removal, replacement or maintenance of the apparatus, the at least a portion of the connection member may be at least partially submerged.

[0037] In use, such as during installation and/or stowage and/or removal, replacement or maintenance of the apparatus, the apparatus, or at least a portion of the apparatus, may be completely above a water line, completely below the water line, or at least partially submerged.

[0038] Advantageously, the apparatus described above does not require implementation of a load bearing pin. Instead, in the present invention, a load is carried by the at least one seat. Having a connection that does not require a load bearing pin is advantageous for high load mooring lines as the Minimum Breaking Load (MBL) directly relates to the load pin size. Very large and heavy load pins add more risk and potentially more cost to the installation.

[0039] Advantageously, minimal connection member retaining features are required, since the

connection member is subject only to a small degree of over rotation during installation, resulting in a lighter, smaller and cheaper apparatus.

[0040] Advantageously, the apparatus described above enables a fully assembled mooring line to be pulled into a socket while the mooring line is under tension. As such, the apparatus may be used with or without a mooring line tensioner in the system.

[0041] Advantageously, the method described herein may permit the mooring line to be pre-cut to size and installed without a tensioning device on such, since the mooring line can be pulled in at a tension above the nominal/design tension of the mooring line to a "pulled in" position and then lowered down to the seat to achieve a design tension.

BRIEF DESCRIPTION OF DRAWINGS

[0042] These and other aspects will now be described, by way of example only, with reference to the accompanying drawings, which are:

Figure 1

a perspective view of a plurality of mooring apparatuses according to a first embodiment;

Figure 2

a perspective view of a mooring system according to the first embodiment;

Figure 3a

a perspective view of a portion of the mooring system according to the first embodiment;

Figure 3b

a schematic representation of a cross-sectional view of the mooring system of Figure 3a;

Figure 4

a side view of the mooring system of Figure 3a;

Figure 5a

a further side view of the mooring system of Figure 3a, with the connection member in the retained position;

Figure 5b

a further perspective view of a portion of the mooring system of Figure 5a;

Figure 6

a side view of the mooring system of Figure 3a, with the connection member in a lowered position;

Figure 7

a side view of the mooring system of Figure 6, with the connection member in a retained position;

Figure 8

a perspective view of the mooring system according to the first embodiment;

Figure 9

a further perspective view of the mooring system according to the first embodiment;

Figure 10

a perspective view of a mooring system according to another embodiment;

Figure 11

a side view of a further embodiment of a mooring apparatus.

[0043] The scope of protection is defined by the appended claims.

DETAILED DESCRIPTION OF DRAWINGS

[0044] Referring firstly to Figure 1, there is shown a perspective view of a plurality of mooring apparatuses, generally denoted 5, according to a first embodiment of the present invention. In the exemplary embodiment there is shown four mooring apparatuses 10a; 10b; 10c; 10d. One will appreciate that such an arrangement is for illustrative purposes and that there may, in use, be fewer mooring apparatuses, such as one, two or three mooring apparatuses, or a greater number of mooring apparatuses, such as five or more, without deviating from the inventive concept disclosed herein.

[0045] Each mooring apparatus 10a; 10b; 10c; 10d comprises a socket 15a; 15b; 15c; 15d, a connection member 20a; 20b; 20c; 20d, and an arrangement 25a; 25b; 25c; 25d for positioning the connection member 20a; 20b; 20c; 20d relative to the socket 15a; 15b; 15c; 15d, the connection member 20a; 20b; 20c; 20d being retainable in the socket 15a; 15b; 15c; 15d. The connection member 20a; 20b; 20c; 20d is removably retainable in the socket 15a; 15b; 15c; 15d. The connection member 20a; 20b; 20c; 20d is removably receivable in the socket 15a; 15b; 15c; 15d.

[0046] The connection member 20a; 20b; 20c; 20d comprises a line engaging apparatus 30a; 30b; 30c; 30d. Each connection member 20a; 20b; 20c; 20d comprises a lever arm.

[0047] Figure 2 shows a further perspective view of a portion, generally denoted 50, according to the first embodiment of the present invention comprising the plurality of mooring apparatuses. Figure 2 shows four complete apparatuses 10a; 10b; 10c; 10d, wherein one of the apparatuses 10a is arranged as part of the system 50. One will appreciate that such a specific arrangement is for illustrative purposes only and that there may, in use, be fewer mooring apparatuses, such as one, two or three mooring apparatuses, or a greater quantity of mooring apparatuses, such as five or more, and that any or all of the mooring apparatuses may be arranged as part of one or more mooring systems 50, without deviating from the inventive concept disclosed herein.

[0048] A first portion of a line 35 is connected to the line engaging apparatus 30a. The positioning arrangement 25a comprises a guide 25a. The guide 25a is a sheave. In other embodiments encompassing the inventive concept of the present invention, the guide 25a can be a wheel, such as a chain wheel or the like, or the guide 25a can be a pulley, or a

component of a pulley mechanism.

[0049] Each socket 15a comprises a pair of seats 40a, 40b. Each seat 40a, 40b is substantially hook-shaped. One will appreciate that in variations of a design that encompass the inventive concept of the present invention, each seat 40a, 40b can be substantially J-shaped, or "reverse-J" shaped, or cup-shaped. Each seat 40a, 40b is a boss or protuberance.

[0050] A distal end 55a of the connection member 20a is adapted for connecting the apparatus 10a to a mooring line 60, or the like. In use, the mooring line 60 can be under tension, such as a mooring tension. Typically, at least a portion of the mooring line 60 comprises a chain.

[0051] A distal end 55a of the connection member 20a is adapted for connecting the apparatus 10a to a support line 80, or the like. In use, the support line 80 can position the connection member 20a, as will be described below. At least a portion of the support line 60 can comprise a chain.

[0052] The line engaging apparatus 30a is positioned at a proximal end 56a of the connection member 20a. The line 35, 35' can be a wire, a rope, a chain, or the like. In use, the line 35, 35' extends around and/or about and/or through the positioning arrangement 25a.

[0053] The socket 15a comprises a guide portion 65. The guide portion 65 extends to a limiting portion 70. The limiting portion 70 limits a degree of movement of the connection member 20a within the socket 15a. The limiting portion 70 stops the connection member 20a interfering with the guide 25a during removal and/or installation of the connection member 20a within the socket 15a. The guide portion 65 is a boss or protuberance.

[0054] The connection member 20a comprises a pair of trunnions 90a, 90b. The pair of trunnions 90a, 90b are adapted to fit and/or sit in the pair of seats 40a, 40b. The pair of trunnions 90a, 90b are adapted to be retained by the pair of seats 40a, 40b.

[0055] Referring now to Figure 3a, there is shown a perspective view of a portion of a mooring system 50, according to the first embodiment of the present invention. Figure 3a shows the arrangement of Figure 2, with the connection member 20a pulled in towards the socket 15a. In use, a pulling force is applied to a second portion 35' of the line 35, 35', the pulling force being in a direction away from the guide 25a. The pulling force pulls the first portion of the line 35 towards the guide 25a.

[0056] In use, the pulling force pulls the connection member 20a towards and into the socket 15a and onto the guide portion 65. Figure 3b shows a representation of a cross-sectional view of the mooring system 50 of Figure 3a, wherein the connection member 20a is shown positioned in the socket 15a.

[0057] Referring now to Figure 4, there is shown a side view of the mooring system of Figure

3a. Figure 4, when compared with Figure 3a, shows that, in use, a reduction in the pulling force on the second portion 35' of the line 35, 35', the pulling force being in a direction away from the guide 25a, the connection member 20a moves towards the seat 40a. In the embodiment as shown in Figure 4, the tension of the mooring line 60 is substantially taken by a support line 80. As such, the proximal end 56a of the connection member 20a can be lowered from the position shown in Figure 3a, to the position shown in Figure 4, and subsequently to the position shown in Figures 5a and 5b.

[0058] Referring now to Figure 5a, there is shown a further side view of the mooring system 50 of Figure 3a, with the connection member 20a in a retained position. Due to the reduction in the pulling force on the second portion 35' of the line 35, 35', the pulling force being in a direction away from the guide 25a, the connection member 20a has moved into the pair of seats 40a, 40b. The connection member 20a can move towards the pair of seats 40a, 40b at least partly under the force of gravity and/or under a force induced by a tension, such as a mooring tension in the mooring line. The connection member 20a moves towards the pair of seats 40a, 40b, from the position shown in Figure 3a to the position shown in Figure 5a, along the guide portion 65.

[0059] The apparatus 10a; 10b; 10c; 10d can optionally comprise a retaining pin 95. The retaining pin 95 is adapted to restrict movement of the connection member 20a when the connection member 20a is positioned on the pair of seats 40a, 40b.

[0060] Referring now to Figure 6, there is shown a side view of the mooring system 50 of Figure 3a, with the connection member 20a in a lowered position. Figure 6 shows an alternative method of installation to that of Figures 4 and 5a. In the embodiment of Figure 6, the support line 80 has been lowered. The connection member 20a is substantially oriented in line with a straight portion of the guide portion 65. Figure 7 shows a subsequent position of the connection member 20a relative to the socket 15a following a reduction in the pulling force on the second portion 35' of the line 35, 35'. In Figure 7, the connection member 20a is in a retained position.

[0061] In order to remove a connection member 20a from a socket 15a, the installation process is essentially reversed. That is, a pulling force is applied to the second portion 35' of line 35, 35'. The pulling force pulls the connection member 20a towards and/or out of the socket 15a and/or along the guide portion 65 and/or away from the guide portion 65. Next, a reduction in the pulling force on a second portion 35' of the line, the pulling force being in a direction away from the guide 25a, coupled with a further pulling force applied to the connection member 20a, moves the connection member 20a out of the socket 15a and/or in a direction away from the socket 15a. The further pulling force is applied to the support line 80. The support line 80 comprises a bridle 85 to maintain the orientation of the connection member 20a during installation and/or removal.

[0062] Figure 8 shows a perspective view of a mooring system 50, according to the first embodiment of the present invention. In Figure 8, the connection member 20a has been

lowered to a mooring angle. That is, the connection member 20a is aligned with the mooring line 60, such that a mooring tension is taken by the socket 15a, and in particular by the pair of seats 40a, 40b.

[0063] Figure 9 shows a final stage in the installation process, wherein the support line 80 is removed.

[0064] Figure 10 shows a perspective view of a mooring system, according to another embodiment of the present invention. Each connection member 120a; 120b; 120c; 120d comprises a retaining member 130a; 130b; 130c; 130d.

[0065] Each retaining member 130a; 130b; 130c; 130d comprises a pair of shoulders or wings 140a; 140b; 140c; 140d. The pair of shoulders or wings 140a; 140b; 140c; 140d is adapted to move around and/or rotate around or about an outer surface of each pair of seats 150a; 150b; 150c; 150d. Each connection member 120a; 120b; 120c; 120d is adapted to be located in a retained position by each pair of shoulders or wings 140a; 140b; 140c; 140d. In the retained position, each pair of seats 150a; 150b; 150c; 150d is located between each pair of trunnions 90a, 90b and each pair of shoulders or wings 140a; 140b; 140c; 140d.

[0066] Referring now to Figure 11, there is shown a further embodiment of a mooring apparatus, generally denoted 300. The mooring apparatus 300 comprises the same socket 15a as the socket of the embodiment shown in Figure 1. In the exemplary embodiment shown in Figure 11, there is a single mooring apparatus 300. One would appreciate that, in use, there may be more mooring apparatuses, such as two, three, four or even more mooring apparatuses, as shown, for example, in Figure 1a.

[0067] The mooring apparatus 300 comprises a connection member 320a. The connection member 320a is receivable within socket 15a.

[0068] The connection member 320a comprises a tensioner apparatus 330. The tensioner apparatus 330 comprises a frame 335 and a guide portion 340 for guiding a portion of a chain 345. The guide portion 340 is a chain wheel. The tensioner apparatus 330 comprises a locking means 350. The locking means 350 is a chain stopper. The guide portion 340 is moveably connected to the frame 335. The locking means 350 is pivotably connected to the frame 335.

[0069] in an engaged position, as shown in Figure 11, the locking means 350 restrains the guide portion 340 and/or the chain 345. The locking means 350 can be adapted to be locked in a disengaged position wherein the locking means 350 does not restrain the guide portion 340 and/or the chain 345. The tensioner apparatus 300 comprises a hole 355. A locking pin 360 can be inserted in the hole 355, such that the locking pin 360 engages with the locking means 350, thus retaining the locking means 350 in the disengaged position.

[0070] It will be appreciated that the embodiments of the present invention herebefore described are given by way of example only and are not meant to limit the scope of thereof. It

will be appreciated that embodiments of the present invention provide benefits over the prior art.

[0071] In the embodiments shown in Figures 1 to 10, the apparatus comprises a universal joint. That is, the apparatus shown is a "Dual Axis" device. Specifically, the connection member 20a is rotatable on the pair of trunnions 90a, 90b, about a first axis defined by the trunnions 90a, 90b. The connection member 20a is also rotatable about a second axis, the second axis being substantially perpendicular to the first axis, the second axis being centred on joint 160a. It will be appreciated that in other embodiments the connection member may be a "Single Axis" device, and may not comprise joint 160a. Such an arrangement would, for example, be adapted for use on a structure, wherein the structure has a rotatable portion, such as a turret mooring.

[0072] Advantageously, the method described herein may permit the mooring line to be pre-cut to size and installed without a tensioning device on such, since the mooring line can be pulled in at a tension above the nominal/design tension of the mooring line to a "pulled in" position and then lowered down to the seat to achieve a design tension.

REFERENCES CITED IN THE DESCRIPTION

Cited references

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Patent documents cited in the description

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FORTØJNINGSANORDNING

PATENTKRAV

1. Fremgangsmåde til konfigurering af en fortøjningsanordning (10a, 10b, 10c, 10d), hvor fremgangsmåden omfatter:
 - 5 tilvejebringelse af en fortøjningsanordning omfattende:
 - en sokkel, der omfatter et par af sæder,
 - et forbindelseselement, der omfatter et par af tapper, der anbragt således, at forbindelseselementet kan rotere omkring en akse defineret af parret af tapper, når forbindelseselementet er modtaget i soklen, og
 - en positioneringsanordning, der omfatter en føring og kan konfigureres til at anbringe parret af tapper
 - 10 på parret af sæder ved hjælp af en line, der er forbundet med forbindelseselementet og strækker sig omkring føringen,
 - hvilken fremgangsmåde endvidere omfatter:
 - forbindelse af en første del af en line (35) med en lineindgrebsanordning (30a), der er placeret ved en proksimal del af forbindelseselementet, og strækning af linen omkring føringen; og
 - 15 anbringelse af parret af tapper på parret af sæder, mens en distal del af forbindelseselementet er forbundet med en fortøjningsline ved påføring af en trækraft efterfulgt af en reduktion af trækraften på linen i en retning væk fra føringen.
 2. Fremgangsmåde ifølge krav 1, hvor fortøjningsanordningen er forsynet med et par af skuldre eller vinger, der er tilpasset til at bevæge sig omkring og/eller rotere om eller omkring en udvendig overflade af
 - 20 sædet, og hvor fremgangsmåden omfatter:
 - placering af forbindelseselementet i en fastholdt position inde i hver sokkel ved placering af hvert sæde mellem ét af parret af tapper og én af skuldrene eller vingerne.
 3. Fremgangsmåde ifølge krav 1 eller 2, hvor parret af fortøjningsanordningens sæder er åbne sæder.
 4. Fremgangsmåde ifølge et hvilket som helst foregående krav, hvor parret af sæder (40a, 40b), eller
 - 25 en basismodtagende del eller vægtbærende del af hvert af parret af sæder, mindst delvist eller i alt væsentligt vender ind mod eller er orienteret i retningen af en føring.
 5. Fremgangsmåde ifølge et hvilket som helst foregående krav, hvor mindst en del af hvert af parret af sæder i alt væsentligt er U-formet, krogformet eller J-formet.

DRAWINGS

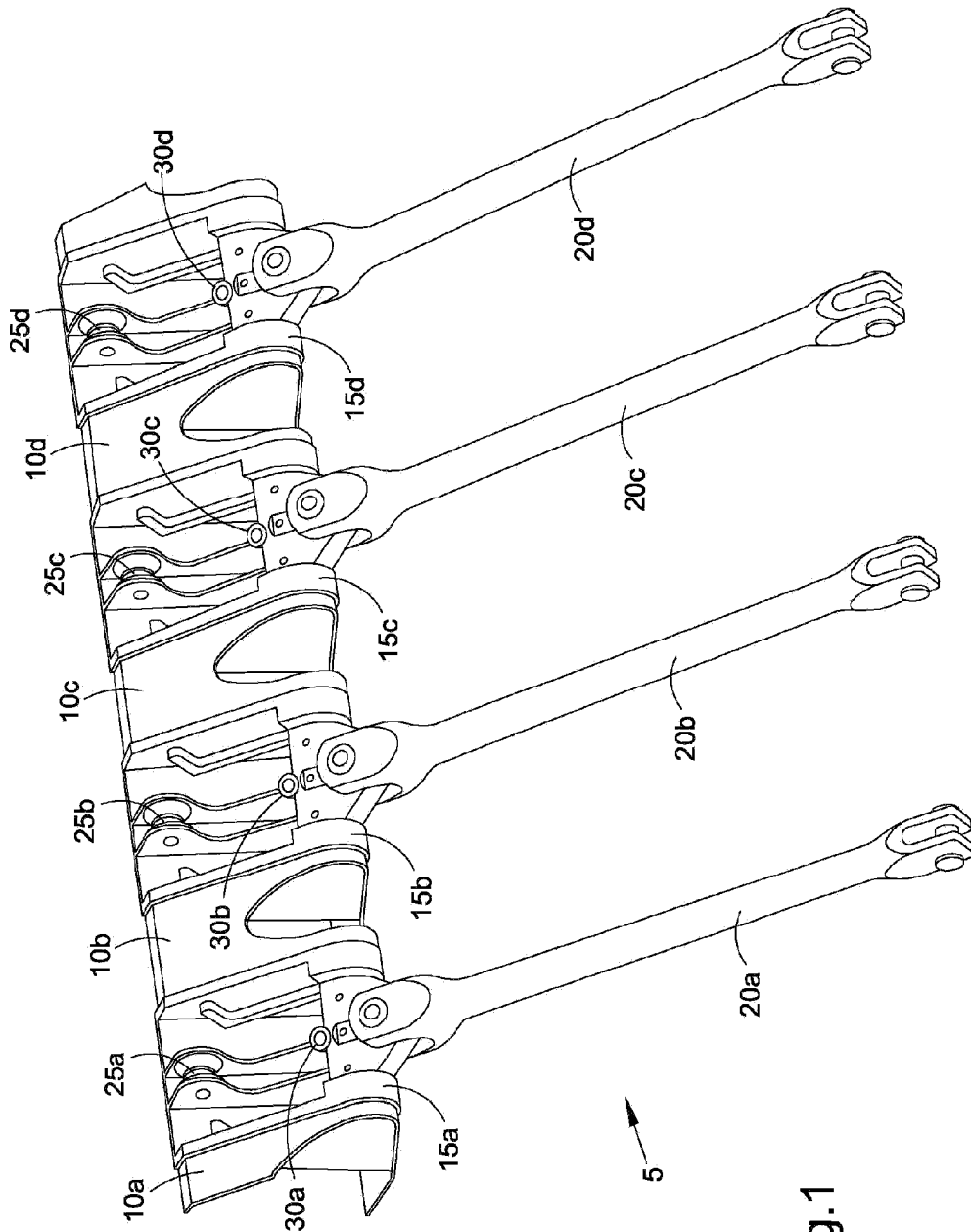


Fig.1

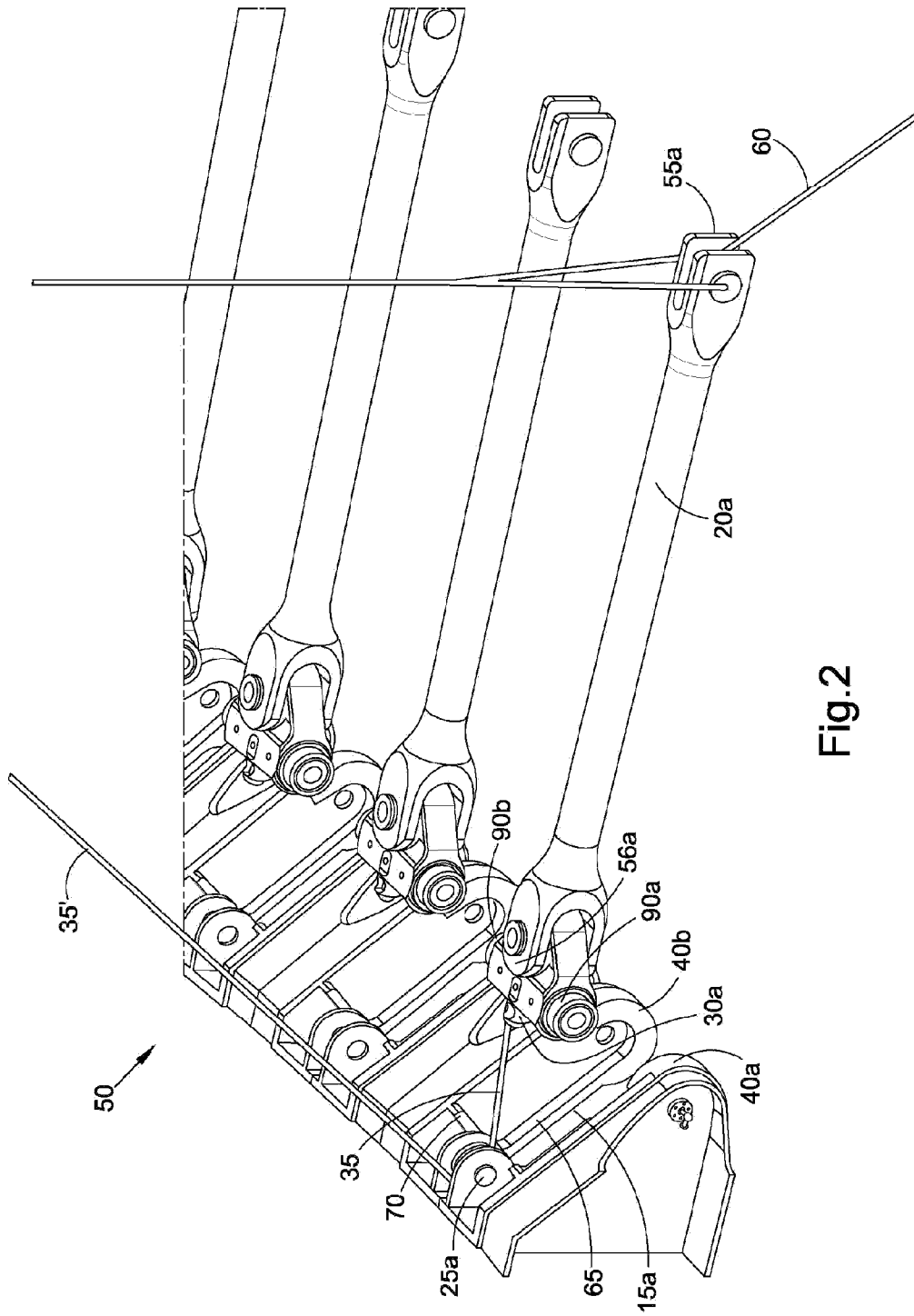


Fig.2

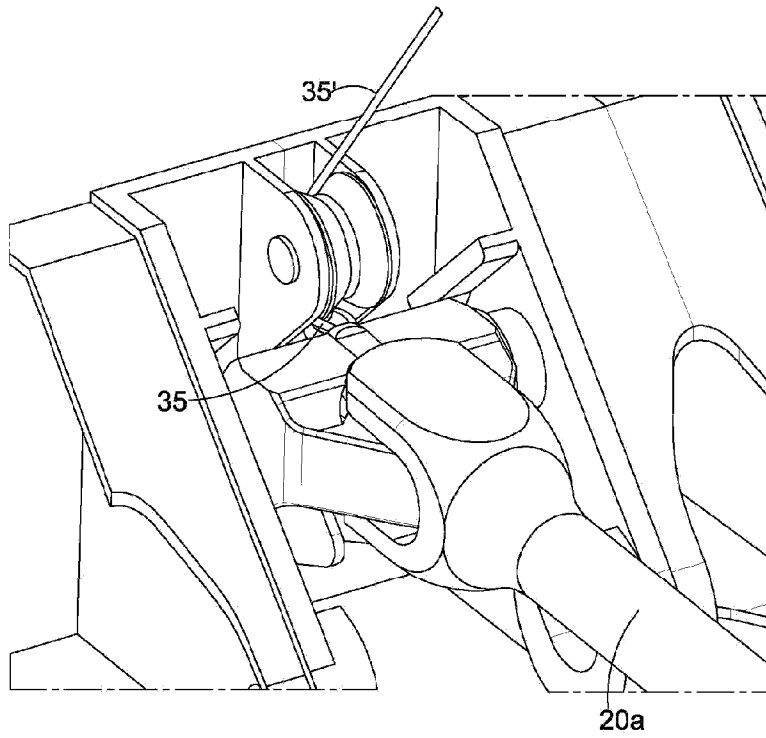


Fig.3a

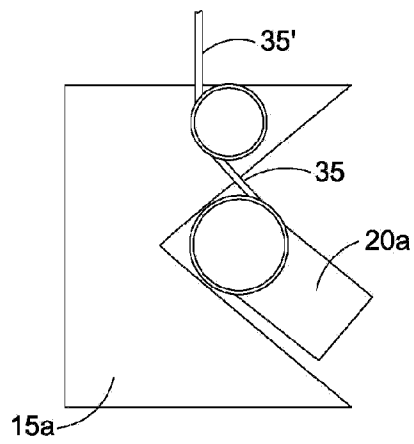


Fig.3b

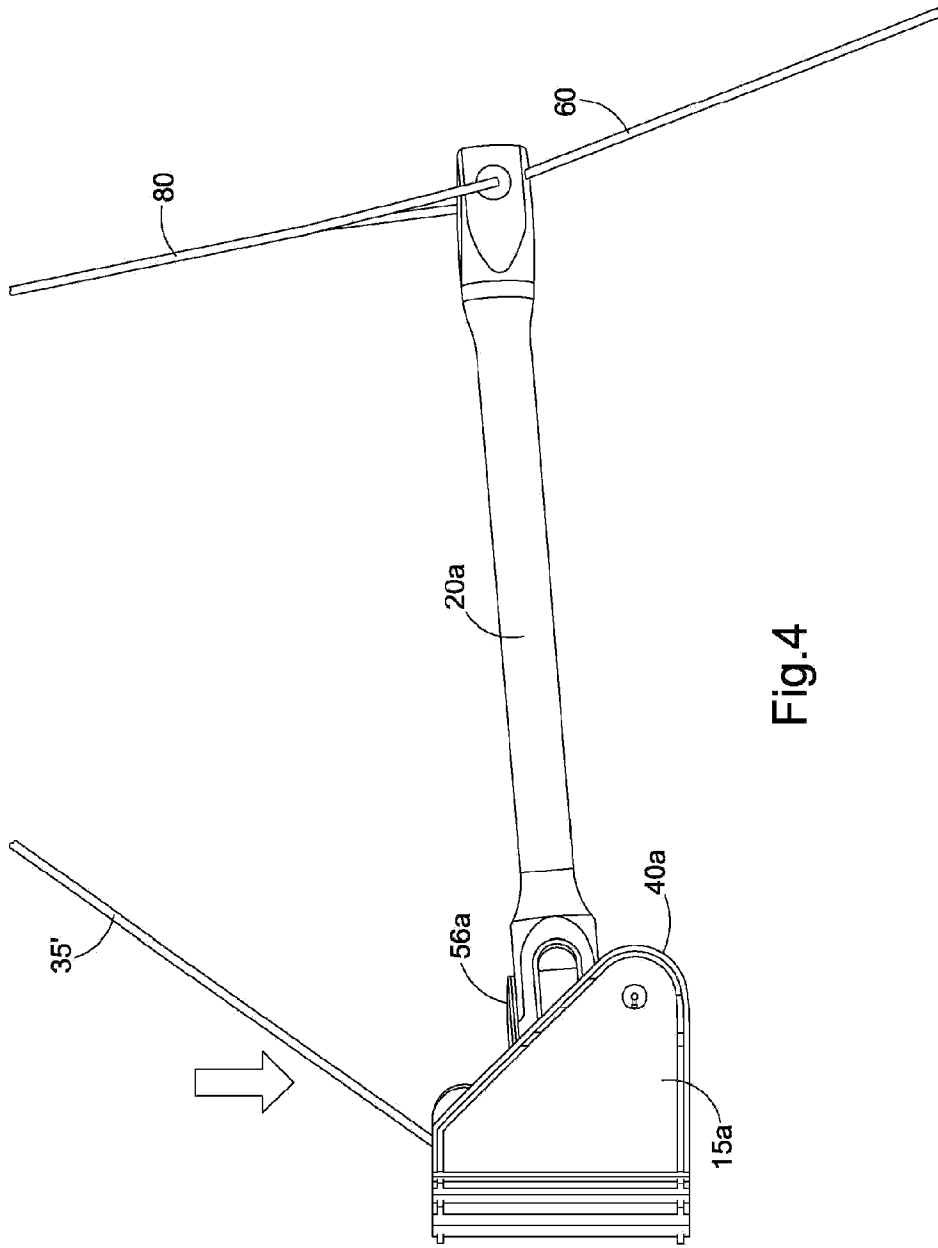


Fig.4

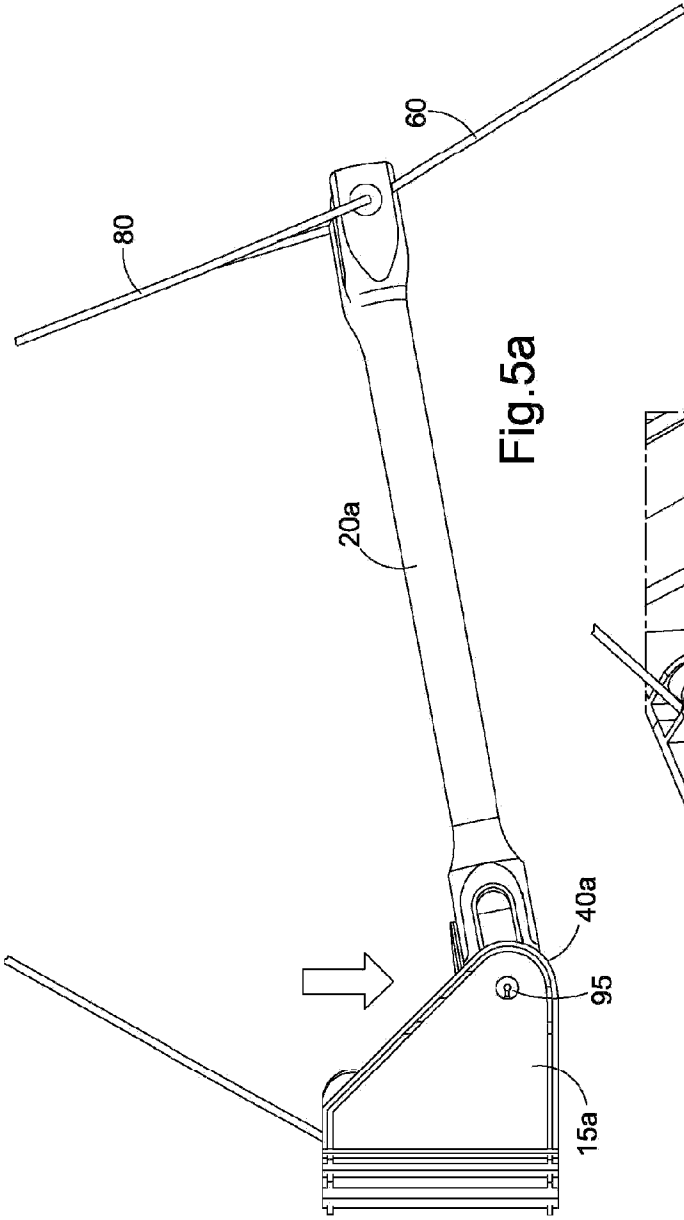


Fig. 5a

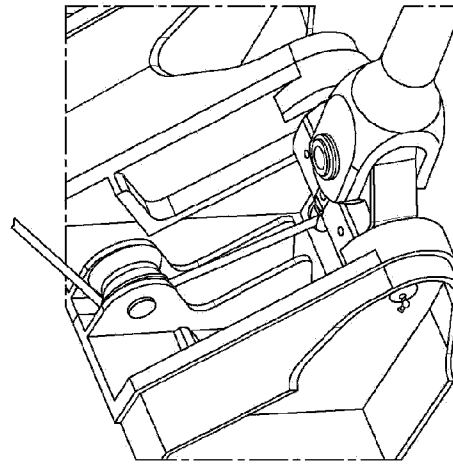


Fig. 5b

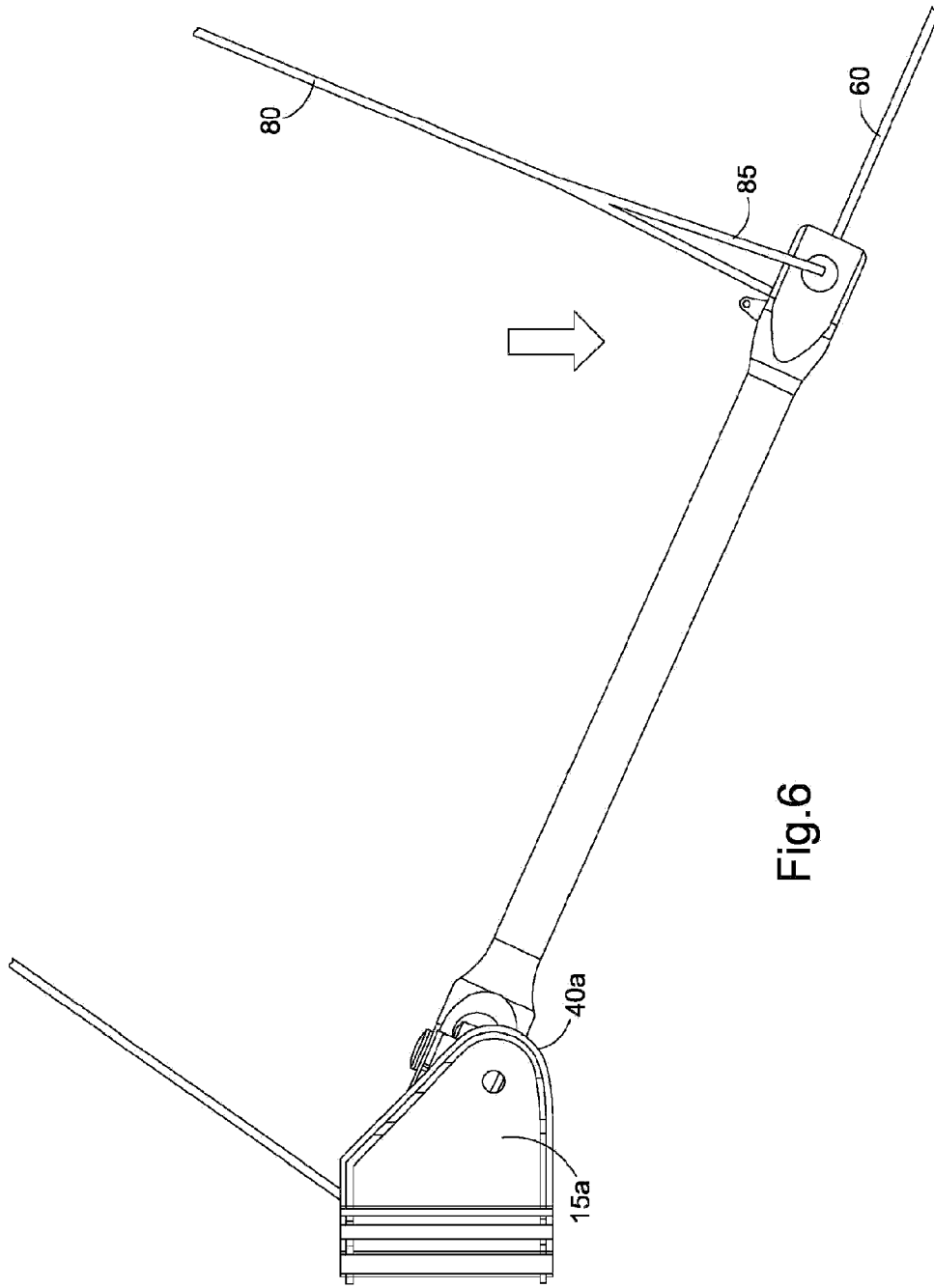


Fig.6

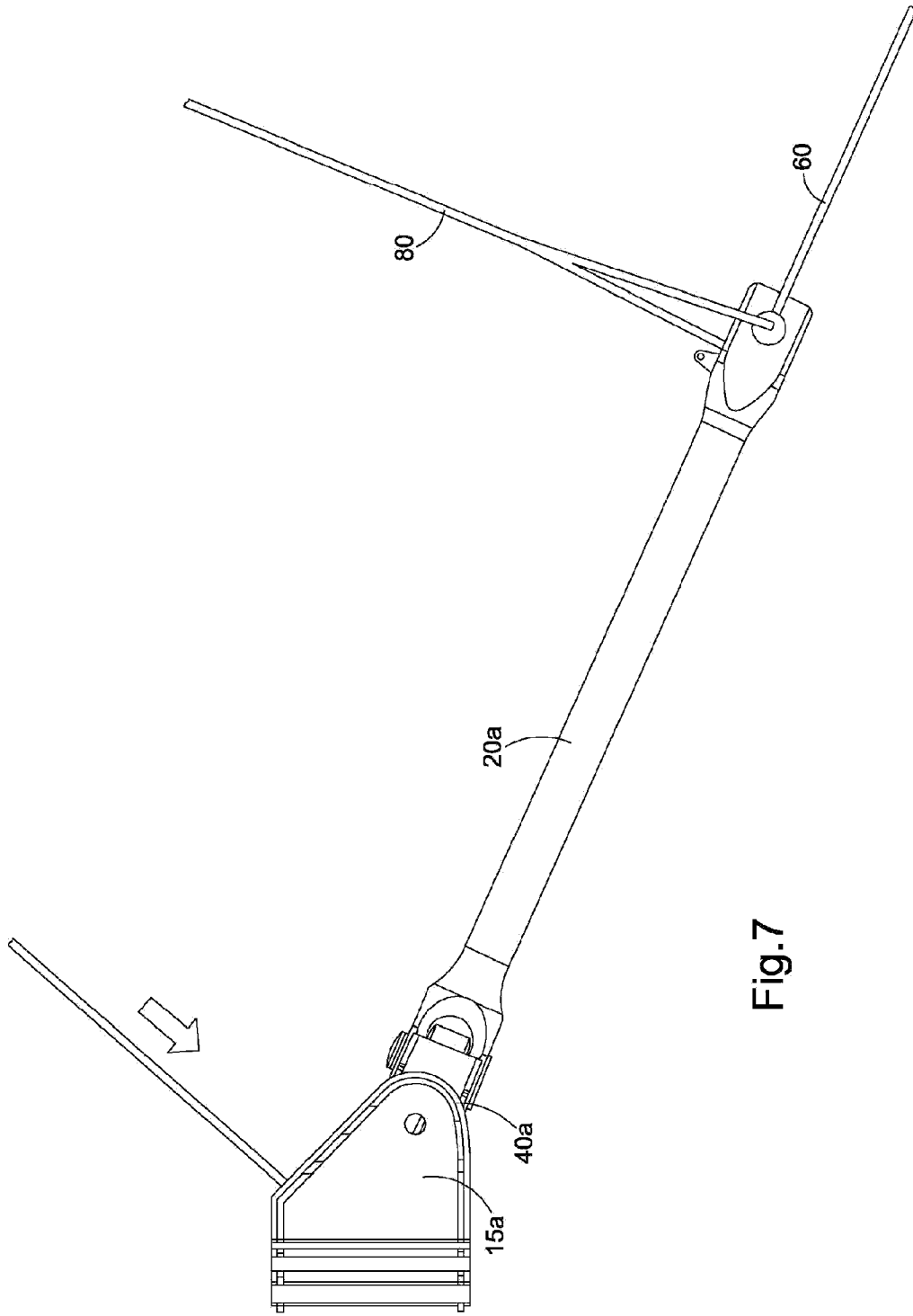


Fig.7

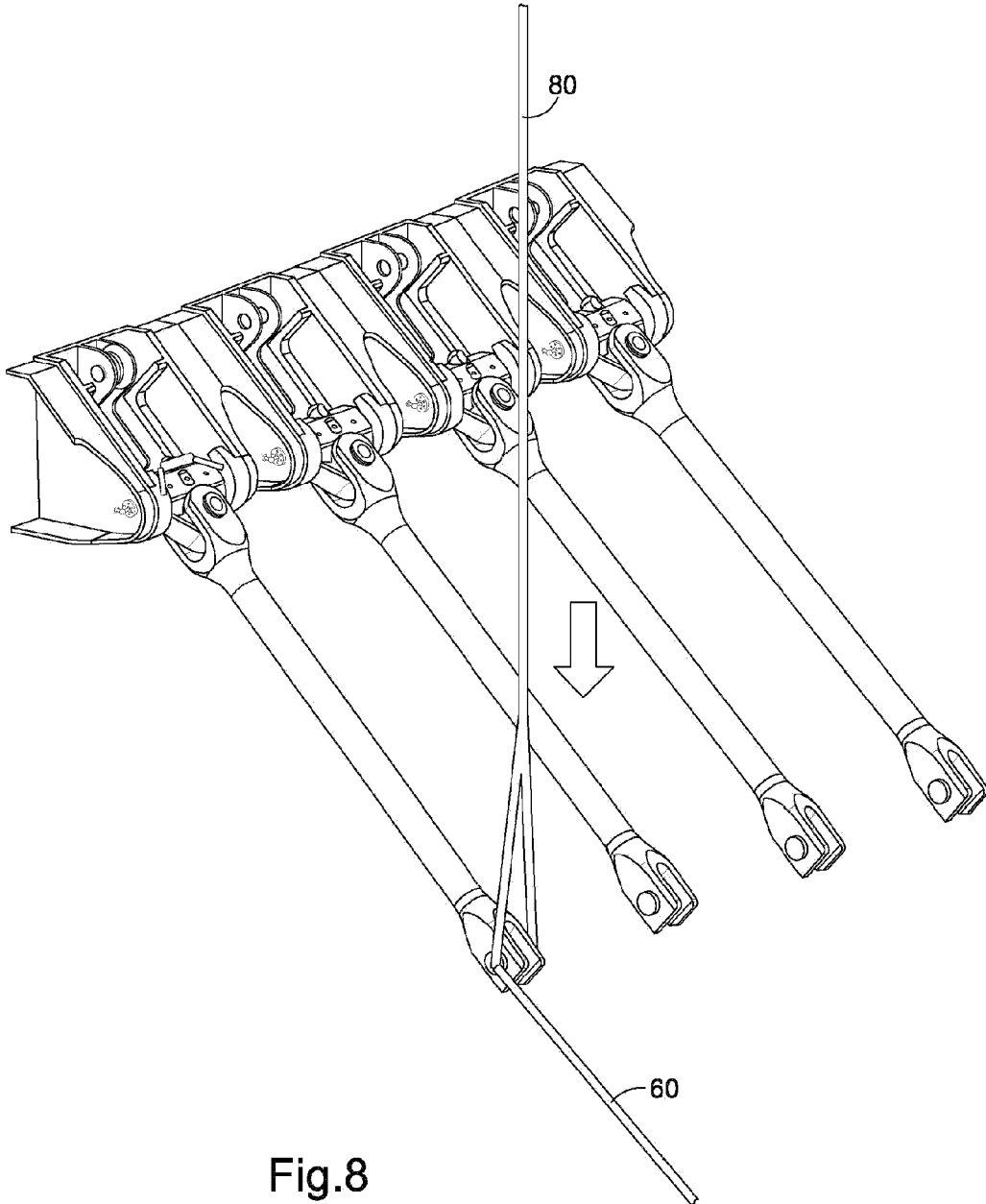


Fig.8

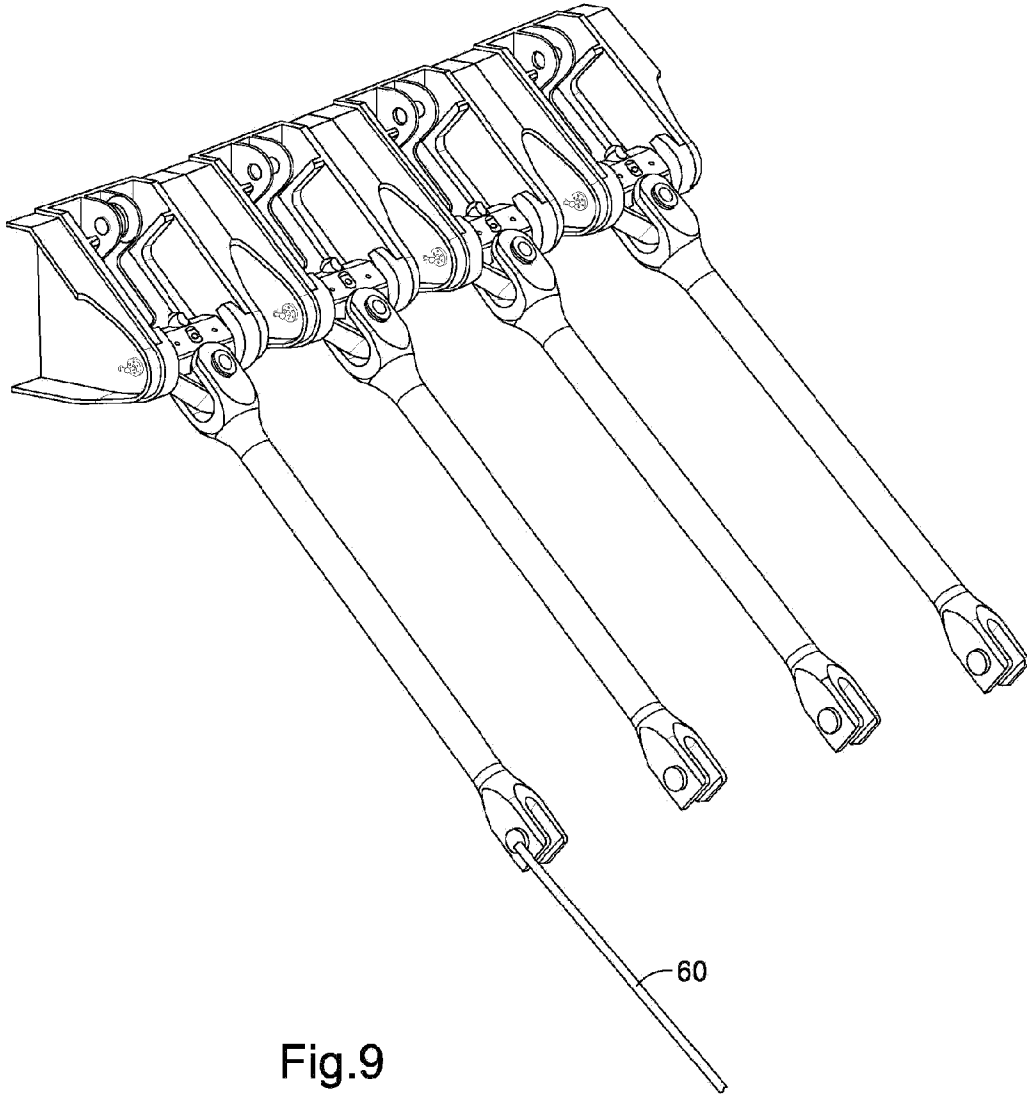


Fig.9

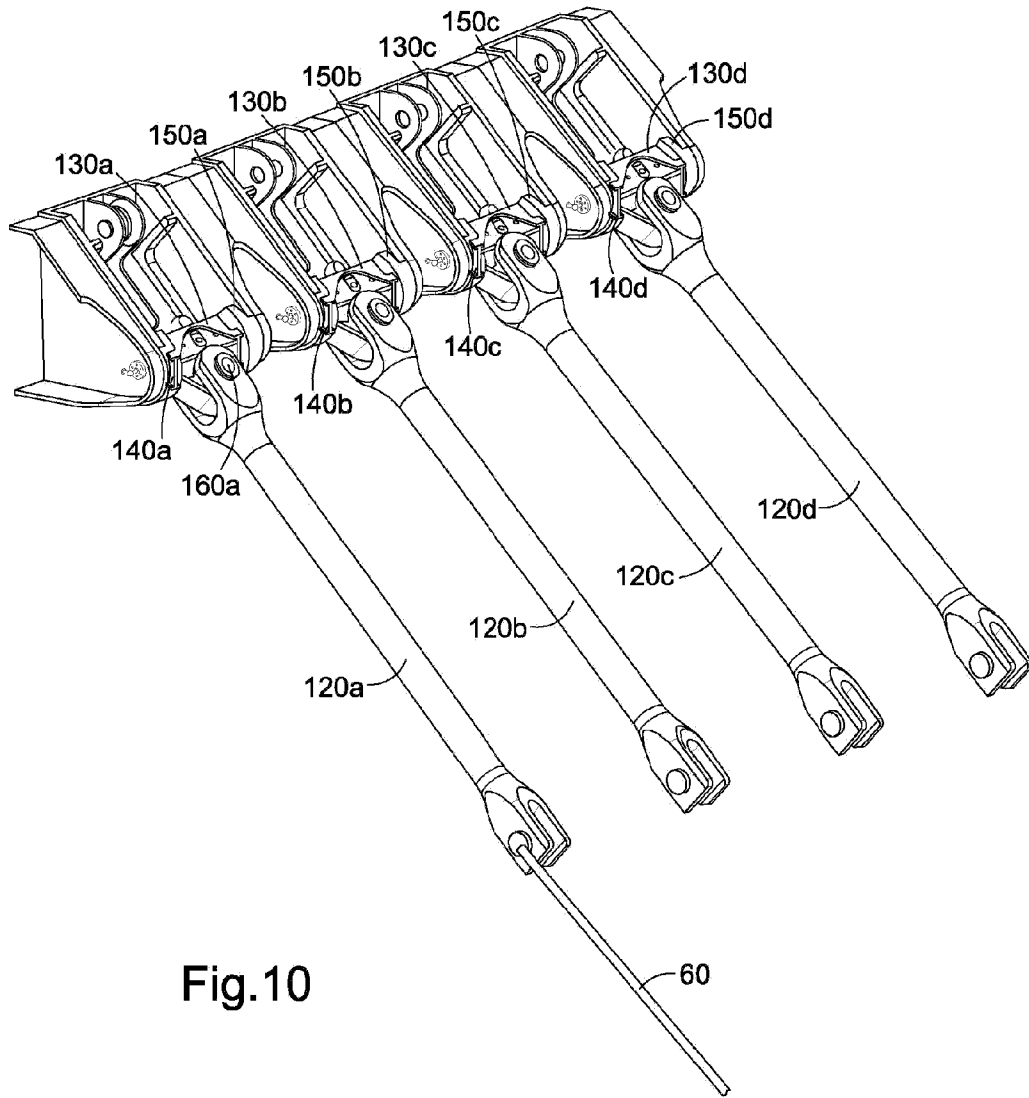


Fig.10

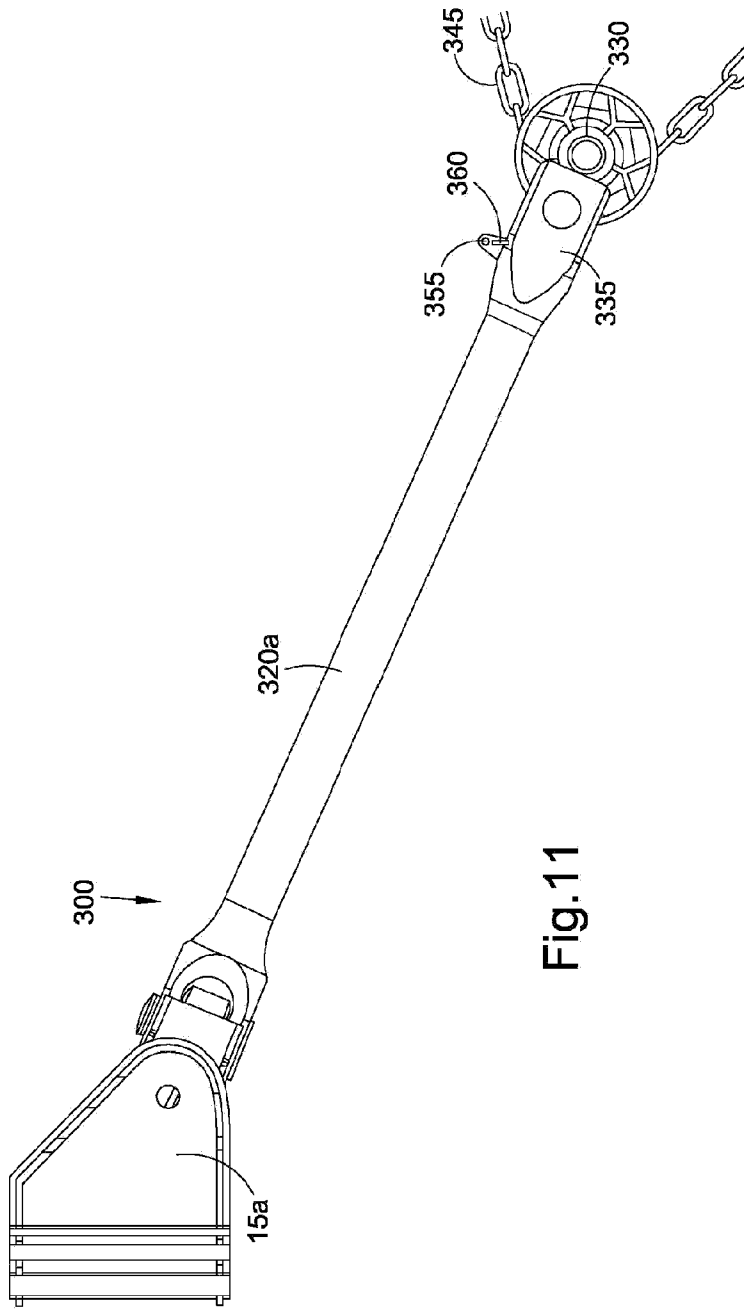


Fig. 11