

5 "LINE GUIDING DEVICE FOR HANGING APPLICATIONS, PARTICULARLY AS
A SERVICE LOOP FOR A DRILLING RIG"

10 The invention generally concerns an apparatus for routing a plurality of supply lines like for example cables, hoses or the like, hereinafter referred to as a line routing apparatus, in particular for hanging applications, in which the line routing apparatus is arranged with two hanging portions and a loop therebetween.

15 The invention concerns in particular but not exclusively a line routing apparatus which is suitable as a so-called "service loop", for example for a drilling rig. Service loops are line bundles which are used for supplying a generally vertically moveable consumer, for example the rotary power head, referred to as the top drive, of a drilling rig and form a loop between two freely hanging portions to afford freedom of movement.

20 Such a service loop is described for example in EP 2105575 B1 and is shown in attached Figure 4 (state of the art) with reference numeral 6 as part of a derrick 1. In that arrangement hoses 5 and cables supply the top drive 3 with energy electrically, hydraulically and/or pneumatically and possibly also transmit measurement and control signals by way of electrical and/or optical lines (not shown). The top drive 3 is supplied by the service loop 6 and displaced vertically with a lifting device 2. EP 2105575 B1, for developing a service loop, proposes a structurally complicated device which is intended to prevent the supply lines becoming entangled with each other when the top drive 3 moves up and down.

30 In conventional service loops a plurality of lines are carried in a condition of being combined by a reinforced rubber hose of large diameter. Typically, the hose is then filled with casting material as described for example in US 7966724 B2 in order to support the lines against the inside

of the outer hose. That structure makes subsequent repair and maintenance, like for example replacement of a line, considerably more difficult. In order to reduce the downtime, the entire hose assembly with all lines is replaced, even if for example only one line is defective. Another
5 disadvantage, in particular in drilling rigs, is the relatively large minimum radius of the loop caused inter alia by the large outside diameter.

As a further development US 9449737 B2 proposes a structure of smaller diameter. Proposed therein is a special inner plastic casing as well as a particular shielding, which both have a high load-carrying capacity in
10 order to be able to avoid having the load-bearing outer hose.

In contrast EP 2986869 B1 discloses a different kind of line routing apparatus which is suitable in particular for supplying a drilling head in offshore drilling rigs. That line routing apparatus has two flexible load strands of high tensile strength, which extend over the length of the line
15 routing apparatus and to which a multiplicity of routing bodies are fixed, arranged in succession in the longitudinal direction of the load strands. That chain-like line routing apparatus is suitable for very high tensile forces, for example hanging uses of up to 200 metres in length as in deep drilling equipment or the like and is inter alia salt water-resistant. The
20 configuration disclosed in EP 2986869 B1 permits very great lengths and affords good protection, that is to say a long service life for the lines, in particular when being winched up and down, but is less suitable for use as a service loop, inter alia because of the structural space required which for example is generally not available in the interior in the derrick.

25 In comparison with the foregoing state of the art a first object of the invention is to design a line routing apparatus in such a way that the finished manufacture including assembly with the desired lines is simplified, in particular even in the case of a long overall length. In addition, the invention seeks to provide that the new line routing apparatus affords good
30 protection, avoids entanglement of a plurality of lines and nonetheless is of a compact and comparatively light structure.

According to a further aspect, subsequent maintenance operations, in particular the replacement of individual lines, is to be facilitated.

Furthermore, in comparison with conventional service loops a smaller minimum radius in the direction-changing region or the loop between two longitudinal portions is desirable.

The proposed line routing apparatus has a flexible carrying strand of high tensile strength, which extends over the length of the line routing apparatus and a number of guide bodies are arranged in succession or consecutively along the longitudinal direction of the apparatus.

According to a core concept of the invention, to attain the first object, it is proposed that adjacent guide bodies can be respectively deflected spatially relative to each other (that is to say they are respectively pivotable relative to each other about at least two axes) and each guide body includes a central part having a central axis which extends coaxially with respect to the carrying strand and an outer part with at least one peripheral element. In that case the peripheral element is held to the central part and radially outwardly delimits a receiving region which is open in the axial direction for one or more lines or appropriately defines said receiving region. Preferably but not necessarily each central part can be provided with an axial through opening which forms a central axis and through which the carrying strand extends.

The carrying strand carries a substantial part of the weight and relieves the load of tensile forces on the lines, similarly to the internal core of a cable. The carrying strand is so flexible that it does not adversely affect deflection of the guide bodies relative to each other. The guide bodies hold the lines in the receiving region, that is to say relative to the central part, and thus fixedly at least in the radial direction relative to the carrying strand. This avoids entanglement and the need for a load-bearing outer hose. By suitable dimensioning of the outer part the lines are held relatively play-free, which would require casting material in known service loops. With a suitable configuration the guide bodies also permit the replacement of individual lines.

Tensile stress relief for the lines is mostly advantageous. For that purpose, for example respective end tensile strain relief means of a suitable structure, for example so-called tensile strain relief socks, can be provided

on both sides of the line routing apparatus, possibly without tensile strain relief in respect of the lines within the line routing apparatus. Alternatively, or in addition tensile strain relief means can also be provided within the line routing apparatus at a number of locations in its longitudinal direction, this
5 however reduces the mobility of the lines. For tensile strain relief within the line routing apparatus for example the peripheral elements at the respective locations can be fixedly tied together and held in tensile strain-resistant fashion at the respective central part or carrying strand.

The invention affords particular advantages where relatively heavy
10 line bundles have to be arranged hanging substantially vertically over a considerable length. The present invention is therefore particularly suitable for use in a land or onshore or sea or offshore drilling rig, in particular as a service loop, but is not restricted to those areas. Further applications of offshore operations are for example supply cables (umbilicals) between the
15 platform and the supply ship or onshore power supply for ships. The solution of the invention is also particularly well suited for land-based applications, in particular hanging applications, for example in drilling or deep drilling systems or in mining.

According to first aspects of the invention it can be provided that in
20 each guide body the outer part can be opened and/or it can be provided that at least some guide bodies, in particular all guide bodies, respectively have at their central part a fixing device for fixing the central part in position to the carrying strand at least in the axial direction, in particular in force-locking relationship and/or positively locking relationship.

25 Openable outer parts can be provided in particular by at least one peripheral element being respectively connected moveably or pivotably to the central part. Alternatively or in addition, at least one peripheral element can be fitted releasably from the guide body, for example by a screw connection, a plug-in connection or the like, preferably by a dropsafe
30 fastening.

Particularly in the case of drilling rigs like land or onshore or sea or offshore drilling rigs basically all releasable elements of a guide body should be dropsafe, in particular secured to the guide body at least doubly

secured, for example by screwing with pin securing or similar secure screwing structures. Accordingly, the central parts are each fixed in position, preferably in dropsafe fashion, at any event to the carrying strand in the axial direction so that in the event of breakage of the carrying strand the guide bodies cannot drop down. Openable outer parts, for example with pivotable peripheral elements, permit lateral access to the receiving region and thus facilitate manufacture and maintenance as lines can be laterally inserted and removed, that is to say they do not have to be "threaded in" or passed through in the axial direction, as for example into the carrying hose of conventional service loops. The peripheral elements can be for example flexible or can be pivoted open by a distinct hinge. In that case fixing to the carrying strand fixes the position in the axial direction, wherein that is possibly required only in portion-wise manner, for example if the guide bodies bear axially against each other. In that arrangement pivotable peripheral elements can be in particular captively held to the guide body so that subsequent maintenance is simplified and parts are reliably prevented from dropping off.

In a further aspect of the invention, it can be provided that at least some and in particular all guide bodies at their at least one peripheral element have on the outside an elastic buffer for shock absorption, in particular in relation to the radial shocks. The buffer preferably extends in the peripheral direction around the central axis, preferably over the entire periphery. The buffers damp lateral impact of the guide bodies in a horizontal swinging movement caused by the vertical movement occurring in operation. In addition, the buffers can at the same time also act as an angular abutment between the individual guide bodies in order to limit the relative deflection thereof relative to each other with a damping action. Thus, with a good protective effect in spite of being of a simple structure this at the same time permits the loop to be of a small radius. The radius can be selected to be of virtually any value by dimensioning of the peripheral elements and buffers on the one hand and the axial spacing between successive peripheral elements on the other hand, but should not be below the smallest permissible minimum radius of the lines.

The number or plurality of guide bodies is so selected that they are provided along by far the predominant length of the carrying strand, but the ends thereof are exposed. The guide bodies can follow each other in particular directly or without spaces therebetween, or however they can be
5 arranged with intermediate spaces. The guide bodies are preferably not braced relative to each other but are fixed to the carrying strand without prestressing or with play for moving around. In a preferred embodiment the central part as its fixing device has a clamping and/or locking device in order to secure the carrying strand in force-locking relationship at an
10 internal surface of the through opening in the central part. That allows inter alia simplified manufacture.

In principle all suitable approaches can be considered as the fixing device, which do not adversely stress the carrying strand.

Particularly if each central part is provided with an axial through
15 opening through which the carrying strand extends the arrangement can have for example a screw clamping device with a clamping screw. That can be in particular in the form of a clamping clip, in particular a hinged clamping clip with a hinge-like joint. In that case there are preferably two shell-shaped regions on the central part. They can be connected by the
20 hinge so that a clamping screw is required only at one side. With a clamping screw which is opposite to the hinge and which can brace the shell-shaped regions relative to each other then in that way secure fixing can be effected similarly as in the case of a clamping clip.

Alternatively, it is also possible to provide a quick-release clamp, a
25 latching clamp or similar device which at least partially reduces the free diameter of the through opening or fixes, for example clamps fast, the central part to the carrying strand, in force-locking and/or positively locking relationship.

Other kinds of fixing the guide bodies in position are also in
30 accordance with the invention. In a further embodiment the carrying strand can be in the form of a link chain, for example a round link chain, wherein each central part forms a kind of special chain link as a load-bearing component of the carrying strand. In that arrangement, for

reducing the weight in relation to length, preferably two respective successive central parts can be spatially deflectably connected by one or more actual chain links which are provided as intermediate members (without the outer part). The intermediate members can then be for
5 example conventional metal links of a round link chain which are linked together with oppositely disposed holding eyes of the central parts.

In a further embodiment the carrying strand can be in the form of a "pearl necklace" with carrying bodies which have a fixed or stationary position seen in the longitudinal direction of the carrying strand and to
10 which the central parts are fixed in force-locking relationship by means of a suitable respective fixing device.

Irrespective of the kind of fixing adopted the central parts are preferably secured fixedly and non-rotatably, in particular in torsion-resistant fashion, to the carrying strand. That can be achieved particularly
15 easily by positively locking clamping to the carrying strand.

In the state of being ready for operation the outer part preferably forms a delimitation which is closed in the peripheral direction or which extends completely around the central axis of the guide body so that all lines are held securely in the plane perpendicular to the carrying strand in
20 the respective receiving region. In a preferred development the outer part of each guide body has two peripheral elements which are respectively connected to the central part moveably or pivotably by way of a rotary joint, a hinge joint, a hinge band or the like, in order to insert the lines into and remove them from the receiving region. The peripheral elements
25 however can also be adapted to be opened in a different fashion, for example can be removable. The latter is considered in particular when a service loop in the event of line damage is replaced completely or as a packet with all lines and line replacement does not have to take place on the rig.

30 The peripheral elements are preferably in the form of half a ring. In addition, the peripheral elements can preferably be identical parts, that is to say both identical, to reduce the number of parts.

All of or the essential components of the central part and the outer part, in particular the peripheral elements, can be made from plastic, in particular as injection mouldings.

The elastic buffer is preferably made from an elastomer, for example from a synthetic rubber or the like, and for example can be in the form of a rubber buffer. The buffer is more elastic than the other components of the guide body. Preferably the buffer is of a ring-shaped or toroidal configuration. The buffer should embrace the predominant part of the periphery. Particularly preferably the buffer surrounds the peripheral element or elements over the full periphery, for example in the form of a closed or closable ring. The buffer can at the same time represent securing or closure of the moveable peripheral element or elements and for example can serve as a holding ring which can be axially pushed on. The buffer can also be in the form of a cut-open ring which is closed together with the peripheral elements.

Preferably all guide bodies have a buffer, wherein each buffer preferably projects axially with respect to the peripheral element or elements or lies axially flush with respect thereto so that the buffers of adjacent guide bodies butt against each other in order to limit the maximum angle of the spatial deflection of those guide bodies relative to each other acting as abutments. Wear is reduced by buffers as the deflection limiting arrangement and inter alia the generation of noise is reduced. The buffers can be held for example by each peripheral element at its outside having a holding groove which extends in the peripheral direction and into which the ring-shaped buffer engages in positively locking relationship to provide the axial holding action or vice-versa.

In a preferred embodiment the carrying strand has at both ends a respective connecting device for releasably fixing the line routing apparatus to the installation to be supplied, for example to the drilling rig. That facilitates replacement of the line routing apparatus. When using a cable as the carrying strand all current cable end connectors or cable end connection devices can be considered, like for example spliced or pressed eyes, pressed or spliced thimbles, pressed clamps or cast thread fittings or

the like and so forth. In the case of a link chain as the carrying strand all current releasable end connections can also be considered, like shackles, hooks, screw connections, clamps, eyes and so forth.

Particularly preferably provided at each connecting device is a fixing
 5 device for tensile strain relief on the lines, in particular by means of so-called cable strain relief socks (referred to as meshed cable supporting grips), preferably with a loop/thimble or holding eye. For that purpose each connecting device is preferably provided with at least two horizontally
 10 opposite holding arms which are fixed to the connecting device in load-carrying relationship and to which the guided lines can be fixed for tensile strain relief, for example by means of shackles which each releasably hold a meshed cable supporting grip. By virtue of such a configuration complete replacement of the line routing apparatus including the lines is simplified as it is only necessary to release the two connecting devices.

15 The outer part can have precisely one peripheral element with a large periphery, in particular $>300^\circ$ angular extent. Preferably the outer part however is of a multi-part configuration with a plurality of peripheral elements. In cross-section the outer part can define an approximately circular shape, that is to say the peripheral elements can preferably be in
 20 the shape of a circular arc, wherein the outer part can be designed in particular with two respective semi-circular elements. Other shapes, for example a polygonal cross-section, are also possible.

The outer part should preferably provide a sufficient inside diameter or diameter for the receiving region for receiving appropriate lines. The
 25 diameter of the receiving region should be perceptibly greater than 100 mm, in particular at least 125 mm, in order to be able to guide supply lines in the intended applications.

In an embodiment the central part can have two hinge regions which project axially relative to the peripheral elements and which are in axially
 30 opposite relationship. In that arrangement the hinge regions are of a conjugate configuration so that the one hinge region of a first guide body can be releasably introduced in the axial direction into the conjugate other hinge region of an adjacent second guide body, that is to say the guide

bodies can be fitted axially together. The axially releasable configuration of the hinge regions considerably simplifies assembly as the guide bodies only have to be fitted to the carrying strand or the carrying strand only has to be passed through the central parts and they can then be "plugged" one
5 into the other. Accordingly such an optional hinged connection of successive guide bodies is preferably loose in the axial direction, but at least can be released or plugged in easily axially.

Implementing tensile strength in the optional hinge connection between the guide bodies, in particular the adjacent hinge regions, is in
10 principle not required by virtue of of the carrying strand in hanging applications. In a preferred development the hinge regions can form a ball hinge-like hinge connection for spatial deflection of adjacent guide bodies. It is possible to achieve a push-in hinge connection with a part-spherical hinge head and an approximately hemispherical hinge socket and/or with a
15 hinge head/socket which can be axially fitted together by expansion of the socket and/or squashing of the head. In another embodiment the guide bodies are fixed to the carrying strand in axially mutually spaced relationship by means of their fixing devices, which reduces the amount of material involved and the weight.

20 The through opening in the central part can preferably have mutually opposite axial mouth regions which widen radially outwardly to reduce wear of the central part and/or the carrying strand.

In a particularly preferred embodiment the central part of each guide body has two one-part carrying arms which each have an inner clamping
25 shell and a radial bar. In that arrangement the clamping shells can be connected together to form therebetween the through opening for the carrying strand, in particular as a clamping device. The central part can substantially comprise those two carrying arms. The bars of the carrying arms preferably have an outer end region to which the outer part, in
30 particular both peripheral elements, is or are connected. The bars thus hold the peripheral element or elements and thereby secure the lines (radially) to the carrying strand, to which the clamping shells are fixed. The or each peripheral element can possibly be integrally connected to the

bars and for example can be flexibly pivoted open. Preferably each peripheral element as a separate part is connected to the bars by way of a hinge.

In addition at its inside atn the through opening the central part can
 5 have a clamping tooth arrangement extending transversely relative to the central axis, for axial securing to the carrying strand.

The carrying strand can be in particular a carrying cable which has good tensile strength, for example of high-strength plastic. In the present case tensile strength means that the carrying strand or the carrying cable
 10 has sufficient tensile strength to carry the total weight of the line routing apparatus including all lines, that is to say a notional end weight which corresponds to the total weight of the line routing apparatus with all lines. The required static load-carrying capability of the carrying strand is dependant on the application involved, but should typically be $>>1000$ kg.

15 A wire cable with individual cable wires is also considered as the carrying strand, preferably with a nominal strength of the wire material of >900 N/mm². In addition or alternatively to cable wires of plastic cable wires of steel can also be considered, possibly with a core of plastic. The carrying strand or the carrying cable should be as low-stretch as possible.
 20 As an alternative to a carrying cable for example it is also possible to use a link chain, for example comprising steel links, as the carrying strand.

Preferably however a carrying cable of high-strength plastic is used in conjunction with guide bodies which are at least predominantly made from plastic. In that way it is possible to achieve a comparatively low
 25 weight in relation to length of <40 kg/m for the line routing apparatus per se (without guided lines) even with a comparatively great receiving capacity in respect of the guide bodies or a large inside diameter, for example $>>200$ mm, and a corresponding load-carrying force. The noise emission level is also markedly lower in comparison with link chains.

30 For intended applications, in particular in drilling rigs, the carrying strand is preferably of a length of at least 5 m, in particular at least 10 m. In that case the carrying strand is preferably completely continuous and

has a higher level of tearing strength and tensile strength than the guided lines.

In hanging applications the line routing apparatus has in particular a first length portion which hangs down and which has a first end connected to a consumer, a second length portion which hangs down and which has a second end connected to a supplying installation/machine component, and a loop connecting the two downwardly hanging length portions. In that arrangement the downwardly hanging length portions extend in a first approximation virtually vertically in a first region starting from the ends, strictly speaking mathematically, or, depending on the respective horizontal spacing of the ends, along a cable curve or chain curve, that is to say a catenoid (referred to as a catenary) which corresponds to the function of the hyperbolic cosine (or cosh).

The carrying strand or the carrying cable extends in that case beyond both ends, that is to say it extends over the desired total length of the line routing apparatus and projects at the end beyond the guide bodies in order to facilitate weight-carrying fixing of the carrying strand or carrying cable.

As an independent aspect of the invention an individual guide body for a line routing apparatus according to one of the foregoing embodiments is also claimed.

According to a core concept the guide body has a central part having an axial through opening which forms a central axis and through which a carrying strand can be passed, and an outer part having at least one peripheral element. The peripheral element delimits a receiving region which is open in the axial direction for the lines outwardly and for that purpose is held to the central part.

According to an aspect of the invention the peripheral element is connected to the central part in such a way that it is moveable or can be pivoted open.

According to another aspect of the invention provided on the central part is a fixing device for fixing the central part in position to a carrying strand.

According to a further aspect according to the invention provided on the peripheral element at the outside thereof is an elastic buffer for shock absorption, for damping in particular in relation to radial shocks and/or acting as an abutment for the guide bodies against each other.

5 Advantageously the guide body can have one or more of the further features described hereinbefore as advantageous in any combination with one of the foregoing aspects.

 The invention also concerns a drilling rig having a top drive including a hangingly arranged line routing apparatus according to one of the
10 foregoing embodiments for supplying the top drive.

 The line routing apparatus is suitable in particular for use in a land or offshore drilling rig as a replacement for a conventional service loop, in initial equipment or as a replacement. Depending on the respective demands involved there can additionally be provided a thin flexible
15 protective casing without a carrying function, which however should be so designed that it can be opened.

 Further details, features and advantages of the invention will be apparent from the detailed description hereinafter of preferred embodiments by way of example with reference to the accompanying
20 drawings. In the drawings:

 Figures 1A-1B show a first embodiment of a line routing device in a hanging arrangement for supplying a vertically moveable consumer as a side view (Figure 1A) and a perspective enlarged view of the lower region or the direction-changing loop (Figure 1B),

25 Figures 2A-2C show an axial section/longitudinal section (Figure 2A) and a radial section/cross-section (Figure 2B) and a perspective view (Figure 2C) of a guide body of the line routing apparatus of Figures 1A-1B,

 Figure 3 shows a radial section/cross-section of a second embodiment of a guide body,

30 Figure 4 shows as an example of application of the invention a drilling rig with a top drive which is supplied with a per se known service loop (state of the art) to be replaced by the line routing apparatus,

Figures 5A-5B show a preferred third embodiment of guide bodies in a modified configuration (Figure 2A-2C),

Figure 6 shows a further embodiment of a line routing apparatus wherein the carrying strand is in the nature of a link chain,

5 Figure 7 shows a further embodiment of a line routing apparatus wherein the carrying strand has carrying bodies for positively locking fixing of the guide bodies,

Figure 8 shows a diagrammatic cross-section through a connecting device for fixing an end of a carrying cable to a cable sleeve and holding
10 arms for tensile strain relief of the lines, and

Figure 9 shows a line with a meshed cable supporting grip for tensile stress relief and fixing to a connecting device, for example as shown in Figure 8.

Figures 1A-1B show a first example of a line routing apparatus 10
15 according to the invention in a hanging arrangement with a first vertical longitudinal portion 12A which has a first end 12C, and a second vertical length portion 12B having a second end 12D. The first end 12C is connected to a machine component M which in this example travels vertically up and down, for example a top drive 3 (see Figure 4) of a derrick. The second length portion 12B in turn is fixed with its end 12D to a frame structure or stationary machine part F. A loop 13 forms a direction-changing region which connects the two substantially vertically hanging length portions 12A, 12B.
20

The line routing apparatus 10 has a flexible carrying cable 11 of
25 high-strength plastic fibres, for example of high-modulus polyethylene or high-modulus polyamide, which as the carrying strand carries the weight load of the line routing apparatus 10. For that purpose, the free end regions 11A, 11B, which project at both sides, of the carrying cable 11 is suitably fixed to the moveable machine part M and the stationary machine
30 part F (diagrammatically shown in Figure 1A). As a second essential component the line routing apparatus 10 has a plurality of annularly closed guide bodies 14 which occur in succession in the longitudinal direction of the carrying strand 11 (Figure 1B). The guide bodies 14 are arranged in a

row on the carrying cable 11 and are carried and held thereby. The carrying cable 11 thereby carries at least the entire weight of all guide bodies 14.

As Figure 1B shows the loop 13 between the length portions 12A, 12B forms a relatively small radius, that is to say the length portions 12A, 12B can extend at a slight horizontal spacing relative to each other. The small radius is possible inter alia by virtue of the fact that adjacent guide bodies 14 can be strongly angled relative to each other. The guide bodies 14 are each moveable spatially relative to each other, as shown in Figure 1B. The spacing between the length portions 12A, 12B however can also be markedly greater depending on the respective application and they do not have to hang down vertically. Depending on the respective application the line routing apparatus 10 can for example also extend similarly to a hanging bridge.

Figures 2A-2B show a first embodiment of a guide body 14 for the line routing apparatus 10. Each guide body 14 has inwardly a central part 15A having a central axis A and a through opening 16 coaxial therewith in order to pass the carrying strand 11 (Figure 1A) therethrough and externally an outer part 15B having two peripheral elements 17 which are in the shape of a circular arc, here with an arc length of about $160 - 180^\circ$, in order to hold the lines. Each peripheral element 17 radially outwardly delimits a receiving region L which is open in the axial direction for the lines (not shown).

The central part 15 includes a fixing device 18 for fixing the guide body 14 axially in position to the carrying cable 11. In Figures 2A-2B this is in the form of a screw clamping device 18 in the manner of a hinged clamping shell or cable clamp. For that purpose, the central part 15A has two one-piece carrying arms 20A, 20B which are integrally produced from plastic and which each have an inner clamping shell 21A, 21B. By virtue of their conjugate configuration the clamping shells 21A, 21B form at one side a hinge-like joint 24 (see Figure 3) which pivotably connects the clamping shells 21A, 21B. At the opposite side the clamping shells 21A, 21B have screw openings for a clamping screw 25 to brace the U-shaped clamping

shells 21A, 21B against each other. Alternatively, quick-release clamping devices or the like can also be considered. The clamping shells 21A, 21B further form centrally two approximately semi cylindrical inside surfaces of the through opening 16. By tightening of the clamping shells 21A, 21B the central part 15A, that is to say the guide body 14, is fixed to the carrying cable 11 for the inside surface of the through opening 16 is fixed in force-locking relationship to the carrying strand 11. A clamping tooth arrangement 28 extending transversely relative to the central axis A is provided at the inside surfaces of the two clamping shells 21A, 21B for giving a better axial securing action.

As Figure 2B shows each carrying arm 20A, 20B includes integrally with the respective clamping shell 21A, 21B a radial bar 22A, 22B, to the outer end region of which the outer part 15B that is to say the two peripheral elements 17, are connected flexibly, here by a rotary hinge. In that way the two peripheral elements 17 are respectively connected to the one bar 22A of the central part 15A pivotably by way of an associated rotary joint 23, for example a hinge, pivotably between the closed position in Figure 2B and an open position (not shown). In that way insertion or removal of lines into or from one of the receiving regions L is facilitated. The peripheral elements 17 are here identical parts and are in the form of a half ring, produced for example from plastic parts or metal sheet. The peripheral elements 17 form releasable eyes for the hinge 23, which similarly as in the case of pipe clamps, are rotatably mounted on a mounting pin or spindle on the one bar 22A. At the opposite end the peripheral elements 17 and the other bar 22B have screw openings passing therethrough for a securing screw 29 with a securing nut or the like. In that way the peripheral elements 17 are fixed to the other bar 22B in the closed position (Figure 2B). The inside diameter of the receiving regions L defined in that way, measured radially between the peripheral elements 17, is in the region of approximately at least 150 mm to 300 mm, or greater. The receiving capacity is predetermined by suitable dimensioning of the peripheral elements 17 and optionally the bars 22A, 22B.

Figure 2A further shows two central axially projecting hinge regions 26A, 26B of the central part 15A. They serve for a defined low-wear relative movement of adjacent guide bodies 14 without transverse shifts relative to each other out of the extended position in the length portions 12A, 12B into the complete angled position at the apex of the loop 13 (downward in Figure 1B) and back. For that purpose, each central part 15A has two hinge regions 26A, 26B in opposite relationship at the ends, coaxially with the central axis 16. The opposite hinge regions 26A, 26B are of such a conjugate or paired configuration that the one hinge region 16A can be axially inserted releasably coaxially into the respective conjugate other hinge region 26B of an adjacent hinge body with the application of a slight force or no force, in particular without needing a tool. The hinge regions 26A, 26B can form a ball joint-like hinge connection for spatial deflection of adjacent guide bodies 14 about any two axes. For that purpose the one hinge region 26A is in the form of a joint head 27A with the outer surface of a ball ring (see Figure 2C) (part spherical) and the corresponding conjugate hinge region 26B is in the form of a joint socket 27B with an approximately hemispherical inside surface (see Figure 2A).

Figures 2A-2C further show an annular elastic buffer 19 comprising an elastomer, which surrounds the peripheral elements 17 substantially over the full periphery. The buffer can be rounded in the transition between the axial end and the peripheral surface and serves on the one hand as an angular abutment for limiting the minimum direction-changing radius of the loop 13 (downward in Figure 1B) and on the other hand for damping radial shocks, for example when impacting against the installation/machine or in transport.

Each buffer 19 is in the form of an open ring with a gap for mounting on the outer part 15B and is closed with the securing screw 29. In the example shown here the buffer 19 does not project axially beyond the peripheral elements 17 but is axially flush with the axial end of the peripheral elements 17, but a projecting configuration is also possible. For axial securing purposes the buffers 19 engage radially into a peripheral holding groove or receiving means at the outside of the peripheral elements

17. It is however also possible to fit peripherally closed buffers 19 (without a gap) in place with a tight fit like a wheel tyre, for example to additionally secure the peripheral elements 17. The elastic shock-absorbing buffers 19 can be solid bodies or, depending on the structural size involved for saving weight, they can be in the form of hollow bodies.

Figure 3 shows a second embodiment of a guide body 34 for a line routing apparatus 10. The guide body 34 differs from that shown in Figures 2A-2B in particular in that it does not have any pronounced joint regions 26A, 26B. The guide body 34 is intended for mounting in a row on the carrying cable 11 with an axial spacing between adjacent guide bodies 34. In the guide body 34 shown in Figure 3 there are mutually opposite trumpet-shaped mirror image-symmetrical mouth regions 36. The mouth regions 36 enlarge radially outwardly or widen in order to reduce frictional wear with the carrying cable 11 when assuming an angled position. Thus if required it is also possible to achieve a still smaller radius for the loop 13 (Figure 1B). Otherwise the same references in Figure 3 denote the same parts as in Figures 2A-2C. A greater enlargement of the through opening 16 however can also be provided in Figures 2A-2C.

Figure 4 shows an example of use for the line routing apparatus 10 shown in Figures 1-3 in a derrick 1. In this case the line routing apparatus 10 can serve as a replacement for the conventional service loop 6 which supplies the top drive 3.

Figures 5A-5B show a variant of Figures 2A-2C with guide bodies 54. One difference is that the carrying arms have material thickenings 52C, 52D for protecting the lines at both bars 52A, 52B in the region around the clamping screw 25. In addition, the bar 52A at which the rotary joint 53 is provided for pivoting the peripheral elements 57 open forms further material thickenings 52E, 52F for protecting the lines in relation to the rotary joints 53 and for mechanically reinforcing the joints 53. In Figures 5A-5B hinge pins are provided at the peripheral elements 57 and are mounted pivotably to the bar 52A. The guide bodies are identical to Figures 2A-2C in other essential features. As in Figures 2A-2C in particular

the central part and also the outer part can be made at least predominantly from plastic injection mouldings.

Figure 6 is a perspective view of a short length portion of an alternative embodiment in which the carrying strand 11 (see Figure 1A) is not in the form of a carrying cable but is in the form of a link chain. For that purpose the individual guide bodies 64 respectively have in axially opposite relationship two holding eyes 63 with which they can be linked in the longitudinal direction by means of intermediate members 62, for example of the structure of typical chain links of a round link chain, and can be deflected relative to each other. The central parts 65A in Figure 6 are thus load-bearing integral component parts of the chain-like carrying strand. In this case each central part 65A of each guide body 64 also has two diametrically opposite carrying arms 60A, 60B to which the outer part 65B is fixed. A further difference in relation to Figures 2A-2C and Figures 5A-5B is that the outer part 65B here has two fixed, non-releasable peripheral elements 67A in the shape of a circular arc, which are produced for example in one piece with the carrying arms 60A, 60B. Two releasable peripheral elements 67B in the shape of a circular arc are removably fixed to the non-releasable peripheral elements 67A of the outer part 65B, for example by a screw connection, as is shown in an exploded view in Figure 6 in relation to the upper guide body 64.

Figure 7 is a partial perspective view of a longitudinal portion of a further alternative embodiment in which the carrying strand is in the form of a carrying cable 71. Block-like carrying bodies 72 are stationarily fitted to the carrying cable 71 at regular intervals. The carrying bodies 72 can be pressed in position and/or fixed to the carrying cable in the longitudinal direction by adhesive. That structure permits a positively locking connection for the central parts 75A, for securing in position on the carrying cable 71. For that purpose the central parts 75A in Figure 7 each have receiving means 77 which are respectively formed on the carrying arms 76A, 76B and which are suitably designed for positively locking engagement with the carrying bodies 72. The receiving means 77 are fitted similarly to holding means in positively locking relationship with the carrying bodies 72 and are

fixedly connected together, for example by screwing. The outer parts (not shown in Figure 7 for the sake of simplicity of the drawing) can in this case be of a structure corresponding to Figures 5A-5B or also Figure 6. In the example in Figure 7 the central parts 75A, in particular the carrying arms 76A, 76B and the receiving means, can also be produced in one piece from plastic in the form of injection mouldings.

Figures 8 and 9 show a connecting device 80, with which the end regions 11A, 11B of the carrying cable 11 (Figure 1) can be releasably fixed to the connecting points of the installation. The connecting device 80 in Figure 8 includes a main body, for example produced by cutting machine in the form of a metal component, with a cable sleeve in the lower region, which includes a coaxial receiving means 83 in which the respective end region 11A, 11B of the carrying cable 11 (Figure 1) is received and fixed in tension-resistant fashion by pressing and/or casting with a casting material (adhesive joint). Provided at the opposite end is a threaded projection 84 with a male or female thread, to which preferably a shackle, a load eye, a load hook or the like (not shown) is screwed to permit easy assembly/disassembly. In addition the connecting device 80 includes at least two oppositely disposed radial holding arms 85A, 85B having transverse bores 86 for fixing a respective individual line 93 directly to the connecting device 80 and thus also to the carrying cable 11. By virtue of the bores 86 meshed cable supporting grips 90 (Figure 9) can be suspended in tensile strain-relieved relationship with a loop/thimble 92 by means of shackles on the holding arms 85A, 85B.

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Applicant:

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"LINE GUIDING DEVICE FOR HANGING APPLICATIONS, PARTICULARLY AS
A SERVICE LOOP FOR A DRILLING RIG"

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List of references

Figures 1A-1B

10 line routing apparatus
15 11 carrying cable (carrying strand)
11A, 11B end region (carrying strand)
12A, 12B hanging length portion
12C, 12D ends (line routing apparatus)
13 loop
20 14 guide body
M moveable machine part
F stationary machine part

Figures 2A-2B

25 14 guide body
15A central part (of the guide body)
15B outer part (of the guide body)
16 through opening
17 peripheral element
30 18 fixing device
19 buffer
20A, 20B carrying arm (on the central part)
21A, 21B clamping shell (on the central part)

	22A, 22B	bar (on the central part)
	23	rotary joint (between peripheral element and carrying arm)
	24	hinge joint (on clamping shells)
	25	clamping screw
5	26A, 26B	hinge regions (on the central part 15A)
	27A	joint head
	27B	joint socket
	28	clamping tooth arrangement
	29	securing screw
10	A	central axis
	L	receiving region

Figure 3

	34	guide body
15	15A	central part (of the guide body)
	15B	outer part (of the guide body)
	17	peripheral element
	19	buffer
	21A, 21B	clamping shell (on the central part)
20	36	mouth region (on the central part 15A)

Figure 4 (state of the art)

	1	derrick
	2	lifting apparatus
25	3	top drive
	5	lines
	6	service loop (state of the art)

Figures 5A-5B

30	19	buffer
	25	clamping screw
	29	securing screw
	52A, 52B	bar (on the central part)

52C, 52D; 52E, 52F (material thickening)

53 rotary joint (between peripheral element and carrying arm)

54 guide body

57 peripheral element

5

Figure 6

60A, 60B carrying arm (on the central part)

62 intermediate member

63 holding eye

10 64 guide body

65A central part (of the guide body)

65B outer part (of the guide body)

66 through opening

67A peripheral element (fixed)

15 67B peripheral element (releasable)

69 buffer

Figure 7

71 carrying cable

20 72 carrying body

75A central parts

76A, 76B carrying arm (on the central part)

77 receiving means

25 Figure 8

80 connecting device

82 cable sleeve

83 receiving means

84 threaded projection

30 85A, 85B holding arms

86 transverse bores

Figure 9

- 90 meshed cable supporting grips
- 92 loop/thimble
- 93 line (cable)

CLAIMS

1. A line routing apparatus (10) for guiding a plurality of lines like cables, hoses or the like, for hanging applications like for example supplying a vertically travelling top drive (3) of a drilling rig (1) or the like, including:
- a flexible carrying strand (11) which has tensile strength and which extends over the length of the line routing apparatus, and
 - a number of guide bodies (14, 34) arranged in succession in the longitudinal direction of the carrying strand,
 - wherein adjacent guide bodies (14) can be spatially deflected relative to each other and each guide body has a central part (15A) having a central axis (A) extending coaxially relative to the carrying strand (11) and an outer part (15B) having at least one peripheral element (17), wherein the peripheral element (17) outwardly delimits a receiving region (L) open in the axial direction for the lines and is held to the central part (15A),
 - wherein in each guide body (14, 34) the outer part (15B) is openable, and
 - wherein at least some guide bodies (14, 34) at their central part (15A) have a respective fixing device (18) for fixing the central part (15A) to the carrying strand (11), characterised in that
 - the central part (15A) has two axially projecting mutually opposite joint regions (26A, 26B), wherein the joint regions are of conjugate configuration, wherein the one joint region (26A) can be releasably introduced in the axial direction into the other conjugate joint region (26B) of an adjacent guide body, and wherein the joint connection of successive guide bodies (14) is axially releasable and loose in the axial direction;
- or
- provided as the fixing device (18) is a screw clamping device with clamping screw, the guide bodies (34) are fixed to the carrying strand (11) in axially mutually spaced force-locking relationship by means of their fixing

device and the central part (15A) has no conjugate mutually opposite joint regions.

5 2. A line routing apparatus (10) for guiding a plurality of lines like cables, hoses or the like, for hanging applications like for example supplying a vertically travelling top drive (3) of a drilling rig (1) or the like, including:

 - a flexible carrying strand (11) which has tensile strength and which extends over the length of the line routing apparatus, and
10 - a number of guide bodies (14) arranged in succession in the longitudinal direction of the carrying strand,

 - wherein adjacent guide bodies (14) can be spatially deflected relative to each other and each guide body has a central part (15A) having a central axis (A) extending coaxially relative to the carrying strand (11)
15 and an outer part (15B) having at least one peripheral element (17), wherein the peripheral element (17) outwardly delimits a receiving region (L) open in the axial direction for the lines and is held to the central part (15A),

 wherein in each guide body (14, 34) the outer part (15B) is
20 openable, and

 - wherein at least some guide bodies (14, 34) at their central part (15A) have a respective fixing device (18) for fixing the central part (15A) to the carrying strand (11),

 characterised in that

25 the carrying strand (11) is in the form of a link chain and the guide bodies (14) are fixed to the carrying strand in axially mutually spaced relationship, wherein two respective successive central parts are spatially deflectably connected by one or more chain links of the carrying strand (11).

30

3. A line routing apparatus according to claim 1 or claim 2 characterised in that the at least one peripheral element (17) is connected releasably, moveably and/or pivotably to the central part (15A).

5 4. A line routing apparatus according to claim 1, claim 2 or claim 3 characterised in that at least some and in particular all guide bodies (14) at their at least one peripheral element on the outside have an elastic buffer (19) for shock absorption.

10 5. A line routing apparatus according to claim 1 characterised in that the fixing device is a clamping and/or locking device (18) which to fix the central part (15A) to the carrying strand (11) fixes the central part in force-locking relationship with an inside surface of the through opening to the carrying strand (11).

15

6. A line routing apparatus according to claim 5 characterised in that as the fixing device there is

- a clamping device (18) in the form of a joint clamping shell having a hinge-like joint (24) which connects two shell-shaped regions (21A, 21B)
- 20 which can be braced against the carrying strand, or
- a quick release clamp, latching clamp or the like, which at least partially reduces the free diameter of the through opening.

25 7. A line routing apparatus according to claim 2 characterised in that each central part (65A) forms a chain link, wherein two successive central parts are respectively spatially deflectably connected by at least one intermediate member (62).

30 8. A line routing apparatus according to claim 1 characterised in that the carrying strand (71) has carrying bodies (72) which are mounted stationarily in the longitudinal direction of the carrying strand and to which

the central parts (75A) are fixed in positively locking relationship by means of the respective fixing device (77).

5 9. A line routing apparatus according to one of claims 1 to 8 characterised in that the outer part of each guide body has two peripheral elements (17) which are respectively connected to the central part pivotably by way of a rotary joint (23) in order to insert lines into the receiving region or remove them from same, wherein the peripheral elements (17) are preferably in the shape of a half ring and/or are in the
10 form of identical parts.

10. A line routing apparatus according to claim 4 characterised in that the elastic buffer (19) is made from an elastomer and/or the buffer is of a ring-shaped or toroidal configuration, wherein the buffer preferably
15 surrounds the peripheral element or elements (17) over the full periphery.

11. A line routing apparatus according to claim 10 characterised in that all guide bodies (14) have a buffer (19) and each buffer projects axially with respect to the peripheral element or elements (17) or is axially
20 flush therewith so that the buffers of adjacent guide bodies limit the maximum angle of the spatial deflection of said guide bodies (14) relative to each other as abutments.

12. A line routing apparatus according to one of claims 1 to 11
25 characterised in that the carrying strand has a first end (11A) and a second end (11B), wherein each end has a connecting device (80) for releasably fixing (84) the line routing apparatus.

13. A line routing apparatus according to claim 12 characterised in
30 that each connecting device (80) has at least two oppositely disposed holding arms (85A, 85B) fixed to the connecting device for tensile strain relief of lines.

14. A line routing apparatus according to claim 1 characterised in that the joint regions form a ball joint-like joint connection (27A, 27B) for spatial deflection of adjacent guide bodies.

5

15. A line routing apparatus according to claim 1 characterised in that the central part (15A) has an axial through opening (16) which forms the central axis (A) and through which the carrying strand (11) extends and the through opening (16) has mutually opposite mouth regions (36) which enlarge radially outwardly.

10

16. A line routing apparatus according to claim 5 characterised in that the central part (15A) of each guide body (14) includes two one-piece carrying arms (20A, 20B) which respectively have an inner clamping shell (21A, 21B) and a radial bar (22A, 22B), wherein the clamping shells can be connected to form therebetween the through opening (16) for the carrying strand (11) and the bars (22A, 22B) have an outer end region to which the outer part (15B), in particular both peripheral elements, is or are connected (23).

15

20

17. A line routing apparatus according to claim 5 characterised in that the central part (15A) at the inside at the through opening (16) has a clamping tooth arrangement (28) extending transversely relative to the central axis (A) for axial securing to the carrying strand (11) and/or the carrying strand is in the form of a carrying cable (11) of plastic and/or is of a length of at least 5 m, in particular at least 10 m.

25

18. A line routing apparatus according to one of the preceding claims characterised in that it has a first substantially vertically downwardly hanging length portion (12A) having a first end (12C) connected to a consumer (M) to be supplied, a second substantially vertically downwardly hanging length portion (12B) having a second end (12D), and a loop (13)

30

connecting the two downwardly hanging length portions and the carrying strand (11) is extended beyond both ends (12C, 12D).

19. A guide body for a line routing apparatus according to claim 1
5 including a central part (15A) having an axial through opening (16) which forms a central axis (A) and through which a carrying strand (11) can be passed, and an outer part (15B) having at least one peripheral element (17), wherein the peripheral element outwardly delimits a receiving region (L) open in the axial direction for the lines and is held to the central part
10 (15A), wherein provided on the central part (15A) is a fixing device (18) for stationarily fixing the central part (15A) to a carrying strand (11), characterised in that

- the central part (15A) as the fixing device has a clamping and/or locking device (18) to fix the central part in force-locking relationship with
15 an inside surface of a through opening to a carrying strand in the form of a carrying cable, and

- the central part (15A) has two axially projecting mutually opposite joint regions (26A, 26B), wherein the joint regions are of conjugate configuration so that the one joint region (26A) can be releasably
20 introduced in the axial direction into the other conjugate joint region (26B) of an adjacent guide body, or

- the central part (15A) has no conjugate mutually opposite joint regions, wherein the fixing device (18) is a screw clamping device with clamping screw.

25

20. A guide body according to claim 19 characterised in that on the outside the peripheral element (17) has an elastic buffer (19) for damping radial shocks.

30 21. A guide body according to claim 19 characterised by the characterising features according to one of claims 3 to 6 or 8 to 18.

22. A drilling rig (1) having a rotary power head (3) or top drive including a line routing apparatus (10) according to one of claims 1 to 18 for supplying the top drive.

- 5 23. Use of a line routing apparatus (11) according to one of claims 1 to 18 as a service loop in an onshore or offshore drilling rig (1), in a deep drilling installation or the like, comprising two substantially vertically downwardly hanging length portions (12A, 12B) connected by a loop (13).