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(54) **Berendezés emelőszerkezeteken használt, nagyszilárdságú szálakból készült kötél leselejtezendő állapotának felismerésére**

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DEVICE FOR DETECTING THE REPLACEMENT STATE OF WEAR OF A HIGH-STRENGTH FIBRE ROPE DURING USE IN LIFTING GEAR

The present invention relates generally to hoists such as cranes which instead of steel ropes use high-tensile fiber ropes. The invention relates in particular to a device for detecting the discard state of a high-tensile fiber rope upon use on such hoists, having a detection device for detecting at least one rope parameter and an evaluation unit for evaluating the rope parameter as well as providing a discard signal depending on the evaluation of the rope parameters.

Instead of the approved steel ropes that have been used successfully for many years, it is recently tested on cranes to use high-tensile fiber ropes made of synthetic fibers such as aramid fibers (HMPA), aramid/carbon composites, highly modular polyethylene fibers (HMPE) or poly(p-phenylene-2.6-benzobisoxazole) fibers (PBO). The advantage of such high-tensile fiber ropes is their low weight. With equal rope diameters and equal or higher tensile strengths, such high-tensile fiber ropes are significantly lighter in weight than corresponding steel ropes. In particular for high cranes having correspondingly long rope lengths, this results in a higher weight reduction reflected in the dead weight of the crane leading to higher payloads for an otherwise unchanged crane design.

However, a disadvantage of such high-tensile fiber ropes is their breaking behavior, i.e. their failure without any distinct long-term prior warning. While wear is clearly indicated with steel ropes, showing failure long in advance, for example when individual steel wires break and splice open, which is easily detected, high-tensile fibers show few signs of excess splicing that could be detected with the naked eye and that would show long before their actual failure. They therefore require intelligent monitoring measures to detect the discard state of high-tensile fiber ropes in good time.

It is known from WO 2012/100938 A1 to detect the discard state of a high-tensile fiber rope by testing various rope discard criteria which change over the time in which a rope is used and under stress. Here, the rope diameter, the shear stress stiffness measured by the cross-sectional changes resulting when the rope is pinched, and by the number of completed stress cycles. However, the informative value of these individual discard criteria is limited, which means that the interaction of these discard criteria must be monitored and evaluated in a rather complex monitoring process to actually definitely detect the discard state. Further cranes having monitoring of the discard state of the rope are known from JP H02 56397 A and JP S58 160841 A.

Based on this, the object of the present invention is to provide an improved device for detecting the discard state of high-tensile fiber ropes which avoids the disadvantages of the prior art and advantageously develops it further. Preferably, a simple but reliable and precise detection of the discard state is to be achieved which economically utilizes the remaining service life of the fiber rope without jeopardizing safety, and which can be used on construction machines with simple detection devicefunctioning reliably even under heavy-duty working conditions.

According to the invention, the object mentioned is achieved with a device according to Claim 1 and a crane according to Claim 13. Preferred embodiments of the invention are the subject of the dependent claims.

It is therefore suggested to monitor the torsional stiffness of the rope and to determine the discard state by means of the torsional stiffness of the rope. The torsional stiffness of the rope means the resistance of the rope or moment of resistance against the rope being twisted. It takes a certain torque to twist the end sections of a rope sector lengthwise relative to each other, i.e. to chordate or twist the rope, to achieve the mentioned twist wherein the said torque depends on the stiffness of the rope. According to the invention, the detection device comprises torsional stiffness determination means for determining the torsional stiffness of the rope, wherein the evaluation unit provides the discard signal depending on the determined torsional stiffness of the rope. While steel ropes do not show significant changes in torsional stiffness depending on the service life of the rope, this is different with high-tensile fiber ropes. The filaments which are still flexible at the beginning of the use of the rope, are made harder and the rope is made stiffer by the tensile stress and the bending stress. This increase in the torsional stiffness of the rope can be measured easily, which means that the discard state can be determined reliably and precisely by the monitored torsional stiffness of the rope. It shows that rope twisting tests with a new rope show a rather low torsional stiffness while ropes driven to the breaking point show a very high torsional stiffness in the end due to prolonged and severe stress, namely many times that of the original state of the rope. This increase rises continuously with the number of stress cycles, reaching the highest point when the rope breaks, which means that the evaluation unit can determine the discard state relatively easily.

In the development of the invention, the torsional stiffness determination means can comprise a swivel that can be integrated in the rope drive or used to sling the rope. Sometimes such a swivel is also called the rope swivel; it usually includes two swivel parts which can be twisted relative to each other in the lengthwise direction of the rope, in particular about a rotational axis coaxially to the longitudinal axis of the rope, wherein for example a fixed swivel part can be non-rotatably hinged to a crane boom in longitudinal direction, while the rotatable swivel part is non-rotatably connected to the rope. To be able to use such a prior-art swivel to determine the torsional stiffness of the rope, a development of the invention can provide a rotary drive for forcing the two swivel parts to rotate relative to each other, in particular this rotary drive can be integrated in an interior space of the swivel wherein the rotary drive can, for example, be an electric motor, if need be in conjunction with a gear.

The rotary drive mentioned functionally sits between the two swivel parts and is rotationally supported in relation to the two swivel parts, i.e. in relation to a twist about the swivel axis. In particular, a drive axis of the rotary drive, for example a gear output shaft, can be connected to the rotatable swivel part on which the rope is non-rotatably secured, while a motor housing on the non-rotatable swivel part is non-rotatably supported or at least with only limited rotatability.

In a development of the invention, a torque meter and/or twist angle meter or folding square meter can be assigned to the swivel to determine the torque applied when the swivel is forced to rotate or to record or determine the twist angle of the two swivel parts relative to each other when the swivel is forced to rotate.

In principle, the mentioned torque meters or torque angle meters can be of various designs. For example, in a further development of the invention, the torque meter can be integrated in the rotary drive, for example when an electric motor is used, it can record its electrical control variables such as currency and voltage to determine the thus generated torque. As an alternative or in addition to such a drive parameter meter, the torque meter can also determine the reaction moment induced by the fixed swivel part in its holding member, for example in the form of a crane boom. As an alternative or in addition to that, the torque meter can also be installed in the drive gear or the rotatable swivel part, for example between the drive gear and the rotatable swivel part, for example in the form of a torsion measurement socket or the like.

In principle, the folding square meter or twist meter can also be of various designs, for example integrated into the drive gear or its drive motor. As an alternative or in addition, the twist meter can directly record the twist of the two swivel parts relative to each other.

The torsional stiffness of the rope can be detected by the torsional stiffness detection device by means of a twist of the rope achieved by a predetermined torque and/r by means of the torque required for a predetermined twist. In a development of the invention, these two detection criteria can also be used in combination with each other, in particular such that it is determined which force is required for a predetermined twist and which twist occurs with a predetermined torque, to take into consideration the non-linearity that may result with torsional stiffness.

To avoid distorting or influencing the measuring of the torsional stiffness of the rope by the stress of tensile forces upon the rope, the torsional stiffness determination means comprises a tensile stress setter which sets the same tensile force conditions on the rope for the repeating detection of the torsional stiffness of the rope. In particular, the mentioned tensile stress setter can comprise a tensile stress release means which essentially completely releases the rope of tensile forces when the torsional stiffness of the rope is determined.

The mentioned tensile release device can be of various designs. In an advantageous embodiment of the invention, the tensile release device can comprise holding means to hold the rope in lengthwise direction, preferably at least one rope clamp for clamping the rope, in particular for catching hoist loads on the lifting hook and the rope section to be tested for the torsional stiffness of the rope, wherein the holding means mentioned can for example be provided on the trolley of a tower crane, to relieve the rope section between the trolley and the swivel. Preferably, the test of the torsional stiffness of the rope test can be conducted without a load on the lifting hook, wherein the lifting hook is preferably moved to a predetermined height by control device or manually to achieve a predetermined tensile force of the rope through the dead weight of the rope and to have a certain rope length for testing.

In an advantageous development of the invention, the torsional stiffness determination means comprise a swivel compensator which prior to conducting the test of the torsional stiffness of the rope eliminates or at least greatly reduces any twist that might be present on the rope. Normally, ropes twist which are coiled on rope drums or run around rope pulleys. To avoid the distortion of the torsional stiffness of the rope measurements, preferably such twist can be removed prior to the torsional stiffness test being conducted. Preferably, the mentioned swivel compensator can also be integrated in or assigned to the above described swivel. For example, the swivel compensator can comprise a rotational direction sensor which helps to determine the rotational direction or effective direction of the twist of the rope, which means that the rotary drive can be activated depending on an associated rotational direction signal to turn the rope via the swivel or its rotatable swivel part in the intended rotational direction. If need be, the height of the torque at the swivel induced by the twist of the rope can be determined by a torque sensor of the above described kind to activate the rotary drive for as long as the detected or determined torque induced by the twist of the rope approaches zero before the torsional stiffness test is begun.

In principle, the evaluation device for providing a discard signal can work in various ways, for example by monitoring changes occurring in the torsional stiffness of the rope and/or by monitoring absolute values of the torsional stiffness. In particular, the mentioned evaluation unit can be designed such that a discard signal is provided when the torsional stiffness of the rope and/or its change reaches an associated threshold value.

For example, one or more reference measurements can be conducted with a new rope such that the percentage change in a torsional stiffness of the rope occurring in operation can be compared with a threshold value for change, and if this value is exceeded or approached, the discard signal is provided. In particular, the discard signal can be provided when the torsional stiffness of the rope increases beyond a still tolerable threshold value. ASs an alternative or in addition, the monitored and in operation constantly or cyclically detected torsional stiffness of a rope can be compared with an absolute threshold value predetermined by the manufacturer for a certain type of rope or a specific rope, and to provide the discard signal when this threshold value is reached or exceeded. Also as an alternative or in addition, the discard signal can be provided when the change in a torsional stiffness of the rope as determined by measuring occurs to fast and/or too slowly, i.e. when the speed of change in the torsional stiffness of the rope over a given time exceeds or remains below a threshold value. The speed of change over a given time can be the speed of change over the number of stress cycles recorded for example with a load cycle counter which can be taken into account by the evaluation device. As an alternative or in addition, the speed of change can also only be taken into account by means of the number of measurements of the torsional stiffness of the rope, for example such that discard signal is provided when the change in the torsional stiffness of the rope detected after a certain number of measurements, for example after the tenth measurement, exceeds a certain predetermined threshold value.

The discard signal can simply be indicated to the crane operator, for example acoustically and/or visually, or it can be used to stop the rope drive.

In an advantageous further development of the invention, the torsional stiffness determination means can be firmly installed in the rope drive of the hoist such that the torsional stiffness of the rope can be constantly monitored during operation, i.e. in the operational state of the hoist, without the necessity of having to convert the hoist into a special test modus. As an alternative or in addition, the torsional stiffness determination means can also be provided as a detachable unit that can be used in different hoists.

Below, the invention is described in more detail by means of a preferred embodiment and with reference to the drawings, where

Fig. 1 shows a schematic illustration of a hoist according to the invention in the form of a tower crane according to an advantageous embodiment of the invention, whose hoisting rope and/or bracing ropes can be designed for the luffable boom as fiber ropes, wherein the torsional stiffness determination means are fastened to the end of a hoist rope running from a rope drum and across a trolley at the crane's boom;

Fig. 2 shows a schematic illustration if a hoist according to the invention in the form of a tower crane according to another advantageous embodiment of the invention, whose boom is luffable, wherein the hoist rope running from a rope drum runs across the boom tip, and the torsional stiffness determination means are fastened to the rope end at the boom end;

Fig. 3 shows a schematic illustration of the swivel of the torsional stiffness determination means integrated into the rope drive of the hoist rope of the crane shown in Fig. 1 in a longitudinal section showing the rotary drive of the swivel, and

Fig. 4 shows a cross-section through the rotary drive of the swivel of the torsional stiffness determination means, wherein the torque support and the torque meter facing the rotary drive are shown.

Fig. 1 shows as an example a hoist according to an advantageous embodiment of the invention in the form of a top-slewing crane 20 whose tower 21 is mounted on a carriage or solid base. Linked to tower 21 in a previously known manner is a boom 23 braced by bracing 24. The mentioned bracing 24 can be rigid, for example in the form of bracing rods, but also adjustable in the form of a rope reeving that can be changed in length via a bracing winch 25 such that the working angle of boom 23 can be changed, as shown in Fig. 2.

As shown in Fig. 1, the tower crane 20 can be provided with a trolley boom. A movable trolley is installed on the mentioned crane in operating position, in particular on its horizontally oriented boom 23, wherein the mentioned trolley 55 can, for example, be moved via a trolley rope which can be guided via deflection pulleys at the boom tip.

The tower crane further comprises a hoist rope 1 that can be lowered via deflection pulleys from the boom tip where it is connected with a crane hook 29, as shown in Fig. 2, or in the version according to Fig. 1 can run via the mentioned movable trolley 55 and deflection pulleys provided there, and can be connected with the crane hook 29. In both cases, the mentioned hoist rope 1 runs on a hoist winch 30.

The mentioned hoist rope 1 and/or the bracing rope can be designed as fiber ropes which can consists of synthetic fibers such as aramid fibers or fibers made from a mixture of aramid and carbon.

In both cases, the mentioned hoist rope can be fastened to boom 23 of the crane by means of a swivel 4.

To monitor or detect the parameters of the mentioned fiber rope relevant to its discard state, a detection device is provided that can be arranged on the crane and which together with an evaluation unit 3, which evaluates the acquired parameters, can be connected with or integrated in the electronic crane control unit 31.

As Fig. 2 and 3 show, the torsional stiffness determination means 2 advantageously comprises the above mentioned swivel 4 shown in greater detail in Fig. 3 and 4. The mentioned swivel 4 comprises two swivel sections 4a and 4b which are rotatable relative to each other in the lengthwise direction of the rope. Swivel part 4a forms a fixed or non-rotatable swivel part which with regard to the lengthwise direction of the rope is rigidly mounted on boom 23. It may have an oscillating, suspended or upright arrangement via a first bearing axis 6 or a lying, also oscillating arrangement via the second bearing axis 7 can be provided which allow oscillating or swiveling movements across the lengthwise direction of the rope while preventing the swivel part 4 to twist in the lengthwise direction of the rope.

The other swivel part 4b forms the rotatable swivel part to which the rope 1 is non-rotatably fastened. The mentioned rotatable swivel part 4b can, for example, be rotatably mounted about the lengthwise direction of the rope via roller bearings such as in the form of an axial bearing 8 and a radial bearing 9 on the fixed swivel part 4a.

Advantageously, the rotatable swivel part 4b can be connected to a rotary drive 5 which advantageously can be located within swivel 4. For this, for example, the fixed swivel part 4a can be bell-shaped or sleeve-shaped to create accommodation for rotary drive 5. However, a reverse arrangement with bell-shaped or sleeve-shaped contours for the rotatable swivel part 4b, which then could also enclose the fixed swivel part 4a, could also be provided.

For example, the mentioned rotary drive 5 can comprise an electric motor connected via a gear or directly non-rotatably via an output shaft to the rotatable swivel part 4b. A drive housing 10 of the rotary drive 5 can be secured against twist on the fixed swivel part 4a, for example by means of one or more torque supports 14 which can be supported via stops or other suitable bearing contours on swivel part 4a; see Fig. 4.

As Fig. 3 and 4 show, the swivel 4 is provided with measuring means beyond the mentioned rotary drive 5 to measure the angle of twist of the two swivel parts 4a and 4b at a rotation relative to each other as well as the torque necessary for a twist of the two swivel parts 4a and 4b and also the rotational direction. In principle, the folding square meter 12, torque meter 11 and rotation direction meter 13 provided for this can be of various designs and may, for example, comprise a means to measure the operating parameters of the motor for the rotary drive 5. For example, the torque can be determined from the operating parameters current and voltage of the drive motor. As an alternative or in addition, the torque meter 11 on the mentioned torque support 14 of the rotary drive 5 opposite to the swivel part 4a can be assigned to measure the torque and make it available to control device 15. The mentioned rotation direction meter 13 can also be assigned to the torque support 14, for example combined with the mentioned torque meter 11 into a measuring unit which measures the pressure of the torque support against the stop contour on swivel part 4a.

As an alternative or in addition, the torque meter 11 and/or the rotational direction meter 13 can also be integrated in or assigned to a connector part 16 with which rope 1 is connected to the rotatable swivel part 4b.

The folding square meter 12 or an equivalent torque sensor can, for example, be connected to an interface between the two swivel parts 4a and 4b to directly measure the twist of the two swivel parts relative to each other. As an alternative or in addition, a folding square meter 12 can be assigned to rotary drive 5 or on a gear shaft or output shaft of rotary drive 5.

Advantageously, the torsional stiffness of rope 1 can be detected by means of the following steps:

- First, the rope is moved into the position to be measured, for which the hoist position measuring means of the lifting hook can be used. In particular, the lifting hook is moved to a certain hoist height, and if need be, the trolley is moved into a certain position, or the boom is moved into a certain luffing position.
- When a new rope is used for the first time, the torsional stiffness of rope 1 is measured in the zero state as a reference base for further measurements. For this, the determined test length L of the rope can be set at a certain value and stored, for example by bringing the lifting hook to a certain hoist height, the trolley to a certain position and(/or the boom into a certain luffing position. This can be measured via suitable positioning or position sensors and stored such that the reference rope length L can be set again as desired for later measurements. As Fig 1 shows, in a tower crane with trolley, the measured rope section and its length L can be between swivel 4 and the deflection pulley of the trolley. In a tower crane with luffable boom 23, the rope section and its length L can be between the mentioned swivel and the lifting hook or the lifting hook sheath.
- Preferable, the test can be done at the hook without a load such that the rope always has the same pull for all subsequent tests.
- To begin a torsional stiffness test, the twist existing in rope 1must first be compensated for as much as possible. For this, the torque induced by the twist of the rope into swivel 4 must be measured,

which can be done with the above described torque meter 11. Then the control unit 15 controls rotary drive 5 depending on the determined torque and its direction, such that the torque induced by the twist of the rope goes toward zero. That is the initial point for the actual torsional stiffness test.

- Now, in the mentioned section L of rope 1 a predetermined number of rotations is induced, and the resulting torque is measured. For that, rotary drive 5 is activated, and the toque required for the twist is measured.

  As an alternative or in addition, the rotary drive can be controlled by control unit 15 such that a certain torque is induced into rope 1, wherein the resulting rotational speed or the resulting angle of twist is measured with the folding square meter.

  The torsional stiffness of the rope is determined from the measured torques and twist angles. With a fixed rotational speed, the torque required for this can be used directly as the measure of torsional stiffness, while with a fixed torque, the resulting rotational speed or the resulting angle of rotation can be used as the measure of torsional stiffness. In particular, the mentioned measuring values of torque and angle of rotation are stored in the memory of the control unit 15 to be used as a reference base for subsequent measuring.

  In predetermined time intervals - if need be in the form of a predetermined number of load cycles or bending cycles that can be recorded by a load cycle counter - the torsional stiffness is again measured as described and the results are compared with those of previous measurements, in particular with those of the new rope.

- Evaluation device 3 evaluates in particular – in the manner as described above whether the torsional stiffness of the rope and/or its change in relation to the new rope exceeds a predetermined threshold value.

- The maximum permissible threshold value of torsional stiffness or of permissible change in the evaluation of a new rope for safe crane operation can be recorded in control unit 15 and used as a comparative basis when measuring the torsional stiffness. In a further development of the invention, a prior warning can be given when the mentioned threshold value is approached, thus indicating that the rope should be replaced. When the mentioned threshold value is disregarded, reached or exceeded, control unit 15 can use the discard signal generated by evaluation unit 3 to automatically shut down the operation with that rope.

- Moving the rope section for determining torsional stiffness can be effected automatically or manually programmed.

BERENDEZÉS EMELŐSZERKEZETEKEN HASZNÁLT, NAGYSZILÁRDSÁGÚ SZÁLAKBÓL KÉSZÜLT KÖTÉL LESELEJTEZENDŐ ÁLLAPOTÁNAK FELISMERÉSÉRE

Szabadalmi igénypontok

1. Berendezés emelőszerkezeteken, különösen darukon használt nagyszilárdságú szálakból készült kötél (1) leselejtezendő állapotának felismerésére, amely berendezés legalább egy kötélparaméter érzékelésére alkalmas érzékelőegységet, valamint a kötélparaméter kiértékelésére és a kötélparaméter-kiértékelés függvényében egy leselejtezési jel előállítására szolgáló kiértékelő egységet (3) tartalmaz, **azzal jellemezve**, hogy az érzékelőegység a kötél (1) csavarási merevségének meghatározásához csavarásimerevség-meghatározó eszközt (2) tartalmaz és a kiértékelő egység (3) a leselejtezési jelet a meghatározott csavarási merevségtől függően állítja elő.

2. Az előző igénypont szerinti berendezés, ahol a csavarásimerevség-meghatározó eszköz (2) egy kötélszakasznak egy előre meghatározott szöggel és/vagy egy előre meghatározott forgatónyomatékkal való csavarásához forgatóhajtóművet (5), valamint a kötélszakasz csavarodásából eredő forgatónyomaték és/vagy elfordulási szög érzékeléséhez érzékelőeszközt tartalmaz, ahol a kiértékelőegység (3) a meghatározott forgatónyomaték és/vagy elfordulási szög függvényében a kötél csavarási merevségét meghatározza.

3. Az előző igénypontok bármelyike szerinti berendezés, ahol a csavarásimerevség-meghatározó eszköz (2) forgócsapágyat (4) tartalmaz két csapágyrésszel (4a, 4b), melyek a kötél hosszirányában egymáshoz képest elfordíthatók és egy/a forgatóhajtómű (5) révén egymáshoz képest kényszerforgatásnak vethetők alá.

4. Az előző igénypont szerinti berendezés, ahol a forgócsapágy (4) egy kötélvéggel elfordulásmentesen össze van kapcsolva, továbbá egy alaprészhez, különösen darugémrészhez, elfordulásmentesen van csatlakoztatva.

5. Az előző két igénypont egyike szerinti berendezés, ahol a forgócsapágy (4) forgatónyomaték-mérővel (11) és/vagy elfordulásmérővel (12) van társítva, ahol a kötél csavarodási merevsége egy előre meghatározott forgatónyomaték kifejtésével elért elfordulás és vagy egy előre meghatározott elfordulás eléréséhez szükséges forgatónyomaték alapján a csavarásimerevség-meghatározó eszközzel (2) meghatározható.

6. Az előző igénypontok bármelyike szerinti berendezés, ahol a forgatóhajtómű (5) a forgócsapágyba (4) van integrálva, különösen egy csapágyrész (4a) által körülvett belső térben van elrendezve.

7. Az előző igénypontok bármelyike szerinti berendezés, amely csavarodáskompenzálót tartalmaz egy adott esetben a kötél csavarási merevségének meghatározását megelőzően fellépő kötélcsavarodás kompenzálásához.

8. Az előző igénypont és az 5. igénypont szerinti berendezés, ahol a csavarodáskompenzáló a forgatóhajtómű (5) vezérléséhez vezérlőegységet tartalmaz a kötél (1) kötélcsavarodása által a forgócsapágyra (4) kifejtett hatás kompenzálásához a forgatónyomaték-mérő (11) által meghatározott forgatónyomaték

függvényében és/vagy egy forgásiránymérő (13) által meghatározott forgásirány függvényében, ahol a vezérlőegység úgy van kialakítva, hogy a forgatóhajtómű (5) olyan módon működtethető, hogy a forgatónyomaték-mérő (11) által érzékelt forgatónyomaték értéke nullára módosuljon.

9. Az előző igénypontok bármelyike szerinti berendezés, ahol a forgatónyomaték-mérő (11) és/vagy az elfordulásmérő (12) és/vagy a forgásiránymérő (13) a forgócsapágyba (4) és/vagy a forgatóhajtóműbe (5) van integrálva.

10. Az előző igénypontok bármelyike szerinti berendezés, ahol a csavarásimerevség-meghatározó eszköz (2) a kötélben (1) egy előre meghatározott húzóerő automatikus beállításához húzóerő-beállító egységet és/vagy a csavarásimerevség-ellenőrzésnek alávetni szándékozott kötélszakasz egy előre meghatározott *L* hosszának beállításához hosszbeállító eszközt tartalmaz.

11. Az előző igénypontok bármelyike szerinti berendezés, ahol a kiértékelő egység (3) leselejtezési jelet állít elő, amikor a kötélnek a csavarásimerevség-meghatározó eszköz (2) által meghatározott csavarási merevsége és/vagy annak változása egy megfelelő küszöbértéket meghalad.

12. Az előző igénypontok bármelyike szerinti berendezés, ahol a kötél csavarási merevségének különböző kötélszakaszokon való meghatározásának lehetővé tételéhez a csavarásimerevség-meghatározó eszköz (2) különböző kötélszakaszok, előnyösen különböző hosszúságú kötélszakaszok automatikus pozícionálásához kötélpozícionáló eszközt tartalmaz.

13. Daru, különösen forgó toronydaru, mobildaru, kikötői mobildaru, úszódaru vagy konzolos járműdaru, amely az előző igénypontok bármelyike szerinti berendezést tartalmaz nagyszilárdságú szálakból készült kötél leselejtezendő állapotának felismerésére.

14. Az előző igénypont szerinti daru, ahol a csavarásimerevség-meghatározó eszköz (2) a daru kötélhajtásához társítva rögzítetten van felszerelve, vagy egy eltávolítható egységként van kiképezve úgy, hogy a kötél csavarási merevsége a daru daruhajtásának üzemelésre kész nyugalmi állapotában meghatározható.

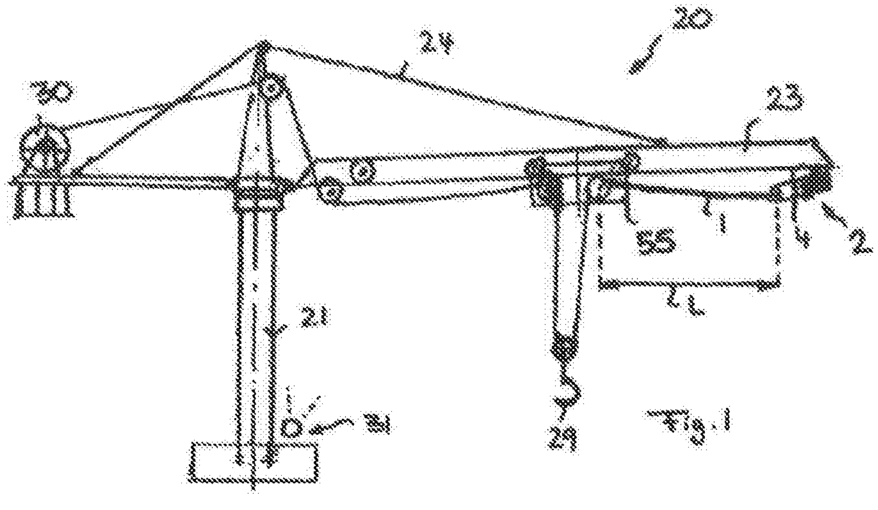

Fig. 1

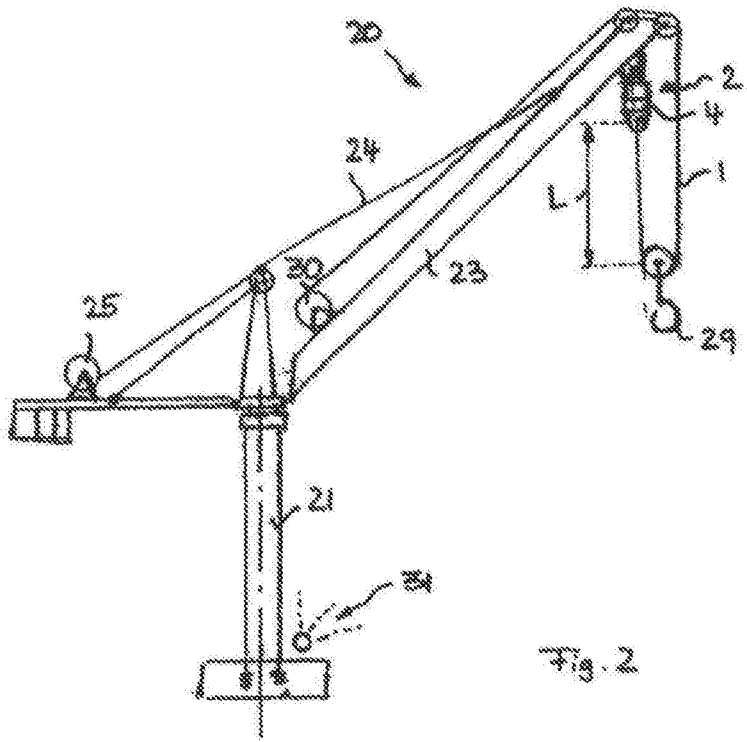

Fig. 2

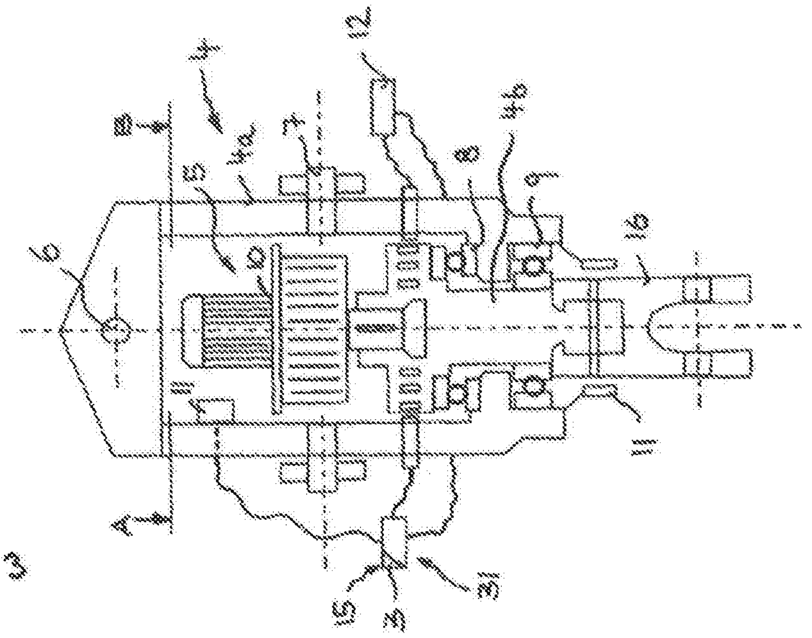

Fig. 3

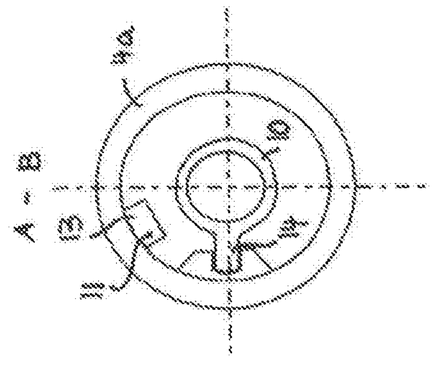

Fig. 4