



(22) Date de dépôt/Filing Date: 2011/04/26

(41) Mise à la disp. pub./Open to Public Insp.: 2011/10/28

(45) Date de délivrance/Issue Date: 2017/05/23

(30) Priorité/Priority: 2010/04/28 (EP10 004 488.2)

(51) Cl.Int./Int.Cl. *G01N 21/956* (2006.01)

(72) Inventeurs/Inventors:

WINTER, SVEN, DE;
MOLL, DIRK, DE;
EISINGER, RALF, DE;
KUEHNER, KONSTANTIN, DE;
GUTTENGEER, EGON, DE;
PROEHL, ANDREAS, DE;
EICHINGER, MARKUS, DE

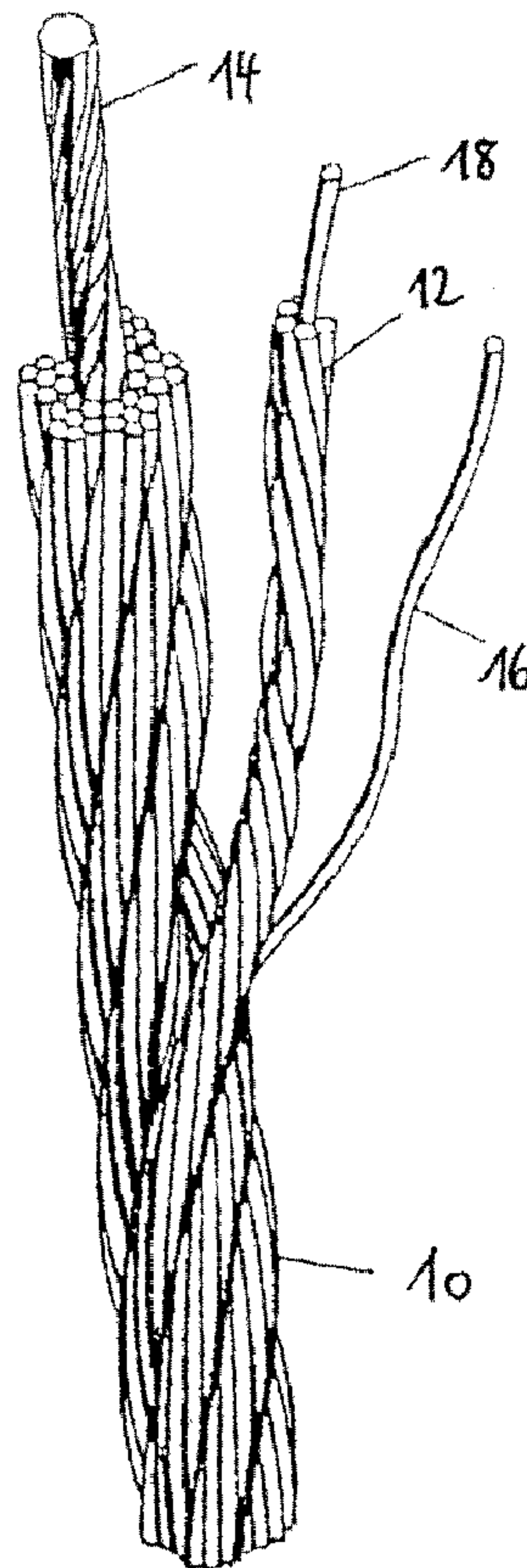
(73) Propriétaire/Owner:

WINSPECT GMBH, DE

(74) Agent: MOFFAT & CO.

(54) Titre : SYSTÈME ET PROCÉDE POUR L'ESSAI DES CABLES

(54) Title: SYSTEM AND METHOD FOR TESTING ROPES



(57) Abrégé/Abstract:

One aspect of the present invention relates to a method for the computer-aided, optical testing of a rope, comprising: - providing an image data set for at least one portion of the rope; - providing target values of a pictorial longitudinal extension J_0 of the



(57) **Abrégé(suite)/Abstract(continued):**

representation of wires relative to a pictorial longitudinal extension L of the rope in the image data set; - determining a pictorial longitudinal extension J_m of the wires in the image data set, wherein determining comprises adapting an estimated longitudinal extension to the image data set; - determining at least one quality value by means of a quality norm as a function of the determined pictorial longitudinal extension J_m of the wires and the target values of the pictorial longitudinal extension J_0 of the wires; - discriminating pictorial positions within the image data set of the rope, at which at least one quality value exceeds or falls below a predetermined, assigned quality threshold value; - providing the discriminated pictorial positions, as well as an associated system and a computer program product.

Abstract

One aspect of the present invention relates to a method for the computer-aided, optical testing of a rope, comprising:

- providing an image data set for at least one portion of the rope;
- providing target values of a pictorial longitudinal extension J_0 of the representation of wires relative to a pictorial longitudinal extension L of the rope in the image data set;
- determining a pictorial longitudinal extension J_m of the wires in the image data set, wherein determining comprises adapting an estimated longitudinal extension to the image data set;
- determining at least one quality value by means of a quality norm as a function of the determined pictorial longitudinal extension J_m of the wires and the target values of the pictorial longitudinal extension J_0 of the wires;
- discriminating pictorial positions within the image data set of the rope, at which at least one quality value exceeds or falls below a predetermined, assigned quality threshold value;
- providing the discriminated pictorial positions,

as well as an associated system and a computer program product.

Applicant: Automation W+R GmbH
"System and method for testing ropes"
Our Ref.: A 6547CA - ro / at

Description

The present invention relates to a system and a method for testing ropes, and to a computer program product.

Depending on the field of application, ropes are subjected to various stresses. For example when used with cableways, cranes or elevators, ropes move over rollers or are deflected by pulleys. Here, the rope with the individual wires is loaded primarily with tensile stresses and secondarily with bending and torsional stresses. Especially moving and stationary ropes have a finite service life for this reason.

10 In order to ensure the operational reliability of the ropes, in particular of ropes used for cableways, bridges, cranes or elevators, the ropes have to be checked on a regular basis. According to the prior art, such checks can comprise visual rope checks by an employee.

15 Based on the known prior art, it is an object of the invention to provide a method for testing a rope, which can be performed more easily and safely and achieves an improved test result. The object is solved by the features of the independent claims. Preferred embodiments are the subject of the dependent claims.

20 Method for testing

One aspect of the present invention relates to a method for the computer-aided, optical testing of a rope, comprising:

- providing an image data set for at least one portion of the rope;
- 25 - providing target values of a pictorial longitudinal extension J_0 of the representation of wires relative to a pictorial longitudinal extension L of the rope in the image data set;

- determining a pictorial longitudinal extension J_m of the wires in the image data set, wherein determining comprises adapting an estimated longitudinal extension to the image data set;
- determining at least one quality value by means of a quality norm as a function of the determined pictorial longitudinal extension J_m of the wires and the target values of the pictorial longitudinal extension J_0 of the wires;
- discriminating pictorial positions within the image data set of the rope, at which at least one quality value exceeds or falls below a predetermined, assigned quality threshold value;
- providing the discriminated pictorial positions.

An optical rope check is possible by means of the provided image data set, wherein great physical strain for the employee performing the visual check, for example by limited-space workplaces, by wrong body postures and wrong sitting positions, poor lighting conditions, and weather factors (cold, rain, wind, etc.), is advantageously avoided. A negative effect on the check result due to loss of concentration of the employee performing the check can advantageously be avoided in particular in the case of a longer test duration. Advantageously, the method according to the invention can be interrupted any time and/or be performed without supervision.

20

Providing the image data set can preferably comprise optically capturing at least one portion of the rope, in particular by means of an optical rope capturing device, so that optical capturing is advantageously possible during operation. Further advantageously, dangers posed to the testing employee by e.g. moving parts, such as rope, rope pulley, rollers, etc., are ruled out by optical capturing.

25

Advantageously, the provided or obtained image data set is available in electronic form and can thus be archived permanently by means of a corresponding archiving device. Thereby, changes of the rope condition can advantageously be detected or understood easily. In addition to the archivability of the visual rope condition, the conditions can be better understood or verified in an objective way. For a better archivability of the image data set, the obtained or provided images or raw image

30

data can preferably be stored with a suitable algorithm in a compressed way. The compression method can preferably be selected such that random access to an arbitrary rope position is possible, for example by a JPEG compression in sections together with a jump table in which the rope position is indexed. Preferably, this
5 compression can already be performed while the image data are obtained, so that a predetermined limited data transfer rate to the storage medium is not exceeded.

Further advantageously, the archivability of the image data set also enables monitoring the rope condition over time. Thus, it is conceivable that a temporal
10 development of the rope condition or a defect can be noticed by assigning same rope positions to image data recorded at a different time.

Further advantageously, the test method can also be applied as a so-called inline check if the calculation duration of the observables to be evaluated, the computer
15 performance, and the inline check permit this. The rope parameters, target values, and threshold values can be stipulated in a preceding configuration process.

Preferably, the test method can comprise a 3D reconstruction. Since the rope geometry is usually well known, conclusions as to a deviation of the rope geometry in
20 the three-dimensional space can be drawn from the determined deviations of the wire positions in a 2D image of the image data set. This 3D rope geometry could then be reconstructed in the three-dimensional space for a more precise visualization, and be illustrated as a model on a display device or display. The 2D image data of the image data set can be used as a texture for this 3D model in particular after a
25 corresponding transformation.

The pictorial longitudinal extension J_m , J_0 , J of the representation of wires as defined by the invention is understood such that an image of a wire, which is included in the image data set, extends substantially along a preferred spatial direction, which can
30 be referred to as a longitudinal extension or longitudinal direction of the wire. Wires of a rope extend spatially preferably along their longitudinal extension, in particular over a length of several meters, while the widthwise extension of wires is approx. 0.5 mm

to approx. 6 mm. The image data set is provided such as to comprise an image of wires of a rope or the rope, in which the longitudinal extension of wires of the rope or the longitudinal direction or longitudinal extension L of the rope coincides substantially with a direction spanning the image plane. Therefore, the image of the wires or the rope in the thus provided image data set also has a longitudinal extension, which e.g. is longer than the widthwise extension of the image of the wire or the rope in the image data set by a factor greater than 2, preferably greater than approx. 5, in particular greater than approx. 10.

10 The term "wire" as defined by the invention is not limited to a metal wire, but also comprises plastic fibers used for forming a plastic rope, or natural fibers. The term "wire" as defined by the invention thus is to be understood as "wire or fiber, in particular plastic fiber or natural fiber". Accordingly, in addition to wire ropes, the term "rope" also comprises plastic ropes, fiber ropes, etc.

15

Target values of the pictorial longitudinal extension J_0 of the representation of wires can be provided by means of a database, by reading out a data carrier or by means of a user input. The target values of the pictorial longitudinal extension J_0 can comprise target points, target positions and/or target directions of the image of wires relative to the pictorial longitudinal extension L of the rope in the image data set. Advantageously, the reference of the target values to the pictorial longitudinal extension L of the rope allows a precise definition of target points, target positions and/or target directions also in the case that the longitudinal extension L of the rope in the image data set does not have a predetermined direction and/or position.

25

In particular, the target values of the pictorial longitudinal extension J_0 of the representation of wires can comprise a wire angle β of one or more wires, wherein the wire angle β can be defined as the angle that is enclosed between the target value of the pictorial longitudinal extension L_0 of the rope and the target value of the longitudinal extension J_0 of the wires. Since a defect-free rope can be assumed for the target values, the wire angles β can be predetermined for all wires by the type of the rope. For example, the wire angles of adjacent wires can have substantially the

30

same size, that is, adjacent wires are arranged substantially in parallel to each other and are shown substantially in parallel to each other in the image data set.

Preferably, the target values of the pictorial longitudinal extension J_0 of the representation of wires can also comprise an expected target start and/or target end position of one or more wires. The target start and the target end position can define the start and the end, respectively, of the longitudinal extension J_0 of the wires visible in the image data set. Alternatively or in addition, the target values can also comprise further target positions of one or more wires of the rope, such as a geometric center or a turning point of the longitudinal extension of the wires visible in the image data set.

Preferably, the step of determining the spatial extension of the wires in the captured portion of the rope is performed by adapting an estimated longitudinal extension of the wires to areas of the image data set with high brightness values. For example, a high brightness value is a brightness value that is above the mean value of all brightness values of the image data set relating to the rope.

The determination of the actual pictorial longitudinal extension J_m of the wires in the image data set is performed by adapting or fitting, in particular by an iterative adaptation or fitting. For the adaptation, the target values of the pictorial longitudinal extension J_0 of wires can be assumed as initial starting values for an estimated longitudinal extension. Adapting comprises determining image information of the image data set present at the position of the estimated longitudinal extension, and changing the estimated longitudinal extension to minimize a deviation between the image information present at the estimated longitudinal extension and expected image information. For example, the target values of the pictorial longitudinal extension J_0 of the representation of a wire can relate to the wire center line, so that at the points of the image data set where the wire center line is located, for example, higher brightness values can be expected than at the border line between two adjacent wires. Based on the pictorial longitudinal extension J_0 according to the target values, the actual longitudinal extension J_m can be determined by adapting the

estimated longitudinal extension by means of the image data set.

According to the method, on the basis of the provided target values of the pictorial longitudinal extension J_0 of the wires and by means of the pictorial longitudinal extension J_m of the wires determined by means of the adaptation, at least one quality value is calculated, which indicates to what extent the actual longitudinal extension J_m deviates from the target value of the pictorial longitudinal extension J_0 . Therefore, determining the quality value can comprise comparing the determined pictorial longitudinal extension of the wires with the target values of the pictorial longitudinal extension of the wires. The quality value can be determined by means of a quality norm as a function of this comparison, i.e. as a function of the determined pictorial longitudinal extension J_m of the wires and the target values of the pictorial longitudinal extension J_0 of the wires. Various distance norms, confidence values, or statistical figures can be used as the quality norm.

15

On the basis of the at least one determined quality value, pictorial positions within the image data set of the rope, at which at least one quality value exceeds or falls below a predetermined assigned quality threshold value, are discriminated. A potential rope defect can be assigned to the exceeding or falling below of a quality threshold value, so that discriminating can also comprise discriminating with respect to the presence of a rope defect or a specific rope defect.

20

The result of the discrimination is provided, wherein in addition to the indication that a quality threshold value is exceeded or fallen below within the image data set, the pictorial position assignable or assigned to the exceeding or falling below can be provided as well. Moreover, the pictorial position within the image data set can be linked with a spatial position, so that alternatively or in addition, the spatial positions at which the exceeding or falling below of the quality threshold value occurs can be provided. It is understood that in case the discrimination has been performed with respect to two or more quality threshold values, there can also be provided the information as to which of the quality threshold values was not complied with and in particular which rope defect assigned to the quality threshold values occurred. The

25

30

provision of the result can in particular comprise the storage on a data carrier, the display on a display device, the printing of a test protocol and the transmission to an external device, for example via an interface in the form of a data stream.

5 Preferably the method further comprises the steps of:

- providing target values of the pictorial longitudinal extension K_0 of the representation of strands relative to the pictorial longitudinal extension of the rope in the image data set;
- determining the pictorial longitudinal extension K_m of the strands in the image
10 data set, wherein determining comprises adapting an estimated longitudinal extension to the image data set;
- determining at least one lay quality value by means of a lay quality norm as a function of the determined pictorial longitudinal extension of the strands and the target values of the pictorial longitudinal extension of the strands.

15

Objects to be preferably tested are stranded ropes, in particular stranded wire ropes, their strands being arranged around a rope core in a spiral-shaped way. The ropes in turn comprise a strand core around which a plurality of wires is arranged in a spiral-shaped way.

20

The pictorial longitudinal extension of the representation of strands as defined by the invention is understood such that an image of a strand, which is included in the image data set, extends substantially along a preferred spatial direction, which can be referred to as a longitudinal extension or longitudinal direction of the wire. Just like
25 the wires of a rope, strands extend spatially preferably along their longitudinal extension, in particular over a length of several meters, while the widthwise extension of strands is approx. 1 mm to approx. 30 mm. If the image data set is provided as described above, the longitudinal extension of one of the spiral-like arranged strands coincides at least partially substantially with a direction spanning the image plane.

30

Target values of the pictorial longitudinal extension K_0 of the representation of strands can be provided by means of a database, by reading out a data carrier or by

means of a user input. The target values of the pictorial longitudinal extension K_0 can comprise target points, target positions and/or target directions of the image of strands relative to the pictorial longitudinal extension L of the rope in the image data set. Advantageously, the reference of the target values to the pictorial longitudinal extension L of the rope allows a precise definition of target points, target positions and/or target directions also in the case that the longitudinal extension L of the rope in the image data set does not have a predetermined direction and/or position.

In particular, the target values of the pictorial longitudinal extension K_0 of the representation of strands can comprise a lay angle α of one or more strands, wherein the lay angle α can be defined as the angle that is enclosed between the target value of the pictorial longitudinal extension L_0 of the rope and the target value of the longitudinal extension K_0 of the strands. Since a defect-free rope can be assumed for the target values, the lay angles α can be predetermined for all wires by the type of the rope. For example, the lay angles of adjacent strands can have substantially the same size, that is, adjacent strands are arranged substantially in parallel to each other and are shown substantially in parallel to each other in the image data set. Alternatively or in addition to the lay angle α , a lay length S of one or more strands can be provided as the target value(s). The lay length S indicates after what distance along the longitudinal direction L of the rope a strand has wrapped the rope core completely. The lay length S can also be determined by means of the strand thickness and the number of strands by a multiplication of the two variables.

Preferably, the target values of the pictorial longitudinal extension K_0 of the representation of strands can also comprise an expected target start and/or target end position of one or more strands or of one or more border lines between adjacent strands. The target start and the target end position can define the start and the end, respectively, of the longitudinal extension K_0 of the strands visible in the image data set. Alternatively or in addition, the target values can also comprise further target positions of one or more strands of the rope, such as a geometric center or a turning point of the longitudinal extension of the strands visible in the image data set, or points on the border line of one of the strands with an adjacent strand.

Preferably, the step of determining the spatial extension of the strands in the captured portion of the rope is performed by adapting an estimated longitudinal extension K_m of the strands to areas of the image data set with low brightness values. For example, a low brightness value is a brightness value that is below the mean value of all brightness values of the image data set relating to the rope.

The determination of the actual pictorial longitudinal extension K_m of the strands in the image data set is performed by adaptation or fitting, in particular by an iterative adaptation or fitting. For the adaptation, the target values of the pictorial longitudinal extension K_0 or strands can be assumed as initial starting values for an estimated longitudinal extension. Adapting comprises determining image information of the image data set present at the position of the estimated longitudinal extension, and changing the estimated longitudinal extension to minimize a deviation between the image information present at the estimated longitudinal extension and expected image information. For example, the target values of the pictorial longitudinal extension K_0 of the representation of a strand can relate to the border line of this strand with an adjacent strand, so that at the points of the image data set where the border line of the strand is located, lower brightness values than at the areas surrounding the border line can be expected due to shadows. Based on the pictorial longitudinal extension K_0 according to the target values, the actual longitudinal extension K_m can be determined by adapting the estimated longitudinal extension by means of the image data set.

According to the method, on the basis of the provided target values of the pictorial longitudinal extension K_0 of the strands and by means of the pictorial longitudinal extension K_m of the strands determined by means of the adaptation, the lay quality value G_S can be calculated. The lay quality value G_S indicates to what extent the actual longitudinal extension K_m deviates from the target value of the pictorial longitudinal extension K_0 , for example by a variation of the lay length S or of the lay angle α . Determining the lay quality value G_S can comprise comparing the determined pictorial longitudinal extension of the strands with the target values of the

pictorial longitudinal extension of the strands. The lay quality value G_S can be determined by means of the lay quality norm as a function of this comparison, i.e. as a function of the determined pictorial longitudinal extension K_m of the strands and the target values of the pictorial longitudinal extension K_0 of the strands. Various distance
5 norms, confidence values, or statistical figures can be used as the lay quality norm.

Preferably, target values of the pictorial longitudinal extension J_0 of the representation of wires are provided relative to the pictorial longitudinal extension of the strands in the image data set. Further preferably, the pictorial longitudinal
10 extension J_m of the wires in the image data set is determined relative to the determined longitudinal extension of the strands.

As has been explained above, the provided target values of the pictorial longitudinal extension J_0 of the representation of wires, for example target points, target positions
15 and/or target directions of the image of wires, can be indicated relative to the pictorial longitudinal extension L of the rope in the image data set. In the preferred case of a test of a stranded rope, these target values of the longitudinal extension J_0 can be indicated alternatively or in addition relative to a target value of the longitudinal extension K_0 of one or more strands. Advantageously, the reference of the target
20 values to the pictorial longitudinal extension K_0 of the strand allows a precise definition of target points, target positions and/or target directions also in the case that the actual longitudinal extension K_0 of the strand relative to the longitudinal extension L of the rope in the image data set does not have a predetermined direction and/or position. Advantageously, this allows distinguishing in particular
25 between cases in which a strand as a whole is not located in the target position, but the longitudinal extension of the wires within the strand corresponds to its target positions, and cases in which deviations in the longitudinal extension of the wires with respect to the target values occur.

30 In particular, the target values of the pictorial longitudinal extension J_0 of the representation of wires can comprise a wire-strand-angle γ of one or more wires, wherein the wire-strand-angle γ can be defined as the angle that is enclosed

between the target value of the pictorial longitudinal extension K_0 of the strand and the target value of the longitudinal extension J_0 of the wires. For a defect-free strand, the wire-strand-angles γ can be constant preferably for all wires, i.e. the adjacent wires are arranged substantially in parallel with each other.

5

Preferably, the at least one quality value comprises a geometry quality value G_G , which is determined by means of a geometry quality norm

- as a function of a geometric distance between the determined pictorial longitudinal extension J_m of the wires and the target values of the pictorial longitudinal extension J_0 of the wires, and/or
- as a function of a geometric distance between the determined pictorial longitudinal extensions J_m of at least two adjacent wires.

10

Preferably, the geometry quality value G_G can be calculated on the basis of the provided target values of the pictorial longitudinal extension J_0 of the wires and the actual pictorial longitudinal extension J_m of the wires determined by means of the adaptation. The geometry quality value G_G preferably indicates to what extent the actual longitudinal extension J_m deviates from the target value of the pictorial longitudinal extension J_0 . The geometry quality value G_G can for example be determined by determining a Euclidean distance as the preferred geometry quality norm between the two longitudinal extensions and/or between marked points with the two longitudinal extensions. Alternatively or in addition, the geometry quality norm can also comprise a difference of the wire angle according to one of the target values and a determined actual wire angle.

20

The geometry quality value G_G can preferably also indicate the extent of the deviation of the actual longitudinal extension J_m of two adjacent wires from each other or from a corresponding target value of the pictorial longitudinal extension J_0 . The geometry quality value G_G can for example comprise a difference of the determined wire angles according to the determined actual longitudinal extension J_m of two or more adjacent wires. A variation of the wire angle can for example be indicative of a displacement or shift of two adjacent wires.

30

Preferably, the method further comprises the step of determining a brightness distribution function along the determined pictorial longitudinal extension of the wires, wherein the at least one determined quality value comprises a continuity quality value G_S , which is determined by means of a continuity quality norm as a function of the brightness distribution function, the first derivative of the brightness distribution function and/or the second derivative of the brightness distribution function and/or their n^{th} -order moments with $n=0, 1, 2$.

- 10 Preferably, the determined pictorial longitudinal extension J_m of one of the wires is parameterized by a continuous line between two end points. Further preferably, the continuous line is selected such that the course of the line substantially coincides with the center line along the wire. One of the values included in the image data set, for example the brightness value of the image, is determined along the line or along a
- 15 band having a predetermined width, in which the line is located, so that the brightness distribution function along the line results therefrom.

Preferably, the resulting brightness distribution function of defect-free wires substantially is a constant function, which can merely be characterized by an mean value of the brightness values. A defective point of the wire can lead to a variation of the brightness distribution function. For example, a breakage of the wire can lead to a change of the mean value of the brightness distribution function at intervals. In other words, the brightness distribution function can include an interval at which the brightness distribution function has lower values, for example values reduced by 50

25 percent with respect to the values within an environment of the interval or values close to zero. These exemplary deviations can be characterized by the first and/or the second statistical moment. Preferably, the continuity quality value can comprises the variance or the mean variance of the brightness distribution function.

- 30 As a further example, notches or local damages (e.g. by lightning stroke) in the wire can lead to an irregular brightness distribution function. Such irregularities can for example lead to changes in the first and/or the second derivative of the brightness

distribution function at intervals, which changes are characterized by a local change of the mean value in the first or second derivative, respectively. These changes in the derivatives can preferably be characterized by the first and/or the second statistical moment of the respective derivative. Preferably, the continuity quality value can
5 comprise the variance or the mean variance of the first or second derivative of the brightness distribution function.

Particularly preferably, a deviation of the determined brightness distribution function from an expected target distribution of the brightness distribution function can be
10 characterized by means of a continuity quality norm, which is calculated on the basis of the mean value and/or the variance of the brightness distribution function, the first derivative of the brightness distribution function and/or the second derivative of the brightness distribution function. For example, the continuity quality norm can comprise a weighted sum of the mean values and/or variances of the brightness
15 distribution function or the derivatives thereof.

Preferably, the method further comprises the steps of:

- determining the local pictorial diameter D_m of the rope in the image data set;
- providing target values of the local diameter D_0 ;
- 20 - determining a diameter quality value by means of a diameter quality norm as a function of the determined pictorial diameter D_m and the target values of the local diameter D_0 .

The local pictorial diameter D_m of the rope can be limited to a portion along the
25 longitudinal extension of the rope in the image data set, for example to a length of approx. 20 or approx. 100 image points, or to a corresponding length of the actual rope of approx. 10 mm or approx. 50 mm.

The local diameter D_m is determined along a diameter direction perpendicular to the
30 longitudinal extension or longitudinal direction L of the rope. Preferably, the diameter can be determined by a distance determination of two envelopes of the rope, which extend along the longitudinal extension or longitudinal direction L . The envelopes can

for example be determined by a Hilbert transform of the two rope contour lines.

Preferably, the provided target value of the local diameter D_0 is constant over the entire rope length. Preferably, the diameter quality value G_D can be calculated on the basis of the provided target value(s) and the determined actual local diameter D_m of the diameter quality value G_D . The diameter quality value G_D preferably indicates to what extent the actual local diameter D_m deviates from the target value of the diameter D_0 , for example by means of the Euclidean distance between the two diameter values as the preferred diameter quality norm. A variation of the diameter quality value G_D can for example be indicative of an expansion or a collapse of the rope.

Preferably, the step of providing target values of the spatial extension of the strands and/or the spatial extension of the wires comprises the following steps:

- selecting an image data set;
- determining at least two support points and a connection line defined by the support points such that the connection line substantially coincides with
 - a border line between two adjacent strands, or
 - a border line between two adjacent wires, or
 - a center line of a strand, or
 - a center line of one of the wires;
- storing the support points on a storage medium.

Preferably, the target values can be determined by means of a selected, in particular representative image data set. Further preferably, one or more target values can be determined on the basis of rope-specific manufacturer's data, for example on the basis of a numerical rope model and the rope-specific characteristic parameters, such as rope diameter, number of strands, strand diameter, type of twist, wire strength, number of wires, diameter of the rope core, diameter of the strand core, etc.

Preferably, at least two or more support points, by which a connection line is defined, are determined. The number of support points can be 2, 3, 4, 5, 6, 7 or a different

natural number. The connection line can be specified between the support points by a linear or cubic interpolation. Moreover, a spline can connect the support points with each other as a connection line. However, the support points can also define a regression line or a regression polynomial, or another regression function, wherein
5 the support points do not have to be on the regression function.

The support points can be positioned with respect to the image data set such that the connection line defined by the support points coincides with a border line between two adjacent strands or with a border line between two adjacent wires or with a
10 center line of a strand or with a center line of a wire. A thus determined connection line can characterize the longitudinal extension of a wire and/or of a strand, and can be used as an initial starting value for adapting and determining an actual longitudinal extension.

15 In order to make the support points or the connection line(s) available as target values for the test method, the support points and/or the connection lines can preferably be transferred to a storage medium.

Preferably, the method further comprises the step of assigning the quality value to
20 the associated, discriminated, spatial positions along the rope. Advantageously, rope portions having a potential, determined rope defect can be detected quickly, in particular to perform a visual check of these rope portions on the rope itself and/or by means of the pictorial representation of the rope.

25 Further preferably, the method can comprise the step of assigning an assessment feature, in particular on the basis of the at least one quality value, to the associated, discriminated, spatial positions along the rope. Exemplary assessment features can comprise classifications of the possible rope defects, such as "wire breakage", "strand shift", "notch", "lightning stroke", etc. The assessment feature could also
30 comprise a score value indicative of the severity of a defect or the determination reliability. In particular, one or more assessment features can be included in an error log in order to advantageously enable a user of the method in a simple way to see

the determined rope defects.

Computer program product

- 5 One aspect of the present invention relates to a computer program product, in particular embodied as a signal and/or as a data stream, which comprises computer-readable instructions, wherein the instructions perform a method according to the invention, in particular as described above, when loaded and executed on a suitable computer system. In other words, a computer program product is provided, which
- 10 comprises program parts for performing the method according to the invention or a preferred embodiment thereof. Moreover, a computer program is provided, which, when loaded on a computer, can perform the method according to the invention or a preferred embodiment thereof. Further, a computer-readable storage medium is provided, on which such a computer program is stored.

15

System

One aspect of the invention relates to a system for the optical testing of a rope, comprising:

- 20 - at least one image data capturing device adapted to optically capture at least one portion of the rope;
- a target value storage unit adapted to provide target values of the longitudinal extension K_0 of the strands and/or of the longitudinal extension J_0 of the wires, in particular relative to the longitudinal extension K_0 of the strands, to a
- 25 discriminating unit;
- an image data evaluating device adapted to determine a longitudinal extension K_m of the strands in the captured portion of the rope and/or the longitudinal extension J_m of the wires in the captured portion of the rope, in particular relative to the determined longitudinal extension K_m of the strands;
- 30 - a discriminating unit adapted to determine at least one quality value by means of a quality norm as a function of the determined longitudinal extension J_m of the wires and the target values of the longitudinal extension J_0 of the wires and/or at

- least one quality value by means of a quality norm as a function of the determined longitudinal extension K_m of the strands and the target values of the longitudinal extension K_0 of the strands, as well as to discriminate the pictorial positions within the image data set of the rope, at which at least one quality value exceeds or falls
- 5 below a predetermined, assigned quality threshold value; and
- an output unit.

Preferably, the discriminating unit is adapted to perform the assignment of the quality value to the associated, discriminated, spatial positions along the rope.

10

Preferably, the system comprises a rope assessment unit adapted to assign an assessment feature to the pictorial or spatial positions along the rope, which are discriminated by the discriminating unit.

- 15 Advantageously, a human inspector can be informed of all potential rope defects and their positions by means of a log output by the output unit. Advantageously, a visual check can be reduced to a fraction of the entire rope length thanks to the system according to the invention. Further advantageously, the rope test is also improved in terms of safety at work for the competent inspector.

20

Description of figures

- Preferred embodiments of the present invention will be described exemplarily in the following on the basis of the accompanying drawings. Individual features of the
- 25 illustrated preferred embodiments can be combined to form further preferred embodiments. The drawings show:

- Figure 1: a stranded rope as an exemplary rope;
- Figure 2: characteristic construction parameters of a stranded rope;
- 30 Figure 3: a schematic preferred image data capturing device;
- Figure 3a: a preferred image data capturing device;
- Figure 4: a preferred step of obtaining rope-specific target values;

- Figure 5: a preferred step of obtaining rope-specific target values;
 Figure 6: exemplary, obtained target values;
 Figure 7: a preferred automatic determination of the local diameter of the rope;
 Figure 7a: exemplarily determined local diameters of the rope;
 5 Figure 8: a preferred automatic determination of the lay length;
 Figure 8a: exemplarily determined local lay length of the rope;
 Figure 9: an automatic detection of wire shifts or wire shifts in an image data set;
 Figure 10: a preferred detection of wire breakages; and
 Figure 11: an exemplary result of the test method.

10

As a preferred rope 10, **Figure 1** shows a stranded rope 10 as an exemplary wire rope. Stranded ropes 10 comprise several strands 12, which are wound helically around a rope core 14. The strands 12 are comprised of one or more layers of wires 16, which are wound or stranded or laid helically around a strand core 18. The
 15 common term "lay" is used synonymously with the term "stranded" in the following. The strand core 18 can be comprised of a plastic fiber or a wire, for example. Preferably, the strands 12 are formed of wires and a strand core 18 having a similar, preferably with a substantially same diameter. Further preferably, six wires 16 are arranged around the strand core 18 to form the strand 12. The rope strand 14 can be
 20 made of non-woven fabrics, in particular of plastics, or of at least one wire, or in turn be formed as a strand or rope. Preferably, the stranded rope 10 is formed of strands 12 and a rope core 14 having a similar, preferably with a substantially same diameter. Further preferably, four to ten strands 12 are arranged around the rope core 14 to form the rope 10. In the illustrated, particularly preferred embodiment, six
 25 strands 12 are arranged around the rope core 14.

Ropes or stranded ropes 10 of the type shown in Figure 1 are used as moving ropes, stationary ropes, or track ropes in various fields of technology. "Moving ropes" are ropes that move over driving pulleys, rope pulleys, and drums, and in doing so adapt
 30 the curvature thereof, e.g. hoisting ropes, tie ropes, block lines of cranes, elevator ropes, scraper ropes, and hauling ropes for cableways. "Stationary ropes", also called anchor cables or standing ropes, are understood to be ropes that do not move

over rope pulleys and the ends of which are supported in fixed points, for example stay ropes for masts and jibs and guide ropes for elevators and winding apparatuses as well as anchor moorings for dredgers with and without anchor windlasses. Track ropes are ropes on which rollers of conveying means move, for example, such as
5 conveying means of cableways, cable cranes, and cable scrapers. Track ropes fulfill a similar function as guide rails. The radius of curvature of a track rope below the roller is larger than the roller radius. It is understood that the different ropes can be made of different materials depending on the application, for example of plastics such as aramid, Dyneema, polyamide, or steel, stainless steel, or galvanized steel.

10

All rope types have specific, unique construction patterns that can be recognized in a digital image analysis. **Figure 2** illustrates the characteristic construction parameters of a stranded rope 10. The diameter D of the stranded rope 10 is measured perpendicularly to a longitudinal direction L of the stranded rope 10. Preferably, the
15 diameter D can be measured by optically capturing the stranded wire 10 and by a subsequent distance determination of the two envelopes 22a, 22b of the associated, captured stranded rope contour lines 20a, 20b, the envelopes extending along the longitudinal direction L . The envelopes 22a, 22b can be determined by a Hilbert transform of the captured stranded rope contour lines 20a, 20b, for example.

20

Further characteristic parameters of the stranded rope 10 are the lay length S and the lay angle α of the strands 12, 12a with respect to the longitudinal direction L . The lay length S describes in what distance along the longitudinal direction L of the rope 10 a strand 12 has wrapped the rope core 14 completely. The lay angle α can be
25 defined as the angle that is enclosed between the longitudinal direction L of the rope 10 and the longitudinal direction K of the strand 12. For a defect-free rope, the longitudinal direction K of two adjacent strands 12, 12a is parallel to each other, so that the lay angle α can be used as a characteristic parameter for all strands 12, 12a.

30 A further characteristic variable of the stranded rope 10 is the wire angle β of the individual wires 16, 16a with respect to the longitudinal direction L of the rope 10. The wire angle β can be defined as the angle that is enclosed between the longitudinal

direction L of the rope 10 and the longitudinal direction J of the wires 16, 16a. For a defect-free rope, the longitudinal direction J of two adjacent wires 16, 16a is substantially parallel in sections. That is, the adjacent wires 16, 16a are wound around the strand core in an adjacent, in particular mechanically contacting way. The wire angle β can therefore be used as a characteristic variable for all wires 16, 16a.

Figure 3 shows a schematic image data capturing device 24 adapted to capture a rope 10 in an image data set. In a preferred embodiment 3 to 5, in particular 4, the image data capturing device 24 comprises cameras 26a-26d, which are arranged in a plane perpendicular to the longitudinal direction L of the rope 10. The cameras 26a-26d are preferably line scan cameras or CCD cameras. Each of the cameras 26a-26d covers an associated quadrant of approx. 90 degrees of the outside surface of the rope, so that an image data set that fully includes the outside surface of the rope can be provided. The rope 10 can be shifted relative to the image data capturing device 24 along or opposite to the longitudinal direction L. It is understood that in the case of a stationary rope, the image data capturing device 24 can be shifted as well. Preferably, the relative speed between the rope 10 and the cameras 26a-26d can be up to 5 m/s.

Preferably, the cameras 26a-26d are displaceable within the image data capturing device 24 relative to the rope in order to adapt the image data capturing device 24 to the diameter of the rope to be tested. The illumination of the rope 10 can preferably be accomplished with artificial light sources, which allow an improved contrast in the image data set. In particular, the image data capturing device 24 can have high-performance LEDs as a light source.

Figure 3a shows an image data capturing device 24 adapted to capture a rope 10 in an image data set. In the preferred embodiment 4, the image data capturing device 24 comprises cameras (not shown), which are arranged in a plane perpendicular to the longitudinal direction L of the rope 10 around a rope passage opening 62 of the image data capturing device 24. The rope 10 can be shifted through the rope passage opening 62 relative to the image data capturing device 24 along or opposite

to the longitudinal direction L. It is understood that in the case of a stationary rope, the image data capturing device 24 can be shifted as well. Further preferably, the image data capturing device 24 has a rope feed measuring device 64, which can measure or detect the length of the rope 10 displaced along or opposite to the longitudinal direction L. In particular, a measuring wheel 64 can be provided as a preferred rope feed measuring device 64, which is in frictional contact with the rope and is therefore rotated by the feed of the rope 10. A pulse generator can be connected with the measuring wheel 64, for example, so that a rotation of the measuring wheel 64 by a predetermined angle generates a recordable pulse. The number of pulses can be recorded or counted during the feed of the rope 10 and be assigned to individual images of the image data set. Advantageously, it is possible by means of the rope feed measuring device 64 or the measuring wheel 64 to assign captured image data or part of the image data set to a geometric position along the rope 10.

Figure 4 shows a step of obtaining rope-specific target values by means of a data input mask 28. For example, the data input mask 28 comprises the lay length S_0 indicated by manufacturer as well as the target value of the diameter D_0 . The actual values of the diameter D_m and the lay length S_m , which are determined on the basis of a representative rope portion, can be input and used as a comparative value for the determination of deviations with respect to the local diameter and the lay length.

Figure 5 shows a further step of obtaining rope-specific target values by means of an image data set including a rope portion 30. The envelopes 22a, 22b of the rope portion 30 can be specified manually or automatically, with the help of which the longitudinal extension L of the rope portion 30 and the diameter D_m in the rope portion can be determined. Moreover, two support points can further be specified e.g. by a user, for example by actuating an operating element of a display device representing the rope portion 30, wherein the support points define a straight connection line or lay line 32 such that the connection line corresponds to the border line between two adjacent strands 12, 12a. This step can be performed for several border lines between several strands. By means of at least a determined connection

or lay line 32, which is parallel to the longitudinal direction K of the strand 12, the lay angle α can be determined relative to the longitudinal direction or longitudinal extension L of the rope portion 30. Further, a reference point 38 can be determined, which is arranged substantially in a centered way between two lay lines 32 and can
5 be used as a reference for the center of the strand 12, for example to determine the support points for the target values of the individual wires 16, 16a relative to this reference point, i.e. relative to the strand 12.

Further support points can be specified correspondingly, which define a substantially
10 straight connection line or wire border line 34 such that the connection corresponds to the border line between two adjacent wires 16, 16a. Further, support points can be specified, preferably by a user, which define a substantially straight connection line or wire line 36 such that the connection line substantially corresponds to the center line of a wire 16a. The wire angle β relative to the longitudinal direction or longitudinal
15 extension L of the rope portion 30 can be determined by means of the wire border line 34 and/or the wire line 36.

Figure 6 shows the target values determined as described with reference to Figure 5.

20

Figure 7 shows the automatic determination of the local pictorial diameter D_m of the rope in the image data set. Preferably, the determination of the local diameter D_m can be performed by means of edge detection, preferably on the basis of a smoothed image data set. For example, the determination of the local diameter D_m can be
25 performed on the basis of a diameter correlation (illustrated in Fig. 7 as a curve with the reference numeral 40), a calculated entropy (illustrated in Fig. 7 as a curve with the reference numeral 42) and/or edge detection (illustrated in Fig. 7 as a curve with the reference numeral 44). The resulting local diameter D_m can be plotted against the rope length, as is shown in **Figure 7a** (illustrated as a curve with the reference
30 numerals 45).

Figure 8 shows the automatic determination of the lay length in the image data set,

i.e. of a localized lay length S_m . Preferably, the determination of the lay length S_m can be performed based on the evaluation of the brightness values of the image data set along the longitudinal direction or longitudinal extension of the rope or the rope portion (illustrated in Fig. 7 as a curve with the reference numeral 46). To eliminate
5 the effect of linear shifts, a transformation in the Fourier space can be performed, wherein the spatial wave numbers are not localized any more and a shift of the rope along the longitudinal direction L does not influence the result. To determine the lay length, the number of strands, e.g. 6, and the previously obtained actual lay length (see Fig. 4) can be used. The lay length S_m can be determined by multiplying the
10 values number of strands and strand width.

The position of border lines of two adjacent strands, i.e. the lay line 32, can be determined by cross correlation with a known strand structure, as it can be obtained in the determination of the target values, for example. The border lines are usually
15 characterized by clearly defined areas with low brightness values, since usually much shadow occurs between two strands.

The determined local lay length S_m can be plotted against the rope length, as is shown in **Figure 8a** (illustrated as a curve with the reference numeral 48). In addition
20 to the lay length S_m , the strand center can further determined as a reference point for further steps of the test method.

Figure 9 schematically shows the automatic detection of wire shifts or wire shifts in an image data set. In a preferred embodiment of the test method, it is determined
25 with the help of the geometry quality value G_G to what extent the actual longitudinal extension J_m of a wire 16 deviates from the target value of the pictorial longitudinal extension J_0 . In the shown embodiment of this method, the target value of the longitudinal extension J_0 is defined relative to the longitudinal extension K_m of the strand 12, which is parallel to the lay line 32. The geometry quality value G_G is
30 preferably defined as an adaptation error with respect to an adaptation by means of a straight line. As is shown in Figure 9, it is difficult to adapt the wire 16 at a shift location 53 by means of a straight line. Therefore, the wire shift can be detected at

this location. Alternatively or in addition, a specific variation of the longitudinal extension between adjacent wires 16, 16a can also be indicative of a shift or shift of two adjacent wires 16, 16a.

5 **Figure 10** schematically shows the automation detection of wire breakage in an image data set. In a preferred embodiment of the test method, as is described with reference to Fig. 8, the strand center 38 is calculated on the basis of the detected strand borders or lay lines 32. At the strand center 38 are aligned the previously obtained target values for the longitudinal extension J_0 of the wires 16, which are part
10 of the strand 12. By means of an adaptation, in particular an iterative adaptation, the actual longitudinal extensions J_m of the wires 16 are determined. Target values representing a center line of a wire are adapted such that these center lines or wire lines follow the brightest possible locations of the image data set. Target values representing a border line between two adjacent wires are adapted such that these
15 border lines follow the darkest possible locations of the image data set. As a further boundary condition of the adaptation it may be provided that adjacent support points of wires and border lines between wires displace each other, i.e. assume a maximum distance to each other. To perform the adaptation, the optimization of a multi-dimensional cost function is necessary, for example.

20

Now, for every identifiable or sufficiently resolvable wire 16, the brightness value of the image can be obtained along an associated, adapted continuous line 50, which represents the longitudinal extension J_m of the wire 16, so that a brightness distribution function 52 along the line 50 results therefrom. In the example shown in
25 **Figure 9**, a break 54 of the wire 16 leads to a variation of the brightness distribution function 52, so that the brightness distribution function 52 has a reduced local mean value in an interval 56.

Changed local mean values of the brightness distribution function 52 can be
30 evaluated automatically by means of a continuity quality norm G_S , so that brightness value changes along a line 50 (bright-dark, dark-bright) lead to the continuity quality value being exceeded and thus to a defect detection. It is understood that the above-

described method can also be applied to the border lines between two wires 16 and is preferably used in addition.

Figure 11 shows the result of the test method. According to the obtained quality values on the basis of the associated quality norms, which each constitute a benchmark for an associated rope defect, conspicuous rope portions have been discriminated and listed in an error log 58 together with the corresponding rope position and the determined rope defect. Preferably, the computer program performing the method according to the invention establishes a link between the elements of the error log 58 and a, in particular full, pictorial representation 60 of the rope portion 30 having the defect (for example a wire breakage 54). Advantageously, a human tester can check or verify all potential rope defects visually on the basis of the pictorial representation without actually looking at the rope portion. Advantageously, the test method can be performed remote from the place of use of the rope. Further advantageously, the visual check or verification can be limited to the automatically discriminated rope portions 30, so that approx. 90 percent of a rope do not require an inspection by a human tester. Further preferably, the test method and the assessment of the discriminated rope defects can be performed automatically.

Applicant: Automation W+R GmbH
 "System and method for testing ropes"
 Our Ref.: A 6547CA - ro / at

List of Reference Numerals

	10	rope or stranded rope
	12, 12a	strand
	14	rope core
	16	wire
5	18	strand core
	20a, 20b	stranded rope contour line
	22a, 22b	envelope of the stranded rope contour line
	24	image data capturing device
	26a-26d	camera
10	28	data input mask
	30	rope portion
	32	connection line or lay line
	34	connection line or wire border line
	36	connection line or wire line
15	40	diameter correlation function
	42	entropy function
	44	edge detection function
	45	function of the local diameter D_m
	46	function of the brightness values along the longitudinal direction L
20	48	function of the local lay length S_m
	50	adapted line
	52	brightness distribution function
	53	shift location
	54	breakage
25	56	interval
	58	error log
	60	pictorial representation

	62	rope passage opening
	64	rope feed measuring device
	D, D ₀ , D _m	diameter
	G _D , G _S , G _G	quality value
5	J, J ₀ , J _m	longitudinal direction
	K, K ₀ , K _m	longitudinal direction
	L	longitudinal direction
	S, S ₀ , S _m	lay length
	α	lay angle
10	β	wire angle
	γ	wire-strand-angle

Claims

1. A method for the computer-aided, optical testing of a rope (10), comprising:
 - providing an image data set for at least one portion (30) of the rope (10);
 - providing target values of a pictorial longitudinal extension of a representation of wires (16, 16a) relative to a pictorial longitudinal extension of the rope (10) in the image data set, wherein the target values are provided by means of a database and electronically represent the rope as defect-free;
 - determining the pictorial longitudinal extension of the wires (16, 16a) in the image data set, wherein determining comprises adapting an estimated longitudinal extension to the image data set;
 - determining at least one quality value by means of a quality norm as a function of the determined pictorial longitudinal extension of the wires (16, 16a) and the target values of the pictorial longitudinal extension of the wires (16, 16a);
 - discriminating pictorial positions within the image data set of the rope (10), at which at least one quality value exceeds or falls below a predetermined, assigned quality threshold value;
 - providing the discriminated pictorial positions.
2. The method according to claim 1, further comprising the steps of:
 - providing target values of a pictorial longitudinal extension of a representation of strands (12, 12a) relative to the pictorial longitudinal extension of the rope (10) in the image data set;
 - determining the pictorial longitudinal extension of the strands (12, 12a) in the image data set, wherein determining comprises adapting the estimated longitudinal extension to the image data set;
 - determining at least one lay quality value (G_s) by means of a lay quality norm as a function of the determined pictorial longitudinal extension of the strands (12, 12a) and the target values of the pictorial longitudinal extension of the strands (12, 12a).

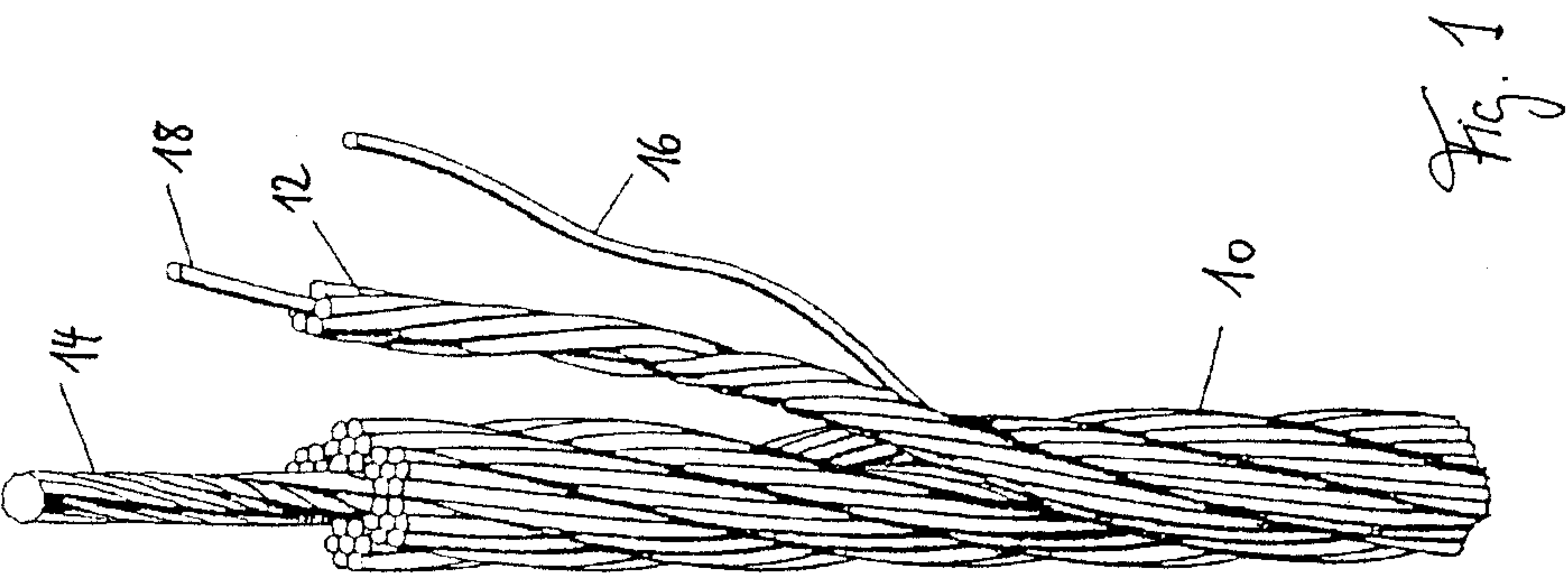
3. The method according to claim 2, wherein the provision of target values of the pictorial longitudinal extension J_0 of the representation of wires (16, 16a) is performed relative to the pictorial longitudinal extension of the strands (12, 12a) in the image data set, and wherein the determination of the pictorial longitudinal extension J_m of the wires (12, 12a) in the image data set is performed relative to the determined longitudinal extension of the strands (12, 12a).
4. The method according to any one of claims 1 to 3, wherein the at least one determined quality value comprises a geometry quality value (G_G), which is determined by means of a geometry quality norm
 - as a function of a geometric distance between the determined pictorial longitudinal extension J_m of the wires (16, 16a) and the target values of the pictorial longitudinal extension J_0 of the wires (16, 16a), or
 - as a function of a geometric distance between the determined pictorial longitudinal extensions J_m of at least two adjacent wires (16, 16a).
5. The method according to any one of claims 1 to 4, further comprising the step of:
 - determining a brightness distribution function (52) along the determined pictorial longitudinal extension of the wires (16, 16a), wherein the at least one determined quality value comprises a continuity quality value (G_S), which is determined by means of a continuity quality norm as a function of a combination of one or more of:
 - the brightness distribution function, a first derivative of the brightness distribution function, a second derivative of the brightness distribution function, and their n^{th} -order moments with $n=0, 1, 2$.
6. The method according to any one of claims 1 to 5, further comprising the steps of:
 - determining a local pictorial diameter D_m of the rope (10) in the image data set;
 - providing target values of the local diameter D_0 ;

- determining a diameter quality value (G_D) by means of a diameter quality norm as a function of the determined pictorial diameter D_m and the target values of the local diameter D_0 .
7. The method according to any one of claims 1 to 6, further comprising providing target values of a spatial extension of the strands (12, 12a) and a spatial extension of the wires (16, 16a), which comprises:
- selecting the image data set;
 - determining at least two support points and a connection line defined by the support points such that the connection line substantially coincides with
 - a border line between two adjacent strands (12, 12a), or
 - a border line between two adjacent wires (16, 16a), or
 - a center line of a strand (12, 12a), or
 - a center line of one of the wires (16, 16a);
 - storing the support points on a storage medium.
8. The method according to any one of claims 1 to 6, further comprising providing target values of a spatial extension of the strands (12, 12a) or a spatial extension of the wires (16, 16a), which comprises:
- selecting the image data set;
 - determining at least two support points and a connection line defined by the support points such that the connection line substantially coincides with
 - a border line between two adjacent strands (12, 12a), or
 - a border line between two adjacent wires (16, 16a), or
 - a center line of a strand (12, 12a), or
 - a center line of one of the wires (16, 16a);
 - storing the support points on a storage medium.
9. The method according to any one of claims 1 to 8, further comprising determining spatial extension of the strands (12, 12a) in the captured portion (30) of the rope (10) by adapting an estimated longitudinal extension K_m of the strands to areas of

the image data set with low brightness values.

10. The method according to any one of claims 1 to 9, further comprising determining spatial extension of the wires (16, 16a) in the captured portion (30) of the rope (10) by adapting an estimated longitudinal extension J_m of the wires to areas of the image data set with high brightness values.
11. The method according to any one of claims 1 to 10, further comprising the step of assigning the quality value to associated, discriminated, spatial positions along the rope (10).
12. A computer-readable storage medium comprising computer-readable instructions, wherein the instructions perform a method according to any one of claims 1 to 11, when loaded and executed on a suitable computer system.
13. A system for optical testing of a rope (10), comprising:
 - at least one image data capturing device (24) adapted to optically capture at least one portion (30) of the rope (10);
 - a target value storage unit adapted to provide target values of at least one of a longitudinal extension K_0 of strands (12, 12a) and of a longitudinal extension J_0 of wires (16, 16a), relative to the longitudinal extension K_0 of the strands (12, 12a), to a discriminating unit, wherein the target values are provided by means of a database and electronically represent the rope as defect-free;
 - an image data evaluating device adapted to determine at least one of the longitudinal extension K_m of the strands (12, 12a) in the captured portion (30) of the rope (10) and the longitudinal extension J_m of the wires (16, 16a) in the captured portion (30) of the rope (10), relative to the determined longitudinal extension K_m of the strands (12, 12a);
 - the discriminating unit adapted to
 - determine one or more of:
 - at least one quality value by means of a quality norm as a function of

- the determined longitudinal extension J_m of the wires (16, 16a)
and the target values of the longitudinal extension J_0 of the wires
(16, 16a); and
 - at least one quality value by means of the quality norm as a function
of the determined longitudinal extension K_m of the strands (12,
12a) and the target values of the longitudinal extension K_0 of the
strands (12, 12a); and
 - discriminate pictorial positions within the image data set of the rope (10),
at which at least one quality value exceeds or falls below a
predetermined, assigned quality threshold value; and
 - an output unit.
14. The system according to claim 13, wherein the discriminating unit is adapted to perform an assignment of the quality value to associated, discriminated, spatial positions along the rope (10).
15. The system according to claim 13 or 14, comprising:
- a rope assessment unit adapted to assign an assessment feature to the pictorial or spatial positions along the rope (10), which are discriminated by the discriminating unit.



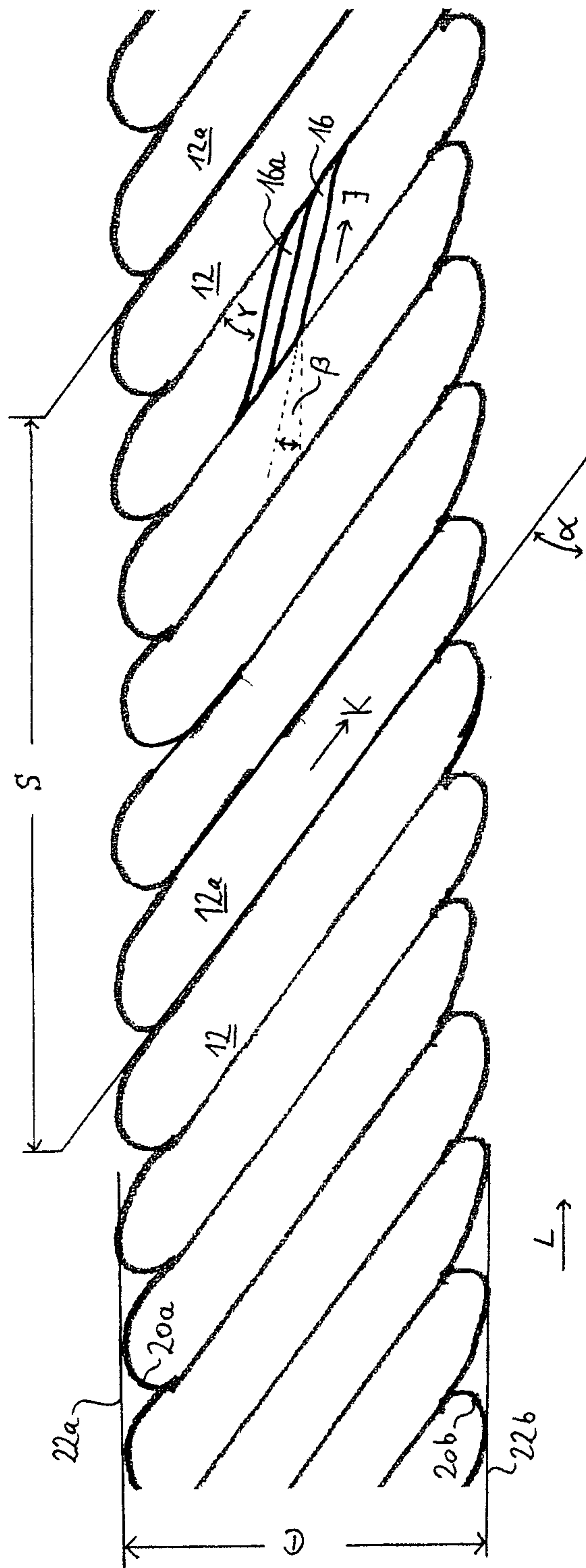


Fig. 2

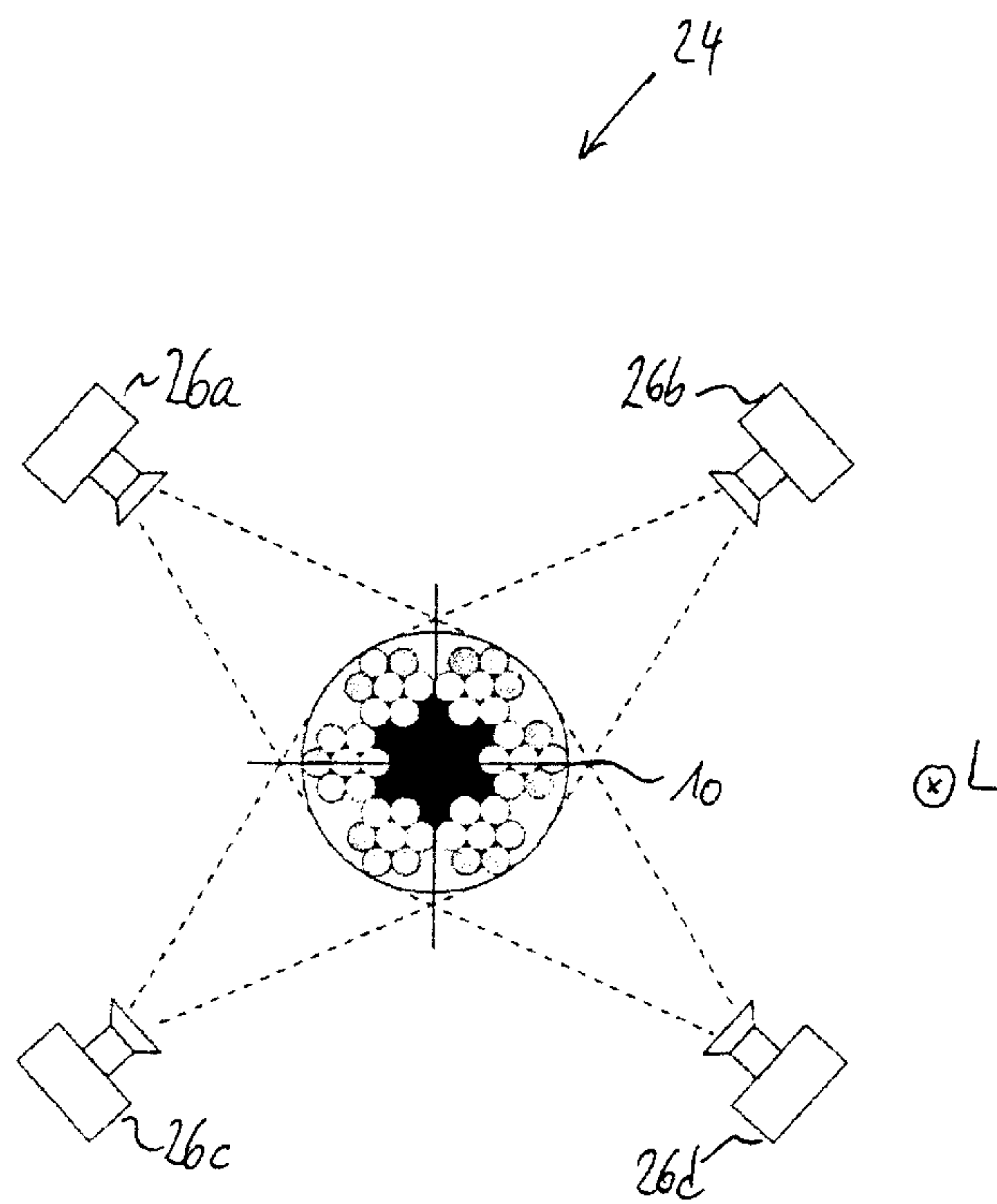


Fig. 3

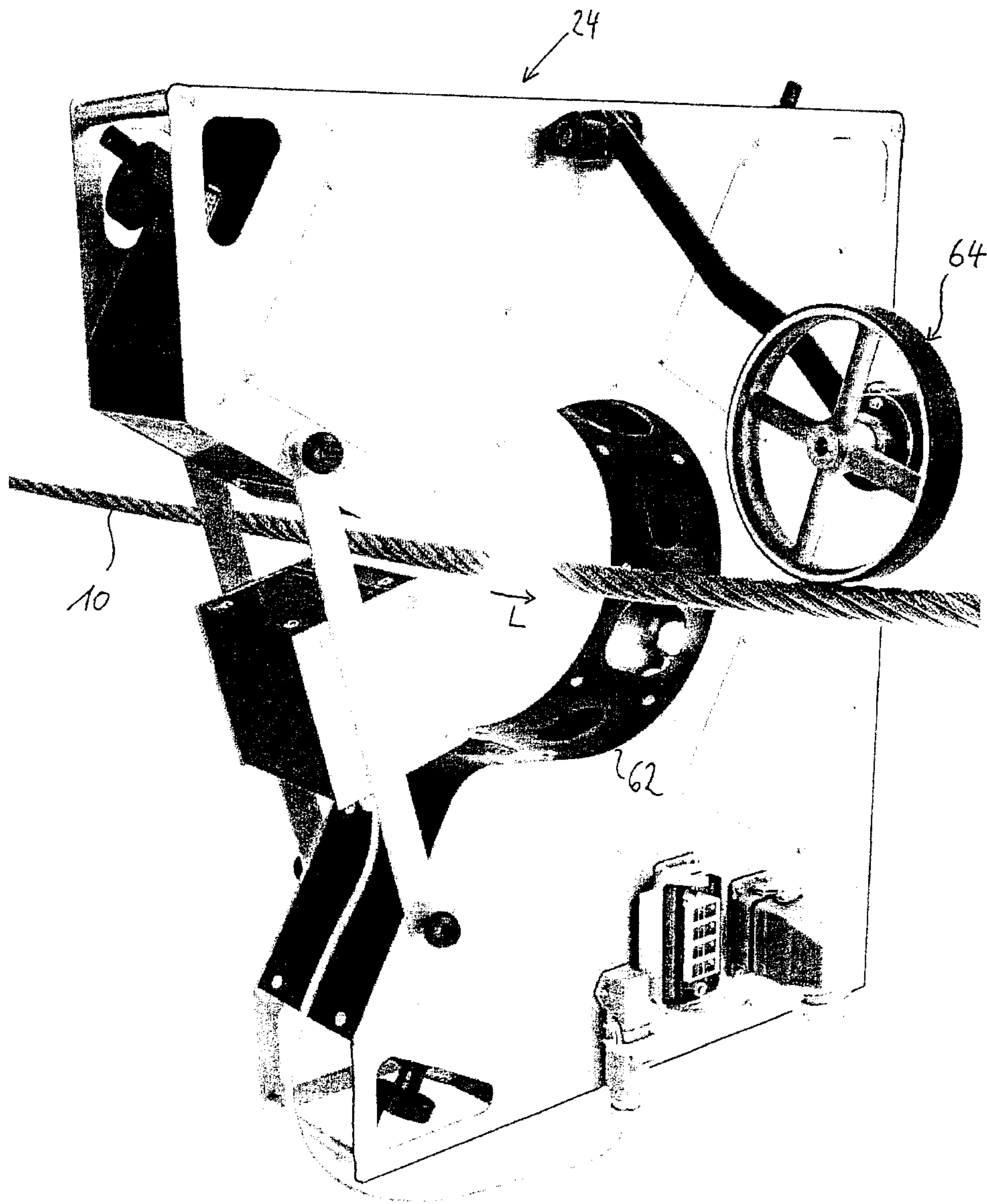


Fig. 3a

RopeRecorder

Rope Data Input

Rope			
Date	11/20/2010		
Place			
Facility and Rope Type			
Person in Charge	Mustermann		
Direction of Measurement	forward		
Weather	sunny, dry		
Nominal Rope Length	3800 m	Nominal Diameter	45 mm
Nominal Diameter	45.5 mm	Nominal Lay Length	318 mm
Nominal Lay Length	320 mm	Type	Stranded Rope 6x36 Warrington-Seale
Cross Section			

Continue

RopeRecorder IFT

FIG. 4

28

WIREPATTERNNUMWIRES ; 13	{Beginning of wire pattern description}
	Number of wire lines in the target pattern (arbitrary, typically 7-20)
WIREPATTERNNUMPOINTSWIRE ; 4	Number of support points for line 1 (arbitrary, typically 2-5)
WIREPATTERNPOINTSWIRE ; -149 60	Coordinates support point 1
WIREPATTERNPOINTSWIRE ; -69 29	Coordinates support point 2
WIREPATTERNPOINTSWIRE ; 50 -25	Coordinates support point 3
WIREPATTERNPOINTSWIRE ; 152 -60	Coordinates support point 4
WIREPATTERNNUMPOINTSWIRE ; 4	Number of support points for line 2 (arbitrary, typically 2-5)
WIREPATTERNPOINTSWIRE ; -201 63	Coordinates support point 1
WIREPATTERNPOINTSWIRE ; -111 26	Coordinates support point 2
WIREPATTERNPOINTSWIRE ; -16 -14	Coordinates support point 3
WIREPATTERNPOINTSWIRE ; 63 -45	Coordinates support point 4
(...)	
WIREPATTERNNUMGAPS ; 10	Number of gap lines in the target pattern (typically wire line number-1)
WIREPATTERNNUMPOINTSGAP ; 4	Number of support points for line 1 (arbitrary, typically 2-5)
WIREPATTERNPOINTSGAP ; -439 81	Coordinates support point 1
WIREPATTERNPOINTSGAP ; -350 50	Coordinates support point 2
WIREPATTERNPOINTSGAP ; -266 21	Coordinates support point 3
WIREPATTERNPOINTSGAP ; -211 4	Coordinates support point 4
WIREPATTERNNUMPOINTSGAP ; 4	Number of support points for line 2 (arbitrary, typically 2-5)
WIREPATTERNPOINTSGAP ; -387 81	Coordinates support point 1
WIREPATTERNPOINTSGAP ; -294 46	Coordinates support point 2
WIREPATTERNPOINTSGAP ; -226 22	Coordinates support point 3
WIREPATTERNPOINTSGAP ; -175 4	Coordinates support point 4
(..)	

FIG. 6

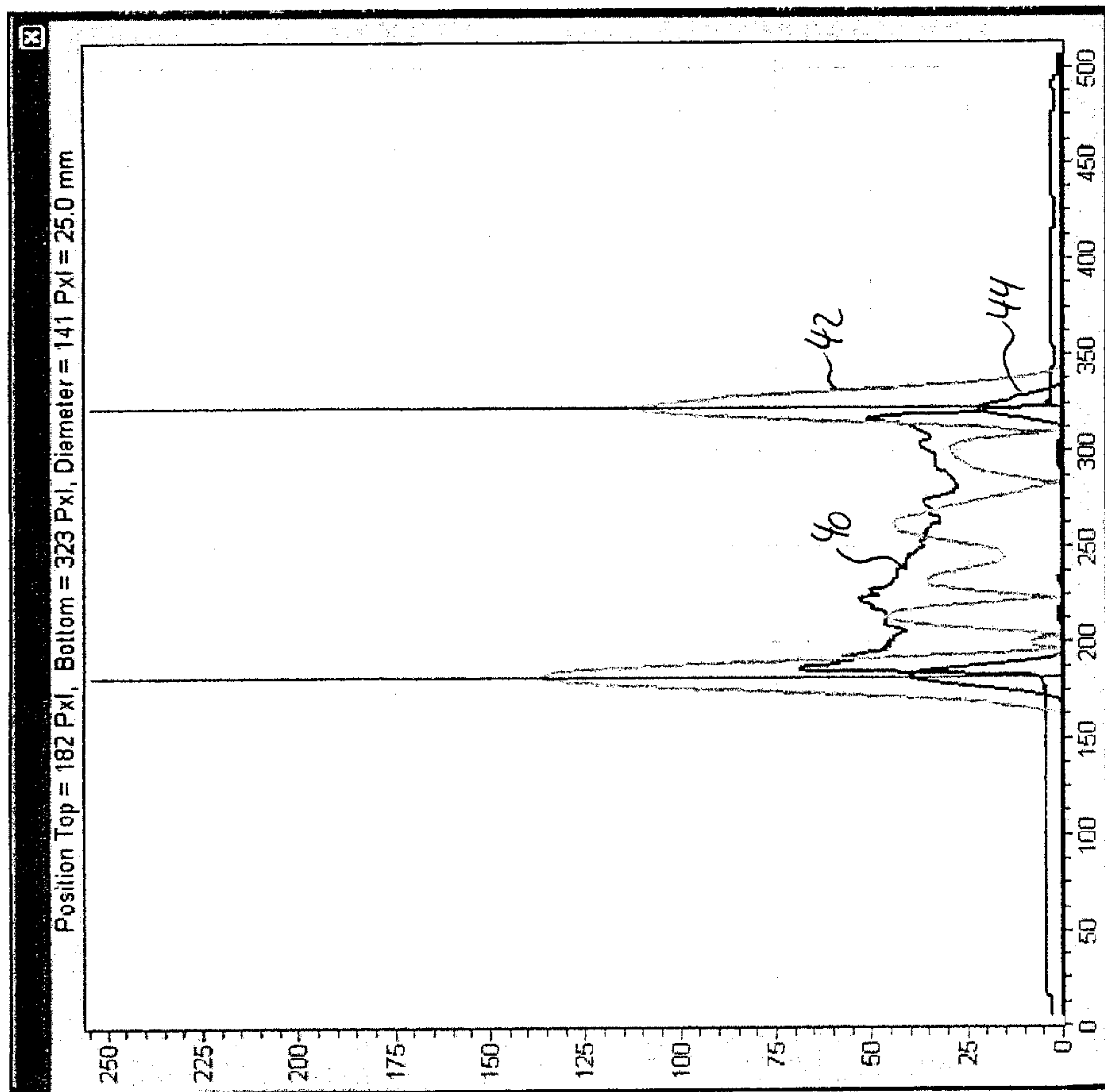


Fig. 7

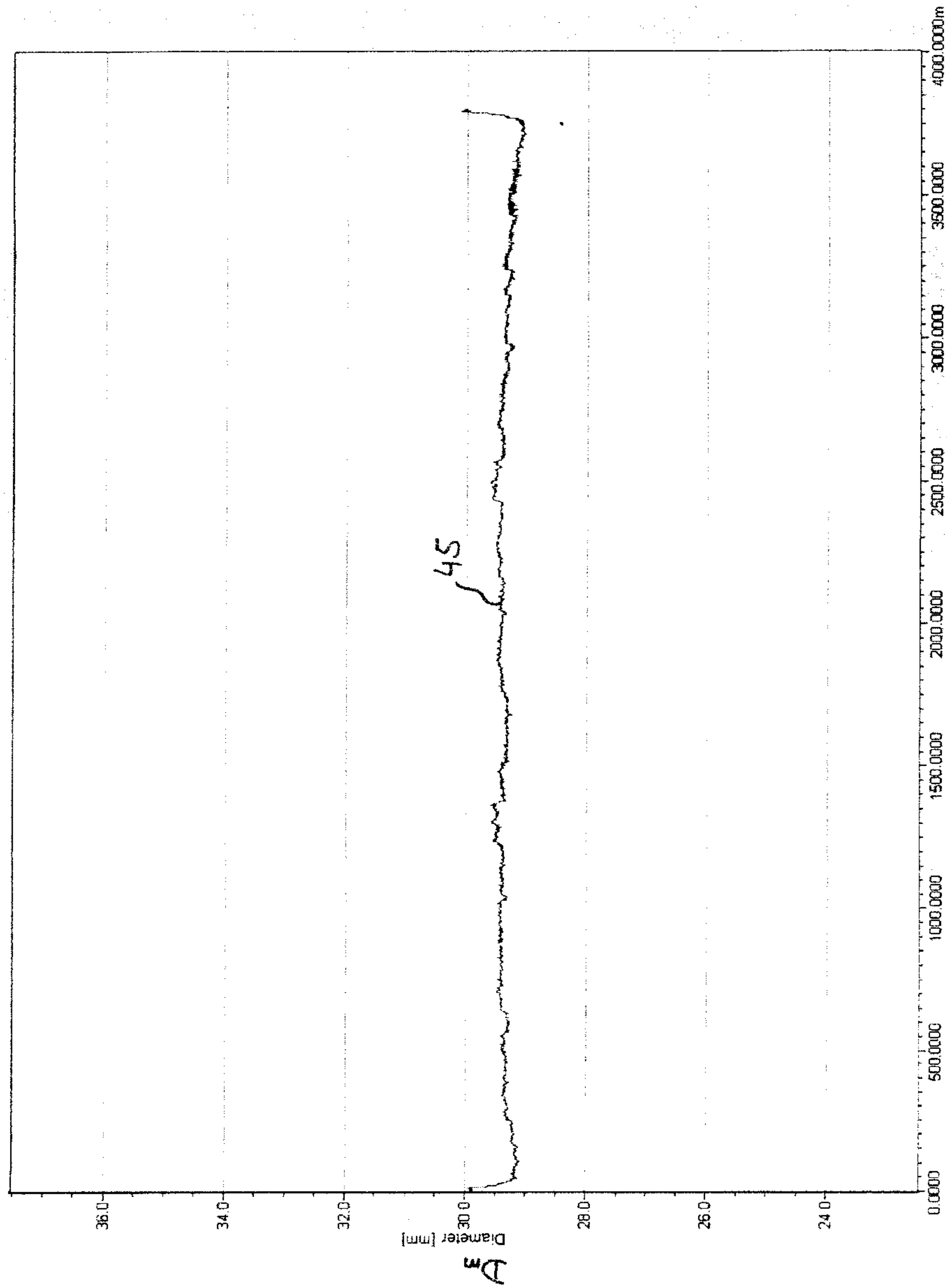


FIG. 7a

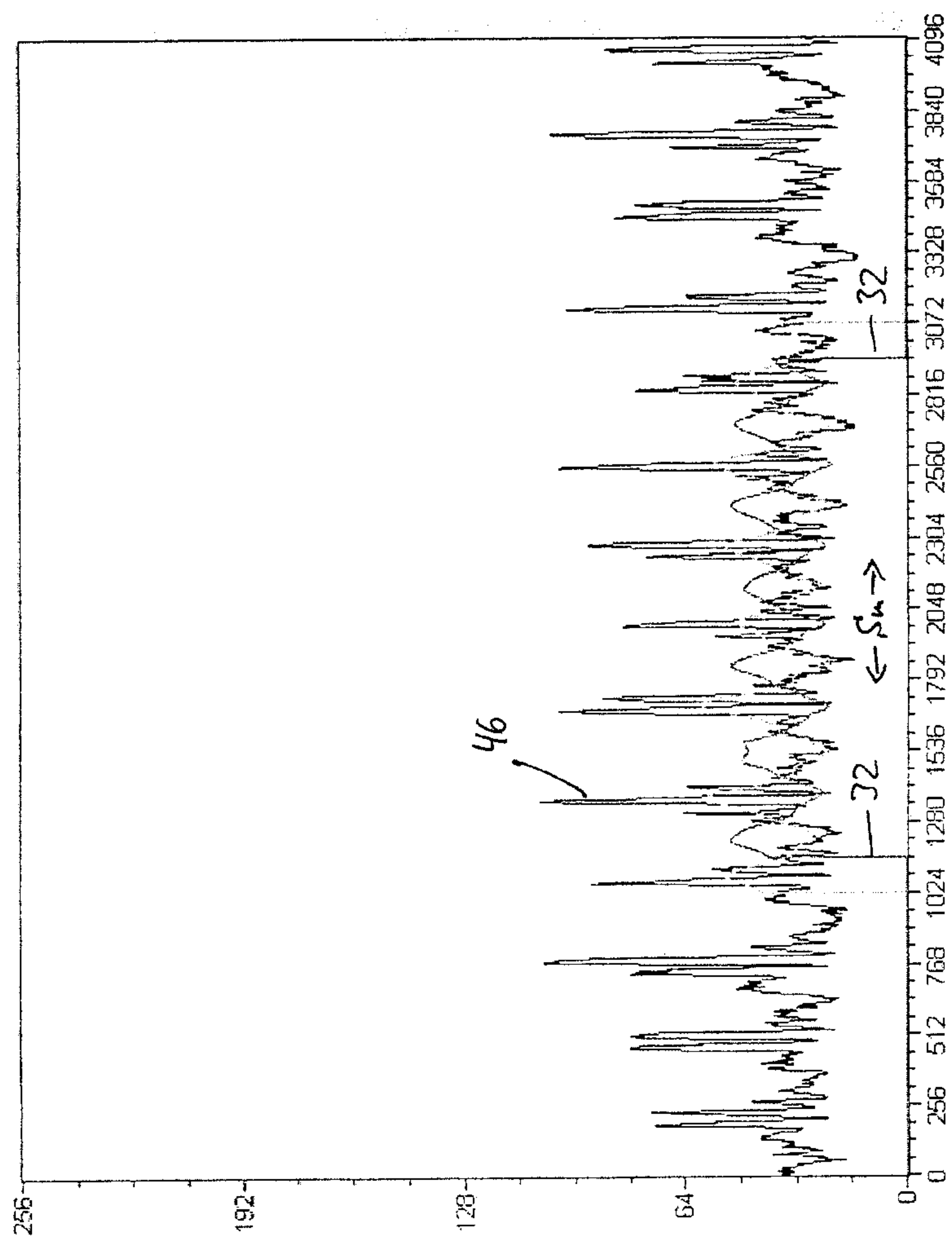


Fig. 8

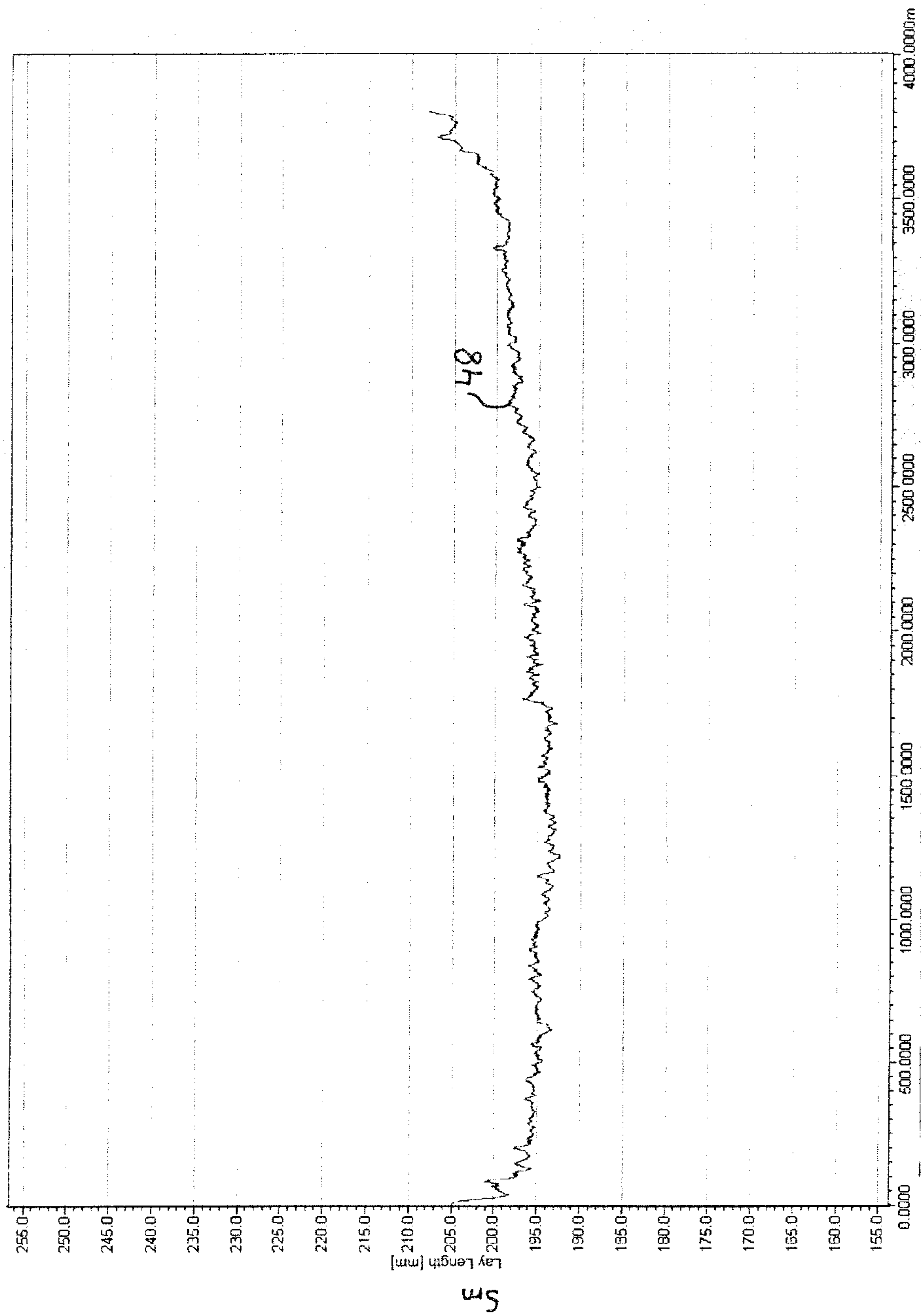


FIG. 8a



Fig. 9

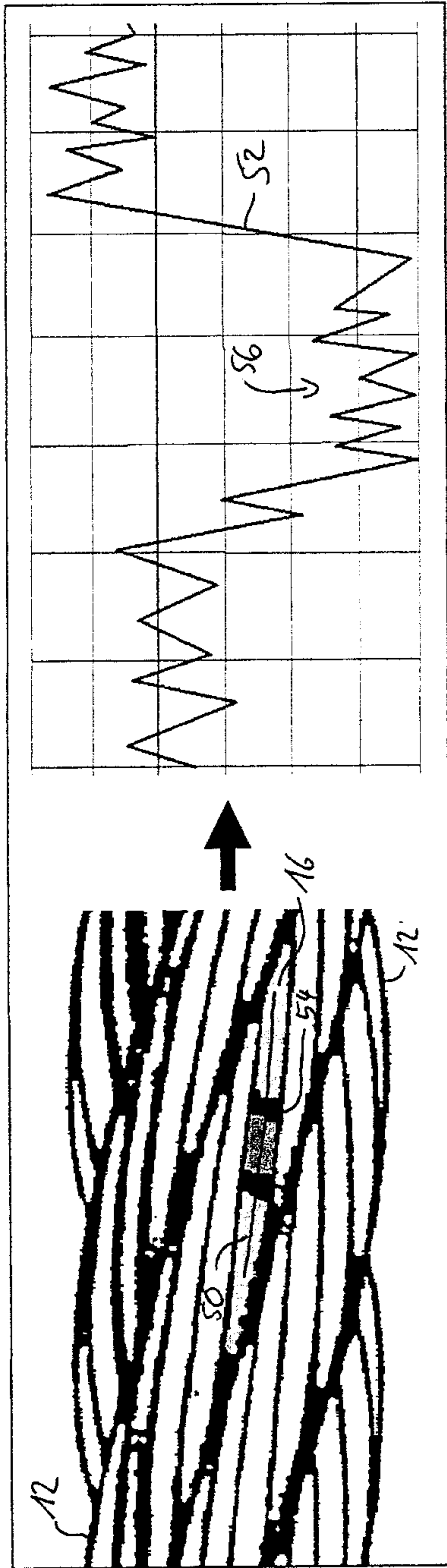


Fig. 10

