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(54) Tapered fiber optic acceleration sensor system

(57) The present invention provides a tapered fiber acceleration sensor system, comprising: a protecting shell, an elastic base layer, a light source, a circulator, a coupler, a fiber phase modulator/demodulator, an isolator and a photodetector. The elastic base layer is arranged in the protecting shell to divide a cavity in the protecting shell into an upper sub-cavity and a lower sub-cavity; an upper surface and a lower surface of the elastic base layer are respectively provided with sensing fiber assemblies for detecting deformation; the sensing fiber assemblies are respectively connected with the fiber phase modulator/demodulator; the light source is coupled with the circulator; the circulator is respectively coupled with the coupler and the photodetector; the coupler is respectively connected with the isolator and the fiber phase modulator/demodulator; and the isolator is coupled with the photodetector. The ends of the sensing fiber assemblies are provided with reflecting layers; monochromatic light generated by the light source is split into two beams of equal-intensity light through the coupler; and the two beams of light are reflected back through the reflecting layers, and then pass through the coupler again.

NL B1 2023992

Tapered fiber acceleration sensor system

The present invention is proposed based on a Chinese patent application with application number of 201910294026.4 and application date of April 12, 2019, and claims the priority of the Chinese patent application, the disclosures of which are hereby incorporated by reference.

Technical Field

The present invention relates to the field of sensor measurement, and particularly relates to a tapered fiber acceleration sensor system.

Background

At present, a main measuring component of an inclinometer used in China and abroad uses a fluxgate sensor or a mechanical gyroscope as an angular velocity sensor combined with an accelerometer to measure an inclined angle and an azimuth.

However, such inclinometer has the disadvantages of low measurement accuracy, short instrument life, untimely data processing and impossibility of monitoring in severe weather such as heavy rain, and seriously affects the efficiency of internal deformation monitoring in coal mines, causing that monitoring personnel cannot know the internal deformation in the coal mines in time.

Moreover, the accelerometer in the prior art has low detection sensitivity and accuracy.

Therefore, the prior art has defects and needs to be improved urgently.

Summary

The purpose of the present invention is to provide a tapered fiber acceleration sensor system having the beneficial effects of sensitivity and accuracy of a tapered fiber acceleration sensor system.

Embodiments of the present invention provide a tapered fiber acceleration sensor system, comprising: a protecting shell, an elastic base layer, a light source, a circulator, a coupler, a fiber phase modulator/demodulator, an isolator and a photodetector.

The elastic base layer is arranged in the protecting shell to divide a cavity in the protecting shell into an upper sub-cavity and a lower sub-cavity; an upper surface and a lower surface of the elastic base layer are respectively provided with sensing fiber

assemblies for detecting deformation; the sensing fiber assemblies are respectively connected with the fiber phase modulator/demodulator; the light source is coupled with the circulator; the circulator is respectively coupled with the coupler and the photodetector; the coupler is respectively connected with the isolator and the fiber phase modulator/demodulator; and the isolator is coupled with the photodetector.

The ends of the sensing fiber assemblies are provided with reflecting layers; monochromatic light generated by the light source is split into two beams of equal-intensity light through the coupler; and the two beams of light are reflected back through the reflecting layers, pass through the coupler again, and pass through the isolator to reach the photodetector.

In the tapered fiber acceleration sensor system of the present invention, the reflecting layers are coating layers.

In the tapered fiber acceleration sensor system of the present invention, the fiber phase modulator/demodulator is a PZT modulator/demodulator.

In the tapered fiber acceleration sensor system of the present invention, the sensing fiber assemblies comprise a compliant cylinder, a sensitive mass block and a sensing fiber; the compliant cylinder is connected with the sensitive mass block; the sensitive mass block is coupled with the sensing fiber.

Both ends of the fiber are coated with the reflecting layers.

In the tapered fiber acceleration sensor system of the present invention, the sensitive mass block is in a shape of a triangular pyramid; and a pyramid top of the sensitive mass block comes into contact with the fiber.

In the tapered fiber acceleration sensor system of the present invention, the protecting shell is provided with an opening for connecting the cavity with the outside.

In the tapered fiber acceleration sensor system of the present invention, an outer outline of the protecting shell is in a shape of a rectangular block.

In the tapered fiber acceleration sensor system of the present invention, an inner wall of the cavity is provided with a circle of clamping grooves; and the edge of the elastic base layer is clamped in the clamping grooves.

In the tapered fiber acceleration sensor system of the present invention, the elastic base layer is in a shape of a rectangular plate.

In the tapered fiber acceleration sensor system of the present invention, adhesives are arranged in the clamping grooves.

The present invention has the beneficial effects of improving detection accuracy and sensitivity. In the present invention, the elastic base layer is arranged in the protecting shell to divide the cavity in the protecting shell into the upper sub-cavity and the lower sub-cavity; the upper surface and the lower surface of the elastic base layer are respectively provided with sensing fiber assemblies for detecting deformation; the sensing fiber assemblies are respectively connected with the fiber phase modulator/demodulator; the light source is coupled with the circulator; the circulator is respectively coupled with the coupler and the photodetector; the coupler is respectively connected with the isolator and the fiber phase modulator/demodulator; the isolator is coupled with the photodetector; the ends of the sensing fiber assemblies are provided with reflecting layers; monochromatic light generated by the light source is split into two beams of equal-intensity light through the coupler; and the two beams of light are reflected back through the reflecting layers, pass through the coupler again, and pass through the isolator to reach the photodetector. The present invention has the beneficial effects of improving detection accuracy and sensitivity.

Description of Drawings

Fig. 1 is a structural schematic diagram of a tapered fiber acceleration sensor system in some embodiments of the present invention.

Fig. 2 is a schematic diagram of a tapered fiber acceleration sensor system in some embodiments of the present invention.

Detailed Description

Embodiments of the present invention will be described below in detail. Examples of the embodiments are shown in drawings, wherein same or similar reference signs refer to same or similar elements or elements having same or similar functions from beginning to end. Embodiments described below by reference to the drawings are exemplary embodiments, and are only used for explaining the present invention, and shall not be understood as a limitation to the present invention.

It should be understood in the description of the present invention that terms such as "central", "longitudinal", "transverse", "length", "width", "thickness", "upper", "lower", "front", "rear", "left", "right", "vertical", "horizontal", "top", "bottom", "inner", "outer", "clockwise", "counterclockwise" etc. indicate direction or position relationships shown based on the drawings, and are only intended to facilitate the description of the present invention and the simplification of the description rather than to indicate or imply that the indicated device or element must have a specific direction or constructed and operated in a specific direction, and therefore, shall not be understood as a limitation to the present invention. In addition, the terms such as "first" and "second" are only used for the purpose of description, rather than being understood to indicate or imply relative importance or hint the number of indicated technical features. Thus, the feature limited by "first" and "second" can explicitly or impliedly comprise one or more features. In the explanation of the present invention, the meaning of "a plurality of" is two or more unless otherwise clearly specified.

It should be noted in the explanation of the present invention that, unless otherwise specifically regulated and defined, terms such as "installation," "connected," and "connecting" shall be understood in broad sense, and for example, may refer to fixed connection or detachable connection or integral connection, may refer to mechanical connection or electrical connection or mutual communication, and may refer to direct connection or indirect connection through an intermediate medium or inner communication of two elements or interaction relationship of two elements. For those ordinary skilled in the art, the specific meanings of the above terms in the present invention may be understood according to concrete conditions.

In the present invention, unless otherwise clearly specified and defined, a first feature is "above" or "below" a second feature comprises that the first feature and the second feature come into direct contact or the first feature and the second feature come into contact through additional features thereof instead of direct contact. Moreover, the first feature is "on", "above" and "over" the second feature comprises that the first feature is directly above or slightly above the second feature, or just indicates that the horizontal height of the first feature is higher than that of the second feature. The first feature is "under", "below" and "beneath" the second feature comprises that the first feature is directly below or slightly below the second feature, or just indicates that the horizontal height of the first feature is lower than that of the second feature.

The following disclosure provides many different embodiments or examples for realizing different structures of the present invention. In order to simplify the disclosure of the present invention, the components and arrangement of specific examples are described below. Of course, they are merely examples and are not intended to limit the present invention. In addition, the present invention can repeat reference numbers and/or reference letters in different examples. This repetition is for the purpose of simplicity and clarity, and does not indicate the relationship among the discussed embodiments and/or arrangement. Moreover, the present invention provides examples of various specific processes and materials, but those ordinary skilled in the art can recognize the application of other processes and/or the use of other materials.

With reference to Fig. 1 and Fig. 2, Fig. 1 is a structural diagram of a tapered fiber acceleration sensor system in some embodiments of the present invention. The tapered fiber acceleration sensor system comprises: a protecting shell 10, an elastic base layer 50, a light source 80, a circulator 70, a coupler 30, a fiber phase modulator/demodulator 20, an isolator 90 and a photodetector 100.

The elastic base layer 50 is arranged in the protecting shell 10 to divide a cavity in the protecting shell 10 into an upper sub-cavity and a lower sub-cavity; an upper surface and a lower surface of the elastic base layer 50 are respectively provided with sensing fiber assemblies 40 for detecting deformation; the sensing fiber assemblies 40 are respectively connected with the fiber phase modulator/demodulator 20; the light source 80 is coupled with the circulator 70; the circulator 70 is respectively coupled with the coupler 30 and the photodetector 100; the coupler 30 is respectively connected with the isolator 90 and the fiber phase modulator/demodulator 20; and the isolator 90 is coupled with the photodetector 100.

The ends of the sensing fiber assemblies 40 are provided with reflecting layers; monochromatic light generated by the light source 80 is split into two beams of equal-intensity light through the coupler 30; and the two beams of light are reflected back through the reflecting layers, pass through the coupler 30 again, and pass through the isolator 90 to reach the photodetector 100.

When the system is under the inertia effect, the acceleration acts on the elastic base layer 50; and the phases of the sensing fiber assemblies 40 are changed, and two phases have constant amplitude and opposite directions. However, for other signals, such as temperature effects and environmental noise, two phases have constant amplitude and

the same direction, thereby generating a differential signal. An acceleration value is obtained by demodulating the differential signal.

The tapered fiber acceleration sensor system comprises a bracket mechanism 60. The bracket mechanism penetrates through a perforation on the elastic base layer 50. The light source 80, the circulator 70, the coupler 30, the fiber phase modulator/demodulator 20, the isolator 90 and the photodetector 100 are arranged on the bracket mechanism 60.

In the tapered fiber acceleration sensor system of the present invention, the reflecting layers are coating layers.

The fiber phase modulator/demodulator 20 comprises a PZT (piezoelectric ceramic transducer) modulator/demodulator, or comprises a PZT modulator 22 and a fiber demodulator 21.

The sensing fiber assemblies 40 comprise a compliant cylinder, a sensitive mass block and a sensing fiber; the compliant cylinder is connected with the sensitive mass block; the sensitive mass block is coupled with the sensing fiber; both ends of the fiber are coated with the reflecting layers.

The sensitive mass block is in a shape of a triangular pyramid; and a pyramid top of the sensitive mass block comes into contact with the fiber.

In some embodiments, the protecting shell 10 is provided with an opening for connecting the cavity with the outside.

In some embodiments, an outer outline of the protecting shell 10 is in a shape of a rectangular block. An inner wall of the cavity is provided with a circle of clamping grooves; and the edge of the elastic base layer is clamped in the clamping grooves. The elastic base layer is in a shape of a rectangular plate. Adhesives are arranged in the clamping grooves.

In the present invention, the elastic base layer is arranged in the protecting shell to divide the cavity in the protecting shell into the upper sub-cavity and the lower sub-cavity; the upper surface and the lower surface of the elastic base layer are respectively provided with sensing fiber assemblies for detecting deformation; the sensing fiber assemblies are respectively connected with the fiber phase modulator/demodulator; the light source is coupled with the circulator; the circulator is respectively coupled with the coupler and the photodetector; the coupler is respectively connected with the isolator and the fiber phase modulator/demodulator; the isolator is coupled with the photodetector; the ends of the sensing fiber assemblies are provided with reflecting

layers; monochromatic light generated by the light source is split into two beams of equal-intensity light through the coupler; and the two beams of light are reflected back through the reflecting layers, pass through the coupler again, and pass through the isolator to reach the photodetector. The present invention has the beneficial effects of improving detection accuracy and sensitivity.

In the illustration of this description, the illustration of reference terms "one embodiment", "some embodiments", "exemplary embodiment", "example", "specific example" or "some examples", etc. means that specific features, structures, materials or characteristics illustrated in combination with the embodiment or example are included in at least one embodiment or example of the present invention. In this description, exemplary statements for the above terms shall not necessarily refer to the same embodiment or example. Moreover, the described specific features, structures, materials or characteristics can be combined appropriately in any one or more embodiments or examples.

To sum up, although the present invention is disclosed above through preferred embodiments, the above preferred embodiments are not used to limit the present invention. Those ordinary skilled in the art can make various changes and modifications without departing from the spirit and scope of the present invention. Therefore, the protection scope of the present invention should be determined by the scope defined by claims.

Conclusies

1. Een taps toelopend vezelsysteem van versnellingssensor, met het kenmerk dat het een beschermend omhulsel, een elastische basislaag, een lichtbron, een circulator, een koppelaar, een vezelfase modulator / demodulator, een isolator en een fotodetector omvat;
waarbij de elastische basislaag is aangebracht in de beschermende schaal om een holte in de beschermende schaal te verdelen in een bovenste subholte en een onderste subholte; een bovenoppervlak respectievelijk een onderoppervlak van de elastische basislaag is voorzien van samenstellen van voelvezels voor het detecteren van vervorming; de samenstellen van voelvezels zijn verbonden met de vezelfase modulator respectievelijk demodulator; de lichtbron is gekoppeld met de circulator; de circulator is gekoppeld met de koppelaar respectievelijk de fotodetector; de koppelaar is verbonden met de isolator en de vezelfase modulator respectievelijk demodulator; de isolator is gekoppeld met de fotodetector;
de uiteinden van de sensorvezelsamenstellen zijn voorzien van reflecterende lagen; monochromatisch licht gegenereerd door de lichtbron wordt gesplitst in twee stralen van licht met gelijke intensiteit door de koppelaar; en waarbij de twee lichtstralen worden teruggekaatst door de reflecterende lagen, weer door de koppelaar gaan en de isolator passeren om de fotodetector te bereiken.

2. Taps toelopend vezelsysteem van versnellingssensor volgens conclusie 1, met het kenmerk, dat de reflecterende lagen coatinglagen zijn.

3. Taps toelopend vezelsysteem van versnellingssensor volgens conclusie 1, met het kenmerk, dat de vezelfase modulator / demodulator een PZT-modulator / demodulator omvat.

4. Taps toelopend vezelsysteem van versnellingssensor volgens conclusie 1, met het kenmerk, dat de sensorvezelsamenstellen een flexibele cilinder, een gevoelig massablok en een sensorvezel omvatten; de flexibele cilinder is verbonden met het gevoelige massablok; het gevoelige massablok is gekoppeld met de detectievezel; en waarbij beide uiteinden van de vezel zijn bedekt met de reflecterende lagen.

5. Taps toelopend vezelsysteem van versnellingssensor volgens conclusie 4, met het kenmerk, dat het gevoelige massablok de vorm heeft van een driehoekige piramide; en een piramide bovenkant van het gevoelige massablok in contact komt met de vezel.

6. Taps toelopend vezelsysteem van versnellingssensor volgens conclusie 1, met het kenmerk, dat de beschermende schaal is voorzien van een opening voor het verbinden van de holte met de buitenzijde.

7. Taps toelopend vezelsysteem van versnellingssensor volgens conclusie 6, met het kenmerk, dat een buitenomtrek van de beschermende schaal de vorm heeft van een rechthoekig blok.

8. Taps toelopend vezelsysteem van versnellingssensor volgens conclusie 1, met het kenmerk, dat een binnenwand van de holte is voorzien van een cirkel van klemgroeven; en de rand van de elastische basislaag in de klemgroeven wordt geklemd.

9. Taps toelopend vezelsysteem van versnellingssensor volgens conclusie 8, met het kenmerk, dat de elastische basislaag de vorm heeft van een rechthoekige plaat.

10. Taps toelopend vezelsysteem van versnellingssensor volgens conclusie 8, met het kenmerk, dat in de klemgroeven lijmen zijn aangebracht.

1/1

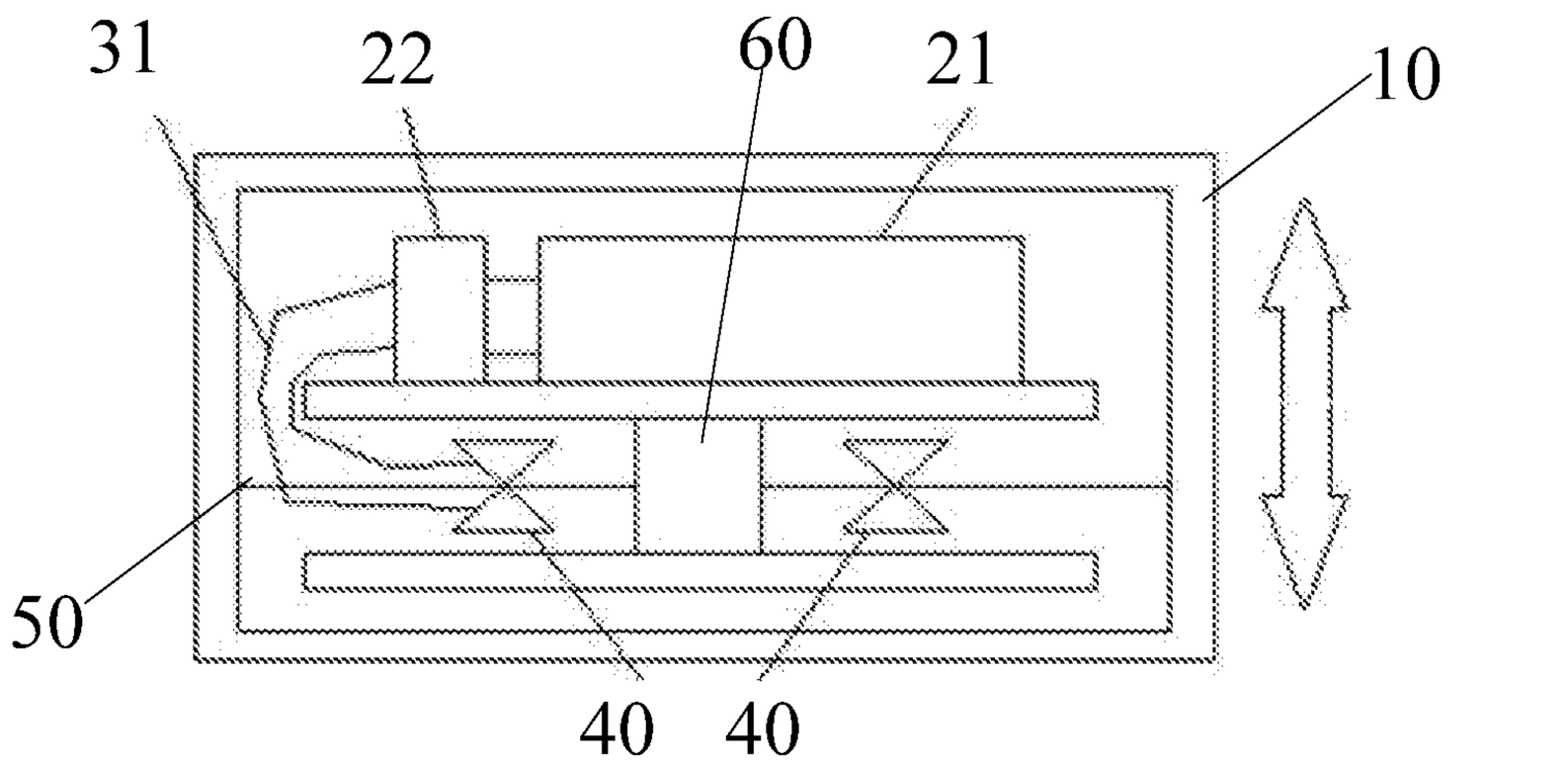

Fig. 1

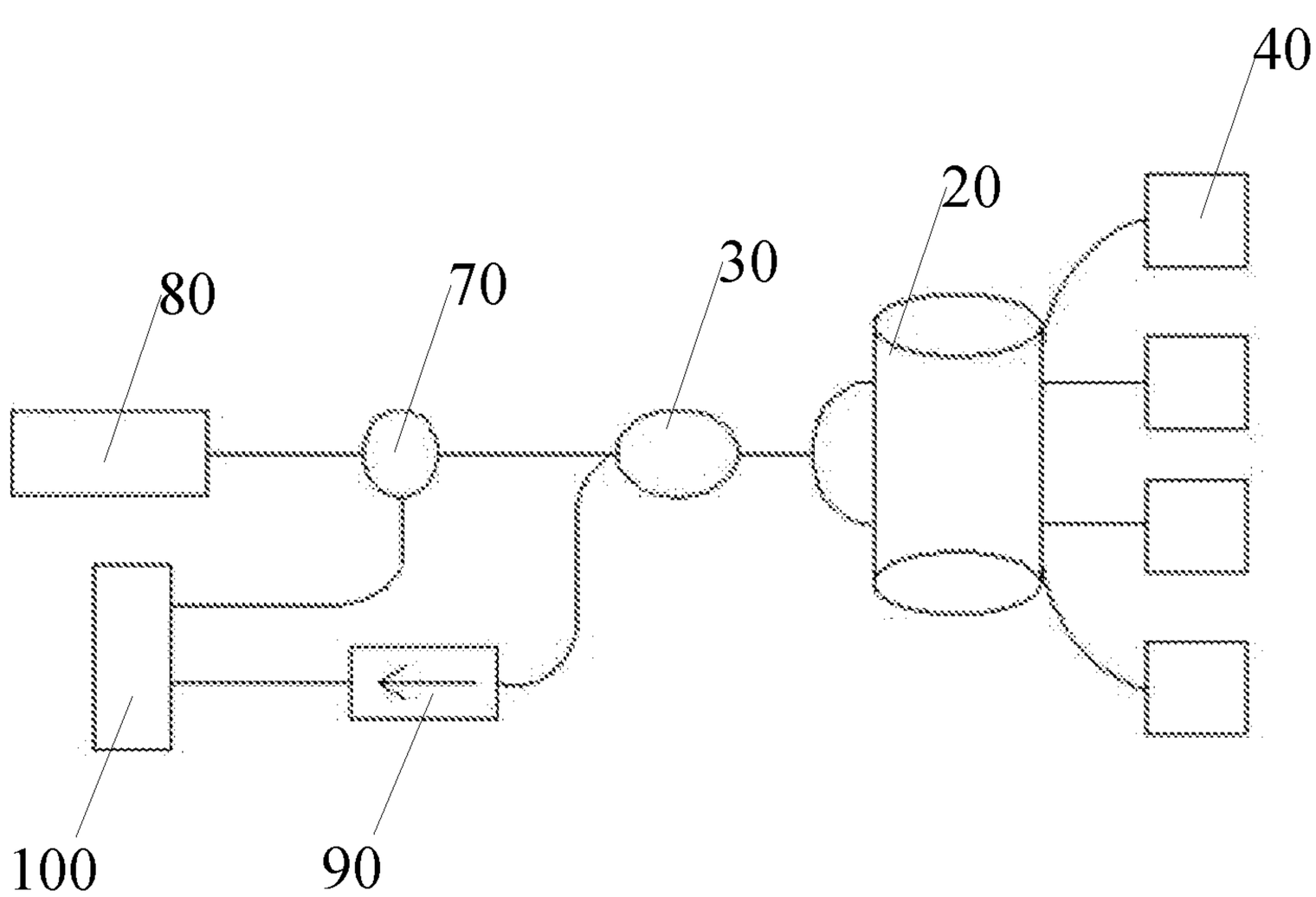

Fig. 2

Rijksdienst voor Ondernemend
Nederland

OCTROOIAANVRAAG NR.:
NO 140499
NL 2023992

ONDERZOEKSRAPPORT

BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK

RELEVANTE LITERATUUR

Categorie[1]	Literatuur met, voor zover nodig, aanduiding van speciaal van belang zijnde tekstgedeelten of figuren.	Van belang voor conclusie(s) nr:	Classificatie (IPC)
Y	CN 106 053 882 A (UNIV NANJING SCIENCE & TECH) 26 oktober 2016 (2016-10-26) * het gehele document * *	1-10	INV. G01P15/093 G01D5/353
Y	CN 108 931 262 A (BEIJING HUAGONG INFORMATION TECH CO LTD) 4 december 2018 (2018-12-04) * het gehele document *	1,5-10	
Y	US 2010/199773 A1 (ZHOU GAN [US]) 12 augustus 2010 (2010-08-12) * bladzijde 2, alinea 20 - alinea 22 * * bladzijde 3, alinea 29 - bladzijde 4, alinea 31; figuren 1, 5 *	2,4	
Y	US 5 420 688 A (FARAH JOHN [US]) 30 mei 1995 (1995-05-30) * kolom 11, regel 38 - regel 63; figuur 7 *	3	
A	CN 108 344 880 A (UNIV BEIJING) 31 juli 2018 (2018-07-31) * het gehele document *	1-10	
A	US 4 799 752 A (CAROME EDWARD F [US]) 24 januari 1989 (1989-01-24) * het gehele document *	1-10	

Indien gewijzigde conclusies zijn ingediend, heeft dit rapport betrekking op de conclusies ingediend op:

Onderzochte gebieden van de techniek

G01P
G01D

Plaats van onderzoek:	Datum waarop het onderzoek werd voltooid:	Bevoegd ambtenaar:
München	30 april 2020	Springer, Oliver

[1] CATEGORIE VAN DE VERMELDE LITERATUUR

X: de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur
Y: de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht
A: niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft
O: niet-schriftelijke stand van de techniek
P: tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur
T: na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding
E: eerdere octrooi(aanvrage), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven
D: in de octrooiaanvrage vermeld
L: om andere redenen vermelde literatuur
&: lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

EOB FORM 02.83 (P0414B)

AANHANGSEL BEHORENDE BIJ HET RAPPORT BETREFFENDE HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK, UITGEVOERD IN DE OCTROOIAANVRAGE NR.

NO 140499
NL 2023992

Het aanhangsel bevat een opgave van elders gepubliceerde octrooiaanvragen of octrooien (zogenaamde leden van dezelfde octrooifamilie), die overeenkomen met octrooischriften genoemd in het rapport.
De opgave is samengesteld aan de hand van gegevens uit het computerbestand van het Europees Octrooibureau per
De juistheid en volledigheid van deze opgave wordt noch door het Europees Octrooibureau, noch door het Bureau voor de Industriële eigendom gegarandeerd; de gegevens worden verstrekt voor informatiedoeleinden.

30-04-2020

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
CN 106053882 A	26-10-2016	GEEN	
CN 108931262 A	04-12-2018	GEEN	
US 2010199773 A1	12-08-2010	GEEN	
US 5420688 A	30-05-1995	US 5420688 A US 5891747 A	30-05-1995 06-04-1999
CN 108344880 A	31-07-2018	GEEN	
US 4799752 A	24-01-1989	GEEN	

Algemene informatie over dit aanhangsel is gepubliceerd in de 'Official Journal' van het Europees Octrooibureau nr 12/82 blz 448 ev

SCHRIFTELIJKE OPINIE

DOSSIER NUMMER	INDIENINGSDATUM	VOORRANGSDATUM	AANVRAAGNUMMER
NO140499	10.10.2019	12.04.2019	NL2023992

CLASSIFICATIE
INV. G01P15/093 G01D5/353

AANVRAGER
Shandong University of Science and Technology

Deze schriftelijke opinie bevat een toelichting op de volgende onderdelen:

- ☒ Onderdeel I Basis van de schriftelijke opinie
- ☐ Onderdeel II Voorrang
- ☐ Onderdeel III Vaststelling nieuwheid, inventiviteit en industriële toepasbaarheid niet mogelijk
- ☐ Onderdeel IV De aanvraag heeft betrekking op meer dan één uitvinding
- ☒ Onderdeel V Gemotiveerde verklaring ten aanzien van nieuwheid, inventiviteit en industriële toepasbaarheid
- ☐ Onderdeel VI Andere geciteerde documenten
- ☒ Onderdeel VII Overige gebreken
- ☐ Onderdeel VIII Overige opmerkingen

	DE BEVOEGDE AMBTENAAR
	Springer, Oliver

Aanvraag nr.:

SCHRIFTELIJKE OPINIE

NL2023992

Onderdeel I Basis van de Schriftelijke Opinie

1. Deze schriftelijke opinie is opgesteld op basis van de meest recente conclusies ingediend voor aanvang van het onderzoek.

2. Met betrekking tot **nucleotide en/of aminozuur sequenties** die genoemd worden in de aanvraag en relevant zijn voor de uitvinding zoals beschreven in de conclusies, is dit onderzoek gedaan op basis van:

a. type materiaal:

☐ sequentie opsomming

☐ tabel met betrekking tot de sequentie lijst

b. vorm van het materiaal:

☐ op papier

☐ in elektronische vorm

c. moment van indiening/aanlevering:

☐ opgenomen in de aanvraag zoals ingediend

☐ samen met de aanvraag elektronisch ingediend

☐ later aangeleverd voor het onderzoek

3. ☐ In geval er meer dan één versie of kopie van een sequentie opsomming of tabel met betrekking op een sequentie is ingediend of aangeleverd, zijn de benodigde verklaringen ingediend dat de informatie in de latere of additionele kopieën identiek is aan de aanvraag zoals ingediend of niet meer informatie bevatten dan de aanvraag zoals oorspronkelijk werd ingediend.

4. Overige opmerkingen:

Aanvraag nr.:

SCHRIFTELIJKE OPINIE

NL2023992

Onderdeel V Gemotiveerde verklaring ten aanzien van nieuwheid, inventiviteit en industriële toepasbaarheid

1. Verklaring

Nieuwheid	Ja:	Conclusies	1-10
	Nee:	Conclusies	
Inventiviteit	Ja:	Conclusies	
	Nee:	Conclusies	1-10
Industriële toepasbaarheid	Ja:	Conclusies	1-10
	Nee:	Conclusies	

2. Citaties en toelichting:

Zie aparte bladzijde

Onderdeel VII Overige gebreken

De volgende gebreken in de vorm of inhoud van de aanvraag zijn opgemerkt:

Zie aparte bladzijde

Item V:

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1 **Technical Field:**

The invention relates to a fiber acceleration sensor.

2 **Independent Claims:**

Claim 1 (apparatus).

3 **State of the Art:**

Reference is made to the following documents:

D1: CN 106 053 882 A (UNIV NANJING SCIENCE & TECH) 26 oktober 2016

D2: CN 108 931 262 A (BEIJING HUAGONG INFORMATION TECH CO LTD) 4 december 2018

D3: US 2010/199773 A1 (ZHOU GAN [US]) 12 augustus 2010

D4: US 5 420 688 A (FARAH JOHN [US]) 30 mei 1995

D5: CN 108 344 880 A (UNIV BEIJING) 31 juli 2018

D6: US 4 799 752 A (CAROME EDWARD F [US]) 24 januari 1989

4 **Novelty and Inventive Step**

The subject-matter of claims 1 to 10 is lacking an inventive step in respect of the prior art:

4.1 **Independent Claim 1:**

Document **D1**, which is considered as closest prior art, shows (see the whole document and the machine translation, the references in parentheses applying to this document) a tapered fiber acceleration sensor system (see the title), comprising:

I. a protecting shell (3), an elastic base layer (5), a light source(12), a coupler (8), a fiber phase modulator/demodulator, and a photodetector (13) (see e.g. page 4, paragraph 28, to p. 5, par. 29, 35, p. 6, par. 50, and figures 1, 5, 6),

II. the elastic base layer (5) is arranged in the protecting shell (3) to divide a cavity in the protecting shell into an upper sub-cavity and a lower sub-cavity (see e.g. p. 4, par. 28, to p. 5, par. 29, 35, and fig. 1);

III. an upper surface and a lower surface of the elastic base layer (5) are respectively provided with sensing fiber assemblies (1) for detecting deformation (see e.g. p. 4, par. 28, to p. 5, par. 29, 35, and fig. 1);

IV. the sensing fiber assemblies (1) are respectively connected with the fiber phase modulator/demodulator (see e.g. p. 4, par. 28, to p. 5, par. 29, 35, p. 6, par. 50, and fig. 1, 5);

V. the coupler (8) is connected with fiber phase modulator/demodulator (see e.g. p. 4, par. 28, to p. 5, par. 29, 35, p. 6, par. 50, and fig. 1, 5),

VI. the ends of the sensing fiber assemblies (1) are provided with reflecting layers (7) (see e.g. p. 3, par. 11, to p. 4, par. 12, p. 4-5, par. 29, to p. 5, par. 29, p. 5, par. 35, p. 6, par. 48, and fig. 1, 5),

VII. monochromatic light generated by the light source (12) is split into two beams of equal intensity light through the coupler (8) (see e.g. p. 6, par. 50, and fig. 5); and

VIII. the two beams of light are reflected back through the reflecting layers (7), pass through the coupler (8) again to reach the photodetector (13) (see e.g. p. 3, par. 11, to p. 4, par. 12, p. 4-5, par. 29, to p. 5, par. 29, p. 5, par. 35, p. 6, par. 48-50, and fig. 1, 5).

The subject-matter of independent claim 1 differs from that of document **D1** in, that the system further comprises a circulator and an isolator, wherein the light source is coupled with the circulator, the circulator is coupled with the coupler and the photodetector, the coupler is connected with the isolator and the isolator is coupled with the photodetector.

This solves the objective technical problem to improve the optical arrangement of the sensor.

The use of optical circulators and optical isolators is well known in the field of optical sensors to improve the sensor arrangement. A circulator ist used for distributing the light, an isolator is used to avoid unwanted reflections. The use of such components is e.g. known from document **D2** (see e.g. p. 4, par. 30, p. 5, par. 42-45, and fig. 1, 2). These parts are described in this document as providing the same advantages as in the present application. The skilled person would therefore regard it as a normal option to include these parts in the fiber acceleration system described in document **D1** in order to solve the problem posed. Thus, the subject-matter od independent claim 1 is not inventive.

4.2 **Dependent claims 2 to 10:**

Dependent claims 2 to 10 only suggest slight constructional changes to the arrangements of independent claim 1 to which they refer:

I. **Claim 2:** The reflecting layers are coating layers (see **D3**, e.g. p. 2, par 20-22; p. 3, par. 29, to p. 4, par 31; figs 1, 5),

II. **Claim 3:** The fiber phase modulator/demodulalor is a PZT modulator/demodulator (see **D4**, e.g. col. 11, l. 38-63, fig. 7),

III. **Claim 4:** The sensing fiber assemblies comprise a compliant cylinder, a sensitive mass block and a sensing fiber, the compliant cylinder is connected with the sensitive mass block; the sensitive mass block is coupled with the sensing fiber, both ends of the fiber are coaled with the reflecting layers (see **D1,** e.g. p. 4, par. 28, to p. 5, par. 29, 35, p. 6, par. 50, and figures 1, 5, 6, and **D3**, e.g. p. 2, par 20-22; p. 3, par. 29, to p. 4, par 31; figs 1, 5),

IV. **Claim 5:** That the sensitive mass block is in a shape of a triangular pyramid, and that a pyramid top of the sensitive mass block comes into contact with the fiber is an obvious feature for the skilled person,

V. **Claims 6 and 7:** The protecting shell (3) is provided with an opening for connecting the cavity with the outside and an outer outline of the protecting shell is in a shape of a rectangular block(see **D1,** e.g. p. 4, par. 28, to p. 5, par. 29, 35, p. 6, par. 50, and figures 1, 5, 6, and **D3**, e.g. p. 2, par 20-22; p. 3, par. 29, to p. 4, par 31; figs 1, 5),

VI. **Claims 8 and 10:** That an inner wall of the cavity is provided with a circle of clamping grooves, that the edge of the elastic base layer (5) is clamped in the clamping grooves, and that adhesives are arranged in the clamping grooves is an obvious feature for the skilled person,

VII. **Claim 9:** The elastic base layer (5) is in a shape of a rectangular plate (see fig. 1, 2, 3),

5 Industrial Applicability

The invention as claimed in claims 1 to 10 is obviously industrially applicable in the field of fiber acceleration sensors.

Item VII:

Certain defects in the international application

1 Independent claim 1 is not in the two-part form concerning document **D1**.

2 Documents **D1** to **D4** are not identified in the description and the relevant background art disclosed therein is not discussed.