Appeal Decision

Appeal No. 2021-2565

Appellant	The Boeing Co.
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The case of appeal against the examiner's decision of refusal of Japanese Patent Application No. 2016-223764, entitled "SYSTEM AND METHOD FOR TACTILE SENSING USING THIN FILM OPTICAL SENSING NETWORKS" [the application published on June 29, 2017, Japanese Unexamined Patent Application Publication No. 2017-116531] has resulted in the following appeal decision.

Conclusion

The appeal of the case was groundless.

Reasons

No.1 History of the procedures

The present application is a foreign language written application filed on November 17, 2016 (claim of priority under the Paris Convention on November 24, 2015, USA), and the history of the procedures is summarized as follows.

November 17, 2016 : Submission of translation
June 08, 2020 : Notification of reasons for refusal
September 16, 2020 : Submission of written opinion and written amendment
October 23, 2020 : Decision of refusal (hereinafter referred to as "the examiner's decision")
(October 27, 2020 : Delivery of the certified copy of the examiner's decision)
February 26, 2021 : Submission of written request for appeal and written amendment

No.2 Decision to dismiss amendment on the written amendment submitted on February 26, 2021
[Conclusion of Decision to Dismiss Amendment]
The Amendment as of February 26, 2021 shall be dismissed.

[Reasons for Decision to Dismiss Amendment]
1. Summary of theAmendment
The amendment as of February 26, 2021 (hereinafter referred to as "the Amendment") to the scope of claims includes amended matters which amend the recitation of Claim 1 of the scope of claims before the Amendment, as recited in item (1) below, to the recitation of Claim 1 of the scope of claims after the Amendment, as recited in item (2) below. The underlines indicate the amended portions.

(1) Before the Amendment
"[Claim 1]
A thin-film flexible tactile sensor, comprising:
a sensing network formed from an array of light guide pathways arranged in a flexible material, each of the light guide pathways being made of a material that functions as an optical strain gauge, and having a first end used as an input end and a second end used as an output end;
a plurality of light sources, one for each of the light guide pathways, each of the plurality of light sources respectively coupled to the input end of a corresponding light guide pathway and respectively supplying a light signal having predetermined first frequency and polarization into the corresponding light guide pathway;
a plurality of light detectors, one for each of the light guide pathways, each of the plurality of light detectors respectively coupled to the output end of a corresponding light guide pathway, each of the plurality of light detectors respectively receiving the light signal from the corresponding light guide pathway and generating an output signal

corresponding to the magnitude of the received light signal at a predetermined second frequency; and

a processor coupled to receive the output signal from each of the plurality of light detectors and configured to determine a pressure applied to the sensing network based on the received signals from the plurality of light detectors."

(2) After the Amendment

"[Claim 1]

A thin-film flexible tactile sensor, comprising:

a sensing network formed from an array of light guide pathways arranged in a flexible material, each of the light guide pathways being made of a material that functions as an optical strain gauge, each of the light guide pathways having a first end used as an input end and a second end used as an output end, and each of the light guide pathways being solid from the first end to the second end;

a plurality of light sources, one for each of the light guide pathways, each of the plurality of light sources respectively coupled to the input end of a corresponding light guide pathway and respectively supplying a light signal having predetermined first frequency and polarization into the corresponding light guide pathway;

a plurality of light detectors, one for each of the light guide pathways, each of the plurality of light detectors respectively coupled to the output end of a corresponding light guide pathway, each of the plurality of light detectors respectively receiving the light signal from the corresponding light guide pathway and generating an output signal corresponding to the magnitude and polarization of the received light signal at a predetermined second frequency; and

a processor coupled to receive the output signal from each of the plurality of light detectors and configured to determine a pressure applied to the sensing network based on the received signals from the plurality of light detectors."

2. Decision on the Amendment by the body

The Amendment restricts "a sensing network formed from an array of light guide pathways arranged in a flexible material, each of the light guide pathways being made of a material that functions as an optical strain gauge, each of the light guide pathways having a first end used as an input end and a second end used as an output end" in Claim 1 before the Amendment, as of "each of the light guide pathways being solid from the first end to the second end".

In addition, the Amendment restricts "the output signals" "generated" by "a plurality of light detectors" in Claim 1 before the Amendment, as of "corresponding to the magnitude and polarization of the received light signal at a predetermined second frequency".

Moreover, the invention recited in Claim 1 before the Amendment and the invention recited in Claim 1 after the Amendment have the same industrial field of application and the same problem to be solved. Therefore, the Amendment is an amendment that is intended for restriction of the scope of claims prescribed in the Patent Act Article 17-2(5)(ii).

Therefore, whether the invention recited in Claim 1 after the Amendment (hereinafter referred to as "the Amended Invention") is one for which the Appellant can be granted a patent independently at the time of filing the patent application, i.e., whether the Amended Invention complies with the provisions of the Patent Act Article 126(7) as applied mutatis mutandis to the Patent Act Article 17-2(6)), will now be discussed below.

(1) The Amended Invention:

The Amended Invention is one recited as follows:

"A thin-film flexible tactile sensor, comprising:

a sensing network formed from an array of light guide pathways arranged in a flexible material, each of the light guide pathways being made of a material that functions as an optical strain gauge, each of the light guide pathways having a first end used as an input end and a second end used as an output end, and each of the light guide pathways being solid from the first end to the second end;

a plurality of light sources, one for each of the light guide pathways, each of the plurality of light sources respectively coupled to the input end of a corresponding light guide pathway and respectively supplying a light signal having a first predetermined frequency and polarization into the corresponding light guide pathway;

a plurality of light detectors, one for each of the light guide pathways, each of the plurality of light detectors respectively coupled to the output end of a corresponding light guide pathway, each of the plurality of light detectors respectively receiving the light signal from the corresponding light guide pathway and generating an output signal corresponding to the magnitude and the polarization of the received light signal at a predetermined second frequency; and

a processor coupled to receive the output signal from each of the plurality of light detectors and configured to determine a pressure applied to the sensing network based on the received signals from the plurality of light detectors."

(2) Cited Documents

a Cited Document 1

The following matters are described in JP S62-502142A (hereinafter referred to as "Cited Document 1") cited in the reasons for refusal of the examiner's decision. The underlines are added by the body.

(a) Lines 9-15 of the upper left column on page 3

"An optical apparatus for force measurement in the present invention comprises at least one optical fiber disposed in such a manner as to form an array; light-emitting means that are disposed at one end, referred to as an entrance, of the several fibers; and light receiving means that are disposed at the other end, referred to as an exit, of the several fibers. The optical apparatus provides information relating to a luminous intensity transmitted by the array of the optical fibers and corresponding measurement of the force."

(b) Lines 7-12 of the upper-right column on page 3

"The present invention is employed in weighing apparatuses, apparatuses for the measurement of stress applied to distortion surfaces, in the industry for producing hollow bodies, reservoirs, clothes, components formed by pressure, or in the industry for testing of hollow bodies of which the inner walls are subjected to periodic or substantially periodic forces, and especially in mechanical systems used in specialist footwear or robotics."

(c) Line 13 of the upper-left column on page 4 to line 6 of the lower left column on page 4

"As shown in Figs. 2a-1, 2a-2, and 3a, weft lines i are configured to be superposed on warp lines j or vice versa. In Figs. 2a-1 and 2a-2, respective cross-sectional views of the weft line of order i and the warp line of order j are shown. In order to ensure a mechanical bonding force of the set of the array 2, it is embedded in a layer of silicone elastic material. The silicone elastic material, for example, consists of a commercially available material that is well known under the trademark "Rhodorsil" manufactured by Rhone-Poulenc Corp. In the embodiment, in a carpet shape, an upper plate 20 and a lower plate 21 are disposed on the surface, and are fixed by an adhesive for protection. The upper plate 20 and the lower plate 21 may, for example, consist of a neoprene material, or a synthetic or natural fiber.

According to another embodiment, the material 22 covering the array 2 of optical fibers may consist of a porous (cytoplasmic) substance of a polyurethane foam type. In the latter case, the density and elasticity of the porous substance are selected in a range where the sensitivity of the array covered by the substance can be obtained so that the density and elasticity lead to determine attenuation of the stress or force applied to the array. In the two aforementioned embodiments, the covering material is a material of a massive type, such as the material of the trademark "Rhodorsil"; the porous material is a polyurethane foam material; and covering of the array is performed by casting (molding).

According to a preferred embodiment, the array 2 consists of woven fibers. Examples of the construction are as shown in Figs. 2b-1, 2b-2, 2c-1, 2c-2, and 3b. As shown in Fig. 2b-1, each weft line i is placed on the corresponding warp line j to form gratings and pitches of the array with each other. The arrangement may be performed in a single direction of the array as shown in Figs. 2b-1 and 2c-1, or according to two directions of the array as shown in Figs. 2b-2, 2c-2, and 3b. Furthermore, Figs. 2c-1 and 2c-2 show examples each with a covering bed 22 of its own and the upper and lower plates 20 and 21. The warp fibers or the weft fibers may be replaced with elements such as metal wires so that the metal wires complete the function to permit applicating the force to the weft lines or the warp lines, which are themselves only constituted by the optical fibers.

The optical fibers used in the embodiments of the array may be mono-mode optical fibers or multi-mode optical fibers having a graded index or a step index. The optical fibers, for example, are plastic optical fibers having a diameter in a range between 1/250 millimeter to 1 millimeter, or silica crystal optical fibers having a diameter of 1/10 millimeter. By using the plastic optical fibers that are used for constituting the array and having a diameter of 1/250 millimeter, it is possible to obtain a final structure, as shown in Figs. 2a and 2c, of which the thickness does not exceed 7-8 millimeters."

(d) Line 13 of the upper-left column on page 5 to line 3 of the upper right column on page 5

"Another apparatus of the present invention can especially permit mapping pressures or plotting (drawing) of relative forces applied to a plurality of points of a test surface, which is described with reference to Fig. 6a below. According to Fig. 6a, the present embodiment relates to an apparatus comprising the array 2, which consists of a plurality of m warp lines in the first direction and a plurality of n weft lines in the second direction. In Fig. 6a, the first direction is perpendicular to the second direction. Each warp line and each weft line is constituted by an independent optical fiber, and the optical fibers are provided with light-emitting means Ei and Ej, and light receiving and detection means Qi and Qj. Dynamic memory means 62 and 63 store values of the relative forces supplied by the detectors corresponding to the optical fibers of orders i and j in the first and second directions. Furthermore, according to a linear combination of measurements supplied by the receivers Qi and Qj as in the following equation, the calculation of the relative forces respectively applied to the points of the array of coordinates i and j in the first and second directions is executed by the read/write means of the memory means 62 and 63, and a calculation means 65."

(e) Line 9 of the upper right column on page 5 to line 1 of the lower left column on page 5

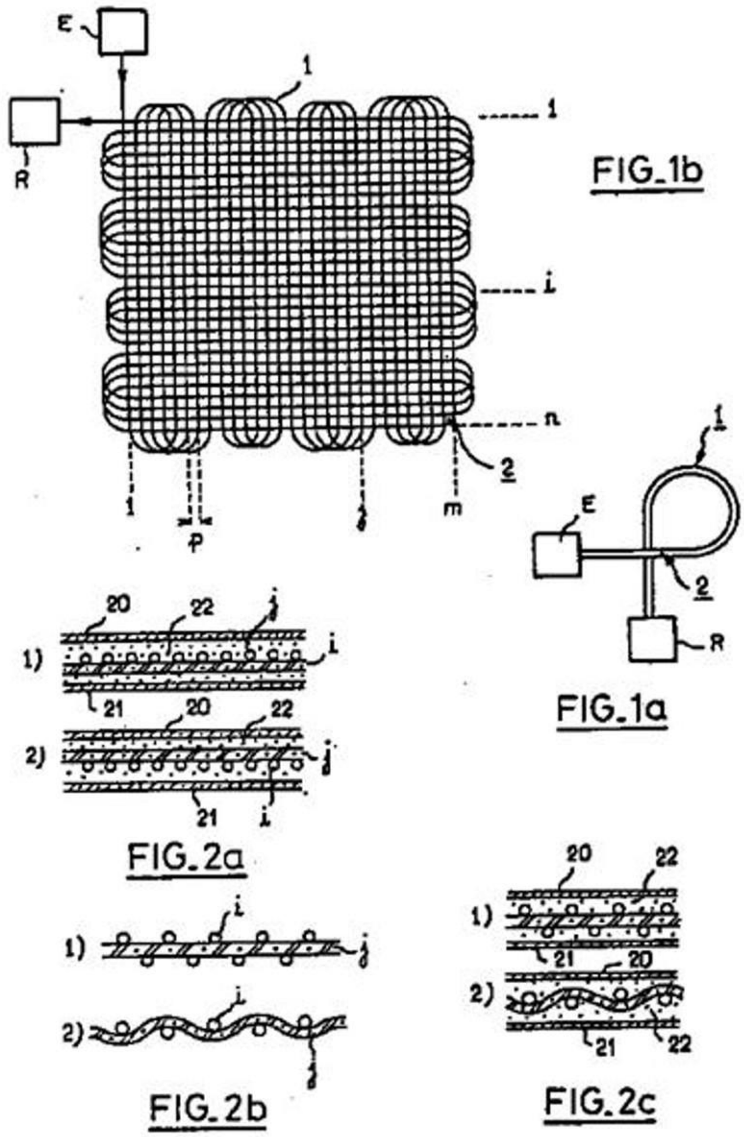
"In Fig. 6a, the read/write means and the means for calculating the relative forces applied to the array may, for example, be constituted by a central processing apparatus 65. Furthermore, in order to ensure the linking of the receivers Qi and Qj to the corresponding memories 63 and 62, a multiplexer system i shown in 61 and a multiplexer system j shown in 60 are provided. The multiplexers controlled by the central processing apparatus 65 permit the sequential connection of the receivers Qi and Qj, and permit the recording at determined addresses of the corresponding memories, memories i, 63, memories j, 62, of attenuation values as detection results provided by the abovementioned detectors. The central processing apparatus 65 may be provided with a keyboard of the computer keyboard type, a television monitor that displays measurement results on a display, and auxiliary memories permitting the storage in the central memory, of any program for processing the measurement provided by the receivers Qi and Qj."

(f) Lines 2-5 of the lower left column on page 6

"The present invention is not limited to the embodiments above, and in particular, corresponding devices utilizing a sensitive skin as described above may be useful in the field of robotics with gripping elements."

(g) Figs. 1-2

"



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(h) Fig. 6

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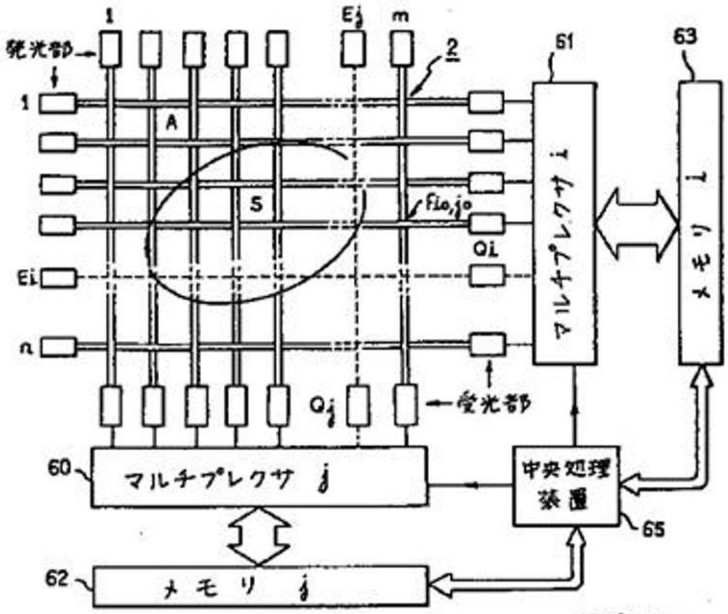


FIG.6a

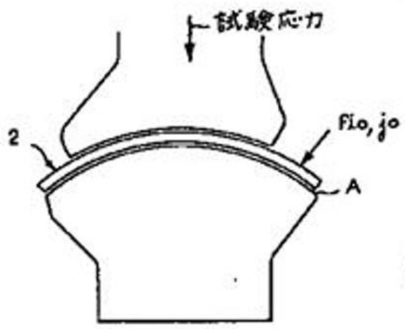


FIG.6b

"

発光部	Emitters
マルチプレクサ	Multiplexer
メモリ	Memory
受光部	Receivers
中央処理装置	Central processing apparatus
試験応力	Testing stress

b Recognition of the Cited Invention

Considering the matters indicated in item a, it is recognized that the Cited Document 1 describes the following invention (hereinafter referred to as "Cited Invention").

[Cited Invention]

"An optical apparatus,

the optical apparatus comprising at least one optical fiber disposed in such a manner as to form an array; light-emitting means that are disposed at one end, referred to as an entrance, of the several fibers; and light receiving means that are disposed at the other end, referred to as an exit, of the several fibers; the optical apparatus provides information relating to a luminous intensity transmitted by the array of the optical fibers and a corresponding measurement of the force, (see item a (a))

the optical apparatus is employed in mechanical systems used in robotics or is employed in apparatuses for the measurement of stress applied to distortion surfaces, and whereby corresponding devices utilizing a sensitive skin may be useful in the field of robotics with gripping elements, (see item a (b) and (f))

the optical apparatus comprises the array 2, which consists of a plurality of m warp lines in the first direction and a plurality of n weft lines in the second direction perpendicular to the first direction, wherein each warp line and each weft line is constituted by an independent optical fiber, and the optical fibers are provided with light-emitting means Ei and Ej, and light receiving and detection means Qi and Qj, (see item a (d))

the weft lines i are configured to be superposed on the warp lines j or vice versa, and in order to ensure a mechanical bonding force, the array 2 is embedded in a layer of silicone elastic material in a carpet shape, and an upper plate 20 and lower plate 21 are disposed on the surface and fixed by an adhesive for protection, whereby the upper plate 20 and the lower plate 21 may, for example, consist of a neoprene material, or a synthetic or natural fiber;

the optical fibers used in the array may be mono-mode optical fibers or multi-mode optical fibers having a graded index or step index, (see item a (c))

dynamic memory means 62 and 63 store values of the relative forces supplied by the detectors corresponding to the optical fibers of orders i and j in the first and second directions and the calculation of the relative forces respectively applied to the points of the array of coordinates i and j in the first and second directions is executed by the read/write means of the memory means 62 and 63 and a calculation means 65 to permit mapping pressures or plotting (drawing) of relative forces applied to a plurality of points

of a test surface, (see item a (d))
the read/write means and the means for calculating the relative forces applied to the array may, for example, be constituted by a central processing apparatus 65. (see item a (e))"

c Cited Document 2

The following matters are described in JP 2008-145315A (hereinafter referred to as "Cited Document 2") cited in the reasons for refusal of the examiner's decision. The underlines are added by the body.

"[0013]

[First embodiment]

Fig. 1(a) is a concept view illustrating the optical fiber temperature and strain measurement method of the first embodiment of the present invention; Fig. 1(b) is a schematic cross-sectional view of the optical fiber shown in Fig. 1(a); and Fig. 2 is an explanatory view illustrating an example of a refractive index in a radial direction of the optical fiber used in the present embodiment.

[0014]

As shown in Fig. 1(a), in the present embodiment, the optical fiber temperature and strain measurement apparatus comprises: a Hole-Assisted Optical Fiber (HAF) 1 that is used as the optical fiber to be measured, and receives a temperature change and strain corresponding to the temperature change and strain of the medium or space; a light source part 2 that emits a light wave used as measurement light to the HAF 1; a polarizer 3 that controls the plane of polarization of the light wave emitted by the HAF 1; an optical/electrical converter 4 that is used as a light receiving part and converts the light wave of which the plane of polarization is controlled by the polarizer 3 into an electrical signal; and a spectrum analyzer that displays a frequency spectrum of the output signal output from the optical/electrical converter 4.

[0015]

When the light wave is emitted from one end of the HAF 1, Brillouin scattered light would be generated in the HAF 1. In the present embodiment, the forward Brillouin scattered light and propagating light pass through the polarizer 3 so that a beat signal of the propagating light and the forward Brillouin scattered light can be obtained in the spectrum analyzer 5. By analyzing the frequency shift or the change in scattered light intensity according to the beat signal, the temperature and strain of the medium or space can be measured.

[0016]

As shown in Fig. 1(b), there are three or more (six in Fig. 1(b)) holes 13 in the HAF 1.

These holes 13 are formed at the periphery of the core region 11 in the cladding region 12, and specifically are formed in parallel with the core region on a coaxial circle with the core region 11 as the axis. Hereinafter, the diameter of the core region 11 is set to be 2a, the diameter of the holes 13 is set to be d, and a distance from the axis to the holes 13 (hereinafter referred to as the hole position) is set to be c/2."

"[0019]

Effects of the present embodiment are described below. Fig. 3(a) is a diagram illustrating temperature dependence (represented by black dots and solid lines in the figure) of the frequency shift of the forward Brillouin scattered light when the HAF 1 as shown in Figs. 1 and 2 is used as the optical fiber to be measured, and the temperature dependence (represented by white dots and broken lines in the figure) of the frequency shift of the forward Brillouin scattered light when a zero-dispersion Single-Mode Fiber (SMF) of 1.3 micrometers band is used as the optical fiber to be measured. Fig. 3(b) is a diagram illustrating the temperature dependence (represented by block dots and solid lines in the figure) of the intensity of the forward Brillouin scattered light when the HAF 1 is used as the optical fiber to be measured, and the temperature dependence (represented by white dots and broken lines in the figure) of the intensity of the forward Brillouin scattered light when the zero-dispersion SMF of 1.3 micrometers band is used as the optical fiber to be measured.

[0020]

It should be noted that Figs. 3(a) and (b) illustrate examples of measuring wherein the cladding diameters of the HAF 1 and the zero-dispersion SMF of 1.3 micrometers band are 125 micrometers, the distance c between holes of the HAF 1 is 18 micrometers, and the diameter d of the holes is 13.5 micrometers.

[0021]

The frequency shift and intensity of the forward Brillouin scattered light generated in the HAF 1 are respectively changed between proportionality coefficient k_f and proportionality coefficient k_I that are obtained by means of slopes of the solid lines shown in Figs. 3(a) and Fig. 3(b) and have specific structure with respect to the temperature. Therefore, when the temperature of the HAF 1, the frequency shift and the scattered light intensity of the forward Brillouin scattered light that are measured before temperature change are respectively set to be T_0, f_0, and I_0, the temperature T after temperature change can be obtained by either equation (1) or equation (2).

[0022] $T=k_f(f-f_0)+T_0$...(1); $T=k_I(I-I_0)+T_0$...(2)

[0023]

Here, f in formula (1) and I in formula (2) respectively represent the frequency shift and the intensity of forward Brillouin scattered light that are measured after temperature change.

[0024]

In addition, as described above, in general the frequency shift and the intensity of the Brillouin scattered light linearly change with respect to the strain amount of the optical fiber. Therefore, by obtaining the proportionality coefficient of the frequency shift or the proportionality coefficient of the intensity of the forward Brillouin scattered light with respect to the change of the strain amount in the HAF 1 in advance, the relational expressions same as equation (1) and equation (2) can be used to calculate the strain amount according to the detected frequency shift or intensity of the forward Brillouin scattered light."

"[0032]

[Second embodiment]

Fig. 6 illustrates a configuration example of the optical fiber temperature and strain measurement apparatus in the second embodiment of the present invention. Compared to the apparatus of the first embodiment, the optical fiber temperature and strain measurement apparatus of the present embodiment is additionally provided with an analysis portion 6 and a measurement result display portion 7. Other configurations are as shown in Fig. 1 and are substantially the same as those of the first embodiment, the same members are marked using the same symbols, and repeated description is omitted.

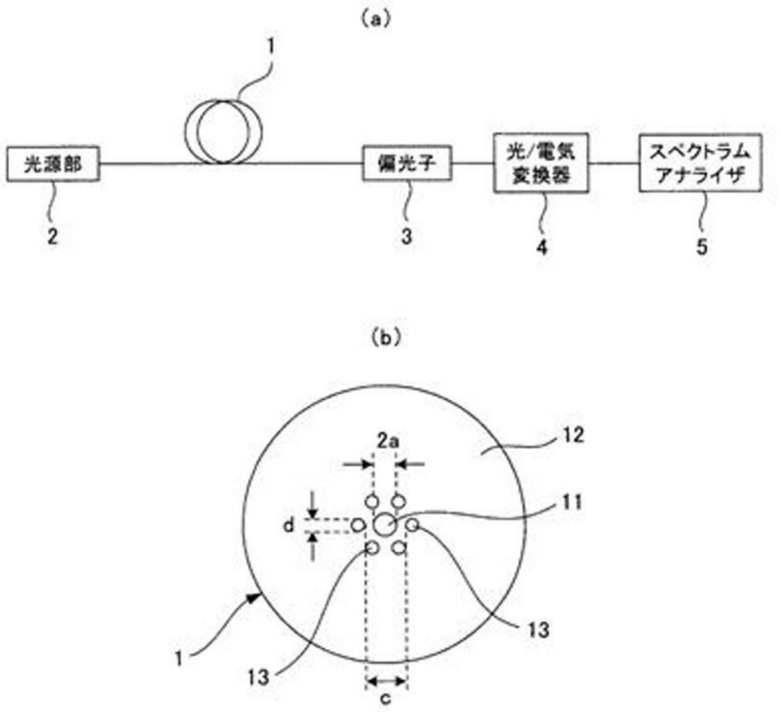
[0033]

As shown in Fig. 6, in the present embodiment, the spectrum analyzer 5 and the analysis portion 6 are connected, and the analysis portion 6 and the measurement result display portion 7 are further connected. The analysis portion 6 is a means for calculating the temperature and strain of the HAF 1 by analyzing the frequency shift or the change of intensity of the forward Brillouin scattered light observed by the spectrum analyzer 5. In addition, the measurement result display portion 7 is a means for displaying the temperature, the strain, or both the temperature and strain of the HAF 1 calculated by the analysis portion 6.

[0034]

According to the present embodiment, by using the analysis portion 6 to analyze the frequency shift or the change of intensity of the forward Brillouin scattered light observed by the spectrum analyzer 5, the temperature or strain of the desired medium or space can be obtained. In addition, in the optical fiber temperature and strain measurement apparatus shown in Fig. 6, it is preferable that the polarizer or a polarization controller is provided between the optical fiber 1 and the light source part 2 in order to improve the light receiving efficiency."

"[Fig. 1]



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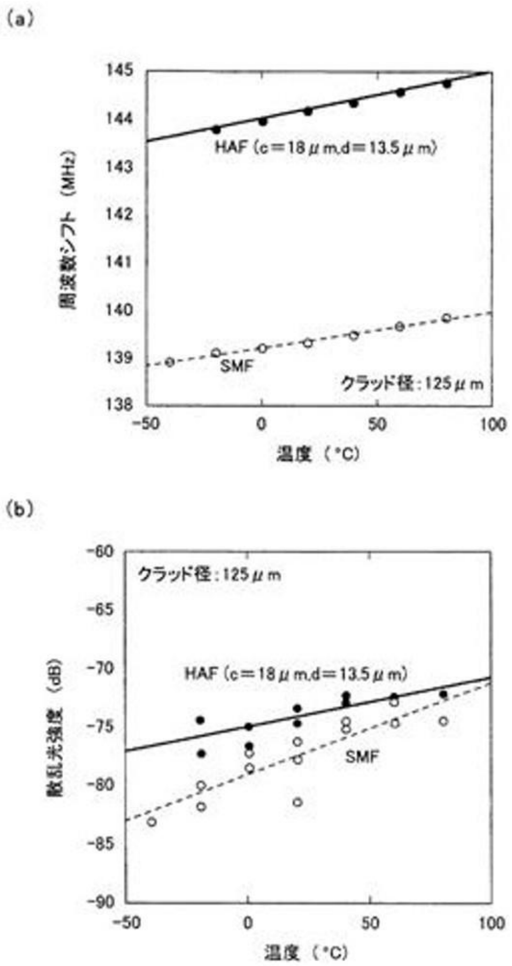
【図１】	[Fig. 1]
光源部	Light source part
偏光子	Polarizer
光/電気変換器	Optical/electrical converter
スペクトラムアナライザ	Spectrum analyzer

"[Fig3]



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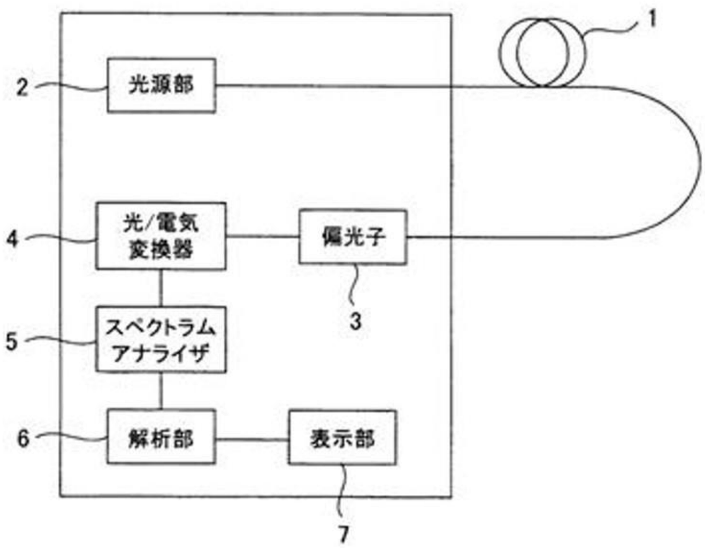
【図３】	[Fig. 3]
周波数シフト	Frequency shift
クラッド径	Cladding diameter
温度	Temperature
散乱光強度	Scattered light intensity

"[Fig. 6]



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【図 6 】	[Fig. 6]
光源部	Light source part
光/電気変換器	Optical/electrical converter
スペクトラムアナライザ	Spectrum analyzer
解析部	Analysis part
偏光子	Polarizer
表示部	Display part

(b) According to the recited matters above, it is recognized that Cited Document 2 describes the following technical matter (hereinafter referred to as "the Described Matter 1 in Cited Document 2")

[The Described Matter 1 in Cited Document 2]

"An optical fiber temperature and strain measurement apparatus, wherein

the optical fiber temperature and strain measurement comprises: a Hole-Assisted Optical Fiber (HAF) 1 that is used as the optical fiber to be measured, and receives a temperature change and strain corresponding to the temperature change and strain of the medium or space; a light source part 2 that emits a light wave used as measurement light to the HAF

1; a polarizer 3 that controls the plane of polarization of the light wave emitted by the HAF 1; an optical/electrical converter 4 that is used as a light receiving part and converts the light wave of which the plane of polarization is controlled by the polarizer 3 into an electrical signal; and a spectrum analyzer that displays a frequency spectrum of the output signal from the optical/electrical converter 4, (paragraph [0014])
and when the light wave is emitted from one end of the HAF 1, Brillouin scattered light would be generated in the HAF 1, the forward Brillouin scattered light and propagating light pass through the polarizer 3 so that a beat signal of the propagating light and the forward Brillouin scattered light can be obtained in the spectrum analyzer 5, and by analyzing the frequency shift or the change in the scattered light intensity according to the beat signal, the temperature and strain of the medium or space can be measured, (paragraph [0015])
the analysis part 6 and the measurement result display part 7 are additionally provided; the spectrum analyzer 5 is connected to the analysis part 6; and the analysis part 6 is further connected to the measurement result display part 7, wherein the analysis part 6 is a means for calculating the temperature and strain of the HAF 1 by analyzing the frequency shift or the change in the intensity of the forward Brillouin scattered light observed by the spectrum analyzer 5, (paragraphs [0032]-[0033] and [Fig. 6])
a polarizer or a polarization controller is provided between the optical fiber 1 and the light source part 2 in order to improve the light receiving efficiency (paragraph [0034])."

(c) According to the recited matters above (paragraphs [0019]-[0024], and [Fig. 3]), it is recognized that Cited Document 2 describes the following technical matter (hereinafter referred to as "the Described Matter 2 in Cited Document 2")
[The Described Matter 2 in Cited Document 2]
"In the optical fiber temperature and strain measurement apparatus of the Described Matter 1 in Cited Document 2, when the Single-Mode Fiber (SMF) is used as the optical fiber to be measured, as same as using the HAF, the frequency shift and the intensity of the Brillouin scattered light are linearly changed with respect to the strain amount of the optical fiber."

d Cited Document 3

The following matters are described in JP 2012-52999A (hereinafter referred to as "Cited Document 3") additionally cited by the body. The underlines are added by the body.
"[0005]

In the present invention, the problem is solved by obtaining an inherent frequency, intensity, or spectral width in the scattered light of the Guided Acoustic Wave Brillouin Scattering (hereinafter referred to as GAWBS) generated in a measuring optical fiber or optical cable for whole propagation direction (length direction)."

"[0009]

Fig. 1 shows an example of the configuration and measurement results of a conventional measurement system for observing the scattered light of GAWBS.

[0010]

As shown in Fig. 1(a), GAWBS is a phenomenon in which a light wave incident into one end of the measuring optical fiber/optical cable (hereinafter only referred to as the measuring optical fiber) 2 causes minute vibration to the measuring optical fiber 2 so as to generate corresponding frequency modulated polarized light (Brillouin scattered light) . In addition, as shown in Fig. 1(a), the scattered light of the GAWBS can be observed by extracting an arbitrary polarization component of the light emitted from the other end of the measuring optical fiber 2 by a polarizer 3, converting it into the electrical signal by a light receiver 4, and using a spectrum analyzer 5 or the like.

[0011]

Fig. 1(b) shows the spectrum of the scattered light of the GAWBS generated by a conventional Single Mode Fiber (SMF), and it can be observed that a plurality of peaks are generated in a relatively low frequency band of several hundred MHz. The frequency of each peak corresponds to the inherent frequency of the acoustic mode $TR_{2,m}$ (m being a natural number), acting on the GAWBS,

and the acoustic mode is determined by the material of the optical fiber and the cladding diameter, and is substantially independent from the structure of the core. Furthermore, the phenomenon and theory are described in detail in Non-patent Literature 1.

[0012]

Fig. 2 shows an example of vibration distribution in the acoustic mode (the $TR_{2,m}$ mode) that induces the GAWBS in the optical fiber; here the example of vibration distribution in $TR_{2,7}$ mode in which the maximum scattered light intensity can be obtained.

[0013]

Fig. 2(a) shows the vibration distribution in a state where no distortion or deformation exists in the optical fiber for example, wherein the same distributions are obtained on perpendicular x-axis and y-axis. Here, according to Non-patent Literature 1, the efficiency of the scattered light of the GAWBS is proportional to the magnitude of the amplitude of the acoustic mode in the propagation region of the light wave. Therefore, when the optical fiber is a perfect circle, the same amplitude can be obtained every 90 degrees in the circumferential direction (for example, the same distribution exists in sections (1) and (2) of Fig. 2(a)), so that the light receiving signal has the same scattered light intensity in a period of 90 degrees with respect to the polarization angle. It is noted that the inherent frequency f_m of this example is 140.14 MHz.

[0014]

As shown in Fig. 2(b), cases where an external force (lateral pressure) is applied to the optical fiber, and distortion or deformation is generated in the optical fiber are considered. Fig. 2(c) shows the vibration distribution of the $TR_{2,7}$ mode when the non-circular ratio of the optical fiber becomes 5% due to the external force. The inherent frequency becomes 138.76 MHz, and the frequency changes due to the external force can be confirmed. Therefore, the external force applied from the lateral side can be detected according to the amount of change in the inherent frequency of the scattered light.

[0015]

In addition, according to Fig. 2(c), it can be observed that the axis of symmetry changes due to the external force, and the amplitudes on the left-right axis and the up-down axis become different. Assuming that the x-axis and the y-axis are orthogonal as Fig. 2(a), the mode distributions on the respective axes are different, and the maximum value of the amplitude on the x-axis is greater than the maximum value of the amplitude on the y-axis. Therefore, the received signal has an angle band (section (1)) in which the scattered light intensity is larger with respect to the polarization angle, and an angle band (section (2)) in which the scattered light intensity is reduced. Therefore, as shown in Fig. 1(a), by controlling the polarization controller 6 between the light source 1 and the measuring optical fiber 2 so that the polarization plane of input light changes 90 degree and obtaining each Brillouin scattered light, applied external force can be detected according to the ratio of the intensity of each scattered light.

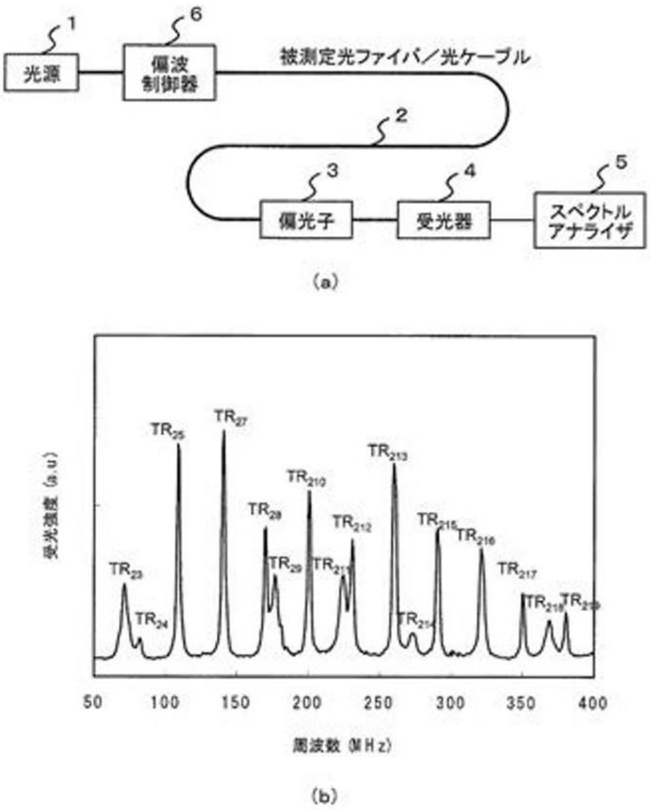
[0016]

In addition, it is preferable to detect the external force more precisely by obtaining both the amount of change of the inherent frequency and the change in the scattered light intensity with respect to the polarization state.

[0017]

Here, as shown in Fig. 2, the vibration component of the acoustic mode that induces the GAWBS is spread over the entire cross section of the optical fiber (in the surface perpendicular to the length direction). Therefore, it can be understood that when distortion or deformation is generated in the optical fiber due to the external force, the distribution of the acoustic mode or the inherent frequency are changed very sensitively with respect to the external force. On the other hand, as described above, there is substantially no dependence on the core structure; therefore, if the main materials of the optical fibers are the same (for example, quartz optical fiber), the characteristics related to the GAWBS are also the same even if the optical characteristics of the fibers are different."

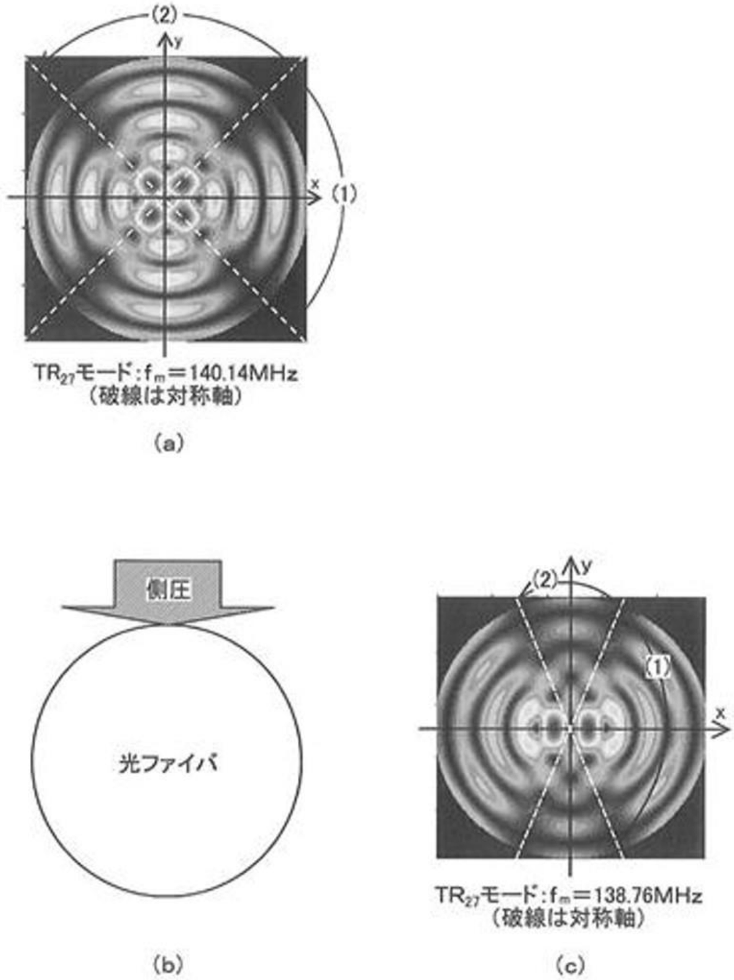
"[Fig. 1]



"

【図１】	[Fig. 1]
光源	Light source
偏波制御器	Polarization controller
被測定光ファイバ/光ケーブル	Measuring optical fiber/optical cable
偏光子	Polarizer
受光器	Light receiver
スペクトルアナライザ	Spectrum analyzer
受光強度	Light receiving intensity
周波数	Frequency

"[Fig. 2]



"

【図２】	[Fig. 2]
TR_{27}モード	TR_{27} mode
破線は対称軸	Broken line being an axis of symmetry
側圧	Lateral pressure
光ファイバ	Optical fiber

According to the recited matters above, it is recognized that Cited Document 3 describes the following technical matter (hereinafter referred to as "the Described Matter in Cited Document 3")

[The Described Matter in Cited Document 3]

"In observation of scattered light wherein a light wave incident into one end of the

measuring optical fiber 2 causes minute vibration to the measuring optical fiber 2 so as to generate corresponding frequency modulated polarized light (Brillouin scattered light), extracting an arbitrary polarization component of the light emitted from the other end of the measuring optical fiber 2 by a polarizer 3, converting it into the electrical signal by a light receiver 4, and analyzing by a spectrum analyzer 5 or the like (paragraph [0010]),
a conventional Single Mode Fiber is used as the measuring optical fiber 2 (paragraph [0011]),
and by controlling the polarization controller 6 between the light source 1 and the measuring optical fiber 2 so that the polarization plane of input light changes 90 degree, obtaining each Brillouin scattered light, and obtaining both the amount of change of the inherent frequency and the change in the scattered light intensity with respect to the polarization state, the external force applied from the lateral side of the measuring fiber 2 can be detected. (paragraphs [0014]-[0016])"

e Recognition of well-known art

According to the Described Matter 2 in Cited Document 2 and the Described Matter in Cited Document 3, it is recognized that the following technical matter is well known for a person skilled in the art (hereinafter referred to as "the Well-known Art").
[Well-known Art]

"In an optical fiber strain measurement apparatus in which the conventional Single Mode Fiber is used as the measuring optical fiber,

when the light wave is incident to one end of the measuring optical fiber from the light source, the polarization controller provided between the light source and the measuring optical fiber is controlled to input the light wave into the measuring optical fiber;

the Brillouin scattered light generated in the measuring optical fiber is emitted from the other end of the measuring optical fiber, the polarization component is extracted by the polarizer and converted by the light receiver into the electrical signal, and the spectrum analyzer or the like is thus used for observation;

the external force applied from the lateral side of the measuring optical fiber is detected by obtaining both the amount of change of the inherent frequency and the change in the scattered light intensity with respect to the polarization state"

(3) Comparison

The Amended Invention and the Cited Invention are compared.

a (a). In the Cited Invention, the feature "at least one optical fiber disposed in such a manner as to form an array" corresponds to the "array of light guide pathways" in the Amended Invention.

In addition, in the Cited Invention, " in order to ensure a mechanical bonding force, the array 2 is embedded in a layer of silicone elastic material in a carpet shape, and an upper plate 20 and lower plate 21 are disposed on the surface and fixed by an adhesive for protection, whereby the upper plate 20 and the lower plate 21 may, for example, consist of a neoprene material, or a synthetic or natural fiber." Therefore, it can be said that the "at least one optical fiber disposed in such a manner as to form an array" in the Cited Invention is disposed on the flexible material.

(b) The features in the Cited Invention, "one end, referred to as an entrance, of the several optical fibers" and "the other end, referred to as an exit, of the several optical fibers," respectively correspond to the "input end" ("first end") and the "output end" ("second end") of the Amended Invention.

In addition, in the Cited Invention, "the end referred to as the entrance" "is provided" with "a light emitting means," and "the other end referred to as the exit" "is provided" with "a light receiving means," " the optical apparatus provides information relating to a luminous intensity transmitted by the array of the optical fibers and a corresponding measurement of the force ", and " permit mapping pressures or plotting (drawing) of relative forces applied to a plurality of points of a test surface". Therefore, it can be said that each "optical fiber" in the Cited Inventions is made of a material that functions as an optical strain gauge.

(c) In the Cited Invention, "the optical fiber used for the array" " may be mono-mode optical fibers or multi-mode optical fibers having a graded index or step index". Therefore, it can be said that in general, the light guide pathway is solid from the "end, referred to as an entrance" to "the other end, referred to as an exit."

(d) In the Cited Invention, "the array 2" "consists of a plurality of m warp lines in the first direction anda plurality of n weft lines in a second direction perpendicular to the first direction," " each warp line and each weft line is constituted by an independent optical fiber, and the optical fibers are provided with light-emitting means Ei and Ej, and light receiving and detection means Qi and Qj" and " the weft lines i are configured to be superposed on the warp lines j or vice versa". Therefore, "the array 2" in the Cited Invention corresponds to "the sensing network" in the Amended Invention.

(e) According to above mentioned(a)-(d), the Amended Invention and the Cited Invention are consistent in comprising "a sensing network formed from an array of light guide pathways arranged in a flexible material, each of the light guide pathways being made of a material that functions as an optical strain gauge, each of the light guide pathways having a first end used as an input end and a second end used as an output end."

b. In the Cited Invention, "the optical fibers" constituting "the array 2" "are provided with light-emitting means Ei and Ej, and light receiving and detection means Qi and Qj," and the "light-emitting means Ei and Ej" "are disposed at one end, referred to as an entrance ", which correspond to the features in the Amended Invention, "a plurality of light sources, one for each of the light guide pathways, each of the plurality of light sources respectively coupled to the input end of a corresponding light guide pathway and respectively supplying a light signal into the corresponding light guide pathway."

Therefore, the Amended Invention and the Cited Invention are consistent in comprising "a plurality of light sources, one for each of the light guide pathways, each of the plurality of light sources respectively coupled to the input end of a corresponding light guide pathway and respectively supplying a light signal" "into the corresponding light guide pathway."

c. In the Cited Invention, "light receiving and detection means Qi and Qj" "are disposed at the other end, referred to as an exit". Therefore, the "light receiving and detection means Qi and Qj" corresponds to "a plurality of light detectors, one for each of the light guide pathways, each of the plurality of light detectors respectively coupled to the output end of a corresponding light guide pathway, each of the plurality of light detectors respectively receiving the light signal from the corresponding light guide pathway and generating an output signal" in the Amended Invention.

Therefore, the Amended Invention and the Cited Invention are consistent in comprising "a plurality of light detectors, one for each of the light guide pathways, each of the plurality of light detectors respectively coupled to the output end of a corresponding light guide pathway, each of the plurality of light detectors respectively receiving the light signal from the corresponding light guide pathway and generating an output signal".

d. In the Cited Invention, "dynamic memory means 62 and 63 store values of the relative forces supplied by the detectors corresponding to the optical fibers of orders i and j in the first and second directions, and the calculation of the relative forces respectively applied to the points of the array of coordinates i and j in the first and second directions is executed by the read/write means of the memory means 62 and 63 and a calculation means 65 to permit mapping pressures or plotting (drawing) of relative forces applied to a plurality of points of a test surface, the read/write means and the means for calculating the relative forces applied to the array may, for example, be constituted by a central processing apparatus 65". The "central processing apparatus 65" executing such processing corresponds to "a processor coupled to receive the output signal from each of the plurality of light detectors and configured to determine a pressure applied to the sensing network based on the received signals from the plurality of light detectors" in the Amended Invention.

Therefore, the Amended Invention and the Cited Invention are consistent in comprising "a processor coupled to receive the output signal from each of the plurality of light detectors and configured to determine a pressure applied to the sensing network on the basis of the received signals from the plurality of light detectors."

e. In the Cited Invention, "the optical apparatus provides information relating to a luminous intensity transmitted by the array of the optical fibers and a corresponding measurement of the force," "is employed in mechanical systems used in robotics" "whereby corresponding devices utilizing a sensitive skin may be useful in the field of robotics with gripping elements". Therefore, the Amended Invention and the Cited Invention are consistent in that both inventions are of "a thin-film flexible tactile sensor."

(4) Corresponding features and different features

According to above-mentioned comparison (3), the Amended Invention and the Cited Invention correspond in the following corresponding features and differ in the following different feature.

[Corresponding features]

" A thin-film flexible tactile sensor, comprising:

a sensing network formed from an array of light guide pathways arranged in a flexible material, each of the light guide pathways being made of a material that functions as an optical strain gauge, each of the light guide pathways having a first end used as an input end and a second end used as an output end, and each of the light guide pathways being solid from the first end to the second end;

a plurality of light sources, one for each of the light guide pathways, each of the plurality of light sources respectively coupled to the input end of a corresponding light guide pathway and respectively supplying a light signal into the corresponding light guide pathway;

a plurality of light detectors, one for each of the light guide pathways, each of the plurality of light detectors respectively coupled to the output end of a corresponding light guide pathway, each of the plurality of light detectors respectively receiving the light signal from the corresponding light guide pathway and generating an output signal; and

a processor coupled to receive the output signal from each of the plurality of light detectors and configured to determine a pressure applied to the sensing network based on the received signals from the plurality of light detectors."

[Different feature]

In the Amended Invention, "the light signal" "supplied" by "the plurality of light sources" to "the corresponding light guide pathway" has "a first predetermined frequency and polarization," and "the output signal" generated by "the plurality of light detectors" is " corresponding to the magnitude and the polarization of the received light signal at a predetermined second frequency", whereas the Cited Invention does not have such a configuration.

(5) Discussion

The aforementioned different feature will now be discussed below.

a As shown in item (2) e above, the following technical matter is well-known art.

" In an optical fiber strain measurement apparatus in which the conventional Single Mode Fiber is used as the measuring optical fiber,

when the light wave is incident to one end of the measuring optical fiber from the light source, the polarization controller provided between the light source and the measuring optical fiber is controlled to input the light wave into the measuring optical fiber;

the Brillouin scattered light generated in the measuring optical fiber is emitted from the other end of the measuring optical fiber, the polarization component is extracted by the polarizer and converted by the light receiver into the electrical signal, and the spectrum analyzer or the like is thus used for observation;

the external force applied from the lateral side of the measuring optical fiber is detected by obtaining both the amount of change of the inherent frequency and the change in the scattered light intensity with respect to the polarization state "

b. Here, the Cited Invention is "an optical apparatus" " comprising at least one optical fiber disposed in such a manner as to form an array; light-emitting means that are disposed at one end, referred to as an entrance, of the several fibers; and light receiving means that are disposed at the other end, referred to as an exit, of the several fibers; the optical apparatus provides information relating to a luminous intensity transmitted by the array of the optical fibers and a corresponding measurement of the force", and "the optical fibers used in the array may be mono-mode optical fibers or multi-mode optical fibers having a graded index or step index".

Considering that in the well-known art, the conventional Single Mode Fiber is also used as the measuring optical fiber, applying the well-known art to the "measurement of force" in the Cited Invention is merely a design matter that could be appropriately selected by a person skilled in the art.

c (a) In the well-known art, as the inherent frequency of the Brillouin scattered light generated in the measuring optical fiber is changed, the frequency of the light wave that is incident to the end of the measuring optical fiber from the light source corresponds to "the predetermined first frequency" of "the light signal" "supplied" to "the light guide pathway" in the Amended Invention; and the frequency of the light emitted from the other end of the measuring optical fiber corresponds to "the predetermined second frequency of "the light signal" "received" from "the light guide pathway" in the Amended Invention.

(b) In the well-known art, the light wave input into the measuring optical fiber by controlling the polarization controller provided between the light source and the measuring optical fiber corresponds to "the light signal having polarization" "supplied" to "the light guide pathway" in the Amended Invention; and the electrical signal, which is emitted from the other end of the measuring optical fiber and is obtained by using the polarizer to extract the polarization component and using the light receiver for conversion, corresponds to "the output signal corresponding to the polarization" "received" from "the light guide pathway" in the Amended Invention.

(c) According to (a) and (b) above, adopting the well-known art in the Cited Invention leads to the feature that the input light has the predetermined frequency and polarization, the output receives the change of the frequency, and the output corresponding to the magnitude and polarization of the received light signal, which accordingly "for the plurality of light-emitting means and light receiving means disposed on the array of the optical fiber, the light source supplied to the light guide path corresponding to each light source has the predetermined first frequency and polarization, and the output signal generated from each light detector that receives the light signal from the corresponding light guide pathway corresponds to the magnitude and the polarization of the light source received at the predetermined second frequency".

Therefore, the configuration of the Amended Invention related to the different feature is merely a design matter of selecting a well-known means, and would be easily conceived of by a person skilled in the art.

d Moreover, the effect yield by the Amended Invention is within the scope that can be predicted from the effects yield by the Cited Inventions and the well-known art, and is not particularly remarkable.

e Therefore, the Amended Invention would be easily invented by a person skilled in the art on the basis of the Cited Invention and the well-known art.

(6) Regarding appellant's allegation

a Appellant's allegation

The appellant alleges as follows in the written request for appeal.

"3. Reason 3 for refusal (Patent Act Article 29(2))

A. Reason 3 for refusal concerning original Claim 1 is not appropriate for the invention recited in new Claim 1 (extending to new dependent Claims 2-10), and the reason for refusal is resolved. The details are as follows.

(1) Except for the other constituent requirements, new Claim 1 also comprises the following constituent requirements. That is,

(a) Each of the light guide pathways is made of a material that functions as an optical strain gauge, has a first end used as an input end and a second end used as an output end, and is solid from the first end to the second end. (The underline is used for emphasis.)

(b) The plurality of light detectors respectively receive the light signal from the corresponding light guide pathways and generate an output signal corresponding to the magnitude and polarization of the received light signal at a predetermined second frequency. (The underline is used for emphasis.)

(2) According to the invention recited in new Claim 1, by extremely simple configuration (each light guide pathway is solid from the first end to the second end), and with the basis of the plurality of characteristics of the received light signals (i.e., the magnitude and

polarization), a thin-film flexible tactile sensor "having much higher sensitivity and much smaller volume compared with a conventional tactile sensor based on strain gauge technology (paragraph [0012])" is provided.
(3) On the other hand, according to the combination of Cited Document 1 (JP S62-502142A) and Cited Document 2 (JP 2008-145315A) used as the basis for refusal, even for a person skilled in the art, the configuration (and the technical effect associated therewith) of the invention of new Claim 1 cannot be easily derived. Therefore, the inventive step of the invention according to new Claim 1 should be approved.
(4) In fact, as correctly implied in the examiner's decision of refusal, Cited Document 1 does not disclose using "polarization". On the other hand, although Cited Document 2 mentions the "polarization," the "polarization" is used necessarily under the premise that the holes 13 are provided inside the optical fiber 1 (refer to Figs. 1-2 and the like). Therefore, even if a person skilled in the art obtains some motivations from Cited Document 2, the necessary configuration (the holes 13) is required to be brought into the invention described in Cited Document 1. Therefore, the invention recited in new Claim 1 would not be easily conceived of.
(5) In conclusion, regarding the invention recited in new Claim 1 (extending to the inventions recited in new Claims 2-10), Reason 3 for refusal is not appropriate, and should be considered to be resolved."

b Judgement by the body on the appellant's allegation

Regarding the optical fiber temperature and strain measurement apparatus disclosed in Cited Document 2, as it can be recognized that even in the case where the Single-Mode Fiber is used as the optical fiber to be measured, as same as the case where the Hole-Assisted Optical Fiber is used, the frequency shift and the intensity of the Brillouin scattered light are linearly changed with respect to the strain amount of the optical fiber (see item (2) c (c)), strain measurement can be performed using any type of optical fiber.

In addition, in the optical fiber strain measurement apparatus that uses the conventional SMF as the measuring optical fiber, it is a well-known art that the external force applied from the lateral side of the measuring optical fiber is detected by obtaining both the amount of change of the inherent frequency and the change in the scattered light intensity with respect to the polarization state (see item (2) e). And as discussed in item (5), it is not particularly difficult for a person skilled in the art to apply the well-known art to the Cited Invention.

Therefore, the conclusion in item (5) cannot be affected by the appellant's allegation.

(7) Conclusion

As considered above, the Amended Invention cannot be granted a patent independently at the time of filing the patent application under the provisions of the Patent Act Article 29(2). Accordingly, the Amendment violates the provisions of the Patent Act Article 126(7) as applied mutatis mutandis pursuant to the Patent Act Article 17-2(6).

Therefore, the Amendment should be dismissed under the provisions of the Patent Act Article 53(1) as applied mutatis mutandis pursuant to the Patent Act Article 159(1).

Therefore, the decision is made according to the conclusion of the decision to dismiss amendment.

No.3 Regarding the Invention

1. The Invention

As described in No.2 above, the Amendment is dismissed, thus the inventions according to Claims 1-13 of the present application are specified by the matters recited in Claims 1-13 of the scope of claims amended by the written amendment submitted on September 16, 2020, wherein the invention according to Claim 1 (hereinafter referred to as "the Invention") is specified as follows.

" A thin-film flexible tactile sensor, comprising:

a sensing network formed from an array of light guide pathways arranged in a flexible material, each of the light guide pathways being made of a material that functions as an optical strain gauge, and having a first end used as an input end and a second end used as an output end;

a plurality of light sources, one for each of the light guide pathways, each of the plurality of light sources respectively coupled to the input end of a corresponding light guide pathway and respectively supplying a light signal having predetermined first frequency and polarization into the corresponding light guide pathway;

a plurality of light detectors, one for each of the light guide pathways, each of the plurality of light detectors respectively coupled to the output end of a corresponding light guide pathway, each of the plurality of light detectors respectively receiving the light signal from the corresponding light guide pathway and generating an output signal corresponding to the magnitude of the received light signal at a predetermined second frequency; and

a processor coupled to receive the output signal from each of the plurality of light detectors and configured to determine a pressure applied to the sensing network based on the received signals from the plurality of light detectors.."

2. Summary of reasons for refusal in examiner's decision

In the reasons for refusal in the examiner's decision, Reason 3 for the Invention is as follows.

The Invention is the invention that can be easily invented by a person skilled in the art on the basis of the inventions described in Cited Documents 1 and 2 below, and cannot be granted a patent under the provision of the Patent Act Article 29(2).

Note

Cited Document 1: JP S62-502142A
Cited Document 2: JP 2008-145315A

3. Matters described in Cited Documents

It is recognized that Cited Document 1 describes the Cited Invention certified as [the Cited invention] (see No.2, 2 (2) b).

According to Cited Document 2, the technical matters certified as [the Described Matter 1 in Cited Document 2] and as [the Described Matter 2 in Cited Document 1] are respectively recognized (see No.2, 2 (2) c (b) and (c)).

According to Cited Document 3, the technical matter certified as [the Described Matter in Cited Document 3] are recognized (see No.2, 2 (2) d).

Moreover, according to the Described Matter 2 in Cited Document 2 and the Described Matter in Cited Document 3, the Well-known Art certified as [the Well-known Art] is recognized (see No.2, 2 (2) e).

4. Comparison and Judgement

In the Invention, the specification of " and each of the light guide pathways being solid from the first end to the second end" is omitted from the feature of the Amended Invention, i.e., "a sensing network formed from an array of light guide pathways arranged on a flexible material, each of the light guide pathways being made of a material that functions as an optical strain gauge, each of the light guide pathways having a first end used as an input end and a second end used as an output end, and each of the light guide pathways being solid from the first end to the second end".

In addition, in the Invention, the specification of corresponding to the "polarization" is omitted from the feature of the Amended Invention, i.e., "an output signal corresponding to the magnitude and polarization of the received light signal at a predetermined second frequency".

In view of the above, as the Amended Invention, which includes all the features of the Invention and further additional features, would be easily invented by a person skilled in the art on the basis of the Cited Invention and the well-known art, the Invention would also be easily invented by a person skilled in the art on the basis of the Cited Invention and the well-known art.

Furthermore, since the Invention does not have the specification that "each of the light guide pathways is solid from the first end to the second end," it is also an invention that would be easily invented by a person skilled in the art on the basis of the Cited Invention and the Described Matter 1 in Cited Document 2.

No.4 Closing

As stated above, the Invention should not be granted a patent under the provisions of Patent Act Article 29(2).

Therefore, the Application shall be rejected even without examining the inventions recited in the other claims.

Therefore, the appeal decision shall be made as described in the conclusion.

October 11, 2021

Chief administrative judge: OKADA, Yoshimi
Administrative judge: HAMANO, Takashi
Administrative judge: SHIMIZU, Yasunori