Examiners' Report Paper A 2015 (Electricity/Mechanics)

I. General considerations

1.1 Introduction

This year's paper relates to force sensors based on optical fibres. The letter makes two concrete examples of products: a floor mat and a mattress including the force sensor of the invention.

1.2 Prior Art

The client first introduces the physical principle allowing the detection of a force by means of optical fibres (Figs.1a,1b, [002-004]). When an "input" optical fibre overlaps an "output" optical fibre at a certain location - called a "coupling location" in the letter - a force applied to this location causes an optical signal to be coupled from the input to the output optical fibre due to the reduction in the distance between the fibres. This coupled optical signal is detected by a photo-detector and provides an indication of the force.

The first piece of prior art is a product ("Alpha") from the same client ([005]-[008]; Fig. 1c). "Alpha" is a floor mat having a force sensor for detecting intruders. This known product includes a plurality of input and output optical fibres forming a matrix of coupling locations. When an intruder steps on the mat, thereby applying a force to at least one coupling location, at least one optical signal is coupled in the output optical fibres and detected by the photo-detectors PD. The electrical signal generated by the photo-detectors triggers an alarm 8. The problem with "Alpha" is that it is not able to identify at which coupling location the force is applied.

The client therefore cites the product of the competitor XY, described by D1, which is able to locate the coupling location at which a force is applied. The sensor of D1 provides one output fibre and one photo-detector for each coupling location. Even for a small number of coupling locations, D1 requires a complicated arrangement of fibres and detectors.

1.3 Challenges of the Paper

The Figs. 2 and 5 show two main examples of the invention.

The first example is a mattress including a force sensor (Fig.2, [010]). This force sensor has a plurality of input and output optical fibres forming a matrix of coupling locations, very much like the matrix of "Alpha". Unlike "Alpha" however, the LEDs injecting light into the input optical fibres are pulsed at different frequencies ([011]). In this way, an optical signal received by a given photo-detector carries a pulse frequency which is characteristic of the input fibre, and therefore of the coupling location, from which this signal comes. A processing unit (8) is thus able to identify, on the basis of this pulse frequency, the coupling location at which a force is applied ([012]).

Whereas in the embodiment of Fig. 2 the pulse frequency is obtained by turning each LED on and off, the alternative shown in Fig. 3 ([017]) foresees a single lamp and one mechanical shutter in correspondence with each input fibre. Optical signals with different pulse frequencies are obtained by opening and closing these shutters at different frequencies.

The alternative shown in Fig. 4 is aimed at increasing the amount of light coupled from the input to the output fibres, by arranging the fibres parallel to each other at the coupling locations.

The second main example (Fig. 5) is a floor mat used to detect the presence of a person in front of three doors in a corridor. This example includes three input fibres and a single output fibre. Three LEDs inject into the respective input fibres light of different colours: red, green and blue. A camera receives the coupled optical signals from the output fibre, and is able to distinguish their colour. A processing unit (8) connected to the camera identifies the coupling location of each signal on the basis of the respective colour.

This second example is not limited to a single output fibre. Multiple output fibres may be implemented ([025]), to obtain a matrix of coupling locations such as in Fig. 2, provided that the camera receives light from each of the output fibres independently from each other.

The second example may be also modified ([026]) by substituting the three LEDs with a single white lamp and three colour filters -red, green and blue- respectively associated with the input fibres.

The challenges in drafting claim 1 rely mainly in the identification of those features that are essential for the purpose of the invention, without unduly restricting the scope of protection.

The invention is a force sensor able to identify the location at which a force is applied, without requiring one photo-detector for each location. Therefore, the optical fibres must be arranged so that each photo-detector receives optical signals from a plurality of coupling locations. This is obtained by a plurality of input optical fibres and one output optical fibre, wherein the output optical fibre must overlap each of the input optical fibres (see [010] and [020]). This feature achieves novelty over D1. On the other hand, a plurality of output optical fibres would exclude the example of Fig. 5.

In the invention, the optical signals coupled into the same output fibre and received by the corresponding photo-detector are distinguishable from each other. This is achieved by a means injecting into each input fibre an optical signal having a different characteristic. The client´s letter describes the examples of signals having different pulse frequencies (fig. 2) or colours (fig. 5), and suggests that other characteristics of the optical signals could be used ([027]). This feature achieves novelty over "Alpha".

Having optical signals of different characteristics is however considered insufficient for the invention, in the absence of a feature identifying the coupling location on the basis of this characteristic. This feature is the processing unit (8), which should appear in the claim either by itself or as a function of the light receiving device (6). An answer lacking this aspect would define a device where the optical signals are indeed different but there is no means for distinguishing them. Such a device may not be inventive (see below point 2.5).

1.4 The Marking Scheme

Answer papers are awarded marks on a scale of 0 to 100 marks:
up to **50 marks** are available for the independent claim,
up to **35 marks** are available for a set of dependent claims, and
up to **15 marks** are available for the introductory part of a description.

II. Independent Claim (up to 50 marks available)

Generally it is noted that the marks awarded for an independent claim reflect the degree to which the claim achieves protection for the client's invention in its broadest possible scope.

This year, the only independent claim expected was a device category claim defining a force sensor.

Where an answer paper has an additional independent claim in a different category, e.g. a method of detecting a force, 50 marks are available for the independent device claim.

Answer papers having multiple independent claims in the device category which attempt to cover different examples of the invention can achieve **up to 35 marks** for the independent claims in total, because it is considered that the invention can be appropriately claimed with a single independent device category claim.

Other cases are considered on a case-by-case basis.

This year, separate applications are not expected and no marks are foreseen for them.

2.1 Example solution

Example feature set as a basis for an independent claim:

a) A force sensor, comprising:
b) a plurality of input optical fibres (1a-1d);
c) an output optical fibre (2),
d) the output optical fibre overlapping each of the input optical fibres at a respective coupling location (3),
e) so that when a force is applied at a coupling location (3) an amount of light coupled from the input optical fibre (1a-1d) into the output optical fibre (2) changes;
f) a light injecting device (5) for injecting into each of the input optical fibres (1a-1d) an optical signal having a different characteristic;
g) a light receiving device (6) for receiving an optical signal from the output optical fibre (2);
h) the light receiving device (6) being configured to identify the coupling location (3) at which the received optical signal is coupled into the output optical fibre (2) on the basis of the characteristic of the received optical signal.

2.2 Equivalent/non-equivalent wording of example solution

In the following notes, remarks are made on features of the example solution claim. “Equivalent” indicates a different wording for a given feature that can achieve the same number of marks as the wording given in the example solution. It is not intended to indicate that the wording itself necessarily has exactly the same meaning as the wording of the example solution. “Non-equivalent” indicates a different wording for a given feature that does not achieve the same number of marks as the wording given in the sample solution.

Remarks on feature (a): *A force sensor*

Equivalents:

- “A force detector", "A sensor"
- "A device/article/product/system for sensing/detecting/locating/finding (the position of) a force/forces”
- "An article/product comprising a force sensor"

Non equivalents:

- *"A mattress"*
- *"A floor mat"*
- *"a mattress or a floor mat"*

are unnecessary limitations, see 2.3.1 and 2.3.3

- "*a sensor for measuring (the magnitude of) a force*": unnecessary limitation, see 2.3.9
- claiming a device in use, e.g. "*Device sensing/detecting/locating/finding the position of a force*": lack of clarity, 2.6.3.

Remarks on feature (b): *a plurality of input optical fibres*

More than one input optical fibre must be claimed.

Equivalents:

- *"a plurality of first optical fibres", "a plurality of input optical/light conductors/guides/pipes"*

Non equivalents:

- *"an input optical fibre":* lack of clarity, see 2.6.2.A*)*
- *"at least three input optical fibres":* unnecessary limitation, see 2.3.4);

Remarks on feature (c): *an output optical fibre*

Equivalents:

- *"at least one output optical fibre", "a second optical fibre", "an output optical/light conductor/guide/pipe"*

Non equivalents:

- *"a plurality of output optical fibres" or "more than one output optical fibre":* unnecessary limitations, see 2.3.4.

Remarks on feature (d): *the output optical fibre overlapping each of the input optical fibres at a respective coupling location*

This feature ensures novelty over D1.

Equivalents:

- "*each of the input optical fibres overlapping each output optical fibre at (a) respective coupling location(s)"*
- *"each of the input optical fibres overlapping the (at least one) output optical fibre at a respective coupling location";*
- the *“coupling location”* may also be called *"sensing/overlap location/area/region"* or just *"location"*;
- "*the input optical fibres and the output optical fibre forming a matrix of coupling locations*" (a matrix can also have size 1 x n).

Non equivalents:

- "*crossing*" or ”*intersecting*” instead of "*overlapping*": unnecessary limitation, excluding fig. 5 (see 2.3.1);
- the wordings:
"*the output optical fibre overlapping an input optical fibre at a respective coupling location*" or
"*the one or more output optical fibres overlapping the plurality of input optical fibres at a respective coupling location*"
"*each of the input optical fibre overlapping an* (not necessarily the same) *output optical fibre at a respective coupling location*"
do not imply a distinction over D1 (see lack of novelty at 2.4.2 and lack of clarity at 2.6.2.B);

Remarks on feature (e): *so that when a force is applied at a coupling location (3) an amount of light coupled from the input optical fibre (1a-1d) into the output optical fibre (2) changes;*

Equivalents:

- "*the amount of coupled light increases*", instead of *"changes"*
- "*so that light can be coupled from the input optical fibre to the output optical fibre upon application of a force";*

Mentioning the reduction of a distance is not penalised, such as in:
- "*so that when a force is applied at a coupling location which reduces the distance between the input optical fibre and the output optical fibre at that coupling location, light from the input optical fibre is coupled into the output optical fibre;*
- "*wherein the application of a force at a coupling location couples (a) light (signal) between the input and output optical fibres by reducing the distance between the fibres at that location*";

Non equivalents:

- "*so that an amount of light is coupled from the input optical fibre (1a-1d) into the output optical fibre (2):* lack of clarity, see 2.6.2.C

Remarks on feature (f): *a light injecting device for injecting into each of the input optical fibres an optical signal having a different characteristic;*

This feature ensures novelty over "Alpha".

Equivalents:

- "*a ((light) injecting) device/means for injecting into each of the input optical fibres an optical signal distinguishable from those injected in the other fibres"*
- *"a (light) injecting device for injecting in the input optical fibres optical signals distinguishable from each other",* as long as one may reasonably conclude that the distinguishable optical signals are injected into different fibres and not in the same fibre*;*

Non equivalents:

- "*optical signals of different pulse frequency/colour*": unnecessary limitations excluding either Fig. 5 or 2, see 2.3.1;
- "*optical signals of different frequencies*": unnecessary limitation, see 2.3.2 ;
- "*pulsed optical signals*": unnecessary limitation, excluding Fig. 5 (see 2.3.1) and no distinction over "Alpha" (see 2.4.1);
- "*a plurality of light sources*": lack of clarity (see 2.6.2.G)

Remarks on feature (g): *a light receiving device for receiving an optical signal from the output optical fibre***;**

Equivalents:

- "*a light detector/sensor/photo-detector*" instead of light receiving device;
- "*a converter for receiving an optical signal and converting it into an electrical signal*"
- "*a converter for receiving optical signals and converting them into different/separate electrical signals (according to their characteristic).*" In the embodiment of Fig. 2, each photo-detector converts an optical signal with a given pulse frequency into an electrical signal with the same pulse frequency, which is therefore different and "separate" (in frequency) from other electrical signals of other pulse frequencies. The camera of Fig. 5 converts the received optical signals into separate electrical signals according to their colour ([022]).

Non-equivalents:

- "*a plurality of photo-detectors*": lack of clarity (see 2.6.2.H);
- "*a camera*": unnecessary limitation, excluding Fig. 2 (see 2.3.1)

Remarks on feature (h): *the light receiving device being configured to identify the coupling location at which the received optical signal is coupled into the output optical fibre on the basis of the characteristic of the received optical signal.*

This feature ensures, together with (f), the inventive step over the combination of "Alpha" and D1 (see 2.5). It can be defined as a function of the light receiving device or as a processing unit (note that in the client's letter the processing unit is defined as a part of the light receiving device, see [012] and [022]).

Equivalents:

- adding: "*thereby detecting/and to detect that a force is applied at the identified coupling location;*
- "*the light receiving device comprises a processing unit configured to monitor the electrical signal to determine the signal characteristics of the respective coupled optical signal and thereby determine the coupling location at which a force is applied.*" (in combination with a feature (g) defining electrical signals)
- "*the light receiving device being configured to identify the coupling locations at which the received optical signals are coupled into the output optical fibre on the basis of the characteristics of the received optical signals",*
- "*the light receiving device is configured to distinguish the optical signals received from the output optical fibre and to determine thereby the (coupling) location or locations at which a force is applied*", insofar it is implied by the rest of the claim that the distinction is based on the different characteristics of these signals.

Non-equivalents:

- "*a light receiving device/processing unit arranged for identifying the location at which a force is applied*": result be achieved, see 2.6.1.A
-"a *light receiving device/processing unit arranged to detect the coupling location of each received optical signal, in order to detect a force applied at the coupling location": result to be achieved, see 2.6.1.B*
- "*a light receiving device/processing unit arranged to determine/monitor the characteristic of the received optical signal*": lack of clarity, see 2.6.2.D;

2.3 Unnecessary Limitations (up to -50 marks)

Unnecessary limitations in an independent claim are considered to be features that: a) are unnecessary for defining the client's invention in its broadest possible scope; and b) disadvantage the client by limiting the scope of the claim.
An unnecessary limitation may for example result in the exclusion of protection for one of the examples of the invention described in the client's letter.

If a feature of a claim is unclear so that it is ambiguous as to whether or not the claim is unnecessarily limited by that feature, then this is considered in the section lack of clarity and not in this section.

2.3.1 Generally, where a claim is unnecessarily limited to the extent that one of the two main examples of the invention is not covered by the claim, i.e. when a claim covers only a sensor based either on optical signals of different pulse frequencies or colours, **30 marks** are deducted.

2.3.2 A claim that attempts to cover both examples by using alternatives, e.g. wherein the "*different characteristic*" of feature (f) is replaced by: *"a different pulse frequency or colour"* loses **15 marks.** This solution excludes other possible characteristics of the optical signal that should be protected by the claim (see client´s letter [027]). A claim defining light signals of "different frequencies" might indeed cover both embodiments, the different colours being seen as different electromagnetic frequencies. However, the same gap in protection occurs (**-15 marks**).

2.3.3 For a claim covering "a mattress or a floor mat", in one or two claims, **20 marks** are deducted.

2.3.4 A claim limited to a plurality of output optical fibres excludes the example of fig. 5 and is penalized with **-30 marks**. A claim limited to at least three input optical fibres contradicts the indication of the client at [019] and loses **20 marks**.

2.3.5 A claim wherein the "light injecting device includes a plurality of LEDs" does not protect the embodiments of Fig. 3 and of [026]: **-30 marks**

2.3.6 [028] mentions two examples for supporting the fibres in the sensor:
1) fibres embedded in a transparent elastic sheet;
2) fibres glued on opposite sides of the sheet;
A claim limited to either 1) or 2) loses **25 marks**.

2.3.7 The wording "*fibres separated by a (elastic)(transparent) sheet/layer at the coupling location*" loses **15 marks** since it excludes the example of the fibres separated by a cavity ([028]).

A "*sheet for holding/supporting the fibres*" does not lose marks, insofar a sensor having fibres separated by a cavity at the coupling location is clearly not excluded by the wording used.
"*Holding/supporting/separating means for the optical fibres*" do not lose marks.

2.3.8 A claim referring to an elastic/resilient sensor, wherein the fibres regain their original condition when a force is no longer applied, loses **5 marks**.

2.3.9 A claim limited by the optional feature ([016]) measuring the magnitude of the applied force, loses **20 marks**.

2.4 Lack of Novelty (-30 marks)

An independent claim that is considered to lack novelty against any of the available prior art loses 30 marks.

2.4.1 The following is noted regarding the prior art "Alpha":

"Alpha" is a force sensor having a plurality of input optical fibres 1 and a plurality of output optical fibres 2 forming a matrix of coupling locations 3. At each coupling location an optical signal can be coupled from an input to an output fibre upon application of a force that brings the fibres closer together. Three identical LEDs (L1-L3) inject optical signals into respective input optical fibres 1. The photo-detectors PD1-PD6 receive coupled optical signals. As a consequence, "Alpha" shows features (a)-(e) and (g) of the example solution claim.

In the sensor "Alpha", however, the LEDs are identical and are switched on and off simultaneously by the switch 7. Therefore, the optical signals injected by the LEDs have identical characteristics and cannot be distinguished from each other. Feature (f) is therefore not disclosed by "Alpha".

As a consequence of this, each photo-detector of "Alpha" receives an identical optical signal regardless of which input optical fibre has coupled it into the output optical fibre. It is thus impossible for "Alpha" to identify the location where the optical signal is coupled and therefore to detect that a force is applied to that location. Feature (h) is not disclosed by "Alpha".

A claim lacking feature (h) and the "different characteristic" of feature (f) is therefore not new over "Alpha".

A claim without the "*different characteristics*" as in feature (f) and wherein (h) is replaced with a generic "*processing unit for analysing/processing/monitoring (a characteristic of) the received optical signal*" is not new over "Alpha". The alarm unit is triggered by the signal of the photo-detectors and therefore monitors/processes a generic characteristic (intensity, presence) of the received optical signal.

2.4.2 The following is noted regarding the prior art document D1:

D1 (Fig. 2) describes a force sensor having a plurality of input optical fibres 3 and a plurality of output optical fibres 5. Each output fibre overlaps one input fibre at a location 4, wherein light can be coupled from an input to an output fibre upon application of a force that brings the fibres closer together. Three LEDs L inject optical signals into the fibres 3. Photo-detectors P receive coupled optical signals from the respective output optical fibres 5. There are as many photo-detectors as coupling locations, so that the optical signal received by each photo-detector can have been coupled only at the corresponding coupling location. Therefore, forces applied at each location can be detected independently from each other. D1 therefore discloses features (a),(b),(c),(e) and (g) of the example solution.

D1 also discloses the possibility of having three LEDs of different colours (see [005]). D1 therefore has a plurality of input optical fibres (one for each LED), wherein the LEDs inject into each of these optical fibres an optical signal of different colour. Thus D1 also discloses feature (f) of the example solution.

D1 does not disclose an output optical fibre overlapping each one of a plurality of input optical fibres. As noted above, in D1 every output optical fibre overlaps one and only one input optical fibre. Feature (d) is not disclosed by D1.

Moreover, there is no disclosure in D1 of a processing unit identifying the location at which an optical signal is coupled into a given output optical fibre based on the different characteristics of the optical signals injected into the input optical fibres. Feature (h) is not disclosed by D1 because the light receiving device is not able to detect the colour, i.e. the characteristic, of the received optical signals.

A claim lacking feature (h) and with a fibre arrangement different from feature (d) risks lacking novelty over D1. The following example claims lack novelty over D1 (in parentheses references to D1):

<u>Example 1</u>
a) A force sensor (Fig. 2), comprising:
b) a plurality of input optical fibres (3);
c) an output optical fibre (5),
d´) the output optical fibre overlapping an input optical fibre at a respective coupling location (4),

e) so that when a force is applied at a coupling location (3) an amount of light coupled from the input optical fibre (1a-1d) into the output optical fibre (2) changes (p. 1, l. 8-12);
f) a light injecting device (LEDs L) for injecting into each of the input optical fibres an optical signal having a different characteristic (p. 2, l. 3-5);
g) a light receiving device (photo-detectors P) for receiving from the output optical fibre each optical signal coupled from one of the input optical fibres into the output optical fibre (p. 1, l.23-24);

Example 2:
a) A force sensor (Fig. 2), comprising:
b) a plurality of input optical fibres (3);
c) one or more output optical fibres (5),
d´´) the one or more output optical fibres overlapping the plurality of input optical fibres at a respective coupling location (4), or
d´´´) each of the input optical fibres overlapping an output optical fibre at a respective coupling location (4);
e) so that when a force is applied at a coupling location (3) an amount of light coupled from the input optical fibre (1a-1d) into the output optical fibre (2) changes (p. 1, l. 8-12);
f) a light injecting device (LEDs L) for injecting into each of the input optical fibres an optical signal having a different characteristic (p. 2, l. 3-5);
g) a light receiving device (photo-detectors P) for receiving from the output optical fibre each optical signal coupled from one of the input optical fibres into the output optical fibre (p. 1, l.23-24).

Furthermore, a claim lacking the different characteristics as in feature (f) and with a different formulation of features (d) and (h) may also be not new over D1. The following example claim lacks novelty over D1.

Example 3:
a) A force sensor (Fig. 2), comprising:
b) a plurality of input optical fibres (3);
c) an output optical fibre (5),
d´) the output optical fibre overlapping an input optical fibre at a respective coupling location (4),
e) so that when a force is applied at a coupling location (3) an amount of light coupled from the input optical fibre (1a-1d) into the output optical fibre (2) changes (p. 1, l. 8-12);
f) a light injecting device (LEDs L) for injecting into each of the input optical fibres an optical signal;
g) a light receiving device (photo-detectors P) for receiving from the output optical fibre each optical signal coupled from one of the input optical fibres into the output optical fibre (p. 1, l.23-24);

h´) a processing unit configured to identify the coupling location at which the force is applied on the basis of (a characteristic of) the received optical signals.

Feature (h´) of this claim is disclosed by D1, because D1 discloses the function of identifying where the force is applied on the basis of the signals received by the photo-detectors (*p. 1, l. 24-26*), e.g. based on the intensity of the signals (p. 1, l. 13-14).

2.4.3 If, due to an unclear formulation, there are doubts as to whether or not the wording of a claim could be interpreted as including a piece of the prior art, then such a claim is considered under lack of clarity, not under lack of novelty.

Claims which are novel over the available prior art, but do not comprise all the features of the example solution are assessed on a case-by-case basis, and are typically considered under the section “Inferior Solutions”.

2.5 Lack of Inventive Step (up to -25 marks)

An answer paper having a single independent claim whose subject-matter is considered to lack an inventive step in the light of the available prior art loses **25 marks**.

The prior art suggests an obvious combination of "Alpha" and D1. The skilled person would substitute the identical LEDs of "Alpha" (see client´s letter, [006]) with LEDs of different colours as taught by D1 ([005]), for more easily identifying defective LEDs of "Alpha". He would thus obtain a sensor having feature (f) but not feature (h). A claim as in the example solution but without feature (h) therefore lacks an inventive step over the prior art.

2.6 Lack of Clarity (up to -30 marks)

Up to 30 marks in total can be lost in this section. A full deduction of 30 marks is applicable where the sum of all clarity issue deductions adds up to 30 marks or more.

Lack of novelty or inventive step takes precedence over lack of clarity.

2.6.1 Claims defined in terms of a result to be achieved (**up to -30 marks**)

A claim which attempts to define the invention in terms of a result to be achieved loses marks under lack of clarity irrespective of whether or not the claim additionally loses marks due to unnecessary limitation or lack of novelty.

This issue arises mainly in the drafting of feature (h). Examples of alternative definitions of feature (h) that would lose marks for this reason are:

A) "the light receiving device is arranged to detect the location of the applied force", with no reference whatsoever to the optical signals, their characteristic and coupling location; **-30 marks**
B) *"the light receiving device is arranged to detect the coupling location of each received optical signal, in order to detect a force applied at the coupling location"*, with no reference to the characteristic of the optical signal; **-10 marks**

To summarise, a claim must define at least implicitly that the light receiving device (or a processing unit included therein) associates the characteristic of each optical signal with a coupling location, and thereby determines that a force is applied at that coupling location. A definition in terms of "*distinguishing the optical signals*" and thereby "*determining their coupling location*" might suffice, insofar this "*distinguishing*" is implicitly based on the characteristic of the optical signals.

2.6.2 Other Clarity Issues

A) A claim defining a sensor comprising a single input optical fibre (e.g. wherein feature (b) of the example solution is substituted by "*at least one input optical fibre*") is not clear. This definition is inconsistent with feature (f), requiring that *"signals of different characteristics",* i.e. at least two different signals, are each injected into a respective input optical fibre. Moreover, this claim would include a sensor having only one coupling location, wherein the problem of identifying the position of a force does not arise. This claim loses **15 marks**.

B) A claim which is new over D1, e.g. due to (h), but defines the overlap of the fibres as in one of features:
d´) the output optical fibre overlapping an input optical fibre at a respective coupling location (4),
d´´) the one or more output optical fibres overlapping the plurality of input optical fibres at a respective coupling location (4),
d´´´) each of the input optical fibres overlapping an output optical fibre at a respective coupling location (4);
loses **15 marks**.

C) A claim wherein feature e) is substituted by:
"*so that an amount of light is coupled from the input optical fibre into the output optical fibre",*
with no mention of a force, does not specify the causal link between the application of a force and the coupling of light (**-15 marks**).

D) If the sensor determines the optical characteristic but does not derive the location of the applied force, e.g. wherein
"a light receiving device/processing unit is arranged to determine/monitor the characteristic of the received optical signal",
the link between the characteristic of the received signal and the location where it has been coupled is missing. In view of the necessity of this feature for solving the problem, **15 marks** are deducted.

E) If the light injecting device does not inject into each input fibre an optical signal with a different characteristic, the sensor cannot identify the location of the applied force, because the link characteristic-input optical fibre-coupling location cannot be established. An essential feature is missing and the claim is therefore unclear. Example:

a) *A force sensor, comprising:*
b) *a plurality of input optical fibres (1a-1d);*
c) *an output optical fibre (2),*
d) *the output optical fibre overlapping each of the input optical fibres at a respective coupling location (3),*
e) *so that when a force is applied at a coupling location (3) an amount of light coupled from the input optical fibre (1a-1d) into the output optical fibre (2) changes;*
f´) *a light injecting device (5) for injecting into each of the input optical fibres (1a-1d) an optical signal;*
g*) a light receiving device (6) for receiving an optical signal from the output optical fibre (2);*
h´) *the light receiving device (6) being configured to identify the coupling location (3) at which the received optical signal is coupled into the output optical fibre (2) on the basis of a characteristic of the received optical signal.*
(-20 marks)

F) A claim as in the example above but without feature (f), is furthermore unclear due to the reference to an external entity (the optical signals). (**-30 marks**)

G) A claim as in the example solution but wherein feature (f) is substituted by *"a plurality of light sources for injecting ..."* does not clearly cover the embodiments having a lamp and a plurality of shutters or filters **(-15 marks**);

H) A claim as in the example solution but wherein feature (g) is substituted by *"a plurality of photo-detectors..."* is unclear with reference to the single output optical fibre of feature (c) (**-15 marks**).

2.6.3 Other minor issues of lack of clarity lose up to 5 marks per feature.

Examples:

- Claiming the device in use (e.g. omitting "arranged for"): **-5 marks**;

2.7 Formal Matters (up to -5 marks)

2.7.1 The example solution claim could be drafted in the two-part form based on either "Alpha" or D1. However, using a one-part form is not penalised.

An example of a claim in the two-part form based on "Alpha" is:

a) *A force sensor, comprising:*
b) *a plurality of input optical fibres (1a-1d);*
c) *an output optical fibre (2),*
d) *the output optical fibre overlapping each of the input optical fibres at a respective coupling location (3),*
e) *so that when a force is applied at a coupling location (3) an amount of light coupled from the input optical fibre (1a-1d) into the output optical fibre (2) changes;*
f1) *a light injecting device (5) for injecting an optical signal into each of the input optical fibres (1a-1d);*
g*) a light receiving device (6) for receiving an optical signal from the output optical fibre (2);*
characterised in that:
f2) *the light injecting device is arranged for injecting into each input optical fiber a light signal having a different characteristic.*
h) *the light receiving device (6) is configured to identify the coupling location (3) at which the received optical signal is coupled into the output optical fibre (2) on the basis of the characteristic of the received optical signal.*

An example of a claim in the two-part form based on D1 is:

a) *A force sensor, comprising:*
b) *a plurality of input optical fibres (1a-1d);*
c) *an output optical fibre (2),*
d1) *the output optical fibre overlapping at least one input optical fibre at a respective coupling location (3),*
e) *so that when a force is applied at a coupling location (3) an amount of light coupled from the input optical fibre (1a-1d) into the output optical fibre (2) changes;*
f) *a light injecting device (5) for injecting into each of the input optical fibres (1a-1d) an optical signal having a different characteristic;*
g*) a light receiving device (6) for receiving an optical signal from the output optical fibre (2);*

characterised in that:
d2) *the output optical fibre overlaps each of the input optical fibres;*
h) *the light receiving device (6) is configured to identify the coupling location (3) at which the received optical signal is coupled into the output optical fibre (2) on the basis of the characteristic of the received optical signal.*

An incorrect two-part form with respect to any of the items of prior art mentioned in the client's letter leads to a deduction of 3 marks.

2.7.2 The total absence of reference signs in the independent claim or claims results in a deduction of 2 marks.

Partially incorrect or very incomplete reference signs in the independent claim or claims results in a deduction of 1 mark.

2.8 Inferior Solutions (up to 30 marks available)

An independent claim which is considered to be an inferior solution is a claim which:
- offers a less favourable scope of protection for the client than the example solution claim, for example because it is contrary to the client's wishes;
- misses at least one feature of the example independent claim;
- has at least one feature that is not in the example independent claim; **and**
- is new and arguably not obvious with respect to the available prior art.

III. Dependent Claims (up to 35 marks available)

Generally it is noted that the marks awarded for a dependent claim reflect the degree to which the claim offers a fall-back position for the client, taking into consideration the independent claim or claims and the prior art available. No marks are awarded for any claims subsequent to a 15th claim, since the client states that claim fees will not be paid.

3.1 Structure

3.1.1 Important requirements for awarding full marks are:
- **clarity**, e.g. consistency of terminology with the independent claim;
- claim **structure**, a set of dependent claims having a structure which gives the client an appropriate set of fall-back options whilst at the same time being concise and having claims with correct back-references is considered to have a good structure.

3.1.2 As a general rule, where a feature A is unnecessarily limited in a set of dependent claims, by grouping it together with a feature B, the full potential of a fall-back position for features A and B is not achieved. The number of marks available for a claim combining features A and B corresponds to the number of marks achieved either by a claim for feature A or a claim for feature B, whichever is lower.

Example:

Dependent claims 2 and 3 depending on the example solution independent claim, and having the wording:
“2. A device according to claim 1, further characterised by feature X" (2 marks).
“3. A device according to claim 1 (and/or claim 2), further characterised by feature Y” (1 mark).

In this case the total obtained for the two features in claims 2 and 3 is 3 marks. However, the above features claimed together in a single claim and not claimed as options, give the client a more limited fall-back position:

"2. A device according to claim 1, having features X and Y" (1 mark)

3.1.3 Where an answer paper has an independent claim that differs from that of the example solution claim, the dependent claims may differ from the example dependent claims. This is considered on a case-by-case basis, considering the value of the dependent claims in the light of the independent claim.

3.2 Example feature set

In this section, an example feature set is defined which could have been used to formulate good dependent claims for an independent claim corresponding to the example solution discussed above. In the example feature set, groups of features for dependent claims are defined, each relating to a specific aspect of the invention. It is however noted that there are different ways of grouping features in dependent claims whilst still achieving the full number of available marks. Care should however be taken of the correct dependencies, not to combine claims with alternative or incompatible features. An example set of claims is attached in annex (see 5).

Detection of the magnitude of the force

- the light receiving device is arranged to detect the intensity of the optical signals and to determine the magnitude of the force applied at the identified coupling location. **[up to 2 marks]**

Plurality of output optical fibres

- the sensor includes a plurality of output optical fibres, each output optical fibre overlapping each input optical fibre; **[up to 2 marks]**

"Pulse frequency" embodiment

- the different characteristic is the pulse frequency of each optical signal; **[up to 4 marks]**

  ◦ the light injecting device comprises an LED for each input optical fibre, and a control unit for turning each LED on and off at the respective pulse frequency; **[up to 2 marks]**

  ◦ the light injecting device comprises a lamp and a plurality of mechanical shutters, each shutter being arranged at the input end of each input optical fibre, and a control unit for opening and closing each shutter at the respective pulse frequency; **[up to 2 marks]**

"Colour" embodiment

- the different characteristic is the colour of each optical signal; **[up to 4 marks]**

  ◦ the light injecting device includes a LED of different colour for each input optical fibre; **[up to 2 marks]**

◦ the light injecting device comprises a white lamp and different colour filters, each different colour filter being associated with one input optical fibre; **[up to 2 marks]**

◦ the light receiving device comprises a camera; **[up to 3 marks]**

Separation of the fibres

- the input and output optical fibres are separated by an elastic layer; **[up to 2 marks]**

- the input and output optical fibres are separated by a cavity; **[up to 2 marks]**

- the input and output optical fibres are arranged such that they are parallel to each other at the respective coupling locations; **[up to 2 marks]**

Products

- A mattress including the force sensor; **[up to 3 marks]**

- A floor mat including the force sensor; **[up to 3 marks]**

3.3 Other dependent claims offering a useful fall-back (up to 5 marks)

3.3.1 Claims considered to offer a useful fall-back position (**up to 5 marks**)

Up to 5 marks in total are available for one or more additional dependent claims which offer a useful fall-back position or positions, provided the total of **35 marks** for the dependent claims is not exceeded. The dependent claims appropriate for achieving fall-back positions may depend on the independent claim. For example, if an answer paper has an independent claim that is considered to lack novelty with respect to one of the prior art documents, a feature of a dependent claim, which would have rendered the claim the same as or equivalent to the example solution, is an important fall-back position for the applicant (**5 marks**).

A dependent claim offering a useful fall-back position for the example independent claim defines that the fibres are glued to opposite surfaces of a sheet (**1 mark)**.

3.3.2 Claims considered as not offering a useful fall-back position

Dependent claims which are considered not to offer a useful fall-back position for the client are not awarded marks.

Examples:

- the input and output optical fibres are embedded in a transparent elastic sheet;
- the input and output fibres are roughened at the coupling locations;
- the light receiving means comprises at least a photo-detector;
- specific colours (e.g. red, green, blue) or specific numbers of input/output fibres

IV. Description (15 marks available)

4.1 For an acknowledgement of prior art, **5 marks** are available. Full marks in this section are available for indicating a single piece of prior art and explaining the features relevant for the invention. When the independent claim is constructed in the two-part form, full marks are available for a brief explanation of the prior art indicated. When the independent claim is constructed in the one-part form, full marks are only awarded in this section for an indication of a piece of prior art and explanations from which it is derivable which of the features defining the independent claim are known, in combination, from the prior art (see Guidelines for Examination at the EPO, F-IV, 2.3.2).

4.1.1 The citation of either "Alpha" or D1 and the explanation of the respective relevant features achieve the same amount of marks. **2 marks** are available for the mere citation of the existing product "Alpha" or of the document D1. **3 marks** are available for the further explanation of their relevant features.

4.1.2 The discussion of "Alpha" could be as follows (using as far as possible the text of the client´s letter):

"Alpha" is a floor mat used to detect intruders. "Alpha" comprises input optical fibres and output optical fibres which are arranged such that each output optical fibre overlaps each input optical fibre at a respective coupling location. The input and output fibres are embedded in a transparent elastic sheet. They form a matrix of coupling locations.
If an intruder treads on the sheet, a force is applied at one or more of the coupling locations, the sheet is compressed and an optical signal is coupled from an input to an output optical fibre. A photo-detector receives this signal and triggers an alarm unit.

The discussion of D1 could be as follows (using as far as possible the text of D1):

D1 discloses a force sensor for detecting forces applied at multiple locations. This sensor includes optical fibres embedded in a transparent elastic sheet.
An input optical fibre overlaps an output optical fibre at a location.
Both fibres are embedded into an elastic transparent material, so that a force applied at the location brings the fibres closer to each other. When the distance between both fibres is reduced, an optical signal injected by a LED L into the input fibre is coupled from the input fibre into the output fibre.
This principle is applied at each location where a force must be detected. By providing as many photo-detectors as locations, forces applied at different locations can be detected independently.

4.2 A total of **4 marks** are available for a discussion of a problem. To receive all the marks available, the problem should be consistent with the prior art acknowledged and with the independent claim of the answer paper. Examples:

- (with respect to "Alpha")*: the force sensor of "Alpha" is not able to determine at which location the force is applied.*
- (with respect to D1)*: D1 requires as many output fibres and photo-detectors as locations, and has therefore a complex construction.*

General problems such as making a device 'more practical' or 'easier to use' or 'less expensive' should not receive more than 1 **mark**.

4.3 A total of **6 marks** are available for a discussion of a solution to the problem provided by the invention. To receive all the marks available, the solution has to be consistent with the independent claim of the answer paper.

Arguments pertaining to problems that are not solved by the independent claim of an answer paper are not awarded marks.

4.3.1 For the example solution independent claim, a solution to the above problems could be discussed as follows:

- (with respect to "Alpha") *To identify the location at which a force is applied, the light injecting device of the invention injects into each input optical fibre an optical signal having a different characteristic. Consequently, optical signals coupled at different coupling location into an output optical fibre would have different characteristics. A light receiving device is able to detect the coupling location of each received optical signal on the basis of this characteristic, thereby detecting the application of a force at the identified coupling location.*
- (with respect to D1) *The sensor of the invention does not require a separate output fibre and photo-detector for each location where a force has to be detected. Because an output optical fibre overlaps each of the input optical fibres at a respective coupling location, optical signals from different locations are coupled into the same output optical fibre. The light receiving device identifies the location at which a force is applied based on the different characteristics of the received optical signals.*

V. ANNEX – Example Set of Claims

1. A force sensor, comprising:
a plurality of input optical fibres (1a-1d);
an output optical fibre (2),
the output optical fibre overlapping each of the input optical fibres at a respective coupling location (3),
so that when a force is applied at a coupling location (3) an amount of light coupled from the input optical fibre (1a-1d) into the output optical fibre (2) changes;
a light injecting device (5) for injecting into each of the input optical fibres (1a-1d) an optical signal having a different characteristic;
a light receiving device (6) for receiving an optical signal from the output optical fibre (2);
the light receiving device (6) being configured to identify the coupling location (3) at which the received optical signal is coupled into the output optical fibre (2) on the basis of the characteristic of the received optical signal.

2. Force sensor according to claim 1, wherein the light receiving device (6) is arranged to detect the intensity of the optical signals and to determine the magnitude of the force applied at the identified coupling location (3).

3. Force sensor according to claim 1 or 2 , wherein the sensor includes a plurality of output optical fibres (2a-2d), each of the output optical fibres (2a-2d) overlapping each of the input optical fibres (1a-1d)**.**

4. Force sensor according to any of claims 1 to 3, wherein the different characteristic is a pulse frequency of each optical signal.

5. Force sensor according to claim 4, wherein the light injecting device (5) comprises an LED (L1-L4) for each input optical fibre, and a control unit (7) for turning each LED on and off at the respective pulse frequency.

6. Force sensor according to claim 4, wherein the light injecting device (5) comprises a lamp (12) and a plurality of mechanical shutters (13a-13d), each shutter being arranged at the input end of each input optical fibre (1a-1d), and a control unit (7) for opening and closing each shutter at the respective pulse frequency.

7. Force sensor according to any of claims 1 to 3, wherein the different characteristic is a colour of each optical signal.

8. Force sensor according to claim 7, wherein the light injecting device (5) includes an LED (L1-L3) of different colour for each input optical fibre (1a-1d).

9. Force sensor according to claim 7, wherein the light injecting device (5) comprises a white lamp and different colour filters, a different colour filter being associated with each input optical fibre (1a-1d).

10. Force sensor according to any of claims 7 to 9, wherein the light receiving device (6) comprises a camera (9).

11. Force sensor according to any of claims 1 to 10, wherein the input (1a-1d) and output (2a-2d) optical fibres are separated by an elastic layer (4).

12. Force sensor according to any of claims 1 to 10, wherein the input (1a-1d) and output (2a-2d) optical fibres are separated by a cavity.

13. Force sensor according to any of claims 1 to 12, where the input (1a-1d) and output (2a-2d) optical fibres are arranged such that they are parallel to each other at the respective coupling locations (3).

14. Mattress (14) including a force sensor as in any of claims 1 to 13.

15. Floor mat (14) including a force sensor as in any of claims 1 to 13.