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Datasheet for the decision of 28 July 2010

Case Number: T 1741/07 - 3.5.02

Application Number: 04251840.7

Publication Number: 1582430

IPC: B61L 23/04

Language of the proceedings: EN

Title of invention:
System and process for monitoring railway tracks

Applicant:
The Hong Kong Polytechnic University

Headword:
-

Relevant legal provisions:
EPC Art. 56
RPBA Art. 13(3)

Relevant legal provisions (EPC 1973):
-

Keyword:
"Inventive step (no)"
"Admissibility of late-filed request (no)"

Decisions cited:
-

Catchword:
-

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Case Number: T 1741/07 - 3.5.02

D E C I S I O N
of the Technical Board of Appeal 3.5.02
of 28 July 2010

Appellant: The Hong Kong Polytechnic University
Hung Hom,
Kowloon
Hong Kong (CN)

Representative: Williams, Ceili
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 11 May 2007 refusing European patent application No. 04251840.7 pursuant to Article 97(1) EPC 1973.**

Composition of the Board:

Chairman: M. Ruggiu
Members: R. Lord
P. Mühlens

Summary of Facts and Submissions

I. This is an appeal of the applicant against the decision of the examining division to refuse European patent application No. 04 251 840.7.

II. The reason given for the refusal was that the subject-matter of the independent claim 1 then on file did not involve an inventive step within the meaning of Article 56 EPC in the light of the following documents:

D1: US 5 330 136 A; and
D2: US 2004/0052444 A.

III. With the statement of grounds of appeal dated 21 September 2007 the appellant filed *inter alia* claims according to a new main request.

In a communication dated 29 March 2010 accompanying a summons to oral proceedings, the board referred also to the following documents:

D3: M.A. Davis and A.D. Kersey, "Matched-filter interrogation technique for fibre Bragg grating arrays", Electronics Letters, vol. 31, no. 10, pages 822 and 823;
D4 R.P. Kenny et al, "Fibre optic in-fibre Bragg grating sensors for use in composite material structural element characterisation and structural monitoring", Proceedings of the IEE Colloquium on Optical Techniques for Smart Structures and Structural Monitoring, 17 February 1997, Paper 11; and
D5: US 5 680 489 A.

With a reply to this communication dated 28 June 2010 the appellant filed *inter alia* claims according to an auxiliary request and "witness statements" by Siu Lau Ho (one of the inventors of the present application) and Kang Kuen Lee.

Oral proceedings before the board took place on 28 July 2010, during the course of which (after completion of the discussion of the main request) the appellant filed claims according to a further (second) auxiliary request, which the board decided not to admit into the proceedings. The appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of claims 1 to 14 of the main request filed with letter of 21 September 2007, or on the basis of claims 1 to 17 of the auxiliary request filed with letter of 28 June 2010.

IV. Claim 1 according to the appellant's main request reads as follows:

"A railway monitoring system (100), comprising:

an optical fiber (101) having a plurality of parts spaced apart along the length of the optical fiber, each part of the plurality being attachable to a respective portion of one of a pair of rails (103,105) of a track,

an optical signal emitter (107) connected to the optical fiber (101) for emitting an optical signal into the optical fiber, and

an optical signal analyzer (111) connected to the fiber for receiving and analyzing altered optical signals;

characterised in that the plurality of parts comprises a first plurality of Bragg gratings (S), each Bragg grating (S) having a distinct reflected wavelength which is altered upon a change in strain arising from a respective portion of the rail, and said optical signal analyzer (111) receives altered optical signals in the form of reflected signals and is adapted to detect shifts in the reflected wavelengths of the Bragg gratings, a shift being indicative of a change in strain at a respective portion of the rail."

V. Claim 1 according to the appellant's auxiliary request reads as follows:

"A railway monitoring system (100), comprising:

an optical fiber (101), wherein a plurality of parts of the optical fiber is attachable to one of a pair of rails (103,105) of a track, and wherein a characteristic of each of the parts of the optical fiber is variable in correspondence to variance of a characteristic of said one rail where each part of optical fiber is attached;

an optical signal emitter (107) connected to the optical fiber (101) for emitting an optical signal into the optical fiber, wherein the optical signal is altered to provide altered optical signals responsive to a variation of said characteristic of each part of the optical fiber, the altered optical signals containing information relating to the variance of the

characteristic of the part of the optical fiber; and

an optical signal analyzer (111) connected to the fiber for receiving and analyzing altered optical signals so as to ascertain the variance of said characteristic of said one rail based upon the information contained in the altered optical signal;

characterised in that each part of the single optical fiber (101) includes a Bragg grating (S), each Bragg grating having a distinct reflected wavelength therein for generating an associated altered optical signal, said optical signal containing information relating to the variance of the characteristic, and wherein the wavelength of each Bragg grating is variable in correspondence to the variance of said characteristic of said one rail, and wherein the optical signal analyzer (111) detects a shift in a wavelength of the altered optical signals for ascertaining the variance of the characteristic of the Bragg grating."

VI. The appellant essentially argued as follows:

The relevant skilled person, a railway engineer with experience in the field of network monitoring systems, was of a very conservative nature, and would not have considered introducing new unproven technologies.

The claimed invention enabled the sensors to be distributed along the length of a long optical fibre, with lengths of many tens of kilometres being possible, in particular since the sensors of the claimed invention detected changes in wavelength, not changes in power, so that attenuation occurring in long lengths

of optical fibre had no significant effect on the operation of the system.

The claimed invention also enabled the electronic components, in particular the optical signal analyser, to be positioned remotely from the track, for instance at a central computing centre, thus removing the need for powering of equipment in isolated locations.

The document D1 disclosed only a system in which the CTS units of the prior art were substituted with optical sensors on a one-to-one basis, thus requiring a set of emitting and receiving equipment for each sensor, whereas the claimed invention required only one set of this equipment for all of the sensors on an optical fibre.

The combination of the reduced number of CTS units with their spacing from the track solved the technical problem of further reducing the effects of electromagnetic interference.

The distributed microbending embodiment of D1 as described in column 4, lines 39 to 52 could only indicate that a train is present within the track section in which the sensors are provided, but provided no further information, since it could not identify which of the sensors had been affected. By contrast the claimed invention enabled the identification of the particular sensor triggered, so could provide functions such as axle counting, which in D1 were provided only by the localised sensor embodiments. The OTDR function of D1 was used only for monitoring the structural integrity of the optical fibre.

The pre-straining of the Bragg grating in the claimed invention enabled the detachment of a grating from the rail to be detected, thus ensuring that a fault did not occur in the network because of a defective sensor.

The auxiliary request filed with the letter of 28 June 2010 differed from the main request only in linguistic aspects, not in substance, and had been filed to address potential clarity issues.

The further auxiliary request filed during the oral proceedings before the board had not been filed earlier, because it had not been clear whether it would be necessary.

Reasons for the Decision

1. The appeal is admissible.

2. *Main request - Inventive step (Article 56 EPC)*

2.1 The document D1, like the present application, relates to railway monitoring systems based on optical fibre sensors, and is the only available prior art document relating to such systems. Thus it is considered to represent the best starting point for the assessment of inventive step.

2.1.1 It is noted that the appellant has argued extensively, in particular with reference to the two "witness statements" mentioned in section III above, that the person skilled in the art is a railway engineer with

experience in the field of network monitoring systems, and that such persons are of a very conservative nature, and would thus not consider it obvious to introduce new unproven technologies (contrasted to the conventional systems using electro-magnetic sensors). In the present case, the implication of this argument is that the skilled person would not consider replacement of the conventional system using electro-magnetic sensors with a system based on optical fibres, since these have not previously been used in the railway network, and would thus not consider D1.

2.1.2 This argument appears to the board to be based on the assumption that the skilled person is starting from a situation in which only electro-magnetic sensors were known. However, it is part of the established case law of the boards of appeal that the skilled person is aware of all of the prior art in the relevant technical field. Thus, in the present case he would be aware of the teaching of D1, and for the reason indicated in paragraph 2.1 above, the skilled person would adopt this document as his starting point and hence assume the use of optical fibres in a railway monitoring system.

2.2 The document D1 discloses in column 4, lines 39 to 66, with reference to Fig. 3A, a railway monitoring system comprising the following technical features of claim 1 of the appellant's main request:

(a) an optical fibre (15 in Fig. 3A) having a plurality of parts (e.g. the part contacting the projection 16) spaced along the length of the optical fibre (see column 4, lines 8 to 12 and

also Figs. 5 to 7 and column 6, lines 39 to 60), each part being attachable to a respective portion of one of a pair of rails of the track (c.f. Figs. 5 to 7);

(b) an optical signal emitter (incident light source 18) connected to the optical fibre so as to emit an optical signal into the optical fibre; and

(c) an optical signal analyser (optical time domain reflectometer or OTDR 20) connected to the optical fibre for receiving and analysing altered optical signals;

(d) these altered optical signals being in the form of reflected signals which are produced in response to a change in strain arising in the respective portion of the rail (by microbending, see column 4, lines 53 to 55), and the signal analyser being arranged (by its time domain analysis as described in column 4, lines 55 to 62) to detect changes in the altered optical signals indicative of a change in strain at a respective portion of the rail.

2.2.1 Concerning the disclosure of D1, the appellant has argued that this document discloses only a one-to-one substitution of the conventional electro-magnetic sensors with optical sensors, so that a coded track set (CTS) comprising optical signal emitter and optical analyser has to be provided for each sensor. The board does not find this argument convincing, because although D1 does indeed describe such arrangements, i.e. the localised sensors depicted in Figs. 8 to 11, it also describes distributed arrangements in which a

plurality of sensors are provided along a single optical fibre, as described with reference to Figs. 5 to 7, see in particular column 6, lines 15 to 18 and 39 to 60.

2.2.2 The appellant also argued that D1 does not describe that the altered optical signals are in the form of reflected light, since the passage in column 4, lines 39 to 52 relating to the sensors concerns the change in intensity of the transmitted light, which arrangement provides no information as to where along the fibre the alteration was generated, and since the passage in lines 62 to 66 of the same column relating to OTDR concerns only the monitoring of the structural integrity of the optical fibre. The board does not find this argument convincing, because the passages of D1 cited in paragraph 2.2(d) above describe that as an alternative to the transmission mode operation described in lines 39 to 52, the system can operate in the reflection mode (OTDR), and that this allows the association of a particular received altered optical signal with an individual sensor at a particular position along the rail ("*correlates the return time-of-flight of reflected energy to generate a time/distance plot of the reflected pulse image*").

2.3 The system of claim 1 of the appellant's main request is thus distinguished from that of D1 in that the plurality of parts formed along the optical fibre are in the form of Bragg gratings, each having a distinct reflected wavelength, in that the altered optical signals are in the form of changes of those wavelengths, and in that the optical signal analyser is adapted to detect those wavelength changes. The technical problem

can thus be seen to be to provide an alternative type of optical sensor to the microbending sensors described in D1 (with consequent adaptation of the optical signal analyser, if necessary).

2.4 The documents D2 to D5 all describe sensing and monitoring systems comprising a plurality of Bragg gratings distributed along an optical fibre, these gratings having distinct reflective wavelengths. These systems operate to sense a change in a parameter such as strain or temperature by detecting the change of wavelength of light reflected by these gratings in response to a change in that parameter, the distinct reflective wavelengths enabling the location of that change to be determined (see D2, embodiments of Figs. 10 to 13, paragraphs [0068] to [0071]; D3, Fig. 1 and first sentence of text; D4, first three paragraphs on first page and Fig. 1; and D5, column 1, lines 36 to 51 and Figs. 1 and 4). As indicated in the cited passages, these documents relate to a variety of different uses (D2: "strain/temperature sensor system"; D3: "strain sensing system ... to provide structure health information"; D4: "structural element characterisation and monitoring"; D5: "composite material analysis", "sensing application of selected equipment, such as machinery"). These documents demonstrate that in the technical field of optical strain sensing systems, the use of Bragg gratings with distinct reflective wavelengths to provide distributed sensing was well known. The skilled person working in the technical field of document D1 can thus be expected to be aware of such systems, and to therefore consider Bragg gratings to be a suitable alternative to the microbending sensors of D1. It would therefore be

obvious to him to make use of these alternative sensors. The replacement of the OTDR device of D1 with an analyser adapted to detect wavelength shifts would then follow as a direct consequence of that modification. Hence, by replacing the microbending sensors of D1 with Bragg gratings in this obvious manner, the skilled person would arrive at a railway monitoring system according to the independent claim 1 of the appellant's main request. The subject-matter of that claim therefore does not involve an inventive step within the meaning of Article 56 EPC.

2.5 The board does not find the appellant's counter-arguments concerning inventive step to be convincing for the following reasons.

2.5.1 The appellant has argued that the claimed invention is advantageous because it allows a single sensing system to be provided with sensors distributed on a long optical fibre, which could be many tens of kilometres in length, in which context he also referred to an experimental arrangement 200 km long. The board considers that this argument is not relevant to the present claim 1, since that claim does not contain any definition indicating that the length of the optical fibre is any greater than that used in the distributed sensing embodiments of D1. Moreover, the present application contains only one item of disclosure relating to the length of the optical fibre along which the sensors are distributed, namely that of Fig. 1, in which the optical fibre extends along the two rails of a track section only 21 m long. The appellant's argument is based on the assumption that the optical fibre is of the order of a thousand times longer than

this, for which there is no suggestion in the application. The question as to whether fibre attenuation would affect the operation of the sensors, as also discussed by the appellant in this context, would be of no significance for the fibre lengths disclosed in the application.

2.5.2 The appellant has argued also that the claimed invention is advantageous because it allows the electronic equipment to be positioned remotely from the track, for instance at a central computer facility. The board considers that this argument is not relevant to the present claim 1 for a similar reason to that given in the previous paragraph, namely that the claim contains no definition indicating that the spacing of the optical emitter and optical signal analyser from the track is any greater than in the arrangement of D1. The appellant has argued that this is at least disclosed in the original application, specifically in the last sentence of paragraph [0011] of the published application. The board considers however that this sentence describes merely that the analyser should be sufficiently far from the track to avoid electromagnetic radiation from the track and train, which is also suggested in D1 as an advantage of the arrangement described there. Thus even if the claim were interpreted as including this teaching from the description, this would not result in a distinction over D1.

2.5.3 The appellant argued further that the use of Bragg gratings with distinct reflective wavelengths is advantageous over D1 since it enables the altered light received by the analyser to be associated with a

particular position, which in turn enables functions such as axle counting to be carried out. The board notes that this argument was based on the appellant's assumption that the OTDR function in D1 was provided only to monitor the structural integrity of the optical fibre. However, as has already been noted in paragraph 2.2.2 above, D1 also describes that the OTDR technique can be used for the primary function of strain detection, thus also providing position information. Hence, also in this respect the claimed invention provides no additional effect with respect to the arrangement of D1.

2.5.4 Finally, the appellant argued that the claimed invention had the advantage that by pre-straining the Bragg gratings it is possible to detect when a grating has become detached from the rail, since that would also result in a change in the reflected wavelength. This would thus enable a warning to be provided that a particular sensor was no longer functioning. The board does not consider this argument to be relevant to the present claim 1, since this feature is defined only in the dependent claim 3, not in claim 1. The board observes moreover that this effect was not mentioned in the original application.

2.5.5 For the sake of completeness, the board also notes that in the appellant's submission of 28 June 2010 he argued that the inventor of D1 was aware of Bragg gratings, since these are mentioned in citations in that patent, but nonetheless he did not teach to use them. The board observes however that two of the citations noted there (those by Vengsarkar et al) are references cited during the examination procedure, not ones cited in the

original application, and that the other citations do not appear in D1 at all, only in D2. Thus there does not appear to be any evidence available as to whether the inventor of D1 was aware of Bragg gratings.

3. *Further requests*

3.1 The independent claim 1 according to the appellant's auxiliary request filed with his letter of 28 June 2010 differs from that according to the main request only in matters of terminology and formulation, with no difference in substance, as the appellant himself stated. Thus the conclusion concerning inventive step which was reached with regard to the main request applies correspondingly to this request.

3.2 The further auxiliary request filed by the appellant during the oral proceedings before the board incorporates into claim 1 of the main request the feature of dependent claim 3 of that request, i.e. the feature concerning the pre-straining of the gratings. As noted in section 2.5.4 above, the appellant argued that this feature provides the technical effect of enabling the detachment of a grating from the rail to be detected. This effect had not been discussed prior to the oral proceedings before the board, and was moreover not mentioned in the application. The board was therefore not in a position to deal with this amendment without adjournment of the oral proceedings. Moreover the board did not consider that the reason given by the appellant for filing the request only at this stage of the procedure was adequate to justify the late filing of the request. Therefore in accordance with Article 13(3) of the Rules of Procedure of the

Boards of Appeal, the board decided not to admit this request into the procedure.

4. Since the subject-matter of the two requests which have been admitted into the procedure does not involve an inventive step within the meaning of Article 56 EPC, neither of the appellant's admissible requests is allowable.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

U. Bultmann M. Ruggiu