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D E C I S I O N
of 23 May 2000

Case Number: T 0021/99 - 3.4.2

Application Number: 91915079.7

Publication Number: 0541697

IPC: G01J 5/16

Language of the proceedings: EN

Title of invention:
Radiation detector with remote temperature reference

Patentee:
EXERGEN CORPORATION

Opponent:
Raytek GmbH

Headword:
-

Relevant legal provisions:
EPC Art. 56, 84

Keyword:
"Inventive step - no (main request - auxiliary requests 1 to 4)"
"Clarity - no (auxiliary request 4)"
"Inventive step - yes (auxiliary request 5)"

Decisions cited:
-

Catchword:
-

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Case Number: T 0021/99 - 3.4.2

D E C I S I O N
of the Technical Board of Appeal 4.3.2
of 23 May 2000

Appellant: (Opponent)
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Decision under appeal: **Interlocutory decision of the Opposition Division of the European Patent Office posted 19 October 1998 concerning maintenance of European patent No. 0 541 697 in amended form.**

Composition of the Board:

Chairman: E. Turrini
Members: M. A. Rayner
B. J. Schachenmann

Summary of Facts and Submissions

I. In its decision in relation to European patent No. 541 697 (application No. 91 915 079.7, WO-A-92/02793), the opposition division rejected the main, first and second requests of the patent proprietor before it and decided that the patent as amended according to the third auxiliary request met the requirements of the Convention.

II. In the opposition proceedings, reference was made, inter alia, to the following documents:

D1: Dr-Ing Georg Keinath, "Elektrische Temperaturmeßgeräte", Verlag Oldenbourg, 1923, pages 128-133, 163-167.

D2: Dr-Ing Georg Keinath, "Messung hoher Temperaturen mit Ardometer und Glühfaden-Pyrometer nach Holborn-Kurlbaum", Siemens & Halske AG, Wernerwerk, Berlin-Siemensstadt, 1925, pages 1-22.

D3: "Die Meßtechnik", "III. Strahlungspyrometer", II. Jahrg., Heft 7, 1926.

D4: DE-C-949 377

D6: Theory and Practice of Radiation Thermometry, 1988, Section 7.4.1

D7: Gutachten - Professor Dr-Ing Günter Dittmar.

The opposition division reasoned that the features of claim 1 of the main request except for the thermopile were known from document D1, but that, as substantiated

by document D7, the term thermopile includes an arrangement of two thermocouples, such an arrangement being shown in document D2. Accordingly, no inventive step could be seen in the subject matter of claim 1 of the main request having regard to a combination of documents D1 and D2. The independent claims of the first and second auxiliary request lacked clarity in view of the term "approximately equal". However, the glass lens known from document D2 does not flatten the response curve below the fourth power when used in a normal measuring range and the age of documents D1 to D3 gave rise to a technical prejudice against using compensating leads with a "modern" thermopile, there also being no evidence in the file relating to a "modern" thermopile having an integrated filter. Therefore, the subject matter of claim 1 of the third auxiliary request provided a combination of a filter and thermocouple providing sufficient accuracy for measurement without compensating electronics and thus involved an inventive step.

III. Notices of appeal against the decision were received both from the patent proprietor and the opponent.

IV. In the statements setting out the grounds of appeal, oral proceedings were requested by both parties on an auxiliary basis. The patent proprietor requested maintenance of the patent and the opponent revocation of the patent in its entirety, the opponent filing

D15: Dexter Research Price List, 9 to 86

stating that it showed buying thermopiles with filters was known in 1986.

V. In the annex to the summons to attend oral proceedings, arranged consequent to the auxiliary requests of the parties, the appeal board commented on the question of the equivalence of the thermoelements disclosed in document D2 and a series of hot junctions at a first temperature and cold junctions at a second temperature and also on doubts about the equivalence of the compensation wires disclosed in document D1 with a thermocouple having two leads of different thermocouple material. The board commented that the significance of a housing and mounting structure to inventive step appeared doubtful and noted the disagreement of the parties about whether a feature relating to a filter constituted a patentable difference in relation to documents D1 to D3.

VI. At the oral proceedings, the main request of the patent proprietor was that the patent be maintained as granted. On an auxiliary basis the patent proprietor requested the patent be maintained according to five auxiliary requests filed during the oral proceedings. The opponent requested revocation of the patent in its entirety. The claim 1 according to the respective requests of the patentee is worded as follows:

Main request (patent as granted)

1. A radiation detector comprising a radiation sensor for sensing radiation from a target and providing a signal indicative of the temperature of the target and a thermocouple; characterized by:

the radiation sensor being a thermopile (19) having a hot junction (8) and a cold junction (9) and the thermocouple (15) having a hot junction

(20) and a cold junction (21,27), the hot junction being associated with the thermopile cold junction temperature and the cold junction being at a reference temperature remote from the thermopile, the thermocouple being electrically connected with the thermopile and providing a signal which combines with the thermopile signal to produce a total output signal.

First auxiliary request

1. A radiation detector comprising a radiation sensor for sensing radiation from a target and providing a signal indicative of the temperature of the target and a thermocouple; characterized by:

the radiation sensor being a thermopile (19) having two ends between which are a series of hot junctions at a first temperature and cold junctions at a second temperature and the thermocouple (15) having two leads of different thermocouple materials connected between a hot junction (20) and a cold junction (21,27), the hot junction being associated with the thermopile cold junction temperature and the cold junction being at a reference temperature remote from the thermopile, the thermocouple being electrically connected with the thermopile and providing a signal which combines with the thermopile signal to produce a total output signal.

Second auxiliary request

1. A radiation detector comprising a radiation sensor for sensing radiation from a target and providing

a signal indicative of the temperature of the target and a thermocouple; characterized by:

the radiation sensor being a thermopile (19) having two ends between which are a series of hot junctions at a first temperature and cold junctions at a second temperature and the thermocouple (15) having two leads of different thermocouple materials connected between a hot junction (20) and a cold junction (21,27), the hot junction being associated with the thermopile cold junction temperature and the cold junction being at a reference temperature remote from the thermopile, the thermocouple being electrically connected with the thermopile and providing a signal which combines with the thermopile signal to produce a total output signal, and in that there is provided a long wavelength pass filter (11) which filters out shorter wavelengths of said radiation prior to its being sensed by the thermopile to flatten the response of the thermopile to target temperature to become lower than the fourth power curve.

Third auxiliary request

1. A radiation detector comprising a radiation sensor for sensing radiation from a target and providing a signal indicative of the temperature of the target and a thermocouple; characterized by:

the radiation detector having a housing within which is a mounting structure supporting a thermopile sensor including a thermopile (19) having a series of hot junctions (8) at a first

temperature and a series of cold junctions (9) at a second temperature, and a pair of thermopile leads and the thermocouple (15) comprising first and second thermocouple leads of different thermocouple materials electrically connected to respective thermopile leads, the first and second thermocouple leads providing a hot junction (20) and a cold junction (21,27), the hot junction being associated with the thermopile cold junction temperature and the cold junction being at a reference temperature remote from the thermopile, the thermocouple being electrically connected with the thermopile and providing a signal which combines with the thermopile signal to produce a total output signal, and in that there is provided a long wavelength pass filter (11) which filters out shorter wavelengths of said radiation prior to its being sensed by the thermopile to flatten the response of the thermopile to target temperature to become lower than the fourth power curve.

Fourth auxiliary request

1. A radiation detector comprising a radiation sensor for sensing radiation from a target and providing a signal indicative of the temperature of the target and a thermocouple; characterized by:

the radiation sensor being a thermopile (19) having two ends between which are a series of hot junctions at a first temperature and cold junctions at a second temperature and the thermocouple (15) having two leads of different thermocouple materials connected between a hot junction (20) and a cold junction (21,27), the hot

junction being associated with the thermopile cold junction temperature and the cold junction being at a reference temperature remote from the thermopile, the thermocouple being electrically connected with the thermopile and providing a signal which combines with the thermopile signal to produce a total output signal, component materials of the thermocouple providing the thermocouple with a thermal response similar to a thermal response of the thermopile in a temperature range of interest at which the hot and cold junctions of the thermopile are of approximately equal temperature.

Fifth auxiliary request

1. A radiation detector comprising a radiation sensor for sensing radiation from a target and providing a signal indicative of the temperature of the target and a thermocouple; characterized by:

the radiation sensor being a thermopile (19) having two ends between which are a series of hot junctions at a first temperature and cold junctions at a second temperature and the thermocouple (15) having two leads of different thermocouple materials connected between a hot junction (20) and a cold junction (21,27), the hot junction being associated with the thermopile cold junction temperature and the cold junction being at a reference temperature remote from the thermopile, the thermocouple being electrically connected with the thermopile and providing a signal which combines with the thermopile signal to produce a total output signal and in that a

calibrator (17) is provided for adjusting the thermopile output signal, and further comprising a temperature dependent variable resistor (216, 316) electrically connected with the thermopile and providing a variable resistance which combines with the thermopile signal to produce a linearized thermopile signal.

VII. The arguments of the patent proprietor can be summarised as follows.

Main request

Claim 1 of the main request is restricted to a thermopile. Document D1 is very old and provides a thermocouple sensing element. There is no thermopile even when the teaching of document D1 is modified by that of document D2. Use of a galvanometer in the teaching of document D2 implies current doubling, which does not amount even to a series connection of the thermocouples. Document D2 does not disclose a thermopile in the modern sense of this term. In the teaching of document D1, no hot junction for the compensating wires is provided and there is not in fact any compensating thermocouple. Moreover, the wires according to document D1 are taught to provide 0.75 of the emf of the thermocouple. The skilled person would in any case have concluded from D1 and D2 that an argon gas filling was preferred to compensating wires. The skilled person was moreover not concerned with the heat flux equation in view of the differences between the hot and cold temperature of the sensing thermocouples. Since the compensating wires of document D1 do not constitute a thermocouple and a thermopile is not disclosed, it is not necessary to formulate a problem

in relation to document D1. The long standing problem of avoiding costly and complex compensation systems is addressed by the invention and not solved by the prior art.

First auxiliary request

Claim 1 of this request recites explicitly structural features pertaining to the thermopile and thermocouple.

Second auxiliary request

Claim 1 of this request adds a feature relating to provision of a long-wavelength pass filter. The filter filters out shorter wavelengths to flatten the response of the thermopile to target temperature to become lower than the fourth power curve. The glass lens according to document D2 is only effective at high temperatures and document D6 teaches away from removal of short wavelengths because it includes reference to shorter wavelength instruments. In order to reach the subject matter of claim 1, it is necessary to select features from documents D1 and D2 in combination and then also take features from document D15. The price list of document D15 is, however, much later than documents D1 and D2 so that the skilled person buying a thermopile according to the price list would, in fact, have dismissed documents D1 and D2 as irrelevant. Even if they were considered therewith, there is no reason at all for the skilled person to replace the glass lens mentioned in the old documents by a long wavelength pass filter.

Third auxiliary request

Document D2 does not disclose any housing with structure in the sense of the present patent supporting a thermopile sensor.

Fourth auxiliary request

The claimed subject matter represents a specific choice of materials for optimum function in the range of interest and the approximate equality of the thermopile junction temperature means that a modern thermopile differing from that of documents D1 to D3 is being used.

Fifth auxiliary request

The thermistor is provided to linearise the thermopile output and not for temperature compensation. The thermistor mentioned in document D1 is as a substitute for the compensation wires.

Therefore, the subject matter of the claims filed according to all the requests involves an inventive step.

VIII. The arguments of the opponent can be summarised as follows.

Main request

Compensating wires used with a thermocouple are known from document D1. The two sensing thermocouples known from document D2 constitute a thermopile. Both of these documents relate to the same detector, the Ardometer, and their obvious combination leads to the subject

matter of claim 1.

First auxiliary request

The features of this request differing from the main request are also to be found in documents D1 and D2.

Second auxiliary request

The calculations presented in writing show that the filter features are present in the case of the Ardometer at temperatures over 4550 K. The calculations also show conventional thermopiles demonstrate this effect when used with an 8 to 14 mm filter.

Third auxiliary request

The thermopile of document D2 is also provided with a structure for its mounting in the housing.

Fourth auxiliary request

The terminology of the claim relating to "similar responses" and "approximately equal" temperatures is obscure. The temperature difference arising according to the teaching of documents D1 to D3 need not be more than a few degrees. The practical situation of the skilled person must be taken into account. The skilled person can only achieve a satisfactory trade off of the values for thermopile and thermocouple output in a limited temperature range because of the output curves concerned. It is obvious that the materials must be chosen for this purpose. Document D1 shows in differing curves for differing materials in Figure 146 thereof.

Fifth auxiliary request

Adjustment of the calibrating aperture on page 132 adjusts the output signal and it is apparent that the resistance mentioned on page 167 would be used. Moreover, the resistor 3 known from document D4 is used to match the main and auxiliary element output. Therefore, no inventive step is involved in the subject matter of claim 1 of any of the requests filed.

IX. At the end of the oral proceedings, the appeal board gave its decision.

Reasons for the Decision

1. *Admissibility*

The appeal complies with the provisions mentioned in Rule 65(1) EPC and is therefore admissible.

2. *Main request*

Novelty

2.1 The detector disclosed by document D1, the Ardometer, is shown (see for example Figure 105 and the corresponding description) as comprising a thermoelement in the form of crossed nickel chrome and constantan wires thermocouple, housing temperature variation being operationally balanced out by compensation wires connected to the thermocouple as disclosed for example at the bottom of page 165. In the Ardometer, the temperature sensing thermocouple senses temperature at its hot end and its cold end is at

housing temperature. The hot end of the compensating wires are at housing temperature and the cold end away from the housing as shown in Figure 145 and so at a reference temperature. However, no thermopile as claimed is disclosed.

Document D2 also relates to the Ardometer as can be seen in Figure 5 which is the same as Figure 105 of D1. It is explained, in the paragraph starting at the end of page 9, that, for lower temperatures, two semicircular elements are arranged together and generate a doubled emf. However, no thermocouple connected to the radiation sensor as claimed is disclosed.

Document D3 too relates to the Ardometer as can be seen in Figure 66 which is the same as Figure 105 of D1 and Figure 5 of D2. Compensation wires of constantan and copper are recommended for connecting the Ardometer and display instrument (see the last paragraph). Use of Argon filled and an air free capsule for the sensing thermocouple are disclosed. As with document D1, no thermopile as claimed is disclosed.

Document D4 discloses the use of a main measuring contact thermocouple (1 in figure 1) together with an auxiliary thermocouple 2 for temperature compensation. A resistor 3 is provided for matching the outputs of the two thermocouples. The disclosure of this reference concerns a contact device and not a radiation sensor and thus differs from the claimed subject matter.

Document D6 is a text book which explains on page 501 that unfiltered thermometers of the point and read variety typically operate over a nominal band of 2 to

20 mm. The actual spectral response is limited by the optical system transmission, primarily the front window, and the detector response as well as the intervening atmosphere transmission. The next most popular band for many of these instruments is 8 to 12 mm. In Table 7.1, a thermopile is disclosed as a typical detector for this band. However, no thermocouple connected to the thermopile as claimed is disclosed.

Document D15 is a price list showing various filters including an 8 to 13.7 mm filter. Again, no thermocouple connected to the thermopile as claimed is disclosed

Therefore the subject matter of claim 1 as granted is novel within the meaning of Article 54 EPC having regard to any one of documents D1 to D4, D6 or D15.

2.2 Inventive step

The board considers the compensating wires known from document D1 or D3 to be of different material (implicit in document D1, explicit in document D3) and to comprise a thermocouple because they generate emf according to temperature difference. As a matter of definition, the board shares the view of the opponent and the opposition division, that the term thermopile includes two thermocouples. Accordingly, a thermopile is disclosed by the arrangement of two thermocouples known from document D2. These two thermocouples must moreover be connected in series to form the thermopile because the generated emf (in practice voltage, see for example the middle of page 13 of document D2) is doubled (see the top paragraph on page 11). An

interpretation that there is no hot junction of the compensating thermocouple in the disclosure of D1 is not correct because the temperature concerned is that of the detector housing, which is also the temperature of the cold junction of the thermopile.

Accordingly, in view of their relevant disclosure, starting from D1 or D3, the objective technical problem is to provide a greater emf. Just this problem is solved by the teaching of document D2 by using a thermopile as in the claimed invention. On the other hand, starting from document D2, the objective problem concerns compensation of housing temperature fluctuation for which the claimed solution is provided by the compensating wires feature of documents D1 or D3. Either way, the subject matter of claim 1 is reached in an obvious manner. The combination of documents D1 to D3 is all the more obvious because they all relate to the same device.

The board observes that the age of prior art documents belongs only to the secondary indicia relating to inventive step and, in the present case, is no substitute for technically assessing the contents of the documents. It must be borne in mind that the teaching in the Ardometer documents is at a both simple and fundamental level of physics of thermocouples. There is in particular no reason to believe any technical prejudice exist against such fundamental Ardometer teachings simply by virtue of their age. In particular, the decisive teaching given by document D2 is that only one sensing thermocouple is not enough for increasing sensitivity at lower temperature. Once this teaching is given, even if, as implied in the submissions of the patentee, claim 1 were restricted by

reading into the term thermopile a multiple of minute thermocouples according to more modern thermopiles, despite such restriction being contrary to the expert opinion of document D7, the board would see this as amounting to no more than obvious standard technical development in the thermopile art not touching on the compensation by a thermocouple as such. Thus, the board would not see any inventive step in satisfying such a putative claim by implementing the Ardometer teachings by the obvious use of a thermopile, of a conventional type modern at the priority date of the patent. The argument that correction has been effected by software or complicated electronics in association with conventional modern thermopiles confirms that correction is necessary but has no technically dissuasive effect in relation to application of the simple and fundamental teaching concerning the Ardometer.

The submissions of the patentee also imply that a particular choice of material is made avoiding 0.75 emf compensation resulting from the range sensed is present in claim 1 and also that the thermopile hot and cold junctions are at the same temperature. However, no such particular material or temperatures are recited in the claim, so that such submissions are not relevant (see also Auxiliary Request 4 below). Furthermore, there is no reason to suppose that when an Argon filling is used, the compensation wires are dispensed with, as document D3 discloses both.

Accordingly, the board comes to the conclusion that an obvious combination of documents D1 or D3 with D2, relating to essentially the same device, leads directly to the radiation detector according to claim 1 without

any inventive step. Therefore, the subject matter of claim 1 of the main request does not satisfy Article 56 EPC.

3. *First auxiliary request*

Inventive step

The additional limitations introduced into claim 1 are also obvious in the light of the Ardometer documents. In particular, the two hot junctions of the thermopile forming thermocouples are next to each other according to document D2 which means they are at the same temperature. The cold junctions are at housing temperature. That there are two ends of the thermocouple for the generated emf is self evident. In order to function, the compensating wires must be of a different material, an explicit recitation of this is present in the last paragraph of D3.

Therefore, the subject matter of claim 1 of the first auxiliary request does not satisfy Article 56 EPC.

4. *Second auxiliary request*

Inventive step

4.1 The skilled person implementing, at the priority date of the patent, the technical teaching of compensation as disclosed in the Ardometer documents would naturally have used an at the time "modern" thermopile. In the view of the board, the idea that the skilled person would have persisted with the old thermopile type in an implementation at the priority date is removed from all practical reality. The prior art shows that use of

filters with such a "modern" thermopile was at that time already standard practice. For example a filtering at 8 to 14 mm is demonstrated both by document D6 filed by the patentees and document D15 filed by the opponents, the former explaining that the 8 to 14 mm band minimises many atmospheric problems and is the next most popular band to the unfiltered 2 to 20 mm band. Use of a 8 to 14 mm filter with the "modern" thermopile therefore falls squarely within the framework of the knowledge of the skilled person and is thus obvious.

4.2 The obvious use of the filter entails blocking short wavelength radiation which as shown by the calculation of the opponent automatically satisfies the requirement of claim 1 relating to flattening of the thermopile response. The board sees no interdependency between use of compensation wires and the filter, in practice the compensation wires are simply arranged to compensate whatever thermopile output is produced. The fact that other filters are disclosed in documents D6 and D15 does not lead away from it being obvious to the skilled person to use the 8 to 14 mm for its advantages in relation to detector properties and atmospheric transmission. Document age in relation to the Ardometer documents, as explained in connection with the main request, does not in the present case play a dissuasive role. Consequently, the entire subject matter of claim 1 is obvious.

Therefore, the subject matter of claim 1 of the second auxiliary request does not satisfy Article 56 EPC.

5. *Third auxiliary request*

Inventive step

5.1 The Ardometer has a housing which contains a supporting structure, this structure being shown by the hatched plug at the left of Figure 4 of document D2. A structure is naturally always necessary, since otherwise the sensing thermocouples would not be located and thus would move out of position. The obvious necessity of provision of leads for the thermopile can also be seen below the plug in Figure 4. Since these features amount to the only differences from the subject matter of claim 1 according to the second auxiliary request, the entire subject matter claim 1 cannot be considered to involve an inventive step.

Therefore, the subject matter of claim 1 of the third auxiliary request does not satisfy Article 56 EPC.

6. *Fourth auxiliary request*

6.1 Clarity and inventive step

The terminology of the claim is obscure in view of use of the terms "similar to" and "approximately equal" because the similarity and approximation are not quantified. Therefore, the features including these terms do not amount to differences which are clear within the meaning of Article 84 EPC in respect of temperature or compensation having regard to the disclosure of documents D1 to D3, where as the opponent explained the temperatures can also be close. Leaving aside the clarity question, the board observes that in practice, for any range of interest a skilled person chooses materials and makes a trade off allowing for

the heat flux equation, the detector never being "just right" for all possible temperatures. So far as the present claim is concerned, no specific material with particular advantages in any specific range is in fact recited, so that as far as the claim can be understood, it amounts to no more than choosing an undefined appropriate material for the range concerned, which is lies within the routine competence of and is thus obvious to the skilled person.

Therefore, the subject matter of claim 1 of the fourth auxiliary request is neither clear within the meaning of Article 84 EPC, nor so far as it can be understood can it be considered to involve an inventive step within the meaning of Article 56 EPC.

7. *Fifth auxiliary request*
Amendments - Article 123(2) and (3) EPC

7.1 The amendments made to claim 1 derive from claims 2 and 9 as granted and effect a limitation thereof. Articles 123(2) and (3) can accordingly be considered satisfied.

Inventive step

7.2 The variable resistor in combination with the thermopile produces a linearised output voltage which combines with the thermocouple output voltage to produce a stable total output voltage over a broad range of thermopile cold junction temperatures. The aperture mentioned on page 132 of document D1 and shown in Figure 104 merely restricts the sensor temperature and allows correct positioning in relation to the incoming radiation. The discussion of the thermally

dependent resistance on page 167 of document D1 is, unlike the presently claimed subject matter, an alternative to the compensation wires. Moreover, the resistor 3 disclosed by document D4 is not temperature dependent. Consequently, the prior art documents cannot suggest the features added to claim 1 of the fifth request.

Consequently, the board is satisfied that claim 1 of this request involves an inventive step within the meaning of Article 56 EPC. The board reaches the same conclusion with respect to independent claim 13 because it includes the features of claim 1.

7.3 Adaptation of the description

The introduction to the description should mention the Ardometer documents and be adapted to the claims. The detailed description of the preferred embodiments also requires adaptation to the more restricted subject matter now claimed, needing careful consideration to ensure that full consistency with the amended independent claims is guaranteed.

7.4 In this context, the department of first instance should in particular deal with the issue of removing any inconsistencies in the description relating to the features of claim 1, ensuring that any embodiments not fulfilling the requirements of the claim are either cancelled, or if retained in the description for the purpose of comprehensibility clearly designated as such (see lines 57 to 58 on page 4 of the published specification for example). Consideration in this respect should be given for example not only to those embodiments lacking a temperature dependent resistor

(for example the Figure 1B embodiment) but also to any embodiment lacking a thermocouple (for example column lines 28 to 35 of page 14 of the specification).

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the first instance with the order to maintain the patent in amended form on the basis of claims 1 to 13 filed as fifth auxiliary request during the oral proceedings with description and drawings to be adapted.

The Registrar: The Chairman:

P. Martorana E. Turrini