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Datasheet for the decision of 4 October 2006

Case Number: T 0663/03 - 3.5.04

Application Number: 93915372.2

Publication Number: 0672325

IPC: H04N 5/33

Language of the proceedings: EN

Title of invention:
Infrared camera with thermoelectric temperature stabilization

Patentee:
HONEYWELL INC.

Opponent:
Commissariat à l'Energie Atomique

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step - (yes) after amendment"

Decisions cited:
-

Catchword:
-

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Case Number: T 0663/03 - 3.5.04

D E C I S I O N
of the Technical Board of Appeal 3.5.04
of 4 October 2006

Appellant: (Patent Proprietor)
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Decision under appeal: **Decision of the Opposition Division of the European Patent Office posted 11 April 2003 revoking European patent No. 0672325 pursuant to Article 102(1) EPC.**

Composition of the Board:

Chairman: F. Edlinger
Members: A. Dumont
B. Müller

Summary of Facts and Submissions

I. An appeal was lodged by the proprietor against the decision of the opposition division to revoke European patent No. 0 672 325.

II. Opposition had been filed based on Article 100(a) together with Article 56 and Article 100(b) EPC, referring *inter alia* to the prior art documents:

D1: US 4752694 A;
D2: JP 55-81735 U and English translation, pages 1 to 3 and
D4: B. E. COLE, "High Tc Superconducting infrared bolometric detector" In SPIE Vol.1394 Progress in High-Temperature Superconducting Transistors and Other Devices, 1990, pages 126 to 138.

III. In the oral proceedings before the board on 4 October 2006 the appellant filed a complete set of documents of the patent specification including a new set of claims 1 to 11 (sole request).

IV. The appellant requested that the decision under appeal be set aside and that the patent be maintained in the version filed in the oral proceedings.

V. The respondent requested that the appeal be dismissed.

VI. The independent claims read as follows.

"1. An infrared camera having: an optical assembly (71) to bring light/infrared radiation to a focal plane array (33) of infrared sensitive microbolometers on a

semiconductor substrate (30), wherein the camera is characterised in that said focal plane array is swept to produce output signals by a decoder (75) which selects particular column and row addresses in said array by providing a bias current thereto in short duration pulses, from a bias current source (76), that heat the microbolometers, wherein the sweep is at such a rate that each microbolometer has time to return to a stabilisation temperature before the sweep generates a second short duration bias pulse to each said microbolometer, said selecting of row and column addresses being determined by a logic controller (77) which generates signals setting switches in said decoder in a pattern designed to sweep the entire array, a thermoelectric temperature stabilizer (20) to maintain said focal plane array constant at a selected temperature, said thermoelectric temperature stabilizer being regulated by a controller (73) based on a signal received from a temperature sensor (27) in close thermal association with said array, wherein sensing material in the bolometers comprises Vanadium Oxide material."

"2. An infrared camera comprising a substrate having first and second surfaces with an aperture formed therethrough, said aperture being surrounded along with an area of said first surface by a contiguous wall structure, said area inside said wall being a bounded surface area;
a thermoelectric temperature stabilizer (20) mounted firmly to said bounded surface so as to not block said aperture;
an array (30) of infrared sensitive microbolometers mounted to the opposite surface of said thermoelectric

temperature stabilizer (20), where said array is driven by short duration pulses, from a bias current source, that heat the microbolometers wherein a sweep of the array is at such a rate that each microbolometer has time to return to a stabilisation temperature before the sweep generates a second short duration bias pulse to each said microbolometer;
a temperature sensor, mounted on a surface of said thermoelectric temperature stabilizer (20) opposite to the bounded surface area, and in thermal proximity to said array (30) of infrared sensitive microbolometers, said temperature sensor being in electrical connection with a controller which regulates said temperature stabilizer (20) based on a signal received from said temperature sensor (22); and
a window for admitting some radiation to said infrared sensitive semiconductor device mounted to seal-in said thermoelectric temperature stabilizer (20), a temperature sensor (27), and said array (30) of infrared sensitive microbolometers, in the interior space definable by said surface, said window for admitting some radiation and said wall structure, wherein sensing material in the bolometers comprises Vanadium Oxide."

"11. A method of operating an infrared camera comprising bolometers, wherein a sensing material comprises Vanadium Oxide, the method comprising reading out changes in resistivity of passive radiation receiving units in an n by m array including:
exposing the radiation receiving surface to an irradiated scene desired to be observed, thus developing a change in resistivity of said receiving

units related to the amount of radiation received from said scene, and
sweeping the receiving units with a short duration pulse of bias current that heats the sensors and is of too large an amperage to allow said units to remain stable if said pulse were of a substantially longer duration, wherein said sweep is at such a rate that each said unit has time to return to a stabilisation temperature before the sweep generates a second short duration bias pulse to each said unit."

Claims 3 to 10 are dependent claims.

VII. In the appealed decision the opposition division held that the opposed patent disclosed the invention in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art having regard to the common general knowledge in the field of bolometers as reflected by D4 (Article 100(b) EPC), but that the subject-matter of granted independent claims 1, 2 and 11 lacked an inventive step, in particular considering a combination of the teachings of D1 and D4 for the broadest claim which was method claim 11 (as granted). The subject-matter of claim 1 as granted lacked an inventive step in view of D1, D2 and D4 because it was obvious to include features of temperature stabilisation, as disclosed in D2.

The opposition division had not admitted, in the oral proceedings, amended claims according to a first and a second auxiliary request. The reason given in the appealed decision for not admitting the second auxiliary request was that *prima facie* the amendments did not make the claimed subject-matter allowable

because the use of vanadium oxide as a semiconductor material for the bolometers represented the mere selection of a material which, without any indication of particular reasons or advantageous properties, had to be considered obvious.

VIII. The arguments of the appellant (proprietor) can be summarised as follows.

(a) D1 relates to a bolometer array of the same general type as the invention. It deals with the problem of the correction of non-uniformities of the individual bolometers and does not address the problem of temperature stabilisation depending on the duration and magnitude of the bias current pulses.

(b) D4 reflects principles of bolometer design specific to superconducting infrared bolometric detectors and its teaching is not generally applicable, irrespective of material and temperature. Also, D4 expressly states on page 127 that the high resistance of semiconductors makes them unattractive for microbolometers.

(c) In addition to its advantageously high thermal coefficient of resistance, vanadium oxide turned out to have an unexpectedly low 1/f noise, despite the application of a high bias current. Further advantages are its good optical properties in the infrared and the ease of application as a thin film coating on a substrate. The description of the opposed patent does not disclose a whole group of materials from which a person skilled in the

art may select to achieve these effects but only one semiconductor material which was found to be particularly suitable. The use of vanadium oxide therefore does not constitute an arbitrary selection.

IX. The arguments of the respondent (opponent) can be summarised as follows.

(a) D4 sets out general principles of bolometer design consisting in addressing the array elements with current pulses of appropriate duration and magnitude so as to find an optimum, taking into account the bolometer responsivity (which increases with the bias current) and the bolometer temperature (which rises with the current, but must be stabilised in order to limit the detector noise and prevent thermal runaway). The principles are applied to superconducting infrared bolometric detectors, but they are valid for the design of all types of bolometer arrays, including in particular state of the art semiconductor arrays.

(b) Since the patent in suit does not describe why the selection of vanadium oxide entails particular advantages or properties, the feature must be ignored altogether for assessing inventive step, or be regarded as arbitrary and fortuitous. Furthermore, if, as stated by the inventor, this particular material is the only one known to generate low noise with large bias currents, the lack of alternatives constitutes a typical one-way street situation. In all cases an inventive step must be denied.

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments*

Compared to the granted claims, each of the independent claims 1, 2 and 11 has been limited by defining the sensing material of the bolometers as comprising vanadium oxide. This feature was described as a preferred embodiment in the application as filed and in the patent specification (see paragraphs [0022] and [0028]). The amendments therefore comply with Article 123 (2) and (3) EPC.

3. *Sufficiency of disclosure (Article 100(b) EPC)*

The respondent did not contest the decision of the opposition division in this respect. The board concurs with the finding that the European patent discloses the present invention in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art.

4. *Novelty (Article 54 EPC)*

The novelty of the claimed subject-matter was not contested.

5. *Inventive step (Article 56 EPC)*

5.1 Independent claim 11

5.1.1 It is not contested that D1 discloses a two-dimensional (n by m) array of bolometers with resistive light-sensitive receiving units (11; Figure 1). The units are sequentially "swept" with a pulse of bias current, thereby heating them due to their resistive nature (D1, figure 1; column 2, lines 28 to 37 and column 3, lines 43 to 52).

D1 does not disclose operating an infrared camera, the pulse duration and sweep rate of the bias current and the sensing material of the bolometers. It proposes solutions to minimise the non-uniformities between the light-sensitive units (see, for instance, column 3, lines 34 to 43) but does not address the technical problem underlying the present invention, i.e. increasing the bolometer sensitivity whilst preserving a thermally stable operation (see paragraphs [0033] and [0037] of the patent specification).

5.1.2 D4 discloses an infrared camera comprising bolometers. D4 states in the paragraph bridging pages 127 and 128 that the responsivity of a bolometer increases with increasing bias current and draws the reader's attention to the fact that, during addressing pixels (receiving units) of low thermal mass, the short pulse of bias current (eg 8 μs) should not drive the pixel resistance out of the linear portion of the responsivity versus temperature curve (at or near the midpoint of superconducting transition; cf. D4, page 127 and figure 1). D4 therefore expressly identifies amplitude and duration as relevant parameters to be optimised for the bias current pulse. Equation (4) on page 128 mathematically expresses the

temperature rise during addressing of the pixels *inter alia* in terms of these two parameters and indicates that a higher amperage (I_{bias}) would call for a shorter pulse duration (Δt).

5.1.3 The board thus considers that a person skilled in the art would design the sweeping of the receiving units, in a bolometer array of the kind disclosed in D1 or D4, with a "short duration pulse of bias current". Since the successive individual addressing of the units of an array allows each unit to recover before it is addressed again, a person skilled in the art would consider increasing the pixel responsivity by increasing the pulse amplitude to values "of too large an amperage to allow said units to remain stable if said pulse were of a substantially longer duration". In order to avoid measurement errors when a pixel is addressed next time, each unit should be given time to return to a stabilisation temperature before the sweep generates a second pulse. Otherwise the temperature would gradually increase to levels leading to overheating.

5.1.4 Claim 11 further defines that a sensing material (in the bolometers) comprises vanadium oxide.

The description mentions this material as the one which is used in the "most desired embodiment" (paragraph [0022]) or as the material (a semiconductor) which is currently preferred (paragraph [0028]). The patent specification mentions advantages of the preferred embodiment resulting from the addressing scheme with pulse biased current, such as high sensitivity and working at ambient temperature ranges

(see paragraph [0029] to [0031] and figure 6), but it does not expressly disclose any specific advantage or property of the material as such, apart from a negative thermal coefficient of resistance (TCR) (see paragraph [0028]). Advantages were mentioned by the appellant and not contested by the respondent, most notably a high TCR and a good 1/f noise performance under high bias current.

5.1.5 D1 does not disclose a semiconductor sensing material and D4 primarily refers to superconducting materials which operate under special temperature conditions (transition temperature). Although it is not contested that semiconductor infrared bolometers operating roughly at room temperature have been put into practice in the prior art, none of the documents at hand even mentions vanadium oxide, let alone its use as an infrared-sensitive semiconductor material. An attempt to construct a one-way street situation leading inevitably to vanadium oxide is therefore based on hindsight.

Rather, the board is convinced that the vanadium oxide as a sensing material in the claimed combination, in particular with short duration pulses of bias current of a large amperage, contributes to the improved performance in operation of an infrared camera. In the judgment of the board, the choice of vanadium oxide as a sensing material therefore cannot be considered as an arbitrary selection from several known sensing materials (there is no evidence for such a known group including vanadium oxide). Nor can it be considered as an arbitrary selection of one particular material, among a group of sensing materials, which were

disclosed in the patent specification as having similar properties as other elements of the group (which other elements happened to be known in the prior art).

Likewise, the further document to which the appealed decision refers, D2, does not disclose specific sensing materials and was merely cited as prior art showing elements of the temperature stabilisation. D2 therefore cannot change the finding of the board that the method of claim 11, having regard to the state of the art, was not obvious to a person skilled in the art.

5.1.6 As a result, the subject-matter of claim 11 involves an inventive step (Article 56 EPC).

5.2 Independent claims 1 and 2

Claims 1 and 2 relate to infrared cameras with constituents embodying *inter alia* all the steps of method claim 11, and wherein the sensing material in the bolometers comprises vanadium oxide material. The board therefore arrives at the conclusion that the subject-matter of claims 1 and 2 shall be considered as involving an inventive step, for the same reasons.

5.3 The board is consequently of the opinion that, taking into consideration the amendments made by the proprietor of the patent during the opposition appeal proceedings, the patent and the invention to which it relates meet the requirements of the Convention (Article 102(3) EPC).

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 as amended in the following version filed in the oral proceedings of 4 October 2006:

   Description: columns 1 to 8;

   Claims: No. 1 to 11;

   Drawings: figures 1 to 6.

The Registrar The Chairman

D. Sauter F. Edlinger