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Datasheet for the decision of 24 February 2020

Case Number: T 1430/15 - 3.5.02

Application Number: 10700896.3

Publication Number: 2387822

IPC: H02N11/00

Language of the proceedings: EN

Title of invention:
Energy Transducer and Method

Applicant:
Pellegrini, Gerald N.

Relevant legal provisions:
EPC Art. 83, 123(2)

Keyword:
Main request - insufficient disclosure
Auxiliary request - added subject-matter

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Case Number: T 1430/15 - 3.5.02

D E C I S I O N
of Technical Board of Appeal 3.5.02
of 24 February 2020

Appellant: (Applicant)	Pellegrini, Gerald N. 37 Granby Road Worcester, MA 01604 (US)
Representative:	Rupprecht, Kay Meissner Bolte Patentanwälte Rechtsanwälte Partnerschaft mbB Widenmayerstraße 47 80538 München (DE)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 17 February 2015 refusing European patent application No. 10700896.3 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman	R. Lord
Members:	F. Giesen
	W. Ungler

Summary of Facts and Submissions

I. This appeal by the applicant lies from the decision of the Examining Division posted on 17 February 2015 refusing European patent application No. 10700896.3 pursuant to Article 97(2) EPC. The Examining Division had found the present application not to fulfil the requirements of Article 83 EPC.

II. The appellant has adduced documents D1, D2 and D4 to D12. In the light of the reasons for this decision it is only necessary to identify:

D2 Yoo, J.-H. et al., An examination of Galfenol mechanical-magnetic coupling coefficients, Smart Materials and Structures 20 (2011) 075008, doi: 10.1088/0964-1726/20/7/075008, published 7 June 2011.

III. Oral proceedings before the Board took place on 24 February 2020.

The appellant requested that the decision under appeal be set aside and a patent be granted on the basis of the main request filed with letter dated 12 June 2012, or if that was not possible that a patent be granted on the basis of the first auxiliary request filed with letter dated 23 January 2020. Furthermore, the appellant requested as a second auxiliary request that the main request and the first auxiliary request be reconsidered by the Board after abandonment of the priority claim.

IV. Claim 1 according to the **main request** reads as follows:

"An energy transducer for the generation of useful work comprising a selected material having internal energy and in which there is a cross coupling between an energy conjugate physical property of a variable primary force and an energy conjugate physical property of a variable secondary force, said cross coupling being characterized by cross coupling coefficients that are not equal under conditions when said transducer is in operation, and in which said internal energy is used as an energy source, said transducer being operable in a cycle and being operable without the need to raise the temperature of said material above ambient temperature, said material being under the influence of said variable primary force through which said useful work is generated, said material also being under the influence of said variable secondary force which controls said energy conjugate physical property of said variable primary force to predetermined values."

Claim 1 according to the first auxiliary request reads as follows:

"Energy transducer system comprising:
- Galfenol in which α, which is the strain/magnetic field coefficient at constant stress, and β, which is the magnetisation/stress coefficient at constant magnetic field, are not equal to each other,
- a mechanical system adapted to apply a sinusoidal mechanical stress to the Galfenol, and
- an electrical system adapted to apply a sinusoidal magnetic field offset by π/2 with respect to the sinusoidal mechanical stress to the Galfenol."

V. The appellant's arguments in so far as they are relevant for the present decision may be summarised as follows:

Main request

The application disclosed the invention in a manner sufficiently clear and complete for it to be carried out by a skilled person. The application provided a complete mathematical model which worked for all materials which had unequal cross coupling coefficients. The model started from valid equations, see D10 to D12. A skilled person was able to measure the cross coupling coefficients for a given material, see D1 and D13. Materials with unequal cross coupling coefficients were known, see D1, D2, D4, D5, D8 and D9.

There was experimental evidence for generation of excess energy per cycle as published in document D2. It was of no legal consequence that up to now there was no generally accepted explanation regarding the origin of this excess energy. It was only important that the effect was demonstrated to occur.

First auxiliary request

The amendments did not contravene Article 123(2) EPC. Figure 1 as originally filed showed a transducer as claimed according to claim 1 of the first auxiliary request but contained no disclosure of the generation of work by lowering the sample's internal energy. Claim 1 according to the first auxiliary request was limited to Galfenol having unequal cross coupling coefficients. As a consequence it was therefore still inherently limited to a suitability to generate work by lowering the internal energy.

Furthermore, claim 1 as originally filed contained only the requirement that the transducer was suitable for generating work and merely an explanation that this is done by lowering the internal energy. The suitability requirement and the offered explanation did not represent a structural limitation on the claimed transducer. Omitting them therefore did not add subject-matter which was not originally disclosed.

Reasons for the Decision

1. The appeal is admissible.

2. Main request

2.1 The patent application does not meet the requirements of Article 83 EPC because it does not disclose the invention in a manner sufficiently clear and complete for it to be carried out by a skilled person.

2.2 Claim 1 is directed to an energy transducer containing a material with unequal cross coupling coefficients between first and second forces and corresponding energy conjugate physical properties, such as for example strain and magnetisation, which is able to generate useful work by lowering the internal energy of the material. Since the claimed transducer is limited to exhibiting this effect, the disclosure has to enable a skilled person to achieve it in order to meet the requirements of Article 83 EPC.

2.3 The application discloses model calculations which predict that during a full cycle of two forces applied to the sample in sine and cosine form, respectively, net work should be performed by the transducer if the cross coupling coefficients are assumed to be different from each other. The amount of work generated only depends on the difference in cross coupling coefficients. Stated differently, more energy per cycle could be produced by such a system than was put into the system per cycle.

2.4 Correctness of the model predictions

2.4.1 The Board is not convinced that the model predictions concerning generation of work by lowering the internal energy are correct. The Board had informed the appellant in a communication pursuant to Article 15(1) RPBA in point 1.3 that they considered unequal cross coupling coefficients to be rather exceptional and that "it appears from the description and the underlying assumptions made for deriving the constitutive equations that the coupling constants would be equal by definition". The Board stated that the cross coupling coefficients were derived by twice partially differentiating the Gibbs free energy.

2.4.2 In response to this, the appellant has adduced documents D1 and D4 to D9 to present evidence for the existence of materials which have different cross coupling coefficients and for the assertion that a skilled person was able to verify whether a given material had unequal cross coupling coefficients. The appellant also directed the Board to documents D10 to D12 in order to demonstrate the fact that in scientific literature the constitutive equations used by him were

accepted to be valid under certain assumptions about the material and experimental conditions.

In view of this evidence, the Board accepts that materials with unequal cross coupling coefficients exist in nature and that a skilled person was able to measure whether these coefficients were different for a given material. The Board also accepts the correctness of the constitutive equations of the model used under the conditions under which they are derived in D10 to D12. For these reasons the aforementioned documents need not be identified in detail and their contents require no further discussion in this decision.

2.4.3 However, in attempting to address the Board's argument, the appellant fails to properly distinguish between whether materials with unequal cross coupling coefficients occur in nature and whether within the assumptions of the model calculations unequal cross coupling coefficients can be assumed without creating inherent contradictions. The appellant has not questioned the fact that the cross coupling coefficients were derived by twice partially differentiating a function (a thermodynamic potential, such as the Gibbs free energy) with respect to the same variables but in a different order. If the second partial derivatives of a function exist and are continuous, then the order of the differentiation can be shown to be irrelevant. Under these conditions the coefficients are equal by definition. The conditions apply to the appellant's model calculations because the appellant clearly treats the coefficients as constants in his calculation of the magnetic and mechanical energy because he takes them out from the respective integrals, see for example the equations on page 5, line 21 and page 6, line 7. If they are constant over

the integration path, it follows that the second partial derivatives exist and that they are continuous on any point over which the integration runs. Therefore, the appellant's assumption of unequal coupling coefficients is in contradiction with the constitutive equations on which the model calculation is based. Within the framework of the model the coupling coefficients are equal by definition. It is noted that when accepting this, the model predicts that exactly the same amounts of conjugate forms of energy are transduced, which is entirely in line with expectations based on classical thermodynamics.

The appellant has not further addressed this point in his letter of reply dated 23 January 2020 or in the oral proceedings. Hence, the Board has no reason to deviate from its preliminary view that cross coupling coefficients are equal by definition within the model. Hence, the model appears to contain an inherent contradiction and its predictions can thus not be assumed to correctly describe a real physical system. This is not to say, that no materials with unequal cross coupling coefficients exist, but merely that the equations used in the appellant's model cannot correctly describe such materials.

2.5 No disclosure concerning conversion of internal energy

2.5.1 The disclosure of the application is silent on any details of the conversion of internal energy to useful work. It merely stipulates this effect. The appellant's model takes into account only two energetic contributions, namely on the one hand the mechanical and and on the other hand the electric or magnetic energy of the sample in an external electric or magnetic field. However, it does not take into account

any details of the internal energy of the sample or any other mechanism allowing its conversion to work.

In these circumstances, the application could only be seen to contain an enabling disclosure if the generation of work by lowering the sample's internal energy was an inevitable consequence of applying forces to a material as prescribed by the claim. The application itself does not contain any experimental evidence in this respect.

2.5.2 The appellant has adduced document D2, which shows an experimental study of the transduction cycles on a Galfenol rod as support for the occurrence of this effect.

D2 uses a system which allows external stresses by a load frame and external magnetic fields by a magnetic field coil to be applied to a Galfenol sample such that the resulting magnetic induction B and strain ε can be controlled. Galfenol is an alloy of gallium and iron which exhibits magnetostriction and which, in previous research, had apparently been shown to have unequal cross coupling coefficients. Two closed cycles were measured around each of three different operating points, see page 5, right column middle paragraph. The mechanical and magnetic energy densities were calculated from the second of these cycles around operating points of (22.5 MPa, 0.32 T) and (22.5 MPa, 0.39 T). D2 reports that in two cases more mechanical energy is extracted from the sample than magnetic energy exerted on it, see page 7, left column, second paragraph.

The Board does not consider D2 sufficient evidence for the inevitable occurrence of the claimed effect because

D2 does, in fact, not report any changes in the samples internal energy. The experiment is not designed to measure changes in internal energy. The internal energy is not normally directly observable, instead the experiment would have to be designed so as to measure all exchange of energy of the sample with the surroundings to conclusively detect a change in the internal energy. However, no experimental precautions are disclosed to have been taken which would allow it to be verified whether a change of the internal energy of the Galfenol rod corresponding to the observed anomalous excess energy could be observed. In particular, the authors of D2 hypothesise in the last paragraph of D2 that thermal fluctuations in the sample might account for the findings. If this is experimentally not ruled out, then the conclusion that a reduction of internal energy of the sample is the source of the anomalous energy gain has not been experimentally demonstrated in D2.

It is important to note that the subject of discussion is whether the application as filed discloses the invention in a manner sufficiently clear and complete for a skilled person to carry it out, not whether the reported findings of D2 are correct or incorrect. The correctness of the observation of excess energy in D2 would still not support the conclusion that the internal energy of the Galfenol was the origin of this energy for the above reasons.

The appellant has argued that the sentence concerning temperature fluctuations was to be understood in context to mean that due to the application of stress and magnetic field it may be possible that the sample cools down and that the additional energy flows to the sample in the form of heat from the surroundings.

This argument is not suitable to demonstrate that the invention is sufficiently disclosed in the application as filed. Given the details of the disclosure of the present application, it would have had to be demonstrated that the claimed effect of lowering the internal energy was an inevitable consequence of applying forces to a sample in the manner prescribed by the claim. The fact that tentative explanations as to the origin of the observed anomalous excess energy are needed merely demonstrates that D2 does not contain any experimental proof of the internal energy being the origin of the excess energy.

2.6 To summarise, the Board is not convinced that the model predictions are correct, there is no disclosure in the application as filed concerning the transduction of internal energy to useful work, merely a hypothesis to this effect, and there is no experimental evidence that the transduction from internal energy, as hypothesised in the application as filed, will necessarily occur when the claim prescriptions regarding the application of forces and choice of material are followed.

2.7 For these reasons, the application in the version of the main request does not meet the requirements of Article 83 EPC.

3. First auxiliary request

3.1 Claim 1 according to the first auxiliary request was amended such that subject-matter was added which was not disclosed in the application as filed. The amendments therefore do not meet the requirements of Article 123(2) EPC.

3.2 The application as filed consistently discloses that the transducer produces useful work by lowering the internal energy of a material, see in particular page 2, lines 8 to 13 and lines 18 to 21, page 3, lines 15 to 19 and page 6, lines 10 to 16.

There are numerous other passages in connection with further embodiments where generation of work by reduction of the internal energy is disclosed.

3.3 The appellant argued that figure 1 as originally filed disclosed the transducer as now claimed, i.e. without the technical effect which the Board considered to contravene the requirements of Article 83 EPC.

The Board is however not convinced by this argument because figure 1 is a schematic drawing which can only be understood within the context of the written description. It cannot be seen to represent an isolated disclosure of its own of a transducer system as claimed in claim 1 according to the first auxiliary request. In particular claim 1 now mixes elements from this figure and the embodiment concerning calculations for the magnetostrictive case, which was only disclosed as producing work by lowering the internal energy, as shown by the passages cited above.

The appellant argued further that claim 1 according to auxiliary request 1 required Galfenol having different cross-coupling coefficients. The technical effect was therefore inherently still present in the claim despite the explicit wording expressing the effect having been deleted.

The Board does not find this argument persuasive. For it to be valid one would have to assume that the underlying model predictions are correct, which has not been conclusively demonstrated.

Furthermore, the appellant argued that the original claim had only expressed a suitability for generation of work and the reference to the internal energy was merely an explanation of the mechanism of generation of work. Hence the claim as originally filed had not been structurally restricted in that respect and the omission of these features did not create new subject-matter.

The Board does not agree. A transducer which can produce more energy than has been provided to it for transduction is clearly structurally different from a transducer which shows energy losses. Hence, the claimed suitability and the technical effect of loss of internal energy are structural limitations on the claimed subject-matter which have been removed in this request. Furthermore, no evidence was provided that the generation of work was possible under arbitrary experimental conditions such as any frequency of the driving fields or any amplitudes. The original independent claim being functionally restricted to a transducer generating work by lowering the materials internal energy, its subject-matter was also inherently limited to those experimental conditions for which the effect could actually be achieved. Removing the requirement of generation of work by lowering the internal energy of the material also removes any restrictions on experimental conditions. The appellant's argument therefore did not persuade the Board.

3.4 Therefore, the first auxiliary request was not allowable.

4. Second auxiliary request

The appellant requested as a second auxiliary request, that the main request and the first auxiliary request be reconsidered with the priority claim of the present application abandoned.

None of the conclusions of the Board depended on the validity or invalidity of the priority claims. Rather, in that discussion, it was assumed that the contents of all submitted documents had been available at the priority date. Hence, abandoning the priority claim would not change the above conclusions reached for the higher ranking requests.

5. In conclusion, none of the appellant's requests was allowable.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

U. Bultmann R. Lord

Decision electronically authenticated