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**Datasheet for the decision  
of 25 March 2019**

**Case Number:** T 0416/14 - 3.5.02

**Application Number:** 10171544.9

**Publication Number:** 2315227

**IPC:** H01H59/00

**Language of the proceedings:** EN

**Title of invention:**

Switch Structures

**Applicant:**

General Electric Company

**Relevant legal provisions:**

EPC Art. 83

**Keyword:**

Sufficiency of disclosure - (no)



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Case Number: T 0416/14 - 3.5.02

**D E C I S I O N**  
**of Technical Board of Appeal 3.5.02**  
**of 25 March 2019**

**Appellant:** General Electric Company  
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Schenectady, NY 12345 (US)

**Representative:** Openshaw & Co  
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**Decision under appeal:** **Decision of the Examining Division of the  
European Patent Office posted on 6 September  
2013 refusing European patent application No.  
10171544.9 pursuant to Article 97(2) EPC.**

**Composition of the Board:**

**Chairman** R. Lord  
**Members:** F. Giesen  
R. Cramer

## Summary of Facts and Submissions

- I. The present appeal by the applicant is directed against the decision of the Examining Division to refuse the European patent application No. 10171544.9.
- II. Concerning the reasons for refusal the decision made reference to official communications dated 12 November 2010, 5 March 2012 and 5 December 2012, in which the Examining Division *inter alia* held the invention not to be sufficiently disclosed to be carried out.
- III. In an annex to the summons to oral proceedings pursuant to Article 15(1) of the Rules of Procedure of the Boards of Appeal, the Board informed the appellant of its preliminary opinion that the invention was not sufficiently disclosed to be carried out. In support of this finding it introduced the following two documents:
- D1: Peschot, A. et al., "*Deviations from the Paschen's law at short gap distances from 100 nm to 10  $\mu$ m in air and nitrogen*", Applied Physics Letters 105, 123109 (2014); doi: 10.1063/1.4895630
- D2: Wallash, A. and Levit, L., "Electrical breakdown and ESD phenomena for devices with nanometer-to-micron gaps", Proc. SPIE 4980, Reliability, Testing, and Characterization of MEMS/MOEMS II, (16 January 2003); doi: 10.1117/12.478191
- IV. Oral proceedings were held before the Board on 25 March 2019. The appellant (applicant) requested that the decision under appeal be set aside and that a patent be granted on the basis of the claims of the

main request filed on 6 July 2012, or on the basis of the claims of the first or second auxiliary request filed with the statement of grounds of appeal, or on the basis of the claims of the third auxiliary request filed with the letter of 22 February 2019.

V. Claim 1 of the **main request** reads as follows

*"A micro-electromechanical systems (MEMS) device comprising:*

*at least one switch having a contact (102), and a conductive element (104);*

*wherein said conductive element (104) comprises a cantilevered beam opposing said contact (102), said cantilevered beam configured to be selectively moveable [sic] between a non-contacting position in which said conductive element (104) is separated from said contact (102) and a contacting position in which said conductive element (104) contacts and establishes electrical communication with said contact (102), wherein:*

*said conductive element (104) and said contact (102) are configured to have an overlap area (A) defining an area (a) of contact surface (114) of said contact (102) of less than or equal to about  $100 \mu\text{m}^2$ , such that when said conductive element is disposed in the non-contacting position, said contact (102) and said conductive element (104) are configured to support an electric field therebetween with a magnitude of greater than  $320 \text{ V}\mu\text{m}^{-1}$  without moving to the contacting position."*

Claim 1 according to the **first auxiliary request** has the features of claim 1 of the main request and the additional feature

*"wherein, when said conductive element (104) is disposed in the non-contacting position, said contact and said conductive element are configured to be separated by a distance that is less than or about equal to 4  $\mu\text{m}$ ."*

at the end of the claim.

Claim 1 according to the **second auxiliary request** has the same wording as claim 1 of the first auxiliary request except in that "4  $\mu\text{m}$ " is replaced by "1  $\mu\text{m}$ ".

Claim 1 according to the **third auxiliary request** has the same wording as claim 1 of the second auxiliary request, except that "about 100  $\mu\text{m}^2$ " is replaced by "100  $\mu\text{m}^2$ " and in that "a distance that is less than or about equal to 1  $\mu\text{m}$ " is replaced by "a distance in the range of 50 nm to 4  $\mu\text{m}$ ."

VI. The appellant's lines of argument can be summarised as follows:

The invention was sufficiently disclosed to be carried out. The disclosure explained that if the gap between contact and cantilevered beam was sufficiently small there were on average only a few molecules of air. Because the contact spacing was smaller than the mean free path of the gas molecules, the ionisation potential for electrical breakdown increased and breakdown surprisingly did not occur. Auxiliary requests 1 and 2 were even restricted to the required gap distances.

The appeal proceedings had, anyway, focused on the question whether or not an electrical field of greater than  $320 \text{ V}\mu\text{m}^{-1}$  between the contact and conductive element can be supported without breakdown or electrical arc formation. This issue was in fact not relevant for the requirements of Article 83 EPC, since the claim was only directed to the fact that the contact and conductive element are configured to support an electrical field therebetween of greater than  $320 \text{ V}\mu\text{m}^{-1}$  without moving to the contacting position. That is, the claim was not directed to a switch that supported the recited electrical field without forming an arc but only to a switch which supported the recited electrical field strength without being closed by it. The skilled person is, however, capable of applying the recited electrical field and was, furthermore, given extensive information in the description on how to dimension the cantilever such that it resisted being pulled into the contact position at the recited electrical field strength.

Documents D1 and D2 being post-published showed that the present invention was in a still active research field, which has to date not provided a clear understanding of the underlying breakdown mechanisms. The inventors found some devices within the claimed range to work while others might not. There was therefore no other way of claiming the invention than by its result without having to specify a plethora of details. The fact that working devices could actually be built was very surprising. The inventors considerably narrowed the parameter space in which one had to search for working embodiments. Competitors should not be allowed to simply exploit this useful information provided by the application. The fact that

the result the inventors found was very surprising should also mean that the level of information needed for a sufficient disclosure should be lower. If devices as claimed could truly not be fabricated, then nobody could infringe a patent granted on it, and granting it would not be a problem for anyone.

### **Reasons for the Decision**

1. The appeal is admissible.
2. *Sufficiency of disclosure (Article 83 EPC) - all request*
  - 2.1 The invention was not sufficiently disclosed in the original application documents to be carried out.

Claim 1 according to all requests is directed to a MEMS switch with a "*contact (102) and a conductive element (104) which are configured to support an electric field therebetween with a magnitude of greater than  $320 \text{ V}\mu\text{m}^{-1}$  without moving to the contacting position.*"

The entire original application suggests that the inventors have, by suitably dimensioning the MEMS switch parts, found a way to avoid breakdown at and above the recited field strength, see in particular page 2, lines 37 to 39 and lines 48 to 52 and page 4, line 45 to page 5, line 10 of the A1-publication. The theory that is proposed by the appellant in the application, see page 4, line 45 to page 5, line 10, and in the appeal grounds is in fact a recital of the well known theory underlying the Paschen curve which

predicts breakdown behaviour in gaps on the order of micrometres. Paschen predicted that because the mean free path is shorter than the gap, the breakdown electrical field strength should show a minimum at a certain gap width of about 5 micrometres at atmospheric pressure and then increase as the gap gets smaller.

The documents D1 and D2 present experimental data of the behaviour of breakdown at gap widths and contact dimensions in the range claimed. The fact that these documents were not published until after the filing date of the present application is not prejudicial to their nature as evidence of physical phenomena, which occur independently of any publication date. The result of these experimental data is that the Paschen theory incorrectly predicts breakdown behaviour at gap widths below the Paschen minimum, i.e. in the range of 0 to about 5 micrometres, because it does not take all relevant breakdown mechanisms into account, see for example D1, Figures 4, 5 and 6 or D2, Figures 1 and 2. Rather than the predicted increase, the breakdown electrical field strength decreases to zero as the gap decreases to zero.

- 2.2 The application documents contain neither experimental data which allowed to verify the claims made, nor did the appellant submit any such data as evidence. The appellant is correct in that Article 83 EPC does not per se require experimental data for a sufficient disclosure. In light of the evidence to the contrary, the Board is, however, not convinced that the appellants were actually able to fabricate a switch that can withstand the claimed field strength without breakdown without any evidence for such claim.



2.3 The appellant withdrew from the clear statements in the application as filed to the argument that the claims were actually not directed to a switch that was configured to be able to withstand the claimed field strength without breakdown. All that was claimed was that the contact and conductive element were configured to support the claimed electrical field strength without moving to the contacting position.

2.4 In the opinion of the Board the expression "support an electric field" means not having electrical breakdown or electric arc formation, because if such breakdown does occur, any attempt to maintain an electric field of such a magnitude would very rapidly lead to destruction of the device. Rather, the feature clearly states two requirements: (i) the contact and conductive element do support the claimed field strength, i.e. not forming an arc, and, additionally, (ii) while said field strength is applied, the conductive element does not move to the closed contact position. If breakdown occurs, the electrical field strength is not supported but drops instantly. Therefore, meeting the first requirement of the claim feature still requires an enabling disclosure regardless of there being a further requirement formulated in the claim.

The appellant's argument is therefore not convincing.

2.5 The further arguments of the appellant also did not convince the Board. While there might not be a complete understanding of when breakdown occurs, this would mean that it is all the more important to include in the original application a detailed description of at least one working embodiment. The level of disclosure needed if the results found by inventors go against a common understanding is significantly higher than in a field

which is already well understood. If the claim is directed to a result, as in the present case, then the disclosure of at least one embodiment successfully realising the result is needed. The mere mentioning of factors which should be taken into account when attempting to find a working embodiment, such as the surface asperities referred to by the appellant, cannot be considered to be adequate in this respect. If, as in the present case, the claims are directed to a broad, open-ended range of parameters, even more embodiments might be necessary in order to sufficiently disclose the invention across the whole range claimed. The argument that a patent on an invention which cannot be carried out would be of no harm, can also not be accepted. Article 83 EPC is a requirement of the Convention that has to be fulfilled, irrespective of what potential effects on competitors a patent might or might not have.

2.6 In conclusion, the application does not disclose the claimed invention in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art. This applies to all requests, which thus do not meet the requirement of Article 83 EPC. Therefore none of the appellant's requests is allowable, so that the appeal has to be dismissed.

**Order**

**For these reasons it is decided that:**

The appeal is dismissed.

The Registrar:

The Chairman:



G. Rauh

R. Lord

Decision electronically authenticated