

**Internal distribution code:**

- (A)  Publication in OJ  
(B)  To Chairmen and Members  
(C)  To Chairmen  
(D)  No distribution

**D E C I S I O N**  
**of 9 April 2002**

**Case Number:** T 0098/97 - 3.4.3

**Application Number:** 93105827.5

**Publication Number:** 0569708

**IPC:** H01L 21/00

**Language of the proceedings:** EN

**Title of invention:**

Apparatus to clean solid surfaces using a cryogenic aerosol

**Applicant:**

AIR PRODUCTS AND CHEMICALS, INC., et al

**Opponent:**

-

**Headword:**

-

**Relevant legal provisions:**

EPC Art. 123(2), 84, 56

**Keyword:**

"Inventive step - yes, after amendment"

**Decisions cited:**

-

**Catchword:**

-



**Europäisches  
Patentamt**

**European  
Patent Office**

**Office européen  
des brevets**

Beschwerdekammern

Boards of Appeal

Chambres de recours

**Case Number:** T 0098/97 - 3.4.3

**D E C I S I O N**  
**of the Technical Board of Appeal 3.4.3**  
**of 9 April 2002**

**Appellant:** AIR PRODUCTS AND CHEMICALS, INC.  
7201 Hamilton Boulevard  
Allentown, PA 18195-1501 (US)

**Representative:** Marx, Lothar, Dr.  
Patentanwälte Schwabe, Sandmair, Marx  
Stuntzstraße 16  
D-81677 München (DE)

**Decision under appeal:** Decision of the Examining Division of the  
European Patent Office posted 14 August 1996  
refusing European patent application  
No. 93 105 827.5 pursuant to Article 97(1) EPC.

**Composition of the Board:**

**Chairman:** R. K. Shukla  
**Members:** E. Wolff  
M. J. Vogel

## Summary of Facts and Submissions

I. This is an appeal from the decision of the Examining Division refusing European patent application No. 93 105 827.5 on the ground that the invention as claimed in claim 1 did not involve an inventive step. The decision of the Examining Division was based on the following prior art documents

D1: EP-A-0 461 476

D2: EP-A-0 228 939

D3: US-A-4 962 891

D4: US-A-4 974 375

D5: DE-A-4 104 543.

II. The decision of the Examining Division was dispatched on 14 August 1996. A notice of appeal was filed on 2 October 1996 and the appeal fee was paid on the same day. The statement setting out the grounds of appeal was furnished on 6 December 1996.

Oral proceedings took place on 9 April 2002. At the oral proceedings, the appellant replaced the previous main request filed with the statement of the grounds of appeal by a new request as follows:

**Claims:** 1 to 15;

**description:** pages 1 to 22;

**drawings:** 4 Sheets, Figures 1 to 4.

Claim 1 of the request reads as follows:

"1. An apparatus (10) for cleaning undesired material from a solid surface using a projected spray of discrete substantially frozen cleaning particles which can vaporize after impingement on the solid surface, comprising:

- a) a generally closed housing (20, 24 - 28) in which a solid surface to be cleaned is accommodated and having entry means (30) for introducing a solid surface into said housing (20, 24 - 28);
- b) a nozzle (18) situated in said housing (20, 24 - 28) so as to project a spray of discrete substantially frozen cleaning particles at said solid surface to be cleaned;
- c) mean (54, 14) for supplying a fluid cleaning medium to said nozzle (18) for generation of substantially frozen cleaning particles;
- d) means (52) for removal from said housing (20, 24 - 28) of said undesired material cleaned from said solid surface;

characterized by

- e) said housing comprising a first chamber (12) and a second chamber;
- f) movable support means (32, 44) in said second chamber for supporting said solid surface to be

cleaned and having means (38, 40) to controllably move said solid surface from said entry means (30) to a position juxtaposed to said projected spray of said nozzle (18); and by

- g) means (50) for supplying a flush gas to said second chamber to control the atmosphere in said second chamber and to assist the removal of said undesired material cleaned from said solid surface, wherein
- h) said housing (20, 24 - 28) has said first chamber (12) accommodating said nozzle (18) with an opening juxtaposed to said second chamber accommodating said support means, and
- i) said first chamber accommodating said nozzle (18) includes flow baffles (34, 36) at said opening for controlling said spray of said cleaning particles and for isolating currents in said first chamber (12) from participating in the fluid dynamics of the second chamber."

III. The arguments presented by the appellant can be summarized as follows:

Document D1 discloses a new process for cleaning semiconductor surfaces. The object of the invention is to provide apparatus for carrying out the process disclosed in document D1.

The apparatus as claimed has the following features which distinguish it from cleaning apparatus disclosed in the prior art. Firstly and most importantly, the housing is divided into two chambers. One of these

chambers contains the nozzle, the other contains a transport mechanism for carrying the articles to be cleaned past the nozzle. The two chambers are separated by baffles which not only direct flow of the cleaning jet into the second chamber but also serve to isolate the environment of the nozzle from the currents in the the second chamber. This isolation is important since, on the one hand, the chamber containing the transport mechanism and the items to be cleaned requires to be flushed in order to carry away the contaminants removed from the surface by the spray. On the other hand, a still atmosphere is required for liquid argon to form the desired size of frozen particles. The cleaning particles need to pass through the flush gas to the surface to be cleaned including the boundary layer above the surface to be cleaned. This is best achieved if the flush gas flowing along the support means exhibits laminar flow. Placing the nozzle in a second chamber to enable the undisturbed formation of the cleaning particles, and controlling the flow of particles with the aid of the same baffles which isolate the nozzle chamber enables the particles stream to be optimally formed and directed for performing the cleaning action.

This arrangement is both new and inventive over the teaching in the prior art documents, none of which discloses the use of a two-chamber apparatus in the manner claimed.

Document D1 itself merely contains a schematic diagram which discloses nothing more than that an enclosure should be used for the item to be cleaned and the nozzle, and that the nozzle should be directed at an angle at the surface to be cleaned.

Document D2, which shows a conveyer belt to transport the items to be claimed past a nozzle, employs a single chamber. It also relates to the quite different technology of shot blasting moulded parts to remove burrs and fins.

Document D4 discloses apparatus for cleaning surfaces of, for example, semiconductor wafers with the aid of ice particles. According to document D4, a spray nozzle is located inside the cleaning chamber, itself, and the cleaning chamber is flushed with filtered air and also contains a motorized support for the surfaces to be moved relative to the nozzle.

Document D5 relates to cleaning surfaces by means of ice particles which are electrically charged and then accelerated and steered by means of electric fields.

Document D3 is merely concerned with nozzle configurations, not with the apparatus surrounding the nozzle.

The prior art therefore teaches the skilled person nothing more than that in various applications of cleaning with spray nozzles it is sufficient to place the nozzle into the same chamber as the object to be cleaned. No incentive is provided in any of the prior art documents to depart from this one-chamber arrangement.

The provision according to the invention of the second chamber with the baffle arrangement makes it possible to separate the area where the solid argon particles develop from the area where the flush gas stream is flowing. The baffles also result in a highly directed

stream of cleaning particles which readily penetrate the flush gas and boundary layer and thus offer improved cleaning efficiency despite the distance and fixed direction between the nozzle and the surface to be cleaned. The baffles separating the chambers also ensure that no contaminants enter the area where the solids particles of the cleaning spray are formed.

A further advantage of the present invention concerns the possibility of minimizing the dead space in the second chamber to make the flow of flush gas more efficient. Because of the small depth of the flush gas flow, the cleaning particles can penetrate more easily to the surface to be cleaned.

The synergetic effects which derive from the combination of the two chamber apparatus and the baffles separating the chambers could not have been foreseen on the basis of the prior art apparatus described in any of the cited documents.

## **Reasons for the Decision**

1. The appeal is admissible.
2. *Amendments*
  - 2.1 Claim 1 of the request differs from claim 1 as originally filed
    - (a) in that the claim now states that the housing is divided into a first and a second chamber (cf. feature (e)) and



(b) by the features set out in sub-paragraphs (h) and (i) of the claim. These features correspond to claims 5 and 6 as originally filed, except that paragraph (i) now additionally specifies that the flow baffles are "for isolating currents in said first chamber (12) from participating in the fluid dynamics of the second chamber".

2.2 Original claim 6 was dependent only upon claim 5 which itself was dependent only upon claim 1. Introducing features (h) and (i) as they correspond to original claims 5 and 6 therefore does not introduce any new subject-matter. The additional feature concerning isolation of the currents in the first chamber is based on lines 6 to 8 on page 13 of the description as originally filed.

2.3 Providing the housing with two chambers, of which one accommodates the nozzle (18) and the other the support means (32, 44), is based on the originally filed description with respect to Figures 1 and 2 of the drawings (eg page 12, lines 16 to 20).

2.4 The amendments to the description and drawings relate to acknowledgement of the cited prior art and removal from the description and drawings of any reference to Figures 5a and 5b of the application as originally filed for consistency with the subject-matter of claims 1. The remaining amendments to the description are merely of an editorial nature.

2.5 The amendments to the dependent claims consist of cancellation of originally filed claim 3, 5, 6, 10 and the original claim 10 relating to the deleted embodiment of Figures 5a and 5b. All other amendments

of the claims are editorial in nature to make the claims consistent with claim 1 of the request.

2.6 The Board is therefore satisfied that the application according to the request does not contain subject-matter extending beyond the contents of the application as filed and therefore complies with the requirements Article 123(2) EPC.

3. The Board is also satisfied that the claims meet the requirements of Article 84.

4. *Inventive step*

Document D1 describes a method of cleaning surfaces using a cryogenic aerosol in which a spray of discrete frozen particles is generated from a fluid cleaning medium supplied to the same nozzle which directs the spray onto the surface to be cleaned. The apparatus illustrated in Figure 1 comprises the features contained in the preamble of claim 1 of the request. Document D1 is therefore considered the closest prior art. The apparatus as claimed in claim 1 of the application in suit differs from the apparatus described in document D1 by the features specified in the characterising portion of the claim.

Starting from the apparatus disclosed in document D1, the problem to be solved is to provide an improved apparatus in which semiconductor surfaces and the like can reliably and uniformly be cleaned by the method which is described in document D1.

Compared to the apparatus disclosed in document D1, the

apparatus as claimed provides the division of the housing into a chamber which accommodates the nozzle and another chamber which accommodates the support means carrying the item to be cleaned. Moreover, the chamber containing the surface to be cleaned is flushed by a flush gas supplied into the first chamber which is separated from the other chamber by flow baffles which have the dual function of controlling the spray of cleaning particles and isolating the chamber in which the frozen particles are formed from the gas flow in the first chamber.

Document D4 describes a cleaning device in which a jet of ice particles of ultra pure water is employed to remove contaminants from a surface such as semiconductor wafer. The apparatus disclosed in document D4 performs the cleaning operation in a cleaning housing (5) flushed with filtered air as a flush gas, and further contains a motorised mount (7) which moves the surface to be cleaned relative to the spray nozzle 8. The frozen particles are formed in separate frozen particle generating means 3 (Figure 1 and column 4 line 50ff) and are then fed from outside the housing (5) to the nozzle (8) where there are mixed with pressurized gas and directed on to the surface to be cleaned.

Similarly, in document D5 the frozen particles are formed in spray nozzles (3) stored and only then supplied to the cleaning chamber (30), where they are electrically charged, accelerated and steered by electric fields to direct the spray onto the surface to be cleaned.

In contrast, according to the present invention and

document D1, the particles are generated by the nozzle from a fluid supply to the nozzle (claim 1 sub-paragraph (c) and document D1, column 9, lines 4 to 6 and column 10, lines 2 to 15.

The apparatus in D2 is concerned with mechanically deburring moulded parts. Shot or other particles are supplied to a hopper (13) from where they are supplied to a mixing chamber (15) to be mixed with a carrier gas to be directed by the nozzles (18) at the surfaces to be treated.

Document D3 concerns the design of a nozzle for use in an apparatus which removes minute particles from a substrate by means of a stream of solid particles in gaseous carbon dioxide, without providing any detail of the apparatus in which the nozzle is to be used.

None of the cited documents points the skilled person towards considering a two-chamber housing, nor is there any indication in the prior art of flow baffles which have the claimed dual function. The Board also accepts the appellant's argument that locating the nozzle in a separate chamber shielded from the fluid dynamics of the flushing gas leads to improved formation and control of the frozen cleaning particles.

For the reason set out, in the judgement of the Board the invention as claimed involves an inventive step in accordance with Article 56 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 grant the patent on the basis of the following documents:

**claims:** 1 to 15;

**description:** pages 1 to 22;

**drawings:** 4 sheets, Figures 1 to 4 all documents filed during the oral proceedings.

The Registrar:

The Chairman

D. Spigarelli

R. K. Shukla