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D E C I S I O N
of 27 November 2001

Case Number: T 0032/99 - 3.2.3
Application Number: 90108067.1
Publication Number: 0395087
IPC: B24D 3/14, B24D 3/28

Language of the proceedings: EN

Title of invention:
Bonded abrasive products

Patentee:
NORTON COMPANY

Opponent:
Minnesota Mining & Manufacturing Company

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step - (yes), after amendment (auxiliary request)

Decisions cited:
G 0010/91; T 0711/90; T 0759/91

Catchword:
-



Case Number: T 0032/99 - 3.2.3

D E C I S I O N
of the Technical Board of Appeal 3.2.3
of 27 November 2001

Appellant: NORTON COMPANY
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Decision under appeal: Decision of the Opposition Division of the
European Patent Office posted 29 October 1998
revoking European patent No. 0 395 087 pursuant
to Article 102(1) EPC.

Composition of the Board:

Chairman: C. T. Wilson
Members: U. Krause
J. P. B. Seitz

Summary of Facts and Submissions

- I. The Appeal contests the decision of the Opposition Division, dated 21 October 1998 and issued in writing on 29 October 1998, to revoke European patent No. 0 395 087 for lack of inventive step.
- II. The Appellant (Proprietor) filed the notice of appeal on 5 January 1999 and paid the appeal fee on the same day. The statement of the grounds of appeal was submitted on 5 March 1999 and accompanied by a declaration of Mr Ralph Bauer.

In response to a communication of the Board issued as an annex to the summons to attend oral proceedings, the Appellant submitted amended claims according to a main request and three auxiliary requests, an amended page 3 of the description and a declaration of Mr Arup Khaund.

During Oral proceedings held on 27 November 2001 the Appellant amended the main and first auxiliary requests and withdrew the other auxiliary requests, the amended first auxiliary request being the only auxiliary request. He also submitted amended description pages 3, 5 to 10, 12, 13 and 16 to 18.

- III. Concerning the issue of inventive step the following documents were considered in the proceedings as particularly important:

D1: US-A-4 623 364

D2: EP-A-0 168 606

D4: US-A-4 786 292

D5: US-A-3 387 957

D9: EP-A-0 291 029

D13: US-A-3 481 723

D14: US-A-3 183 071

IV. The claims of the main request comprise an independent claim 1 and dependent claims 2 to 11. Independent claim 1 has the following wording:

"1. A bonded abrasive product comprised of a sintered sol gel alumina based filament shaped abrasive and a bond therefor, wherein said filament shaped abrasive is a seeded sol gel filament shaped abrasive which has a substantially uniform cross-section, an average aspect ratio of at least 1.5, a hardness of at least 16 GPa, is consisting of sintered alpha alumina crystals having a size of less than 1 um and has a cross-section of below 0.5 mm."

The independent claim 1 of the auxiliary request is restricted to an aspect ratio of at least 2 and includes the additional feature that the filament shaped alumina based abrasive is curved and/or twisted in its longer dimension.

V. The Appellant requests that the decision under appeal be set aside and the patent be maintained on the basis of either claim 1 of his main request filed with letter dated 26 October 2001 or his auxiliary request filed during the oral proceedings of 27 November 2001.

The Respondent requests that the appeal be dismissed.

VI. In support of his request the Appellant submits essentially the following arguments:

D1 was the closest prior art because it also related to precision grinding. However, it lacked any disclosure of bonded abrasive products comprising filament-shaped abrasives because the abrasive particles of all examples were produced by crushing dried sol-gel material into pieces, and the alternative method is described in column 2, lines 62 to 66, to finally produce "appropriately sized pieces" as also obtained by crushing a dried gel, whereby the extruded rods obviously formed an intermediate product only. Thus, the subject-matter of claim 1 was distinguished from the abrasive product disclosed in D1 in that the abrasive grains are filament shaped, the filaments have a substantially uniform cross-section of below 0.5 mm and an aspect ratio of at least 1.5. As a result, the grinding performance or efficiency was considerably enhanced. Although mentioning filament-shaped grains, D5 could not suggest using filaments in D1 for this purpose for several reasons. First, it was an old document which never entered into practice, and more recent documents such as D4 and D9 did not teach a superiority of filament-shaped abrasives over crushed shapes in grinding performance. In fact, it was evident from a comparison of the examples described in D4 that the crystal size, rather than the shape of the grits, was crucial for the grinding performance, and in D9 the improvement was to be attributed to the addition of zirconia. Second, such a superiority was not even supported by the test data presented in D5 which, instead, pointed at the crucial importance of other factors such as grain size with or without rounded edges. Third, D5 concerned heavy-duty grinding

(snagging) wheels, rather than precision grinding wheels as in D1 and in the patent, and any conclusions drawn for such snagging wheels could not be applied to precision grinding wheels. Fourth, the fine grit sizes of 36 grit and smaller, as referred to in D5, were not intended for bonded abrasives and merely speculative because, as pointed out in the Declaration of Mr Khaund, the excessive pressures required would prevent using an extrusion process for fabrication of the grits. Fifth, a teaching concerning bauxite abrasives, as in D5, could not be directly transferred to the seeded sol gel abrasives of D1 because of the entirely different production process and behaviour during grinding. Further, according to the Declaration of Mr Bauer the process of cutting or breaking the extruded filaments, as described for example in D1, D2 and D9, was meant to produce irregular abrasive grits, rather than filament-shaped pieces. The thin fibers described in examples IV to VIII of D9 were not used in grinding wheels. Thus, the enhanced grinding performance obtained with the claimed abrasive product could not be expected in the light of the prior art.

The curved or twisted configuration of filaments having an aspect ratio of at least 2, as defined in the auxiliary request, would make the abrasive more difficult to be pulled out of its bond and make it easier to obtain a desired density in the grinding wheel. This configuration was not disclosed in any prior art referring to extrusion and would not be automatically obtained by extrusion of the abrasive material. A random occurrence of curved filaments would not anticipate this feature because claim 1 required that "the abrasive", ie all of the filaments, be curved and/or twisted.

VI. The counterarguments of the Respondent can be summarized as follows:

As to the description of the process of producing the grains by cutting, breaking or crushing the extruded rods into pieces, the language used in the patent was the same as that of D1, D2 and D9 and should therefore be understood in the same manner as defining the final pieces as shorter rod-shaped portions. An inventive step was lacking in view of D9, disclosing abrasive filaments comprising alumina and zirconia and having a slightly larger size than in the patent. Zirconia was not disclaimed in the patent and no particular effect of its omission was disclosed. The choice of an appropriate grit size for the intended use, for example in the case of precision grinding, was a matter of routine considerations and no particular effect of the smaller sizes could be derived from the patent. In D9, no problems were encountered when extruding rods having a diameter of 0.6 mm, and the description of the extrusion as "conventional" in the patent indicated that no technical problems would arise even with thin filaments. Further, the subject-matter of claim 1 was not inventive when starting from D1 as closest prior art which disclosed, in connection with abrasives, the alternative method of extruding and cutting or breaking the abrasive material, whereby rod-shaped pieces with an aspect ratio within the claimed range would be obtained. The application to grains of a size as small as 54 grit, as in example X of D1, would require filaments having a cross-section of below 0.5 mm. The extrusion method was known for producing efficient snagging wheels with rod-shaped abrasive grains from D4, D5 and D9, the grains having the typical aspect ratios defined in claim 1. The advantages, concerning a

better use of the abrasive by holding it more firmly in the bond and a greater wheel strength by the interlocking effect between the filaments and the bond, as described in D5, were related to the filament shape, rather than to the particular abrasive material, and therefore likewise valid for sintered sol gel alumina. A positive effect on the G-ratio and on the required specific power was also derivable from D5, see tables V and VI. Although it was an old document, the discussion of D5 in D9 demonstrated that it was not disregarded in the art. The skilled person would, in the light of the described advantages, prefer the alternative extrusion technique described in D1, or consider the extruded filament-shape described in D5 also in connection with more powerful abrasives, such as sol gel alumina described for example in D1, which were not yet available at the date of D5. It was evident from D5, column 4, lines 61 to 65, and D9, examples IV to VIII, that the extrusion technique could be applied to grain sizes below those used in snagging wheels. Moreover, the limit of 0.5 mm for the cross-section of the filaments was arbitrary as no particular effect of these smaller grain sizes was derivable from the patent.

The invention defined in claim 1 of the auxiliary request was unclear and suffered from a lack of disclosure because a rod having an aspect ratio of 2 could hardly be curved or twisted and the patent did not describe how this could be made. It was demonstrated by own experiments that extrusion would practically result in a curved shape of some of the filaments, in particular with higher aspect ratios. The desired effect of improved anchorage of the filaments in the bond was not surprising.

Reasons for the Decision

1. The appeal meets the requirements of Articles 106 to 108 EPC and of Rules 1(1) and 64 EPC and is, therefore, admissible.

2. *Main request*

2.1 Amendments

Claim 1 of the main request was not amended in the appeal proceedings and thus corresponds to claim 1 according to the decision under appeal. The support for any amendments made with regard to the granted wording was set out in the impugned decision, point 2 of the reasons, and it was stated that the amendments did not extend the scope of protection. No further comments are required because the Board fully agrees with these statements and there is no dispute on this issue.

However, the Board wishes to emphasize that the term "consisting of" used in claim 1 is, in agreement with the general practice of the Boards of Appeal (see for example unpublished decisions T 711/90 and T 759/91), understood in an exclusive manner whereby the claimed bonded abrasive product is limited to monocrystalline abrasive filaments or grains of alpha alumina crystals. This may include minor amounts of impurities, but excludes any additives or other crystals in the same filament. However, since the abrasive is a "seeded" sol gel, the alpha alumina crystals may be formed around a seed material which may be different. This is set out in more detail on page 3, lines 16 to 20 and 48 to 58, and page 4, lines 1 to 6 of the patent.

2.2 Novelty

A novelty objection based on D9 was not maintained by the Respondent. Indeed, this objection was unfounded because, as stated in the decision under appeal, the abrasive material in the filaments of D9 is a polycrystalline mixture of alumina and zirconia, whereas claim 1 requires monocrystalline alumina filaments. Further, the cross-section of the filaments of D9 used in bonded abrasive products such as grinding wheels is above 1.2 mm (Example 1), which is considerably above the upper limit of 0.5 mm defined in claim 1. The fiber bodies of examples IV to VIII of D9, having a cross-section of 0.6 mm, are not described in connection with, or for use in, bonded abrasive products.

Since there is no other novelty-destroying document in the proceedings, claim 1 can be considered to meet the requirement of novelty.

2.3 Inventive activity

- 2.3.1 The Board concurs with the decision under appeal and the Appellant in that document D1 is the closest prior art. In fact, this document concerns bonded abrasive products comprising abrasive grains of the same composition and size as those of claim 1, and intended for the same purpose of fine grinding applications, whereas the documents D5 and D9 which were also considered as suitable starting points by the Respondent refer to grains of different composition and size and intended for snagging purposes.

Example X of D1 describes a bonded abrasive product in

the form of a glass bonded grinding wheel comprising, in one embodiment, abrasive grains consisting of alpha alumina crystals with some impurities in amounts of less than 1%. The grains are of a 54 grit size, which corresponds to a grain diameter of about 0.3 mm to 0.35 mm. Concerning the production of the grains example X refers to example I which describes the steps of gelling a mixture of alumina and water, milling and drying the gelled sol mixture, crushing the dried gels to obtain particles of the desired grit size, prefiring the crushed particles at lower temperature and firing at higher temperatures to obtain sintered abrasive particles. As pointed out in column 2, lines 19 to 25, and column 5, lines 56 to 63, the milling introduces fine particulate matter acting as seeds in the crystallisation of the alpha alumina during the firing. The process is generally described to result in high purity alpha alumina crystals having a submicron size and a hardness greater than 18 GPa (see column 6, lines 48 to 52).

Instead of crushing the dried gel, an alternative method for producing the desired size of the abrasive particles by extrusion and subsequent cutting or breaking the formed rods into appropriately sized pieces is briefly mentioned in column 2, lines 62 to 66. The Appellant holds that the expression "appropriately sized pieces" was also used in connection with the crushing method and should therefore be understood in the same manner as defining irregularly shaped pieces, and that it was clear from the declaration of Mr Bauer that it was never intended to describe the production of rod-shaped pieces by a cutting or breaking method. The Board cannot accept this argument because cutting extruded rods, which is

one of the possibilities mentioned in D1, would apparently result in short rod-shaped pieces, rather than in an irregular shape, unless the cut pieces are later crushed, which is however not described. This is what a skilled reader is taught by the above mentioned passage in D1, irrespective of what the intention of the writer might have been. What counts is the objective information made available to the public by a document, whereas a considerable legal uncertainty would arise if an unknown subjective intention of the author were to be taken into account.

2.3.2 On the other hand, it can be accepted that the above alternative method of forming the abrasive pieces is described cursorily and differs from the method used in all the examples of D1. Thus, it is rather an indication or suggestion to consider this method than a clear teaching to obtain filament shaped abrasives with a certain aspect ratio, as defined in claim 1. A skilled person taking up this suggestion will therefore have to consult other documents in order to find out how this method can be applied in practice. An answer to this question is found in documents D4, D5 and D9 which all disclose cutting extruded rods of green abrasive material into short lengths having an aspect ratio of greater than 1, for example between 1.1 and 2 in D4, between 1.5 and 5 in D5 and between 1 and 10 in D9. The diameter of the extruded rods is related to the desired grit size, with diameters ranging from 0.0469" (1.2 mm) for 24 grit to 0.1250" (3.18 mm) for 8 grit in D5 and about 2.4 mm for grit 16 in examples I to III of D9 before firing. A skilled person applying this teaching to the abrasive product disclosed in D1 will choose extruded rods of a diameter corresponding to the desired grit size, for example about 0.35 mm for the

diameter after firing in the case of 54 grit in example X, and cut the rods into short lengths having an aspect ratio of between 1 and 10, thereby obtaining the filament shaped abrasives defined in claim 1. The teaching of any of the documents D4, D5 and D9 will therefore lead the skilled person directly to the subject-matter of claim 1.

2.3.3 The various arguments raised by the Appellant against obviousness are not convincing. D5 certainly is an old document which may never have gained practical importance. However, the fact that the extrusion technique of D5 is also described in recent documents such as D4 and D9 demonstrates that this method of producing abrasive grits remained relevant in the meantime. Whilst D5 clearly states in column 9, lines 21 to 25, that the grinding performance of grinding wheels containing abrasive grains having an aspect ratio of more than 1 is unexpectedly good, this may be valid only for the particular composition and size of the grain as described in D5 and other factors such as the crystal size investigated in D4 may be more important. However, at least some of the further advantages referred to in column 8, lines 49 to 59, of D5, for example better use of the abrasive due to the improved bond in the wheel and greater wheel strength due to the interlocking effect provided by the filaments, are unequivocally associated with the filament shape of the grains, rather than with the grain size and composition or crystal size, and can therefore reasonably be expected also for other grain sizes and compositions, in particular thinner filaments, than those used in the snagging wheels of D4, D5 and D9. The potential problems arising from an extrusion of the wet abrasive material of D5 through

the small die holes required for thin filaments, such as the excessive and detrimental amount of additives required, as described in the Declaration of Mr Khaund, would apparently be solved by the fact that the gelled extrudate of D1 has a lower viscosity than the extrudate of D5 comprising bauxite particles. This explains why the extrusion of filaments as thin as 0.6 mm for the final grain size of 0.38 mm in example III of the patent is described as "conventional".

2.3.4 As a consequence, the Board comes to the conclusion that the subject-matter of claim 1 of the main request is obvious and, therefore, lacks an inventive step. Thus, the main request cannot be allowed.

3. *Auxiliary request*

3.1 Claim 1 of the auxiliary request is restricted to an aspect ratio of at least 2, corresponding to the lower limit of the preferred range of the aspect ratio as defined on page 10, line 9 of the application as filed (page 5, line 11 of the patent). Apart from this difference the claim is a combination of claim 1 of the main request with granted claim 9 which corresponds to original claim 9. The dependent claims 2 to 10 correspond to granted claims 3, 5, 6 (the first part), 8, and 11 to 14. No objection under Articles 123(2) and (3) therefore arises.

3.2 As outlined on page 5, lines 17 to 21 of the patent, the curved and/or twisted configuration of the filaments, in combination with the higher aspect ratio, makes it more difficult to pull the abrasive grains out of their bond and makes it easier to obtain a desired

range of loose packed density in a grinding wheel. Whilst these benefits are evident, the measure itself does not appear to be obvious. In fact, the various documents referring to filament-shaped abrasive grains, the documents D4, D5 and D9 discussed above and the further documents D13 and D14, all show straight configurations. Even document D5 mentioning the improved bond of a filament-shaped grain in the grinding wheel does not disclose configurations other than the straight shape shown in Figures 2 to 4. Thus, there is no evidence that the measure of curving or twisting the filaments was ever considered for improving the bond of a filament shaped grain in the grinding wheel, although this problem was made public by D5 about 20 years before the priority date of the patent under appeal. Further, a curvature of the filaments would not be automatically or randomly obtained in the extrusion process because the filaments would normally be suitably supported or guided after extrusion and before and after cutting to preserve the straight configuration shown in the documents.

3.3 Thus, the Board comes to the conclusion that the invention as defined in claim 1 according to the auxiliary request involves an inventive step. This also applies to the dependent claims 2 to 10 which define further developments of the product defined in claim 1.

3.4 The further argument of the Respondent that it was unclear how a rod having an aspect ratio of 2 can be curved relates to a clarity issue which is not among the grounds for opposition as defined in Article 100 EPC. However, it may be taken into consideration as arising out of the incorporation of granted claim 9 into claim 1. As to the merits of this argument, it

should be borne in mind that the aspect ratio of 2 is a minimum value and claim 1 does not require a rod having this aspect ratio to be curved. Rather, it could also be twisted. Nevertheless, taking into account that the term "curved" is used to distinguish the filaments from those extending along a straight line, the Board is convinced that it is not a serious problem in practice to bend or twist even short filaments to such an extent that they can be distinguished from straight filaments.

The argument concerning a lack of disclosure as to how curved or twisted rods may be made relates to a fresh ground for opposition which cannot be introduced into the proceedings at the appeal stage without the consent of the patentee (G 10/91, OJ 1993, 420). Taking the comments of the Appellant on this issue as a tacit consent, however, the argument could be considered but it is likewise without merits because there are common ways of curving or twisting extruded filaments, for example by guiding the filaments along a curved path or using a twisted opening in an extrusion die for filaments of non-circular cross-section, and no detailed description is, therefore, required.

4. Concerning the amendments to the description the Respondent argued that the term "about" should be deleted at its second occurrence on page 3, line 13, as being unclear in combination with a range, and that example VI relating to a cut-off wheel, rather than to a precision grinding wheel, should be marked as not being part of the claimed invention. The Board cannot follow these arguments. In fact, a possible minor uncertainty introduced by the definition of the upper limit of the crystal size as being "about 0.4 μm ", which is also found in claim 3, can be accepted because

this feature is not essential for distinguishing the invention from the prior art, whereas the objections raised by the first instance against similar expressions was obviously based on novelty considerations (see point 5.2 of the annex to the summons to attend oral proceedings before the first instance, issued on 6 August 1997). As to example VI, the Board cannot see any reason why bonded abrasive products for fine grinding applications should be limited to surface grinding and exclude cut-off wheels for fine cutting operations having a fine grit size such as 50 grit and a wheel thickness of about 2 to 3 mm, as defined in example VI. The omission of the cut-off wheels in the examples given on page 5, lines 30 and 31 cannot form a basis for such an exclusion because this list, reciting products "such as grinding wheels, segments, and sharpening stones", is clearly non-exclusive.

5. In summary, the grounds for opposition do not prejudice maintenance of the patent on the basis of the auxiliary request.

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:

- Claims 1 to 10 of the first auxiliary request filed during the oral proceedings;
- Description pages 2,4,11,14,15 as granted and pages 3,5,6,7,8,9,10,12,13,16,17 and 18 as filed during the oral proceedings.

The Registrar:

The Chairman:

A.Counillon

C. T. wilson