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Beschwerdekammern | Boards of Appeal | Chambres de recours

T 128/82

Case Number: T 12 / 82

DECISION

of the Technical Board of Appeal 3.3.1

of 2 February 1984

Appellant: Sciaky Bros., Inc.
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USA

Representative: David Hartley
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Decision under appeal: Decision of Examining Division 017 of the European Patent Office dated 9 September 1981 refusing European patent application No 78 300 484.9 pursuant to Article 97(1) EPC

Composition of the Board:

Chairman: D. Cadman

Member: K. Jahn

Member: L. Gotti Porcinari

SUMMARY OF FACTS AND SUBMISSIONS

I. European Patent Application No. 78 300 484.9 filed on 11 October 1978 and published on 16 May 1979 under publication No. 0 001 889, claiming the priority of the US prior application of 17 October 1977, was refused by decision of the European Patent Office dated 9 September 1981 on the basis of 5 claims of which claim 1 has the following wording:

"A method of surface hardening metal by heating and subsequent rapid cooling wherein the heating is effected by generating a beam of electrons, directing and focusing the beam of electrons onto the surface of the workpiece, scanning the beam over the surface of the workpiece from one to the next of a predetermined pattern of spaced points of intended impingement of the beam such that the beam is directed to each point in turn for a predetermined length of time characterised in that the entire surface of the metal bounded by the said predetermined pattern of points, is brought to a temperature above the transformation temperature of the metal but below its melting point and is maintained at that temperature for a predetermined time, by repeatedly scanning the surface in accordance with the said predetermined scanning pattern."

II. The refusal was on the grounds that this method was obvious for the man skilled in the art from a combination of DE-B-2 013 674 and FR-A-2 173 303.

A method of surface hardening metal by heating and subsequent rapid cooling wherein the heating is effected by generating a beam of electrons, directing and focusing

the beam of electrons onto the surface of the workpiece, scanning the beam over the surface of the workpiece from one to the next of a predetermined pattern of spaced points of intended impingement of the beam such that the beam is directed to each point in turn for a predetermined length of time, so that the entire surface of the metal bounded by the said predetermined pattern of points is brought to a termperature above the transformation temperature of the metal but below its melting point, and is maintained at that temperature for a predetermined time, has been described in DE-B-2 013 674. The method according to claim 1 differs from this known method only in the sense that the surface is heated and maintained at the required temperature by repeatedly scanning the surface in accordance with the said predetermined scanning pattern.

FR-A-2 173 303 discloses a method of suface hardening metal by repeatedly scanning the surface with a predetermined scanning pattern until the desired hardening is obtained. The method according to this French specification differs from the method according to Claim 1 only in the sense that the points of impingement are remelted.

From the French document it is therefore obvious to the skilled man in the art that repetition of an electron beam pattern can be used to achieve the necessary temperature control for the desired hardening effect. In addition, only two methods of surface hardening with an electron beam are feasible, viz. the method by heating to a temperature above the transformation temperature but below the melting temperature of the metal and the method of remelting.

III. On 10 November 1981 the appellant lodged an appeal against the decision of 9 September 1981, with payment of the fee.

In the Statement of Grounds submitted on 7 January 1982 it was pointed out that document A (DE 2013674) discloses hardening a surface by heating and cooling minor zones in a stepwise fashion. It is essential to this process that each zone be treated independently and this preferably involves moving the beam from a one to another zone spaced from it so as to enable adequate removal of heat by conduction through the metal surrounding the said one zone. Zones immediately adjacent the said one zone are not heated until hardening of that zone is complete. With this process, repeated scanning is unnecessary: indeed it is entirely contrary to the teaching of this document. In contrast, the present invention requires scanning the beam over a pattern of spaced points until the entire surface bounded by the pattern reaches the desired temperature and has been maintained at that temperature for a predetermined time. This feature is not to be found in the cited prior art.

Document B (FR 2 173 303) discloses hardening surface elements which are separated to leave ductile regions in between. The surface elements may be arranged in groups, the groups being spaced over the surface of the component. Where the surface elements are somewhat larger than the beam diameter the beam may be moved continuously to sweep the area of an individual element. All of the surface elements are remelted and cooled by conduction of heat into the surrounding metal so producing a pattern of hardened elements separated by ductile regions. It may be that the entire surface is eventually

hardened by virtue of the consecutive treatment of minor zones which constitute the surface, in which case all of the minor zones will at some stage during the process have reached the desired temperature, but at no time is the entire surface at the desired temperature.

Moreover, the reimbursement of the appeal fee is asked for.

IV. In a series of communications the Board pointed out that it would appear obvious to the skilled person faced with the problem of improving the continuous quasi-simultaneous heat treatment according to DE-A-2 037 108 to propose an intermittent pulse like treatment in view of Document A and DE-A-2 209 148, the latter being an equivalent to Document B.

V. During oral proceedings held on 2 February 1984 at the appellant's request, the representatives reiterated their above arguments and considered the cited prior art as falling into three categories. Document B relates to a remelting process which produces a pattern of hardened elements separated by ductile zones. As an example of the second category, Document A aims to produce a patchwork of separately hardened minor zones. In DE-A-2 037-108 falling within the third category of hardening methods, the beam is caused to describe Lissajou patterns upon the work surface so raising the temperature to, and maintaining it at, the transformation temperature.

The present invention which may be assimilated to the conventional hardening process, modifies the last mentioned method by eliminating the over-heating conditions

which occur at the cross-overs. This is achieved by repeated scanning of an electron beam according to a pattern of points with a controlled dwell time of the beam at each point. Such treatment represents a radical shift against the teaching of the prior art. The fact that even Hiller, who is considered as pioneer in the field of electron beam applications, made no reference to the process as claimed is an indication that it cannot be obvious.

The appellant apparently requests that the decision refusing the European patent application be set aside and the patent be granted on the basis of Claim 1 according to the main request, in the alternative on the basis of the version of this claim according to the auxiliary request, both claims being submitted during oral proceedings.

The presently proposed claims are as follows:

Main request

"1. A method of surface hardening metal by heating a selected area of the surface to a temperature above the transformation temperature of the metal but below its melting point, maintaining the selected area of the surface at that temperature for a predetermined time and subsequent rapid cooling to below the transformation temperature, wherein heating is effected by generating a continuous beam of electrons, directing and focussing the beam of electrons onto the surface and causing the beam to move rapidly and repeatedly over the selected surface area until the said temperature has been reached and maintained for the said predetermined length of time

after which the beam is deenergised, characterised in that the surface of the selected area is brought to and maintained at a uniform temperature by rapidly and repeatedly moving the beam over the surface from one to the next of a predetermined pattern of points of intended impingement and such that the beam is directed to dwell at each point in turn for a predetermined length of time."

Auxiliary request

"1. A method of surface hardening metal by heating a selected area of the surface to a temperature above the transformation temperature of the metal but below its melting point, maintaining the selected area of the surface at that temperature for a predetermined time and subsequent rapid cooling to below the transformation temperature, wherein heating is effected by generating a continuous beam of electrons, directing and focussing the beam of electrons into the surface and causing the beam to move rapidly and repeatedly over the selected surface area until the said temperature has been reached and maintained for the said predetermined length of time after which the beam is de-energised, characterised in that the surface of the selected area is brought to and maintained at a uniform temperature by rapidly and repeatedly moving the beam over the surface from one to the next of a predetermined pattern of points of intended impingement and such that the beam is directed to dwell at each point in turn for a predetermined length of time, during which time the beam current remains substantially constant."

REASONS FOR THE DECISION

1 The appeal is in accordance with Articles 106-108 and Rule 64 EPC; it is therefore admissible.

2. The question as to whether or not Claim 1 according to the main request is admissible can be left in abeyance, since the appeal fails in this respect for other reasons.

3. The Board considers DE-A-2 037 108 as representing the closest prior art. This document discloses a method of surface hardening which requires relative movement of the surface and an electron beam (Claim 9) at a relatively high constant velocity (Claim 1) whereby the beam passes over each element of the selected surface more than once (Claim 2) and by virtue of the high velocity produces quasi-simultaneous treatment of all of the elements of that surface (cf. page 3 paragraph 1). It is claimed that in this manner a workpiece may be submitted to transformation heat-treatment without remelting (cf. page 6 paragraphs 1 and 2), in such a way that a throughout uniform hardening of the treated surface is achieved (cf. Claim 1 line 3 and pages 2 and 3, paragraph 2).

There are three possibilities of performing this method, either the workpiece or the beam or both are moved (cf. page 3 last paragraph to page 4 paragraph 2 and the paragraph bridging pages 6 and 7). At any rate the repeated treatment of the surface during a certain time (page 7 lines 6 to 8) implies that the selected surface is brought to and maintained at a predetermined length of time (cf. the pre-characterising part of Claim 1 in suit).

As the appellant correctly states, such a hardening method where the beam sweeps over the surface continuously implies a cross-over of the pattern, so subjecting the material there to a higher average energy input which, in turn, due to over-heating conditions, gives rise to a non-uniformity in the hardening effect, even melted spots in the overlapping areas. Moreover, satisfactory hardening results are only produced for parts which are flat and of uniform section and where the heat-treatment does not have to be carried out close to the edge of the part.

Thus, there was the twofold technical problem to overcome these drawbacks by proposing a method which avoids cross-overs and allows a controlled energy input irrespective of the complete part geometries (see also the present application page 9 lines 9 to 21).

In defining this problem the Board is in accordance with its own jurisprudence which stipulates that advantages which are effectively achieved beyond the closest prior art must be considered in the assessment of the technical problem (cf.T 20/81 Shell/Aryloxy benzaldehydes, OJ, EPO 1982, 217, 221 especially paragraphs 2 and 3, and T 24/81 "metal refining" OJ, EPO 1983, 133).

According to the application in suit this problem is solved according to Claim 1 of the main request by rapidly and repeatedly moving the beam over the surface from one to the next of a predetermined pattern of points of intended impingement and such that the beam is directed to dwell at each point in turn for a predetermined length of time.

4. The appellant claims that the wording of Claim 1 (according to the main request) excludes applying energy impulses, since the term "by generating a continuous beam of electrons, directing and focussing the beam onto and moving over the surface..." in its pre-characterising part indicates that the beam current never goes to zero, which is said to be a pre-requisite of an impulse. The Board acknowledges that the precharacterising part of a claim can introduce limitation to what is claimed. However, in the present case the terms "continuous" has no limiting character, it is rather superfluous, since a discontinuous, i.e. an interrupted, beam cannot move.

Moreover, the definition of impulse, or pulse which is more commonly used to distinguish from a mechanical impulse, is more general than alleged by the appellant. According to textbooks these terms are e.g. defined as electrical disturbances having a wave-form whose duration is short in relation to the time scale of interest, and whose initial and final values are the same (cf. International Electro-technical Vocabulary 2nd Ed., Group 55, Telegraphy and telephony, published by the Central Office of the IEC, Geneva, 1970 page 58). Similar definitions can be found in other text books (cf. International Electrotechnical Vocabulary Chapter 101, Mathematics, Geneva 1977 page 12; Communications Standard Dictionary, Martin H. Weik, D.S.C., Van Nostrand Reinhold Co. New York, Cincinnati, Toronto, London, Melbourne, pages 442, 730 and 731, and IEEE Standard Dictionary of Electrical and Electronics Terms 2nd Edition, An American Standard, Approved May 12, 1978 pages 320, 534). Such a definition implies that an impulse does not necessarily start from and end at zero-level.

In the absence of a limiting effect of the term "continuous" the method claimed according to the main request covers the possibility of applying the beam in the form of impulses.

However, even if one should follow the appellant's definition, Claim 1 comprises a method where a continuously generated electron beam of relatively low intensity is moved over the surface to be heat-treated in such a way that impulses are superimposed when the beam arrives at the desired spots of a predetermind pattern of points. This mode of performance is likewise considered by the Board as obvious, as set out below.

5. A teaching so defined cannot be gathered from any of the publications before the Board. Therefore, the application in suit is deemed to be novel.

It is therefore to be examined whether the subject matter of the application is obvious in relation to the prior art. To that end, one may begin with DE-B-2 013 674 which is concerned with a method of hardening selected areas of the surfaces of work parts. According to this method that area is subdivided into several segments which are successively treated with an electron beam at a velocity which allows a sufficient flowing away of the heat from the already treated segment before the adjacent segment is treated (see Claims 1 and 5). Immediately adjacent sub-areas are e.g. jumped over and are treated only after at least one treatment of a minor zone further away (cf. Claim 2). This method is said to result in uniform quench which is crucial for avoiding tensions or distortions relative to hardness (cf. column 2, penultimate paragraph, especially lines 34 to 62).

The electron beam can be moved over the surface in the form of impulses according to a grid pattern (Claims 6 and 9). It can be advantageous to apply in turn at least two energy impulses of a predetermined length of time to the segments of the surface (cf. column 4 lines 1 to 6). Further, the treatment can be carried out to achieve different depth of hardness at adjacent areas of the work piece (cf. column 3 lines 32-40). That result can e.g. be attained by the number of impulses (cf. column 4 lines 6 to 9).

6. The appellant considers this hardening method different in category from that as claimed and submits that the above DE-B must be construed as representing a method in which a patchwork of hardened areas is produced by single impingement of the beam at each segment.

The Board is aware that such a type of performance, although not literally described, is embraced by the teaching of the document. However, it is also clear that such a treatment is not the only way of carrying out the described process. The teaching to apply at least two energy impulses to the segments of the selected area may be construed as sweeping that area at least twice. The question of how to construe this document is, however, in the present case of no importance.

In any case, the above document teaches hardening of coherent surface areas in uniform or different depth by application of impulses of electron beam followed by self-quenching (see column 3 lines 32 to 40, column 3 line 60 to column 4 line 12, and column 1 line 11). The document gives no details of how to apply in practice the impulses or sub-impulses, since such practice is assumed to be known (cf. column 3 lines 45 to 51).

7. However, that practice can be gathered from DE-A-2 209 148 (equivalent of FR-A-2 173 303) which is concerned with the production of point-like or dash-like remelting islands and groups of islands (cf. pages 5 to 7, as originally numbered and figures 8 to 10). According to the described method the electron beam is submitted to a jumping motion of deflection so that the beam strikes each element of intended impingement during a short time. This treatment is periodically repeated until the desired effect is achieved at each element of the surface (cf. page 5 paragraph 4). Figure 8 demonstrates such a pattern of points which can be repeatedly scanned in any sequence whatsoever (cf. page 6 lines 1 to 9, 15 to 17 and 20 to 23). Normally, a group comprises a much higher number of points which are, in figure 8, reduced for sake of clarity (cf. page 6 lines 17 to 20). The beam jumps quickly from one to the next point so that the decrease of temperature at each point between two successive impingements can be kept within limits, such treatment resulting in a quasi-simultaneous energy input at all points of a group and hence a practically identical hardening result at each point at the same time (cf. page 6 lines 23 to 33).

According to that teaching the repeated scanning of a pattern, associated with a selected area of surface, with an electron beam results in a quasi simultaneous energy, i.e. heat, input, a result which can be alternatively achieved according to the method of DE-A-2 037 108 (cf. page 3 paragraph 1). Where the skilled man felt the method of DE-A-2 037 108 unsatisfactory, there was the alternative method of DE-A-2 209 148 at his disposal. Evidently this method offered as well, in the sense of the envisaged technical problem, a promising way to

eliminate the cross-overs disadvantageously felt in the continuous method of DE-A-2 037 108, by simply excluding these points from repeated scanning.

8. The relevance of the teaching according to DE-A-2 209 148 is not, as the appellant claims, impaired by the fact that this document is concerned with a remelting process instead of the trasformation hardening method without remelting, and which is to be judged here. Both methods differ only in degree, that is by energy input which, in the remelting process, makes the point of impingement melt in contrast to the transformation hardening process where this point is brought close to, but below, the melting point of the material. For this reason both methods are spoken of by an expert in the same breath (cf. Feinwerktechnik & Micronic 77, 1973, pages 98 to 106, particularly page 99 left-hand column paragraph 2, and page 101 left-hand column paragraphs 1, 4 and 6). Thus a teaching emanating from a remelting process about the expediency of energy input into a selected surface area can normally be applied to the transformation hardening method using the same thermal tool.

9. Moreover, the skilled person in search of an improved hardening method would not ignore this citation on the ground that it concerns the formation of remelted islands instead of coherent areas, since such change is merely a question of accumulation of points (see also DE-2 013 674).

10. Already the prospect, in itself, of avoiding cross-overs during the repeated scanning of the surface by means of electron beam offered the person skilled in the art sufficient incentive to propose this method for the solu-

tion of the existing two-fold problem. Moreover, it was evident that applying this method was in addition an answer to the secondary problem. The energy input into the work-part in form of impulses allows a precise dosage of energy by tuning the parameters of the beam (cf. DE-B-2 013 674 column 4 lines 38 to 40) at points where, according to the geometrical requirements of the workpiece, i.e. the intricate shape of the part, different amounts of energy are needed.

Notwithstanding the fact that the problem of different energy requirements with respect to the geometry of a work part was not mentioned in the citations, it is basic physical knowledge that the capacity of the envisaged surface element to retain heat depends, in addition to its heat capacity, on the size of the cross-section in contact therewith through which the heat may be conducted away. In case of an outside edge, the neighbouring material in contact is much more limited than with an inside edge which is thickly surrounded with heat conducting material.

11. The argument that the application in suit represents a radical shift against the prior art cannot be accepted. It was admitted by the representatives during oral proceedings that the mode of repeatedly scanning a selected area with pulses of an electron beam according to a predetermined pattern of points was well known (cf. DE-A-2 209 148). Applying that method is rather within the stream of the art than against it. It was evident that this pulse-like scanning, if performed according to a pattern of sufficient density, could be used in order to heat up coherent areas of the surface (cf. DE-B-2 013 674), since such treatment resulted in a quasi-simultaneous energy input at all points of impingement (cf. DE-A-2 209 148 Claim 8) alternatively achieved by the continuous method (cf. DE-A-2 037 108) from which the application starts. In taking advantage of such treatment the application in suit cannot be considered as representing a radical shift against the prior art. It rather describes nothing more than what a skilled man faced with the problem as defined, in effect, would have done without application of ingenuity.

12. Furthermore, the appellant advances the argument that Hiller, a recognised expert in the field of electron beam treatment, made no reference to the process as claimed. The fact that the author of a publication did not take up an earlier teaching in spite of the obvious advantage of such a combination may well be irrelevant to the assessment of the inventive step of such a combination at a later date. The development of a technique commonly proceeds in a series of short steps during the course of which the skilled man focuses his attention ever closer on questions which initially have been regarded as of lesser importance, and the fact that workers in a particular technical field had not earlier addressed themselves to solving a particular problem should not of itself be taken as a reliable indication that the solution eventually proposed was not obvious.

13. Furthermore, the appellant cited the subsequently-published article "The Electron Beam at work in Detroit" in the journal Iron Age, January 9, 1978, which is said to demonstrate the importance, the acclaim and the commercial success of the method according to the application in suit in that early stage. It can be gathered from this article that the Sciaky-process using the "dot

method" is superior to the "continuous method", since it eliminates cross-overs causing hot edges or even surface melting. Moreover, a much more uniform energy input can be achieved by placing and controlling the beam precisely. However, these are precisely the advantages which sprang to the mind of the man skilled in the art who addressed himself to the problem, as set out above.

In this respect the application thus contains nothing other than was to be expected. Further advantages cannot be seen. Particularly, the statement in the article that according to the Sciaky-process 74% of the energy supplied to the machine is put into the piece part offers no comparison with the "continuous sweep method".

14. In contrast to this, Claim 1 according to the auxiliary request has to be treated differently, since this claim is restricted with regard to the energy profile of the beam current during its dwell time at each point. It is now claimed that the beam current remains substantially constant in that time interval.

15. There can be no formal objection to the current version of this claim, since it is adequately supported by the specification as originally filed (cf. page 14 lines 1 to 18 in combination with figure 11). The term "substantially" is justified in view of the change of the beam current beam between the six blocks of points in figure 11 affecting the invariability of the beam current at points at both ends of each block.

16. The method as now claimed represents a particular form of energy profile at each point, resulting, according to the appellant, in an easier control of the energy quan-

tum. This is, at present, irrefutable with the documents before the Board. The Examining Division has not yet examined whether the hardening method as now claimed is patentable. Under these circumstances the Board deems it not timely to decide on this issue, but makes use of its power given by Article 111(1) EPC to remit the case to the first instance for further prosecution.

17. The appellant considers the refusal improper and asks for reimbursement of the appeal fee on the ground that the application was rejected on the basis of an objection not previously raised in prosecution. This reasoning supposes at a substantial procedural violation. However, this question only arises if the Board deems the appeal allowable. It is true that the decision of the Examining Division has to be set aside and the case to be remitted to the first instance for further examination on the basis of Claim 1 according to the essentially restricted auxiliary request. Nevertheless, it is clear from this decision that the appellant fails with his main request which, in effect, corresponds with the request underlying the decision impugned. Rule 67 EPC pre-supposes that the Board renders a decision in the appellant's favour. Whether this is the case can only be judged on the basis of the requests of the appellant on which the Examining Division had to decide. If the case is to be remitted as a consequence of restricted claims filed in course of the appeal there is no success as to the substance for the applicant and no reason for reimbursement of the appeal fee.

ORDER

It is decided that:

1. The decision of the Examining Divison of the European Patent Office dated 9 September 1981 is set aside.

2. The application is remitted to the first instance for further examination on the basis of Claim 1 according to the auxiliary request submitted by the appellant during the oral proceedings.

3. The appeal fails in respect of the main request concerning Claim 1 submitted by the appellant during the oral proceedings.

4. The request for the reimbursement of the appeal fee is rejected.

Registrar: Chairman: