Paper No. 23

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte JOSEPH F. KRANTZ

Appeal No. 1997-2242
Application No. 08/084,370

ON BRIEF

Before BARRETT, RUGGIERO, and LEVY, Administrative Patent Judges.

LEVY, Administrative Patent Judge.

DECISION ON APPEAL

This is a decision on appeal under 35 U.S.C. § 134 from the examiner's final rejection of claims 1-3, which are all of the claims pending in this application.

BACKGROUND

The appellant's invention relates to a method of reorganizing the data on a RAID-4 or RAID-5 array in the absence of a disk. An understanding of the invention can be

derived from a reading of exemplary claims 1 and 3, which are reproduced as follows:

> 1. In a storage system having n+1 disks arranged in a RAID array, a plurality of data blocks arranged into a plurality of data chunks, a plurality of parity blocks arranged into a plurality of parity chunks, each parity block associated with n data blocks in n data chunks, said data chunks and said parity chunks distributed over said n+1 disks, one of said parity chunks and all of said data chunks that are associated with said parity chunk forming a strip, a method of reorganizing said data chunks when one of said n+1 disks fails, comprising the steps of:
>
> detecting the failure of one of said n+1 disks;
>
> determining if said failed disk contains all parity chunks;
>
> if said failed disk contains all parity chunks, terminating said method;
>
> if said failed disk contains at least some data chunks, then for each strip containing a data chunk located on said failed disk, regenerating the data of said data chunk located on said failed disk and writing said regenerated data onto said parity chunk associated with said data chunk of said failed disk to form a fully folded array.

> 3. In a storage system having n active disks and one failed disk formerly organized into strips when said failed disk was active, a plurality of data blocks arranged into a plurality of data chunks,

said data chunks distributed over said n active disks and said n active disks arranged into a fully folded array, the failed disk having chunks, each of said chunks located on a different one of said strips, a method of restoring said fully folded array to a fully redundant condition comprising the steps of:

substituting a replacement disk for said failed disk;

determining, for each one of said strips, if said chunk of said failed disk originally contained only parity information or originally contained data;

if said failed disk chunk originally contained only parity information, then calculate said parity information from said data chunks originally associated with said parity information and write said parity information on a corresponding chunk of said replacement disk;

if said failed disk chunk originally contained data, then

determine which one of said n active disks originally contained a chunk of parity information;

read said data from said one of said n active disks;

write said data on said corresponding replacement disk chunk;

calculate new parity information for said strip; and

write said recalculated parity information to said one of said n active disks.

The prior art references of record relied upon by the examiner in rejecting the appealed claims are:

Ewert et al. (Ewert)	5,166,936	Nov. 24, 1992
Jones et al. (Jones)	5,313,626	May 17, 1994

Chen et al., "RAID: High Performance, Reliable Secondary Storage", ACM Computing Surveys, vol. 26, no. 2, June 1994.

Claims 1-3 stand rejected under 35 U.S.C. § 103 as being unpatentable over Jones in view of Ewert.

Rather than reiterate the conflicting viewpoints advanced by the examiner and the appellant regarding the above-noted rejections, we make reference to the examiner's answer (Paper No. 14, mailed January 21, 1997) and the final rejection (Paper No. 6, mailed April 7, 1995) for the examiner's complete reasoning in support of the rejections, and to the appellant's brief (Paper No. 15, filed January 22, 1996) and reply brief (Paper No. 17, filed March 24, 1997) for the appellant's arguments thereagainst. Only those arguments actually made by the appellant have been considered in this decision. Arguments which the appellant could have made but

chose not to make in the briefs have not been considered. See 37 CFR 1.192(a).

OPINION

In reaching our decision in this appeal, we have carefully considered the subject matter on appeal, the rejections advanced by the examiner, and the evidence of obviousness relied upon by the examiner as support for the rejections. We have, likewise, reviewed and taken into consideration, in reaching our decision, the appellant's arguments set forth in the briefs along with the examiner's rationale in support of the rejections and arguments in rebuttal set forth in the final rejection and the examiner's answer.

It is our view, after consideration of the record before us, that the evidence relied upon and the level of skill in the particular art would not have suggested to one of ordinary skill in the art the invention as set forth in claims 1-3. Accordingly, we reverse, essentially for the reasons set forth by the appellant.

In rejecting claims under 35 U.S.C. § 103, it is incumbent upon the examiner to establish a factual basis to support the legal conclusion of obviousness. See In re Fine, 837 F.2d 1071, 1073, 5 USPQ2d 1596, 1598 (Fed. Cir. 1988). In so doing, the examiner is expected to make the factual determinations set forth in Graham v. John Deere Co., 383 U.S. 1, 17, 148 USPQ 459, 467 (1966), and to provide a reason why one having ordinary skill in the pertinent art would have been led to modify the prior art or to combine prior art references to arrive at the claimed invention. Such reason must stem from some teaching, suggestion or implication in the prior art as a whole or knowledge generally available to one having ordinary skill in the art. Uniroyal, Inc. v. Rudkin-Wiley Corp., 837 F.2d 1044, 1051, 5 USPQ2d 1434, 1438 (Fed. Cir.), cert. denied, 488 U.S. 825 (1988); Ashland Oil, Inc. v. Delta Resins & Refractories, Inc., 776 F.2d 281, 293, 227 USPQ 657, 664 (Fed. Cir. 1985), cert. denied, 475 U.S. 1017 (1986); ACS Hosp. Sys., Inc. v. Montefiore Hosp., 732 F.2d 1572, 1577, 221 USPQ 929, 933 (Fed. Cir. 1984). These showings by the examiner are an essential part of complying with the burden of

presenting a prima facie case of obviousness. Note In re Oetiker, 977 F.2d 1443, 1445, 24 USPQ2d 1443, 1444 (Fed. Cir. 1992). If that burden is met, the burden then shifts to the applicant to overcome the prima facie case with argument and/or evidence. Obviousness is then determined on the basis of the evidence as a whole. See id.; In re Hedges, 783 F.2d 1038, 1039, 228 USPQ 685, 686 (Fed. Cir. 1986); In re Piasecki, 745 F.2d 1468, 1472, 223 USPQ 785, 788 (Fed. Cir. 1984); and In re Rinehart, 531 F.2d 1048, 1052, 189 USPQ 143, 147 (CCPA 1976).

At the outset, we note that the examiner (answer, page 2) lists under the heading "*New prior art*" (italics original) the following references:

Rathunde 5,574,851 November 11, 1996

Chen et al., (Chen article) "RAID: High Performance, Reliable Secondary Storage," ACM Computing Surveys, vol. 26, Number 2, June 1994.

The examiner states (answer, page 7) that the new prior art is cited to show the state of the art in view of appellant's argument, for the first time, that the references to Jones and Ewert "are not capable of being combined to produce the claimed invention." However, the examiner has not listed either of these two references in the statement of the rejection. In addition, the examiner only refers to the newly cited Chen article in the "*Response to argument*" (italics original) section of the brief. From our review of the examiner's answer, we are not aware of any reference to the Rathunde patent, other than Rathunde being listed in the examiner's answer under the heading of "New prior art." Accordingly, the record is unclear as to how the examiner is attempting to rely upon the Rathunde patent.

Appellant asserts (reply brief, page 5) that the Chen article has a publication date of June 1994, which is later than the filing date of appellant's application, and is therefore not entitled to prior art status relative to the claimed invention.

We note that the Chen article is a “survey” article which discusses a number of published papers. The published papers of Reddy and Chandy (Chandy) and Gibson, referred to in the Chen article have publication dates prior to appellant’s filing date. If the examiner intends to rely upon the Chandy and Gibson papers, the examiner should rely upon the actual papers in order to establish publication dates for these papers that are prior to appellant’s filing date. In addition, the examiner should rely upon the actual papers of Chandy and Gibson to clearly establish the precise portions of the Chen article that are attributed to each of Chandy and Gibson. Appellant (reply brief, page 5) questions the examiner’s findings of teachings attributed to the Chandy paper, stating “[i]f it is assumed that the examiner intends to attribute the expanded concept of parity sparing entirely to the earlier Chandy reference, then such attribution is misplaced.”

In addition, the examiner (answer, pages 8 and 10) attributes the following quote in the Chen article to Gibson:

"*[b]y logical extension, a second disk failure would result in a RAID level-0 disk array.*" (emphasis original) From the Chen article, it is not altogether clear as to whether the quote is from the Gibson paper or the Chen article. The quote does not appear in the Chandy paper. the Gibson paper is of record. However, only an abstract of the Gibson article appears in the application file. Also of note is the fact that no arguments regarding this quote relied upon by the examiner, are made by the appellant in the reply brief.

"Where a reference is relied on to support a rejection, whether or not in a 'minor capacity,' there would appear to be no excuse for not positively including the reference in the statement of rejection." In re Hoch, 428 F.2d 1341, 1342 n.3, 166 USPQ 406, 407 n.3 (CCPA 1970). It is clear that the references to the Rathunde patent and the Chen article have not been included in the statement of the rejection set forth by the examiner. In view of our analysis, supra, we conclude that the references to the Rathunde patent and the Chen

article, as well as the papers to Chandy and Gibson cited in the Chen article, are not properly before us for decision on appeal. Consequently, we will limit our determinations to the teachings of the Jones and Ewert references relied upon by the examiner in the statement of the rejection.

As per claims 1-3, the examiner acknowledges with respect to Jones (final rejection, pages 2 and 3) that "[n]ot explicitly taught is reconstructing data blocks over parity blocks." To overcome this deficiency in Jones, the examiner turns to Ewert. The examiner asserts (final rejection, page 3) that Ewert "teaches remapping of data blocks (abs.)." In the opinion of the examiner (id.) it would have been obvious to "modify the invention of Jones with a remap routine that would allow remapping of a bad data block to another block (i.e., parity). This modification could be accomplished by making use of any
remap-routine, such as the one disclosed by Ewert et al."

Appellant asserts (brief, page 17) with regard to claims 1 and 2 that

> [i]f one were to combine the teachings of Jones and Ewert, the combination would simply yield a method which allows defective units of data to be recovered, remapped to a temporary storage area on the same disk that contains the defective unit of data and subse-quently unmapped and written to either the original location on the same disk if it was repairable or to a replacement disk; however, such a solution would still be limited to moving data to reserve areas or a replacement disk, so that parity is maintained. Neither reference addresses the problem which arises when an entire disk fails and a replacement disk is not available.
>
> In sum, neither Jones nor Ewert either alone or in combination teaches or suggests reorganizing chunks of data to form a fully folded array. Because the solu-tions disclosed by the cited references are geared towards maintaining parity and do not suggest the type of modification necessary to reliably operate an array with a completely bad disk, obviousness is not estab-lished.

Appellant further asserts (brief, page 18) with regard to claim 3 that

> Jones and Ewert fail to disclose a method of "unfolding" a fully folded RAID array or functional equivalents thereof as claimed by the Applicant. Instead, and as previously indicated, the Jones method simply remaps sector data to reserve areas on the same disk or rebuilds a disk in its entirety onto a spare disk. Jones does not eliminate parity, so there is never any need to restore it. The same can be said of the Ewert reference. Ewert only remaps tracks to reserve areas and subsequently

> moves the remapped track back to its original location. Neither of the two, however, discloses a method of "unfolding" a fully folded array to restore the array to its former fully redundant condition as claimed by the applicant.

As stated by the court in In re Hiniker Co., 150 F.3d 1362, 1369, 47 USPQ2d 1523, 1529 (Fed. Cir. 1998) “[t]he name of the game is the claim.” Claims will be given their broadest reasonable interpretation consistent with the specification, and limitations appearing in the specification are not to be read into the claims. In re Etter, 756 F.2d 852, 858, 225 USPQ 1, 5 (Fed. Cir. 1985).

Claims 1-3 recite the following limitations:

Claim 1

> determining if said failed disk contains all parity chunks;
>
> if said failed disk contains all parity chunks, terminating said method;
>
> if said failed disk contains at least some data chunks, then for each strip containing a data chunk located on said failed disk, regenerating the data of said data chunk located on said failed disk and writing said regenerated data onto said parity chunk associated with said data chunk of said failed disk to form a fully folded array.

Claim 2

> determining if said failed disk contains all parity chunks;
>
> if said failed disk contains all parity chunks, terminating said method;
>
> if said failed disk contains at least some data chunks, reorganizing said data chunks of said array to form an array with the characteristics of a RAID level 0 array.

Claim 3

> In a storage system having n active disks and one failed disk formerly organized into strips when said failed disk was active . . . said n active disks arranged into a fully folded array, the failed disk having chunks, each of said chunks located on a different one of said strips, a method of restoring said fully folded array to a fully redundant condition.

We find that Jones discloses (col. 15, lines 44-50) the need for

data guarding both when the number of defective sectors has grown

so large as to exhaust the capacity of one of the disk drives,

and when the drive fails for some other reason such as mechanical

failure. Jones further teaches (col. 14, line 60 - col. 15, line

30) that

> After DDA has determined that a drive has failed, it combines bytes from the remaining three data drives with the corresponding byte from the parity drive to regenerate the failed drive's data. These are:
>
> data0*fourdrives*=data3rdata2rdata1rparity
>
> data0*threedrives*=data2rdata1rparity
>
> data0*twodrives*=data1rparity
>
> data1*fourdrives*=data3rdata2rdata0rparity
>
> data1*threedrives*=data2rdata0rparity
>
> data1*twodrives*=data0rparity
>
> data2*fourdrives*=data3rdata1rdata0rparity
>
> data2*threedrives*=data1rdata0rparity
>
> data3*fourdrives*=data2rdata1rdata0rparity
>
> This is done by microcode and data accesses suffer a slight performance degradation after a drive has failed.
>
> Data guarding suffers a fairly severe write performance degradation as partial strip write must do a read modify write cycle to correctly update the parity data.

from the above teachings of Jones, it is clear the when a drive

fails, the data from the failed drive data is not regenerated

over the parity drive to form a fully folded array. In addition,

Jones further states (col. 15, lines 56-60) that

> [i]n essence, controller 100 rebuilds the data of the failed drive into the replacement disk drive by reconstructing the data bit by bit from the remaining data and parity. Of course, this also applies in the same manner when a parity disk drive fails.

Thus, Jones will regenerate a failed parity drive onto a replacement drive. In contrast, when appellant’s parity drive is found to have failed, the method of reorganizing the data terminates. We note that Jones discloses (col. 18, lines 32-36) remapping blocks on redundant modes. However, this is in the context of remapping correctable errors, i.e., soft errors. we further find, as stated by the examiner, (answer, pages 5 and 6)

that Ewert teaches remapping of bad sectors to good sectors on the same disk, and does teach regenerating data to form a fully folded array.

The examiner asserts (answer, page 4) that in Jones, the requirement for a spare disk is a direct result of the fact that the defective sectors have exceeded the storage capacity of a particular drive unit. In the examiner's opinion (id.), this teaching of Jones, along with Jones' teaching of replacing the disk in order to continue complete data guarding,

> would strongly suggest that there is another course of events which are available to sector remapping. It is the Examiner's position that the other possible event is the choice of remapping without data guarding, that is, to remap the defective sectors onto the same disk until the capacity of the disk is fully utilized, as cited above in Jones. While the Examiner realizes that this is not an explicitly [sic] suggestion for over-writing parity data, it is a strong suggestion that data on a disk maybe [sic] over-written, and as acknowledged by Appellant, the disk in this invention contains both parity and raw data. Therefore, it would seem logical that the data being over-written maybe [sic] either old undesirable data or the guarded data (parity data) which is being sacrificed in order to retain desirable data.

and that (answer, page 5)

> [a]cknowledging, that Jones' invention is primarily concern [sic] with retaining with a high degree, the reliability or guarding (redundancy) of data in the system. This does not mean that he is oblivious to

> other secondary considerations,, such as the tradeoff between cost, reliability, and performance. Nowhere, does Jones exclude the use of his remapping system in an environment that does not have spares.

From our review of Jones and Ewert, we find no suggestion for the examiners assertions, other than from appellant's own disclosure. From the teachings of Jones and Ewert of remapping data, we find no suggestion of regenerating, for each strip containing a data

chunk located on the failed disk, the data of the data chunk located on the failed disk, and writing the regenerated data onto the parity chunk to form a fully folded array as required by claim 1. Nor do we find any suggestion in Jones and Ewert for reorganizing the data chunks of the failed disk to form an array with the characteristics of a RAID level-0 array as required by

claim 2. In addition, as Jones and Ewert do not disclose or suggest a storage system including active disks and one failed disk where the active disks are arranged into a fully folded

array, Jones and Ewert therefore do not suggest a method of restoring the fully folded array to a fully redundant condition as required by claim 3.

"Obviousness may not be established using hindsight or in view of the teachings or suggestions of the inventor." Para-Ordnance Mfg. v. SGS Importers Int'l, 73 F.3d 1085, 1087, 37 USPQ2d 1237, 1239 (Fed. Cir. 1995)(citing W.L. Gore & Assocs., Inc. v. Garlock, Inc., 721 F.2d 1540, 1551, 1553, 220 USPQ 303, 311, 312-13 (Fed. Cir. 1983)).

As Jones and Ewert do not address replacing parity information with data recovered from a failed disk to yield a non-redundant (i.e., fully folded or RAID level-0) array, and therefore do not address restoring the fully folded array to a fully redundant condition, we are not persuaded that teachings from the applied prior art would have suggested the claimed limitations. In Jones, if the parity disk failed, the remaining active disks would constitute a fully folded array since the system of Jones would have no remaining parity until a

replacement disk was provided. However, Jones and Ewert would not meet the limitation of regenerating the data of the data chunk located on the failed disk and writing the regenerated data onto the parity chunk associated with the data chunk to form a fully folded array, as the array would have already existed upon failure of the parity disk. Similarly, Jones and Ewert would not meet the limitation of claim 2 of reorganizing the data chunks of the array to form an array characteristic of a RAID level-0 array since the array would have already existed upon failure of the parity disk. In addition, Jones and Ewert would not meet the limitation of claim 3 determining which one of said n active disks originally contained a chunk of parity information because the parity information was on the failed disk.

From our analysis, supra, we conclude that the examiner has failed to establish a prima facie case of obviousness over Jones

and Ewert. Accordingly, the rejection of claims 1-3 under 35 U.S.C. § 103 as obvious over Jones and Ewert is reversed.

CONCLUSION

To summarize, the decision of the examiner to reject claims 1-3 under 35 U.S.C. § 103 is reversed.

REVERSED

LEE E. BARRETT Administrative Patent Judge	)
JOSEPH F. RUGGIERO Administrative Patent Judge	) BOARD OF PATENT APPEALS AND INTERFERENCES
STUART S. LEVY Administrative Patent Judge	)

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