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BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte WILLIAM L. WALKER, ROBERT F. KRICK,
TARUN NAKRA, and PRAMOD SUBRAMANYAN¹

Appeal 2015-004808
Application 13/473,778
Technology Center 2100

Before ST. JOHN COURTENAY III, KRISTEN L. DROESCH, and
NORMAN H. BEAMER, *Administrative Patent Judges*.

DROESCH, *Administrative Patent Judge*.

DECISION ON APPEAL

STATEMENT OF THE CASE

Appellants seek review under 35 U.S.C. § 134(a) from the Examiner's
Final Rejection of claims 1–20, all of the pending claims in the application.

We have jurisdiction under 35 U.S.C. § 6(b).

We AFFIRM-IN-PART.

¹ Appellants indicate the real party-in-interest is Advanced Micro Devices,
Inc. App. Br. 3.

BACKGROUND

The disclosed invention relates to a method and cache system that includes a first plurality of caches at a first hierarchy level and a second cache at a second hierarchy level lower than the first level and coupled to the first plurality of caches. The second cache enforces a cache line replacement policy in which the second cache selects a cache line for replacement based in part on whether the cache line is present in any of the plurality of first caches and in part on another factor. *See Spec. ¶ 10, Abstract.*

CLAIMED SUBJECT MATTER

Representative claims 1 and 16, reproduced from the Claims Appendix of the Appeal Brief, read as follows (disputed limitations in *italics*):

1. A cache system comprising:
 - a plurality of first caches at a first level of a cache hierarchy; and
 - a second cache at a second level of the cache hierarchy coupled to each of the plurality of first caches, the second level lower than the first level, *wherein the second cache enforces a biased cache line replacement policy in which the second cache selects a valid cache line for replacement based in part on whether the cache line is present in one or more of the plurality of first caches and in part on another factor.*

16. A method for biased cache line replacement in a lower level cache comprising:
 - selecting a first valid cache line of the lower level cache as a candidate cache line for replacement;
 - determining whether the first cache line is present in any one of a plurality of higher level caches;
 - if the candidate cache line is not present in any one of the plurality of higher level caches, replacing the first cache line with a new cache line; and

if the candidate cache line is present in at least one of the plurality of higher level caches, selectively replacing a second cache line with the new cache line.

REFERENCES AND REJECTIONS ON APPEAL

Claims 1, 4, 6, 11, 12, and 16 stand rejected under 35 U.S.C. § 102(b) as anticipated by Vishin (US 7,774,549 B2; Aug. 10, 2010).

Claims 2, 3, 13, and 14 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Vishin and So et al. (US 5,530,832; June 25, 1996) (“So”).

Claims 5 and 17 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Vishin and Merrell et al. (US 5,829,038; Oct. 27, 1998) (“Merrell”).

Claims 7, 15, and 18 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Vishin and McDermott et al. (US 5,860,105; Jan. 12, 1999) (“McDermott”).

Claims 8–10, and 19–20 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Vishin and HIGH PERFORMANCE CACHE REPLACEMENT USING RE-REFERENCE INTERVAL PREDICTION (RRIP), ISCA '10 (2010) (“Aamer”).

ANALYSIS

We have reviewed the Examiner’s rejections in light of Appellants’ arguments in the Brief, the Answer, and the arguments in the Reply Brief. We are not persuaded by Appellants’ arguments addressing claims 1–17, and 19–20. We agree with and adopt as our own the Examiner’s findings and conclusions of law for these claims. However, we are persuaded by

Appellants' arguments addressing claim 18. We highlight and address specific findings and arguments below for emphasis.

Claims 1, 4, and 11

Appellants argue that Vishin does not disclose “wherein the second cache enforces a biased cache line replacement policy in which the second cache selects a valid cache line for replacement based in part on whether the cache line is present in one or more of the plurality of first caches and in part on another factor,” as recited in independent claims 1 and 11. *See* App. Br. 7. Appellants contend that Vishin discloses “what to do with cache lines that have already been selected as victim cache lines, instead of how to select victim cache lines.” *Id.* at 8; *see id.* 7–8 (citing Vishin Fig. 1A, 5:60–6:8); Reply Br. 3. Appellants argue that Vishin discusses the selection of victim cache lines with respect to Figure 2, element 205, and discloses at column 6, lines 29–35 that victim cache lines are selected by conventional means. *See id.* at 8–10; Reply Br. 3–4.

We are not persuaded by Appellants' arguments because the disputed claim limitation is not entitled to patentable weight. The “wherein” clause does not limit the structure of the second cache, but merely recites the use or function of the second cache of the cache system—“enforces a biased cache line replacement policy in which the second cache selects a valid cache line for replacement based in part on whether the cache line is present in one or more of the plurality of first caches and in part on another factor.”²

Although applicants are free to define something by what it does rather than by what it is, there is inherent risk in doing so. *See In re Swinehart*, 439

² *See* MPEP § 2111.04, Ninth Ed., Nov. 2015 (regarding “wherein” clauses).

F.2d 210, 212 (CCPA 1971). One risk is that the recited use will cover any and all embodiments capable of performing the recited use or function. *See id.* at 213; *see also In re Schreiber*, 128 F.3d 1473, 1477 (Fed. Cir. 1997) (“Schreiber’s contention that his structure will be used to dispense popcorn does not have patentable weight if the structure is already known, regardless of whether it has ever been used in any way in connection with popcorn.”). Apparatus claims, similar to the system recited in claim 1, and the processor recited in claim 11, “cover what a device is, not what a device does.” *Hewlett-Packard co. v. Bausch & Lomb, Inc.*, 909 F.2d 1464, 1468 (Fed. Cir. 1990); *but cf. In re Giannelli*, 739 F.3d 1375, 1378 (Fed. Cir. 2014) (“adapted to” clause limited a machine claim where “the written description makes clear that ‘adapted to,’ as used in the [] [application, has a narrower meaning, viz., that the claimed machine is designed or constructed to be used as a rowing machine whereby a pulling force is exerted on the handles.”)³

We agree with, and adopt as our own, the Examiner’s finding that Vishin discloses the claimed structure “a plurality of first caches at a first level of a cache hierarchy; and a second cache at a second level of the cache hierarchy coupled to each of the plurality of first caches, the second level lower than the first level.” *See* Final Act. 2–3 (citing Vishin Fig. 1B: “L1,” “victim cache”; Fig. 4: “L1 cache,” “L2 cache”; 1:47–60, 3:58–60, 4:3–5, 25–42, 9:66–67; 10:1–17). The remaining “wherein” clause recited in

³ *Cf. In re Man Mach. Interface Techs. LLC*, 822 F.3d 1282, 1286 (Fed. Cir. 2016) (“We have noted that the phrase ‘adapted to’ generally means ‘made to,’ ‘designed to,’ or ‘configured to,’ though it can also be used more broadly to mean ‘capable of’ or ‘suitable for.’”) (citations omitted).

claims 1 and 11 does not patentably distinguish the claimed invention over the Vishin reference because the “wherein” clause describes the intended use or function of the second cache, and does not describe or further limit the structure of the second cache. *See* MPEP §2111.04.

Accordingly, on this record, we are not persuaded of Examiner error in the rejection of claims 1 and 11 based on Appellants’ arguments focusing on the use or function of the second cache of the cache system recited in claim 1, and the processor recited in claim 11. Appellants do not address dependent claims 4 and 12 separately. *See* App. Br. 10. Accordingly, for the same reason as claims 1 and 11, we are not persuaded of Examiner error in the rejection of claim 4.

Claims 2, 3, 13

Appellants present arguments addressing dependent claims 2, 3, and 13 under a separate heading. *See* App. Br. 12–13. Appellants argue that Vishin does not disclose how to select a cache line for replacement as recited in claims 1 and 11. *See id.* at 12. Appellants contend that So does not teach or suggest these limitations either. *See id.* at 13. For the same reasons as those explained above addressing claims 1 and 11, we are not persuaded of Examiner error in the rejection of claims 2, 3, and 13.

Claims 5–10 and 14–15

Appellants present arguments addressing each of claims 5–10 and 14–15. *See* App. Br. 10–11, 13–17; Reply Br. 4–9. Claims 5–8 and 10 further describe the cache line replacement policy recited in the “wherein” clause of claim 1. Claims 9 and 14–15 recite additional uses or functions of the second cache of the cache system recited in claim 1, and the processor recited in claim 11. Similar to claims 1 and 11, the disputed limitations of

claims 5–10 and 14–15 are not entitled to patentable weight. The additional recitations of claims 5–10 and 14–15 do not further limit the structure of the second cache, but merely recite additional uses or functions of the second cache, and provide additional description of the biased cache line replacement policy that is to be enforced by the second cache. Therefore, we are not persuaded of Examiner error in the rejections of claims 5–10 and 14–15 based on Appellants’ arguments addressing the additional functions of the second cache and additional descriptions of the biased cache line replacement policy recited in claims 5–10 and 14–15.

Claim 16

Appellants argue that Vishin does not disclose “the steps of selecting, determining, replacing the first cache line, and selectively replacing a second cache line as recited in [independent] claim 16.” App. Br. 10. Appellants assert that Vishin discloses “what to do with cache lines that have already been selected as victim cache lines, instead of how to select victim cache lines.” *Id.* at 8; *see id.* 7–8 (citing Vishin Fig. 1A, 5:60–6:8); Reply Br. 3. Appellants assert that Vishin discusses the selection of victim cache lines with respect to Figure 2, element 205, and “discloses at col. 6, lines 29-35 that victim cache lines are selected by conventional means and not ‘based in part on whether the cache line is present in one or more of the plurality of the first caches and in part on another factor’ as recited in claim 1.” *Id.* at 9; *see id.* at 8–10; Reply Br. 3–4.

Appellants’ arguments are not persuasive of Examiner error because they are not commensurate in scope with the limitations of claim 16. Claim 16 does not recite that the step of selecting “is based in part on whether the cache line is present in or more of the plurality of the first caches and in part

on another factor.” Instead, claim 16 recites “selecting a first valid cache line of the lower level cache as a candidate cache line for replacement.” Appellants do not present arguments addressing substantively the remaining steps of claim 16. Therefore, for this reason, we are not persuaded of Examiner error in the rejection of claim 16.

Claim 17

Appellants argue that dependent claim 17 relates to using a biased pseudo least recently used (PLRU) policy for victim selection. *See* App. Br. 13. Appellants contend that the combination of Vishin and Merrell would result in a cache that selects victims using a conventional PLRU policy, not a biased PLRU policy. *See id.* at 14; Reply Br. 6–7.

Appellants’ arguments are not persuasive of Examiner error because they are not commensurate in scope with the limitations of claim 17. Claim 17 does not recite a biased PLRU policy. Instead, claim 17 recites “selecting the candidate cache line comprises selecting the candidate cache line based on a pseudo least recently used policy.” Likewise, independent claim 16 recites “selecting a first valid cache line of the lower level cache as a candidate cache line for replacement,” but does not recite a biased cache line replacement policy. Accordingly, for these reasons we are not persuaded of Examiner error in the rejection of claim 17.

Claim 18

Dependent claim 18 recites “wherein the selecting the candidate cache line comprises selecting the candidate cache line based on a skip policy.” The Examiner finds that Vishin does not disclose a skip policy. *See* Final Act. 9. The Examiner finds that McDermott reaches a cache line replacement policy comprising a skip policy. *See id.* (citing McDermott

2:34–35 “the next line is skipped if it is clean”); *see id.* at 10 (“[C]laim 18 is rejected for the same reasons set forth in the respective rejections of claim 7.”). The Examiner determined it would have been obvious to one of ordinary skill in the art to modify the cache line management policy taught by Vishin and incorporate the skip policy taught by McDermott, and would have been motivated to make the modification in order to improve the performance of the cache management system as suggested by McDermott. *See id.* at 10 (citing McDermott 1:39–44).

Appellants argue that Vishin does not disclose victim selection by any other than conventional means. *See App. Br. 14.* Appellants further contend that McDermott also doesn’t disclose victim selection either. *See id.* Appellants assert that McDermott discloses skipping cache lines in a search for cache lines with dirty data. *See id.* at 15 (citing McDermott 1:32–37, 1:65–2:30); Reply Br. 7 (citing McDermott 2:31–35). We agree with Appellants’ argument that the combination of Vishin and McDermott does not teach or suggest, and would not render obvious “the selecting the candidate cache line comprises selecting the candidate cache line based on a skip policy,” as recited in claim 18. *See App. Br. 15; Reply Br. 7.* Therefore, we are constrained on this record to reverse the Examiner’s rejection of claim 18.

Claim 19

Appellants argue that dependent claim 19 relates to using a biased reference interval prediction (RRIP) policy. *See App. Br. 15.* Appellants contend that the combination of Vishin and Amer would result in a cache that selects victims using Amer’s unbiased RRIP policy, not a biased RRIP policy. *See id.* at 16; Reply Br. 8.

Appellants' arguments are not persuasive of Examiner error because they are not commensurate in scope with the limitations of claim 19. Claim 19 does not recite a biased RRIP policy. Instead, claim 19 recites "selecting the candidate cache line comprises selecting the candidate cache line based on a re-reference interval prediction policy." Similarly, independent claim 16 recites "selecting a first valid cache line of the lower level cache as a candidate cache line for replacement," but does not recite a biased cache line replacement policy. Accordingly, for these reasons we are not persuaded of Examiner error in the rejection of claim 19.

Claim 20

Appellants argue that dependent claim 20 relates to using a biased cache line replacement policy that is based on the length of time a candidate cache line has been present in the higher level cache. *See* App. Br. 16. Appellants contend that the combination of Vishin and Aamer would result in a cache that selects victims using Aamer's unbiased RRIP policy, but not a biased RRIP policy, and not a policy that is based on a length of time a candidate cache line has been in the upper level cache. *See id.* at 16.

Appellants' arguments are not persuasive of Examiner error because they are not commensurate in scope with the limitations of claim 20. Claim 20 does not recite a biased cache line replacement policy or a biased RRIP policy. Appellants' arguments also are not persuasive because they do not address sufficiently the Examiner's following findings:

selecting a 'stale' cache block to be replaced based on [a] 're-reference prediction value (RRPV)' implies selecting based on a 'length of time.' An ideal [least recently used] LRU policy looks at when each cache line was last accessed and evicts the cache line that has not been accessed for the longest time, i.e. 'distant re-reference' block).

Final Act. 12. Appellants further contend that the Examiner's findings are "irrelevant because the combination of Vishin and Aamer would just result in a cache that selects victims using Aamer's unbiased RRPV policy and decide what action to take based on Vichin's selective action policy." Reply Br. 8 (emphasis omitted). Again, claim 20, and independent claim 16 do not recite a biased cache line replacement policy. Therefore, for these reasons, we are not persuaded of Examiner error in the rejection of claim 20.

DECISION

We AFFIRM the rejections of claims 1–17, and 19–20.

We REVERSE the rejection of claim 18.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a)(1)(iv).

AFFIRMED-IN-PART