The opinion in support of the decision being entered today was *not* written for publication and is *not* binding precedent of the Board.

Paper No. 26

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte YING-WAI HO, MICHAEL SCHULTE, and JOHN LAWRENCE KELLEY

Appeal No. 2004-0115
Application No. 09/363,637

HEARD: Apr. 13, 2004

Before GROSS, BARRY, and SAADAT, *Administrative Patent Judges*.

BARRY, *Administrative Patent Judge*.

DECISION ON APPEAL

A patent examiner rejected claims 17-40. The appellants appeal therefrom under 35 U.S.C. § 134(a). We reverse.

BACKGROUND

The invention at issue on appeal approximates the "reciprocal square root" of a number. The reciprocal square root of a number (N) is 1 divided by the square root of N. (Spec. at 2.) The Newton-Raphson algorithm can be used to approximate a

reciprocal square root. More specifically, the Newton-Raphson algorithm for approximating the reciprocal square root of N is expressed as follows:

$$X_{i+1} = (3 - N*X_i*X_i)*X_i/2,$$

where X_i is an approximation of the reciprocal square root of N at the ith iteration, í is greater than or equal to 1, and X_{i+1} is a more accurate approximation. (*Id.* at 3.)

According to the appellants' method for approximating the reciprocal square root of a number (N), a reciprocal square root of N is estimated as X_i. The estimate and N are multiplied to produce a first intermediate result (IR1). A second intermediate result (IR2) is determined according to the equation: IR2 = $(1-X_i*IR1)/2$. The second intermediate result and the estimate are multiplied to produce a third intermediate result. The third intermediate result and the estimate are added to produce an approximation of the reciprocal square root of the number. (*Id.* at 4.)

According to the appellants, the order in which their method performs multiplication "makes it likely that all results will be in normalized form." (*Id.*) Although the Newton-Raphson algorithm requires one to determine the product of: $N*X_i*X_i$, they explain that their method first multiplies N by X_i to produce an intermediate result, which will likely be in normalized form. Their method then multiplies the intermediate result by X_i to produce: $(N*X_i)*X_i$. If their method first multiplied X_i and X_i to produce the

intermediate result, the appellants assert that the intermediate result would most likely be in a "denormalized" form when N was large, which would reduce accuracy. (*Id.*)

The appellants assert that IR2 "is typically a very small number." (*Id.*) When IR2 is expressed in a normalized floating-point form, they add, "the precision of the result is increased, thereby improving the approximation of the reciprocal." (*Id* at 4-5.)

A further understanding of the invention can be achieved by reading the following claim.

> 17. A method for approximating the reciprocal square root of a number, comprising:
>
> (a) estimating the reciprocal square root of the number to produce an estimate (X_i);
>
> (b) multiplying said estimate by the number to produce a first intermediate result (IR1);
>
> (c) determining a second intermediate result (IR2) according to the equation: $IR2=(1-X_i*IR1)/2$;
>
> (d) multiplying said second intermediate result by said estimate to produce a third intermediate result; and
>
> (e) adding said third intermediate result to said estimate to produce an approximation of the reciprocal square root of the number.

Claims 17-40 stand rejected under 35 U.S.C. § 103(a) as obvious over U.S. Patent No. 5,341,321 ("Karp").

OPINION

Rather than reiterate the positions of the examiner or the appellants *in toto*, we address the main point of contention therebetween. The examiner admits "that Karp et al do not specifically detail the claimed plurality of steps. . . ." (Examiner's Answer at 3.) Observing that "the equation (see col. 10, last line) is provided the same result as claimed," (*id.*), however, he asserts, "it would have been obvious . . . to design the claimed invention according to Karp et al's teaching because the reference is a floating point system for performing square root operation as claimed." (*Id.*) The appellants argue, "the algebraic equivalence of the equation on the last line of column 10 of Karp . . . and any equation used to represent claim 17 does not make the recited combination of steps in claim 17 obvious." (Appeal Br. at 21.)

In addressing the point of contention, the Board conducts a two-step analysis. First, we construe claims at issue to determine their scope. Second, we determine whether the construed claims would have been obvious.

1. CLAIM CONSTRUCTION

"Analysis begins with a key legal question -- *what* is the invention *claimed*?" *Panduit Corp. v. Dennison Mfg. Co.*, 810 F.2d 1561, 1567, 1 USPQ2d 1593, 1597 (Fed. Cir. 1987). Here, claim 17 recites in pertinent part the following limitations: "estimating the reciprocal square root of the number to produce an estimate (X_i); . . . multiplying said estimate by the number to produce a first intermediate result (IR1); . . . determining a second intermediate result (IR2) according to the equation: IR2=(1-X_i*IR1)/2; . . . multiplying said second intermediate result by said estimate to produce a third intermediate result; and . . . adding said third intermediate result to said estimate to produce an approximation of the reciprocal square root of the number." Claim 22 recites in pertinent part the following limitations: "providing an estimate instruction to the floating-point unit that enables the floating-point unit to produce an estimate (X_i) of the reciprocal square root of the number; . . . providing a multiply instruction to the floating-point unit that enables the floating-point unit to produce a first intermediate result (IR1) equal to said estimate multiplied by said number; . . . providing an instruction to said floating-point unit that enables the floating-point unit to produce a first intermediate result (IR1) according to the equation: IR2 = (1 - X_i*IR1)/2; and . . . providing a multiply-add instruction to said floating-point unit that enables the floating-point unit to produce an approximation (X_i) of the reciprocal square root of the number according to the

equation: $X_{i+1} = X_i + X_i$*IR2." Claims 23, 26, 30, 31, and 35 include limitations similar to those of claim 22.

2. OBVIOUSNESS DETERMINATION

Having determined what subject matter is being claimed, the next inquiry is whether the subject matter would have been obvious. "The mere fact that the prior art may be modified in the manner suggested by the Examiner does not make the modification obvious unless the prior art suggested the desirability of the modification." *In re Fritch*, 972 F.2d 1260, 1266, 23 USPQ2d 1780, 178-84 (Fed. Cir. 1992) (citing *In re Gordon*, 733 F.2d 900, 902, 221 USPQ 1125, 1127 (Fed. Cir. 1984)). "[T]he factual inquiry whether to combine references must be thorough and searching." *McGinley v. Franklin Sports, Inc.*, 262 F.3d 1339, 1351-52, 60 USPQ2d 1001, 1008 (Fed. Cir. 2001). This factual question cannot "be resolved on subjective belief and unknown authority," *In re Lee*, 277 F.3d 1338, 1343-44, 61 USPQ2d 1430, 1434 (Fed. Cir. 2002); "[i]t must be based on objective evidence of record." *Id.* at 1343, 61 USPQ2d at 1434. Although couched concerning combining references, we hold the same requirements apply to modifying references. Namely, the factual inquiry whether to modify references must be thorough and searching. The inquiry cannot be resolved on subjective belief and unknown authority; it must be based on objective evidence of record.

Here, Karp's "invention relates to a data processing system having a floating point arithmetic unit and, more particularly, to a method and apparatus for performing floating point division and square root operations." Col. 1, ll. 8-11. "To determine a square root of a value (A), the Newton-Raphson method first determines a reciprocal of the square root of the value and then the resulting reciprocal is multiplied by the value." Col. 10, ll. 51-54. The equation cited by the examiner represents "iterations for the reciprocal of the square root of the value (A) according to the conventional Newton-Raphson method." Although designing Karp's arithmetic unit to perform the claimed steps may be possible, the examiner shows no objective evidence of the desirability of the modification. His statement that "the reference is a floating point system for performing square root operation as claimed," (Examiner's Answer at 3), does not allege that, let alone explain why, such an extension would have been desirable. We will not "resort to speculation," *In re Warner*, 379 F.2d 1011, 1017, 154 USPQ 173, 178 (CCPA 1967), as to a possible explanation. Therefore, we reverse the obviousness rejection of claims 17; of claims 18-21, which depend therefrom; of claim 22; of claims 23; of claims 24 and 25, which depend therefrom; of claim 26; of claims 27-29, which depend therefrom; of claim 30; of claim 31; of claims 32-34, which depend therefrom; of claim 35; of claims 36-40, which depend therefrom.

CONCLUSION

In summary, the rejection of claims 17-40 under § 103(a) is reversed.

REVERSED

ANITA PELLMAN GROSS Administrative Patent Judge	)
LANCE LEONARD BARRY Administrative Patent Judge	) BOARD OF PATENT) APPEALS) AND) INTERFERENCES
MAHSHID D. SAADAT Administrative Patent Judge	)

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