United States Court of Appeals for the Federal Circuit

(Serial No. 11/395,232)

IN RE BLAISE LAURENT MOUTTET

2011-1451

Appeal from the United States Patent and Trademark Office, Board of Patent Appeals and Interferences.

Decided: June 26, 2012

BLAISE LAURENT MOUTTET, of Arlington, Virginia, pro se.

RAYMOND T. CHEN, Solicitor, United States Patent and Trademark Office, of Alexandria, Virginia, for appellee. With him on the brief were LYNNE E. PETTIGREW and KRISTI L. R. SAWERT, Associate Solicitors.

Before PROST, O'MALLEY and REYNA, *Circuit Judges*.

REYNA, *Circuit Judge*.

Mr. Blaise Laurent Mouttet ("Mouttet") appeals the decision of the Board of Patent Appeals and Interferences ("Board") affirming the rejection of all pending patent

claims under 35 U.S.C. § 103(a). Substantial evidence supports the Board's factual determinations, and we agree with the Board's conclusion that Mouttet's claimed invention would have been obvious to one having ordinary skill in the art. We therefore *affirm*.

I. BACKGROUND

A. Mouttet's Patent Application

On April 3, 2006, sole inventor Mouttet submitted utility patent application No. 11/395,232 ("the '232 application") entitled "Crossbar Arithmetic Processor." It discloses a computing device for processes such as addition, subtraction, multiplication, and division using nanoscale materials in a crossbar array.[1] Specifically, Mouttet claimed in representative[2] claim 1:

1. A computing device comprising:

    at least one crossbar array including a first set of N conductive parallel wires (N≥2) forming a set of columns and a second set of M conductive parallel wires (M≥2) forming a set of rows, and formed so as to intersect the first set of conductive parallel wires, wherein intersections are formed between the first and second sets of wires forming MxN crosspoints wherein each of the crosspoints is programmable so as to be in a relatively high conductive state representative of a binary value 1

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[1] Nanoscale materials have dimensions ranging between 1 and 100 nanometers.

[2] The Board treated Mouttet's independent claim 1 as representative according to 37 C.F.R. § 41.37(c)(1) and *In re Dance,* 160 F.3d 1339, 1340 n.2 (Fed. Cir. 1998). This decision by the Board is uncontested on appeal.

or a relatively low conductive state representative
of a binary value 0;

a programming unit configured to program
the crosspoints to have one of the relatively high
conductive state or the relatively low conductive
state so that at least one column of the crossbar
array stores a bit pattern representative of a pro-
grammed numerical value;

an input unit configured to provide a bit pat-
tern representative of an input numerical value to
the columns of the crossbar array; and

a post-processing unit configured to convert
analog signals output from each of the rows of the
crossbar array into digital output bit patterns and
configured to combine the digital output bit pat-
terns so as to form a resultant bit pattern repre-
sentative of an output numerical value,

wherein the output numerical value is
mathematically dependent on both the pro-
grammed numerical value and the input numeri-
cal value.

Ex parte Mouttet, No. 2009-010041, 2011 Pat. App. LEXIS
15036, at *1-2 (B.P.A.I. Mar. 29, 2011).

Mouttet's crossbar array consists of two intersecting
sets of conductive parallel wires. At the wire junctions, or
"crosspoints," a thin film material or molecular compo-
nent acts as a bridge between the wires. The resistance of
the thin film material or molecular component between
the intersecting wires may be altered by controlling the
voltages applied to individual wires in the first and sec-
ond sets. By altering the resistance, each crosspoint can

be programmed to be in a high resistance (low conduction) state or low resistance (high conduction) state. The two states can represent the binary values "0" and "1" and thus store digital data. For example, Mouttet's Figure 2b from the '232 application, below, illustrates the internal structure of a 3x8 crossbar array with various crosspoints in either state after programming:

Fig.2b

◯ = non-conductive   ● = conductive

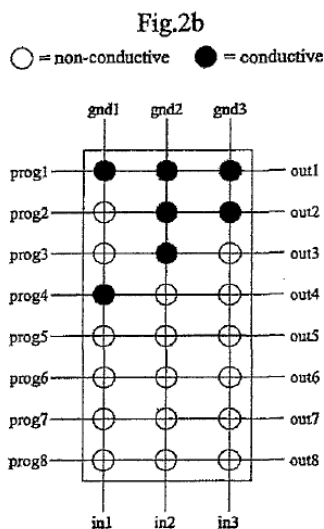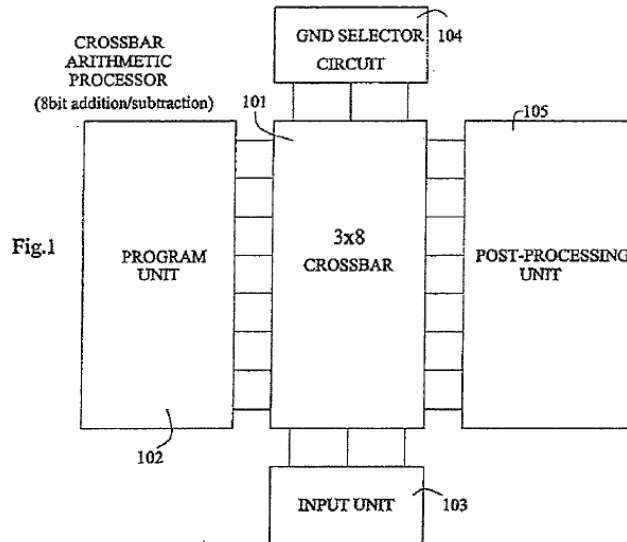|	gnd1	gnd2	gnd3	
prog1	●	●	●	out1
prog2	◯	●	●	out2
prog3	◯	●	◯	out3
prog4	●	◯	◯	out4
prog5	◯	◯	◯	out5
prog6	◯	◯	◯	out6
prog7	◯	◯	◯	out7
prog8	◯	◯	◯	out8
	in1	in2	in3	

Figure 2b depicts binary values 00001001, 00000111, and 00000011, which in the base 10 number system represent the numerals 9, 7, and 3.

Mouttet's claimed computing device adds other input and output units to the central crossbar array. As shown in Figure 1 of the '232 application, reproduced below, an input unit **103** and a program unit **102** provide the necessary voltage to the array of crossbar wires **101**, altering the resistance at the crosspoints:

Fig.1

By altering the conductive states of the crosspoints, input unit **103** and program unit **102** provide the crossbar array with bit patterns (a series of "0"s and "1"s) representative of numerical values. Post-processing unit **105** converts the analog signals from each of the rows of the crossbar array **101** into digital output bit patterns representative of numerical values, for example, the sum of the values provided by the input unit **103** and program unit **102**.

B. Prior Art

The examiner at the United States Patent and Trademark Office ("PTO") rejected all twenty of Mouttet's pending claims under § 103(a) as unpatentable over a publication by Shamik Das[3] ("Das") and four prior art

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[3] Shamik Das, et al., *Architectures & Simulations for Nanoprocessor Systems Integrated on the Molecular Scale, in* Introducing Molecular Electronics 479, ch. 17 (2005), *available at http://www.mitre.org/work/tech papers/tech papers 05/05 0977/05 0977.pdf*.

patents: U.S. Patent Nos. 4,633,386 (filed Apr. 6, 1984) ("Terepin"), 5,249,144 (filed Sept. 29, 1989) ("Falk"); 6,693,821 (filed June 28, 2001) ("Hsu"), and 6,867,996 (filed Aug. 29, 2002) ("Campbell"). The only relevant references for purposes of this appeal are Falk, Das, and Terepin. *See infra* nn. 4 & 5.

1. Falk

Falk, a patent issued September 28, 1993, discloses a programmable computing device for performing arithmetic and logic operations. *See* Abstract; *id.* at col.1 ll.7-11. Falk's central circuit component consists of a crossbar array having two intersecting sets of parallel optical channels, or simply put, crossed paths of light. *Id.* at col.1 ll.35-39; col.6 ll.39-42. Figure 1 of Falk illustrates an example of a 4x4 optical crossbar circuit:
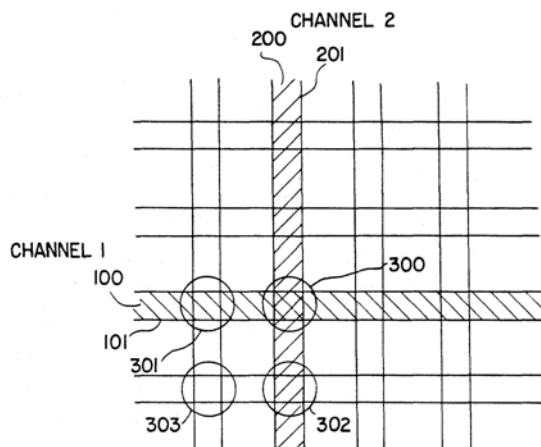

FIG. 1

In Figure 1, the crossbar array has two sets of inputs. *Id.* at col.3 ll.38-51. Input **100** from channel 1 and input **200** from channel 2 are light sources that have been turned on

so as to beam light along optical paths **101** and **201**. *Id.* at col.3 ll.38-46. The intensity of light at each intersecting region along the crossbar's optical paths (e.g., **300-302**) represents a particular logic state. *Id.* at col.1 ll.39-42; col.3 ll.46-51. The examiner determined, on the basis of these disclosures, that Falk teaches an optical crossbar array for its principle arithmetic/logic unit.

Figure 13 shows the larger computing device that encapsulates the optical crossbar array as arithmetic unit **133**, *id.* at col.5 ll.48-51 ("arithmetic unit **133** . . . is implemented as per FIGS. 1-4"):
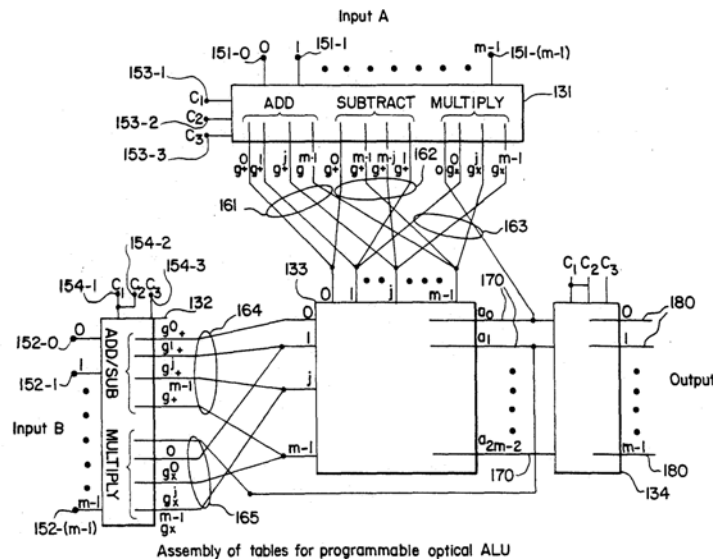

Assembly of tables for programmable optical ALU
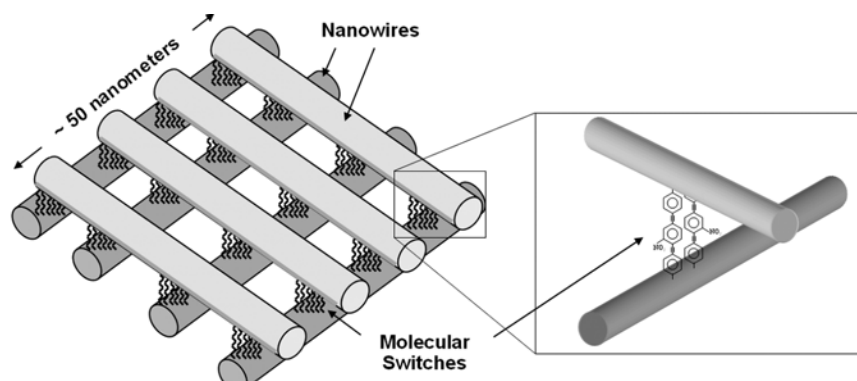
FIG. 13

Falk's crossbar arithmetic unit **133** receives inputs from reordering tables **131** and **132**. *Id.* at col.6 ll.39-48. Inputs from **131** and **132** are configured to send signals along lines **161-165**, providing inputs to crossbar arithmetic unit **133** and programming the device to perform the desired arithmetic operation. *Id.* at col.5 l.67-col.6 l.46;

col.6 ll.55-61. Crossbar arithmetic unit **133** produces a set of outputs **170** based on the logic states at the crossbar intersections. *Id.* at col.6 ll.46-52. Outputs **170** are further processed at unit **134** to represent the result of the arithmetic operation at output **180**. *Id.*

2. Das

Das, a 2005 publication cited by Mouttet in the '232 application, discloses nanoprocessor systems integrated on the molecular scale. "By integration on the molecular scale," Das explains generally, "we mean the basic switching devices, as well as the wire widths and the pitch dimensions (i.e., spacing between the centers of neighboring wires), all will measure only a few nanometers—the size of a molecule—in the computer systems of interest here." Das at 481.

Das specifically discloses a nanoscale crossbar array with molecular switches. Das's Figure 17.1 depicts structures of one or a few molecules, sandwiched between intersecting wires at the junctions of a crossbar array:

"**Fig. 17.1** 'Crossbar' array of nanowires with molecular devices at junctions."

Das at 483. Das explains that the electrical behavior of
the molecular-scale structures at each junction can act as
a switch with two states: a high-conductance "on" state
and a low-conductance "off" state. *Id.*; *see also id.* at 484
& fig.17.2. This "allows the 'programming' of a junction
into one of two states. Such bistable switches are essen-
tial components of any computing system." *Id.* at 483.
On the basis of these disclosures, the examiner deter-
mined that Das teaches molecular switches on a nano-
scale crossbar array capable of being programmed into
high resistance or low resistance states, thereby con-
structing functional circuits that can be used to build
larger processor systems. *Id.*

3. Terepin

Terepin, a patent issued December 30, 1986, is enti-
tled "Digital Signal Processor." The examiner determined
that Terepin teaches the use of analog-to-digital ("A/D")
converter capable of converting analog signals to digital
bit patterns. Terepin, col.3 ll.22-27.

C. Examiner Rejection and Board Decision

The examiner found that Falk taught all of Mouttet's
recited limitations in representative claim 1 except for (1)
a crossbar array implemented with electrical wires rather
than optical light paths, (2) crosspoints with programma-
ble states based on electrical conductivity rather than
optical intensity, and (3) conversion of analog signal
outputs to digital output bit patterns in the post-
processing unit. *Ex parte Mouttet*, 2011 Pat. App. LEXIS
15036, at *3-4. The examiner relied on Das to teach the
missing crossbar array using wires and crosspoints that
are programmable to have electrical conductive states,
and on Terepin to teach a component converting analog

signals to digital bit patterns. The examiner thus rejected claims 1, 2, 6-12, and 16-20 of the '232 application under 35 U.S.C. § 103(a) as obvious over Falk, in view of Das and Terepin.[4] Mouttet appealed to the Board under 35 U.S.C. § 134(a).

On March 29, 2011, the Board affirmed the examiner's rejection of all twenty claims.[5] *Ex parte Mouttet*, 2011 Pat App. LEXIS 15036, at *1. The Board agreed that an ordinarily skilled artisan, i.e., an electrical engineer with several years of related industry experience, would have recognized that substituting Das's wired crossbar array for Falk's optical path crossbar would have predictably yielded Mouttet's claimed computing device. *Id.* at *6, *9 (citing *KSR Int'l Co. v. Teleflex, Inc.*, 550 U.S. 398, 416 (2007)). The Board found that while Falk notes certain advantages to optical devices, the reference in no way suggests that using electronic hardware instead of optical hardware would destroy Falk's operability as a programmable arithmetic unit, nor that it teaches away from electrical circuitry. *Id.* at *7. The Board also found adequate reasons to combine the references because (1) as taught in Das, electrical circuitry "enable[s] more complex and specialized functions to be performed," (2) "combining these references would predictably yield the claimed computing device," and (3) "the relative advantages and

    [4] The examiner also rejected claims 3, 4, 13, and 14 under § 103(a) as unpatentable over Falk, Das, Terepin, and Hsu, as well as rejecting claims 5 and 15 under § 103(a) as unpatentable over Falk, Das, Terepin, and Campbell.

    [5] As the rejections of claims 3-5 and 13-15 were not appealed to the Board by pointing out with particularity alleged errors in the examiner's reasoning, the Board sustained these rejections as well without discussing the teachings of Hsu and Campbell. These issues are not before us in this appeal.

disadvantages in selecting electrical circuitry in lieu of optical circuitry amounts to an engineering tradeoff—a decision well within the level of ordinarily skilled artisans." *Id.* at *8-9. Importantly, the Board noted that there is no requirement that the examiner show how to physically incorporate Das's features into Falk, because obviousness focuses on what the combined teachings would have suggested. *Id.* at *8 (citing *In re Keller,* 642 F.2d 413, 425 (CCPA 1981)). The Board affirmed the examiner rejection of all claims in Mouttet's application on § 103(a) grounds. *Id.* at *9-10. Mouttet appealed to this court, submitting an Overdue Informal Brief of Appellant on August 5, 2011.[6] We exercise jurisdiction pursuant to 28 U.S.C. § 1295(a)(4)(A).

II. DISCUSSION

A. Standard of Review

Whether an invention would have been obvious to one of ordinary skill in the art is a legal determination based on underlying findings of fact. *KSR*, 550 U.S. at 427; *In re Gartside,* 203 F.3d 1305, 1316, 319 (Fed. Cir. 2000) (citing *Graham v. John Deere Co.*, 383 U.S. 1, 17-18 (1966)). The scope and content of the prior art, as well as whether the prior art teaches away from the claimed invention, are determinations of fact. *See Para-Ordnance Mfg., Inc. v. SGS Importers Int'l, Inc.*, 73 F.3d 1085, 1088 (Fed. Cir. 1995). The PTO bears the initial burden of showing a prima facie case of obviousness. *In re Mayne*, 104 F.3d 1339, 1341 (Fed. Cir. 1997). If the PTO carries its burden, the applicant must rebut the PTO's showing. *Id.*

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[6] *In re Mouttet*. No. 2011-1451, 2011 U.S. App. LEXIS 17401 (Fed. Cir. Aug. 19, 2011).

While this court reviews the Board's legal conclusion of obviousness without deference, it upholds the Board's factual findings if supported by substantial evidence. *In re Gartside,* 203 F.3d at 1313-16. Substantial evidence is something less than the weight of the evidence but more than a mere scintilla of evidence. *Id.* at 1312 (citing *Consol. Edison Co. v. Nat'l Labor Relations Bd.*, 305 U.S. 197, 229-30 (1938)). It means such relevant evidence as a reasonable mind might accept as adequate to support a conclusion. *Consol. Edison*, 305 U.S. at 229-30. Thus, "where two different, inconsistent conclusions may reasonably be drawn from the evidence in record, an agency's decision to favor one conclusion over the other is the epitome of a decision that must be sustained upon review for substantial evidence." *In re Jolley,* 308 F.3d 1317, 1329 (Fed. Cir. 2002); *see also Gartside*, 203 F.3d at 1312 (noting that the possibility of drawing inconsistent conclusions from the evidence does not prevent the Board's findings from being supported by substantial evidence).

B. Analysis

A claimed invention is unpatentable "if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains." 35 U.S.C. § 103(a). Where "a patent claims a structure already known in the prior art that is altered by the mere substitution of one element for another known in the field, the combination must do more than yield a predictable result." *See KSR,* 550 U.S. at 416. A reference may be read for all that it teaches, including uses beyond its primary purpose. *See id.* at 418-21; *see also Beckman Instruments, Inc. v. LKB Produkter AB*, 892 F.2d 1547, 1551 (Fed. Cir. 1989).

The government argues on appeal that substantial evidence supports the factual determinations underlying the Board's conclusion that Mouttet's claimed invention would have been obvious in view of the combination of Falk, Das, and Terepin. The '232 application broadly claims a computing device comprising a crossbar array of wires with programmable crosspoints that can be in a relatively high or relatively low conductive state, programming and input units, and a post-processing unit that converts analog signals to digital signals to output a numerical value. The Board found that Falk discloses a computing device with all the recited limitations of Mouttet's representative claim 1 except that Falk lacks an A/D converter and uses optical paths rather than electrical wires for the crossbar array. The Board found that Terepin supplied the missing A/D converter and that Das taught the electrical crossbar array with programmable crosspoints in relatively high or low conductive states. The government maintains that a person having ordinary skill in the art would have implemented Falk's arithmetic processor design using Das's known electrical crossbar array.

Mouttet makes two arguments on appeal: first, that substituting electronic hardware for optical hardware would destroy the Falk device's principle of operation and physical structure; and second, that Falk teaches away from the claimed invention. Each is addressed below.

1.   Principle of Operation and Physical Structure

According to Mouttet, the Board erred in finding that Falk does not suggest that using electronic wires instead of optical paths would destroy Falk's ability to operate as a programmable arithmetic unit. Mouttet argues that eliminating the optical components from Falk impermis-

sibly destroys its principle of operation. He cites *In re Ratti,* 270 F.2d 810, 813 (CCPA 1959), for the proposition that if the combination of references would change the principle of operation of the prior art, then the teachings cannot suffice to render claims obvious.

We find the Board's determination that eliminating the optical components of Falk would not destroy its principle of operation to be supported by substantial evidence. As the examiner found, the type of circuitry used is the main difference between Mouttet's invention, which is based on electrical conductivity, and Falk's invention, which is based on optical paths. But this difference does not affect the operability of Mouttet's broadly claimed device—a programmable arithmetic processor. The Board found, and we agree, that the principle of operation of Falk's computing device is its high level ability to receive inputs into a programmable crossbar array and processing the output to obtain an arithmetic result. Similarly, Mouttet's claim 1 operates by combining Falk, Das, and Terepin to receive inputs into a programmable crossbar array and processing the output to obtain an arithmetic result. Stated differently, the examiner saw nothing in the programming and processing of junction states in Falk that is unique to its optical implementation, and Mouttet has not shown otherwise. Thus, the Board's determination that the difference in the circuitry—electrical versus optical—does not affect the overall principle of operation of a programmable arithmetic processor was supported by substantial evidence. *See, e.g.*, *In re Umbarger*, 407 F.2d 425, 430-31 (CCPA 1969) (finding *Ratti* inapplicable where the modified apparatus will operate "on the same principles as before").

Mouttet further objects that replacing Falk's optical crossbar circuitry with Das's electrical crossbar circuitry would destroy the physical structure of Falk. Mouttet argues that there is no evidence that electrical crossbar circuitry would have been recognized by ordinarily skilled artisans as equivalent to, or able to be substituted for, optical crossbar circuitry.

Any alleged nonequivalence in the type of circuit is irrelevant to the Board's determination since the examiner did not rely on art-recognized equivalence in substituting the crossbar arrays. It is well-established that a determination of obviousness based on teachings from multiple references does not require an actual, physical substitution of elements. *In re Etter,* 756 F.2d 852, 859 (Fed. Cir. 1985) (en banc) ("Etter's assertions that Azure cannot be incorporated in Ambrosio are basically irrelevant, the criterion being not whether the references could be physically combined but whether the claimed inventions are rendered obvious by the teachings of the prior art as a whole."); *In re Sneed*, 710 F.2d 1544, 1550 (Fed. Cir. 1983) ("[I]t is not necessary that the inventions of the references be physically combinable to render obvious the invention under review."); *In re Keller*, 642 F.2d 413, 425 (CCPA 1981) ("The test for obviousness is not whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference . . . .").

Thus, it was not requisite to the Board's § 103(a) determination that Das's features be deemed equivalent for purposes of substitution into Falk's device. Rather, the test for obviousness is what the combined teachings of the references would have suggested to those having ordinary skill in the art. *Id.* The Board properly found that an electrical engineer with several years of related industry experience would indeed have recognized that Falk's

arithmetic processor could have been combined with Das's wired crossbar array to predictably yield Mouttet's claimed computing device. *See KSR*, 550 U.S. at 416, 421.

We further note that Mouttet's objection to substituting the electrical components of Das into the optical crossbar array of Falk is based on an incorrect assumption: that, because the Board designated Falk as the "base reference," Falk's optically-based crossbar implementation—vis-à-vis Das's electrically-based implementation—is a controlling principle of operation that any prior art combination must preserve. But where the relevant factual inquiries underlying an obviousness determination are otherwise clear, characterization by the examiner of prior art as "primary" and "secondary" is merely a matter of presentation with no legal significance. *See In re Bush*, 296 F.2d 491, 496 (CCPA 1961) (Rich, J.); *In re Krammes*, 314 F.2d 813, 816-17 (CCPA 1963). While we recognize that there may be some cases in which relevant factual determinations inhere in such characterization of prior art references, this case is not one.

Here, as found by the Board, Das clearly teaches what is at the core of Mouttet's invention: a crossbar of parallel conductive wires with programmable molecular-scale switches at the junctions. Das at 483-84. Using Das's principles of operation, one skilled in the art readily could have made a larger computer processor system using known input, output, and A/D converter units, as taught in Falk and Terepin. Thus, from either perspective, the claimed invention would have been obvious under § 103(a).

2. Falk Does Not "Teach Away" from Electrical Circuitry

Mouttet argues that Falk "teaches away" from the claimed invention. A reference that properly teaches away can preclude a determination that the reference renders a claim obvious. *See DePuy Spine, Inc. v. Medtronic Sofamor Danek, Inc.*, 567 F.3d 1314, 1326-27 (Fed. Cir. 2009). Whether or not a reference teaches away from a claimed invention is a question of fact. *See In re Napier*, 55 F.3d 610, 613 (Fed. Cir. 1995).

To this end, Mouttet relies on the following passage to suggest that Falk teaches away from electrical circuitry:

> There is a fundamental difference between optical circuits, in which the information carriers are photons, and electronic circuits, where the carriers are electrons . . . . [I]n optical devices, there exist interconnect possibilities that do not exist with electronic hardware, in particular, interconnected parallel architectures which permit digital arithmetic and logic operations to be performed in a completely parallel, single step process. After the inputs are switched on, the output appears in the time it takes a photon to transit the device. No faster computation time is possible.

Falk, col.1 ll.12-17.

In *In re Gurley*, 27 F.3d 551, 553 (Fed. Cir. 1994), we emphasized that "[a] reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the applicant."

Thus, the "mere disclosure of alternative designs does not teach away." *In re Fulton,* 391 F.3d 1195, 1201 (Fed. Cir. 2004). This court has further explained that just because better alternatives exist in the prior art does not mean that an inferior combination is inapt for obviousness purposes. *Gurley*, 27 F.3d at 553.

The Board determined that the Falk passage Mouttet recites does not "teach away" from a computing device using an electrical crossbar array under our law. That determination is supported by substantial evidence. Falk indeed recognizes a "fundamental difference" between circuit types, and even suggests that electrical circuits are an inferior to optical circuitry for certain purposes. Falk, col.1 ll.12-17. But the Board found that "even if Falk's [sic] discusses a preferred embodiment (e.g., an optical circuit with more interconnect possibilities), this does not teach away from a non-preferred embodiment containing an arithmetic/logic system having electrical circuitry with wire sets." March 29, 2011 Board Decision at 6. While Mouttet's reading of Falk is plausible, our standard of review mandates that we uphold factual findings that are supported by substantial evidence as opposed to revisiting them de novo.

As noted by the Board, Mouttet fails to cite any reference suggesting that the claimed invention would be unlikely to work using electrical circuitry; he alleges only that it may be inferior for certain purposes. *See id.*; *Gurley*, 27 F.3d at 553; *Baxter Int'l, Inc. v. McGaw, Inc.*, 149 F.3d 1321, 1328 (Fed. Cir. 1998) (finding no teaching away where nothing in the prior art device suggested that the claimed invention was unlikely to work). In this case, a known system such as an arithmetic/logic unit "does not become patentable simply because it has been described as somewhat inferior to some other product for the same

use," such as an arithmetic/logic unit having electrical circuitry despite fewer interconnect possibilities than optical circuitry. *Gurley*, 27 F.3d at 553. Nor do we recognize in Falk any teaching—sufficient to overturn the contrary determination of the Board—that a crossbar arithmetic processor "should not" or "cannot" be implemented with electrical circuitry, *Para-Ordnance,* 73 F.3d at 1090, or that "criticize[s], discredit[s], or otherwise discourage[s]" a device like Mouttet's, *In re Fulton,* 391 F.3d at 1201.

III. CONCLUSION

We find that the Board's factual determinations are supported by substantial evidence, and that it would have been obvious to persons having ordinary skill in the art to combine the features of Falk, Das, and Terepin to arrive at the invention claimed in the '232 application. The Board's decision is therefore affirmed.

AFFIRMED

COSTS

No costs.