IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

MAGSIL CORP., et al.	:	CIVIL ACTION
	:	
v.	:	
	:	
SEAGATE TECHNOLOGY, et al.	:	NO. 08-940

MEMORANDUM

Bartle, C.J. March 1, 2010

Plaintiffs MagSil Corporation and Massachusetts Institute of Technology bring this action against defendants Western Digital Corporation, Western Digital Technologies Inc., Hitachi Global Storage Technologies Inc., Hitachi America Ltd., Hitachi Data Systems Corporation, and Shenzhen ExcelStor Technology, Ltd.[1] for infringement of U.S. Patent No. 5,629,922 (the "'922 patent"), entitled "Electron Tunneling Device Using Ferromagnetic Thin Films."

Now before the court are the parties' proposed constructions for disputed terms in claims 1, 23, and 29 of the '922 patent. The parties briefed their respective positions, and

1. The complaint has been dismissed by prior orders of the court as to defendants Seagate Technology, Seagate US LLC, Seagate Technology LLC, Maxtor Corporation, Samsung Electronics Co. Ltd., Samsung Electronics America Inc., Hitachi Ltd., Toshiba America Inc., Toshiba American Information Systems, Inc., ExcelStor Technology Inc., TDK USA Corporation, TDK Corporation of America, Headway Technology Inc., SAE Magnetics (HK), Ltd., Headway Technologies, Inc., and Samsung Semiconductor, Inc.

on February 4, 2010 the court held a Markman hearing. See Markman v. Westview Instruments, Inc., 517 U.S. 370 (1996).

The '922 patent pertains to the use of electron tunneling, which is "a quantum phenomenon in which electric current can pass from one electrode through a thin insulating barrier layer into a second electrode." '922 patent at 1:18-20. The strength of the resistance exhibited by the electrical current flowing between the electrodes is dependent on the relative magnetization directions of those electrodes. The resistance is lowest when their magnetization directions are parallel to one another, and it is highest when they are antiparallel. The level of resistance can therefore be controlled by manipulating the relative alignment of the magnetization directions of the electrodes. The patent contemplates that the invention could be used in memory or sensor devices such as computer hard drives.[2]

I.

The Patent Act requires all patents to include "one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention." 35 U.S.C. § 112 (2006). Interpretation of the terms within each claim is a matter of law which must be decided by the court.

2. For example, by assigning a binary code value, that is, a "1" or a "0," to high and low resistance levels, a device which senses a change in resistance could be used to read magnetically encoded binary data.

Markman, 517 U.S. at 391; O2 Micro Int'l Ltd. v. Beyond Innovation Tech. Co., 521 F.3d 1351, 1361 (Fed. Cir. 2008).

"It is a 'bedrock principle' of patent law that 'the claims of a patent define the invention to which the patentee is entitled the right to exclude.'" Phillips v. AWH Corp., 415 F.3d 1303, 1312 (Fed. Cir. 2005) (quoting Innova/Pure Water, Inc. v. Safari Water Filtration Systems, Inc., 381 F.3d 1111, 1115 (Fed. Cir. 2004)). Accordingly, "we look first to the words of the claims themselves, both asserted and nonasserted, to define the scope of the patented invention." Vitronics Corp. v. Conceptronic, Inc., 90 F.3d 1576, 1582 (Fed. Cir. 1996). Words in a claim are generally given their "ordinary and customary meaning," that is, "the meaning that the term would have to a person of ordinary skill in the art in question at the time of the invention, i.e., as of the effective filing date of the patent application." Phillips, 415 F.3d at 1313.

As would the person of ordinary skill in the art, we read the claim terms in context, including not only the particular claims in which the terms appear but also in the context of the entire patent, including the specification and, if in evidence, the prosecution history. Id. For example, the doctrine of claim differentiation provides that when a broadly drafted independent claim is followed by a dependent claim that adds a particular limitation, a presumption arises "that the limitation in question is not found in the independent claim."

Liebel-Flarsheim Co. v. Medrad, Inc., 358 F.3d 898, 910 (Fed. Cir. 2004).

In addition to the context provided by the claims themselves, the patent specification is an invaluable resource during the interpretive process. The specification is defined in the Patent Act as:

> a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.

35 U.S.C. § 112 (2006). As the Federal Circuit instructs, "the specification 'is always highly relevant to the claim construction analysis. Usually it is dispositive; it is the single best guide to the meaning of a disputed term.'" Phillips, 415 F.3d at 1315 (quoting Vitronics, 90 F.3d at 1582). The specification may reveal that the patentee has given a particular claim term a special definition which differs from its ordinary meaning. In such a case, "the inventor's lexicography governs." Id. at 1316. Similarly, "the specification may reveal an intentional disclaimer, or disavowal, of claim scope by the inventor." Id.

Although the specification can shed light on the meaning of claim terms, "it is improper to read a limitation from the specification into the claims." Liebel-Flarsheim, 358 F.3d at 904. However, "'there is sometimes a fine line between

reading a claim in light of the specification, and reading a limitation into the claim from the specification.'" Id. (quoting Comark Commc'ns, Inc. v. Harris Corp., 156 F.3d 1182, 1186-87 (Fed. Cir. 1998)).

The danger of reading limitations into the claims is of particular concern when examining the preferred embodiments. The Federal Circuit has "repeatedly warned against confining the claims to [the] embodiments" and has "expressly rejected the contention that if a patent describes only a single embodiment, the claims of the patent must be construed as being limited to that embodiment." Phillips, 415 F.3d at 1323. Rather, "[e]ven when the specification describes only a single embodiment, the claims of the patent will not be read restrictively unless the patentee has demonstrated a clear intention to limit the claim scope using 'words or expressions of manifest exclusion or restriction.'" Liebel-Flarsheim, 358 F.3d at 906 (quoting Teleflex, Inc. v. Ficosa N. Am. Corp., 299 F.3d 1313, 1327 (Fed. Cir. 2002)). Thus, even in the absence of an express disclaimer, there must be "specific reasons dictating a narrow claim construction beyond the mere fact that the specification disclosed only a single embodiment or a particular structure." Id. at 907.

Finally, when the meaning of a claim term as understood by persons of skill in the art is not otherwise apparent, we look to "extrinsic evidence concerning relevant scientific principles, the meaning of technical terms, and the state of the art."

Innova, 381 F.3d at 1116. Extrinsic evidence is "all evidence external to the patent and prosecution history, including expert and inventor testimony, dictionaries, and learned treatises." Phillips, 415 F.3d at 1317 (quoting Markman v. Westview Instruments, 52 F.3d 967, 980 (Fed Cir. 1995), aff'd 517 U.S. 370 (1996)). Although we may consider such evidence, it is "less significant than the intrinsic record in determining 'the legally operative meaning of claim language.'" C.R. Bard, Inc. v. U.S. Surgical Corp., 388 F.3d 858, 862 (Fed. Cir. 2004) (quoting Vanderlande Indus. Nederland BV v. Int'l Trade Comm'n, 366 F.3d 1311, 1318 (Fed. Cir. 2004)).

II.

The text of claims 1 and 23, with the disputed terms underscored and emphasized,[3] is as follows:

> 1. A device forming a **junction** having a resistance comprising:
> a first electrode having a first magnetization direction,
> a second electrode having a second magnetization direction, and
> an electrical insulator between the first and second electrodes, wherein applying **a small magnitude of electromagnetic energy** to the junction **reverses at least one of the magnetization directions** and causes **a change in the resistance by at least 10%** **at room temperature**.

'922 patent at 8:43-54 (emphasis added).

> 23. A memory device for storing binary data comprising:

3. The parties initially disputed the meaning of the term "magnetization direction." However, this dispute was resolved during the Markman hearing.

> a movable read-write sensor head comprising two trilayer devices, each having a **junction** with a resistance, separated by a gap, wherein each device comprises:
> a first film layer having a first magnetization direction,
> a second film layer having a second magnetization direction, and
> an electrical insulator layer between the first and the second film layers, wherein applying **a small magnitude of electromagnetic energy** to the junction **reverses at least one of the magnetization directions** and causes **a change in the resistance by at least 10%** **at room temperature**.

Id. at 10:25-37 (emphasis added).

"Junction"

Plaintiffs propose that the term "junction" as used in claims 1 and 23 does not require construction, or, alternatively, that it means "a region where three or more layers meet." Defendants suggest that the term is substantially more limited. They assert that, in claim 1, the term means, and is limited to, "the three layers of the first electrode, insulator, and second electrode," and in claim 23 means, and is limited to, "the three layers of the first film layer, insulator, and second film layer." The heart of the dispute between the parties regarding the term "junction" is whether that term limits the invention to being constructed with exactly three layers.

We first consider the meaning of the term "junction," which is not defined in the patent. After reviewing all of the intrinsic and extrinsic evidence, the meaning of that term as understood by a person of ordinary skill in the art at the time of the invention is, in our view, the same as we find in everyday

parlance. See Roche Diagnostics Operations, Inc. v. Abbott Diabetes Care, 2009 WL 2973165 at *10 (D. Del. Sept. 15, 2009); Advanced Tech. Incubator Inc. v. Sharp Corp., 2009 U.S. Dist. LEXIS 28456, at *13-14, *40 n.8 (E.D. Tex. Mar. 11, 2009). The Oxford English Dictionary defines "junction" as "[t]he point or place at which two things join or are joined; a joint, meeting-place." 1 Oxford English Dictionary: Compact Edition 1521 (1984). Similarly, Webster's Third New International Dictionary defines "junction" as "a place or point of union or meeting." Webster's Third New International Dictionary 1226 (1986). These dictionaries establish a clear definition for the word "junction," which both comports with the language of the claims and is the meaning that would be given to the term by a person of ordinary skill in the art at the time of the invention.

Next we consider the more contentious issue of whether claims 1 and 23 limit the invention to devices constructed with exactly three layers. We begin with the words of the claims themselves. Vitronics, 90 F.3d at 1582. Claim 1 describes a "device forming a junction having a resistance comprising: a first electrode ..., a second electrode ..., and an electrical insulator between the first and second electrodes ...." '922 patent at 8:44-50 (emphasis added). Claim 23 describes "a memory device for storing binary data comprising: a movable read-write sensor head comprising two trilayer devices ...." Id. at 10:25-27 (emphasis added). These two trilayer devices are described as: "each having a junction with a resistance, separated by a

gap, wherein each device comprises: a first film layer ..., a second film layer ..., and an electrical insulator layer between the first and the second film layers ...." Id. at 10:27-33 (emphasis added).

In patent parlance, use of the word "comprising" as a transition from the preamble to the body of a claim "signals that the entire claim is presumptively open-ended." Gillette Co. v. Energizer Holdings, Inc., 405 F.3d 1367, 1371 (Fed. Cir. 2005). In this way, "the transition 'comprising' creates a presumption that the recited elements are only a part of the device, that the claim does not exclude additional, unrecited elements." Crystal Semiconductor Corp. v. TriTech Microelectronics Int'l, Inc., 246 F.3d 1336, 1348 (Fed. Cir. 2001).

In Gillette, the court determined that a patent for a safety razor which claimed "a safety razor blade unit comprising a guard, a cap, and a group of first, second, and third blades ..." was not limited to razors containing exactly three blades, but, because of the open-ended transition "comprising," also covered razors with more than three blades. Gillette, 405 F.3d at 1369-71 (emphasis added). In addition to its reliance on the word "comprising," the court also focused on the invention's purpose. It noted that the objective of the patented device was to "reduce drag forces in safety razors with more than two blades," and that it was not the precise number of blades which accomplished this objective, but rather the arrangement of the blades within the razor blade unit. A device could therefore

embody the underlying principle of the patent, that is, using a particular arrangement of blades to reduce drag force in multi-bladed razors, regardless of the exact number of blades it contained. Id. at 1371.

In the instant patent, the use of the word "comprising" in claims 1 and 23 signals that the listing of a first electrode or film layer, insulator, and second electrode or film layer does not preclude additional, unrecited layers which may be added to the device. As did the court in Gillette, we also consider the objective of the invention. Here, a professed objective of the invention is to achieve at least a 10% change in resistance at room temperature. See '922 patent at 2:44-49, 61-64. Although the specification provides examples where this objective is achieved using a trilayer device, the same 10% change in resistance may be achievable using a device with more than three layers. Therefore, we will not read the claims as limiting the invention to only trilayer devices. A review of the remainder of the patent only confirms this conclusion.

Claim 5 recites "[t]he device of claim 1, wherein the junction forms a tunnel junction." Id. at 8:66-67. Similarly, claim 28 states "[t]he memory device of claim 23, wherein each trilayer junction forms a tunnel junction." Id. at 10:54-55. Both claim 5 and claim 28 are dependent claims which modify the independent claims 1 and 23 respectively. According to the doctrine of claim differentiation, the presence of these dependent claims, which add particular limitations not found in

the independent claims, raises a presumption that the limitations imposed by the dependent claims are not found in the independent claims. Liebel-Flarsheim, 358 F.3d at 910. Applying that doctrine here, the junctions mentioned in claims 1 and 23 are not limited to tunnel junctions.

Although the term "tunnel junction" is not defined in the claims, it is defined in the Background section of the patent. That section begins by explaining that "[e]lectron tunneling is a quantum phenomenon in which electric current can pass from one electrode through a thin insulating barrier layer into a second electrode." '922 patent at 1:18-20. It then states that "[t]his three layer system-electrode, barrier and counter-electrode-is referred to as a tunnel junction." Id. at 1:20-22 (emphasis added). From this, we can conclude that the term "junction" as used in claims 1 and 23 is not limited to a three layer system of "electrode, barrier and counter-electrode."

Because defendants' suggested construction mirrors the patent's definition of "tunnel junction" it cannot be used to define the term "junction" in claims 1 and 23, as the junction referred to in those claims is not limited to a tunnel junction. In Liebel-Flarsheim, the court stated, "the presumption that an independent claim does not have a limitation that is introduced for the first time in a dependent claim 'is especially strong when the limitation in dispute is the only meaningful difference between an independent and dependent claim, and one party is urging that limitation in the dependent claim should be read into

the independent claim.'" 358 F.3d at 910 (quoting SunRace Roots Enter. Co. v. SRAM Corp., 336 F.3d 1298, 1302-03 (Fed. Cir. 2003)). By essentially defining "junction" to mean "tunnel junction," defendants would render the dependent claims 5 and 28 meaningless, thereby violating a fundamental principle of claim construction. See, e.g., In re Cruciferous Sprout Litig., 301 F.3d 1343, 1348-49 (Fed. Cir. 2002); Comark, 156 F.3d at 1187.

Although the claim language strongly suggests that the invention not be limited to trilayer devices, defendants argue that the specification, which exclusively describes tunnel junction devices,[4] supports their proposed construction. According to the defendants, the fact that the specification discusses only tunnel junction devices means we should read the term "junction" in claims 1 and 23 as limiting the invention to only three layers. We disagree.

As noted above, "[e]ven when the specification describes only a single embodiment, the claims of the patent will not be read restrictively unless the patentee has demonstrated a clear intention to limit the claim scope using words or expressions of manifest exclusion or restriction." Liebel-Flarsheim, 358 F.3d at 906 (internal quotation marks omitted). Far from demonstrating a "clear intention to limit the claim

4. For example, Figure 1 depicts a particular species of tunnel junction, the ferromagnet-insulator-ferromagnet ("FM-I-FM") trilayer tunnel junction. See '922 patent at 3:10-12,53-55; 1:22-24.

scope," the patentee here expressly rejected any limitation whatsoever. At column 3, lines 2-7, the patent states:

> It will be understood that the particular devices and methods embodying the invention are shown by way of illustration only and not as limitations of the invention. The principles and features of this invention may be employed in varied and numerous embodiments without departing from the scope of the invention.

Similarly, column 8, lines 38-42 read: "[w]hile the invention has been described in connection with specific methods and apparatus, it is to be understood that the description is by way of example and not as a limitation to the scope of the invention as set forth in the claims." Accordingly, the specification provides no support for defendants' attempt to limit the claimed device to only three layers.

"A Small Magnitude of Electromagnetic Energy"

Plaintiffs suggest that the term "a small magnitude of electromagnetic energy" in claims 1 and 23 does not require construction. Defendants propose that the term be construed to mean "the electromagnetic energy associated with an applied magnetic field of approximately 100 Oe[5] or less." Contrary to plaintiffs' suggestion, we find the term "a small magnitude of electromagnetic energy" to be in need of construction, because

5. The symbol "Oe" represents oersteds, which is the "unit of magnetic field strength in the centimeter-gram-second electromagnetic system of units." McGraw Hill Dictionary of Scientific and Technical Terms 1463 (6th ed. 2003).

quantifying electromagnetic energy is not something with which the jury can be expected to be familiar.

Although the claims do not define the term, they do provide some guidance. According to claims 1 and 23, "a small magnitude of electromagnetic energy" is a magnitude of energy sufficient to "reverse at least one of the magnetization directions" and cause "a change in the resistance by at least 10% at room temperature." '922 patent at 8:50-54; 10:33-37. For additional context, we look to the remainder of the patent. See Phillips, 415 F.3d at 1313.

The Background and Summary sections of the patent state that an important attribute of the present invention is its ability to achieve a change in junction resistance of at least 10% at room temperature. '922 patent at 2:9-12, 44-46, 61-64. The patent states that prior-art devices were only capable of creating very low changes in resistance at room temperature. '922 patent at 1:65-67. Although some prior-art devices achieved moderate resistance change (2-6%), this was only at extremely low temperatures (-450°F). Id. at 1:62-64. By obtaining such a high change in resistance at room temperature, the patentee believed that the present invention provides "significant promise for application in magnetic recording devices, such as high density fixed disk drives found in personal computers." Id. at 2:59-61.

The invention achieves this all-important change in resistance through manipulation of the relative magnetization

directions of the ferromagnet layers ("FM layers").[6] As noted above, "[t]he junction resistance is higher when the magnetization of one [FM layer] is antiparallel to that of the other [FM layer] and lower when they are parallel to one another." Id. at 1:29-32. Therefore, to achieve a change in resistance of at least 10%, electromagnetic energy is applied to the junction in such a way as to reverse the magnetization direction of one FM layer, but not the other. By manipulating the magnetization of only one FM layer, the relative directions of magnetization of the two layers can be modulated between parallel and antiparallel states, thereby causing a fluctuation in resistance. By contrast, if the magnetization direction of both FM layers were reversed, then the magnetization direction of each FM layer relative to the other would remain constant, and a change in resistance would not result. Therefore, it is essential that only one FM layer experience a reversal in magnetization direction.

To ensure that the magnetization direction of only one FM layer is affected, the patent provides that each of two FM layers have a different coercive field magnitude or "coercivity." Id. at 8:55-58; 10:38-41. Coercive field magnitude, measured in oersteds (Oe), relates to the gross magnitude of applied electromagnetic energy required to reverse the magnetization

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6. For the purposes of this section we describe the first and second "electrodes" or "film layers" as FM layers. However, the claims themselves are not limited to this one, specific embodiment.

direction for a particular type of ferromagnetic material. Id. at 2:29-31. By fabricating one FM layer with a material that exhibits lower coercivity, and the other with a material that exhibits higher coercivity, a quantity of electromagnetic energy can be applied which is large enough to reverse the magnetization direction of one FM layer but not the other, thereby changing the alignment of the two magnetization directions and causing a change in resistance of at least 10%.[7]

Defendants would have us restrict the term "a small magnitude of electromagnetic energy" to "the electromagnetic energy associated with an applied magnetic field of approximately 100 Oe or less." Although this limitation is found nowhere in the claims, defendants argue that such an interpretation is compelled by statements in the patent's Summary and Abstract.

The Summary states "[a] small change of magnitude, approximately 100 oersted (Oe), in applied magnetic field is capable of changing the junction resistance of the device by at least 10% at room temperature." Id. at 2:19-22. The Summary goes on to say that this change in magnitude of the applied magnetic field is appropriate where the material used in the bottom FM layer provides a coercive force of 100-1000 Oe and the material used in the top layer provides a coercive force of 20-

7. For example, Fig. 3A shows the change in resistance measured in a device in which one FM layer was constructed using cobalt (Co), which has a coercive field magnitude of 100 Oe, and the second FM layer constructed using cobalt-iron (CoFe), which has a coercive field magnitude of 200 Oe. '922 patent at 5:3-17.

100 Oe. Id. at 2:24-29. Clearly, when a device is constructed with FM layers exhibiting these specific coercive force values, a 100 Oe change in magnitude of the magnetic field would be sufficient to reverse the magnetization direction of the bottom layer but not the top layer.

However, this level of change in magnitude is entirely relative and contingent on the materials used to create the FM layers. The claims themselves do not specify the materials with which the FM layers may be constructed. Although the specification provides examples of devices wherein the FM layers were constructed with particular materials, it does not "demonstrate[] a clear intention to limit the claim scope using words or expressions of manifest exclusion or restriction." Liebel-Flarsheim, 358 F.3d at 906 (internal quotation marks omitted). To the contrary, the patent explicitly disclaims using the examples as placing limitations on the claims. See '922 patent at 3:2-7; 8:38-42. The specification merely provides examples of ways in which the patent could be constructed, not how it must be constructed, and we therefore refuse to read defendants' suggested limitation from the specification into the claims. See In re Cruciferous Sprout Litig., 301 F.3d at 1348-49.

Nor will we read the Abstract to limit the claim language. The Abstract reads: "[f]erromagnetic/insulator/ ferromagnetic tunneling has been shown to give over 10% change in the junction resistance with H less than 100 Oe, at room

temperature ...." Again, this language does not demonstrate a clear intention to limit the claim scope. Liebel-Flarsheim, 358 F.3d at 906. As noted above, a change in magnitude of 100 Oe is sufficient only where the device is constructed using certain materials for each FM layer, a limitation which does not appear in the claims.

Thus, having read the claim term in light of the remainder of the claims and the specification, we find that a person of ordinary skill in the art at the time of the invention would understand "a small magnitude of electromagnetic energy," as used in claims 1 and 23, to mean that magnitude of electromagnetic energy which is sufficient to reverse the magnetization direction of the electrode or film layer with a lower coercive force (thereby achieving a change in resistance of at least 10%) but less than the amount necessary to reverse the magnetization direction of the electrode or film layer with a higher coercive force.

"Reverses at Least One of the Magnetization Directions"

Plaintiffs suggest the term "reverses at least one of the magnetization directions" in claims 1 and 23 should be construed to mean "moving at least one of the magnetization directions towards a contrary direction or tendency." Defendants propose, "causes at least one of the magnetization directions to point in the opposite of its previous direction, resulting in a parallel or antiparallel alignment." Basically, the parties disagree as to whether the change in magnetization must be a full

180° rotation from its original position, or whether some lesser degree of rotation is sufficient. To resolve this ambiguity we must analyze the term within the context of the claims and the specification, reading both "with a view to ascertaining the invention." Astrazeneca AB v. Mutual Pharm. Co., Inc., 384 F.3d 1333, 1337 (Fed. Cir. 2004).

As always, we begin by looking at the claims themselves. Vitronics, 90 F.3d at 1582. Both claims 1 and 23 state: "... wherein applying a small magnitude of electromagnetic energy to the junction reverses at least one of the magnetization directions and causes a change in the resistance by at least 10% at room temperature." '922 patent at 8:50-54; 10:33-37. This claim language suggests that any reversal must be sufficient to "cause a change in the resistance by at least 10% at room temperature." As discussed above, the change in resistance is a function of the relative magnetization directions of the FM layers, with resistance increasing as the layers move toward an antiparallel alignment and decreasing as they move towards a parallel alignment. This emphasis on resistance change is consistent throughout the patent.

Claim 27, which is a dependent claim based on independent claim 23, explains how the invention can be put to use as a memory device: "[t]he memory device of claim 23, wherein the resistance of each junction indicates a binary state such that the change in resistance correspondingly changes the binary state, and such state can be maintained without the

electromagnetic energy." Id. at 10:49-53. This claim suggests that the 10% change in resistance, not the orientation of magnetization directions, is the more important aspect of claims 1 and 23, because it is the change in resistance, and not the alignment of the magnetization directions, which translates into the binary data necessary for memory usage. The Background and Summary of the Invention sections only bolster this conclusion.

The Background states:

> Scientists, for many years, have known in theory about the fundamental dynamics of the tunnel resistance arising from conduction electron spin polarization. However, the past efforts in this area have failed to produce an adequate level of change in the tunneling resistance ($\Delta R/R$) for any practical and effective use of the phenomenon. Consequently, a need exists for an FM-I-FM trilayer junction construction in which the magnitude of the junction resistive change is at least 10%. Such a junction would then find practical use as a memory or sensor device.

Id. at 2:3-12 (emphasis added). This passage demonstrates that the key attribute of the present invention which differentiates it from the prior art is its ability to achieve at least a 10% change in resistance at room temperature, not its ability to achieve some particular alignment of magnetization directions.

The Summary of the Invention also describes the current invention as a solution to the inadequate resistance change in prior-art devices: "In the present invention, some of the problems leading to low values of resistance change ($\Delta R/R$)... have been solved. Over a ten percent change in the tunneling

resistance ... has been observed in devices constructed in accordance with the invention." Id. at 2:44-49 (emphasis added). The Summary goes on to conclude that "the present invention provides a spin polarized electron tunneling device and method which overcomes the past ineffectiveness for application in nonvolatile memory or sensor elements." Id. at 2:61-64. As in the Background section, the professed utility of the invention is its application in electronic data storage, and the essential attribute which permits such application is its ability to achieve at least a 10% change in resistance. Accordingly, when considering how a person of ordinary skill in the art would understand the term "reverses at least one of the magnetization directions," we consider how that term contributes to this ultimate purpose.

The patent describes the invention as being designed to achieve at least 10% change in resistance at room temperature, thereby solving the problem of low resistance change which plagued the prior art. The application of electromagnetic force and resultant change in magnetization direction are simply steps in the process by which that resistance change is achieved. By applying electromagnetic energy in the right quantity, the magnetization direction of the FM layer with the lower coercive force begins to turn towards an opposing position. As this rotation occurs, the resistance of the junction changes. When the magnetization direction of one of the FM layers turns towards an antiparallel alignment the resistance increases, and as it

turns towards a parallel alignment the resistance decreases. As Fig. 3A makes clear, this process is a continuous one wherein the degree of resistance and alignment of magnetization directions can be measured at varying points over time. A movement from parallel to antiparallel, or vice-versa, would correspond to the greatest possible change in resistance. However, nothing in the claims or the specification limits the invention to only those two alignments.

The specification describes a number of tests during which devices constructed in accordance with the invention were able to achieve resistance changes of 10% or higher. Id. at 5:32-37. These tests measured change in resistance between the parallel and antiparallel states. See id. Fig. 3A. Defendants argue that these examples demonstrate that the term "reverses" should be restricted to a change in magnetization direction which causes a full 180° rotation between completely parallel and antiparallel alignments. We disagree that the claims are so limited.

The tests described in the specification were conducted in order to demonstrate the maximum change in resistance that could be achieved with particular devices under particular conditions. Because resistance is highest at antiparallel and lowest at parallel, a researcher attempting to demonstrate the maximum resistance change for a particular device would necessarily use the parallel and antiparallel alignments as the ends of the resistance spectrum within which change would be

measured. However, the claims in question do not specify a maximum change in resistance of 10%, but rather a change in resistance of at least 10%. The specification describes devices embodying the invention which were capable of achieving resistance changes of as high as 11.8%. Id. at 5:36-37. If a device achieves a change in resistance of greater than 10% when the magnetization direction is turned a full 180° from parallel to antiparallel (or vice versa), then that device will necessarily achieve "a change of resistance of at least 10%" before the full 180° rotation is complete, that is, when the magnetization direction is turned by less than 180°.

In sum, by interpreting the word "reverses" within the context of the entire patent, we find that a person of ordinary skill in the art at the time of the invention would interpret the term "reverses at least one of the magnetization directions" to mean a turning or change of the magnetization direction of at least one of the electrodes or film layers, towards an opposing alignment, to such a degree as necessary to achieve at least a 10% change in resistance.

Defendants raise two objections to such a construction, neither of which is persuasive. First, defendants claim that such a construction runs contrary to the ordinary meaning of the word "reverse" and would allow the absurd result that a 1° rotation could be deemed a "reversal" so long as it achieves at least a 10% change in resistance. The problem with this argument is that there is no evidence that a 1° rotation or change is

capable of causing a 10% change in resistance. To the contrary, the highest reported change in resistance using a device constructed according to the patent is 11.8%, and that was measured across a full 180° rotation. None of the examples described in the patent indicates that a change in resistance of at least 10% is possible with anywhere close to a 1° rotation of magnetization direction. See 'Id. Fig. 3A.

Second, Defendants argue that, by interpreting "reverses" to mean a change in direction which causes a 10% change in resistance, the word "reverses" is rendered superfluous. This is incorrect. The term "reverses" is necessary to explain the means by which the change in resistance is achieved.

"A Change In the Resistance By at Least 10%"

The parties disagree as to the manner in which a 10% change in resistance should be calculated. Plaintiffs suggest that claim construction is unnecessary, or, alternatively, that the term should be defined as "an increase or decrease in the resistance of the junction of at least 10%." Defendants, on the other hand, propose "a change in the resistance of the junction by at least 10% as defined by the formula [$\Delta R/R$ =] $(R_a-R_p)/R_a$, where [$\Delta R/R$ represents the percent change in resistance and] R_a and R_p are the resistances at antiparallel and parallel respectively."

We cannot presume that a jury will know how to correctly calculate a percentage change in resistance. Thus, the

term requires construction. As defendants correctly note, failure to provide a formula to the jury could result in a calculation error. However, the parties' proposed constructions are insufficient. Plaintiffs' interpretation fails to provide the jury with a workable formula, and defendants' proposed formula is unduly restrictive.

Again, an essential attribute of the invention is its ability to achieve a change in resistance of at least 10% at room temperature. According to the claims, this change in resistance is caused by the reversal of the magnetization direction of at least one of the FM layers. Defendants suggest that we apply the formula "[$\Delta R/R=$]$(R_a-R_p)/R_a$, where R_p and R_a are the resistances with magnetization directions of the electrodes parallel and antiparallel respectively." This formula is derived from a larger formula presented in the Background section of the patent. The full formula is $\Delta R/R=(R_a-R_p)/R_a=(G_p-G_a)/G_p=2P_1P_2/(1+P_1P_2)$, and is described as "an explanation for the change in junction resistance with change in magnetization direction" proposed by Julliere in 1975. Id. at 1:33-47.

Although defendants' proposed formula may be appropriate within the context of Julliere's mathematical explanation, it is not appropriate for the purposes of construing the present claim term. The formula $\Delta R/R=(R_a-R_p)/R_a$ presumes that the magnetization directions of the FM layers start in an antiparallel alignment and move toward a parallel one; however, nothing in the claims or the specification limits the patent in

such a way. In fact, Fig. 3A, which presets a graphical representation of the change in resistance achieved in a device embodying the invention, shows the relative magnetization direction of two FM layers starting in the parallel position, and then moving towards antiparallel as electromagnetic energy is applied to the junction. Defendant's proposed formula would therefore be inapplicable to one of the embodiments explicitly described in the patent itself.

Instead, we will construe the claim term to mean a change in the resistance of at least 10% by using the formula $\Delta R/R = (R_1-R_2)/R_1$, where $\Delta R/R$ is the percent change in magnetization direction,[8] R_1 is the resistance of the junction before the application of electromagnetic energy reverses at least one of the magnetization directions, and R_2 is the resistance of the junction after the application of electromagnetic energy and the resultant reversal of at least one of the magnetization directions. Because this formula provides the percent change in resistance regardless of the beginning and ending alignments of magnetization directions, it will guide the jury in making the necessary calculation without imposing limitations on the claims.

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8. This formula will provide $\Delta R/R$ in decimal form, which can then be converted to a percentage by multiplying the absolute value of the decimal by 100.

"At Room Temperature"

Plaintiffs assert that the term "at room temperature" does not require construction, or, alternatively, that it means "an ambient temperature of between 20 to 25°C (68 to 77°F)." Defendants propose that we read the term "at room temperature" to mean "the junction is about 72°F (295 K[9])." Neither the claims nor the specification provides a specific definition for the term "at room temperature." However, some insight can be gleaned from the patent's description of the prior art.

The Background section discusses the changes in resistance achieved by researchers using FM-I-FM tunnel junction devices[10] similar to the present invention. It states that "in most of these cases, the change in the tunnel resistance ΔR/R was 2-6% at 4.2 K, and only fractions of a percent at room temperature." '922 patent at 1:62-64. This means that in some cases the researchers actively manipulated the temperature of the device to achieve extremely cold conditions, whereas in other cases the temperature of the device was not intentionally cooled but rather was allowed to remain consistent with the ambient environment in which it was tested. Although prior researchers

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9. The symbol "K" stands for "Kelvin." Named in honor of Lord Kelvin, it is "the basic scale used for temperature definition." McGraw Hill Dictionary of Scientific and Technical Terms 1147 (6th ed. 2003). Kelvin is converted to Celsius by the formula C = K - 273.15. Id. at 352. Celsius can then be converted to Fahrenheit by the formula F = (C x 9/5) + 32. Id. at 774.

10. A FM-I-FM tunnel junction is defined as a three layer system consisting of a ferromagnet electrode, an insulator, and a second ferromagnet electrode. '922 patent at 1:20-24.

were able to achieve only "fractions of a percent" of resistance change at room temperatures, the patent here proclaims that "[i]n the present invention, some of the problems leading to low values of resistance change (ΔR/R) in spin-polarized tunneling of FM-I-FM trilayer have been solved." Id. at 2:44-46.

With this context in mind, we find that a person of ordinary skill in the art at the time of the invention would understand that a device which causes a change in resistance of at least 10% "at room temperature" is a device capable of achieving such resistance without actively manipulating the temperature of the device, that is, that the device is capable of achieving a 10% change in resistance while operating within a room-temperature environment.

As for the exact range of temperatures which can be considered "room temperature," we again turn to the intrinsic evidence provided in the specification. In column 5, lines 23-49, the patent discusses a number of tests in which the resistance generated by a device embodying the invention was measured at various temperatures: 295 K (71.6°F), 77 K (-320.8°F), and 4.2 K (-451.84°F). It reports that "[t]he change in the junction resistance with respect to the absolute value at the peak, ΔR/R, for this junction is 10.6% at 295 K [71.6°F]. In several tens of junctions, over a 10% effect has been consistently observed at room temperature ...." Id. at 5:32-36 (emphasis added). This suggests that when the device was tested under "room temperature" conditions, it was tested in an

environment which was approximately 72°F. By contrast, the specification reports that "[i]n general, a percentage change of junction resistance nearly doubled at 77 K compared to a value taken at 295 K. A further increase in resistive change occurred upon cooling the junction to 4.2 K ...." Id. at 5:39-42; Fig. 4. This description clarifies that resistance measurements taken at "room temperature" are in contrast to those taken under conditions in which the device is actively cooled to cryogenic temperatures.

Accordingly, we believe the ordinary meaning of "room temperature" to a person skilled in the art would be understood as an ambient temperature of approximately 72°F. However, because the term "room temperature" as used within the context of the patent is placed in contrast to extremely cold conditions exceeding -450°F, some reasonable deviation up or down from 72°F would still fall within the scope of the claim.[11] Unlike some of the other claim terms under dispute, we believe a jury is capable of grasping the concept of "room temperature" to include a reasonable deviation up or down from 72°F.

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11. For example, there was discussion during the Markman hearing that the heat generated in the process of applying a small magnitude of electromagnetic force to a junction, along with the other motions and frictions inherent in the normal operation of a computer hard drive (an anticipated application of the invention), would cause the device to experience a relatively minor increase in temperature. Such a change in temperature would not be beyond the scope of the claims.

III.

The remainder of the disputed terms are contained in claim 29. The text of that claim, with the disputed terms underscored and emphasized, is as follows:

> 29. The memory device of claim 23 further comprising: a disk having two magnetically coated surfaces fixed in the gap between the two junctions so that an interface between one surface and one of the junctions and another interface between the other surface and the other junction are formed in a stack;
>
> an actuator coupled to the sensor head for positioning the sensor head across both surfaces fo the disk simultaneously; and
>
> a **stepping motor** coupled to the actuator for **linearly driving the actuator**.

'922 patent at 10:56-66.

"Stepping Motor"

Claim 29 is a dependent claim that follows the independent claim 23. As discussed above, claim 23 describes a "memory device." Id. at 10:25. This "memory device" is further defined in claim 29 as comprising, among other things, "an actuator coupled to the sensor head for positioning the sensor head" and "a stepping motor coupled to the actuator for linearly driving the actuator." Id. at 10:62-66 (emphasis added). The parties' disagreement as to the construction of the term "stepping motor" is minor. Plaintiffs suggest that a "stepping motor" is "a motor that moves in small steps," whereas defendants suggest that it is a motor "that can only position the actuator in discrete steps." Because the definition of "stepping motor" is not discussed in the

claims, specification, or anywhere else in the patent,[12] we turn to extrinsic evidence to aid construction. Phillips, 415 F.3d at 1317.

During the Markman hearing, the parties provided the court with a technology tutorial to explain the relevant scientific terms and principles involved in this dispute. A portion of this presentation was dedicated to stepping motors and the means by which they operate. According to that presentation, stepping motors contain a rotor, the circumference of which is fitted with a series of uniformly sized and spaced teeth, similar to a gear. Each tooth is magnetized. The rotor is connected to a shaft, and is surrounded by a circular housing on which are located a series of electromagnets. Electromagnetic pulses are sent sequentially from each of the electromagnets surrounding the rotor, thereby advancing the rotor tooth-by-tooth.

In the Modern Dictionary of Electronics, a stepping motor is defined in a number of ways, including: "[a] motor whose normal operation consists of discrete angular motions of essentially uniform magnitude, rather than continuous rotation"; "a bidirectional permanent-magnet motor that turns through one angular increment for reach pulse applied to it"; and "an

12. The only mention of a stepping motor outside of claim 29 is in the description of Fig. 9A. This description merely identifies the stepping motor in the diagram depicted at Fig. 9A and states that the "[t]he stepping motor linearly drives the actuator." '922 patent at 8:28-29.

electric motor that moves incrementally." Modern Dictionary of Electronics, 735 (7th ed. 1999).

Based on the extrinsic evidence before the court, we find that a person of ordinary skill in the art would understand a "stepping motor" to be an electric motor that is capable of moving only in small, discrete increments. We reject plaintiffs' proposed construction, because it fails to acknowledge that such motors are inherently limited to moving in discrete, incremental steps. Although defendants properly defined the motor as only moving in discrete steps, we disagree with defendants' construction insofar as we find it unnecessary to refer to an actuator when defining the term "stepping motor."

"Linearly Driving the Actuator"

The "actuator" mentioned in claim 29 is an arm connected to a sensor head which is used to position the sensor head across the surface of a disk inside of a computer's hard drive. Plaintiffs argue that the term "linearly driving the actuator" does not require construction, whereas defendants propose that it means "moving the actuator along a straight line." Because the claims do not define the term "linearly driving the actuator," we look to the specification for guidance.

Figure 9A diagrams a preferred embodiment of the patent and includes a drawing of a stepping motor linearly driving an actuator. The actuator depicted in Fig. 9A is clearly being driven in a straight line, as the drawing depicts a guide rod connected to the actuator to ensure that it is restricted in its

path of travel. We are not assuming that this one embodiment places a limitation on the claims. See Liebel-Flarsheim, 358 F.3d at 906. Rather, the embodiment merely provides insight into whether or not the patentee was acting as his own lexicographer by using the term "linearly" in a manner other than its ordinary usage. See Phillips, 415 F.3d at 1316. The example provided in Fig. 9A suggests that he was not.

The argument for construing the term "linearly driving" to mean "driving in a straight line" is further supported by the specification's description of the "sensor head" that is connected to the actuator. Although the actuator in Fig. 9A is described only as moving "linearly," the sensor head is described as moving both "linearly" and "angularly." '922 patent at 8:25-28. Therefore, we can assume that, in the context of the patent, "linear" movement is different than "angular" movement. This also comports with the plain meaning of the word "linear," which Webster's Dictionary defines as "following a straight course: being or going in a straight direction." Webster's Third New International Dictionary, 1315 (1986).

Accordingly, we find that a person of ordinary skill in the art at the time of invention would understand "linearly driving the actuator" to mean driving the actuator in a straight line.