UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF COLUMBIA

SD3, LLC, Plaintiff v. MICHELLE K. LEE, Under Secretary for Intellectual Property and Director, United States Patent and Trademark Office, Defendant	)	Civil Case No. 08-CV-1242

MEMORANDUM OPINION, FINDINGS OF FACT, AND CONCLUSIONS OF LAW

Plaintiff SD3, LLC ("SD3") brought this action under 35 U.S.C. § 145 (2002)[1] to set aside a decision by the United States Patent Office ("PTO") Board of Patent Appeals and Interferences ("BPAI") rejecting a patent application by SD3 for safety technology associated with power tools, and more specifically, power cutting tools.

This case, was tried to the Court on May 10-13, 2016. The Court has considered the evidence presented at trial, facts stipulated to by the parties, the arguments of counsel, and the controlling legal authority. The Court has ascertained the credibility of each witness and evaluated the probative value of all relevant

[1] Subsequent to the institution of this suit, Section 145 was amended to require suits instituted thereunder to be filed in the District Court for the Eastern District of Virginia. *See* 35 U.S.C. § 145 (2016).

evidence admitted at trial. Based upon the foregoing, the Court makes the following findings of fact and conclusions of law.

I. BACKGROUND

A. Procedural History

The factual and procedural history of this case is set forth in detail in two prior rulings by this Court, *SD3, LLC v. Dudas*, 952 F. Supp. 2d 97 (D.D.C. 2013) and *SD3, LLC v. Rea*, 71 F. Supp. 3d 189 (D.D.C. 2014). Only limited factual and procedural information is therefore given here.

SD3 filed U.S. Patent Application Serial No. 10/100,211 ("'211 application") on March 13, 2002. That application claims priority to U.S. Provisional Application 60/275,583 filed on March 13, 2001. At issue in this proceeding are claims 1, 22-24 and 30 of the '211 application, which recite:

> 1. A machine compromising:
> an operative structure adapted to perform a task, where the operative structure includes a mechanical cutting tool adapted to move in at least one motion; and
> a safety system adapted to detect the occurrence of an unsafe condition between a person and the cutting tool, where the safety system includes a detection subsystem adapted to detect the unsafe condition, and a reaction subsystem adapted to mitigate the unsafe condition
> where the reaction subsystem includes a brake mechanism adapted to stop at least one motion of the cutting tool within 10 milliseconds after detection of the unsafe condition.

22. The machine of claim 1 where the brake mechanism is adapted to stop at least one motion of the cutting tool within 7 milliseconds after detection of the unsafe condition.

23. The machine of claim 1 where the brake mechanism is adapted to stop at least one motion of the cutting tool within 5 milliseconds after detection of the unsafe condition.

24. The machine of claim 1 where the mechanical cutting tool is adapted to rotate and where the brake mechanism is adapted to stop that rotation.

30. The machine of claim 1 where the brake mechanism is adapted to stop at least one motion of the cutting tool in less than 5 milliseconds after detection of the unsafe condition.

The BPAI affirmed a rejection of claims 1 and 22-24 under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 3,858,095 issued December 31, 1974, to Wolfgang Friemann and Josef Proschka ("Friemann patent"). The Friemann patent claims in pertinent part:

1. A protective device for use in cutting machines having a moving cutting member compromising:
   safety circuit means, responsive to touching of the cutting member by an operator, for generating an output signal; and
   braking means electrically connected to said safety circuit means for substantially instantaneously stopping the cutting member in response to said generated output signal of said safety circuit means.
2. The protective device of claim 1 wherein said cutting member compromises a band cutter having a drive motor; and said safety circuit means compromises a bridge circuit balanced during normal operation and when unbalanced by the operator touching the band cutter provides an output signal by which full braking of said band cutter is triggered, wherein said band cutter is electrically insulated

> from the rest of the cutting machine and is connected as capacitance in said bridge circuit.

The BPAI also affirmed the rejection of claim 30 under 35 U.S.C. § 103(a) as being obvious in light of the Friemann patent.

In response, SD3 instituted the current action under 35 U.S.C. § 145, alleging that the PTO's rejections should be reversed because the Friemann patent fails to enable one skilled in the art to construct a band cutter capable of stopping its blade within 5ms or 10ms without undue experimentation. Therefore, according to SD3, the Friemann patent could not anticipate or make obvious SD3's claimed invention.

III. RELEVANT LEGAL AUTHORITY

A. Enablement

A patent application will be rejected for anticipation under 35 U.S.C. § 102(b) (2006)[2] if "the invention was patented or described in a printed publication in this or a foreign country . . . more than one year prior to the date of the application for patent in the United States." "A prior art reference can only anticipate a claim if it discloses all the claimed limitations 'arranged or combined in the same was as in the claim.'" *Kennametal, Inc. v. Ingersoll Cutting Tool Co.*, 780 F.3d 1376, 1381 (Fed. Cir. 2015) (quoting *Wm. Wrigley Jr. Co. v. Cadbury Adams USA LLC*, 683 F.3d 1356, 1361

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[2] Congress amended Section 102 in the America Invents Act, Pub. L. 112-29, Sec. 3, 125 Stat. 284 (Sept. 16, 2011). The amendment, however, was not retroactive, and because the '211 patent was filed before the Act's effective date, the prior version of the statute applies here.

(Fed. Cir. 2012)). "However, a reference can anticipate a claim even if it does not expressly spell out all the limitations arranged or combined as in the claim, if a person of skill in the art, reading the reference, would at once envisage the claimed arrangement or combination." *Id.* (internal punctuation omitted) (internal quotation marks omitted) (quoting *In re Petering*, 301 F.2d 676, 681 (1962)).

To be anticipatory, prior art must be enabling. "A prior art reference cannot anticipate a claimed invention 'if the allegedly anticipatory disclosure . . . [is] not enabled.'" *In re Antor Media Corp.*, 689 F.3d 1282, 1287 (Fed. Cir. 2012) (internal quotation marks omitted) (quoting *Amgen Inc. v. Hoechst Marion Roussel, Inc.*, 314 F.3d 1313, 1354 (Fed. Cir. 2003)). Claimed and unclaimed materials in a patent are presumptively enabled. *In re Antor Media Corp.*, 698 F.3d 1282, 1287 (Fed. Cir. 2012). Therefore, the burden of proof is on the party challenging the patent as nonenabled to rebut the presumption of enablement by a preponderance of the evidence. *In re Sasse*, 629 F.2d 675, 681 (CCPA 1980). If the challenging party succeeds in rebutting the presumption of enablement, it falls to the opposing party to produce evidence sufficient to rebut the challenging party's contention. *Id.* If the opposing party succeeds in doing so, the ultimate burden then rests with the challenging party. *Id.*

"Enablement requires that 'the prior art reference must teach one of ordinary skill in the art to make or carry out the claimed invention without undue experimentation.'" *Elan Pharms., Inc. v. May Found.*, 346 F.3d 1051, 1054 (Fed. Cir. 2003) (quoting *Minnesota Mining & Mfg. Co. v. Chemique, Inc.*, 303 F.3d 1294, 1301 (Fed. Cir 2002)). "Undue experimentation" is determined by evaluating eight factors:

(1) the quantity of experimentation;

(2) the amount of direction or guidance present;

(3) the presence or absence of working examples;

(4) the nature of the invention;

(5) the state of the prior art;

(6) the relative skill of those in the art;

(7) the predictability or unpredictability of the art; and

(8) the breadth of the claims

Impax Labs., Inc. v. Aventice Pharms., Inc., 545 F.3d 1312, 1314–15 (Fed. Cir. 2003) (citing *In re Wands*, 858 F.2d 731, 737 (Fed. Cir. 1988)). Enablement is a "question of law based upon underlying factual findings." *Id.* at 1315. Whether the Friemann patent is sufficiently enabling "must be considered together with the knowledge of one of ordinary skill in the pertinent art" on the date SD3 filed its application. *In re Paulsen*, 30 F.3d 1475, 1480 (Fed. Cir. 1994) (internal quotation marks omitted) (quoting *In re Samour*, 571 F.2d 559, 562 (CCPA 1978)). Thus, for present purposes, the question is whether Friemann enables one of ordinary skill in the art in 2001 to construct his band cutting machine without undue experimentation.

B. Obviousness

A patent application will be rejected for obviousness where "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) (2006). Obviousness is a legal conclusion underpinned by "factual questions relating to the scope and content of the prior art, the differences between the prior art and the claimed invention, the level of ordinary skill in the art, and any relevant secondary considerations such as commercial success, long-felt need, and the failure of others."[3] *PharmaStem Theapeutics, Inc. v. ViaCell, Inc.*, 419 F.3d 1342, 1359 (Fed. Cir. 2007).

But to render a claimed invention obvious, the prior art must allow or enable one skilled in the art to create the claimed invention. *See In re Kumar*, 418 F.3d 1361, 1368 (Fed. Cir. 2005) (citing *Motorola, Inc. v. Interdigital Tech. Corp.*, 121 F.3d 1461, 1471 (Fed. Cir. 1997)); *cf. KSR Int'l v. Teleflex Inc.*, 550 U.S. 398, 421

[3] Referred to as the *Graham* factors, these considerations are derived from the Supreme Court's decision in *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966). It is the rule in the Federal Circuit that district courts evaluating a claim of obviousness engage in the inquiry outlined in *Graham*. *Ruiz v. A.B. Chance Co.*, 234 F.3d 654, 662–63 (Fed. Cir. 200).

(2007) ("If [an obvious combination of elements] leads to the anticipated success, it is likely the product not of innovation but of ordinary skill and common sense."). The prior art itself need not be enabled, since even "a non-enabling reference may qualify as prior art for the purpose of determining obviousness, and even an inoperative device is prior art for all that it teaches." *ABT Sys. LLC v. Emerson Elec. Co.*, 797 F.3d 1350, 1360 n.2 (Fed. Cir. 2015) (internal punctuation omitted) (internal quotation marks omitted) (quoting *Symbol Tech., Inc. v. Opticon, Inc.*, 935 F.2d 1569, 1578 (Fed Cir. 1991) and *Beckman Instruments, Inc. v. LKB Produkter AB*, 892 F.2d 1547, 1551 (Fed. Cir. 1989)).

IV. DISCUSSION

Although the BPAI provided two distinct grounds for rejecting SD3's claims, the dispute as to both grounds largely centers on a single determination: whether Friemann's patent enables one skilled in the art in 2001 to build Friemann's band cutter without undue experimentation. Unsurprisingly, the parties have largely—if not exclusively—focused on resolving that determination in their respective favor. Accordingly, SD3 has adduced evidence tending to demonstrate the Friemann band cutter could not be constructed by one skilled in the art in 2001 without undue experimentation. Conversely, the PTO has adduced evidence tending to show a number of methods and components available to one skilled in the art in 2001 that would enable the building of Friemann's band cutter.

The Court addresses the parties' respective evidence and arguments for each of SD3's asserted grounds for nonenablement.

A. Ground One

The Friemann patent issued December 31, 1974 and is prior art to the '211 application. *See* PX1.[4] The Friemann patent explains that "in the case of band cutter machines used in the textile industry for cutting out garment blanks, a large number of accidents, some very serious, have occurred as a consequence of the operator touching the moving band cutter." *Id.* at col. 1, ll. 10-14. To address this problem, the Friemann patent discloses a band cutting machine provided with a "protective circuit arrangement suitable for a motor driven band cutter and which immediately stops the band cutter when it is touched." *Id.* at col. 1, ll. 45-47.

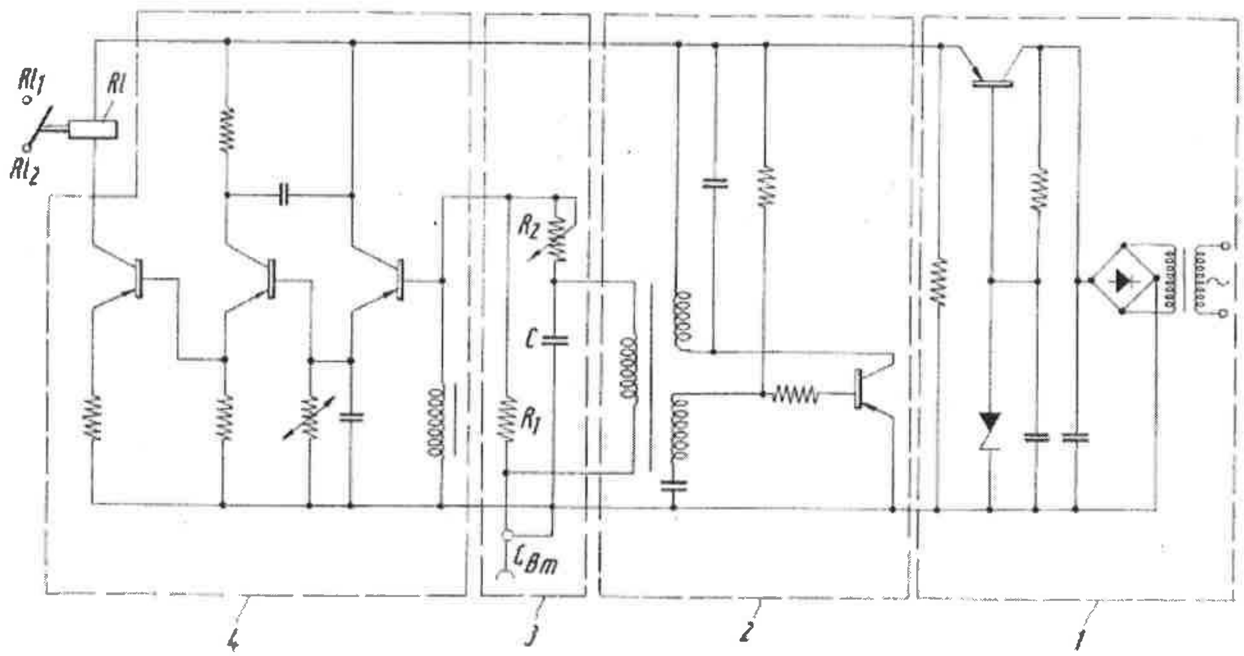
The Friemann patent states that "[e]xperiments have shown that with a protective circuit arrangement in accordance with the invention it is possible for a band cutter to be stopped in about 1/200th of a second, so at the usual speed of rotation of the band cutter of 14 meters per second the run-on distance amounts to 3-5 cm." *Id.* at col.2, ll. 15-20. One two-hundredth of a second is 5ms. The Friemann patent also claims to stop the blade in 10ms. *Id.* at col. 4, l. 6. SD3 claims that

4 Citations to trial exhibits shall appear "PX_" where "PX" denotes plaintiff's exhibit and the following number denotes the exhibit number itself. Conversely, citations to the PTO's trial exhibits shall appear "DX_."

stopping times in these ranges cannot be obtained by one of ordinary skill in the art using the Friemann patent without undue experimentation.

The circuit shown in Figure 1 below depicts the circuit design utilized by the Friemann patent to detect contact between a person and the blade:

Fig. 1



PX1. When contact between a person and the blade is detected, the circuit shown in Figure 1 energizes the relay depicted as R1. A relay is an electromagnetic or electromechanical switch used to make or break and electrical connection. TT. 5/10/2016 A.M. at 58:25 to 59:3.[5]

[5] Citation to the trial transcript shall appear "TT. [Date] [A.M. or P.M.]" followed by the page and line pin citation.

The Friemann patent discloses the use of motor braking in conjunction with electromechanical braking to stop the blade. The Friemann patent discloses two alternate circuit arrangements to accomplish such braking. One circuit is depicted in Figures 3 and 4, and the other in Figures 5 and 6. The Friemann patent does not disclose any other circuit arrangements to control or initiate braking.

1. Embodiment and Disclosed in Figures 3 and 4

Figures 3 and 4 from the Friemann patent are reproduced below:

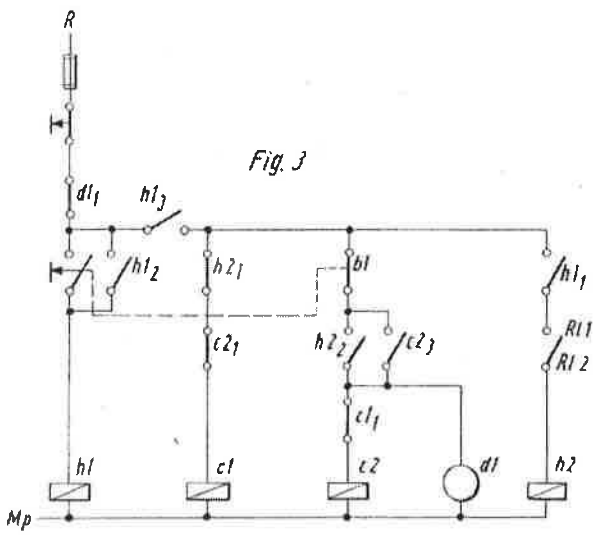
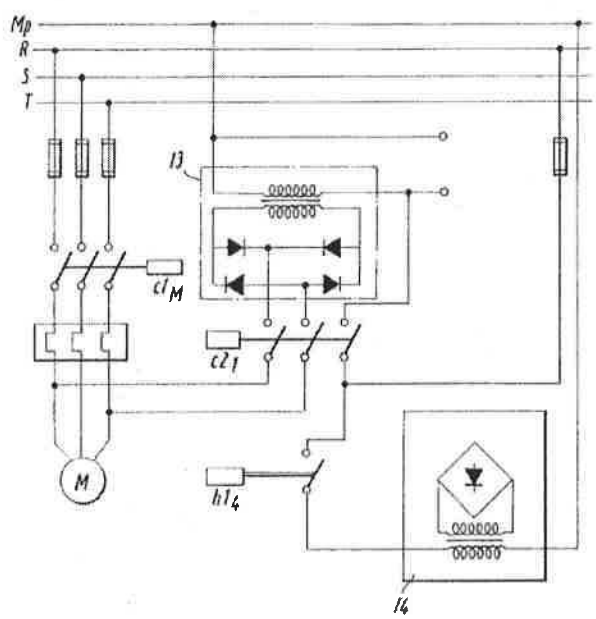


Fig. 4



PX1. The Figures 3 and 4 depict relay h2 being energized when relay R1 closes contact pair $R1_1 - R1_2$. PX1 at col. 3, ll. 55-56. When energized, relay h2 opens contact to $h2_1$ which then de-energizes motor relay c1 cutting off power to the motor. *Id.* at col. 3, ll. 56-59.

The Friemann patent identifies relay c1 as connecting the three-phase electrical power to the motor by way of contact $c1_m$. *Id.* at col. 3, ll. 48-50. Contact $c1_m$. must therefore be of sufficient size to supply current to the motor.

Relay h2 also closes contact $h2_2$ when energized. *Id.* at col. 3, ll. 59-60. Closing contacts $h2_2$ energizes the relay c2 as depicted in Figure 3 above. *Id.* at col. 3, l. 160. When energized, relay c2 closes contact $c2_1$ as depicted in Figure 4 above to initiate motor braking and electromechanical braking. Contact $c2_1$ must be of a size sufficient to supply current to the motor for motor braking and to the electromechanical brake for additional braking.

Thus, for Figures 3 and 4, the Friemann patent contemplates the following sequence when a user's flesh makes contact with the cutting blade: first, contact pair $R1_1 - R1_2$; second, contact $h2_1$ opens and contact $h2_2$ closes; third, contact $c1_m$ closes and contact $c1_1$ opens; fourth, contact $c2_1$ closes.

Relays require time to open and close. SD3 introduced evidence suggesting relays require between 3ms and 25ms to close and between 2ms and 25ms to open. *See* PX305. SD3 also introduced evidence showing closing and opening times of 3ms and 5ms respectively for "subminiature" signal relays. PX306. Dr. Stephen Gass, who is both one of the listed inventors of SD3's claims as well as an expert in the field, testified that relay R1, if it is a typical relay, will switch in between 3 and 5ms. TT. 5/10/2016 A.M. at 70:19-20. The same is true for relay h2. However, because relays c1 and c2 provide power to the motor, their opening and closing times will typically be longer. *See* PX303. The PTO's expert, Dr. Charles Landy,[6] testified at deposition that "a contactor would work in a system as disclosed by Friemann" in "10, 15 milliseconds." Deposition of Dr. Charles Landy, May 21, 2014, at 131:12-16. Lastly, because Friemann teaches direct current ("DC") injection braking, each relay in the sequence must perform its function—that is open or close—before the next relay can safely begin its function.

Thus, according to SD3, a formula for determining the amount of time it would take for the embodiment contained in Figures 3 and 4 to begin motor and electromechanical braking is:

$$T_{r1} + T_{h2} + T_{c1} + T_{c2} = T_{\text{Initiate Braking}}$$

Where T is the amount of time it would take the respective relay to open or close. Taking SD3's relay opening and closing time estimates at face value, the formula suggests that the time it would take Friemann's band cutter to begin braking to be between 18ms and 20ms.[7]

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[6] Dr. Landy was an expert hired by the PTO. Tragically, Dr. Landy passed away during the pendency of this action. He held a Ph.D. in electrical engineering from the University of Witwatersrand in Johannesburg, South Africa. Testimony from Dr. Landy's depositions were admitted into evidence at trial. TT. 5/12/2016 P.M. at 98:16-21.

[7] 2ms (R1) + 2ms (h2) +6ms (c1) +8ms (c2)

In response, the PTO contends that SD3 overestimates the amount of time it would take the relays to close because SD3 fails to take into account overexcitation, which entails the application of current in excess of the normal operating current. In response, Dr. Gass testified that while overexcitation may increase the speed at which a relay closes, it cannot increase the speed at which a relay opens, because the opening of a relay relies not on the building up of a magnetic field, but upon a magnetic field's decay. TT. 5/10/2016 A.M. at 83:3-14. The PTO did not dispute that assertion. Nor did the PTO provide evidence detailing the reduction in closing times one would expect from an over-excited relay. However, SD3 contends that even accepting overexcitation could decrease closing time by a third, it would still require the Friemann band cutter, as depicted in Figures 3 and 4, 15ms to being braking.[8] Likewise, if overexcitation halved the closing times, it would still require 12ms to begin motor braking.[9]

Accordingly, SD3 argues Friemann, as disclosed in Figures 3 and 4, could not enable one of ordinary skill in the art to stop the band saw blade in 5ms or 10ms.

Beyond its reliance on overexcitation, the PTO offers no other method for permitting Friemann's embodiment as disclosed in Figures 3 and 4 to being braking within 5ms or 10ms.

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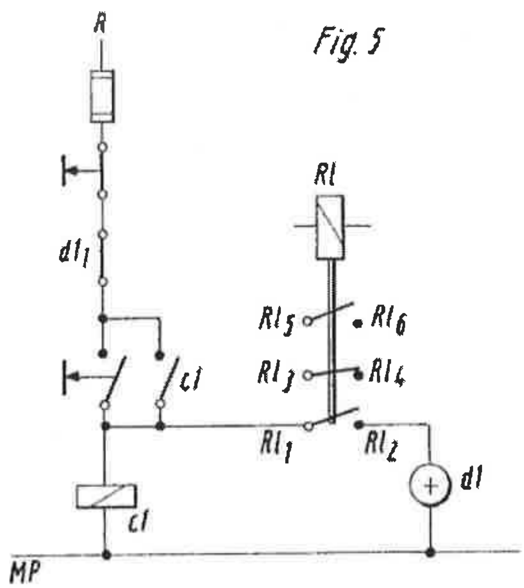
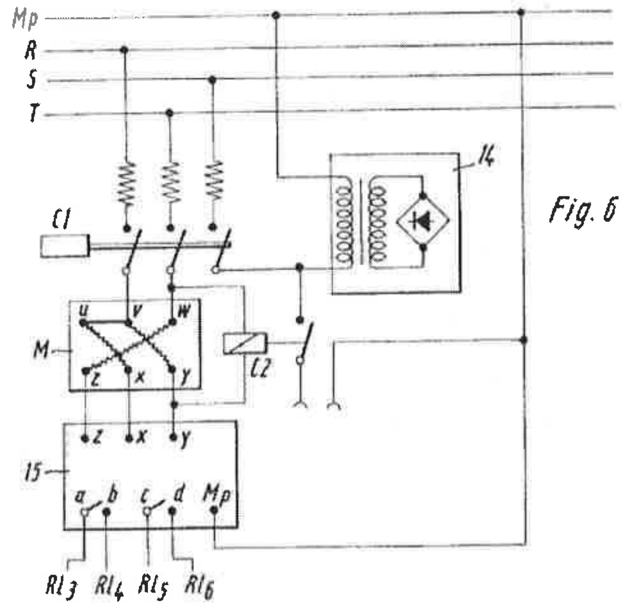
[8] 1.5ms (R1) + 1.5ms (h2) +6ms (c1) +6ms (c2)

[9] 1ms (R1) + 1ms (h2) +6ms (c1) +4ms (c2)

2. Embodiment as Disclosed in Figures 5 and 6

Friemann provides an alternative circuit configuration for his band cutting machine as demonstrated by Figures 5 and 6 below:





PX1. Figures 5 and 6 depict relay R1 being energized when contact between a person and the band blade is detected. When energized, R1 closes contact pair $R1_1 - R1_2$ and $R1_5 - R1_6$, and opens contact pair $R1_3 - R1_4$. *See* PX1, col. 4, ll. 40-42. The closing of contact pairs $R1_1 - R1_2$ and $R1_5 - R1_6$ actuates an electronic reversing switch—denoted as "15" in Figure 6—to initiate motor braking, and simultaneously close relay c2 to energize electromechanical braking. *Id.* at col. 4, ll. 45-53.

The Friemann patent identifies electronic reversing switch 15 as being of the type "Rewimat 2000." *Id.* at col. 4, l. 48. SD3 introduced evidence that the Rewimat 2000 is a type of reversing switch known as a triode for alternating current

("TRIAC") solid state relay. *See* PX314. Dr. Gass testified that, at minimum, a relay like the Rewimat 2000 at 60 Hz would require 5.5ms to switch from three-phase alternating current ("AC") to direct current because at that frequency 5.5ms is the shortest possible time in which voltage on all three phases to cross to zero. TT. 5/10/2016 A.M. at 90:10-22.

It is extremely important that, prior to switching from AC, the three phases reach zero voltage, elsewise a short circuit will result with possibly grave results. TT. 5/10/2016 A.M. at 93:4-7; TT. 5/11/2016 P.M. at 60:8. As a result SD3 introduced evidence demonstrating that manufacturers typically include an interlock time in their electronic switches in order to avoid short circuits. PX302; TT. 5/10/2016 A.M. at 92:21–93:10. One of the PTO's experts, Mr. Michael Gilliland[10] also testified that reversing switches include interlock times. TT. 5/11/2016 P.M. at 59:19–60:11. SD3 introduced evidence demonstrating that in commercially available TRIAC-based solid state relays, the interlock time is between 50ms and 100ms. *See* PX302; TT. 5/10/2016 A.M. at 94:15-17.

Thus, according to SD3, Friemann's band cutter as disclosed in Figures 5 and 6 could not initiate braking within 5ms or 10ms.

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[10] Mr. Gililland holds a bachelor's degree in electrical engineering from Louisiana Tech University; he has extensive experience as a safety engineer for power tool companies.

Contrary to SD3's assertions, the PTO's experts testified that a person of ordinary skill in the art would use electronic switches such as silicon controlled rectifiers ("SCR") to initiate braking. *E.g.*, TT. 5/11/2016 P.M. at 61:9–62:7. One of the PTO's experts, Dr. Bruno Lequesne[11] stated that SCRs were invented in the 1950s, and widely used in the 1970s and 1980s, but were largely displaced by power transistors in 2001. TX300 at ¶66; TT. 5/12/2016 P.M. at 37:24–38:8. Dr. Lequesne went on to testify that in 2001 one of ordinary skill in the art would have used power transistors, rather than SCRs or electromechanical relays. TT. 5/12/2016 P.M. at 37:24–38:5. These SCRs and power transistors can switch power on the order of microseconds.

SD3 did not contest the PTO's assertion that SCRs could be designed to switch power off in microseconds. SD3 did contest the assertion that such an SCR could be purchased commercially; SD3 also claimed that the design and construction of such an SCR would be "a new invention." TT. 5/10/2016 A.M. at 96:20-23. Mr. Gililland echoed this point. When asked whether the Friemann specification contained the requisite circuitry to operate an SCR that could switch power off in microseconds, Mr. Gililland responded: "[n]o, you have to have more circuitry than that." TT. 5/11/2016 P.M. at 91:17. When asked whether an SCR that would meet

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[11] Dr. Lequesne holds a PhD in electrical engineering from the Missouri University of Science and Technology. He is a specialist in electric machines, actuators and, and electromechanical systems, including the design of electric motors.

the requirements to implement the Friemann patent was available commercially in 2001, Mr. Gililland responded: "I could probably find some control circuits that could be adapted to do that . . . ." *Id.* at 92:4-6. Accordingly, SD3 asserts one of ordinary skill in the art could not design such a circuit without undue experimentation, and, therefore, could not build Friemann's band cutting machine without undue experimentation.

B. Ground Two

SD3's second ground for nonenablement is that the motor and electromechanical braking as disclosed in the Friemann patent cannot stop the blade in the time frames specified in SD3's claims.[12]

SD3 focused its arguments here on the amount of inertia contained in a band cutting machine like Friemann's, and using various estimates of pulley inertia, pulley ration, motor inertia, motor torque, and so forth, SD3 calculated the time it would take to stop the blade. The basic formula for that calculation is: stopping time (t) = inertia (J) x angular velocity (ω) $\div$ torque (τ). As applied to this case, the equation is:

[12] SD3 has four time-specific claims at issue. Claims 1 and 24 require the blade to stop "within 10 milliseconds." Claim 22 requires the blade to stop within 7 milliseconds. Claim 23 requires the blade to stop within 5 milliseconds. Claim 30 requires the blade to stop "in less than 5 milliseconds."

$$t = \frac{\left[\left(\begin{matrix}\text{motor}\\ \text{inertia}\end{matrix} + \begin{matrix}\text{belt}\\ \text{pulley}\\ \text{inertia}\end{matrix}\right) \times \begin{matrix}\text{motor}\\ \text{angular}\\ \text{velocity}\end{matrix}\right] + \dfrac{\left(\begin{matrix}\text{rollers and}\\ \text{belt pulley}\\ \text{inertia}\end{matrix} + \begin{matrix}\text{blade}\\ \text{inertia}\end{matrix}\right) \times \begin{matrix}\text{roller}\\ \text{angular}\\ \text{velocity}\end{matrix}}{\text{gear ratio}}}{\text{motor torque}}$$

Due to the nature of the above equation, the time required to stop can be reduced in a number of ways. For instance, the motor inertia and speed can be reduced. The same is true for the inertia and speed of the pulleys. Alternatively, the motor torque can be increased. Torque may also be increased by the addition of electromechanical braking. Theoretically, any one of these changes or combination of them, will lead to faster stopping times. The parties principally dispute what changes are practically possible without undue experimentation, and indeed, what changes are possible within the realm of current knowledge and capability.

1. *The Pulley and Roller Inertia, Blade Inertia, Gear Ratio, and Angular Velocity*

The parties disputed the pulley inertia and belt pulley ratio that should be included in the equation. According to SD3, the Friemann patent speaks to "industrial" band cutters, and, therefore, the pulleys would be made of metal—a material that would have a higher inertia than materials like plastic. TT. 5/10/2016 P.M. at 26:8-13. The PTO disputes that characterization of Friemann, noting that neither Friemann nor SD3's claims are limited to "industrial" applications.

Accordingly, the PTO adduced evidence of a consumer-grade, 1/3 horsepower band saw that had pulleys made of fiberglass. PX29; PX30. Dr. Landy, one of the PTO's experts, calculated that pulley would have a rotational inertia of .0055 kg-m^2. At trial, SD3 accepted, for the sake of argument, the .0055 kg-m^2 estimate. TT. 5/10/2-2016 P.M. at 25:6–26:13.

For the belt pulley inertia, both parties utilized .0015 kg-m^2, though that number would necessarily be higher if a heavy-duty pulley were utilized. Further, based on the 1/3 horsepower saw, SD3 utilized a 1.1 rather than 2 gear ratio.

The parties did not disagree that a blade inertia of .00162 kg-m^2 was reasonable. Furthermore, the parties did not dispute that a 1,500 RPM or 157 rad/sec angular velocity for the motor was reasonable. Both parties utilized a 140 rad/sec roller angular velocity.

2. The Motor Inertia and Motor Torque

The parties principally dispute the amount of torque that can be reliably produced by induction motors, and, to a lesser degree, the amount of inertia those motors would have. At trial, the parties centered their arguments on a motor called the FL-1838 which is manufactured by a company named Baldor. PX 320(d)(1). The FL-1838 is a "Medium and Low Inertia (DPG-FV) Induction Servo" motor. *Id.* at 44. According to the Baldor catalogue, these types of motors inherently have the "lowest inertia (highest torque to inertia ratio) of any induction motor." *Id.* The catalogue lists the FL-1838 as a "Non-Stock Custom Built Motor[.]" *Id.* It has a rotational inertia of .022 kg-m^2 and produces 81 Newton-meters continuous torque, and 121 Newton-meters peak torque. According to the Baldor catalogue, peak torque is the "One-Minute overload torque available from 0 RPM to the maximum speed at which the inverter can maintain constant flux at this overload." *Id.* n.3.

The Baldor catalogue is not sufficiently detailed to demonstrate whether the FL-1838 motor existed in 2001. *See* PX320(d1). When asked whether he was confident a similar motor could be found in 2001, Dr. Lequesne responded: "Absolutely. In fact, in my supplemental report, I have one paper from the '50s." TT. 5/12/2016 A.M. at 54:9-16. That paper discussed "Low-Inertia induction Motors" and was dated June 1957. *See* PX320(d3). The paper identified six motors, four of which, Models A through D, could not stop within 10ms, and the two remaining motors stopped in approximately 8ms and 5ms respectively. *Id.* at Fig. 3. According to Figures 9 and 10 in the paper, the Model E motor produced only around 0.1 horsepower and no more than 0.2 foot-pounds of torque at 1500 RPM, which is roughly .3 Newton-meters of torque. By contrast, the FL-1838 motor is a 15-20 horsepower motor that produces 81 Newton-meters of rated torque and 183 Newton-meters of breakdown torque. DX318 at 5; DX320 at 2.

Plugging the FL-1838's specifications into the formula for determining the stopping time for Friemann's machine renders the following results:

$$t = \frac{\left[(0.022 + 0.0015) \times 157\right] + \frac{(0.0055 + 0.00162) \times 140}{1.1}}{183}$$

$$t = 25 \text{ ms}$$

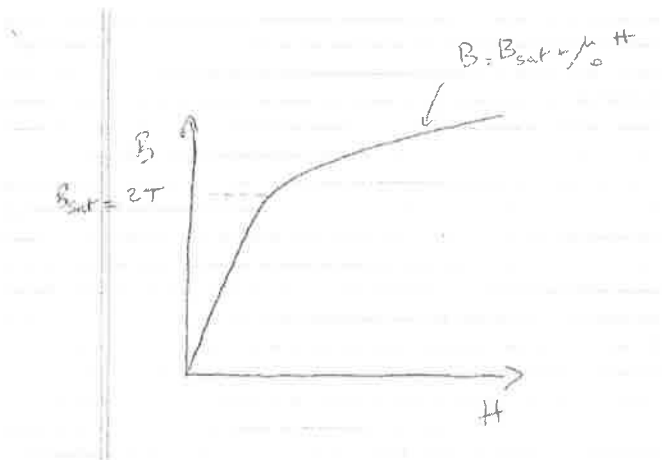
Without additional braking and using the FL-1838 motor, a machine as described by Friemann would require 25ms for the blade to come to a stop, assuming braking could begin at the exact same time the user's flesh came into contact with the blade.[13]

Through its experts, the PTO asserts that a number of well-known techniques along with the addition of one or more electromechanical brakes would permit the Friemann band cutting machine to stop within the times specified in SD3's claims. Those techniques include the use of overexcitation of the motor, the inclusion of

[13] This calculation omits friction and windage. Although their inclusion would lead to a shorter stopping time, the difference would be marginal to the point of irrelevance for these purposes. *See* TT. 5/13/2016 A.M. at 8:15–9:1 (explaining that the difference in torque required to stop the machine would be on the order of 0.1% lower).

"transient torques" in the calculations, the use of one or more electromechanical brakes, and the overexcitation of those brakes.

The torque generated by an induction motor is "proportional to the square of the voltage applied to the machine." DX300 at 16. "Therefore, the application of a smaller voltage reduces the machine torque, and conversely the application of a larger voltage increases the machine torque." *Id.* at 17. Thus, "higher voltages can be used to apply larger torques and obtain, when critical, faster accelerations and decelerations." *Id.* The use of overexcitation is generally limited by two considerations: first, because overexcitation requires larger currents to flow through the motor, it can lead to overheating. *Id.* Second, the amount of additional torque per increase in voltage is limited by the motor's rotor magnetic saturation. *Id.* "This is because the voltage applied to a machine determines the magnetic flux in the machine steel core, and magnetic flux in steel saturates at some level." *Id.* The unit of measurement for magnetic flux density is the tesla. Steel will start to experience saturation around 2 tesla, and induction machines are generally designed to operate at around 1.7-1.8 tesla. TT. 5/13/2016 P.M. at 49:19-21; *Id.* at 55:13. When asked whether the FL-1838 motor would fit that norm, Dr. Lequesne stated: "I would expect so." *Id.* The following graph, drawn by Dr. Lequesne, represents the typical magnetic saturation curve for a material where the Y axis represents magnetic density and the X axis represents magnetic field, and the dotted line represents the saturation point for steel of two Tesla:



DX340. Dr. Lequesne estimated that if the FL-1838 voltage were increased by two, a conservative estimate for the increase in torque would be "2 to 3" which would give the FL-1838 between 366 and 549 Newton-meters of torque.

To buttress the conclusion that overexcitation could provide that level of increased torque, Dr. Lequesne provided computer simulations. The first simulation using the SPEED program, demonstrated that a motor could produce three times breakdown torque when overexcited by 200%, that is, when receiving twice the rated voltage. TT. 5/13/2016 P.M. at 12:21–13:15. The manual for the SPEED software, however, warns that it is weak in simulating the effects of magnetic saturation, and magnetic saturation is the primary limitation on the amount of torque a motor can produce when overexcited. *See* PX336 at 2; TT. 5/13/2016 P.M. at 14:3-21; TT. 5/10/2016 P.M. at 35:4-7. The manual in fact states that the results of the simulation should be viewed with skepticism. TT. 5/13/2016 P.M. at 21:2-9. Furthermore, on cross-examination Dr. Lequesne acknowledged that he did not use SPEED's recommended settings, and the settings he did select lessened the program's ability to accurately simulate magnetic saturation. *Id.* at 17:2-20:18. When asked why he failed to use the recommended settings, Dr. Lequesne responded:

> This manual is very long. I mean, it's very thick. I mean, there are recommended settings. What they mean, and it's well known that, you know the more you are saturated the more difficult it is to predict results. The direction will be correct, but the numbers, the precision of the numbers is less.

Id. at 53:19–54:1. Dr. Lequesne did not use the recommended settings even though he testified that he has used software tools since the beginning of his career. *Id.* at 22:3-6.

Dr. Lequesne also performed a finite element analysis with a software program called FLUX to support his conclusion that a motor could produce three times breakdown torque through overexcitation. TT. 5/13/2016 P.M. at 13:7-15. The SPEED analysis discussed above was "used for programming the FLUX." *Id.* The FLUX analysis showed a possible 4 to 5-fold increase in breakdown torque. *Id.* at

55:20–57:7. Thus, according to Dr. Lequesne, his 2-3 times increase may have been "conservative." *Id.* The FLUX analysis was not conducted based on the FL-1838 motor, but according to Dr. Lequesne, "motors are motors." *See id.* at 26:18.

Based on these simulations, Dr. Lequesne maintains that the FL-1838 motor could obtain three times its breakdown torque of 183 Newton-meters when overexcited by 200%. Though, he does admit that number may be an overestimate by "10, 20 percent." TT. 5/12/2016 P.M. at 65:18-23. To further buttress his claims, Dr. Lequesne contacted Baldor representatives in a series of e-mails. Dr. Gass did the same. Both sets of e-mails were admitted into evidence.

In the e-mails the Baldor representative, Rick Shaefer, explained that a motor like the FL-1838 can be designed for "150%, 200%, 300%" overload. PX320(d2).[14] In Dr. Gass's e-mails with Baldor, Mr. Shaefer stated that the maximum torque that could be generated by an FL-1838 motor over a 10ms time frame is "148 ft-lb for the full ten milliseconds so long as the drive can provide the needed current." PX318. 148 ft-lb is 200 Newton-meters of torque. When asked whether this value could potentially be increased by three times through overexcitation, Mr. Shaefer responded: "I have been told by engineering that this will not work." *Id.* "Basically

[14] In his e-mails with Dr. Gass, Mr. Shaefer clarified that the "150%, 200%, 300%" overload increase was in relation to rated torque, not overload torque. PX318. The rated torque for the FL-1838 is 81 Newton-meters. PX320(d1).

we simply need to design a motor that will give you the best possible [breakdown torque] for the given rating (HP & base speed) without increasing the rotor length or diameter (rotor inertia)." *Id.*

Upon learning of Dr. Gass's communications with Baldor, Dr. Lequesne stated at trial: "I still believe that you can increase the torque from the nominal value of 183 . . . I can see somebody else having a different opinion, some may think it's less." TT. 5/13/2016 P.M. at 46:19-25. Referring to his computer simulations, Dr. Lequesne stated, "After I saw my results from the finite elements, there may be some people that think [his 2-3 times breakdown torque estimate is] too conservative." *Id.*

After learning of Dr. Gass's e-mail correspondence with Baldor and unbeknownst to SD3, Dr. Lequesne held a phone conference with Baldor on May 10, 2016, the first day of the bench trial in this matter. The next day, he provided notes of his phone conference to SD3, and they were subsequently introduced into evidence. PX340; TT. 5/13/2016 P.M. at 24:17–25:22.

After summarizing the problem, Dr. Lequesne asked Baldor of the FL-1838 breakdown torque could be increased by design. PX340. Baldor responded that the number of turns in the winding could be reduced and may result in a 19% increase in torque. *Id.* Dr. Lequesne went on to ask whether a special motor could be designed to be able to get a better torque per inertia ratio. *Id.* Baldor responded that it was possible, but would "require lamination patterns no currently in production, and the capital investment cost would be high." *Id.* When asked whether the FL-1838 could be overexcited during DC injection braking, Dr. Lequesne notes Baldor's response as being that it was possible but would require wires rated for the next voltage level. *Id.* Baldor, however, could not guess as to how much more torque was possible. *Id.*

In response to Dr. Lequesne's testimony that overexcitation would permit a motor like the FL-1838 to produce three times breakdown torque, Dr. Gass testified that he had never heard of a motor achieving that level of increased torque over a stop period of 10ms. TT. 5/13/2016 P.M. at 83:15-25. SD3's other expert, Dr. David Turcic,[15] stated that if overexcitation could lead to a 300% increase in breakdown torque, it would "be a complete surprise in my opinion." TT. 5/11/2016 P.M. at 7:9-10. Dr. Gass also testified that a motor like the FL-1838 is a "high-speed servomotor." TT. 5/10/2016 P.M. at 40:1-2. To operate it requires "a servo controller" *Id.* at 5-6.

SD3 also pointed to an article titled "Dynamic Braking of a Voltage Supplied Induction Motor Using Finite Element Analysis," written by T.H. Pham, P.F. Wendling, P. Lombard, J.S. Salon, and H. Acikgoz ("Pham paper"). The Pham paper

[15] Dr. Turcic holds a PhD in mechanical engineering from Pennsylvania State University and has experience with high-speed systems. He is currently a tenured professor at Portland State University in Portland, Oregon.

was originally identified by Dr. Landy, one of the PTO's experts, and was published in 1997 by the Institute of Electrical and Electronics Engineers. PX4; TT. 5/10/2016 P.M. at 7:9–8:8; TT. 5/12/2016 P.M. at 6:6-11. The Pham paper used computer program, finite elements—the same program utilized by Dr. Lequesne in one of his simulations—to simulate the effects on an AC induction motor under the effects of DC injection braking. TT. 5/10/2016 P.M. at 8:11-15; TT. 5/13/2016 P.M. at 46:13-14. The motor in the paper required 37ms to stop. PX6.

The parties disagree whether the motor in the Pham paper was overexcited. Dr. Gass testified that it is his opinion the motor in the paper was overexcited by as much as 15 times normal operating current. TT. 5/10/2016 P.M. at 12:14-25. Dr. Gass testified that the Pham paper therefore supports his testimony that a motor cannot produce three times breakdown torque when overexcited during DC injection braking. *Id.* at 34:16. He explained that "from the total time that it takes to stop and the inertia of the motor, you can go back to this formula [Newton's Second Law of Motion for rotating bodies] and you can figure out what the effective torque that the motor produced was during its deceleration." *Id.* at 22:1-3, 34:24–35:3. Based on that analysis, Dr. Gass estimates the motor in the Pham paper achieved "just over one times" breakdown torque. *Id.* at 81:6-7. Dr. Gass further contrasted the Pham paper with Dr. Lequesne's simulations by noting "[the Pham paper is] published and reviewed. It's not just a quick, off-the-cuff simulation . . . that nobody else has ever looked at." *Id.* at 83:23-25.

Dr. Lequesne disagrees that the motor in the Pham article was overexcited at all. TT. 5/13/2016 P.M. at 45:23–46:2. In his opinion, "if they had modeled overexcitation, they would have said so." *Id.* at 90:3-6. Dr. Landy, the expert who identified the Pham article, testified at his deposition that it was his opinion the motor in the Pham paper was overexcited. Landy Dep. 5/21/2014 at 87:3-5. When asked if he could quantify the overexcitation, Dr. Landy responded: "probably 20 times," "[b]etween 10 and 20," and "8 times, that sort of order." *Id.* at 87:9–88:2. When asked whether the amount of overexcitation in the motor was "quite a bit," Dr. Landy responded "it appears so, yes." *Id.* at 103:21-23.

On a final note about motor torque and inertia, the PTO suggested at various times that a smaller motor might be able to stop faster by virtue of its lower inertia (and the lower inertia of the accompanying pulleys, and so forth). *E.g.*, TT. 5/11/2016 A.M. 23:20-25. However, that line of reasoning is in tension with testimony given by Dr. Lequesne, the PTO's expert who explained:

> Bigger [motor] has a bigger inertia, but the load, the rest of the load does not change. So there's an advantage in using your bigger machine because you get more torque over total inertia.

Dr. Lequesne's testimony makes clear that a faster stopping time will only be achieved if the overall torque to inertia ration is altered through the scaling down of the size of the machine in question. It is not necessarily true, then, as the PTO suggests, that a smaller machine will have a better torque to inertia ratio, and no evidence was received demonstrating that to be the case.

3. Electromechanical Brakes

The Friemann patent also discloses the use of electromechanical brakes to aid in stopping the band blade. PX1 at col.1, l. 66, col. 4, ll. 3, 16-17, and 61, col. 6, ll. 6-7. Assuming an induction motor cannot provide sufficient torque to stop the band blade in 10ms, the parties disagree whether electromechanical brakes can provide sufficient additional torque to halt the band blade within 10ms after a user's flesh comes into contact with the blade.

Friemann discloses the use of electromechanical braking as an aid in stopping the band blade. PX1 at col. 3-4, ll. 63-6. He suggests, by way of example, that an electromechanical brake could be placed on the drive pulley or the motor's flywheel. The PTO suggested throughout trial that multiple brakes could be used, including a brake on the blade itself.

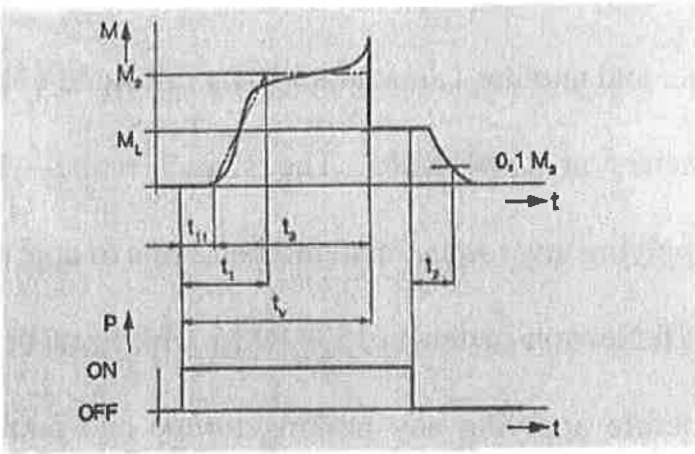
The PTO identified three electromechanical brakes from a company called Mayr that it believed would provide sufficient torque in sufficient time. The specific brakes are the ROBA-quick electromagnetic brakes sizes 3, 5, and 6. PX23; TT. 5/13/2016 A.M. at 59:7-9. The catalogue identifying these brakes and their characteristics is dated "28/05/2010." PX23 at 60 ("Product Summary" page). When asked whether brakes like these existed in 2001, Dr. Lequesne stated that he did not know, but that "something similar could well have existed, even if the Mayr brakes did not" because braking technology had "not changed that much." TT. 5/13/2016 A.M. at 64:11-13.

The Mayr brake specifications are:

Switching times				Size 3	4	5	6	7	8	9
Without overexcitation	Type 520.___._	t_{11}	[sec]	0,006	0,008	0,010	0,015	0,025	0,027	0,030
		t_1	[sec]	0,035	0,040	0,055	0,100	0,150	0,245	0,330
		t_2	[sec]	0,010	0,018	0,030	0,060	0,090	0,100	0,140
With overexcitation	Type 520.___._	t_{11}	[sec]	0,002	0,003	0,004	0,006	0,008	0,010	0,015
		t_1	[sec]	0,020	0,022	0,030	0,050	0,075	0,120	0,165

Table 3

PX320 at 30. The figures in Table 3 are explained by Diagram 3, below:



Key:

M_2 = Nominal torque of the brake
M_L = Load torque of the drive
P = Electrical power
t_v = Deceleration time
t_1 = Connection time
t_{11} = Response delay on connection
t_2 = Disconnection time
t_3 = Slip time

Diagram 3: Torque-time

PX320 at 39. The torque each brake can provide at a given RPM is described by Diagrams 1 and 2 below:

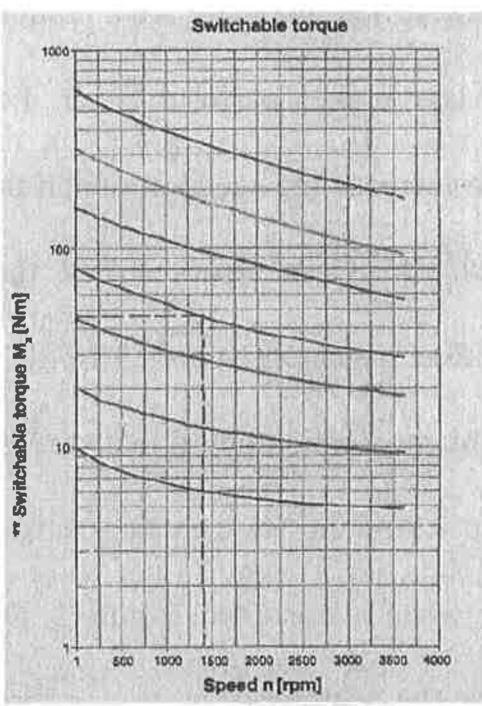


Diagram 1 ** Friction surfaces have been run in

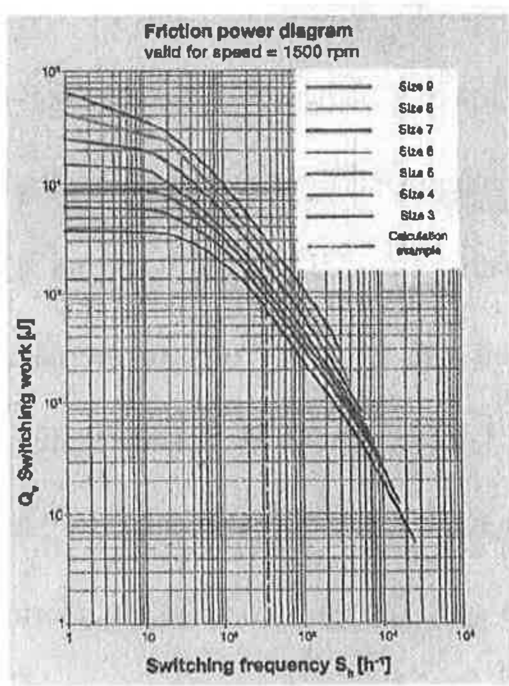


Diagram 2

PX320 at 38. Diagrams 1-3 and Figure 1 taken together render the following approximations for the Mayr brakes: size 3 is the smallest and fastest of the brakes identified. According to the Mayr catalogue, when overexcited it requires 2ms before applying any braking torque, and another 18ms to apply its full-rated torque of approximately 6-7 Newton-meters at 1500 RPM. The size 5 brake when overexcited requires 4ms before applying any torque, and another 26ms to apply its full-rated torque of approximately 26 Newton-meters at 1500 RPM. The size 6 brake when overexcited requires 6ms before applying any braking torque and another 44ms before applying its full-rated torque of approximately 45 Newton-meters at 1500 RPM.

In response to SD3's argument that these specifications show that the Mayr family of brakes are not fast enough, Dr. Lequesne testified that there are a number of ways to make off-the-shelf brakes like the Mayr brakes perform faster. For instance, he suggested the use of overexcitation to increase the speed at which the brakes actuate. TT. 5/12/2016 P.M. at 47:8-24. Dr. Gass also testified that overexcitation was a known way to increase brake engagement speed. 5/10/2016 P.M. at 115:1-4. Similarly, Dr. Landy stated that overexcitation could increase the speed at which the Mayr brakes engaged. PX8 at 8 n.4. And the Mayr catalogue itself in fact gives specifications for brake performance when overexcited. Figure 1. Dr. Gass also agreed that overexcitement could reduce the response time to one forth nominal response time. TT. 5/11/2016 A.M. at 56:10-15. He also stated his own tests showed that the brake's holding force was increased by around 60-70%. *Id.* at ll. 3-

9. He was able to get the size 6 brake to engage in approximately 5.2ms. *See* PX300. But he clarified that for his own tests he had to develop a circuit because the Mayr overexcitation brake controller "wouldn't do what I wanted to do to fairly test the maximum possible characteristics of the brake." *Id.* at 50:23–51:5. He characterized the effort to design that circuit "substantial . . . it wasn't something that you could buy." *Id.*

Based on Dr. Gass's experiments, Dr. Lequesne testified that a size 5 Mayr brake may be able to engage in as fast as "four or even three milliseconds." TT. 5/12/2016 P.M. at 54:4-11. Dr. Lequesne went on to suggest that the brake response time could be further improved by keeping the brake cool, as well as lowering the air gap between the brake and the engagement surface. *Id.* at 54:17-25–55:11. Mr. Gililland also testified that customized brakes could be designed to act faster than the Mayr brakes by, for example, changing the springs, air gap, or windings. 5/11/2016 P.M. at 63:11–64:12.

In addition to the response time, the Mayr brakes do not reach their peak torque for some time after they engage. Diagram 3, *supra*, represents that interval as t_1. There was no testimony at trial presented regarding the amount of torque an overexcited Mayr brake could be expected to produce within 10ms of engaging. In other words, the was no testimony describing the amount of torque a Mayr size 6 brake would produce within 4.8ms of its 5.2ms engagement time.

Additionally, the Mayr brakes must stop themselves before they can begin aiding in stopping the band saw blade because each brake has its own inertia. TT. 5/11/2016 P.M. at 115:14-18. Thus, the Mr. Gililland testified that although adding multiple brakes would increase the inertia in the system, "they will still apply additional stopping force." *Id.* at ll. 10-13. Thus, he testified that although each brake has to account for its own inertia, "if you trigger them all at the same time, then they will all be applying whatever force they can apply." Dr. Lequesne similarly testified that adding more breaks will increase inertia, but will also increase torque. TT. 5/12/2016 P.M. at 58:8. There was no evidence admitted detailing the amount of inertia the Mayr brakes would add and whether that additional torque would offset the increased inertia in a 10ms timeframe.

4. Transient Torques

The parties also disagree on the role, if any, that transient torques would play in stopping the motor.

As described by Dr. Landy in his report, induction motors do not always generate a "steady" amount of torque. PX8 at 6. Rather, when "the motor is no longer operat[ing] in a steady state mode from the time the AC supply is removed and during the DC dynamic braking." *Id.* "In this period the motor operates in a transient state until it stops because the speed is changing." During that transient state, according to Dr. Landy, "the induction motor differential equations must be used to predict DC dynamic braking torque produced and its variation with time." *Id.* at 6–7. According to Dr. Lequesne, "it is well known that during starting or stopping induction machines, you will have an average torque, which is the same torque that you would have in a steady [nontransient] state." TT. 5/13/2016 P.M. at 4:2-8. "[Y]ou add to that transient torque, which are oscillating torques. You add, subtract, add, subtract, in an oscillating manner." *Id.* at ll. 9-11. The oscillations in the following figure demonstrate the transient torques that existed in the motor simulated by the Pham paper:

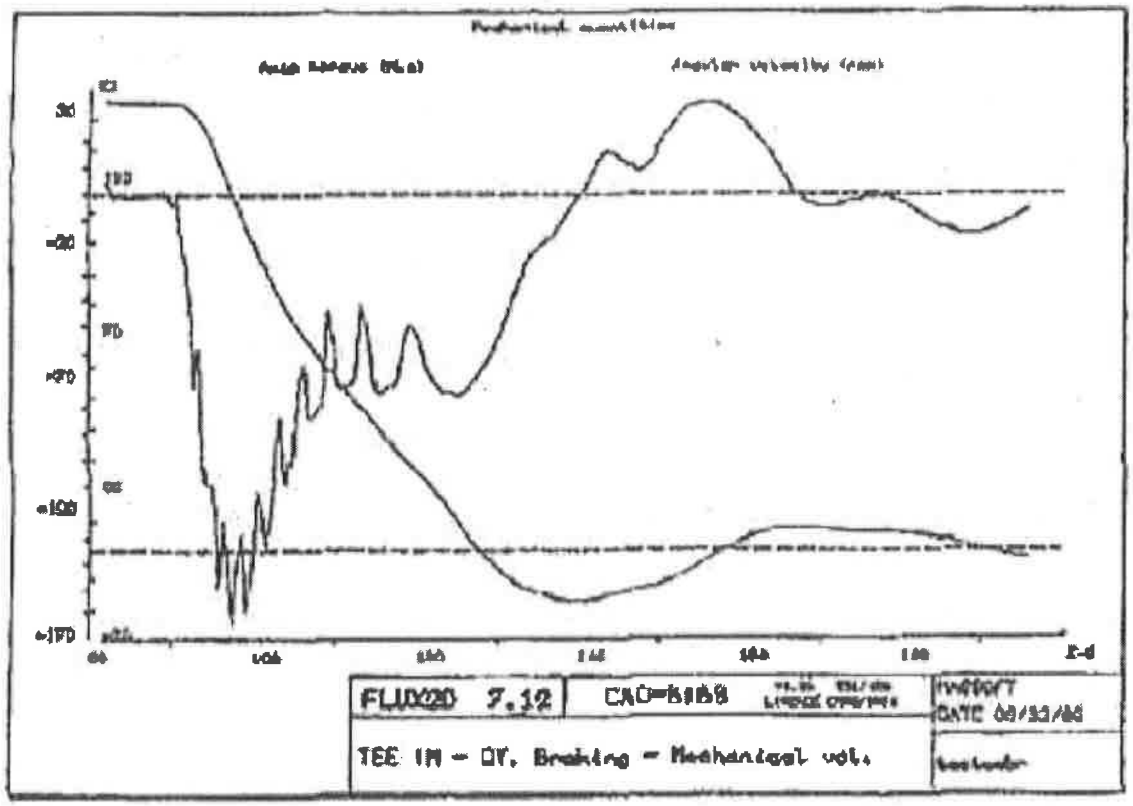


Figure 4: Torque and Rotor Velocity during the Dynamic Braking

PX 8. The line with the large oscillations is the torque over time simulated by the motor. PX 8 at 7. The oscillations themselves are what the parties in this matter have referred to as transient torques. TT. 5/13/2016 P.M. at 7:9-12. An overexcited motor will produce oscillations of greater magnitude.

Dr. Lequesne further explained that eventually the oscillations die down and the torque generated by the motor remains steady. *Id.* at 10: 6-11. And indeed due to their oscillating nature, over time the effect of transient torques is "zero." *Id.* at l. 12. However, according to Dr. Lequesne, if one manages to stop the motor with the first "pulse" of negative transient torque, then the transient torques could help stop a motor within 10ms. *Id.* at 11:12–12:5.

Pointing to the Pham article, Dr. Landy concluded that the peak transient during DC injection braking could be as much as 6.5 times full-load torque at 7.5ms. PX16 at 1. Dr. Landy went on to perform a number of simulations in a program called MATLAB to confirm the role transient torques played in stopping a motor in the relevant time frame. Landy Dep. 12/16/2016 at 21:11-25. Dr. Landy explained in his declaration, DX29, that he obtained 12 times the full load torque in that simulation. Landy Dep. 12/16/2015 at 33:18–35:7. Dr. Landy went on to explain that the motor he programed into his simulation was a motor that he "designed." *Id.* at 21:11-25. In other words, it is a motor that does not exist except in Dr. Landy's simulations. In explaining why he believed his simulation reflected the real-world performance of the motor, Dr. Landy pointed out that the program he designed and utilized had been used "many hundreds of times" by companies that manufacture induction motors. *Id.* at 23:16–24:21. Thus, he explained: "I am totally confident that this program produces machines that are viable to work . . . . So on that basis and with my design experience, I designed this motor." *Id.*

Dr. Lequesne reviewed Dr. Landy's simulation and testified about it at trial. TT. 5/12/2016 P.M. at 21:11–22:15; PX35. Dr. Lequesne testified that the motor specifications used by Dr. Landy were "reasonable."

During trial, Dr. Gass questioned the reliability of a simulation based on a nonexistent motor. TT. 5/11/2016 A.M. at 48:7-18. Further, during trial, it was later disclosed that—though not specifically relevant to the question of transient torques—the 10ms stopping time obtained by Dr. Landy in his simulation was partially effected through the addition of a brake applying roughly 220 Newton-meters of torque to the simulated motor. TT. 5/13/2016 A.M. at 14:10-15. The simulation however does not explicitly mention the use of a brake. *See* PX35.[16]

5. Slippage

Lastly, the parties disagree on what role, if any, slippage would play in stopping the band blade.[17]

Slippage, according to Mr. Gililland, can occur when the blade itself is stopped, while the motor, rollers, and pulleys continue to rotate. TT. 5/11/2016 P.M. at 67:7-9. This can be accomplished by braking the band saw blade directly, rather than braking the saw's other moving parts, namely the motors, rollers, and pulleys. *Id.* at 67:20–68:25. To support Mr. Gililland's assertion, the PTO points to an

[16] The use of a brake likewise went unmentioned by Dr. Lequesne when he, in great detail, explained the technical details of Dr. Landy's simulation. *See* TT. 5/12/2016 P.M. at 18:1–30:8.
[17] SD3's failure to consider slippage was one of the grounds under which the BPAI affirmed the denial of SD3's claims here. PX200 at A907.

Australian band saw—called the "BladeStop"—that applies braking directly to the band saw blade. TT. 5/10/2016 P.M. at 122:21–123:16.

In response, Dr. Gass testified that there were a number of complications involved in grabbing a band saw blade directly. *Id.* at 121:18–122:2. He further explained that grabbing a steel blade is difficult, and to get around that difficulty one of SD3's patents uses carbide jaws to "bite into the [band saw blade] to be able to grab it to then use the energy of the blade to pull those jaws down tighter to then pinch it in two or sever the blade." *Id.* at ll. 14-19. Dr. Gass further testified that based on that technology, the makers of the BladeStop device "spent the next 10 years or so trying to further refine it to get a system that would actually stop quick enough." *Id.* at 123:8-12.

C. Findings of Fact

By a preponderance of the evidence, the Court makes the following findings of fact:

1. One of Ordinary Skill in the Art

A person of ordinary skill in the art is an individual with a bachelor's degree in engineering, either mechanical or electrical, and who has a few years of experience designing power tools.

2. SD3's First Claim of Nonenablement

SD3's first claim of nonenablement involved the time it required for the circuitry disclosed by Figures 2-5 in Friemann's patent to initiate motor braking once a user's flesh came into contact with the band blade.

The Court finds that electromechanical relays require between 3ms and 25ms to close and between 2ms and 25ms to open. However, relays used to provide power to an electric motor will typically take longer to open, and, therefore, the Court finds that relay c1 requires around 6ms to close, while relay c2 requires 8ms to open. The Court also finds that if these relays were overexcited, their closing times would be reduced, but their opening times would not be affected. The Court finds even if overexcited, these electromechanical relays could not initiate motor braking within 10ms.

With respect to the Friemann patent as disclosed in Figures 5 and 6, the Court finds that electronic reversing switches, such as the Rewimat 2000, require at least 5.5ms to switch power at 60 Hz. Further, the Court finds that these types of switches also include interlock delay times to prevent internal short circuits, and those interlock times are generally between 50ms and 100ms. Therefore, the Court finds that a band cutter as disclosed in Figures 5 and 6 of the Friemann patent incorporated a commercially available electronic reversing switch such as the Rewimat 2000, it could not begin motor braking within 10ms of a user coming into contact with the band blade.

However, the evidence supports the conclusion at as of March 2001, forced commutation circuits existed, which would permit an electronic reversing switch such as the Rewimat 2000 to switch power in microseconds. Therefore, a band cutting machine as disclosed in the Friemann patent that included an electronic reversing switch along with a forced commutation circuit could begin motor braking within 10ms of a user coming into contact with the band blade.

The evidence further supports the conclusion that as of March 2001, alternative means for switching power existed in the form of power transistors. These transistors can switch power to the motor in microseconds. If a band cutter based on the Friemann band cutter utilized power transistors rather than electromechanical relays or electronic reversing switches like the Rewimat 2000, it could begin motor braking within 10ms of the user's flesh coming into contact with the blade. For the purposes of this dispute, power transistors would permit motor braking to begin instantaneously.

3. SD3's Second Claim of Nonenablement

i. Pulley and Roller Inertia, Blade Inertia, Gear Ratio, and Angular Velocity

A rotational inertia of .0055 kg-m^2 for the band cutting machine's rollers, though low, is an acceptable estimate for a small band cutting machine.

A belt pulley inertia of .0015 kg-m^2 for the band cutting machine's pulley inertia, though low, is an acceptable estimate for a small band cutting machine.

A gear ratio of 1.1 for the band cutting machine's pulley inertia is an acceptable estimate for a small band cutting machine.

A blade inertia of .00162 kg-m^2 was not disputed by the parties.

A rotational velocity of 157 rad/sec for the motor was not disputed by the parties.

A rotational velocity of 140 rad/sec for the rollers was not disputed by the parties.

ii. Motor

The FL-1838 motor is a high torque to inertia, 15 horsepower motor. Motors like the FL-1838 were commercially available in March 2001. Because the FL-1838 motor is specifically designed to have a high torque to inertia ratio, if it is unable to stop the Friemann band cutting machine within 10ms, it is unlikely there were commercially available motors in March 2001 that could do so.

The FL-1838 motor produces 81 Newton-meters of rated torque. The maximum torque the FL-1838 motor can produce over a 10ms stopping period is 200 Newton-meters.

The FL-1838 motor has a rotational inertia of .022 kg-m^2.

The FL-1838 requires a controller box to function.

It is not possible to double or triple the breakdown torque produced by the FL-1838 motor by doubling its rated voltage.

A smaller motor than the FL-1838 would not of necessity permit faster stopping times due to the relationship between torque and inertia in induction machines.

It is possible to build a motor that would have a higher torque to inertia ratio. Further, it is possible to build a motor that would tolerate higher levels of overexcitation. Such motors are not commercially available. Such motors would need to be custom designed and built by a motor manufacturer.

iii. Brakes

The ROBA-quick Mayr family of brakes identified by the parties in this suit are electromechanical brakes. Brakes like these were commercially available in 2001. The torque and speed at which these brakes operate is representative of electromechanical brakes commercially available in 2001. No evidence was received stating or suggesting other commercially available electromechanical brakes would operate faster or apply more torque.

The Mayr brakes are designed to brake by applying torque to a brake rotor. Each brake has its own inertia. No evidence was received detailing what that inertia might be.

The Mayr brakes require a period of time between initiating braking operations and applying stopping torque. Furthermore, the brakes require additional time between applying stopping torque and applying their fully rated torque.

The Mayr brakes can apply more torque in a shorter period of time when overexcited.

The Mayr brakes can initiate braking faster when configured with a smaller air gap.

With respect to the Mayr brakes, the Court makes the following findings regarding their performance when overexcited:

At minimum, the size 3 brake requires 1ms to begin applying braking torque and 10ms before it reaches full braking torque. The maximum braking torque it can apply when overexcited is 12 Newton-meters.

At minimum the size 5 brake requires 2ms to begin applying braking torque and 15ms before it applies full braking torque. The maximum braking torque it can apply when overexcited is 44 Newton-meters.

At minimum, the size 6 brake requires 5.8ms to begin applying braking torque and 20ms before it applies full braking torque. The maximum braking torque is can apply when overexcited is 77 Newton-meters.

4. Further Findings

Based upon the foregoing, the Court also finds the preponderance of the evidence supports the following:

To stop a band cutting machine with a motor spinning at 157 rad/sec and with a belt pulley inertia of .0015 kg-m^2, a roller and belt puller inertia of .0055 kg-m^2, a blade inertia of .00162 kg-m^2, and a motor inertia of .022 kg-m^2 it would require 919 Newton-meters of torque to stop the band blade in 5ms, 657 Newton-meters of torque to stop the band blade in 7ms, and 460ms to stop the band blade in 10ms.

Assuming the FL-1838 motor can produce 200 Newton-meters breakdown torque over a 5, 7, or 10ms timeframe, electromechanical brakes would be required to add 719 Newton-meters of torque to stop the band blade in 5ms, an additional 457 Newton-meters of torque to stop the band blade in 7ms, and an additional 260 Newton-meters of torque to stop the band blade in 10ms.

If the Mayr brakes could produce their fully rated torque instantaneously, it would require either 59 Mayr size 3 brakes, 17 size 5 brakes, or 10 size 6 brakes to stop the band blade in 5ms. To stop the band blade in 7ms it would require either 39 size 3 brakes, 11 size 5 brakes, or 6 size 6 brakes. To stop the band blade in 10ms it would require either 22 size 3 brakes, 6 size 5 brakes, or 4 size 6 brakes.

Nevertheless, the Mayr brakes cannot produce full torque instantaneously. Thus, the Court finds that even if the Mayr brakes could produce enough torque to overcome their own inertia in these time frames, they cannot produce enough torque to permit a stopping time of less than 10ms.

Finally, the Court finds that slippage may decrease the stopping, assuming a braking mechanism can be applied directly to the blade in the appropriate time frame.

D. Conclusions of Law

The Friemann patent is presumptively enabled. *In re Antor Media Corp.*, 698 F.3d 1282, 1287 (Fed. Cir. 2012). Therefore, the burden rests with SD3 to rebut that presumption. If that presumption is rebutted, the burden shifts to the PTO to adduce evidence showing that the Friemann patent is in fact enabling. *Id.* If the PTO does so, the burden once more rests with SD3 to show that the Friemann patent is not enabling.

As noted previously, the proper test for determining enablement is whether one of ordinary skill in the art "could take the description of the invention in the printed publication and combine it with his own knowledge of the particular art and from this combination be put in possession of the invention on which the patent is sought." *In re Sasse*, 629 F.2d 675, 681 (CCPA 1980). To be enabled, no more is required of prior art than is required by the claims themselves. *See In re Gleave*, 560 F.3d 1331, 1336 (Fed. Cir. 2009). "Undue experimentation" is determined by evaluating the eight *Wands*, 858 F.2d at 737, factors.

1. Findings as to SD3's First Claim of Nonenablement

In order to prevail on its first ground of nonenablement, SD3 was required to show that one of ordinary skill in the art would be incapable of building a band cutter based on the Friemann patent that could stop itself within 10ms of a user coming into contact with the band cutting blade. Specific to this particular ground for nonenablement, SD3 was required to show that the electronic circuitry associated with detecting and initiating braking within 10ms of a user's contact with the blade could not be built by one of ordinary skill in the art absent undue experimentation.

SD3 presented evidence that the relays and circuitry disclosed in the two embodiments contained in Friemann could not begin braking within 10ms due to their physical limitations. Specifically, for the embodiment as disclosed in Figures 3 and 4 could not begin braking because the relays disclosed in those figures are electromechanical, and as such, require time to open and close. Furthermore, SD3 presented evidence that one of ordinary skill in the art would have understood the diagrams disclosed by Figures 3 and 4 to disclose the use of electromechanical relays. SD3 also presented evidence that due to the nature of the Friemann patent, the time required to open or close each respective relay was cumulative, and that once added up, that cumulative time exceeded 10ms. The Court credits all of SD3's evidence here. That evidence is sufficient to rebut the presumption of enablement as to Figures 3 and 4. Accordingly, the Court looks to any contrary evidence adduced by the PTO.

In response, the PTO presented evidence demonstrating the response times for electromechanical relays could be decreased by overexciting the relays. The Court credited that testimony. However, the PTO did not present evidence showing that overexcitation could speed the opening of such relays. Moreover, the PTO did not present convincing evidence regarding the expected increase in response time one should expect from overexcited relays. Accordingly, the Court finds that the PTO failed to carry its burden here and the Friemann patent, as disclosed in Figures 3 and 4, is not enabled, and, therefore cannot anticipate SD3's claims. The Court makes no *Wands* findings here, because application of the *Wands* factors presupposes some evidence in the record indicating experimentation is required to practice the invention. *See Alcon. Research Ltd. v. Barr Labs., Inc.*, 745 F.3d 1180, 1189 (Fed. Cir. 2014). Here, the PTO has failed to carry its burden indicating *any* experimentation would permit the practicing of the Friemann patent as disclosed in Figures 3 and 4. Accordingly, the Court need not address whether such experimentation would be "undue." Futile experimentation is undue by its very nature.

SD3 also presented evidence that the time required to initiate braking would exceed 10ms in the embodiment disclosed in Figures 5 and 6 of the Friemann patent. Specifically, SD3 provided evidence showing that electronic reversal switches such as the Rewimat 2000 would require more than 10ms to initiate motor braking from the time a user contacted the band blade.

In response, the PTO established that by use of a forced commutation circuit, the Friemann patent could begin braking in microseconds. Additionally, the PTO established that as of March 2001, power transistors that would allow braking to begin in microseconds also existed. SD3 did not present contrary evidence. Rather, it claimed one of ordinary skill in the art would require undue experimentation to enable the Friemann patent as disclosed in Figures 5 and 6. Whether that is true depends on the *Wands* factors.

i. The Quantity of Experimentation

The PTO's expert, Mr. Gililland, testified that no such circuit is likely commercially available. A forced commutation circuit would therefore have to be designed. Dr. Gass testified that it is "non-trivial to design a motor control circuit."

TT. 5/10/2016 A.M. at 96:10. Dr. Gass further claimed "[i]t would involve a significant amount of work, it's not a simple thing." *Id.* at 96:20-23.

No testimony or evidence was received regarding the amount of experimentation that would be required to incorporate a power transistor into the Friemann patent.

The Court finds at least some experimentation would be necessary to design and incorporate a commutation circuit. However, because there is no evidence in the record regarding the amount of experimentation that would be necessary to incorporate a power transistor, the Court finds this factor weighs in favor of the PTO, because it was SD3's ultimate burden to show the use of such transistors would require undue experimentation.

ii. Amount of Direction or Guidance

The Court finds this factor weighs in favor of SD3. The Friemann patent claims 10ms and even perhaps 5ms stopping times are possible utilizing the circuity disclosed in his patent. SD3 has demonstrated, with respect to the embodiment in Figures 3 and 4 that, the Friemann band cutting machine cannot likely achieve such stopping times. Moreover, although Friemann does teach the use of an electronic reversing switch, it does not mention the need for a forced commutation circuit, nor is such a circuit contained in Friemann's diagrams. Accordingly, Friemann offers no guidance on how to incorporate a forced commutation circuit. Friemann likewise fails to provide any direction on the incorporation of power transistors.

iii. Presence or Absence of Working Examples

The PTO did not introduce into evidence any example of a circuit able to initiate motor braking and electromechanical braking within 10ms. The only circuits in evidence to control and initiate motor braking and electromechanical braking are the circuits shown in the Friemann patent, and as explained, those circuits do not allow braking of any kind to begin within 10ms. This factor favors SD3.

iv. Nature of the Invention

SD3's invention satisfies a long-felt but previously unsatisfied need for safer cutting machines. SD3 introduced evidence showing that its SawStop band saws have saved the fingers of thousands of persons who had accidents while working with saws. SD3 has in turn experienced commercial success from its saws. Indeed, SD3's invention led to the Advance Notice of proposed Rulemaking from the U.S. Consumer Product Safety Commission regarding a potential standard requiring all table saws to incorporate some kind of active injury mitigation technology. PX108.

Taken together, these facts demonstrate that, as of March 2001, there existed a significant incentive to design a cutting tool able to stop the blade within 10ms. Despite the existence of that incentive and aside from the Friemann patent and its limited fanfare in the 1970s, there is no other evidence demonstrating the physical existence of a cutting tool that can stop itself within 10ms of its blade coming into contact with a user's flesh.

v. State of the Prior Art

The PTO relied on three prior art patents at trial: U.S. Patent No. 3,785,230 to Lokey, U.S. Patent No. 4,117,752 to Yoneda, and U.S. Patent No. 5,272,946 to McCullough. DX202; DX204; DX205. There is no evidence, however, that these patents disclose a circuit capable of initiating motor or electromechanical braking within 10ms. To the contrary, the Lokey patent discloses a schematic with an electronic relay like Friemann's electronic reversing switch 15. As stated, such switches include interlock times ranging from 50ms to 100ms. The Yoneda and McCullough patents disclose circuits with relays like those shown in Figures 3 and 4 of the Friemann patent. The fact that the three prior art patents cited by the PTO all include relays or an electric relay like those disclosed in Friemann indicates that even inventors were not aware of the need to utilize fast acting components like low inertia motors. The prior art does not include the use of power transistors or a commutated electronic switch. This factor favors SD3.

vi. Relative Skill of Those in the Art

The Court has previously concluded that the evidence supports the conclusion that one of ordinary skill in the art would possess a mechanical engineering or electrical engineering degree and would have a number of years' experience designing and building power tools.

In light of the aim of Friemann's invention, one of ordinary skill in the art would recognize the need to use faster acting electronic components rather than simply rely on what, in March 2001, would have been decades-old technical specifications.

With respect to commutation circuits, the PTO's expert Dr. Lequesne testified that as an undergraduate electrical engineering student he was taught how to design and use forced commutation circuits. By contrast, Dr. Gass testified that commutation circuits were not well known to the ordinary artisan.

On balance, the Court finds that one of ordinary skill in the art would be aware of and would know how to design and implement a forced commutation circuit. That design and implementation process would require at least some experimentation.

More importantly, Dr. Lequesne testified that one of ordinary skill in the art in March 2001 would have used power transistors as a matter of course. SD3 presented no evidence to the contrary.

The Court finds that this factor heavily favors the PTO.

vii. Breadth of the Claims[18]

The breadth of SD3's claims here are broad. There is no limitation on the size or type of "cutting tool" covered by SD3's claims. Neither is there a limitation regarding the expected use of SD3's claimed invention; it covers all "cutting tools" from industrial to hobbyist applications. Thus, this factor favors the PTO.

The Court finds that the factors on the whole favor the PTO as to SD3's first claim for nonenablement. Particularly salient in the Court's mind is the dearth of evidence regarding the incorporation of power transistors into Friemann's disclosed circuitry. SD3 bears the burden of showing the incorporation of such transistors into Friemann's disclosure would require undue experimentation. There, however, is no evidence in the record showing that to be the case. The Court therefore rejects SD3's first claim of nonenablement.

2. SD3's Second Claim of Nonenablement

As discussed previously, SD3's second ground of nonenablement is that the Friemann motor braking and electromechanical braking cannot stop the blade in the

[18] The parties did not address the predictability or unpredictability of the art at trial.

time periods recited in SD3's claims. The claims at issue are addressed separately because the claims each contain different time limitations.

i. Claims 1 and 24: 10 Milliseconds

SD3's Claims 1 and 24 recite a machine with a brake mechanism adapted to stop "at least one motion of the cutting tool within 10 milliseconds after detection of the unsafe condition." PX101.

Dr. Gass testified that he calculated the torque required to stop the blade in Friemann's band cutter in 10ms, and a motor and an electromechanical brake as disclosed in the Friemann patent cannot provide the required torque. Dr. Turcic, one of SD3's experts, also testified that he too calculated that the required torque could not be provided by an electromechanical brake and motor as disclosed in Friemann. Furthermore, one of the PTO's own experts, Dr. Landy, testified that he doubted a motor could stop itself in 10ms. Furthermore, SD3 presented evidence that the FL-1838 motor, a specifically designed high torque to inertia motor, would not produce enough torque to stop a band cutter based on Friemann, even where that band cutter utilized undersized rollers and pulleys. In addition, SD3 showed that electromechanical brakes such as the Mayr family of brakes require at least some amount of time to initiate braking, and an additional amount of time before they begin applying their fully rated torque. SD3 demonstrated that none of those brakes alone could produce the required additional torque to stop the Friemann band cutter in 10ms, and would require between 22 and 4 brakes, depending on their size.

The evidence submitted by SD3 at trial was sufficient to rebut Friemann's presumption of enablement. Accordingly, the burden fell to the PTO to rebut SD3's assertions.

As noted above, the PTO relied on the overexcitation of the FL-1838 motor to produce three times breakdown torque; it relied on using multiple brakes; it relied on the inclusion of transient torques in the calculations; and it relied on the potential to brake the band blade directly to induce slippage between the band blade and the rollers.

In response, SD3 presented evidence showing that the FL-1838 motor cannot produce three times breakdown torque, and therefore it would require an ordinary artisan undue experimentation to design and build a motor capable of producing a sufficient amount of torque; it demonstrated that transient torques would not play an appreciable role in stopping times; and it established that additional brakes increase the overall inertia in the system, and, therefore would not necessarily lead to faster stopping times. Finally, regarding slippage, SD3 argued it would require an ordinary artisan undue experimentation to induce slippage in the Friemann band cutting machine. Whether an ordinary artisan could design and build a motor capable of producing the required torque and whether an ordinary artisan could adapt the Friemann band cutting machine to directly grip the blade and induce slippage requires an analysis of the *Wands* factors.[19]

a. Quantity of Experimentation

Dr. Lequesne testified that ordinary electrical engineers are not familiar with electric motor design, and ordinary mechanical engineers design motors "at their own peril." TT. 5/13/2016 P.M. at 54:17-20. Dr. Turcic testified that a person of ordinary skill in the art would not have experience designing custom electric motors. TT. 5/11/2016 P.M. at 11:18-20. A preponderance of the evidence suggests that a significant amount of experimentation would be required for one of ordinary skill in the art in March 2001 to design and build a motor capable of the stopping times required by the Friemann patent.

Regarding slippage, Dr. Gass testified that there were a number of complications involved in fashioning a mechanism to break a band saw blade directly. TT. 5/11/2016 P.M. at 121:18–122:2, 14-19. Dr. Gass further testified that the only band saw capable of directly grabbing the band blade as a means of braking required 10 years of development. *Id.* at 123:8-12.

[19] The Court does not address the PTO's claim that multiple brakes could be used to decrease stopping times because the PTO failed to show those brakes could overcome their own inertia within 10ms.

The Court finds that this factor heavily favors SD3.

b. Amount of Direction or Guidance

The Friemann patent teaches using a "driver motor" and specifically a "three-phase motor." PX1, col. 1, 11. 60-61; col. 3 ll. 49-50; col. 4 l. 34; and col. 6 l. 4. The Friemann patent does not teach the need for a specifically designed low inertia motor or a high torque motor. Indeed, the Friemann patent fails to mention the motor's torque to inertia ratio as a relevant factor at all, and in doing so implies a run-of-the-mill motor will suffice. Even assuming the Friemann patent would disclose to one of ordinary skill in the art the need to design a custom motor, it provides no guidance whatsoever regarding how such a motor should be constructed, nor would one skilled in the art possess the requisite knowledge.

Assuming that the Friemann patent teaches braking directly applied to the band blade,[20] it provides no guidance on how one would go about designing and implementing a mechanism to do so.

This factor weighs heavily in SD3's favor.

[20] Mr. Gililland testified that claim 6 of the Friemann patent teaches applying an electromechanical brake directly to the blade. TT. 5/11/2016 P.M. at 65:18–66:19. The Court makes no explicit finding on whether the Friemann patent actually teaches such a braking technique, but for the sake of argument assumes that it does.

c. Presence or Absence of Working Examples

A German newspaper from 1973 shows two pictures of Friemann's prototype band cutter. PX17. Dr. Gass testified that despite an exhaustive search, SD3 was unable to locate any prototype or band cutter based on Friemann's patent.

Further, no evidence was admitted establishing the existence of an induction motor and brake combination capable of producing sufficient torque to stop a band cutter based on Friemann's design in 10ms. And finally, the record is devoid of evidence touching upon the existence of a band cutting machine in March 2001 capable of stopping in 10ms by directly grabbing the band blade.

This factor strongly favors SD3.

d. Nature of the Invention

This factor strongly favors SD3 for the reasons expressed previously in connection with SD3's first ground of nonenablement.

e. State of the Prior Art

As discussed, the PTO relied on U.S. Patent Nos. 3,785,230 (Lokey), 4,117,752 (Yoneda), and 5,272,946 (McCullough) as prior art. Assuming that these patents are indeed prior art to SD3's claims, they fail to disclose the need to minimize inertia and maximize torque in order to stop a motor or blade quickly. None of these prior art references disclose how to design and build a motor capable of producing the required torque, nor do they even disclose the need for such a motor.

And while these prior art reference disclose the concept of directly braking a blade—and in the case of McCullough loosening the tension on the band blade to induce slippage—none of these patents address directly braking the blade with an electromechanical brake. Their applicability to one attempting to utilize Friemann is therefore dubious.

This factor favors SD3.

f. Relative Skill of Those in the Art

Dr. Gass testified that one of ordinary skill in the art would know "very little about motor design." TT. 5/10/2016 A.M. at 44:14. Dr. Lequesne also testified that ordinary mechanical engineers and ordinary electrical engineers do not know much about the design of electric motors. TT. 5/13/2016 P.M. at 32:4-13. The record also supports the conclusion that one of ordinary skill in the art would have no experience stopping the blade of a power tool fast enough to mitigate injury. TT. 5/10/2016 P.M. at 54:3-16.

Because the records supports the conclusion that a person of ordinary skill in the art would have little or no experience designing and building electric motors, and additionally, because the record supports the conclusion that a person of ordinary skill in the art would have little or no experience attempting to directly brake a band blade as a safety mechanism, this factor strongly favors SD3.

g. Predictability of the Art

As stated, the parties did not focus on this factor during trial. It therefore does not bear on this case.

h. *Wands* Finding

Based upon the foregoing, the Court concludes that one of ordinary skill in the art could not build a motor capable of producing sufficient torque to stop the blade of a band cutter based on the Friemann patent within 10ms without engaging in undue experimentation, assuming such a motor can be designed.

The Court also concludes that one of ordinary skill in the art would not be able to design and implement a mechanism to grab the band blade of the Friemann band cutter and stop the blade within 10ms by utilizing electromechanical brakes without first engaging in undue experimentation, assuming that such a feat is even possible.

In light of the Court's previous conclusion that the addition of electromechanical brakes—even when overexcited—would not produce enough torque to permit a band blade in the Friemann band cutter to stop within 10ms, the Court concludes one of ordinary skill in the art in March 2001 would not be capable of building the Friemann band cutter without undue experimentation.

The Court therefore finds the Friemann patent nonenabled with respect to SD3's Claims 1 and 24.

ii. SD3's Claims 22 and 23

SD3's remaining claims all involve the stopping of the cutting tool in less than 10ms.[21] In light of the above findings, the Court concludes a preponderance of the evidence shows that undue experimentation would be required for a person of ordinary skill in the art as of March 2001 to obtain and use a motor and an electromechanical brake or brakes able to provide sufficient torque to stop the Friemann band cutter within 7ms or 5ms, if it could be done at all.

The Court finds that the Friemann patent is nonenabled with respect to SD3's Claims 22 and 23.

3. SD3's Claim 30: Less Than 5 Milliseconds

Because the Friemann patent does not claim to stop its band blade in less than 5ms, the BPAI found that Friemann rendered SD3's Claim 30 unpatentable for obviousness, rather than anticipation. But as previously noted, prior art must enable

[21] Claim 22 recites a machine with a brake mechanism "adapted to stop at least one motion of the cutting tool within 7 milliseconds after detection of the unsafe condition." PX101. Claim 23 recites the same language, except that it requires a stopping time of "within 5 milliseconds." *See id.* SD3's last claim, Claim 30, will be addressed below.

one of ordinary skill in the art to build the claimed invention in order to deny it patent protection under § 103(a). *Kumar*, 418 F.3d at 1368.

The Court has previously found that the Friemann patent could not enable one of ordinary skill in the art to build a band cutter capable of stopping a band blade within 10ms of a user's flesh coming into contact with the blade. That analysis took into account the use of multiple brakes, overexcitation, the FL-1838 motor, and the possibility of inducing slippage. The PTO argued, however, that these same methods could be used to enable one of ordinary skill in the art to fashion a band saw capable of stopping the band blade within 5ms. Because the Court has rejected that argument in the 10ms time-frame, it also rejects the argument in the 5ms time frame. Indeed, Dr. Landy, one of the PTO's experts, testified that it was "[a]bsolutely" not feasible to achieve stopping times of less than 5ms with Friemann's band cutter. TT. 5/11/2016 P.M. at 30:16.

Accordingly, the Court finds that a preponderance of the evidence shows that undue experimentation would be required for a person of ordinary skill in the art in March 2001 to obtain and use a motor and an electromechanical brake or brakes able to provide sufficient torque to stop the blade in Friemann's band cutter in less than 5ms, if it could be done at all.

Therefore, the Friemann patent is not prior art capable of rendering SD3's Claim 5 unpatentable for obviousness.

IV. CONCLUSION

For the foregoing reasons, the Court finds in favor of SD3. A separate judgment shall issue this date.

Royce C. Lamberth
United States District Judge

DATE: 8/31/16