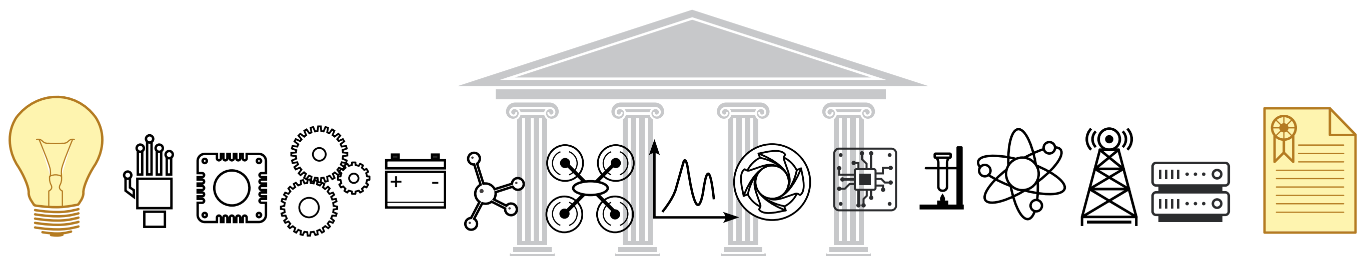
Looking at Patent Law: Opportunity Prospecting by Analysis of Analogous Patent Art

by E. Jennings Taylor and Maria Inman



In this article we discuss the use of patent citation analysis to identify additional technology applications and potential collaborators or licensees for the patented technology. U.S. law stipulates[1] that:

"[Patents] shall have the attributes of personal property."

As we noted in a previous article[2] in *Interface*, the analogy between real property and intellectual property (patents) can provide helpful perspective. Of particular relevance to patent citation analysis is the analogy between the deed of real property and the claims of a patent. The deed defines the boundaries of ownership by the owner of the real property. The patent claims define the boundaries of ownership by the assignee of the patent. Recall, inventors are generally obligated to assign patent rights to their employer.[3] In the case of real property, modern surveying methods lead to precise determination of the boundaries of the real property described in the deed. In the case of a patent, the courts have recognized that language can be imprecise:[4]

> *"The nature of language makes it impossible to capture the essence of a thing in a patent application [claim]."*

Consequently, the intellectual property "boundaries" defined by the claims are often referred to as the "metes and bounds" of the patent. The "metes and bounds" description is derived from an early system of defining the boundaries of real property, where the boundaries are described by the local geography of the parcel of land and are therefore somewhat imprecise.

Related to our discussion of opportunity prospecting, when a prospective buyer initiates the purchase of a parcel of land, a search is conducted by a title company to ensure there are no previous owners or legal encumbrances on the real property. During this search, the title company identifies previous owners, current owners, and neighboring properties.

Analogously, when an inventor files a patent application, an examination of the prior art is conducted by the U.S. Patent & Trademark Office (USPTO) to ensure there are no previous owners of all or part of the claimed invention upon which the pending patent application would "trespass." If prior art is identified that impacts the patentability of a patent application, then the inventor may limit the claims of her/his patent application in order to overcome said prior art. In addition, during the prior art search, the patent examiner identifies background or "neighboring" prior art patents, published patent applications and other publications. Consequently, inventors have the opportunity to become aware of a rich landscape of prior art during examination of their patent applications.

Similarly, after a patent application is published and/or subsequently issues, it becomes part of the prior art landscape. Consequently, once a Faraday patent issues, we find it valuable to review the prior art landscape of "backward" citations cited during the examination of the patent application. Additionally, we continue to monitor U.S. Patent & Trademark Office actions to identify "forward" citations where Faraday patents are referenced as prior art against subsequent patent applications. These forward or "referenced by" citations provide the basis for opportunity prospecting by analysis of this analogous prior art. Herein we provide an actual case study illustrating the use of patent citation analysis to identify additional technology applications and potential collaborators or licensees for one of Faraday's patented technologies. To begin the case study, we provide a brief background of Faraday Technology Inc. as perspective.

Our perspective is based on over 25 years of experience at Faraday Technology Inc., a research, development, and engineering company, that was founded in 1991 to conceive, develop, and commercialize novel electrochemical technologies based on pulse current/pulse reverse current (PC/PRC) electrolytic principles. Excellent reviews on PC/PRC plating are available in the seminal work edited by

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Puippe[5] and more recently updated.[6] Our unique approach to PC/PRC plating AND surface finishing are summarized as well[7,8] and illustrated in the company vision:

> ***"To develop robust and environmentally friendly electrochemical deposition and surface finishing processes based on simple electrolytes enabled by pulse/pulse reverse electric fields."***

The company's mission is to conceive and commercialize electrochemical processes based on the PC/PRC technology platform. To support these activities, funding is obtained through the U.S. Small Business Innovative Research (SBIR) and Small Business Technology Transfer (STTR) programs. These programs consist of a Phase I feasibility demonstration activity followed by a Phase II technology development and validation activity. Once the Phase II development activity has been completed, commercialization of the technology for private sector use or transition of the technology for government use comes from private sector or non-SBIR government funding, respectively. Critically, while the SBIR/STTR programs represent a highly competitive source of technology demonstration and validation funding, these programs allow the small business to retain assignment of the inventions "conceived or first actually reduced to practice" with said funds.[9]

We first demonstrated the effectiveness of PC/PRC surface finishing of automotive planetary gears by replacing a DC electrochemical deburring process based on ethylene glycol with a PC process using a low concentration aqueous salt solution.[10] Building on the deburring results, we obtained Phase I and II SBIR funding from the National Science Foundation to demonstrate the ability to use PRC to electropolish nickel alloy coupons in low concentration aqueous salt solution.[11] This work provided the basis for two patents assigned to Faraday.

Subsequently, we were approached by an engineer from a manufacturer of stainless steel valves for the semiconductor industry. The manufacturer employed conventional DC electropolishing as the final step for surface finishing of their stainless steel valves, fittings and tubular products. The conventional electropolishing process was based on the well-established viscous salt film paradigm[12] and used a chilled electrolyte solution consisting of concentrated sulfuric/phosphoric acid as well as proprietary additives that may have included fluoride species.

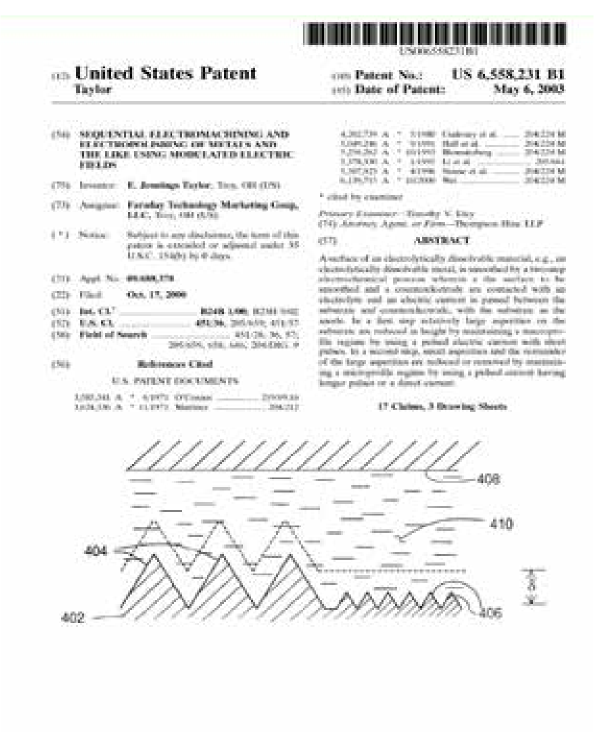
Under a stage-gated research-for-hire activity, we demonstrated the ability to electropolish their stainless steel coupons using PRC in conjunction with a low concentration aqueous salt electrolyte. We subsequently demonstrated and validated the PRC electropolishing process on actual stainless steel products using an α-scale manufacturing apparatus in Faraday's prototyping facility. For competitive reasons, the manufacturing company wanted to retain exclusive rights to the subject technology and we negotiated a "field-of-use" license consistent with Faraday's business model.[13] The field-of-use license was defined as follows:

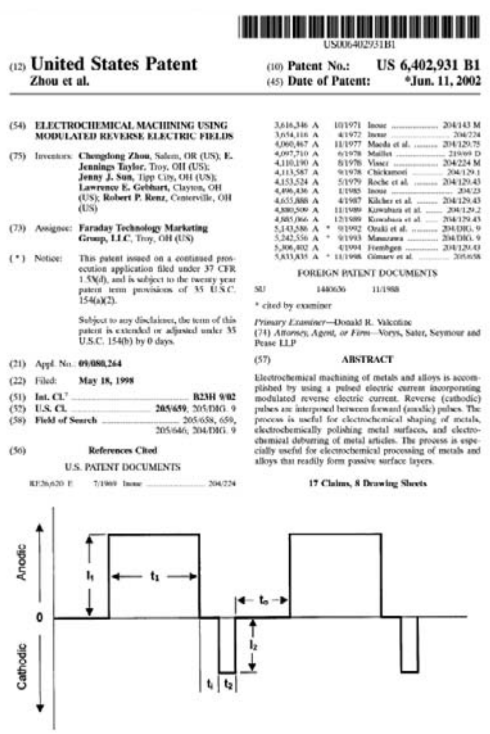
1. Market – semiconductor
2. Product – valves and fittings
3. Material – stainless steel

The license was based on two patents (Fig. 1) covering the subject PRC electropolishing technology.[14,15]

As noted above, we continuously monitor our issued patents to review backward prior art citations and identify forward prior art citations. Specifically, we define them as follows:

1. Backward prior art citations: Prior art cited by Faraday inventors and/or the USPTO examiner during the prosecution of the Faraday patent application,
2. Forward prior art citations: Citations of the Faraday patent as prior art by the inventors and/or the USPTO examiner during the prosecution of subsequent patent applications.





Field-of-Use (FoU) License
- Market – Semiconductor
- Product – Valves & Fittings
- Material – Stainless Steel

Fig. 1. *Faraday patent nos. 6,402,931 and 6,558,231 licensed to valve manufacturer.*

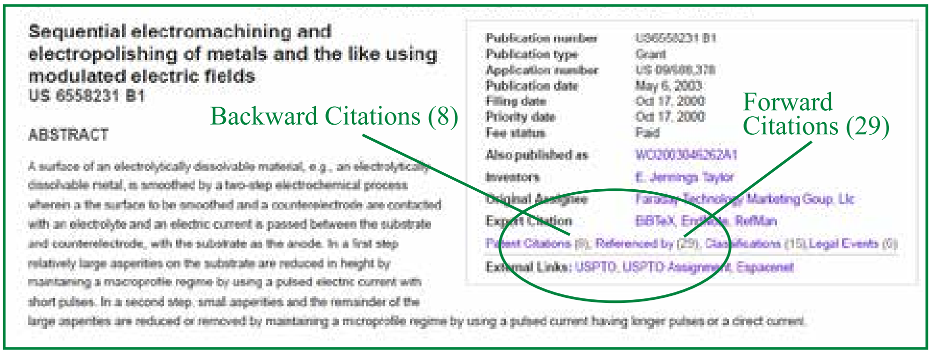
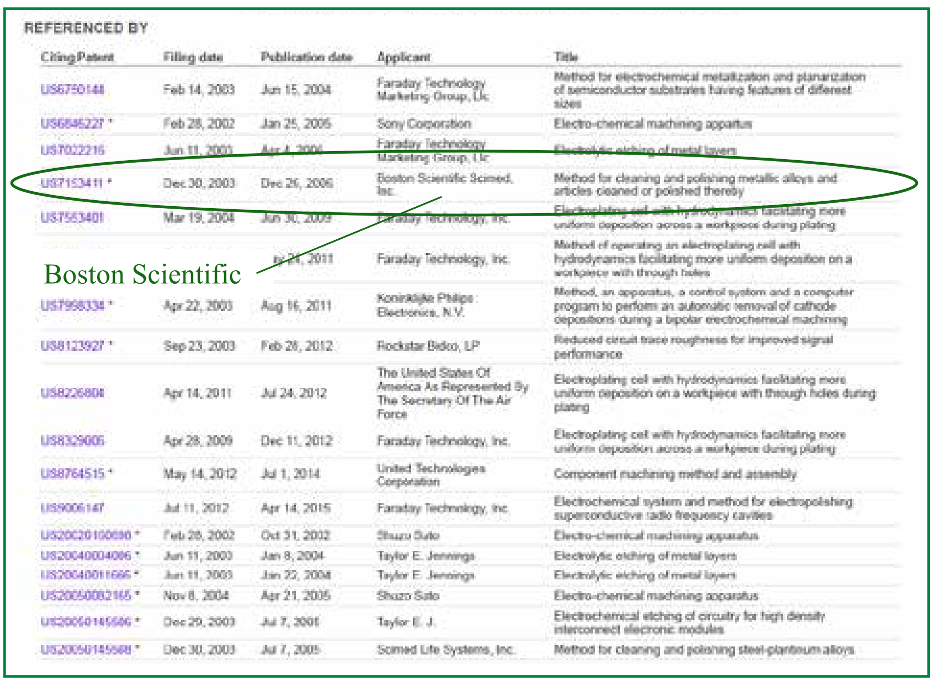


Fig. 2. *Google patent search results for Faraday patent no. 6,558,231.*

These citations are easily tracked using the USPTO website[16] or "Google patents."[17] In Fig. 2, we illustrate the search results for U.S. patent no. 6,558,231 (referred to below as the '231 patent) using Google Patents accessed on September 12, 2017. From the first page, we see that there were eight (8) background or prior art "patent citations" during the prosecution of the '231 patent. This number does not change as a function of the date the Google Patents database is accessed. In addition, we see that there are twenty-nine (29) forward



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Citing Patent	Filing date	Publication date	Applicant	Title
US6750144	Feb 14, 2003	Jun 15, 2004	Faraday Technology Marketing Group, Llc	Method for electrochemical metalization and planarization of semiconductor substrates having features of different sizes
US6846227 *	Feb 28, 2002	Jan 25, 2005	Sony Corporation	Electro-chemical machining appartus
US7022216	Jun 11, 2003	Apr 4, 2006	Faraday Technology Marketing Group, Llc	Electrolytic etching of metal layers
US7153411 *	Dec 30, 2003	Dec 26, 2006	Boston Scientific Scimed, Inc.	Method for cleaning and polishing metallic alloys and articles cleaned or polished thereby
US7553401	Mar 19, 2004	Jun 30, 2009	Faraday Technology, Inc.	Electroplating cell with hydrodynamics facilitating more uniform deposition across a workpiece during plating
		y 24, 2011	Faraday Technology, Inc.	Method of operating an electroplating cell with hydrodynamics facilitating more uniform deposition on a workpiece with through holes
US7998334 *	Apr 22, 2003	Aug 16, 2011	Koninklijke Philips Electronics, N.V.	Method, an apparatus, a control system and a computer program to perform an automatic removal of cathode depositions during a bipolar electrochemical machining
US8123927 *	Sep 23, 2003	Feb 28, 2012	Rockstar Bidco, LP	Reduced circuit trace roughness for improved signal performance
US8226804	Apr 14, 2011	Jul 24, 2012	The United States Of America As Represented By The Secretary Of The Air Force	Electroplating cell with hydrodynamics facilitating more uniform deposition on a workpiece with through holes during plating
US8329006	Apr 28, 2009	Dec 11, 2012	Faraday Technology, Inc.	Electroplating cell with hydrodynamics facilitating more uniform deposition across a workpiece during plating
US8764515 *	May 14, 2012	Jul 1, 2014	United Technologies Corporation	Component machining method and assembly
US9006147	Jul 11, 2012	Apr 14, 2015	Faraday Technology, Inc.	Electrochemical system and method for electropolishing superconductive radio frequency cavities
US20020100690 *	Feb 28, 2002	Oct 31, 2002	Shuzo Sato	Electro-chemical machining apparatus
US20040004006 *	Jun 11, 2003	Jan 8, 2004	Taylor E. Jennings	Electrolytic etching of metal layers
US20040011666 *	Jun 11, 2003	Jan 22, 2004	Taylor E. Jennings	Electrolytic etching of metal layers
US20050082165 *	Nov 8, 2004	Apr 21, 2005	Shuzo Sato	Electro-chemical machining apparatus
US20050145506 *	Dec 29, 2003	Jul 7, 2005	Taylor E. J.	Electrochemical etching of circuitry for high density interconnect electronic modules
US20050145508 *	Dec 30, 2003	Jul 7, 2005	Scimed Life Systems, Inc.	Method for cleaning and polishing steel-plantinum alloys

Fig. 3. *Forward citations for Faraday patent no. 6,558,231.*

or "referenced by" citations as of the date the Google Patent database was accessed. Clearly, these forward citations can change with time as subsequent patent applications issue. For our trivia readers, U.S. patents always issue on a Tuesday.

By selecting the "Referenced by" hyperlink, we are taken to the Google patent page with the 29 forward prior art patent citations shown in part in Fig. 3. This page provides the citing patent or patent application number, filing date, publication date, assignee, and title of the patent/patent application. For the prior art highlighted with an asterisk (*), the '231 patent was cited as prior art by the USPTO examiner during prosecution of the citing patent. For the prior art without a highlight, the '231 patent was cited as prior art by the applicant during prosecution of the citing patent.

Upon scanning the list of forward citation prior art, we observe a number of Faraday patents/patent applications and patents/patent applications generally related to electrochemical machining or electrochemical polishing. Of particular interest for this case study is patent no. 7,153,411 (referred to below as the '411 patent) assigned to Boston Scientific Scimed, Inc. The highlighted "*" associated with the '411 patent indicates that the USPTO examiner cited the '231 patent during prosecution. By selecting the "US7153411" hyperlink, a Google patent page displaying the '411 patent appears. We downloaded the complete patent by selecting the "Download PDF" hyperlink. By reviewing the claims,[18] we determined that the '411 patent was directed towards the method or process statutory class. As illustrated in Fig. 4, the cover page of the '411 patent indicates that the method is an electropolishing method. Additionally, as illustrated in Fig. 4, Fig. 3/Fig. 2 of the '411 patent indicates that the electropolishing method is directed towards medical stents using pulse reverse waveforms. Finally, by review of the claims, we noted that many of the dependent claims were directed towards strong acid electrolytes with additions of chelating agents. This approach is in contrast to Faraday's approach to development of PC/PRC electrochemical processes based on simple aqueous electrolytes.

To summarize, based on this straightforward and simple preliminary analysis, we identified a potential new application, of which we were not previously aware, for Faraday's PC/PRC process development activities. A more detailed understanding of the prior art citation of Faraday's '231 patent application may be obtained by reviewing the file history of the prosecution of the '411 patent at the USPTO Patent Application Information Retrieval (PAIR) website portal.[19]

In Fig. 5, we illustrate the various documents within the "Image File Wrapper" for the '411 patent. These documents represent the correspondences between the USPTO examiner and the patent applicant during the prosecution of the subject patent application. These correspondences include the examiner's prior art search, the examiner non-final and final rejection office actions, the applicant's responses to non-final/final rejections, applicant's amendments to claims, issue notification and so forth. Our review of the prosecution history of the '411 patent application indicates that Faraday's '231 patent was used to support an "obviousness" (35 USC §103) rejection of the claims directed towards pulse reverse electropolishing.[18] The '411 patent applicant modified their claims to include limitations to the pulse reverse electropolishing method, which then allowed the patent to issue. As discussed earlier, there still could be "freedom to operate" issues associated with the '411 patent.[2]

With this analysis of analogous patent art, we identified a new opportunity for our platform PC/PRC technology directed towards electropolishing of medical stents in simple aqueous electrolytes enabled by our pulse reverse current approach. We successfully pursued funding from the National Institutes of Health (NIH) SBIR program and were awarded Phase I and Phase II projects. With this funding, we demonstrated the feasibility of electropolishing medical stent materials (nickel-titanium) in simple aqueous electrolytes.[20] Subsequently, we worked with a supplier of nickel-titanium wire for stent applications to demonstrate and validate the pulse reverse electropolishing process in an α-scale reel-to-reel electropolishing apparatus consisting of 300 and 5,000 foot wire spools.[21] These activities led to a license of the same two patents licensed to the semiconductor valve manufacturer but for a different "field-of-use" defined as follows:

1. Market – medical
2. Product – wire based stents and shape sets
3. Material – nickel-titanium alloys

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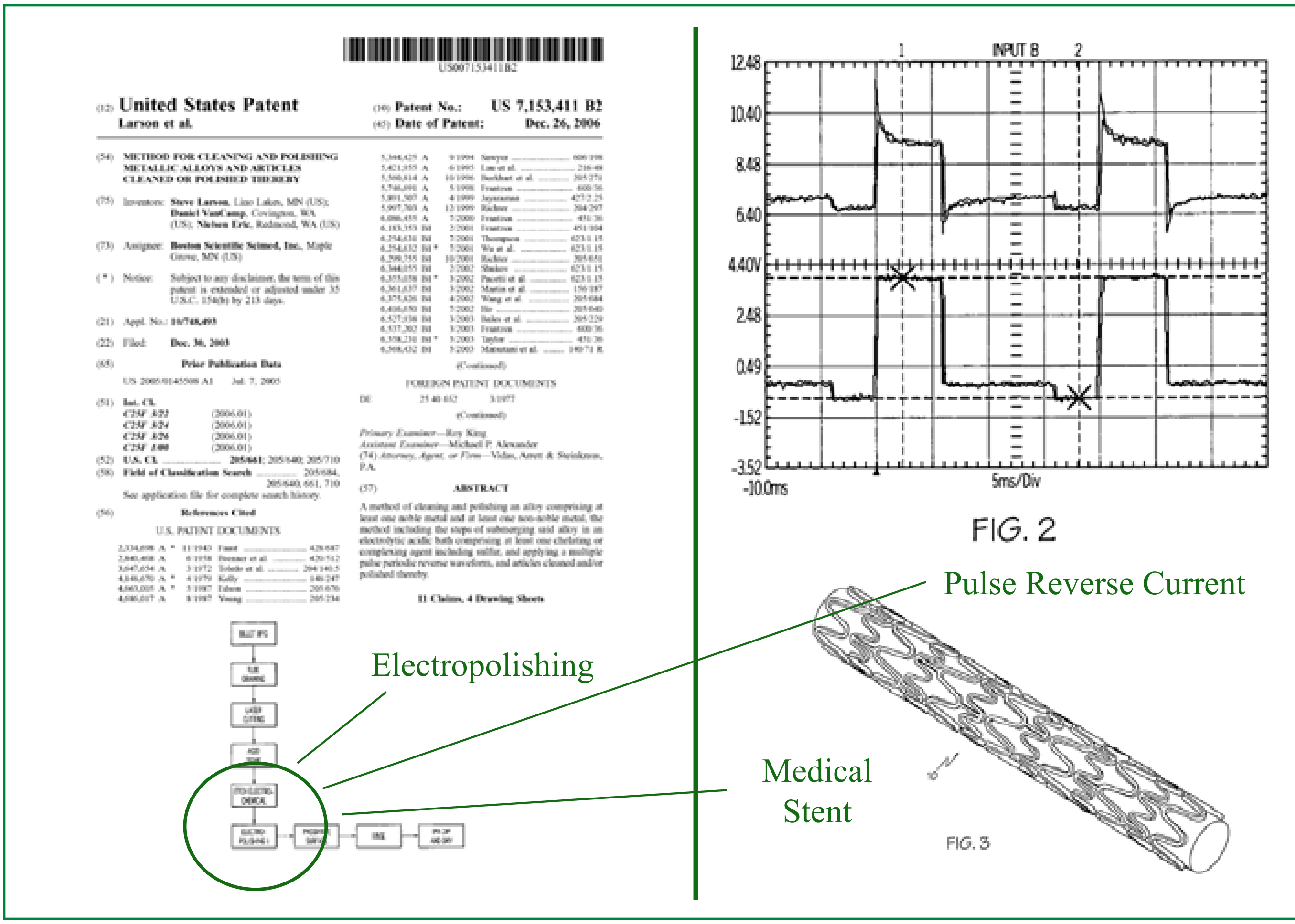

Fig. 4. *Boston Scientific patent no. 7,153,411 citing Faraday patent no. 6,558,231.*

In summary, we presented a case study for opportunity prospecting by analysis of analogous patent art (Fig. 6). The approach uses forward or "referenced" by patent citation analysis to identify examiner or applicant prior art citations of the patent of interest during the prosecution of subsequent patent applications. The prior art citation analysis was illustrated using the Google patent search but is also easily conducted using the USPTO patent Boolean search function. While the case study was based on the experience at Faraday Technology Inc., an electrochemical research, development and engineering company with an electrochemical platform technology, we believe the approach would be valuable for other businesses, universities and federal laboratories. More specifically, we suggest that electrochemical scientists, engineers and technologists consider the patent literature in addition to their review of the technical literature.

About the Authors

E. Jennings Taylor is the founder of Faraday Technology, Inc., a small business focused on developing innovative electrochemical processes and technologies based on pulse and pulse reverse electrolytic principles. Jennings leads Faraday's patent and commercialization strategy and has negotiated numerous via field of use licenses as well as patent sales. In addition to technical publications and presentations, Jennings is an inventor on forty patents. Jennings is admitted to practice before the United States Patent & Trademark Office (USPTO) in patent cases as a patent agent (Registration No. 53,676) and is a member of the American Intellectual Property Law Association (AIPLA). Jennings has been a member of the ECS for thirty-eight years and is a fellow of the ECS and currently serves as treasurer. He may be reached at jenningstaylor@faradaytechnology.com.

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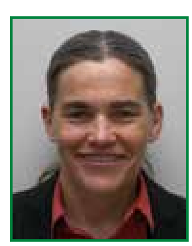

Maria Inman is the research director of Faraday Technology, Inc. where she serves as principal investigator on numerous project development activities and manages the companies pulse and pulse reverse research project portfolio. In addition to technical publications and presentations, Maria is competent in patent drafting and patent drawing preparation and is an inventor on seven patents. Maria is a member of ASTM and has been a member of the ECS for twenty-one years. Maria serves the ECS as a member of numerous committees. She may be reached at mariainman@faradaytechnology.com.

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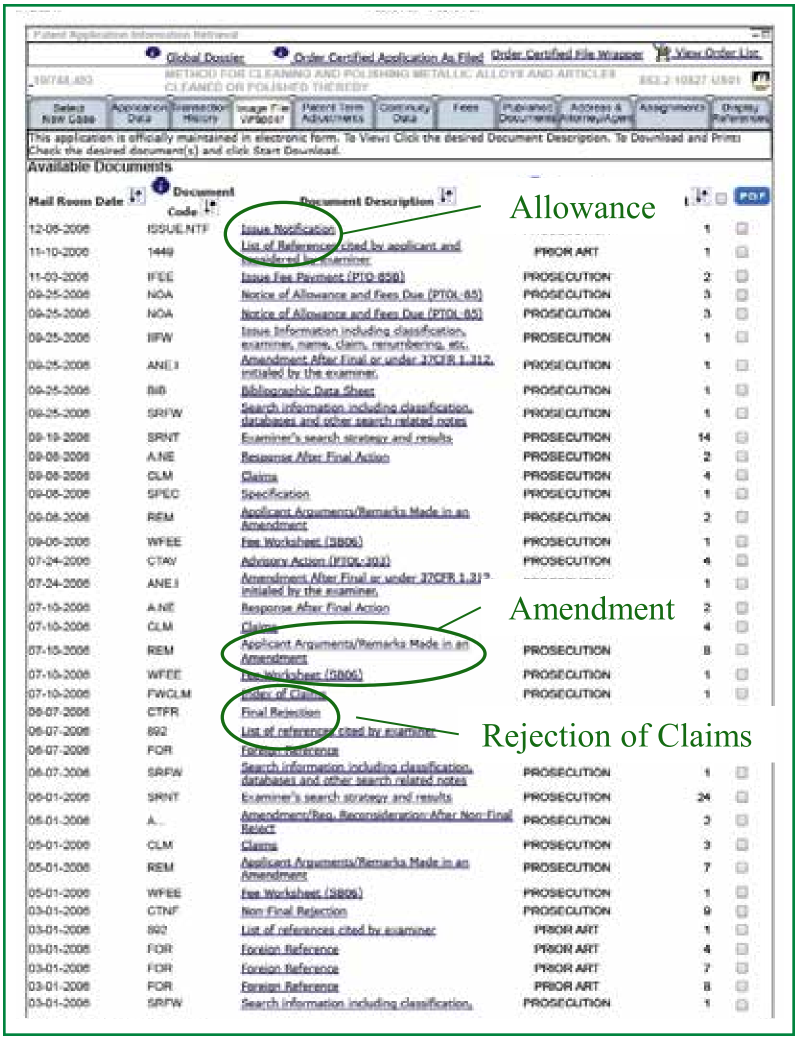
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METHOD FOR CLEANING AND POLISHING METALLIC ALLOYS AND ARTICLES CLEANED OR POLISHED THEREBY

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Available Documents

Mail Room Date	Document Code	Document Description		Page Count
12-06-2006	ISSUE.NTF	Issue Notification		1
11-10-2006	1449	List of References cited by applicant and considered by examiner	PRIOR ART	1
11-03-2006	IFEE	Issue Fee Payment (PTO-85B)	PROSECUTION	2
09-25-2006	NOA	Notice of Allowance and Fees Due (PTOL-85)	PROSECUTION	3
09-25-2006	NOA	Notice of Allowance and Fees Due (PTOL-85)	PROSECUTION	3
09-25-2006	IIFW	Issue Information including classification, examiner, name, claim, renumbering, etc.	PROSECUTION	1
09-25-2006	ANE.I	Amendment After Final or under 37CFR 1.312, initialed by the examiner.	PROSECUTION	1
09-25-2006	BIB	Bibliographic Data Sheet	PROSECUTION	1
09-25-2006	SRFW	Search information including classification, databases and other search related notes	PROSECUTION	1
09-19-2006	SRNT	Examiner's search strategy and results	PROSECUTION	14
09-08-2006	A.NE	Response After Final Action	PROSECUTION	2
09-08-2006	CLM	Claims	PROSECUTION	4
09-08-2006	SPEC	Specification	PROSECUTION	1
09-08-2006	REM	Applicant Arguments/Remarks Made in an Amendment	PROSECUTION	2
09-08-2006	WFEE	Fee Worksheet (SB06)	PROSECUTION	1
07-24-2006	CTAV	Advisory Action (PTOL-303)	PROSECUTION	4
07-24-2006	ANE.I	Amendment After Final or under 37CFR 1.312 initialed by the examiner.		1
07-10-2006	A.NE	Response After Final Action		2
07-10-2006	CLM	Claims		4
07-10-2006	REM	Applicant Arguments/Remarks Made in an Amendment	PROSECUTION	8
07-10-2006	WFEE	Fee Worksheet (SB06)	PROSECUTION	1
07-10-2006	FWCLM	Index of Claims	PROSECUTION	1
06-07-2006	CTFR	Final Rejection		
06-07-2006	892	List of references cited by examiner		
06-07-2006	FOR	Foreign Reference		
06-07-2006	SRFW	Search information including classification, databases and other search related notes	PROSECUTION	1
06-01-2006	SRNT	Examiner's search strategy and results	PROSECUTION	24
05-01-2006	A...	Amendment/Req. Reconsideration-After Non-Final Reject	PROSECUTION	2
05-01-2006	CLM	Claims	PROSECUTION	3
05-01-2006	REM	Applicant Arguments/Remarks Made in an Amendment	PROSECUTION	7
05-01-2006	WFEE	Fee Worksheet (SB06)	PROSECUTION	1
03-01-2006	CTNF	Non-Final Rejection	PROSECUTION	9
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03-01-2006	FOR	Foreign Reference	PRIOR ART	4
03-01-2006	FOR	Foreign Reference	PRIOR ART	7
03-01-2006	FOR	Foreign Reference	PRIOR ART	8
03-01-2006	SRFW	Search information including classification,	PROSECUTION	1

Fig. 5. *Image file wrapper for Boston Scientific patent no. 7,153,411.*

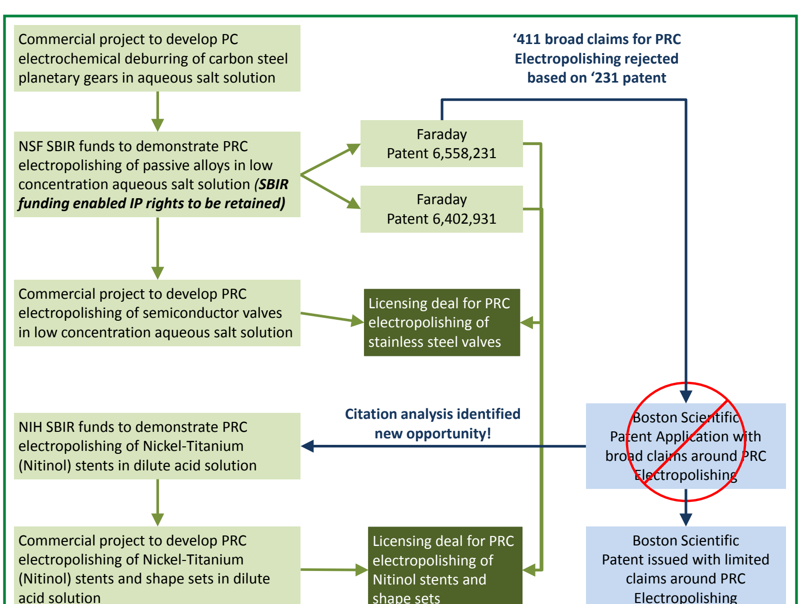

Fig. 6. *Case study of opportunity prospecting.*

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