

# Top ten highly cited patents in USPTO

Yang Zhong-kai<sup>1</sup> Liu Qian-nan<sup>2</sup> Liu Ze-yuan<sup>3</sup>

31 May 2008

## Abstract

This article draws a profile of the top ten highly cited patents in USPTO. After a complex analysis, this article shows main character about the ten patents, includes: basic status; geography distribution; time distribution; co-citation network., etc. At last, this article concludes the social and economic laws behind the top ten patents.

## 1 Introduction

USPTO is the most famous country patent organization throughout the world, which accept millions and thousands patent application every year. Being different from some countries and regions applying for the patent, applying for the USA patent must provide record about referencing patents in the past during the process of R & D and patent application, which is to provide references. The significance of "references" is unlike general significance scientific literature, Including patent documents and scientific literature two categories to continue refining it into the United States cited patents, patent cited other countries, the scientific literature cited three levels. Accordingly, the patents citing other patents and cited by other patents come out of the citing process, and that having been cited more often seen as the key or based technology, because it can lead to more far-reaching and A wide range of technology spillovers that lay a solid foundation for other technologies according to cited process. Economists think the highly cited

patent have a higher economic value, which will bring considerable economic benefits and market competitiveness for enterprises (B. H et al). Analyzing these patents, can identify basic and key technologies (Karki.1997), and we can outline the course of development of technology and trends, at the same time, through the patent holder's confirmation, Competition on certain technical areas can be portrayed (Baneriee et al.2000).

In fact, the number of patents owned by countries or enterprises of United States is recognized on behalf of the level of technological development of the countries or enterprises, while countries and enterprises having more high-cited patents have shown a higher level of technological development and international Competitiveness (Huang et al.2003). Therefore, the measurement of highly cited patent can bring a much clear understanding of the international technology competition.

## 2 Data

NBER issued the patent cited statistics since 1963 in 1999, the integration of databases based on the USPTO database sort on the number of patents. By re-search analysis citation frequency of the top 500 of the patent in 1999, confirmed the new order of highly cited patent once again and extract ranking till December 31, 2006, which selected the top 10 The highly cited patents and analyze them in-depth and from more aspects of view.

1 WISELAB, Dalian University of Technology, Dalian, China

2 WISELAB, Dalian University of Technology, Dalian, China

3 WISELAB, Dalian University of Technology, Dalian, China

### 3 Method And Results

These 10 patents extracted from the database are all have seven number beginning with four, according to USPTO's principle of the patent, these patents applied and granted at an approaching period, application time from 1980 to 1986 less than seven years, given time are arranged in 1982-1988 also less than the seven years. This reflects the aggregation of time of these 10 patents, also USPTO's efficiency. According to China's Patent Law, patent applications to the final decision whether to grant probably need three years or even longer period of time, while Japan often have more than five years of patent examination time.

#### 3.1 Citation Frequency

Table 1 Number of cited times of Top ten highly patents

Number of the patent	Name of the patent	Number of cited times
4723129	Bubble jet recording method and apparatus in which a heating element generates bubbles in a liquid flow path to project droplets	1849
4683202	Process for amplifying nucleic acid sequences	1683
4463359	Droplet generating method and apparatus thereof	1617
4683195	Process for amplifying, detecting, and/or-cloning nucleic acid sequences	1572
4740796	Bubble jet recording method and apparatus in which a heating element generates bubbles in multiple liquid flow paths to project droplets	1558
4558333	Liquid jet recording head	1507
4345262	Ink jet recording method	1479
4313124	Liquid jet recording process and liquid jet recording head	1446
4459600	Liquid jet recording device	1411
4733665	Expandable intraluminal graft, and method and apparatus for implanting an expandable intraluminal graft	1098

In this 10 patents, patent No. 4723129 for Bubble jet recording method and apparatus in which a heating element generates bubbles in a liquid

flow path to project droplets has the largest number of patents cited frequency, which is 1849 times, a patent 4740796 with a similar theme reached a cited frequency of 1558, and several other highly cited patent such as 4463359, 4558333, 4345262, 4313124, 4459600 are also associated with this patent. The other two patents related to the field of biotechnology DNA replication technology, 4683202 and 4683195. the last one of 10 patents is a medical technology patent, a stent technology applied in "Interventional Cardiology " Surgery.

From the results of statistics, the frequency of this 10 highly cited patents are just more than 1000, and the number of the patent ranking 11 is just only more than 900. 5103459 patent is a patented CDMA technology of communications, the application time also developed to 1992, which may indicate that the next wave of highly cited patents will be from the 1990s, and communication technology will become the new highly cited area.

#### 3.2 Sort Of History And Instant Sort

Table 2 Ranking changes of 10 highly cited patents

Number of the patent	Cited number in 1999	Cited number in 2006	Ranking in 1999	Ranking change	Ranking in 2006
4723129	779	1849	1	0	1
4683202	605	1683	9	+7	2
4463359	716	1617	2	-1	3
4683195	631	1572	7	+3	4
4740796	678	1558	3	-2	5
4558333	654	1507	5	-1	6
4345262	658	1479	4	-3	7
4313124	633	1446	6	0	8
4459600	613	1411	8	-1	9
4733665	360	1098	13	+3	10

The ranking of 10 highly cited patents is not static, patent 4683202, the 9th in 1999 became the second in 2006, and patent 4733665 from

1999's 13th to top 10. From technical field, in addition that patent 4723129 dominated the first, the other patents related to inkjet technology had different degree of decline. Two patents related to nucleic acid technology reflected rise.

### 3.3 National And Regional Distribution

Table 3 National and regional distribution of 10 highly cited patents

Number of the patent	Inventor	Inventor country	Patentee	Patentee country
4723129	Endo Ichiro ; Sato Yasushi ; Saito Seiji ; Nakagiri Takashi ; Ohno Shigeru	Japan	Canon Kabushiki Kaisha	Japan
4683202	Mullis Kary B.	USA	Cetus Corporation	USA
4463359	Ayata Naoki ; Shirato Yoshiaki ; Takatori Yasushi ; Seki Mitsuaki	Japan	Canon Kabushiki Kaisha	Japan
4683195	Mullis Kary B. ; Erlich Henry A. ; Arnheim Norman ; Horn Glenn T. ; Saiki Randall K. ; Scharf Stephen J.	USA	Cetus Corporation	USA
4740796	Endo Ichiro ; Sato Yasushi ; Saito Seiji ; Nakagiri Takashi ; Ohno Shigeru	Japan	Canon Kabushiki Kaisha	Japan
4558333	Sugitani Hiroshi ; Matsuda Hiroto ; Ikeda Masami	Japan	Canon Kabushiki Kaisha	Japan
4345262	Shirato Yoshiaki ; Takatori Yasushi ; Hara Toshitami ; Nishimura Yukuo ; Takahashi Michiko	Japan	Canon Kabushiki Kaisha	Japan
4313124	Hara Toshitami	Japan	Canon Kabushiki Kaisha	Japan
4459600	Sato Yasushi ; Takatori Yasushi ; Hara Toshitami ; Shirato Yoshiaki	Japan	Canon Kabushiki Kaisha	Japan
4733665	Palmaz Julio C.	USA	Expandable Grafts Partnership	USA

There is no doubt that the United States and Japan are the two countries with the world's most powerful technologies, Coincidentally, the 10 highly cited patents also comes from these two countries, which Japan occupied 7, while the

United States occupied 3. From the distribution of the patentee, Japan's Canon is in control of seven patents related to inkjet technology; U.S. Cetus Corporation holds two nucleic acid technology patents, and the remaining surgical patent is owned by U.S. Expandable Grafts Partnership.

Canon is a world's famous company focus on R&D and production of copiers, printers, digital cameras and other equipment; Cetus Corporation had R&D on DNA technology early, which now does not exist, Technology owned by it transferred to the Hoffmann-La Roche, making the latter a PCR technology leader. Expandable Grafts Partnership is a tripartite partnership specialized for patent 4733665, the partners include the inventor Palmaz Julio C., later this technology are sold to Johnson & Johnson, setting off strong confrontation among Johnson & Johnson and Boston Scientific Corporation and ot, and many other large companies in the field of technology.

### 3.4 Other Natural Conditions

From the classification of the IPC, patent 4733665 attributable to the A61F (implantable blood vessels within the filter), A61M (Media will enter the human body or the equipment lost to the human body); nucleic acid technology patents belong to C12N (microorganisms or enzymes; their portfolio ; Propagation, preservation or maintenance of micro-organisms; mutation or genetic engineering; medium), C07H (sugar, and its derivatives; nucleoside; nucleotide; nucleic acid) and other classification; inkjet technology patents belong to B41J (typewriters), G01D (non-specific variables dedicated to the measurement; not included device in the other separate subcategory measuring two or more variables;)and other IPC classification.

Among these 10 patents, patent 4733665 has the largest number of other cited patents, it cites 24 U.S. patents and two foreign patents and has eight scientific literature cited; patent 4683192 cites five scientific literature, patent 4683202 cited the three scientific literature, and ink-jet technology patents rarely quote scientific literature, it reflects from one side the difference of the technology field between scientific research and technological development.

Table 4 Other natural conditions of 10 highly cited patent

Patent 4463359 proposed 51 patent claims, and 4459600 only has two, it is generally believed

Number of the patent	IPC Classification	The number of other cited U.S. patents	The number of patents cited in other countries	The number of cited scientific literature	The number of claims
4723129	B41J, G01D	14		1	9
4683202	C12Q, C12P, C12N, G01N, C07H			3	21
4463359	B41J, G01D, H04N, C12Q, C12P, C12N, G01N, C07H	9	Germe <sup>3</sup> Britain <sup>1</sup>		51
4683195	B41J, G01D	1		5	26
4740796	B41J, G01D	16		1	10
4558333	B41J, G01D	6			14
4345262	B41J, G01D	3	Germe <sup>1</sup>		15
4313124	B41J, G01D	2			7
4459600	B41J, G01D	6			2
4733665	A61F, A61M	24	Spain <sup>1</sup> Britain <sup>1</sup>	8	28

that the number of claims would be reflected on the strength of legal protection requirements. In particular, it is worth mentioning that patent 4733665 applied to surgery has implemented compulsory licensing order by the U.S. Government, as a patent with strong public service, regardless of whether the is willing to involve the interests of the public when necessary, States can be paid compulsory acquisition, which also reflect great practical value of the patented technology.

### 3.5 The Time Distribution Of Cited Frequency

It can be seen in Table 5 that the peak cited times of different patents also has a slight difference, an earlier application for the patent to be the peak with a longer time, while the late application for the patent to be the peak with a shorter time. Comprehensively, patents' cited process is uneven distribution over time, every patent has a process from low to high then to the decay, which also comply with the life-cycle of technology. A technology often slowly fall behind the development so that can be replaced by other tech-

nologies corresponding the quoted chance will reduce until no one ask about it. It does not rule out that some patent after the failure will receive a higher number of citations, although such patents are very few.

Table 5 Peak statistics of highly cited patents

Number of the patent	Application date	Granted date	Cited peak	Start year	Time difference of application year
4345262	1980.2.7	1982.8.17	192	1997	17
4463359	1980.3.24	1984.7.31	205	1995	15
4313124	1980.5.13	1982.1.26	186	1997	17
4459600	1981.11.25	1984.7.10	190	1995	14
4558333	1982.7.2	1985.12.10	205	1997	12
4683202	1985.10.25	1987.7.28	216	1995	10
4733665	1985.11.7	1988.3.29	126	2001	13
4723129	1986.2.6	1988.2.2	229	1995	9
4740796	1986.2.6	1988.4.26	207	1995	9
4683195	1986.2.7	1987.7.28	229	1995	9

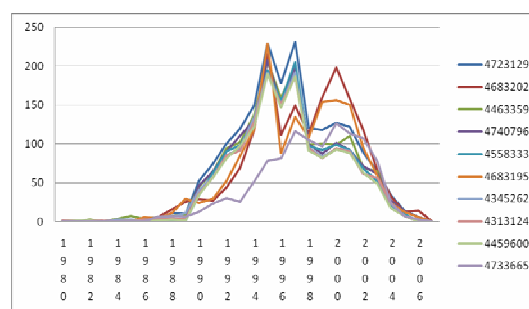


Figure 1: The trend of frequency of the highly

An interesting phenomenon reflected by Figure 1 is that the wave of several patents related to inkjet technology cited frequency over time is also similar. Speculation is that there should exist a large-scale use of common law about these patents. So does Nucleic acid technology patents, , is only slightly different from the peak wave, but generally the same wave.

Another noteworthy issue is that the number of the cited patents reached the peak was even as many as six in 1995, in fact, the emergence of the peak is after 1995. Recalling the U.S. history of

the development of the patent system, it can be speculated that focus on emerging of the peak had related to the reform of the patent system around the year 1995. U.S. Congress passed the Uruguay Round Agreements Act (URAA) in 1994, and ratified the TRIPS Agreement. President Clinton signed the bill in December 1994, which entered into force on June 8, 1995. In order to fulfill the U.S. commitment to international obligations, in accordance with the requirements of the TRIPS Agreement, the United States patent law make some changes as follows: (1) expanding the scope of patent violations, including promised sales and import violations.(2) In determining the invention date of patent applications, recognized the invention conducted by member countries of WTO outside the United States; (3) the patent's protection period extended to 20 years, from the date of patent applications;(4) the creation of The provisional application system, similar to domestic priority system. These initiatives lead to a new upsurge from the U.S. patent application, and cited peak appeared after 1995 is the logical thing in accordance with the probability.

### 3.6 Co-cited analysis

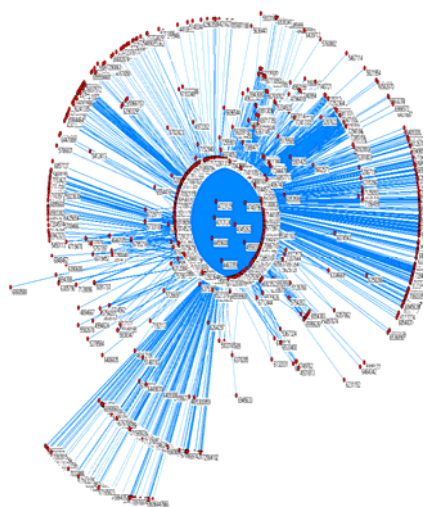


Figure 2: Co-cited network of inkjet

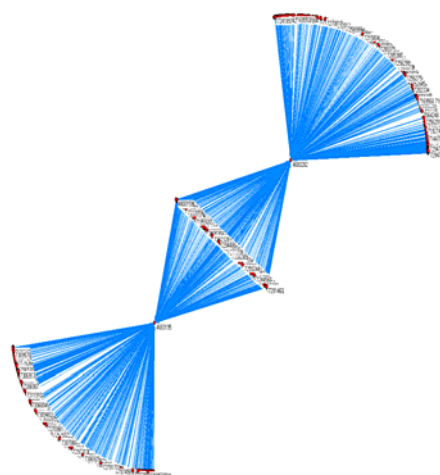


Figure 3: Co-cited of nucleic acid-related patents

In order to verify the former speculated patents' co-cited phenomenon, drawing two patents co-cited network using PAJEK software. Figure 2 revealed co-cited network developed by 4740796, 4723129, 4558333, 4345262, 4313124, 4459600, 4463359 these seven patents belong to Canon inkjet technology-related patents as the center. The seven points in the middle is that seven key patents and patent lap around is patent ethnic groups having the common use of this seven patents, a circle of the outer lap only has the citing relationship with one of the seven patents. The citing relationship between the patent between the inner and the outer circle and the seven patents is among(1,7). In fact, although this seven patents each have the frequency of citation of more than 1,000 times, citing relations in the tens of thousands, but statistics tell us if Calculating by the number of patents, the number of patents related is no more than 2500, That is to say, co-cited phenomenon exist significantly.

As there are only two key patents, co-cited phenomenon of nucleic acid-related patents in more clearly visible, the two connection point in the middle is that these two key patents, among three patents group formed, a group of middle and these two patents have cited relation, two groups of the two end each with a patent-related.

## 4 Discussion

### 4.1 Endovascular Graft Methods And Equipment

In 1985, heart disease expert Richard Schatz get to know the Argentine doctor Julio Palmaz, who has a technology using small metal tube to distract the rabbit vascular. Later, Schatz find investors —Phil Romano. A tripartite partnership called “Expandable Graft Partnership” was established. Palmaz and Schatz continued to test their invention on rabbits and dogs. After the success of animal experiments, they applied for the most extensive patent, covering all types of extended stent balloon. In 1986, Romano, Schatz and Palmaz began selecting medical company, to sell the technology license, and alternative enterprises are Johnson & Johnson and Boston Scientific. In order to get the technology license, Johnson & Johnson paid \$10 million to the three partners and promised to give them substantial royalties. In 1998, Johnson finally bought the entire Palmaz-Schatz franchise, it paid \$500 million. Now the market value of the technology is about \$4.5 billion, very impressive. The practical significance of this technology is not only to bring the economic benefits to the franchise, but to lead the Interventional therapy’s development. In the process of competition between Boston Scientific and Johnson, new technological inventions are in an endless stream, greatly promoting raising the level of medical technology of cardiac surgery.

### 4.2 The New Method Of Copying DNA Molecules

Kary Mulls, One staff of Cetus, responsible for inventing the new method for copying DNA molecules. he found a cloning method using enzyme called DNA polymerase to copy the DNA instead of bacteria- bacteria that use this enzyme to copy its own DNA. The method he invented called polymerase chain reaction, or PCR, by this method scientists can use polymerase enzyme in vitro to zoom the DNA sequence in their study. Each time their number will be doubled, which will produce large quantities of DNA sequences. This technology allows

researchers to do the large number of copies for certain required DNA sequences.

In July 1987, Cetus Corporation get the basic PCR patent approval in the United States, and launched the first PCR reagent products and the first heat cycle in November of this year. In 1989 "Science" reported the heat resistance of the Taq DNA polymerase indicating that the arrival of the era. In 1993, Kary Mullis won the Nobel Prize in Chemistry because of invention the PCR. It can be said that the invention of the technology was a revolutionary breakthrough in the 1980s in the field of molecular biology, having playing a great role in molecular biology, medicine, law and other fields.

### 4.3 Thermal Inkjet Technology

By the Canon company, then Ichiro Endo (incumbent the director of product development), having found the phenomenon of the heat ink emitted by chance, and creating the basic principle of the ink-jet technology. Thus, Canon claims to be the inventor of the inkjet printer, while Hewlett-Packard claims itself the invention of this technology. HP dominates the inkjet printer market with 56 percent market share, while Canon is in second place by 22 percent, but the number of patents of inkjet printing technology owned by Canon is more than HP.

Thermal inkjet print head technology is one of the great invention of the 20th century, also the main printing technology used by the wide color inkjet printers. Thermal inkjet print heads use a small resistance to the rapid heating ink, form a bubble after gasification of the liquid in the pipeline, press ink out of the nozzle, output to the surface of medium, then form patterns or characters. Because that thermal inkjet technology started in the 1980s, mature, lower-cost, and can reduce the overall cost of wide print to some extent, as a result having an extensive application in the field of wide print.

There are many products using thermal inkjet printing technology, mainly Canon and HP's products. Only two years ago, laser printing also seems to represent the future trend, but a series of Canon and HP's technology, however cumbersome the original fuselage, print rough inkjet printer into a lightweight, low-cost and high-quality popular Color Printer. According to

this trend of development, Canon will focus the development on the latest inkjet technology.

#### 4.4 Discussion And Outlook

Recalling the historical development three categories of patented technology, we can see that 10 high-cited patents can be called as the patents with milestone significance, which opened a new era of technology. The reason why highly-cited patents has larger number of citations is that they contains a sophisticated or even common technical knowledge. It is worth reference for the follow-up patents, but also led the development of technology (Narin.1994).

In accordance with time-series, patent 4345262 raised the ink jet recording methods, in order to solve the problem of liquid, patent 4463359 provides the method and equipment for its production, later patent 4313124 designed liquid spray recording head, patent 4459600 designed ink jet recording devices, patent 4558333 upgrade the liquid spray recording head, patent 4723129 developed a new method and equipment of foaming spray record (a heating component produce bubble in the liquid flow to produce liquid-jet), 4740796 further deepen the sparkling jet recording methods and equipment (including a heating device in multiple liquid flow in the bubble to produce liquid-jet). Patent 4683202 is only study the process of amplified nucleic acid sequences group, and patent 4683195 focus on amplification, detection and (or) nucleic acid sequences group cloning process ,enriching the connotation of the study.

Through this study we can not directly come to the conclusion to prove how to obtain a highly cited patented technology, which is before the patent stage, R & D staff need to work through the very complex innovation activities in order to achieve the target, and has a chance. In addition, none of the original intention for apply a patent is to obtain a higher frequency of citation, because the patent application is intended to benefit. However, the analysis of highly cited patents can reveal the proliferation and sharing of patented technologies in post patent phase. The rule revealed in this paper can be used to identify and confirm basic patents and key patents in this field, in order to provide theory and practical reference for further research and access to patents.

## Acknowledgement

This research was supported by the National Natural Science Foundation of China under Grant 70773015, 70431001, 70620140115, National Social Sciences Foundation under Grant 07CTQ008, Project of DUT under Grant DUTHS1002, Specialized Research Fund for the Doctoral Program of Higher Education under Grant 20070141059, projects of League of Social Sciences in Liaoning Province under Grant 20071slktglx-52.

## References

- Banerjee, P., Gupta, B. M. & Garg, K. C. (2000). Patent statistics as indicators of competition: an analysis of patenting in biotechnology. *Scientometrics* 47(1) : 95-116.
- B. H. Hall, A. Jaffe, M. Trajtenberg. Market value and patent citations: a first look [DB/OL]. *NBER Working Paper* No. w7741.
- Huang Mu-xuan, Chen Da-ren, Zhang Han-wen.(2003). Evaluation of national competitiveness the from the view of patent technology. *Paper of China Society of Library* (70):18-30.
- Karki, M. M. S. (1997). Patent citation analysis: a policy analysis tool. *World Patent Information* 33(4):269-272.
- Narin, F. Patent bibliometrics. (1994). *Scientometrics* 30(1):147-155.
- Trajtenberg, M and Jaffe, Adam. The NBER patent citations data file : lessons, insights and methodological tools[DB/OL] .*NBER Working Paper*, No.8498.