

Patent Map of Torque Wrench Technology for Digital Display Tools

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Abstract: By consulting the patent database about the torque wrench in the past 80 years, the technical development and technological process of the torque wrench at home and abroad are studied in detail on the patent map. A series of patent maps in the field of torque wrench technology are drawn by using patent information data mining method, patent map analysis method and international patent IPC classification method. This paper also makes a detailed analysis of the number of applications, application trends, major applicant countries, major competition agencies, patent distribution patterns, changes of main technical hot spots, key technical development areas, etc. It also analyses the current research situation and technical hot spots in the field of torque wrench technology, and predicts the future technical development trend of torque wrench.

1. Introduction

Torque Wrench, also known as torsion wrench, is designed on the basis of the bending principle of beams, the bending principle of torsion rods and the compression principle of helical springs. It can not only fasten bolts, but also measure the magnitude of the moment acting on nuts^[1]. Torque wrench has been widely used in aerospace and aerospace manufacturing, automotive assembly, high-speed rail manufacturing, engine manufacturing and assembly, bridge construction and shipbuilding industries because of its function of setting torque value while fastening bolts and arbitrarily adjusting torque value^[2].

As a tool for collecting, collating and utilizing patent information, patent map is easy to understand and understand. It points out the direction of technology development for research institutes, summarizes and analyses the trend of technology distribution. Making a good patent map can effectively improve the efficiency of research, improve the quality of technology research and development, and reduce the investment of funds^[3].

This paper searches the patent databases of torque wrench published at home and abroad from 1937 to December 2018 (patent data source comes from Baiteng Patent Retrieval System), and retrieves 3408 patent data through the keyword "ti:(torque wrench) OR ti:(torque wrench)" from the patent databases at home and abroad^[4]. On this basis, the above-mentioned patent data at home and abroad are analyzed, and the annual patent distribution map of torque wrench technology is drawn. The patent maps of the number of patent applications, patent applicants, patent technology distribution, research hotspots, major competition agencies and key technical fields in major countries and regions are analyzed in detail.

2. Global Torque Spanner Technology Analysis

2.1. Global Patent Annual Trends.

At the request of the British military and Rolls-Royce, Norbar produced the first torque wrench to control tightening torque in 1942, and became the first manufacturer of all kinds of torque tools and instruments in the world^[1]. Fig. 1 shows the relationship between the number of global patent

applications for torque wrenches and annual changes since 1973.

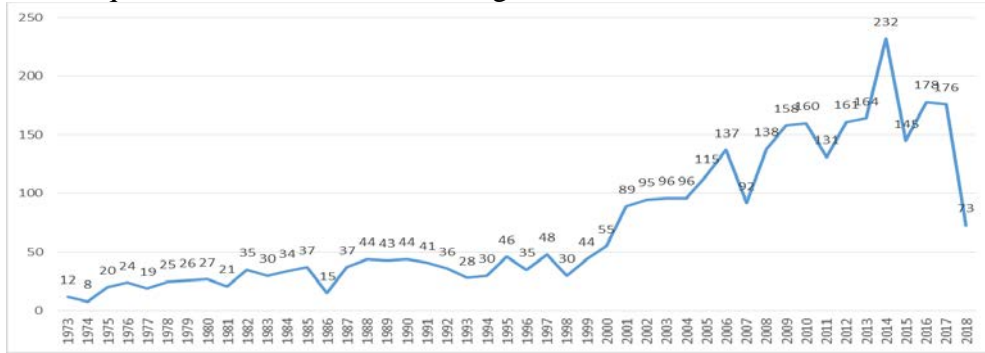


Figure 1. Patent application and annual trend of torque wrench

Although the first patent for torque wrenches was born in 1937, the number of global patent applications for torque wrenches was only about 10 per year in the past 40 years from 1937 to 1973. From Figure 1, we can see that from 1973 to 2000, the number of global patent applications for torque wrenches showed an upward trend, but the number of patent applications per year did not exceed 50. From 2000 to 2012, the torque wrench has become the main research object in various countries. With the popularization of the application of the torque wrench, the price tends to be reasonable, and the number of patent applications has generally increased, with an average of about 120. It is noteworthy that in 2014, the number of patent applications worldwide reached a peak of 232. From 2015 to 2018, as the core technology of torque wrench is relatively mature, more and more enterprises can mass produce various types of torque wrench, the number of patent applications began to show a downward trend, to 2018, the number of patent applications is only 73^[5].

2.2. Patent Quantity Distribution in Global and Regions.

Fig. 2 shows the distribution of 3408 patents filed between 1937 and 2018, which reflects the distribution of national and regional sources of torque wrench patented technology^[6].

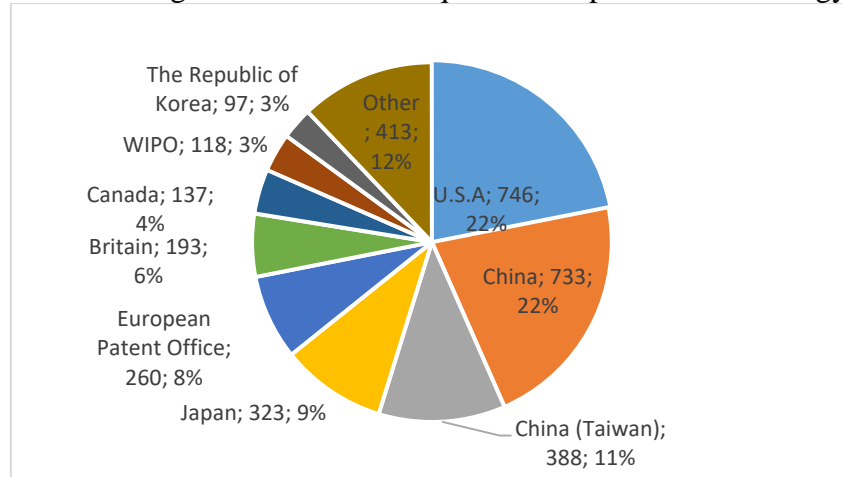


Figure 2. Global Patent Quantity Distribution

As can be seen from Fig. 2, the United States is the first country to apply for patent technology for torque wrenches, with 746 patents, accounting for 21.89%. China mainland has 733, accounting for 21.51%, ranking second. The third place is 388 in China (Taiwan), accounting for 11.38%. Japan has 323 pieces, accounting for 9.48%, ranking fourth. The European Patent Office ranked fifth with 260 pieces. Britain ranks sixth in 193 and Canada seventh in 137. The United States is still the world leader in torque wrench technology, and its technical strength cannot be underestimated. In the 1990s, he devoted himself to the research of torque wrench technology. At the beginning of the 21st century, he has gradually become the leader of the torque wrench industry. The development of technology is obviously ahead of other countries, and all kinds of torque

wrench products occupy most of the market. The number of patents in mainland China has been increasing in recent 10 years. The number of patents in mainland China has reached the second place in the world, which is not far from the total number of patents in the United States. Obviously, China mainland has accumulated patents in the field of torque wrench technology and relatively mature technology, as well as mainland Chinese enterprises have maintained a high degree of attention to the technology in this field, and their torque wrench technology has gradually been in the leading position in the world.

3. Analysis of Main Patent Application Institutions

About 1000 institutions are active in the research and development field of torque wrench technology in the world. Among them, the top 10 major applicants or applicants in the world are listed in Table 1.

Table 1 Top 10 Patent Application Institutions or Patent Applicants in the World



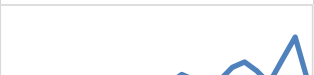



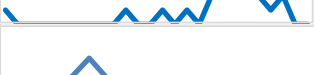



applicants	countries	patent application volume	active period of patent application	the relationship between the number of patents and the year
SNAP ON TOOLS CORP	U. S. A	79	1989–2016 (28 years)	
KABO TOOL CO	China (Taiwan)	77	2003–2018 (16 years)	
Shaanxi Oriental Aviation Instruments Co., Ltd.	Chinese Mainland	53	1994–2018 (25 years)	
URYU SEISAKU LTD	Japan	43	1983–2015 (33 years)	
TOHNICHI MFG CO LTD	Japan	42	1996–2017 (22 years)	
Xie Zhi Qing	Chinese Mainland	20	1987–2010 (24 years)	
HEDLEY PURVIS LTD	Britain	19	1988–1996 (9 years)	
ISUZU MOTORS LTD	Japan	19	1999–2013 (15 years)	
NAKAMURA SEISAKUSHO KK	Japan	17	1978–2014 (37 years)	
NORBAR TORQUE TOOLS	Britain	16	1993–2015 (23 years)	

Table 1 shows that among the top 10 institutions in the world, there are 4 in Japan, 2 in mainland China, 2 in Britain, 1 in the United States and 1 in China (Taiwan). According to the number of patent applications, two companies in the United States and China (Taiwan) are in the first echelon. SNAP ON TOOLS CORP in the United States ranks first in the number of 79 patent applications, leading enterprises in other countries. Its patent active period is up to 28 years. KABO TOOL CO of China (Taiwan) ranks second in the number of 77 patent applications with a patent active period of 16 years. Following the second echelon are one company in mainland China and two companies in Japan. The number of patent applications is about 40-50. Shaanxi Oriental Aviation Instruments Co., Ltd. of China mainland ranks third in the number of 53 patent applications, with a patent active period of 16 years. URYU SEISAKU LTD of Japan ranks fourth with 43 patent applications, with a patent active period of 33 years. TOHNICHI MFG CO LTD ranks fifth with 42 patent applications, and its patent active period is 22 years. After that, 5-10 companies belonged to the third echelon, and the number of patent applications was about 20. Xie Zhiqing, a Chinese mainland, ranks sixth in the number of 20 patent applications filed by individuals, with a patent active period of 24 years.

ISUZU MOTORS LTD in Japan ranks eighth with 19 patent applications, and its patent active period is as long as 15 years. There are two companies in the UK in the top ten. HEDLEY PURVIS LTD in the UK is seventh with 19 patents and has a patent active period of up to nine years. The UK NORBAR TORQUE TOOLS, with 16 patents in its tenth place, has a patent active period of 23 years.

According to the active period of patent application of various applicants and individuals, the longest active period of patent application is 37 years, the shortest is 9 years, and most applicants are between 13 and 33 years. From the trend chart of patent application in Table 1, we can see that the peak of patent application in the top ten institutions in the world is mostly in the last ten years. It can be seen that the torque wrench itself has the space and potential to improve in various technical fields, which is also the key point of research and development of the torque wrench technology.

4. IPC Classification Analysis of Global Patents

Through the international patent IPC code classification method, the technical field of torque wrench can be divided. The specific technical field of torque wrench can be divided as shown in Table 2.

Table 2 Main Technical Types of International Patent IPC Classification of Global Torque Wrench

Sorting	Classification Number	Chinese Interpretation	Number	Percentage
1	B25B23	Clamps, spanner parts or accessories	771	20.86%
2	B25B13	Clamps, wrenches	330	9.68%
3	B25B21	A portable tool for tightening bolts or nuts.	181	5.31%
4	G01L25	Detection or calibration of force measuring instruments	65	1.91%
5	G01L5	A device for measuring forces produced by impact	32	0.94%
6	B25B17	Manual Gear-operated wrench	17	0.50%
7	A61C8	Dental implant tools	15	0.44%
8	A61B17	Surgical instruments, devices or methods	14	0.41%
9	B25/B1	Vice device	12	0.35%
10	E21B19	A device for feeding a drill pipe or wire rope.	11	0.32%

According to the IPC classification of international patents, its main technical fields are in three technical categories: plate pliers, wrench parts or accessories, plate pliers, wrenches and portable tools for elastic bolts or nuts. The number of patent applications for clamp, wrench parts or accessories was the first, totaling 771 patent applications, accounting for 20.86%. The number of patents applied for forceps and wrenches was the second, totaling 330 patents, accounting for 9.68%. The number of patent applications for portable tools with elastic bolts or nuts was the third, totaling 181 patent applications, accounting for 5.31%. It can be seen that foreign enterprises invest the most in human and capital work in the above three kinds of technology fields, and their R&D efforts are also the greatest. The number of specific patent applications for the international patent IPC classification of major enterprises in the world is shown in Table 3.

Table 3 Quantity Distribution of International Patent IPC Classification Applications in the Top 10 Globally

Applicants	B2 5B 23	B2 5B 13	B2 5B 21	G0 1L 25	G0 1L 5	B2 5B 17	A6 1C 8	A6 1B 17	B2 5/B 1	E2 1B 19
SNAP ON TOOLS CORP	40	4	3	2	0	0	0	0	0	0
KABO TOOL CO	60	4	0	3	2	0	0	0	0	0
Shaanxi Oriental Aviation Instruments Co., Ltd.	7	2	3	5	2	0	0	0	0	0
URYU SEISAKU LTD	15	0	29	0	0	0	0	0	0	0
TOHNICHI MFG CO LTD	33	2	2	1	2	0	0	0	0	0
Xie Zhi Qing	16	1	0	0	0	0	0	0	0	0
HEDLEY PURVIS LTD	0	2	17	0	0	0	0	0	0	0
ISUZU MOTORS LTD	18	0	1	0	0	0	0	0	0	0
NAKAMURA SEISAKUSHO KK	16	0	0	0	0	0	0	0	0	0
NORBAR TORQUE TOOLS	10	0	0	4	4	0	0	0	0	0

As can be seen from Table 3, the United States Fast-breaking Tools Company, China (Taiwan) KABO TOOL CO. and Japan's East Japan Manufacturing Institute have applied for the largest number of patents in the field of plate pliers, wrench parts or accessories, and their technical reserves are strong. Two enterprises, URYU SEISAKU LTD. in Japan and HEDLEY PURVIS LTD in Britain, have comparative advantages in the field of portable tools technology for elastic bolts or nuts. Although the number of patents applied by other companies is small, they still focus on the above three categories of technology.

5. Change of Main Technological Hotspots

Based on the data of 3408 global torque wrench patents, combined with the results of IPC classification of global torque wrench patents in Table 3, and classified and screened by year, the dividing line of 2010 as the main hotspot technology change of torque wrench is finally determined, which is divided into two sections before 2010 and after 2010. Fig. 3 reflects the main hot spot technological changes of the global torque wrench before 2010 and after 2010^[7].

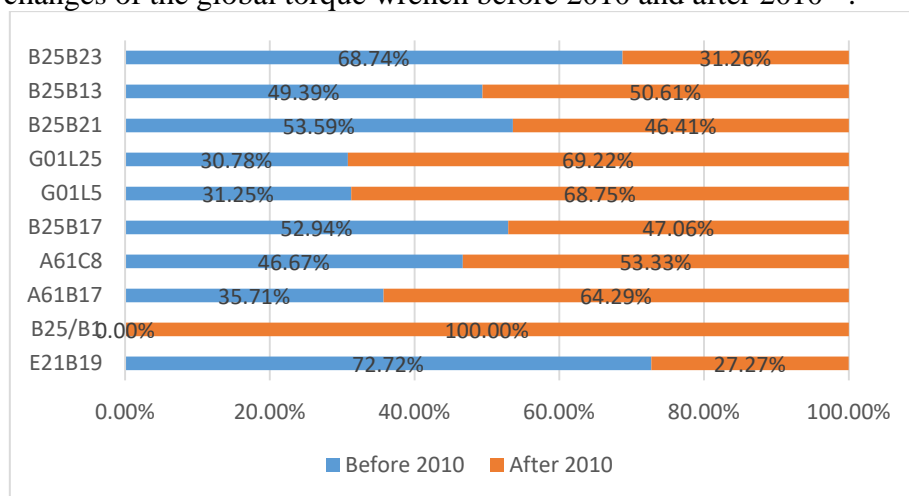


Figure 3. Technical Changes of Torque Spanners

As can be seen from Fig. 3, the main research directions of torque wrenches before 2010 are mainly focused on four technical categories: plate pliers, wrench parts or accessories, wrenches

operated by manual gears, portable tools for loose screws or nuts, plate pliers and wrenches. But after 2010, the development trend of technology category of torque wrench has changed greatly, that is, technology hotspots continue to be maintained in the field of pliers, wrench parts or accessories, portable tools for loose bolts or nuts, pliers and wrenches. Beginning to move toward the two major technical fields of measuring force instruments, such as the detection or calibration of force meters and the measurement of force devices generated by impact.

6. Summary

1) The United States and the mainland of China still maintain absolute advantages in the field of torque wrench technology, especially in recent years, the rapid development of torque wrench technology in China. With the increasing demand for torque wrench in all walks of life, the domestic research and development of core technology of torque wrench has gradually increased, and the number of patent applications for torque wrench has reached the second place.

2) Through the analysis of annual change trend chart, the number of patent applications for torque wrench technology in the world has gradually increased since 1973, and reached its peak in 2014. In recent years, the number of patent applications has declined. Although the technology of torque wrench started late in China, the number of patent applications has developed rapidly in recent years. The total number of patent applications has reached 733, and the number of patent applications for torque wrench is still on the rise. This shows that domestic enterprises and institutions have begun to recognize the research and development of independent property rights of torque wrench, the accumulation of technology, and the patent application and protection of technological progress. Importance.

3) From the point of view of the change of technology hotspots, the key technologies of torque wrench still lie in the following three categories: plate pliers, wrench parts or accessories, wrenches operated by manual gears, portable tools for tightening bolts or nuts, and wrenches. In order to improve the core competitiveness in the world, it is suggested that domestic enterprises and institutions continue to increase R&D efforts in three core technical categories: plate pliers, wrench parts or accessories, wrenches operated by manual gears, portable tools for tightening screws or nuts, plate pliers and wrenches. At the same time, compared with foreign enterprises, domestic enterprises need to further improve the core technology areas, patent holdings and patent distribution, and make breakthroughs in other categories of technology areas.

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