

# Research on innovation and Development of China's Equipment Manufacturing Industry from the perspective of patent

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**Abstract:** Incomat patent database as the data source, from the year of patent filings, application type and the legal status, research and development subject, technical structure, operating status, key technologies and development route of Chinese equipment manufacturing industry to conduct a comprehensive analysis of patent information, find the problems existing in the equipment manufacturing industry in our country, is advantageous to the government, enterprises and academia reference countermeasures and Suggestions.

**Keywords:** China; Equipment manufacturing industry; Patent; Incomat

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Equipment manufacturing industry is the most important part of a country's economy and society. It can drive the development of the whole society and economy, and at the same time, it can reflect a country's technical strength. A patent is the result of an invention-creation and scientific and technological innovation, a legal proof of the exclusive right of the patentee to intellectual property granted by the state intellectual property administration, and a legal weapon to protect intellectual property. The patent archive is the largest source of technical information in the world. It is a collection of technical, economic and legal information that provides access to the latest technical information in the field. Through literature search on CnKI, it is found that domestic scholars' research on equipment manufacturing industry mainly focuses on analyzing the current situation of equipment manufacturing industry in China or a certain region and then putting forward Suggestions for development. There are few literatures involving patent analysis of equipment manufacturing industry.

## I. Overview of the development of domestic and foreign equipment manufacturing industries

### 1.1 Concepts related to equipment manufacturing industry

Manufacturing refers to the processing and reprocessing of raw materials (extractive products and agricultural products) and the industrial sector of parts and equipment. It includes food, beverage, tobacco, clothing, textile, wood, paper and other manufacturing industries; Petroleum, chemistry, medicine, rubber, non-metallic ore, brown metal non-ferrous metal processing industry, machinery and electronics, weapons and ammunition manufacturing industry and other 29 industries (Table 1).

**Table 1** Equipment manufacturing industry classification

Categories	In the class
Metal products manufacturing industry	Metal structure manufacturing industry, cast iron pipe manufacturing industry, cutting tool manufacturing industry, mold manufacturing industry, wire mesh and its products industry, construction metal products industry, metal surface treatment and heat treatment industry
General machinery manufacturing industry	Boiler and prime mover manufacturing, metal processing machinery manufacturing, general equipment manufacturing, bearing valve manufacturing
Special equipment manufacturing	Metallurgical equipment manufacturing, mining equipment manufacturing, petrochemical equipment manufacturing, light textile equipment manufacturing, agricultural and forestry equipment manufacturing, medical equipment manufacturing
Transportation equipment manufacturing industry	Automobile manufacturing industry, railway transportation equipment manufacturing industry, shipbuilding industry, aviation and spacecraft manufacturing industry
Electrical machinery and equipment manufacturing industry	Electrical machinery manufacturing, transmission and distribution and control equipment manufacturing, electrical equipment manufacturing

Electronic communication equipment manufacturing industry	and	Communication equipment manufacturing, radar manufacturing, radio and TELEVISION equipment manufacturing, electronic computer manufacturing, electronic component manufacturing
Instruments and office machines	and cultural	General instrument and meter manufacturing industry, special instrument and meter manufacturing industry, electronic measuring instrument manufacturing industry, computing equipment manufacturing industry

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## **1.2 Development status of China's equipment manufacturing industry**

Equipment manufacturing development beginning in the 1880s, China started late, after forty years of development, it has formed complete kinds, industry scale of industrial clusters, according to the National Bureau of Statistics data show that by 2018 China's 90.0309 trillion yuan GDP, industrial output is 36.6001 trillion yuan, the equipment manufacturing industry added value 16.3236 trillion yuan, which accounts for 44.6% of industrial, second only to the United States, Japan and Germany, fourth in the world, the average annual growth rate of 17.6%. However, at the present stage, China's equipment manufacturing industry is large but not strong, core technologies are still in the hands of developed countries, most industries in China's equipment manufacturing industry do not have research and development capabilities, lack independent intellectual property rights, a large number of advanced equipment need to rely on imports, such as medical machinery, integrated circuit chips.

## **II. Patent analysis of China's equipment manufacturing industry**

### **2.1 Patent literature search**

The patent analysis and retrieval strategy takes into account that the equipment manufacturing industry has many categories and involves a wide range of industries. Using points total retrieval strategy is more appropriate, retrieval strategy is based on the technology of total breakdown, retrieval technology of the branch, then the technology branch of the retrieval results merging to get the general retrieval results, the concrete process is: technology branch of technical breakdown of the retrieval, retrieval result to obtain the technology under the branch; Secondly, the retrieval results of each branch of technology are combined to obtain the total retrieval results. After that, the data will be indexed and processed by batch classification number, grouping manual indexing and dryness removal to ensure the accuracy.

When selecting a database, the authority and comprehensiveness of the data should be considered so as to conduct in-depth analysis from multiple angles and levels. All data for this article is from the IncoPat database. Considering the characteristics of each industry of equipment manufacturing industry, the patent retrieval model is formulated with keywords to carry out a comprehensive search for the patents of the national equipment manufacturing industry.

### **2.2 Application trend analysis**

Figure 1 shows the application trend of China's equipment manufacturing industry, with its overall development showing a gradual upward trend. Due to the time required for database inclusion in 2018, the data are for reference only. According to the search, it was found that the relevant patents had been applied since 1985, the first year of the implementation of China's patent Law, indicating that China's equipment manufacturing industry had a certain technical basis at that time.

The period from 1985 to 1996 was the initial stage, during which the number of patent applications fluctuated but did not increase significantly. The annual number of patent applications remained within 100, reaching a peak of 98 in 1995, of which the average annual number of applications was 74. It is understood that in the 1880s, when China was in the early stage of reform and opening up, with the strong support of national policies, the proportion of agriculture and light industry gradually declined and approached that of heavy industry, and the equipment manufacturing industry showed significant development.

During the growth period from 1997 to 2008, the number of patent applications increased every year, especially after 2005, the number increased to 100 each year and reached 834 in 2008. It is reported that the state issued several opinions on accelerating the revitalization of the equipment manufacturing industry in 2006, and issued policies to support the development of the equipment manufacturing industry in the following years.

Since 2009, it has been in the take-off stage. In 2009, the number of patent applications exceeded 1,000, and in 2011, the number of patent applications exceeded 2,000. After that, the number of patent applications continued to rise, reaching a peak of 4,123 in 2017. Because the equipment manufacturing industry is fundamental to the national economy, the state has invested a lot of energy in the equipment manufacturing industry. The development of equipment manufacturing industry has always been guided by policies.

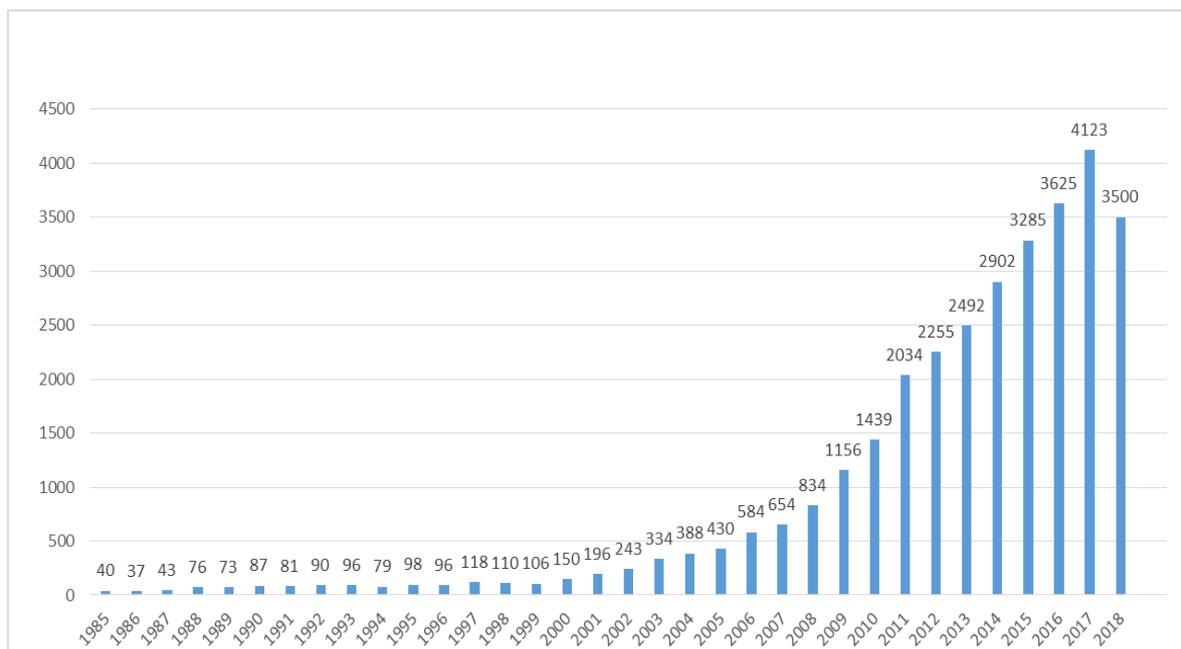


FIG. 1 Patent application trend of China's equipment manufacturing industry

### 2.3 Analysis of application type and legal status

The legal status of China's equipment manufacturing industry patents is shown in Table 2. By 2018, China's equipment manufacturing industry has applied for 12,331 authorized patents, accounting for 39% of the total number of national applications, 7,691 patents under review, accounting for 16%, and 7,691 patent terminations, accounting for 24%. 3765 patents were withdrawn, 1368 were rejected, 937 were disclosed, and 745 were abandoned. In general, the proportion of authorized patents is the largest, and the technology development of China's equipment manufacturing industry shows a good trend.

Table 2 Distribution of legal status of China's equipment manufacturing industry

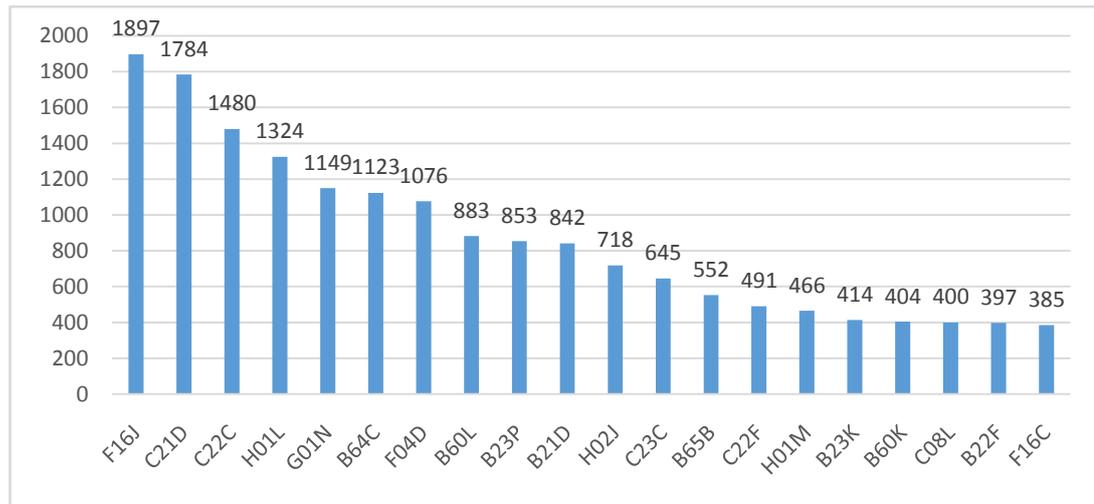
Current state of law	The number of patents	Current state of law	The number of patents
authorization	12331	public	937
Right to terminate	7691	To give up	745
Examination as to substance	5099	All invalid	11
To withdraw	3765	All cancellation	1
rejected	1368	Part of the invalid	1

### 2.4 Research and development subject analysis

Enterprises account for a large proportion of patent applications in China's equipment manufacturing industry, accounting for more than half of the total number of applications, reaching 21,473, indicating that the number of patent applications filed by enterprises in China's equipment manufacturing industry is the main body. This was followed by 5,363 individuals, or 17 per cent, followed by universities (4,311) and research institutes (1,179). The large number of individual applications also indicates the low threshold of equipment manufacturing industry.

### 2.5 Technical Analysis

As you can see from Figure 2. The patented technologies applied for are mainly distributed in F16J, C21D, C22C, H01L and other five sub-categories. Where F16J (piston; Cylinder; General pressure vessels; Seal) class of patent 1897, C21D (change the physical structure of black metal) has 1784 in patent, C22C patent 41 pieces (alloy) class, H01L (semiconductor device) patent have 38 pieces of class, G01N (by means of chemical or physical properties of the determination of material to test or analysis materials) class and other belongs to the technical patent classification B64C (planes; Helicopter), G01N(to test or analyze materials by determining their chemical or physical properties), 1149 pieces. Other technology categories are metal processing, power or distribution, energy storage, vehicles and other categories. It can be seen that China's equipment manufacturing sector is complete, but the new energy electric vehicles, power distribution and other parties are more prominent.



**FIG. 2** Composition diagram of China's equipment manufacturing technology

Jiangsu, Zhejiang, Guangdong, Beijing and Shandong were the top five provinces in terms of the distribution of equipment-related patent applications in China. Among them, the patent applications of Jiangsu, Zhejiang, Guangdong and Beijing mainly focus on F16J(piston; Cylinder; General pressure vessels; Seal), followed by C21D(changing the physical structure of the ferrous metal), C22C(alloy), and H01L (semiconductor device).

Jiangsu and Zhejiang provinces are big economic provinces with a strong business atmosphere. After the reform and opening up, the total amount of industrial economy is gradually rising, with its superior geographical location, obvious advantages in capital, talents and technology, and numerous enterprises. Patent applications in Shandong province mainly focus on H01N (semiconductor devices). The earliest patent applications are for the super-transistor tube shell of Shandong University and the high-speed steel surfacing strip of Shandong University of Technology. Shanghai patent applications mainly focus on C22C(alloy) category; Liaoning province is concentrated in F16J(piston; Cylinder; General pressure vessels; Seal) on classification. It is well known that China's Pearl River Delta, Yangtze River Delta and Beijing-Tianjin-Hebei region are China's three economic circles, among which Beijing-Tianjin-Hebei region is also dominated by heavy and chemical industry, and is China's heavy and chemical industry, equipment manufacturing and high-tech industrial base. In addition, it is found that most patent applicants in these regions are R&D institutions and universities, indicating that the equipment manufacturing industry in eastern China is dominated by R&D.

Anhui province patent applications mainly focus on F16J and C22C. Anhui province is located in the "One Belt And One Road" and an important node of the Yangtze river economic belt, and is an important destination and preferred choice for international investment and industrial transfer. Anhui Huijing mould R&d Technology Co., LTD. Is a modern enterprise that develops precision mould and metal processing, and applies for patents mainly for various types of mould.

### III. Countermeasures and Suggestions for China's equipment manufacturing industry

#### 3.1 Concentrate superior resources to strengthen enterprise development

At the government level. We will give policy guidance to enterprises with development potential, eliminate backward enterprises, merge scattered and small enterprises or plan for them to form industrial clusters, cooperate with each other, and promote rational allocation of resources.

At the enterprise level. Grasp their own positioning in the market, give play to their own advantages. Actively use patent information to grasp market opportunities and competitors' development status to promote the development and expansion of enterprises.

#### 3.2 Support the development of high-tech industries and promote strategic adjustment of economic structure

Learn from the experience of developed provinces, combined with the actual situation of the province. While maintaining the development of local enterprises, encourage the development of science and technology companies, expand the coverage of enterprises and optimize the industrial structure; We will increase preferential policies and publicity for science and technology.

### **3.3 Promote the development of enterprises, universities and research institutes, and effectively connect universities and enterprises**

Enterprises are encouraged to go to universities and research institutes to jointly cultivate talents, provide on-the-spot learning assistance, and strengthen their r&d teams. In addition, enterprises should also pay attention to cultivating their own R&D team, formulate reasonable employment mechanism and retain talents. In addition to setting special R&D funds and increasing r&d rewards, enterprises should also take into account the self-needs of talents, ensure a good development platform and environment, and attract and retain talents.

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