Application and research of patent evasion design in automatic connection device

LI Zhen-guo*, REN Gong-chang, YANG Yue-xin, WANG Le
College of Mechanical and Electrical Engineering, Shanxi University Of Science and Technology, Xi'an, Shanxi Province, 710021
201505060329@sust.edu.cn

Abstract. The patent evasion design may reduce the value of the original patent. In order to avoid this possibility, it is necessary to analyze the development status of the patented technology while conducting the patent evasion design. Combining value analysis with patent evasion methods, a patent evasion design method based on value analysis is proposed. Firstly search related patents by identifying multi-level keywords to obtain the target patent database; then predict and analyze the maturity of the database patents to determine the core patent group; the structure/function model of the core patent is established and its value analysis is analyzed to find the low-value components as the target technology of the circumvention design; next, the contradictory points of the target patent are found through the TRIZ theoretical tool to perform the evasion design, and the new scheme is obtained and the infringement judgment is made. Finally, the method was verified by an automatic connecting device, and the result showed that the improved automatic connecting device has the advantages of simple structure and convenient operation.

1. Introduction
In recent years, scholars from all over the world have done more and more research on patent circumvention methods, and put forward a large number of targeted patent circumvention design methods by combining different needs in different fields with patent circumvention design. Tan Runhua et al. Proposed a method of patent portfolio analysis among enterprises based on multi-dimensional calibration, which realized the determination of eluding target enterprises and target patents\[^1\][^2]. Jiang Ping et al. Determined the core patent group through IPC cluster analysis, analyzed the circumvention direction through original weight analysis, finally solved the problem through TRIZ theory, and carried out the circumvention design of packer\[^3\]. F. J. veldhuijzen van Zanten et al. Classified patent circumvention opportunities into three types, and proposed different circumvention methods for different types\[^4\]. Vaneker t.h.j and others have made a systematic study on the application of TRIZ theory and the avoidance of patent infringement in the product development stage, and put forward a variety of methods to avoid patent infringement\[^5\]. Shi Bingxuan et al. Studied and explained the replacement method of patent evasion in detail, and applied it in technological innovation\[^6\][^7]. Miao Li has done a lot of research on cutting methods based on patent evasion design, and carried out patent evasion design for injection mold mandrel engineering system\[^8\].

At present, researchers have done a lot of research on patent circumvention methods, and achieved patent circumvention through TRIZ theory. However, the circumvention of patents or patent groups may reduce the technical value of patents. Therefore, it is necessary to conduct a comprehensive analysis of patents and design new schemes without affecting the original basic functions of patents.
This paper proposes a patent avoidance design method based on value analysis: firstly, with the help of keyword search and classification screening, the patent database is obtained, and the maturity and citation of its patent technology are summarized and analyzed to obtain the core patent group. Then, the structure / function model diagram of related patents is established, and the value of related patent technology is analyzed, and finally the target technology to be evaded is obtained. Next, after determining the target technology, TRIZ tool is used to solve the problem, and a new technology model is obtained. Finally, the infringement is judged to complete the patent avoidance design. The feasibility of this method is verified by an automatic connection device.

2. Method Study

The process of the patent evasion design method proposed in this paper is shown in Figure 1. Combining technology, value and development stage, while carrying out patent evasion design, it also guarantees the value of new technology and provides new ideas for patent evasion innovative design.

The method of patent circumvention design based on value analysis is mainly divided into five parts: patent analysis, function model establishment and analysis, value analysis, TRIZ solution and infringement judgment.

(1) Patent analysis. Patent analysis mainly includes three stages: the first level keywords are determined for preliminary retrieval; the second level keywords are determined for accurate retrieval; the patents obtained from the retrieval are classified and selected to obtain the target technology patent group.

(2) Value analysis. High value patents or patent portfolio reflect the R & D investment of patent holders from the side, but they do not necessarily have high market value. Therefore, it is necessary to analyze the patent value in detail to determine the target technology.

This paper mainly evaluates the patent technology around the potential value and surface value of the patent. The main consideration factors are the advanced value, substitution, application scope and evasion of the patent. These four value indicators are based on the above indicators, marking the potential and surface value of the patent, and determining the patent to be circumvent according to the score.
(3) The establishment and analysis of functional model. Through the detailed analysis of different parts of each patent, it can help designers to find the target patents that can be avoided successfully. At the same time, by analyzing different strategies adopted by different patents in realizing the same role, not only can quickly accumulate a large number of design methods, but also improve the design ability of relevant personnel, and get more valuable solutions.

(4) TRIZ solution. Through the analysis of core patents, the target technology to be avoided is found. According to the contradiction type, the corresponding TRIZ theoretical analysis method is selected, and the problems in engineering practice are transformed into standard TRIZ model. Combining with the relevant knowledge in the technical field, the technical design is carried out through the invention principle, separation principle and standard solution, and the standard solution is obtained, and a new scheme is obtained.

(5) Infringement judgment. The infringement judgment process is shown in Figure 2[9].

3. Application research
This section seeks out the core patented technology of the automatic connection device of the distribution robot, and conducts an evasive design on it to obtain a more valuable patented technology, and at the same time verifies the core patent group evasive design method proposed in this article.

3.1. Determine the core patent
The article mainly uses patent search, maturity prediction and citation analysis to determine core patents.

(1) Patent search. Firstly, the key words of "automatic connection device" and "distribution robot" are initially determined for one-time retrieval; then the key words of "machinery" and "trailer" are further determined for two-time retrieval, and finally 50 patents are obtained. Through preliminary screening, five patents are obtained after removing some expired patents, unauthorized patents and patents unrelated to the target technical field, and these five patents are regarded as patents This is a patent library for design evasion.

(2) Maturity prediction. The maturity prediction of automatic connection device is shown in Table 1. According to the analysis of patents related to automatic connection device, the technology of automatic connection device is in a growing period, which has realized the basic needs of users, but
users expect a more stable, practical and concise technology. Therefore, the invention should be more simple and convenient.

Table 1. Technology maturity prediction of automatic connection device

| Technology             | Time | Number |
|------------------------|------|--------|
| Automatic connection device | 2003 | 1      |
|                        | 2006 | 1      |
|                        | 2008 | 1      |
|                        | 2009 | 2      |
|                        | 2010 | 1      |
|                        | 2011 | 2      |
| Automatic connection device | 2013 | 6      |
|                        | 2014 | 2      |
|                        | 2015 | 5      |
|                        | 2016 | 3      |
|                        | 2017 | 8      |
|                        | 2019 | 11     |

(3) Identify core patents. The patent numbers of the five patents in the patent library are CN20182065712.9, CN201920746997.3, CN90223044.1, CN20192070762.1 and CN201134561.4 respectively. The citation quantity analysis of the above patent technologies is shown in Table 2.

Table 2. Ranking of patent citation analysis in patent database

| Time | Patent number      | Number of citations |
|------|--------------------|---------------------|
| 2018 | CN20182065712.9    | 1                   |
| 2019 | CN201920746997.3   | 1                   |
| 1990 | CN90223044.1       | 0                   |
| 2019 | CN20192070762.1    | 1                   |
| 2011 | CN20113034561.4    | 0                   |

Since the patent CN201820654712.9 is used for automatic connection and docking of the feeding port, CN201920746997.3 and CN20192070762.1 are selected as the core patents for this circumvention.

3.2 Establish structure/function model diagram

The structure of the two patents in the core patent group is analyzed in detail, and the structure / function model of each patent system is established, as shown in Figure 3 and Figure 4.

Figure 3. CN201920746997.3 structure / function model
3.3. Value Analysis

According to the above detailed analysis of patents and the evaluation criteria of various indicators of value analysis, the evaluation results of various indicators of patents CN201920746997.3 and CN201920706762.1 were tested, and a patent value analysis score table was constructed. As shown in Table 3.

| Patent number: CN201920746997.3 | Patent number: CN201920706762.1 |
|---------------------------------|---------------------------------|
| Supporting indicators          | Supporting indicators           |
| Progressiveness                | Progressiveness                |
| Substitutability               | Substitutability               |
| Scope of application           | Scope of application            |
| Avoidability                   | Avoidability                   |
| Score                          | Score                          |
| 6                              | 6                              |
| 2                              | 4                              |
| 10                             | 6                              |
| 2                              | 4                              |

According to the above analysis results, it can be seen that patent CN201920706762.1 is more difficult to evade; patent CN201920746997.3 is less difficult to evade, so this patent is regarded as the object of patent evasion this time.

The patent CN201920746997.3 designs a built-in automatic connection device, as shown in Figure 5.
The functional value analysis of each component of patent CN201920746997.3 combined with Figure 3 shows that the scores for excess, basic, and harmful effects are 0, 1, and -1, respectively. The analysis results are shown in Table 4. It can be seen from Table 4 that the connector has a harmful effect. If the force is too large, the tractor and the carriage will collide and damage the car body. If the force is too small, the connector will collide with the connecting rod fixings and damage the car body.

### Table 4. Functional value analysis of patent CN201920746997.3

| Device Parts                      | Function      | Action image | Function type     | Value score |
|-----------------------------------|---------------|--------------|-------------------|-------------|
| Fixed and guided frame            | Chute Shackles slider | Excess effect | 0                 |
| Linear guide rail                 | Guide Fixed slider | Basic function | 1                 |
| Lock slider                       | fixed Connecting rod fastener | Basic function | 1                 |
| Trailer link                      | Connector pull Connecting rod | Harmful effects | -1                |
| Main pole                         | brace Connector | Basic function | 1                 |
| Automatic connection device       | Connecting rod fixed | Connecting rod fastener | Basic function | 1 |
|                                  | Spring elastic force Connecting rod fastener | Excess effect | 0                 |
|                                  | Core spring elastic force Movable iron core | Basic function | 1                 |

#### 3.4. TRIZ solution

When the tractor and the trunk are docking, the force is too large or too small will cause collision. In order to realize the collision free docking between the tractor and the trunk, it is necessary to control the force when connecting the tractor and the compartment. Therefore, it is necessary to control the tractor more accurately, that is, the negative impact is the complexity of the tractor. The general engineering parameters for controlling the force of automatic connection between tractor and car body are: the engineering parameter to be improved is 10 force, and the engineering parameter to be deteriorated is 36 complexity. By looking up the TRIZ conflict matrix table, it is found that the invention principle numbers to be applied in this design are 26, 35, 10 and 18 respectively, as shown in Table 5.

### Table 5. Invention principle of automatic connection device

| Number | Principle of invention | Explain                                                                 |
|--------|------------------------|------------------------------------------------------------------------|
| 26     | copy                   | 1) Replacing complex, inefficient and vulnerable objects with economical and efficient copies; 2) Mirror instead of object |
| 35     | Parameter change       | 1) Changing the physical state of the system; 2) Changing the concentration or degree of concentration; 3) Change flexibility; 4) Change the temperature or volume |
| 10     | Pre operation          | 1) Complete the function in advance; 2) The object is placed in advance so that it can immediately complete the expected function under certain conditions |
| 18     | Vibration              | 1) Make objects vibrate; 2) If it has vibrated, increase its vibration frequency; 3) Using vibration frequency; 4) Replacing mechanical vibrator with piezoelectric vibrator |
For the above problems, the structure/function model of the new scheme is established, as shown in Figure 6.

![Figure 6. Structure model of new automatic connection device](image)

Using TRIZ tools, combined with the structure/function model of the new scheme, the final product is shown in Figure 7.

![Figure 7. New automatic connection device](image)

The working principle of the new automatic connection device is: when the tractor and the vehicle box are in the separation and connection state, the spring 9 is in the relaxed state; while the tractor and the vehicle box are docking, the spring 9 is in the compression state. When connecting, the tractor moves towards the vehicle box. At this time, the connecting head 7 with inclination angle contacts and compresses the transverse baffle 4 with the guiding inclination angle, so that the transverse baffle 4 moves vertically along the sliding groove 3. When the connecting head 7 moves horizontally to the connecting hole 8, the transverse baffle will drop vertically under the spring force and its own gravity. The connecting head 7 is fixed in the connection hole 8 to realize the tractor and the tractor and the horizontal baffle 4 Automatic connection of the car box.

3.5. Infringement judgment

According to the above process of infringement judgment, it is judged whether the new scheme has achieved technical circumvention. The patent features of the original patent have fixed and guide frame modules, and the scheme patent does not exist the module, so there is no comprehensive coverage. Because the automatic connection is realized by the extrusion of the connecting head and the transverse baffle plate, there is no problem of the same. According to the principle and method of patent infringement determination \(^{10-14}\), the combination scheme is determined to be non infringement.
4. Conclusion

The method of circumvention design proposed in this paper is helpful for R & D personnel to develop new products quickly and avoid infringement at the same time. In the process of patent circumvention design, we can get the direction of patent circumvention design by looking for the existing patents. Based on the value analysis of patents, we can get the patent technology with higher cost performance by combining with the target demand of patents. In this paper, a trailer automatic connection device for patent evasion, through the value analysis of the patent, find out low value components, use TRIZ theory to improve the design of low value components, and finally design a more simple automatic connection device without infringement, and successfully realize the patent evasion.

References

[1] Li Hui, Liu Li-meng and Zhao Shao-kui.2015 Research on functional cutting path for patent evasion of mechanical products J. China Mechanical Engineering.26(19):2581- 89.

[2] Li Hui, Huo Jiang-tao and Xu Bo.2014 Research on Patent Portfolio Design Theory Based on TRIZ J. Science Technology and Engineering.14(36):197-203.

[3] Jiang Ping, Wang Chuan and Sun Jian-guang.2015 Patent group evasion design method and application combining IPC cluster analysis and TRIZ J.Chinese Journal of Mechanical Engineering.51(07): 144-54.

[4] JULIAN F.J. VELDHUIZEN VAN ZANTEN, WESSE.WITS.2015 Patent circumvention strategy using TRIZ-based design-around approaches J. Procedia Engineering.76(131):798-806.

[5] Vaneker T.H.J., Damgrave R.G.J., Kuster J.G. 2015 TRIZ as an enabler for intellectual property protection during product develop J.Procedia Engineering.89(131):731-6.

[6] Shi Bing-xuan.2006 Research on Patent Avoidance Strategy D. Hangzhou: Zhejiang University.

[7] Shi Bing-xuan.2008 Talking about the evasion strategy of appearance patent J. Business Culture (Academic Edition). (04):54-5.

[8] Li Miao, Ming Xin-guo and He Li-na.2015 A TRIZ-based Trimming method for Patent design around J. Computer-Aided Design.62(1):20-30.

[9] Mu Xiu-xiu, Cao Guo-zhong and Wei Cong-ge.2015 Case study of core patent group evasion design J. Journal of Engineering Design.22(03):201-10.

[10] Jiang Ping, Wang Chuan.2015 Patent group evasion design method and application combining IPC cluster analysis and TRIZ J.Chinese Journal of Mechanical Engineering.51( 07) :144-54.

[11] Huang Hai-yang,Gao Ying and Li Yan.2018Research on patent evasion design of elevator guide shoes based on TRIZ theory J. China Special Equipment Safety.34(10):12-17+23.

[12] Cheng Si-yuan, Mi Jing-jing and Yang Xue-rong.2016 Research on innovation-oriented patent avoidance design J.Packaging Engineering.37(14):1-6.

[13] Huang Yu-hao,Yang Xue-rong and Cheng Si-yuan.2015 Patent avoidance design based on computer-aided innovation J.Packaging Engineering. 36(24):37-42.

[14] Xiao He-man, Cheng Si-yuan and Yang Xue-rong.2018 Patent evasion design for heterogeneous products based on functional similarity matrix J.Journal of Guangdong University of Technology, 35(05):5-10.