Design and research of multifunctional fast binding device

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Abstract. In order to solve the problem of hand injury and low efficiency of steel wire binding by hand, a multifunctional fast binding device is designed. It works on the principle of large pitch screw and is a sliding friction structure, which makes the binding work of steel bar change from manual reciprocating winding to linear expansion and contraction movement. At the same time, a counter is added to meet the needs of different steel wires. It is convenient to use and reduces the labor intensity of workers, High efficiency, in line with the construction site for equipment requirements.

1. Introduction

Binding connection technology is widely used in civil construction, workers are faced with a lot of steel wire binding work every day. One of the workers has to tie more than 4000 steel wires every day, and the steel wires are very hard, and the steel wires may fall off when they are tied with pliers. The requirements for the arm strength of the workers are very high. After a day's work, the workers often can't lift their arms, which causes great damage to human health. This work is time-consuming, laborious and inefficient.

In the existing technology, the steel wire binding used for steel bar fixation in civil engineering such as bridge and civil engineering is generally completed by long nose pliers or bare hands. However, it is easy to abrade the skin of the hand in the process of operation, and the operation process is slow, which wastes more labor costs. With the rapid development of infrastructure projects, the workload of steel wire binding is increasing. At the same time, the speed of steel wire binding directly affects the project progress and project cost. People are eager to have a special steel wire binding device available to solve the problems of low efficiency and easy injury of steel wire binding.

The purpose of the invention is to provide a simple and fast special binding tool for binding steel wire, which can not only overcome the shortcomings of the above binding method, such as low construction efficiency and easy to hurt hands, but also meet the requirements of economy and binding quality.
2. Structure design and working principle of multifunctional fast binding device

2.1. Structure design of multifunctional fast binding device
In view of the problems existing in the existing technology, through a large number of practical operation analysis, according to the action characteristics of binding steel wire, the principles of "rotary mop" and "bamboo dragonfly" are transplanted to the binding device, so as to design a semi-automatic direct pulling type fast binding device. The structural characteristics are analyzed as follows:

- It uses the screw working principle and is a sliding friction structure, which makes the binding work of steel bar change from manual reciprocating winding to linear stretching motion; at the same time, a counter is added to meet the needs of different steel wires; according to the "ergonomic design principle", anti-skid rubber sleeve is set outside the sleeve or directly knurled on the sleeve to increase friction.

![Figure 1. Overall structure of multifunctional binder](image)

2.2. Material performance analysis of each component

2.2.1. Spiral core. The spiral core is the core structure of the product, which transforms the linear tension of the hand into the rotating force of the rotating core (hook). Its strength and reliability completely determine the final quality of the binder, so the material and processing technology of the core are particularly important. High hardness carbon steel is selected as the raw material of the product. This material has high hardness and weak ductility, which shows strong superior performance in tensile resistance and deformation resistance. Can withstand the requirements of the product such as tensile and wear resistance. Rolling process is widely used in the forming of rotating core in China. The biggest advantage of this process is high production efficiency, which can make full use of raw materials; the internal structure of the processed core body has fiber continuity, fine grain size, uniform carbide distribution and high red hardness.

![Figure 2. Spiral core](image)

2.2.2. Counter. The counter uses the transmission of gear and rotating core to reasonably control the clearance and count through gear rotation. The setting of the counter is a major feature of this product, inspired by the principle of rope skipping counter. As an auxiliary function of the product, the practicability of the product is greatly improved. Since the strength of the product to the counter is not high, the material is made of plastic. Using the counting principle of gear rotating machinery, the number of rotations can be recorded automatically. It is displayed in a two digit large window. Through the connection and engagement between a plurality of gears and the rotating core. As a result, the number increases by "1" for each turn of the core. It plays a very convenient auxiliary function for the binding work with high precision requirements.
2.2.3. Other parts. The sleeve is made of stainless steel, and its surface is processed with knurling or provided with anti-skid rubber sleeve, which can improve the friction force and prevent slipping when holding.

The spring is made of carbon steel with high toughness and soft hardness. The elastic limit is large, it can produce large elastic deformation, and it is easy to stretch without consuming too much force.

The front hook is made of high carbon steel with high hardness. The diameter difference between the tip and the end is large, and the curvature is small, which can ensure the structural strength of the hook while taking the iron wire, so it has high bending resistance.

2.2.4. Connection process between components. The connection between the core and the hook and the connection between the spring and the core are welded. In order to ensure the close connection between the welding parts, lap welding and double-sided welding are adopted between the components. During the welding process, the standard welding requirements shall be strictly followed. Even if the surface of the slag removal weld is smooth, the weld reinforcement shall be gentle and excessive, and the arc pit shall be filled. So as to ensure that the weld surface is flat without depression or overlap.

2.3. Working principle.
When in use, hold the sleeve in hand, hook the steel wire with a hook and pull it backward with force. The spring inside is stretched by force, and the spiral rotating core in the sleeve will rotate, so that the steel wire can be quickly tied up: after binding, release the hook, and the tension spring will reset, thus driving the reset of the spiral core. At the same time, the gear rotation counting method is used to count the number of turns, so as to meet the needs of different materials of wire. It can effectively avoid the quality problems caused by too large or too small force of binding steel wire, and provide great convenience for construction.

3. Product innovation and Application
Compared with the traditional manual method, the semi-automatic straight pull type fast binding device can fast bind the steel wire through the rotation of the spiral core, which reduces the loss of the staff's wrist turning back and forth.

Through the rotation counter to control the number of turns, can deal with different materials of metal wire, hook part tightly wound on the steel wire, will not slide.

Compared with the traditional way, the work efficiency is greatly improved, and the time of binding a steel wire is less than 3 seconds.

Due to its simple structure, easy to obtain materials, low production cost and high cost performance, it meets the requirements of construction site for instruments.

4. Conclusion
In this paper, the innovative design and research of steel wire binding tools are carried out, and the material properties of various parts are analyzed, and a multi-functional fast binding device is developed. It brings convenience to the steel bar binding, saves time and effort to carry out the steel bar binding work quickly, reduces the labor intensity of workers, has high efficiency, good binding quality, creates considerable economic benefits, and conforms to the construction Site requirements for equipment.
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