Ergonomics Rope Self-locking Device Used in Electric Power Construction Field

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Abstract: The installation of equipment in power system is generally related to high-place operation where the operator needs to use the self-locking device of safety rope. The traditional self-locking device does not take fully into account the principle of human mechanics, and is not easy to grasp in use. The safety factor is affected. In this paper, the principle of self-locking device is analyzed. The new self-locking device characterized by full function and good use effect is designed, which can better meet the safety requirements of the on-site and high-place operation.

1. Project Background
Generally, electric power construction field involves the installation of electric devices, wherein, there are many tasks requiring high-place operation, while rope self-locking device is required for high-place operation. The existing conventional self-locking devices are with a simple structure, they fail to comply with the principles of ergonomics. At the same time, it is not easy to hold the conventional rope self-locking device, the cooperation of two hands is required for unlocking, and it is quite strenuous. The operation is not convenient enough, so that it is a waste of time. The present study involves the equipment of high-place operation. This study abandons the design methods in traditional field, specifically, it involves the development and application of a kind of ergonomics rope self-locking device.

2. Research Direction
The technical problem which should be solved by this technical study is how to overcome the existing technical defect to provide an ergonomic rope self-locking device. Compared with the existing technologies, the length of this device can be adjusted at will in accordance with the high and low positions of the high-place operation; the hand-holding angle complies with the principles of ergonomics; and when unlocking, as long as hold slightly, the safety rope will be allowed to freely slide within the inner pipe channel of the part for locking the rope. So that, this device gives consideration to comfort, security and operationability, and it is time-saving and labor-saving when
using this device. The device is with easy operation and extremely high reliability. The R&D team is formed by four persons, wherein, three of them are the technicians with senior professional title, one of them is the technician with a postgraduate degree. Since 2015, this team has successively explored the design scheme of the self-locking device of safety rope. The design scheme which is the best one for self-locking device can be found out by screening.

3. Solutions
This technical problem can be solved by the following technical scheme: In order to make the technical means, creative features, purposes achieved and effects of the utility model easy to understand, the following is a further elaboration of the technical study combined with specific graphic.

As shown in Figure 1, there is a ergonomics rope self-locking device, including self-locking grab handle 1 and the part for locking the rope 2. The mentioned self-locking grab handle 1 connects with the part for locking the rope 2 by connecting part 3. The characteristics are:

The mentioned self-locking grab handle 1 is arc-shaped, the upper end and lower end set the connecting through holes 11 and 12 crossing itself. The mentioned grab handle 1 also includes the limit embossment 13 at the upper end and safety belt connecting hole 14 which is set at the lower end. The mentioned part for locking the rope 2 is U-shaped, the upper end and lower end set the connecting through holes 21 and 22 crossing itself. There are 4 grooves 23 on the inner side. There is a U-shaped tubulous channel 24 which is the same as part for locking the rope 2 set on the inner side of part for locking the rope 2. The mentioned connecting part 3 includes upper connecting shaft 31, expansion spring 32, lower connecting shaft 33 and nonreturn lock 34. The mentioned upper connecting shaft crosses the through holes 11 and 21 at the upper end of grab handle 1 and part for locking the rope 2 to splice self-locking 1 with part for locking the rope 2; The mentioned expansion spring 32 is fixed between the self-locking grab handle 1 and part for locking the rope 2, it adjusts the distance between self-locking grab handle 1 and part for locking the rope 2 by the compression and bounce of the expansion spring 32; One end of the mentioned lower connecting shaft 33 splices to through hole 12 at the lower end of self-locking grab handle 1, the other end down leans and extends to the inner side of part for locking the rope 2 and spliced with through hole 22 at the lower end of part for locking the rope 2; The mentioned nonreturn lock 34 is set at the end which connects to lower connecting shaft 33 and extends to part for locking the rope 2.

By enclasping self-locking grab handle 1 and part for locking the rope 2 and compressing expansion spring 32 to ensure the nonreturn lock 34 is discrete from the outlet end of safety rope 4 which is on the inner side of the part for locking the rope 2 to facilitate the adjustment of the length of safety rope 4, so that the up and down position of the operators in high-place operation can be adjusted flexibly. By opening of expansion spring 32 and bounce of expansion spring 32, nonreturn lock 34 is holding-on with the outlet end of safety rope 41 which is on the inner side of the part. So that safety rope 4 can be fixed to further fix the position of the operators to avoid the operators moving up and down during operation. The mentioned nonreturn lock is with dentation structure.
During actual use, loosen the spring, thread the safety rope from the U-shaped tubes of the part for locking the rope to fix the seat belt of on the waist of the operator with the connecting hole of the
safety belt of the self-locking grab handle. During operation, if the height of operation needs to be adjusted, directly hold the self-locking grab handle and the part for locking the rope, the nonreturn lock will separate from the outlet end of the safety rope, the human body will fall with the safety rope. When falling to the designated position, loosen the self-locking grab handle, the nonreturn lock will be holding-on with the outlet end of the safety rope, and then just fix the safety rope. If there is any accident falling during operation, the lower connecting shaft will bear an extremely large downward impact force tension due to the effect of impact force. By lever principle, the lower connecting shaft acts on the toothed nonreturn lock so that the safety rope will be closely bitten to ensure the security of the operators.

4. Achieved Objectives and Application of the Project
In 2015 - 2017, this device was used by Tieling Electric Power Supply Company. The actual using effect was very good. The research team finds that, in the high-place operation on the construction site, this device greatly guarantees the security of the personal safety of the operators on the site. The use of the mechanism is very smooth, there is no any clamping stagnation. In addition, the operation of this device is simple, it is easy-to-use, and with good reliability. This device is with extremely high practical value, it perfects the non-smooth of the original self-locking device, which eliminates the problem that the mechanism is easy to clamp. The site effect of the device is good, so that the device gains high praise of the first tier constructors. On Jun. 6, 2017, this technical research gained national utility model patent certificate.

5. Main Effect Analysis
Provide an ergonomics rope self-locking device. Compared with the existing technologies, the length of this device can be adjusted at will in accordance with the high and low positions of the high-place operation; the hand-holding angle complies with the principles of ergonomics; and when unlocking, as long as hold slightly, the safety rope will be allowed to freely slide within the inner pipe channel of the part for locking the rope. If there is any accident falling during operation, the toothed nonreturn lock will closely bite the safety rope to ensure the security of the operators. This device gives consideration to comfort, security and operationability, and it is time-saving and labor-saving when using this device. The device is with easy operation and extremely high reliability.

Reference
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