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Improvement of assembly process for GIS bellows adjusting screw

Guangze Zhu[1,*], Lu Wang[1], Mengdie Lu[1], Jingtao Tong[2]

[1]*Zhejiang Electric Transmission & Transformation Co., Ltd., Hangzhou, 310020, China*

[2]*State Grid Zhejiang Electric Power Company Hangzhou Branch, Hangzhou, China*

*Corresponding author: 1109947846@qq.com

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Abstract: GIS equipment is increasingly wide in demand in power construction. With the gradual advancement of production practice process, many process improvements and appliance innovation are derived in the assembly process. Based on the assembly process of GIS bus bellows regulating screw, we analyzes the disadvantages of lower mechanization, proposes an electric tool that can improve production efficiency and reduce safety risks, and discusses the feasibility of related process improvement.

1. Background

With the rapid development of economy and society, people's electric power demand is increasing, and electric power construction is of great significance in meeting the national production demand. As a hub of power transmission and power distribution, the substation plays an important position in the power grid. Its functions include: transforming and adjusting voltage, power distribution, collecting current and other [1] s.

After more than 30 years of research and development, the electrical equipment of the substation has gradually changed from the traditional open power distribution device to the high-voltage combination electrical appliances (GIS) equipment, and is quickly applied to the power system [2] around the world. G IS equipment has the advantages of small land area, all sealed components without environmental interference, high operation reliability, convenient operation, long maintenance cycle, small maintenance workload, rapid installation, low operation cost, and no electromagnetic interference.

At present, GIS equipment mainly relies on manual manual manual assembly, including the assembly of circuit breaker, bus, isolation switch, voltage transformer, current transformer, lightning arrester, casing, grounding switch knife and other originals.

2. GIS bus bar bellows

2.1 GIS busbar

GIS bus is the electrical connection equipment between various components in GIS, and it is also the main element of GIS carrying current. According to the different carrying current, it is mainly divided into branch bus and main bus. The bus is mainly composed of three parts of shell, inner guide and insulation, as well as three types of straight cylinder bus, corner joint and corrugated pipe. The bus line is an integral part of GIS, and has the role of collecting, distributing and transmitting electric energy. Depending on the layout size of the substation, the bus length is several meters to dozens of meters. For some outdoor installed power stations, the bus length can even reach 100 meters. In long bus installation and operation, there are inevitable installation error, heat expansion and cold shrinkage, foundation settlement, etc., which results in size change. To solve these problems, it is usually necessary to set up the bellows in the bus line to ensure the safe and reliable [4] operation of the GIS.

2.2 Wound lines

The corrugated pipe is a metal pipe shell part with elastic characteristics and sealing characteristics. It changes the shape and size of the element under the external load, and returns to its original state when the load is removed. Therefore, the GIS installation can be used to compensate for the bus or equipment size changes caused by machining error, foundation error and installation error; GIS operation can be used to absorb the bus expansion caused by foundation settlement, mechanical vibration, thermal expansion and cold contraction, etc. At present, there are four main types of GIS bus bellows: pull rod bellows, free type bellows, force balance bellows and universal bellows. The bellows is [5] composed of flange, end tube, bellows, spring gaskets, nuts, double-head screw, support plate, ball gaskets, and cone gaskets. In order to limit and restrict the expansion distance of the bellows and balance the internal stress of the wire cylinder, the adjustment screw shall be installed outside the bus cylinder. Take the ZF28-550 type GIS equipped with a power substation in Zhejiang Province as an example. The equipment is equipped with four regulating screws for each busbar, with a seismic grade of Grade 9 and the surrounding air temperature range of-40℃ ~ + 55℃.

Figure 1: The bellows and the adjusting screw

3. Analysis of adjusting screw installation process

3.1 Conventional installation process

Take the GIS bus on the high voltage side of a 220kV substation as an example, a single adjustment screw mainly includes the following steps:

① In the material preparation stage, spin two 24 # nuts into both ends, with a depth of not less than 50cm, and put them into the gasket;

② Install screw, two busbars, 13 intervals, single busbar each interval needs 4 screws;

③ Adjust the screw position, spin the 4 nuts back to both ends of the screw, set aside a distance of 6-10cm, and fix the screw with another 4 nuts;

④ Fine-tune the screw together with sulfur hexafluoride gas injection.

These assembly work are usually done manually by operators due to lack of effective tools.

3.2 Process analysis

Through the above process, it can be significantly found that there are many pieces of long travel nut operation, a single operation of the nut movement to dozens of centimeters. It is estimated that the whole group of GIS bus adjustment screw installation part, the nut long distance travel can reach an amazing 400 meters.

In engineering practice, excessive mechanical repetitive labor will have an adverse impact on engineering quality and work efficiency.

3.3 Risk points and pain points

The first problem is the large amount of mechanical and repetitive labor. The nut seems to be easy, which is very exhausting in the actual operation process. The operation efficiency decreases seriously with time. The long time to rest in the middle is high, and the coherence is weak, which affects the progress of the project.

Secondly, there are many safety risks in the operation process. The installation height of the upper nut rod is more than two meters, which is working at high altitude. Bamboo ladder and safety rope shall be used. The outer surface of the GIS bus is a smooth column. During the process of screw installation, the operators need to hold the screw with both hands, and the center of gravity swing range is large. When twisting the screw, the body often swings with the nut stroke, which also has great safety risks, and the operators and monitors need to be extra careful. The narrow working space and the longer screw nut working time also increase the working risk.

Figure 2: Operating environment

Third, the means of operation are original. The essential reason for the above problems is the lack of effective assembly tools on the market and the low efficiency of human utilization. Appropriate tools should be introduced to improve the human efficiency and boost the operation level.

4. Process improvement

4.1 Electric tools are used instead of manual assembly

In order to solve the problem of long-trip nut assembly, an electric nut assembly tool is designed. The electric drive part uses a conventional electric screwdriver for its torque drive and nut ratchet part.

4.2 Design requirements for electric tools

Combined with the field situation, analyze the requirements that the electric tools should meet. Provide the requirements for the design of electric construction equipment:

① Tools should be able to effectively improve the work efficiency of workers, save physical energy, improve the operation level, and realize the role of scientific and technological innovation in driving production practice.

② The tools shall meet the needs of the existing use scenarios, face the actual needs of operations such as narrow space operation and high altitude operation, and avoid other risk points such as high altitude landing objects whenever possible.

③ Tools should be as lightly structured as possible, with low single production cost and better economy.

5. Related results

5.1 Overall design

The target requirements are designed by Rhino software, and the target appliance design sketch is as follows.

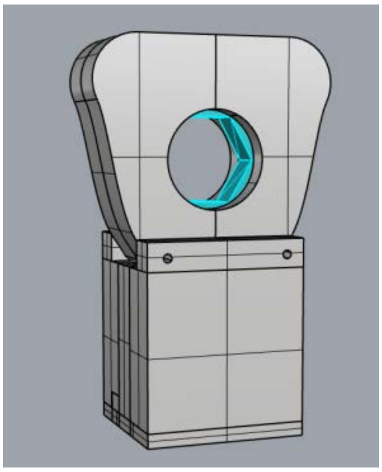

Figure 3: Tool design drawing

The tool design consists of drive rod, nut socket, gear system and housing. During use, the shell can be opened, and the internal sleeve can be installed on the nut to facilitate one-hand operation at high places. In the future, the parts such as shell and sleeve can be replaced with magnetic absorption to improve the installation efficiency.

5.2 Introduction of each section

The detailed design of the work and appliance design drawing is shown in Fig:

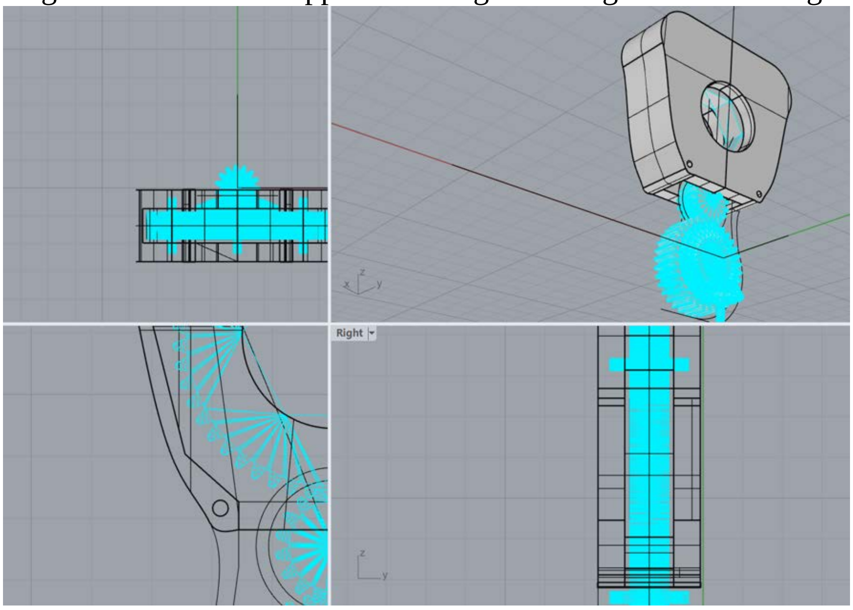

Figure 4: Local design

The drive lever introduces the electric torque and changes the torque direction by changing the gear. The reversing torque is output to the sleeve through the transmission gear, and the two auxiliary gears provide support without exporting power.

6. Conclusion

This paper mainly introduces the assembly process of bus bellows regulating screw of GIS equipment, analyzes the disadvantages of its current low mechanization, finally proposes an electric tool that can improve production efficiency and reduce safety risks, and discusses the feasibility of related process improvement.

The plastic model of the tool, obtained through 3D printing, was preliminarily proved to be feasible, which can effectively improve the efficiency of screw assembly and save the physical strength of the operator.

In addition, the tool designed in this paper is a long-trip assembly tool for screws, which has good universality and has good application prospects in construction, bridge, railway, industry and other environments.

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