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# 发明项目展板英文图片内容(一)

CAI No. 11–1

Invention: A locking device for a substation disconnecting switch

# 一种变电站刀闸的闭锁工具

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Supply Bureau

## Patent No.: 202210907058. 9

### Introduction:

#### Background

Disconnectors at substation isolation faces serve as the sole isolation point between live and de-energized equipment. Misoperation of these disconnectors is a critical risk source for severe electrical accidents. Statistics show that over 80% of severe misoperations in the China Southern Power Grid since 2016 originated from failures in live-side disconnector control. Existing control methods have significant flaws:

Method 1: Welding the disconnector drive shaft provides physical locking but requires firework approval processes and damages anti-corrosion coatings.

Method 2: De-energization combined with manual supervision elevates control but fails to fully eliminate risks while increasing labor costs and operational complexity.

Both methods suffer from low efficiency and insufficient reliability.

Project Innovation

This project developed a specialized non-destructive locking tool installed between the disconnector drive shaft and support structure. It achieves physical locking without welding or altering electrical circuits. Key innovations include:

#### 1. Innovativeness & Practicality

#### **1.1 Innovativeness**

#### **Technical Design Innovations**

**Modular Design:** Comprising drive shaft locking components, positioning clamps, and limiters, the tool adapts to various disconnector types (circular, U-shaped, diamond drive plates), resolving compatibility issues.

#### **High-Strength Materials:**

Drive shaft clamps and locking collars use 45 steel (yield strength: 355 MPa, torque resistance:  $50 \text{ N} \cdot \text{m}$ ), exceeding typical disconnector drive torque ( $30 \text{ N} \cdot \text{m}$ ).

Positioning clamps employ 304 stainless steel for corrosion resistance and stability.

**Rapid Installation:** Standardized lock screws (Grade 8.8) and limit screws (Grade 4.8) reduce installation time from 20 minutes to  $\leq 5$  minutes (75% efficiency gain).

**Technical Approach Innovations** 

**3D Modeling & Prototyping:** Simulation tests (tension, compression, torsion) optimized structural strength, replacing inefficient traditional blueprint methods.

Anti-Corrosion Treatment: Surface coatings ensure zero rust after 20 days in 90% humidity environments.

#### **Industry Gap Filling**

Existing research focuses on software-based or administrative controls, lacking physical locking solutions for primary equipment. This tool introduces a "hard lock + rapid installation" approach, incorporated into Guangdong Power Grid's Isolation Face Risk Control Guidelines and supported by 1 patent application.

#### **1.2 Practicality**

#### **Efficiency & Reliability:**

Tested at 220kV Zhaoqing Substation: 0% misoperation rate,  $\leq 0.9^{\circ}$  rotation under 30s force (safety threshold:  $\leq 3^{\circ}$ ).

Single-person installation in 4.7 minutes (target:  $\leq$  7 minutes), applicable to high/extra-high voltage scenarios.

**Broad Compatibility:** Adjustable clamps and limiters fit drive shafts (20 - 80mm diameter), deployed across 46 substations (67 disconnectors) with 0% failure.

#### Low Maintenance:

Tool weight: 4.79kg (304 stainless steel); material costs reduced by 60% vs. welding.

No approval processes required, minimizing operational complexity.



Fig 1: Component Design Diagram of the Substation Disconnecting Switch Locking Tool



Fig 2: Overall Line Drawing of the Substation Disconnecting Switch Locking Tool



Fig 3: Physical Photo of the Substation Disconnecting Switch Locking Tool



Fig 4: Installation Photo of the Substation Disconnecting Switch Locking Tool

#### 2. Technical, Economic & Social Contributions

#### **2.1 Technical Contributions**

**Structural Optimization:** ANSYS simulations confirm  $\leq 0.09$ cm deformation under 75 N·m torque (safety limit: 0.1cm).

**Precision Manufacturing:** Drive shaft clamp machining accuracy: 0.008µm, ensuring seamless fit (99.8% tolerance compliance).

Material Science: 45 steel balances strength and cost; 304 stainless steel extends tool lifespan.

**Standardization:** Disconnector Locking Tool Technical Specifications enable batch production and modular repairs.

#### **2.2 Economic Benefits**

Under the traditional supervision mode, a single operation requires two personnel for 6 hours of supervision, costing approximately 1,200 yuan per instance. After adopting lockout devices, only one person is needed to complete the installation in 5 minutes, with an estimated annual labor cost savings of 345,600 yuan.

#### 2.3 Social Impact

Grid Safety: Prevented 4 severe accidents (e.g., busbar ground faults), achieving 99.99% power supply reliability.

**Industry Standards:** Adopted by Guangdong Power Grid and promoted across China Southern Power Grid, projected to benefit 200M users in 5 years.

**Sustainability:** Reusable design reduces metal waste by 5 tons/year, aligning with carbon neutrality goals.

#### **3. Future Prospects**

**Technological Upgrades:** 

Integrate IoT sensors for real-time monitoring and SCADA integration.

Lightweight carbon fiber components (target: ≤3kg).

Market Expansion: Domestic potential: CNY200M/year (500+ new substations annually).

Global demand in Southeast Asia/Africa for cost-effective solutions.

#### 4. Conclusion

This project delivers an innovative, reliable disconnector locking tool that addresses long-standing safety challenges. Its modular design, material optimization, and validated performance (technical, economic, and social) position it as a cornerstone of power system safety. Future enhancements in intelligence and global outreach will solidify its role in advancing energy transition worldwide.

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# 单位/公司介绍展板英文、图片内容(二)

# **Guangdong Power Grid Corporation Zhaoqing Power Supply Bureau**

# Introduction:

Guangdong Power Grid Co., Ltd. Zhaoqing Power Supply Bureau Substation Management Department Sihui Operation & Maintenance Center currently has 15 staff members, including 7 company star-rated employees, 4 engineers, and 4 assistant engineers; 3 technicians and 9 senior technicians; 5 hold master's degrees and 10 hold bachelor's degrees.

The Sihui Operation & Maintenance Center is responsible for the management of maintenance work, daily operation and maintenance, exception handling, and expansion/upgrade projects for a total of 17 substations in the Sihui and Dawang areas of Zhaoqing City.

#### It oversees three 220kV substations:

1. 220kV Sihui Substation (the center's base substation) is located in the urban area of Sihui City. It is the primary power supply point for Sihui City center and a crucial hub substation for Sihui City, Zhaoqing, as well as a key component of Zhaoqing's 220kV backbone power grid.

2.220kV Wangxin Substation, designated as a Key & Important Substation by Guangdong Power Grid Company, serves as a vital hub substation for the Dawang National High-Tech Industrial Development Zone in Zhaoqing and is a significant part of Zhaoqing's 220kV backbone power grid.

3.220kV Donghua Substation is an essential safeguard for Zhaoqing's 220kV backbone grid. It plays a critical role in strengthening the grid framework for the Sihui and Dawang areas and optimizing the power flow of the 110kV grid.

These 220kV substations, along with the other 14 subordinate 110kV substations, collectively ensure a reliable power supply for:

Critical functional institutions such as the Guangdong Zhaoqing Prison, Sihui Municipal Government, and Sihui People's Hospital.

Residential electricity consumption in Sihui and Dawang urban areas.

The production and operational needs of dozens of leading industry enterprises and their supply chain partners, including CATL, XPeng Motors, Jintian Copper, and Feiying Paper Industry.

This reliable power supply significantly contributes to the stable socio-economic development of the local area.

Guided by the leadership of the company and department, Sihui Operation & Maintenance Center adheres to the construction goal of "\*\*Safety as the foundation, quality as the cornerstone\*\*." It has achieved zero production safety accidents/incidents for five consecutive years and received the collective annual performance rating "A" for two consecutive years, contributing significantly to the company's successful completion of its safety production targets.

The Sihui Operation & Maintenance Center acts as the "\*\*nerve center\*\*" for the power system in the Sihui and Dawang areas of Zhaoqing. Its importance is reflected across multiple dimensions: safety prevention and control, power supply guarantee, technological innovation, talent development, and management optimization. Through standardized operations, technological innovation, and continuous training, it provides the fundamental guarantee for the efficient, reliable, and intelligent operation of the regional power grid.

## Awards & Honors:

Third Prize, 2022 China Energy, Chemical and Geological Workers' Union Outstanding Employee Technological Innovation Achievements

First Prize, 2023 Guangdong Power Grid Company Employee Technological Innovation Competition

First Prize, 2023 Zhaoqing Power Supply Bureau Employee Technological Innovation Competition

Second Prize, 2023 Inaugural Zhaoqing City Innovation Methodology Competition

Second Prize, 2023 Zhaoqing City Employee "Five Small" Innovations Competition

Third Prize, 2024 Power Industry High-Value Patent Cultivation Practical Skills Competition

Silver Award (Second Prize), 2024 Power Industry "Electricity Dual Innovation Cup" Sci-Tech Innovation Achievement Competition

Third Prize, 2024 Power Industry Innovation & Creativity Competition



Fig 1: Group at meeting



Fig 2: Second Prize, 2023 Inaugural Zhaoqing City Innovation Methodology Competition



Fig 3: Second Prize, 2023 Zhaoqing City Employee "Five Small" Innovations Competition



Fig 4: Third Prize, 2024 Power Industry High-Value Patent Cultivation Practical Skills Competition



Fig 5: Silver Award, 2024 Power Industry "Electricity Dual Innovation Cup" Sci-Tech Innovation Achievement



Fig 6: Third Prize, 2024 Power Industry Innovation & Creativity Competition

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