Design Of Charge and Discharge Performance Inspection System for Lead-Acid Battery in Coal Mine

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Abstract. On the basis of the introduction of coal mine safety production situation and coal mine lead-acid battery, we designed the coal mine lead-acid battery charging and discharging performance inspection system, focusing on the design of the charging or discharging test voltage detection circuit, current detection circuit and IGBT isolation drive circuit, to realize the inspection of the charging and discharging performance , battery capacity and other test items of lead-acid battery in coal mine.

Keywords: Coal mine, Lead-Acid Battery, Charge and Discharge, inspection system.

1. Introduction

In recent years, due to the development of intelligent and mechanized mining technology in coal mines, the state has increased the management of coal mine production safety and improved the awareness of safety production of underground workers, thus making the situation of underground production safety continue to improve steadily. The safety work in coal mines has achieved remarkable results, but the safety problems are still serious, and the hidden dangers of accidents that jeopardize the smooth progress of the safety work have not been thoroughly managed. Lead-acid battery explosion-proof battery forklift, explosion-proof battery coal trucks, mining battery motor vehicles and other coal mine production equipment, the main source of power performance is directly related to the mine and the operator's life and property safety. In the process of lead-acid battery development and factory, factory test and type test are important means to ensure product performance and improve product life. Therefore, the design of inspection system for lead-acid batteries in coal mine is of great significance to ensure the reliability of underground lead-acid battery power supply equipment and improve the current situation of coal mine safety production.

2. Lead-acid Batteries in Coal Mine

Coal mine lead-acid batteries can be divided into coal mine special lead-acid batteries, explosion-proof starter lead-acid batteries and explosion-proof stationary lead-acid batteries according to the different occasions of use. Coal mine special type lead-acid battery meets the requirements of the standard “MT 334 2008 Coal mine lead-acid battery explosion-proof special type power supply device specification”, the maximum capacity of the battery can reach 1200A-h, the voltage can reach 336V, belongs to the explosion-proof battery with the largest storage energy today. The battery has a strong self-recovery ability, without the need for complex battery management system. The harm caused by overcharging or over discharging to the battery is small, and the performance of the battery can be restored by utilizing small current charging. Special lead-acid batteries have hydrogen emissions during charging or discharging, especially in the late charging electrolysis of a large amount of water releases flammable gases, bringing safety risks to coal mine production. Explosion-proof starter type lead-acid battery has a large area of thin internal plates, and the acid is in colloidal state, which has the features of less water loss during charging or discharging, no need of replenishment for maintenance, and high discharge multiplier, and it is suitable for vehicle starting

and other high-current applications. The capacity of the explosion-proof stationary lead-acid battery is only 20A-h, which belongs to the maintenance-free backup battery for mining use, and the battery will lose a lot of water when it is overcharged, which will affect the service life of the battery.

3. Inspection System for Charging and Discharging Performance

Combined with the characteristics of coal mine lead-acid batteries and the requirements of product industry standards, the design of charging and discharging performance inspection system for lead-acid batteries in coal mines is capable of completing the inspection projects of coal mine lead-acid batteries with constant-current and constant-voltage charging, constant-current discharging and constant-power discharging, etc. The inspection system is mainly composed of processor, IGBT isolation drive, IGBT, system information detection circuit, signal processing circuit, display, operation panel, timer and constant temperature water tank. Inspection system of charging and discharging performance of lead-acid battery in coal mine is shown in Fig. 1, in which the processor is the core of the whole control system, which is used to control and regulate the inspection system in the whole process; IGBT isolation drive circuit is used to isolate and amplify the drive signal to realize the positive-voltage conduction and negative-voltage shutdown, which improves the reliability of experimental device; IGBT is used to control the charging and discharging circuits; and the system information detecting circuit consists of Voltage detection, current detection and temperature detection circuits, for the collection of system operation information and feedback to the processor; signal processing circuit to adjust the output signal of the system information detection circuit to achieve signal isolation, conversion; display screen is used to display the operating status of the system; operating panel for the test process of the external command input; timer is used to record the test operation time; constant temperature water tank controls the temperature of the test environment through water circulation and heating device, thus controlling the internal temperature of the battery and realizing the constant temperature charging/discharging test; the system is connected with PC through Ethernet on-line interface, which can realize the storage and printing of the test data and centralized network control of multiple testers, and at the same time, it has protection functions such as over-current, wire breakage, reversed polarity, over-heating, data preservation of power-down, and automatic recovery of power-up.

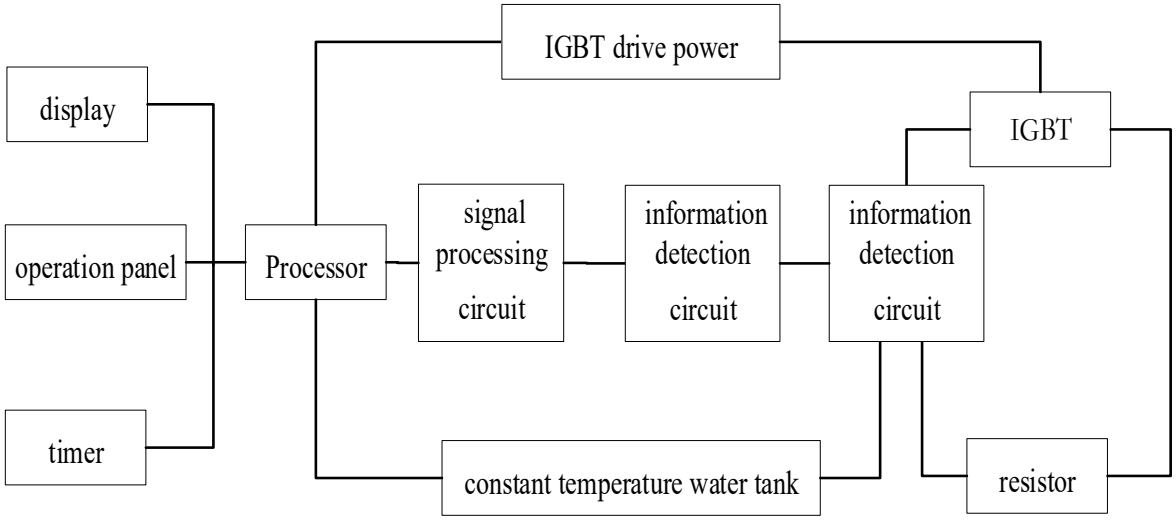


Fig 1. Structure of inspection system for lead-acid battery charging and discharging performance in coal mine

3.1. Current Detection Circuit

The charging and discharging performance inspection system of coal mine lead-acid battery can realize the functions of constant-current and constant-voltage charging and constant-current discharging, etc. The accuracy of current detection is directly related to the accuracy of the monitoring

system. We choose Hall-type current sensor for real-time detection of charging/discharging circuit current, which is characterized by wide measurement range, fast response speed, good linearity and high stability of the measurement results, and is widely used in industrial control, frequency control and power grid monitoring and other fields. The sensor uses ± 12V power supply, output a signal proportional to the current value, the processor receives the current signal value of the sensor, and arithmetic processing to get the current value of the circuit, Hall-type current sensor wiring diagram shown in Figure 2.

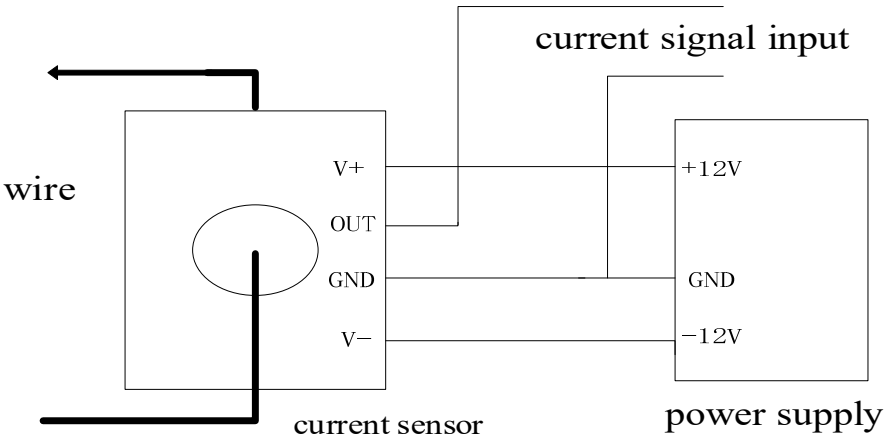


Fig 2. Hall-type current sensor wiring diagram.

3.2. Voltage Detection Circuit

The coal mine lead-acid battery charging and discharging performance inspection system to measure the voltage for the DC voltage variable, you can use resistance voltage divider measurement, to get a non-isolated low-voltage DC signal, and then through the linear opto-coupler isolation will be converted into a DC voltage proportional to the DC voltage sent to the A/D converter measurement. Bridge voltage divider circuit shown in Figure 3, the measurement of the measured part and a, b two ends can be connected. R1, R2 in the figure is an additional standard resistor, of which R1 = 9R2, so that the voltage at the two endpoints of c, d is 1/10 of the measured voltage signal, it is only equal to the ground voltage measured voltage 1/20.

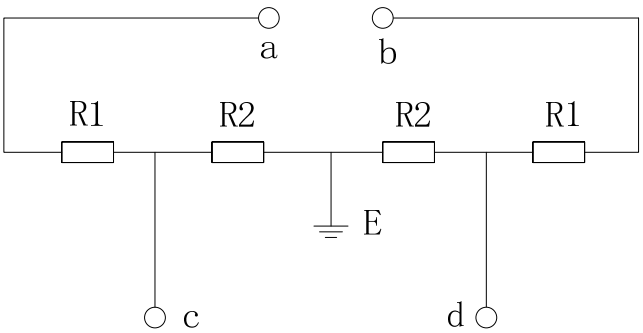


Fig 3. Voltage Measurement Circuit

3.3. IGBT Driver Circuit

The charging and discharging process of coal mine lead-acid battery is controlled by IGBT, with high charging/discharging power factor, low harmonics, and low impact on the power grid, which is in line with the requirements of the national green power grid. In order to ensure the reliable action of IGBT, IGBT special driver chip M57962L is selected as the core to build a circuit to realize the stable connection and disconnection of IGBT, isolated drive circuit shown in Figure 4. In the isolated drive circuit, resistor R1 is the gate limit current resistor, diode VD1 is the detection diode for short-

circuit, overload and other faults, the circuit faults are displayed by the light-emitting diode VD2, and the regulator diodes VD3 and VD4 are connected in series in the reverse direction to prevent the input voltage of the IGBT from exceeding the permissible value. Continuity diode VD5 is connected in parallel between the collector and emitter of the IGBT to avoid inductive potential breakdown of the collector and emitter of the IGBT and to ensure reliable operation of the IGBT.

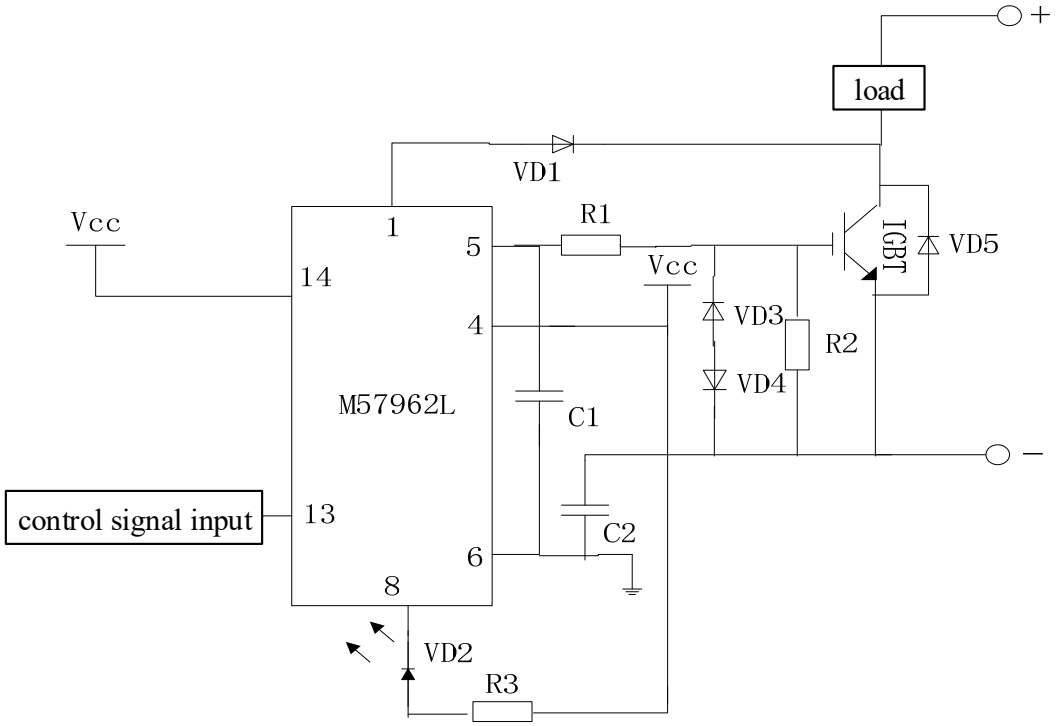


Fig 4. Diagram of IGBT isolated drive circuit

4. Conclusion

The safety of mining is a hotspot of concern in all fields of contemporary society, and the safety of mining equipment plays a very important role in the safe production underground. Inspection system of charge and discharge performance of coal mine lead-acid battery can complete the type test of coal mine lead-acid battery with different rules, and the device is characterized by high precision, good stability, and strong real-time.

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