Broken and fine powder detection method of fuses

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Abstract: Since powder and cotton wool may cause mechanical test fail, and the accuracy of ray detection method is not very ideal, this paper introduces the tiny capacitance detection method for broken gunpowder, in which the medium type capacitive sensor's capacitance changes when the gunpowder core diameter changes. The detection is based on the relationship between non-electric quantity and electric quantity. Simulation results show that the designed system works well with easy installation and low power consumption. Therefore, it is suitable for broken gunpowder detection.

Key words: fuse; power detection; tiny capacitance detection

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For various types of fuses, the broken and fine powder often affects the performance of them and makes it dangerous when using them. Therefore, How to discover the broken fine gunpowder timely in the production of fuses is an urgent issue to be solved. In our country, we often use mechanical method to detect the defects of the fuse. However, the accumulation of impurities due to powder and cotton wool often makes the detection a failure, and ray detection method is not ideal in testing medicine core and it is harmful to the human body. Therefore, this paper proposes a new broken and fine gunpowder detection method by using the tiny capacitors.

1 General capacitance detection method

In recent years, with the rapid development of detection technology, research on capacitance and micro variation detection and real-time monitoring on parameters have become more and more important.

Capacitance detection method is based on the relationship between the electric capacity and structural parameters of objects, in which signal transform is completed by changing one of the parameters of a capacitor. Capacitive sensor has such advantages as good temperature performance, high precision and simple structure. Its dynamic response is quite fast, and it also can realize the non-contact measurement with average effect. These advantages are very important for the tiny capacitance measurement. Now capacitance detection method is widely used due to its high sensitivity, fast dynamic response and low cost.

Using capacitance detection method, we design the system for broken and fine power detection. When the fuse goes through the capacitor, the capacitance value and voltage value will change and a changing analog signal will be produced. Then the signal is filtered through an external passive filter, which consists of inductors and capacitors. Before the circuit works, the analog signal is converted to a digital signal which is transmitted to the chip. Finally, the corresponding data will be displayed on LCD screen through the keyboard command. Fig. 1 gives the principle diagram of tiny capactance detection.

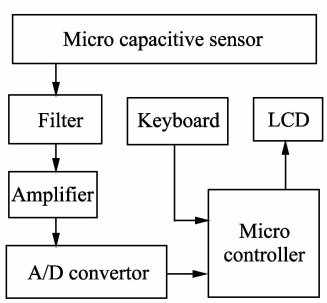

Fig. 1 Tiny capacitiance detection principle diagram

The output signal received by the capacitive sensor is converted to digital signal and transmitted to

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micro controller, at last it is display on LCD screen through the keyboard command. The conversion of signals is based on the relationship between the electric capacity and the structural parameters of objects, and is realized by the changing of one of the parameters in capacitor caused by mechanical changes. In most cases, the capacitor is composed of two opposite parallel metal plates with air as medium. Then the changing value being measured is converted into variation of capacitance.

As long as the three parameters, including the dielectric constant of the medium, the area of opposite part of plates and the distance between plates, directly or indirectly change, the capacitance will change. The change of the physical variables is judged by converting variation of capacitance into useful output signal. If two of the three parameters keep fixed, the variation of the third one can be changed into a single capacitance change. So the detection types can fall into two classes: Flat line displacement type, namely capacitance detection method of the displacement of fuse parts. When the parts move horizontally, capacitance will change. Polar distance type, namely capacitance detection method of the polar distance of fuse parts, with the parts as one pole beside a fixed pole. As long as the parts move up and down, capacitance will change.

Medium type capacitive sensor is used in the study, in which the area and polar distance are fixed and just the medium of the capacitance changes. The dielectric constant capacitive sensor is mostly used for measuring the thickness, the displacement and the liquid level of dielectric. The temperature, humidity and electric capacity can be measured according to the changing of that of dielectric constant medium of between the plates.

1.1 Capacity bridge

Capacity bridge has been widely used for high frequency fields because of its higher sensitivity and stability, small parasitic capacitance, and simplified circuit shielding and grounding: 1) High-frequency AC sine wave power supply; 2) Bridge output amplitude wave which requires least voltage fluctuation by taking measures to make amplitude and frequency steady; 3) The sensor must work at a balanced state, otherwise automatic balance bridge should be adopted at the occasion of high accuracy when the bridge increases in a nonlinear way. Capacity reactance bridge method adopts capacity reactance comparative value measurement. The design has made effective test results, but to use the equipment, you need to adjust and check it much more carefully in advance. When the material of production or process conditions change, we must accordingly adjust it. Good temperature stability, simple structure and fast dynamic response can achieve non-contact measurement. It can be promoted to widely use with its simple technology and low cost.

1.2 Full-wave rectifier bridge

Single-phase rectifier circuit can be divided into single-phase half wave, single-phase full wave and single-phase bridge according to the circuit wiring. Different rectifier circuits have different rectification characteristics and applications. In practical, the load of rectifier power source has different characteristics, such as electric resistance, inductance and back electromotive froce (BEMF) and so on. The principle of full-wave rectifier bridge is to convert input AC voltage into output DC voltage by four diodes bridge inside. In every working period of rectifier bridge, there are only two diodes working at the same time. They can convert AC voltage into a one-way DC voltage through the diode unilateral conduction function. The detection results show that this circuit has a good effect.

2 Capacitance detection principle of broken and fine powder

Capacitance detection principle of broken and fine powder is that when the thickness of varies, the capacitance of medium sensor also varies. Then the change of capacitance will cause the change of voltage. Through the real-time display of the power hose's voltage changes, operators can observe and detect wall thickness visually. Some functions such as alarming can be achieved when the thickness of blasting core changes.

In Fig. 2, when the core is homogeneous, the capacitance value will be stable; if not, capacitance value will change and an alarm will go off. When the core breaks, capacitance value will be close to 0 and then immediately become larger. It will give an alarm immediately after a large wave.

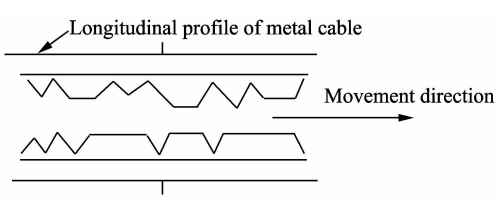

Fig. 2 Capacitance detection principle diagram of broken and fine powder

3 Simulation

By using circuit simulation software Multisim, the simulation, debugging and experiment of the capacitance-voltage converting and the measurement of rectifying, filtering and entire circuit are conduct-

ed, focusing on the circuit measurement after conversion of capacitance-voltage. Through some simulations, the capacitor voltage is got. Also, the simulation results about sinusoidal excitation signal circuits, full-wave rectifying and filtering circuits are got. The results show that tiny capacitance detection method has good performance and reliable stability. Mechanical testing would fail due to impurities of powder and cotton wool accumulating, and the precision of X-ray detection method for core of blasting fuse measurement is not ideal. So we can use capacitance detection method to obtain the anticipated results.

By measuring the conversion of capacitance-voltage, the capacitor voltage is given which is stable as shown in Fig. 3.

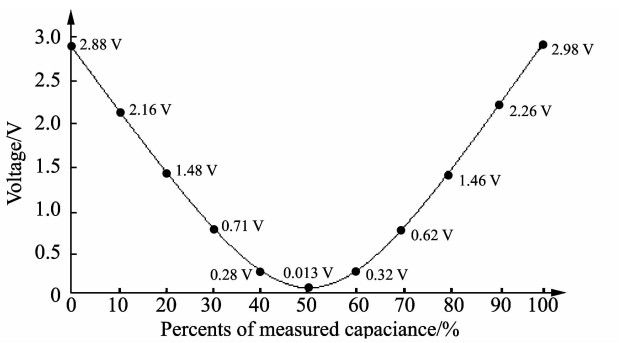

Fig. 3 Diagram of curves when the measured capacitance changes

In Fig. 3, the vertical axis shows the voltage (V), and the abscissa shows the percentage of the measured capacitance. Capacitance is measured at 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%. In the measurement, two waveforms coincide at 50% and the voltage close to 0. Because the capacitance percentage increasing is equivalent to that capacitance value becoming larger, the voltage will change from high to low and then to high again. As a result, the voltage change is certain relevant to the specific sensor calibration parameter. The simulation results will change from high to low, so the measured value of power is stable. Compared with other conventional techniques, capacitance detection method has advantages of accurate defects location, high sensitivity, fast and convenient application, etc. So it can be promoted in the future.

4 Conclusion

In this paper, we use capacitance detection method for broken and fine powder detection. When the thickness of core changes, the capacitance of medium sensor will also change. The measurement takes use of the relationship between electronic quantity and non-electronic quantity. Simulation results show that the method is of stability, easy installation, low power consumption and reliable performance. But when we detect the core of blasting fuse, specific details parameters are not available, so it is necessary to conduct further to specific fine improvement in the future.

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