

Application and research of hydraulic weighing sensor in dynamic detection of hoisting wire rope

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Abstract

In view of the increasing frequency of wire rope breakage due to the uneven force and wear of steel wire rope in the process of mine mining and hoisting, it is more important to prevent the fracture of steel wire rope by means of weighing sensor for dynamic tension detection of hoisting wire rope. However, because of the poor working environment and complicated work conditions, the current weighing sensor has various defects in the application of wire rope dynamic detection, so it is necessary to find a new type weighing sensor. In this paper, a new hydraulic weighing sensor is designed to collect the dynamic tension of the hoisting wire rope, and the application of the hydraulic weighing sensor in the dynamic tension detection of the hoisting wire rope is introduced from the aspects of the structure characteristics and application process of the hydraulic weighing sensor.

Keywords

Wire rope fracture; Dynamic detection of wire rope; Hydraulic weighing sensor.

1. Introduction

The sensor is equivalent to the human "facial features", can be directly felt in the non-electrical signals (measured, such as physical quantities, chemical quantities, biomass) in accordance with a certain law to facilitate the processing and transmission of electrical signals (usable amount), can help people to obtain a variety of useful information and needs data. With the rapid development of informatization, the sensor as the front-end device of system detection is the basis of information detection, transformation, transmission and application for measurement and control system. Therefore, in today's World sensor technology for industrial development and social progress of great significance, sensor technology has been involved in national economy and national Defense research is one of the important technologies. With the continuous development of the economy, the people's demand for minerals has also increased, however, in the mining process, due to the breakage of wire rope and other causes of casualties and property loss Japanese serious. Therefore, with the advantages of the sensor itself, the sensor is applied to the detection of wire rope, which can prevent the breakage of the wire rope, and can better protect the life and health of the staff and reduce the property loss of the country.

2. Overview of sensors

2.1 Introduction to Sensors

International Electrotechnical Basel defines the sensor as: "A sensor is a front part of a measurement system that converts input variables into measurable signals." The gb7765-87 defines the sensor as a device or device that is capable of sensing the specified measured and transformed into usable output signals, usually composed of sensitive components and conversion elements. The sensitive element is the sensor can directly feel the part of the measurement; the conversion element is a sensor that converts the sensing or response of a sensitive element to an electrical signal suitable for transmission or measurement. But the electrical signal obtained by converting the element is a weak electrical signal, the weak signal can not be directly used in general, so it needs to be further converted and processed by measuring circuit, such as amplification, filtering, compensation, and so on to obtain

better quality characteristics, so that the subsequent circuit can be better realized display, record, processing and control of the composition of the functional sensor diagram as shown in Figure 1 [1]:

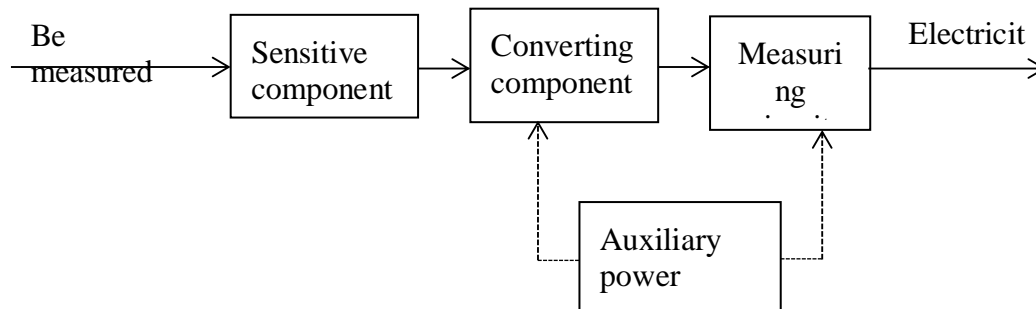


Fig. 1 Schematic diagram of sensor composition

2.2 Classification of sensors

With the position of sensor technology in measurement and control system becoming more and more important, the research of sensor technology has never been interrupted, and the sensor technology has been developed rapidly. Because now a measured physical quantity can usually be measured with different kinds of sensors, and based on the same principle of sensors, usually can also measure a variety of non-electric signals, so the sensor classification methods are numerous, usually according to the principle of action, energy relations, input and output to classify it, the specific classification is as follows:

- (1) According to the principle of action: according to the role of sensors on the principle of the name can be divided into strain, capacitive, piezoelectric, thermoelectric sensors, hydraulic sensors.
- (2) According to the energy relationship: the output of the sensor is directly converted from the measured energy, called the source-type sensor; the output energy is supplied by the external source as the external sensor.
- (3) According to the input volume: mainly including displacement, pressure, temperature, flow, gas and other sensors.
- (4) According to the output: mainly including analog, digital sensors.

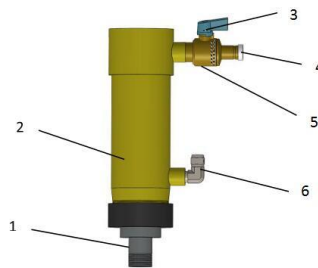
2.3 Type and disadvantage of weighing sensor

At present, the main weighing sensors used in the project are: cylindrical weighing sensor, bridge weighing sensor, double shearing beam ring weighing sensor, axisymmetric torsion loop type weighing sensor, spoke type weighing sensor, hydraulic weighing sensor. These weighing sensors have their own advantages and disadvantages, the following mainly describes the shortcomings of these weighing sensors:

- (1) Cylindrical weighing sensor: poor lateral and eccentric load capacity (better double diaphragm structure), inherent linear poor, weighing sensor is not easy to be fixed easily rotating.
- (2) bridge weighing sensor: high center of gravity, poor overload capacity, large scale weighing sensor difficult to achieve high accuracy level.
- (3) Double shear beam ring weighing sensor: complex structure, installation trouble, high cost of manufacturing, overload capacity, large footprint, such products are not suitable for the production of large scale structure.
- (4) axisymmetric torsion ring type weighing sensor: The installation is slightly complex, the accessory manufacture cost is higher.
- (5) Spoke-type weighing sensor: machining difficulty, high manufacturing cost, inherent lag big and difficult to control.
- (6) Hydraulic weighing sensor: there is an oil leakage phenomenon.

3. Hydraulic weighing sensor's structure characteristic

According to the disadvantage of the weighing sensor, a new type of hydraulic weighing sensor is designed, and the schematic diagram of the structure is shown in Fig. 2. In order to solve the problem of leaking oil in the working process of hydraulic weighing sensor, this design has been improved from two aspects of seal and connection between the hydraulic cylinder and the inner seal.

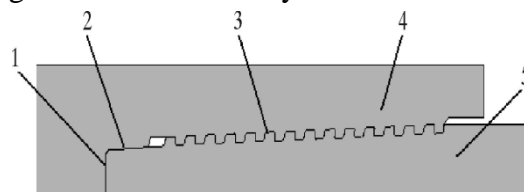


1: Piston rod; 2: Hydraulic cylinder; 3: ball valve switch; 4: pressure sensing element; 5: Ball valve; 6: oiling Port

Fig. 2 schematic diagram of hydraulic weighing sensor

The sealing method of the inner seal of the hydraulic cylinder adopts the seal of the Bingley Ring and the Rooster seal. The sealing principle of the Bingley ring and the Rooster seal is [2]: The Teckan ring and the Rooster Seal are composed of a combination of the ring seal and the Force O ring. They are through the radial interference fit, together with the O-ring pre-compression, to ensure that even under the low pressure has a good sealing effect. When the pressure of the system increases, the O-ring exerts greater force through the fluid, allowing the Bingley and rooster seals to cling closer to the sealing surface. Among them, the Bingley ring, Rooster seal mainly sealed, O-ring auxiliary seal. The connection between the ball valve and the hydraulic cylinder, the pressure sensing element and the ball valve is connected with a special threaded joint, and for the special threaded joint, the thread only bears the connection function, and the sealing function is realized by the main seal. In this way, the Non-contact seal of API thread is changed to contact type seal, and the sealing performance is improved remarkably. The special threaded joint is composed of 3 parts, including thread, seal structure and torque abutment, and its structure is shown in Fig. 3, and the special threaded joint has the following advantages [3]:

- (1) Special sealing structure, good sealing performance;
- (2) The use of eccentric trapezoidal thread, high connection strength, not easy to occur slippage failure;
- (3) The number of tightening coils of thread machine decreases, the stress level of thread is reduced, and the stress corrosion is avoided.
- (4) The inner wall of the joint is designed with Casement, and the inner diameter of the junction is smooth transition, which avoids the turbulence in the joints and enhances the corrosion resistance of the joints;
- (5) with torque abutment, can effectively control the buckle torque and seal surface interference, improve the thread and sealing surface of the ability to resist adhesion.



1: Torque abutment shoulder; 2: main seal; 3: Eccentric trapezoidal thread; 4: internal thread; 5: External thread

Fig. 3 Main structure of special threaded joint

4. The application of hydraulic weighing sensor in dynamic tension detection of hoisting wire rope

At present, the tension automatic balancing device is adopted in the multi rope friction hoisting system in order to alleviate the tension difference between hoisting wire ropes. The tension automatic balance device can alleviate the tension between the wire rope well, and in the actual application also achieved a certain effect, but the balance device is the hydraulic system, its pressure can not be abrupt, tension difference is too large can not be eliminated in time, easy to make the wire rope in the process of running a larger jitter, There is even a danger of job-hopping. In addition, limited by the size of the suspension device, the automatic balancing device adjusts the travel of the oil cylinder is small, when the tension between the wire rope is large, the piston rod of the hydraulic balance device will reach the limit position and cannot be adjusted automatically.

Based on the tension automatic balancing device, the hydraulic weighing sensor is installed in the tension automatic balancing device between the end of the piston rod and the cushion block groove, which can directly detect the tension of the wire rope.

5. Conclusion

The hydraulic weighing sensor greatly reduces the oil leakage phenomenon of the weighing sensor at work, and in the structure of the injection port, when used for a long time, but also through the injection port for the hydraulic cylinder oil replenishment, improve the sensor life, and the weighing sensor structure size is small, easy to install, The dynamic tension of the hoisting wire rope can be effectively detected by using the weighing sensor, which can prevent the breakage of the wire rope.

References

- [1] Shixing Yang, Xiucan Guo. Principle and practical design of monitoring and controlling system [M]. Beijing: China Electric Power Press, 2007.
- [2] Chenghui Luo, Shiyao Xiao, Yueling Xie. Application of combined seal in sealing of hydraulic cylinder [J]. Foshan Ceramics, 2010 (7): 31-33.
- [3] Hua Kong, Yuhuan Bu, Mingxin Ma. Study on the sealing characteristics of cone/cone structure of special threaded joint [J]. Petroleum Machinery, 2011,39 (4): 14-22.