Magnetostrictive Position Transducer Used in Mill Control System

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Abstract: Magnetostrictive now is widely used in the field of Measuring and Control system. This article takes it for example that usage of Temposonics III position transducer with CANbus interface for hydraulic mill control system. The principle, interface, features, mechanical fixings and programming of MTS position transducer is detailed.

Key words: Magnetostrictive，CAN bus，Position Transducer，AGC

1 Application overview

Black and colored strip production of the main equipment of hydraulic rolling mill，the main indicators include thickness difference of plate belt, shape of plate and output, among which thickness difference of plate belt is the main index of equipment production thickness difference control is the most critical control link in the whole rolling production, and the detection of cylinder position (that is, roll joint detection) in the control link is the most important link, and the cylinder position value is the feedback amount of the closed loop of roll joint control. According to the bouncing principle of rolling mill, the rolling thickness of strip is controlled by roll joint control. The basic roll seam control principle of hydraulic rolling mill is shown in FIG. 1.

Throughout the hydraulic mill automatic gauge control system at home and abroad（AGC）, the hydraulic cylinder position detection is usually used by the sensor linear differential transformer（LVDT）, magnetic ruler. As magnetostrictive sensor design and manufacture more and more mature, the market products in metallurgy, aviation, wood processing, petroleum, industrial vehicles, bridge monitoring field application gradually, Shaanxi Hitech Electronic CO.,LTD. Development of hydraulic mill gauge control system, the oil cylinder position detection boldly adopted American MTS company bus type magnetostrictive displacement sensor.

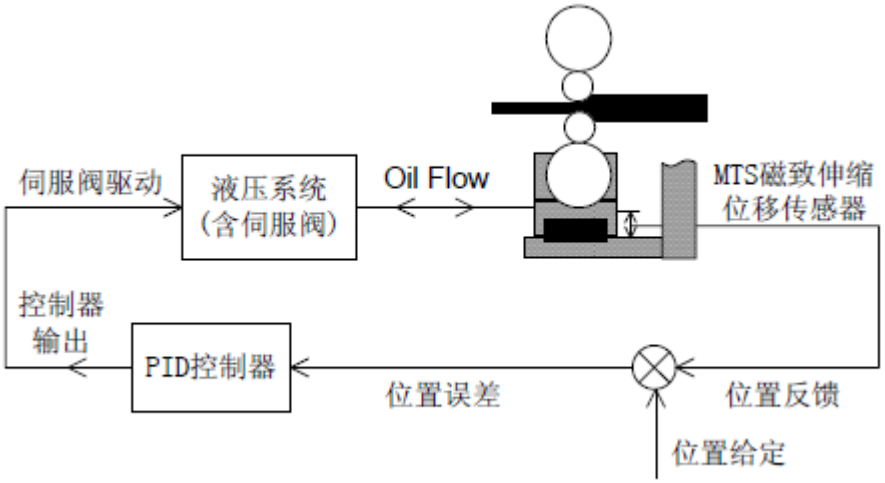

FIG. 1 schematic diagram of basic inner ring of roll seam control

2 Principle of magnetostriction technology

The principle of magnetostrictive technology is to generate a strain pulse signal by intersecting two different magnetic fields, and then calculate the time period for the signal to be detected, so as to convert the exact position. The two magnetic fields are generated by an active magnet outside the sensor and by a pulse of current from the waveguide inside the sensor, which is generated by the electronic components inherent in the sensor head. When two magnetic fields

intersect, a strain pulse is generated that travels back to the sensor coil of the electronic component at a fixed speed of sound. From the moment the current pulse is generated to the time period needed to measure the response to the variable pulse multiplied by this fixed velocity, we can accurately calculate the change in position of the magnet. See figure 2. This process is continuous, so whenever a moving magnet is driven, a new position is quickly sensed. Since the output signal is a real absolute position output, rather than a scaled or re-amplified signal, there is no signal drift or variable value, so it does not need to be re-calibrated and maintained regularly like other displacement sensors.

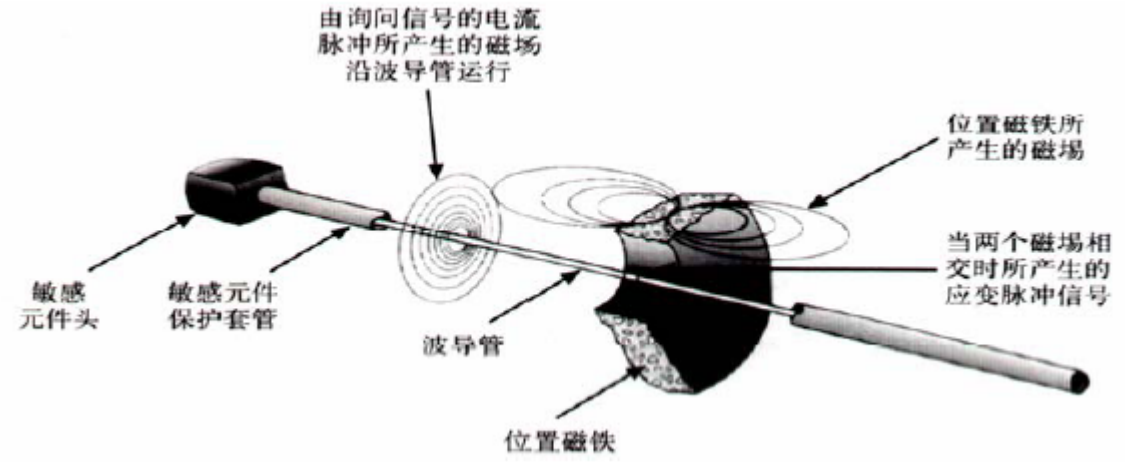

FIG. 2 schematic diagram of magnetostrictive displacement sensor

Magnetostrictive displacement sensors use non-contact technology to monitor the displacement of moving magnets. Since magnets do not have direct contact with the sensors, the sensor is not a problem in harsh industrial environments, such as vulnerable to oil stains, solutions, dust or other pollution. In addition, the sensor can withstand high temperature, high pressure and high vibration environment. The output signal of the sensor is absolute value, so if the power supply is interrupted, reconnection will not pose a problem for data reception, let alone return to zero. Finally, because the sensor elements are non-contact, even if the sensing process is repeated, there will be no wear and tear on the sensor.

Therefore, magnetostrictive displacement sensor is very suitable for this kind of work in harsh environment rolling mill equipment.

3 Sensor characteristic

MTS systems is a pioneer in the market for Magnetostrictive displacement measurement technology. Innovative technology and support have kept MTS products in a leading position in the market. Its products include TEMPOSONICSIII, TEMPOSONICSII, TEMPOSONICS E, TEMPOSONICS L four series. Among them, TEMPOSONICSIII series output forms include analog output, digital output and bus output. Bus output includes CANbus, DeviceNet, Profibus, etc. CANbus output bus form was selected in our design. See figure 3.

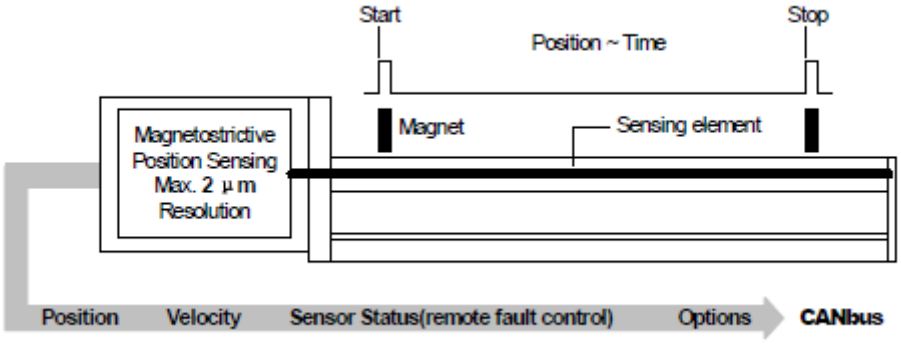

FIG. 3 Temposonics CANbus Ⅲ type sensor structure

Controller Area Network (Controller Area Network) CAN fieldbus has become a new standard for communication in instrumentation. It provides high-speed data transmission and is very suitable for high-speed industrial automation applications. CAN bus CAN be connected to a variety of different functions of sensors (such as location, temperature or pressure, etc.) on the same network, or add other instruments such as display or driver. It's essentially a broadcast system, where all networked devices mark (Node) locations and are ready to signal as soon as they receive instructions. The connection diagram is shown in figure 4.

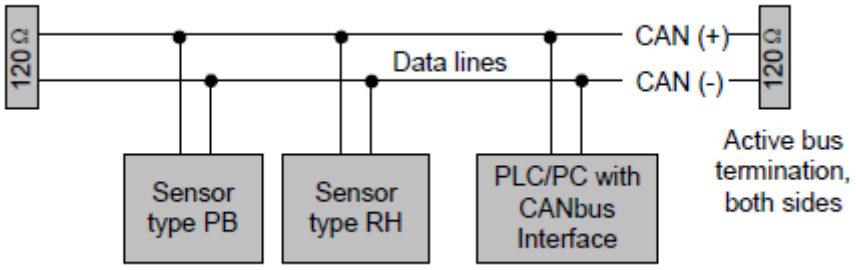

FIG. 4 CAN bus connection diagram

Temposonics Ⅲ displacement sensor with CANbus output because of the built-in microcomputer processor, so the data processing and transmission can extremely accurate and high speed and reliable. Furthermore, the microcomputer can convert the sampled position value into velocity output after calculation. At the same time, setting points can be stored in memory. That is to say, the magnetostrictive displacement sensor of MTS has both displacement output and velocity output. So we can also monitor the speed of cylinder piston rod movement through the sensor.

The sensor is an intelligent displacement sensor, high-speed, two-wire data transmission, built-in diagnostic program, self-check, status report, with 2um resolution, location and speed output, networking, a bus system can accommodate up to 32 devices, multiple position measurement, provide 5-point positioning, the highest rate up to 1Mbit/Sec.

4 CAN bus interface and programming

In AGC system of rolling mill, in order to collect displacement and speed information of MTS sensor, double-port isolated CAN bus interface card pcl-841 was selected. The card CAN operate two independent CAN network ports at the same time, the transmission rate up to 1Mbps, 16MHz CAN controller frequency, occupying 4Kb address space, 40 adjusted base addresses between C800H and EF00H, 1000VDC optical isolation protection, to ensure reliable system, free

IRQ selection of each port. And the developer provides users with LIB and DLL libraries to facilitate users' secondary development and use. The program flow of read-write displacement and speed is shown in figure 5.

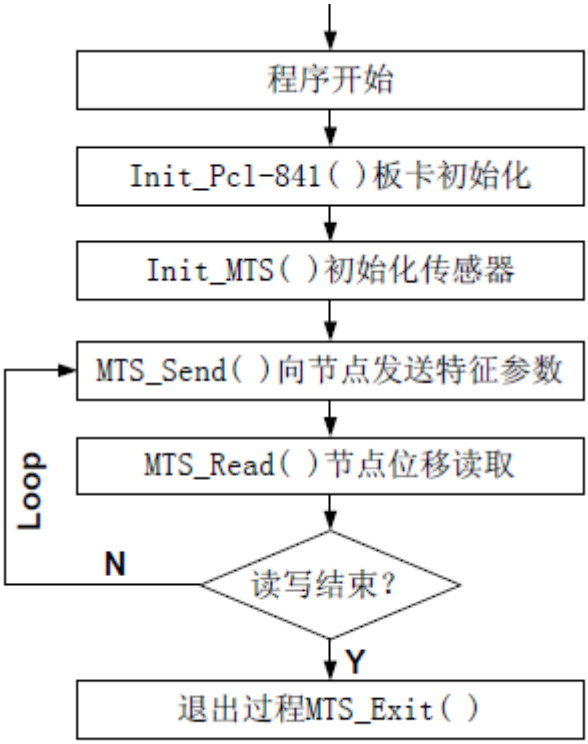

FIG. 5 flow chart of read-write displacement program

5 Sensor mounting

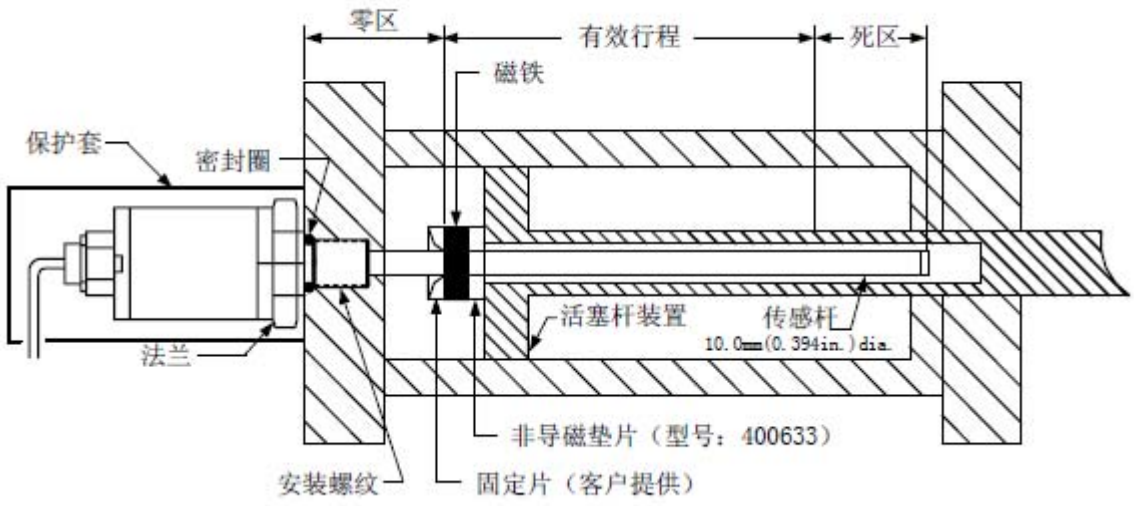

FIG. 6 cylinder displacement sensor installation diagram

FIG. 6 shows the installation diagram of displacement sensor. Displacement sensor installation plays a very important role in the use of sensors, and the installation method and precision directly affect the test accuracy. There are many oil stains and metal chips in the position of the cylinder of the rolling mill, so the sensor is installed with protective sleeve and sealing ring. When working, the magnetic ring of the displacement sensor moves together with the piston of the

cylinder. The displacement measured by the magnetic ring moving up and down is the displacement of the piston, that is, the displacement of the cylinder moving up and down. The installation design must consider the three areas of the sensor rod: zero area, dead area and effective travel area. Zero zone and dead zone are the invalid zones of magnetic ring sensing, and the effective range of magnetic ring movement is the effective travel zone of the sensor rod.

6 Conclusions

In design for Guangzhou nonferrous group of two sets of hydraulic rolling mill production line, the successful use of MTS company CANbus Temposonics Ⅲ magnetostrictive displacement sensor, using results show that the reliability of the sensor and work precision has reached the factory index, to ensure the finished product longitudinal thickness difference of strip in the range of 0.1 + / - 0.002 mm. In particular, the sensor has built-in fault code, which is very convenient for sensor fault location and system maintenance.