



Study on the Balloon Ring Follow-up Device Control System of Spinning Machine

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Abstract

To enhance the production efficiency of ring spinning and reduce the tension in the spinning process, the system which installed the balloon control ring on the ring spinning machine to control the balloon configuration of the yarn in the spanning process and control the tension in the spinning process was designed in the article. The system is the automatic control system based on PLC (Programmable Logic Controller) which uses MT5000 configuration software to compile the human-computer interface of eView touch screen, and control the balloon ring position of the ring spinning machine through the communication between the touch screen and OMRON CP1H PLC. This control system could be easily operated and monitored real-timely, and control the balloon ring position of the ring spinning machine.

Keywords: Spinning machine, PLC (Programmable Logic Controller), Touch screen, Step motor

High speed spinning has been the development tendency of the ring spinning machine nowadays (Jin, 1994, P.30-33). In the spinning process, when the peak value of the spinning tension exceeds the valley value of the spinning strength, the broken ends of spinning will occur, so to control and stabilize the spinning tension, especially to reduce the tension break and the cross opportunity of the tension wave peak and strength valley, is one of effective measure to reduce the broken end rate of spinning. The spinning tension is closely relative to the highness of the balloon. In recent years, the ring spinning machine develops from traditional single motor to present multiple motors, and the online checking of PLC application, industrial control machine, frequency conversion and servo control, touch screen display, subsection drive and technological parameters, and the network function have been applied very broadly, which makes the harmonized cooperation of multiple motors and the automatization degree achieve quite higher level (Song, 2003 & Luo, 2005 & Li, 2003 & Li, 2001). Gwaltne was the first scientist who applied the balloon control ring in the ring spinning machine, and he found that the balloon control ring could reduce the maximum semi-diameter of the balloon and decrease the spinning tension. At present, Fraser et al further studied the function of balloon ring in the ring spinning production. Except for reducing the tension, the application of the balloon control ring in the ring spinning production can help to form stable tow balloon (C. Mack, 1953, P.483-498 & W. B. Fraser, 1993, P.439-468).

However, the maximum semi-diameter and the correlative position of the free balloon in the spinning process are always changing, and the position of the balloon control ring should be dynamic. To optimize the position and size of the balloon control ring and enhance the production efficiency of the ring spinning, the balloon ring follow-up device of spinning machine was designed in the article, which could realize the computer digital control the balloon ring position in the spinning process. The new system only needs to modify the PLC program of the spinning machine and add corresponding drive machine, and this device is independent, and it can be applied in other digital spinning machines.

1. Confirmation of the control scheme

Based on the present digital spinning machine, the multi-motor independent drive is composed by PLC, touch screen and servo motor. PLC and touch screen are adopted as the upper system to monitor the production process and the dynamic change of the signals. Because the step motor can be controlled by the digital signals, and it can work in the open loop without feedback, and it has not the accumulated positioning errors, and its control precision is very high, and PLC is internally installed by the pulse output function and set up corresponding control orders to control the step motor (Zhou, 2008, P.100-101 & Wang, 2006, P.36-42 & Zhao, 2008, P.115-117). Therefore, the touch screen is used to communicate with PLC in the system, and PLC is the control core, and the step motor is the execution component to

realize the computer digital control of the balloon ring position in the spinning process.

2. Implementation of the control system

The system is mainly composed by touch screen, PLC, switch power supply, step motor driver, step motor, pulling-thread displacement sensor and linear module (seen in Figure 1). The control system mainly uses the programs to control the speed, direction and displacement of the balloon ring and keep the balloon ring at the 1/2 between the ring rail and the twizzle for perfecting the yarn quality.

PLC is the core of the whole control system, and it stores the technological parameters and controls the running of the step motor through certain control algorithm. The step motor driver converts and amplifies the control signals from PLC to control the pulse and direction of the motor. As the execution unit, the step motor mainly complete the ascending and descending actions of the balloon control ring of the spinning machine through the mechanical drive. The pulling-thread displacement sensor converts the displacement of the ring tail into the digital variables to PLC. The switch power supply offers the work power supply for the touch screen, PLC and step motor.

As the human-computer interface, the touch screen can set up the technological parameters and monitor the running status. The new generation industrial embedded touch screen eView MT5000 is adopted in the design. In the configuration software of MT5000, define the serial port equipment is OMRON CP1H PLC, the serial port number is COM1, the data bit is 7, the stop bit is 2, the baud rate is 9600, and check is even parity check, PLC station number is 0, and after define the equipments, define the I/O variables to respectively connect with input register and output register and control the switch. The connection between the touch screen and PLC is seen in Figure 2.

3. Work principle of the system

OMRON CP1H PLC is adopted in the spinning machine control system, and CP1H is the machine integrating multiple functions, which is embedded 4-axis high speed pulse output function (100KHz), simulation variable I/O function and serial communication function, and many functions such as high speed count input, pulse enactment PULS, frequency enactment SPED and positioning control PLS2 are very convenient to control the speed and position of various motors.

In the system seen in Figure 3, PLC output port 00 inputs pulse speed into the PU port of the step motor driver, and controls the revs and displacement of the step motor in the follow-up system. PLC output port 02 inputs the direction signals into the DR port of the driver to control the direction turning of the step motor. PLC input ports 03, 08 and 09 take the return values of the displacement sensor as the input signals of the high speed counter 0 to check the position of the ring rail real-timely. Input ports 00 and 01 respectively are the start signal and stop signal of the step motor, and the input port 02 is the reset signal of the step motor. The ports 04 and 05 are the input signals of the approach switch to control the highest point and the lowest of the balloon ring for protecting the balloon ring. When the manual operation is needed, the signals 06 and 07 can be inputted by PLC to control the positive and passive rotations of the step motor by the inching mode. When the port 06 is ON, the motor rotates positively and the balloon ring ascends, and when the port 07 is ON, the motor rotates negatively and the balloon ring descends.

4. Software design of the control system

Some special functions such as high speed pulse processing order, logic control order and count operation order offered by OMRON PLC can be used conveniently to control the ascending, descending, positively rotating, negatively rotating, and constant speed shifting of the balloon ring, especially, PLS2 positioning control can make the step motor achieve the sports status of desynchronizing.

Figure 4 is the control software program flow according to the electric control principle of the above balloon ring follow-up device and combining the program design method of PLC and the action requirement of the ring tail of the spinning machine.

5. Practical application

The raw materials including the combing pure cotton roving which ration was 3.98g/10m and the combing polyester/cotton 65/35 blended roving which ration was 5.97g/10m were respectively spun in the spinning machine installing the follow-up balloon control ring, in the spinning machine installing the fixed balloon control ring, and in the spinning machine without the balloon control ring. The data of the results are seen in Table 1.

YG172B instrument was adopted to test the hairiness, and the results included that the hairiness amount of the 2mm yarn of 30texT/C of the spinning machine installing the follow-up balloon control ring decreased 11.28% comparing with the spinning machine installing the fixed balloon control ring, and decreased 12.96% comparing with the spinning machine without the balloon control ring, and the hairiness amounts of 3mm respective decreased 43.17% and 30.11%.

The hairiness amounts of 2mm 23tex cotton yarn respectively decreased 25.07% and 8.16%, and the hairiness amounts of 3mm respectively decreased 37.18% and 30.15%.

The electric continuous tension test instrument R-3192 of Switzerland ROTHSCILD Company was adopted to test the

dynamic spinning tension, and the result indicated that the tension of yarn reduced 2/3 after the follow-up balloon control ring was installed.

The spinning machine installed the control system could control the balloon configuration in the spinning process, reduce the fluctuation of the dynamic tension of the yarn, decrease the maximum tension of yarn, reduce the broken end rate, enhance the spinning efficiency, save energy and reduce the consumption. The control system possesses many characteristics such as flexible control, simple usage, convenient function extension, and stable running, and the control system program is independent module which can be applied in other digital-control spinning machines.

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Table 1. Main technological parameters of the yarn variety

No.	Yarn variety	Spindle speed (r/min)	Total drawing multiple	Twist degree (T/10cm)	Weight of steel wire ring (mg)
1	Yarn of 30 tex T/C	8000	19.9	76	25.9
2	Cotton yarn of 23tex	8000	17.3	78	22.7

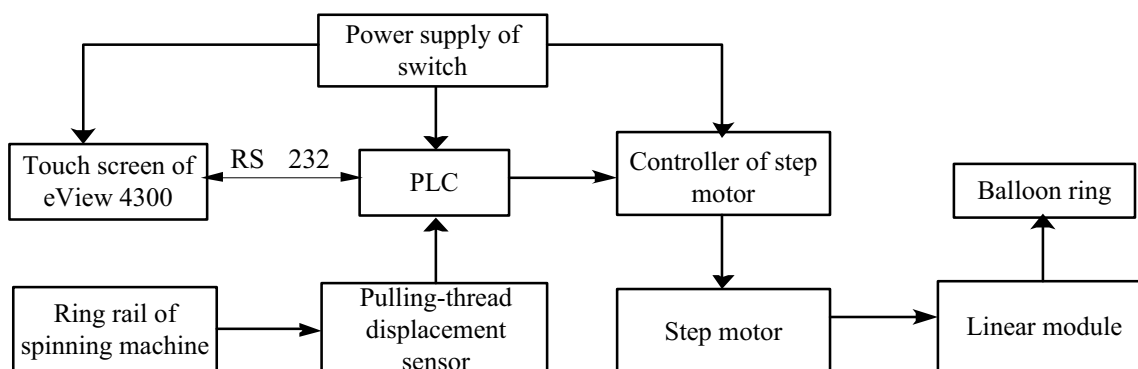


Figure 1. Constitution and Structural Diagram of Control System

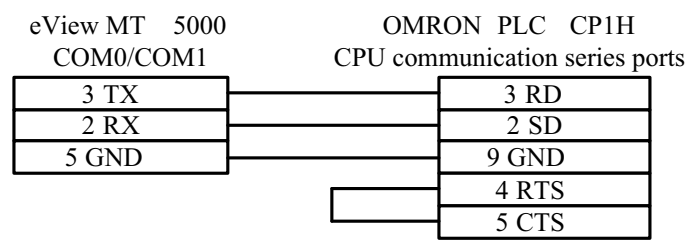


Figure 2. Connect Diagram of eView MT5000 and OMRON PLC

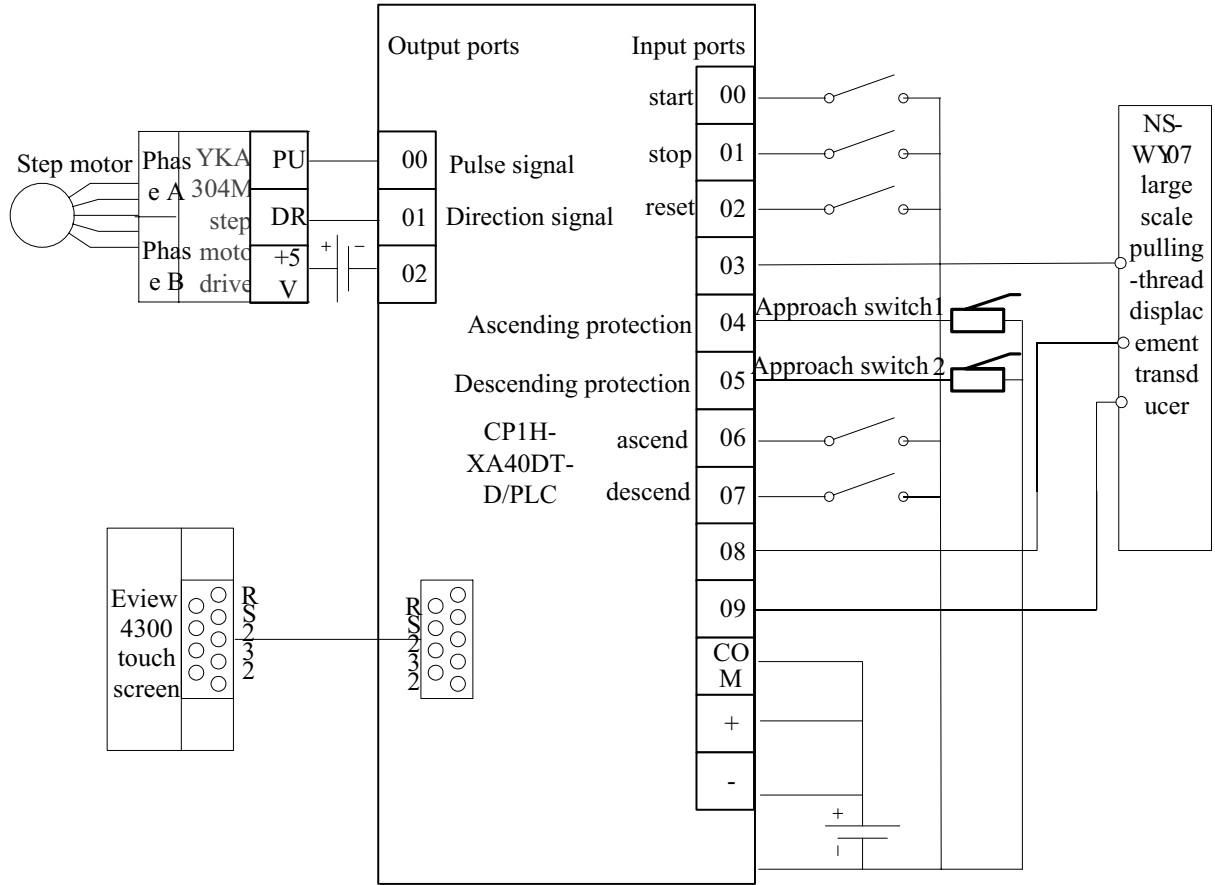


Figure 3. Principle Diagram of Control System

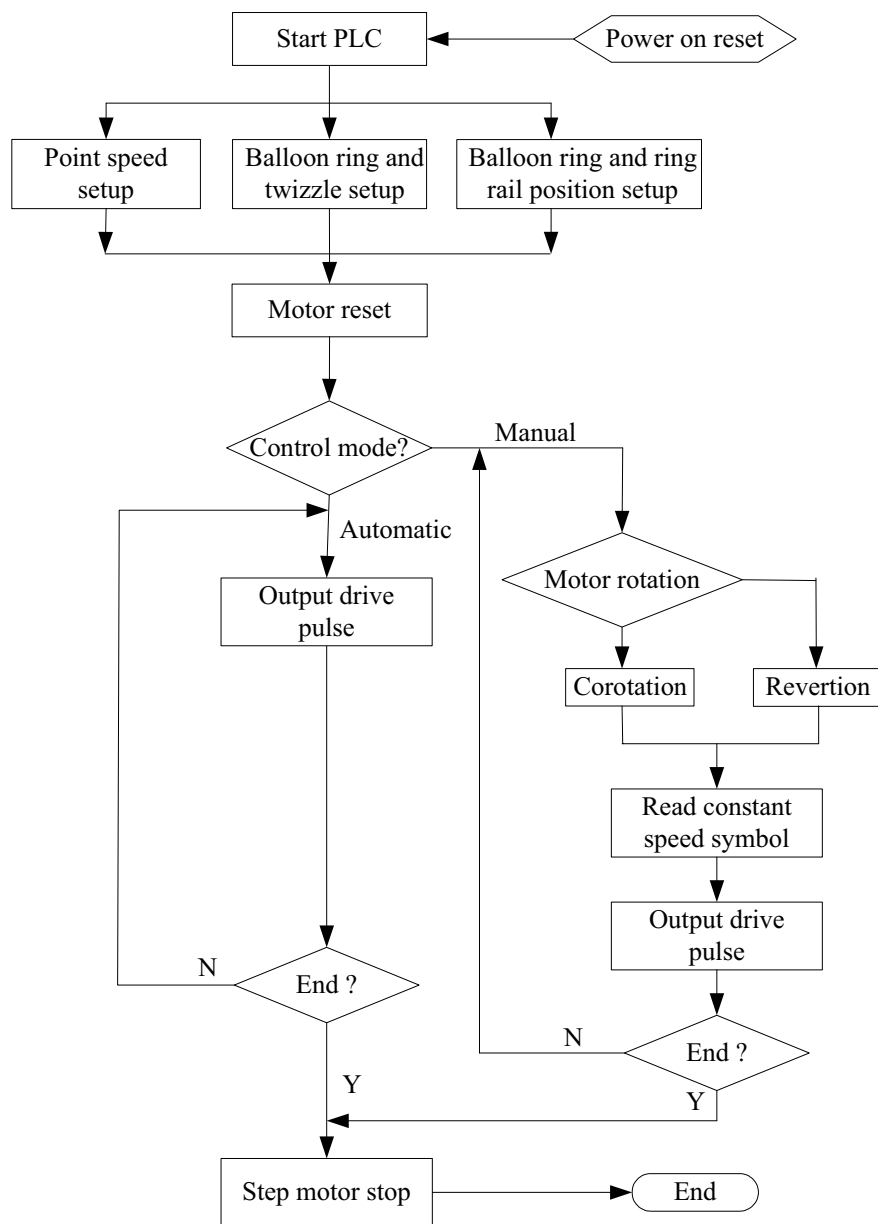


Figure 4. Program Flow of Control System