

## Original Research Article

# Maintenance and Fault Handling of ZD6 Series Electric Switch Machine

Xueli Qi, Fenglou Yang, Wanzhu Xie

School of Electrical Engineering, Nanjing Institute of Mechanical and Electrical Engineering, Jiangsu, China

**ABSTRACT**

Turnout and conversion system is essential for rail transit infrastructure, it is the weak links on the line, the need for specialized technology and facilities to protect the safety of the train. Turnout conversion and locking, is directly related to traffic safety key equipment. Turnout of the manipulation is divided into manual, electric two kinds of ways. Manual is the operator through the turnout grip in the field directly manipulate the turnout of the conversion and locking. This method is low efficiency, labor intensity, cannot meet the requirements of railway modernization. Manual mode is positive with the non-centralized chain was transformed and gradually reduced. Electric way, is converted by various types of switch machines and lock the turnout, easy to focus on the operation, to achieve automation. The switch machine is used to reliably switch the turnout position, change the turnout direction, lock the turnout track, reflecting the turnout position. The switch machine is an important signal basic equipment, it is to ensure traffic safety, improve transport efficiency, improve the driving force of labor degree, and play a very important role. To meet the train speed after the traffic safety and improve transport efficiency of the requirements, turnout conversion device must be high security, high reliability, long life, and less maintenance. ZD6-type electric switch machine cannot meet this requirement, so now widely used S700K-type electric switch and ZYJ7 type electric hydraulic switch machine. Their common features are: the use of external locking, sharp and heart of the dynamic security from the external lock to ensure that the two sharp rails from the linkage to split; sharp track, heart track are more traction, can achieve the whole Close the paste and the whole folder foreign body inspection to ensure the safety of the train; the use of three-phase asynchronous motor failure, and long life.

**KEYWORDS:** Turnout; hydraulic switch machine; conversion system;

## 1. Overview

### 1.1. Usage

For the railway electrical concentration station is used to change the turnout direction, trivial turnout orifice, reflecting the state of the turnout orifice of the equipment.

Main technical indicators working environment: Model and classification

ZD6 - \*\* / \*: where Z represents the switch machine D represents the electric 6 represents the design sequence number first \* represents the derived sequence number second \* represents the action lever moves the third \* represents the rated conversion force 1.2. 3 main technical parameters Model ZD6-D165 / 350, rated conversion force 3430N, action rod moving 165mm, said rod moving 135-185 mm, conversion time  $\leq 5,5$  seconds, operating current  $\leq 2A$ , the main vice-resistant anti- Are  $29420 \pm 1961N$ , said rod resistance to shear 14700-17600

## 2. Machine structure and the role of the main components

### 2.1. Structure

ZD6 series of electric switch machine, by the motor, reducer, automatic switch, spindle, action bar, that pole, bottom shell, cover, shift contactor and other components. (Manufacturers without wiring, E-type machine without shift contactor)

## **2.2. The role of the main components**

### **2.2.1 Motor**

Electric power machine, the general use of DC motor, the motor current provided by the signal machine, according to the intention of the station operator, by the signal to the motor to send positive or reverse polarity of the current, so that the motor is rotating or reverse To rotate. ZN6 switch machine equipped with the motor for short-term operation of the DC half reversible motor, it has recorded in the rated torque of 1.8 times the case, the use of safe use, the maximum friction current allowed to 3.3 times.

DC semi-excited motor features:

- 1, Starting torque.
- 2, Soft features.
- 3, Change the direction easy.

Three features are suitable for turnout conversion, so ZN6 series of machine using this machine, DZG motor can be used ZN6 series of machine. But should pay attention to the ZN6 series do not have the type of motor gear distinction, such as A-type machine for the 27 teeth, D-type machine for the 20 teeth, E-type and J-type machine for the 12 teeth, the replacement of the motor when the model need to pay attention.

It is concluded that when the motor is switched at the time of the switch machine, the function of the mechanical transmission action source is used to change the track, and the switch control circuit is composed first, and the power is turned on. DZ220V, DF220V after power, by the

Automatic switch connector sent to the motor, so that the stator and rotor coil semi-excitation, the rotor coil drive shaft

According to the current flow through the direction of the non-rotation. In order to achieve the conversion of electrical energy into mechanical energy. The motor rotates

Driven all levels of gear rotation, and ultimately turn the switch to the control bit, and then by the automatic switch connector cut off the road

Fork control current.

### **2.2.2 Reducer**

Reducer with planetary deceleration mechanism, its role is:

1)

Reduce motor speed,

Obtain the torque required to drive the spikes.

Path of the error is the high speed of the motor

Reduced to the low speed for the turnout, at the same time, the motor input low torque, increased

To be able to drive the drive to drive the load to change the lock mechanism.

2)

As a result of the planetary slowdown,

It has a certain degree of anti-reverse function,

To prevent the train through

Turn the turn when the impact torque generated when crossing the turnout.

3)

When the power outage or failure, the input head of the head of the head for hand-held turnout.

### 2.2.3 Friction couplings

1)

When the turnout is over, the operating current is cut off, and the motor cannot be stopped immediately because of a chronic relationship,

This chronic kinetic energy dissipates on the friction belt, protects the mechanical transmission part,

2) When the spikes are blocked in the middle of the conversion, the load exceeds a certain limit, the gears within the friction plate

Idle, disconnect the turn of the fork rail and the motor contact, so that the motor continues to rotate, not changed to be burned.

### 2.2.4 Conversion lock device

The locking device is mainly composed of main shaft, action rod, locking gear and action rack. Its role is: 1) the reducer output rotation torque into a turnout to change the location of the required level of push C pull 7 force. 2) turnout in the opening position, that is, after the track and the basic track paste, the sharp rail inside the mechanical lock. Two main points: 1) between the spindle and the output shaft with a cross-joint role of the starting pieces connected together. 2) Power rod and rack block between the squeeze pin connections.

#### 2.2.5 Contact conversion device

The contact conversion device is mainly composed of components such as indicating rod and automatic switch,

Automatic switch function

Mainly: timely and correctly connected to and disconnect the electric switching mechanism of the starting and indicating circuit, which

The main role has the following three points:

1)

Constitute the switch machine after the start of the switch circuit, in the conversion process, with its mechanical action constitute two times

Point change, the first displacement off the original said circuit, for the next return to start the circuit to prepare conditions;

The second displacement off the start circuit, so that the motor stops rotating.

2)

Supervise the whole process of switching machine, with the bar that action, uninterrupted check turnout opening position

As well as the tip of the state.

3)

When the turnout is squeezed, the interruption of the turnout represents the circuit.

Indicating the role of the rod: that the rod is through the electric switch machine outside the rod and the turn of the track

Then, its role is: in the automatic switch with the check, and check the tight track of the state,

With the automatic switch to complete the conversion of the contacts, when the turn was crowded, the top of the check column, off

Turn the circuit that the signal does not work, you may all know that the rod and the turn

Then connected, only the tip rail to the end, and with the turnout to maintain a basic gap of less than 4 mm,

That the bar gap to check the correct column head, the contacts can be knocked down, otherwise the moving contact, although the exit

Static contact group, but cannot be touched with reverse contact. The other function of the rod is that when the turn is crowded, the vertex has no check column, cut off the circuit, and acts as a turnout.

### **2.2.6 Knuckle protection device**

The tandem blocks and the dynamic induction are tightly connected by a main sub-squeeze pin into a unit, in normal condition. The action of the rack to complete the turnout conversion, squeeze, squeeze the pin was broken, so that the action rod and teeth. The strip is disengaged, and the displacement adapter contacts the top, cut off the circuit, thus protecting the other mechanical components.

### **2.2.7 Shift the role of contactor**

ZN6 switch machine (except E line) installed within the two shift contactor, respectively, with the rack block out or the position of the mandrel when the corresponding position of the corresponding, when the switch is normal use, the shift contactor often closing the junction in the circuit, when the turnout is squeezed, the mandrel will be normally closed contact top, cut off the machine that the circuit, to the traffic attendant sound and light alarm.

### **2.2.8 The role of wiring machine wiring**

Switch machine wiring is the way to turn off the way, line system requirements, preparation of molded products, access connected to the start circuit and the circuit in the switch machine.

### **2.2.9 Chassis and cover**

The role of the casing (main) installation of the components of the switch machine, and fixed on the turnout. At the same time, machine, shell and cover act as open, closed and protective effect. Through the above ZN6 series of machine, use, structure, point, transmission principle, and a large part of the study, so that students to strengthen the ZN6 series of machine thinking, for the next step analysis of a simple fault, provide the theoretical basis.

## **2.3. The main features of the main part of the machine**

The motors, reducers, automatic shutters and spindles of the switch machine can be individually disassembled and are not affected for maintenance. The reducer and the opening of the automatic shutters are open to the limit slot to ensure that they are fixed in the bottom case With the center line of the spindle concentric, after installation do not need to adjust the left and right position of the whole machine installation size of  $360 \times 610$  mm, four foot mounting hole diameter of 422 mm, the action rod and said the center of the foot from the foot base height of 50 mm All turnout mounting and tie bars are based on these dimensions, and are installed in the field with both mounting (reverse opening) and reverse mounting (left open). If you want to install the action bar, that lever switch direction. The so-called left open, right open are from the motor to see the direction of the two bars out. The static contact piece on the shutter is made of new material, bronze, and the movable contact ring adopts the new material copper nickel alloy or stainless steel to improve the electrical conductivity and wear resistance. Since the beginning of September 2002, the speed of the claws with no oil roller, small elbow for the spline shaft, reducing the amount of open. Action rod, said rods are used hard chrome plating process. Indicating that the rod with a new type of enhanced said pole, the main and auxiliary pole at the same time bear the force, an increase of the overall strength. Said rod adjustment nut as a whole across the type, with two rods do not have another nut. Eliminate the slider and the main, deputy said the rod off the runaway phenomenon. DZG motor with a new technology, new materials, greatly reducing the motor disconnection failure.

## **3. ZD-6 series electric switch machine drive principle**

The operating rod is pulled in the state, and the closing lever is moved to the right. The current from the turnout control circuit is connected to the motor (starting circuit) via the first row of automatic shutters to rotate the motor in the clockwise direction, the spindle is connected together by the actuating chip. The spindle is rotated together by the output shaft. During the rotation of the spindle, the circuit can be switched and the mechanical unlocking, switching and locking are performed.

## **4. Analysis and Treatment of Common Faults of ZN6 Series Switch Machine**

ZD6-type switch machine failure, from the structure can be divided into circuit failure and mechanical failure; from the circuit action program can be divided into the starting circuit failure and said circuit failure; from the device location can be divided into indoor equipment failure and outdoor equipment failure; From the fault phenomenon can also be divided into turnout cannot start, idle and no fault that three failures.

According to the action procedure of the turnout circuit, combined with the current pointer swing on the console, the phenomenon of the turnout current ringing and the turnout position of the switch shows a comprehensive analysis, and gradually narrow the fault range, stable, accurate and fast to handle the fault.

#### 4.1. Distinguish between indoor and outdoor failure

Turnout control circuit failure, the most critical is to distinguish between the points of failure is indoors or outdoors, to avoid running back and forth, delay processing fault time.

##### 4.1.1 Differentiation of the turnout circuit

Turnout cannot start, you should first see the console phenomenon, if necessary, should also be measured in the sub-line circuit resistance to accurately distinguish between indoors or outdoors.

When the turnout start circuit failure, can be individually manipulated turnout, turnout the original position that lights are immortal, that 1DQJ not excited; turnout the original position that lights off, but release the single operation button, the original position that the lamp is lit, 2DQJ does not turn. The above two kinds of fault phenomena, can determine the fault in the room.

When the turnout, anti-bit that lights are not expressed, and the occurrence of anger when the alarm cannot be individually manipulated turnout, should be in the sub-line on the terminal to start circuit resistance to distinguish between indoor and outdoor failure.

For the four-wire turnout, X1 for the positioning of the start and that the public line, X2 for the start of the anti-bit and that the public line, X3 asked Oh, anti-bit that the public line, X4 for the set, anti-start the public line. Therefore, the turnout in the positioning, X2 and X4 should be through between; turnout in the reverse position, X1 and X4 should be through between. To turnout in the positioning, for example, X2 and X4 between the barrier, indicating that the fault in the outdoors, if there is resistance between X2 and X4, generally can be determined as open circuit for indoor circuits. For the sake of reliability, can be individually manipulated turnout, with a multimeter DC 250V voltage block in the sub-line test X2 and X4 with or without DC voltage, if no voltage, certainly fault in the room, if there is voltage, fault outdoors. When judging in the room, you should first check the indoor turnout fuse circuit, if the fuse blown, should be put on the fuse test once again, and then fuse, the mixed line failure. If the fault is mixed indoors or outdoors, it should be tested again at the sub-line. Remove the cable from the sub-line at the fault of the X2 or X4 cable, measured the resistance of the inner side of the circuit, if the resistance is infinite (open), then the outdoor failure; if there is resistance to indoor failure. For double-acting turnout, the ammeter pointer is swung once for an outdoor fault.

##### 4.1.2 Turnout to indicate the distinction between circuits

For the four-wire turnout control circuit, the positioning is not shown, in the sub-line measured X1 and X3 AC voltage; anti-bit without the time, in the sub-line measured X2 and X3 AC voltage. If the measured AC voltage is about 110V, indicating outdoor open circuit. If the measured voltage is 0V, it should be broken X3 cable core and then test the voltage, about 110V for the outdoor short circuit; still 0V is the indoor open circuit. Outdoor short circuit, in the room measuring 750Ω resistance should be on the AC voltage, but no DC voltage, do not break X3.

#### 4.2. Analysis of mixed line failure

Four-wire turnout cable fault occurs more common, the following may occur on the mixed line failure analysis.

##### 4.2.1 X1 and X2 mixed with

Turnout in the original position to the reverse position, to the reverse operation, the turnout after the start of the fuse RD2 can be converted to the end, no position that.

When the turnout to reverse position after the start, turn on the automatic opening of the first 2, 4 row of contacts, because X1 and X2 mixed, so that the start of the DZ power supply from the room after the X2 sent out and then to the X1, the automatic opening and closing 41-42 contacts sent to the stator coil 1 terminal, so that turnout and turn the trend. In this way, the two-stator coil self-inductance potential offset each other, resulting in loop current is too large, fuses off the fuse, so that turnout to stop conversion.

Turnout in the original position, to the positioning operation, the turnout after the fuse after the fuse RD1, so that turnout cannot be converted completely without position. The reasons for the analysis with the above.

#### **4.2.2 x1 is mixed with x2**

Turnout in the original position, no position that, to the reverse operation, the turnout can be converted to the end, but in the reverse position close the paste back and forth, the console on the current pointer swing, has been no position that.

Since X1 and X3 are mixed, when the turnout is reversed, the first row of contacts of the automatic shutter is turned off and the second row of contacts is turned on. Although the reverse start circuit is disconnected, the 1DQJ has a slow- , in the contact conversion process can always keep sucking, start the power supply is not broken. So DZ by automatic switch 11-44-21 -22-Z1-2-automatic switch 23-24 shift contactor 01-01-automatic switch 43-44-X3-X1 automatic switch 41-42 - motor 1-3 - motor 3-4- interrupter switch 05-06-X4-DF, turn on the positioning start circuit, so that turnout to the positioning conversion. But as long as the turnout to start positioning, automatic switch connector immediately displacement, disconnect the second row of contacts and connected to the first row of contacts, that is, just open the positioning of the boot circuit, re-connected to the anti-start circuit, And turn the turnout inversion. Anti-bit just conversion is completed, the automatic opening and closing contact with the rapid contact to the second row of contacts, so the positioning start circuit has been connected. In this way, the recurrence of the turnout in the positioning of the stick back and forth around the phenomenon.

The turnout is in the reverse position, there is anti-bit representation; manipulation to the positioning, can be converted, but no positioning that; then the counter-bit turnout in the anti-bit density of the phenomenon of back and forth, the reasons for the same.

#### **4.2.3 X2 is mixed with X3**

Turnout in the original positioning, there is positioning that manipulation to the reverse position, turnout can be converted to the end, no anti-bit said. Because X2 and X3 mixed line, the reverse position that power short circuit caused by turnout no reverse position.

Turnout in the positioning, anti-bit without representation, manipulation to positioning, there is positioning that. Line X1 and X3 mixed to the line.

#### **4.2.4 X1 is mixed with X4**

Turnout in the original positioning, there are positioning that manipulation to the reverse position, has broken as, the reverse of the melting RD1 and RD2, turnout cannot be converted to the end, has been the location that.

As X1 and X4 mixed line, turnout by the positioning operation to reverse position, in 1DQJ just a suction, 2DQJ. The DZ and DF can be supplied normally, so that the turnout is activated, but when the automatic switch is moved, the DZ, DF power supply is short-circuited and the fuse is positioned. When the fourth row of static contacts is connected, the DF of X4 is connected to the stator winding 1 terminal by X1 and the automatic shutter 41-42. The rotor coil is short-circuited, resulting in the fuse inversion of the fuse RD3. Conversion, positioning and anti-bit are not shown. Similarly, we can analyze the failure phenomenon of the turnout from the positioning operation to the reverse position.

#### **4.2.5 X2 is mixed with X4**

Turnout in the original positioning, operation to reverse position, as long as 2DQJ pole, direct fuse inversion fuse RD2, the road cannot be automatic, no turnout position.

When the turnout is in the reverse position, 1DQJ sucks up, the fuse is directly blown in the reverse position of the fuse RD2, 2DQJ after the turn, the turnout is just started, the fuse is located in the fuse RD1, no turnout position.

#### **4.2.6 X3 is mixed with X4**

Turnout in the original positioning, manipulation to the reverse position, turnout switch in the end, and there is anti-bit, but the reverse fuse RD2 fuse.

Because X3 and X4 mixed line, when the turnout to reverse conversion, although the anti-start circuit is disconnected, but 1DQJ slow release effect, the slow release process may also send DZ and DF power, so the X2 on the DZ automatically open Closed device 11-21-22-Z1-2 Automatic switch 23-24-43-44-X4-DF, which shorts DZ to DF and fuses the reverse fuse RD2.

Turnout in the original anti-bit, can be normal to the positioning, when the next bit in the reverse operation will appear when the above phenomenon. When operating to the positioning, the fuse RD1 will not be removed because DZ and DF are blocked by the diode in reverse direction.

### 4.3. Failure analysis

#### 4.3.1 The reason why the cover is not flexible

The original should be linked to the machine lock the moving parts of the grinding head, pull the spring force is small, or long extension spring. The method is

Check the lock linkage parts, shaft pin connection oil, to use a smooth pull can be, pull the spring aging Elastic can be replaced.

#### 4.3.2 The reason why the cover does not lock

Cover does not lock the lock has two reasons: First, the cover of the elevation angle is too large, the cover before the hook is not locked

Card, the second is the lock installation skew, the treatment method is 1. Tensing the cover, adjust the elbow screw, Note that the two elbow screws this leveling, not a high and one low, so that the cover off the corner of the effect. 2. Re-install the lock.

#### 4.3.3 Safety contact in the hand rub when the automatic cut off the circuit, not by artificial recovery and then connected to the circuit?

The reason is that the power off distance is less than 2MM, the processing method is to adjust the locking angle of the motor contact group,

The specific approach is to seal the back of the plate with a wrench to pull down,

Pull to make the safety door moving contact, but not with the static contact piece can be opened more than 2MM.

#### 4.3.4 Safety door dynamic contact ring into the static contact piece contact depth of less than 4MM what is the reason?

Because the power is too large distance caused by the treatment method is to adjust the locking contact group, the angle of the arm, the specific approach is to seal the back of the plate with a wrench to pull up, pull to the safety of the door contact ring Into the static pieces to meet more than 4MM can.

#### 4.3.5 What is the reason why the water inlet is in the casing?

- 1) Perforated plate and sealing cover (plug) closed lax.
- 2) Machine cover plate is not smooth, limited limit.
- 3) The cover inside the water screw is not on or no solid,
- 4) Protective cover cylinder vent hole spin,

5) Water damage, the key check the location of the keyhole is the keyhole and insert the hand of the hole after the plastic block lax or plastic block caused by damage, and other aspects have to check to take targeted measures.

(1) Motor failure. The rotor is broken, for example, the motor cannot work in the carbon brush position; carbon brush in the brush grip moderate inappropriate, too loose or too tight, so that the motor will produce a large spark or simply cannot start. (2) Failure of the gear unit. The friction current is affected by temperature and humidity. It has been found that in winter, the friction current increases; in the summer, the friction current decreases. Friction with oil or internal gear out of the end of the corrosion is more serious, so that the friction current changes. The self-structure of the friction belt is caused by the friction current deviation. (3) Automatic switch failure. First, for the second displacement, the shutter cannot be achieved. Check the column and the opening of the receiver hole oil and produce dry friction, so that check the column does not groove. Work in the switch machine in the locked position did not notify the electrician staff, the shaft in the switch joint operation due to external force deformation occurred. Second, the dynamic contact by the train vibration and other causes of the screw on the fastening nut loosening, so that the adjustment screw is also followed by loosening, resulting in connecting pin out, in the contact seat plane stuck. Again, due to the shaft and the shaft hole lack of oil, prone to dry friction, moving contact was stuck cannot be converted. Fourth, in the unlock, because the quick-moving claws and quick-motion gap is small, quick-acting claws are fast-moving piece to withstand, so that unlock cannot be carried out. Fifth, quick-acting bushing and the spindle between the lack of oil, resulting in the occurrence of shaft failure, so that the switch cannot play the role of conversion. (4) The displacement contactor is

faulty. First, the displacement contactor contact shrapnel is affected by the long vibration of the train and its pressure is reduced, the displacement contactor shrapnel is automatically bounced. Second, the fixed contact bolts of the fixed contactor are loosened and the rack block plane will be displaced from the contactor contacts. (5) The fault of the rack block and the locking gear. Replace the squeeze pin, the rack block on the screw is not tightened, locking gear and rack block jam, resulting in the switch machine cannot be converted. Locking gear starting teeth in the rack slot on the side of the gap is less than 1 ~, there may be teeth and groove edge collision, a serious direct lead machine cannot be converted. (6) Turnout of the Department of the problems that turn over tight. Public service personnel in the case of non-notification of cooperation with the electrician, in the joint operation of the turnout, change the gauge, resulting in turnout too tight, the machine cannot be locked. Indicating that the card gap failure. The reason is that the tip rod nut is loose; the tip rod L iron nut is loose; the parts of the pin hole is overstretched; the first connecting rod screw is loose and loosened; the tuyere track is moving; the fork is crawling;

## **5. Conclusion**

According to the action procedure of the switch control circuit, combined with the ammeter swing on the console, the twist bell ringing and the turnout position indicate the change of the lamp, and gradually reduce the fault range, stable, quasi-fast and fast fault.

Under the leadership of the teacher, we carried out a visual feast, not only familiar with the operation of the machine, but also a deep understanding of the failure of the machine. On-site teachers are the staff of the railway bureau, through communication with them, deepened my understanding of the railway bureau, especially the power section, for the future into the railway bureau more quickly to work to lay a solid foundation.

## **References**

---

1. Lin Yujun. Railway signal base. China Railway Press. Year 2006.
2. Wang Yongxin Li Yu Bing. Station signal. China Railway Press. Year 2008.
3. AD-6 type electric turnout fault analysis and treatment. Hebei Railway Association in October 1982.