Research on the Electromagnetic Relay Selection and Reliability

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Abstract. The electromagnetic relay is one kind of controlling electric appliances. The electromagnetic relay is also a kind of electromechanical product. It has its superiority over other controlling appliances because of it's highly insulation with open circuit and its absolutely little resistance with closed circuit. The electromagnetic is often used in many kinds of controlling systems and in the industry. It is an important way of improving the system's reliability to improve the electromagnetic relay's reliability. For the problem that designers is difficult to select relay in practical engineering, based on common electromagnetic relays, this paper analyzes its electrical characteristics, and specifically proposes relay selection requires as well as reliable using measures. Practice has proved that, according to the actual service conditions and product technical parameters, in accordance with "value engineering principle" to select the relay, and it can give full play to the relay functionality to meet the product design reliability.

Introduction

The structure and working principle of electromagnetic relay. Relay is an electronic control device, it has a control system (also known as the input circuit) and control system (also known as the output circuit), usually used in automatic control circuit, it is actually a kind of "automatic switch to control a high current by a low current". The structure and working principle of relay is the same with the contactor. Electromagnetic relay consists of electromagnetic system, contact and other components of the system and release the spring, the electrical principle as shown in figure l.

Types of electromagnetic relay are various, but the basic principle is to use the electromagnet control circuit. Relay operated in automatic control, remote has important application. Electromagnetic relay don't need arc extinguish chambers because it is used to control the circuit and the current through the contact is small (often below 5 A).

Electromagnetic relay consists of iron core, coil, Armature ,contact and so on. When a voltage is added across the coil, there'll be a current flow in the coil and Generate electromagnetic effect, the armature will overcome the Elastic Force of Spring and is attracted to the core under the action of electromagnetic force, which makes the Moving contact and the static contact closed(open switches). Electromagnetic relay switch or off circuit depends on switches is closed or open.

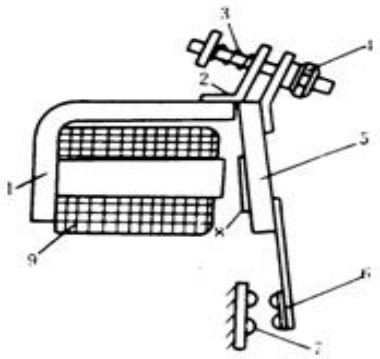


Fig.1 The principle diagram of the electromagnetic relay

1- iron core, 2- Rotating angular, 3- releasable spring, 4- Adjusting nut, 5-- armature, 6- Moving contact, 7- static contact, 8- Nonmagnetic spacer, 9-coil

Environmental conditions of using. Mainly to consider the influence of temperature, atmospheric pressure and mechanical stress. Due to different materials and structures, environmental conditions bore by the mechanical relays are also different, and using relay under conditions over environmental standards for mechanical products may destroy the relay. Generally speaking, selecting relay is according to the mechanical condition of the machine's environment or a high-level conditions.

1) The effect of temperature on the relay

The temperature will have serious impact on the relay performance. First, the temperature rising accelerates aging oxidation of metal parts and insulating material. Second, because the electronic coil increases as the temperature rises, the coil power is reduced, so under high temperature conditions, the relay operating voltage will rise, while at low temperature, release voltage relay will decrease, affecting the normal switching relay; The relationship curve of relay pull / release voltage and ambient temperature as shown in Figure 2. Third, the temperature rising accelerates the release of the organic gas, increasing the contact resistance of the surface film formation, especially under conditions of low level, directly influence the contact reliability. Tests show that for some domestic small power relays, although the usage conditions specified low temperature is -55 ℃, but in fact in this condition relays can not be converted normally recommended choice to allow sufficient margin.

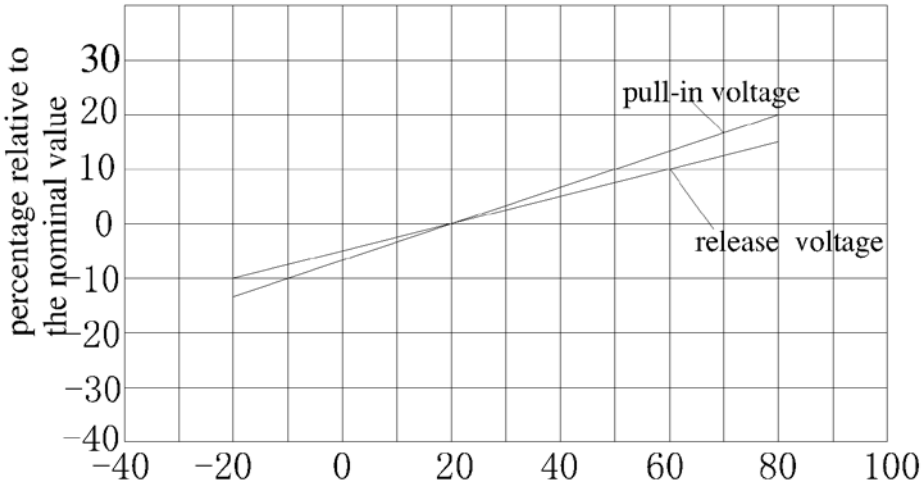


Fig.2 The relationship curve of relay pull-in / release voltage and ambient temperature

2) The effect of low pressure on the relay

Under low pressure conditions, the relays thermal conditions are bad, and the coil temperature rising makes the relay pull-in, release parameters change, affecting the normal operation of the relay. Low pressure can also reduce the insulation resistance of the relay, easy to cause welded contact, affect the reliability of the relay. For harsh environmental conditions, it is best to use an all-enclosed relay.

3) The effect of mechanical stress on the relay

It mainly refers to vibration, stress, shock, impact and other factors. Electromagnetic relay contacts point, reed are cantilever structure with a low natural frequency, while vibration and shock can cause resonance, resulting in pressure drop relay contacts, prone to momentary disconnection or contact jitter, which can cause severe structural damage, and movable armature part malfunction may affect the reliability of the relay. It should be preferred electromagnetic relay with balanced armature mechanism, because of its best shock resistance. In addition, the small size relay’s shock resistance is higher than the bulky relay.

Relay wire enclosed areas (control circuit). It mainly refers to the selection of the operating voltage of the relay coil. The best relay coil is working at rated voltage, rather than the operating voltage. Typically, it is easy to make mistakes to treat the the coil operating voltage as the operating voltage, resulting in voltage can not continue normal operation. For example, when the relay is 27V nominal voltage, the operating voltage is generally 70%, that is 18V, it can not be used as the operating voltage to 18V. Generally, the coil voltage can not be higher than the maximum operating voltage coil and lower than 90% of rated working voltage, otherwise it will endanger the life of the

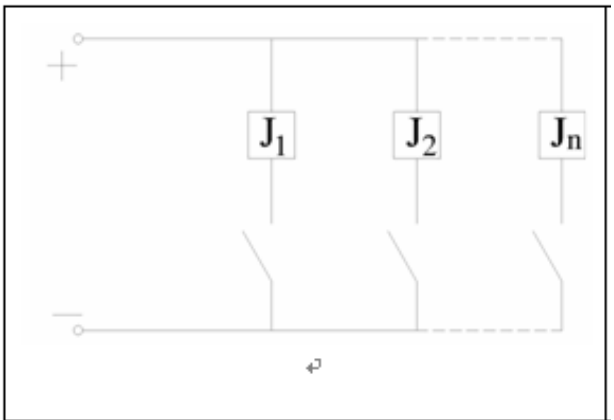
coil and reliability.

Relay contacts aspects (accused circuit). The relay contact is the most important part of relay. Their performance is affected by the following factors, such as contact materials, applied voltage and current values (especially the contact voltage and current waveforms for energizing and de energizing time), the type of load, frequency, atmospheric environment, contact configuration and beating. If any of these factors can not meet the predetermined value, may have occurred such as metal electrical contact between the products, contact welding, wear, problems or contact resistance rapid increase.

The contact reliability of relay is one of the main indicators to measure its working reliability. The reliability of relay work mainly refers whether the contacts can be completed under the switching circuit function. E.g., if the actual load switching is inconsistent with selected provisions of the relay switching loads, reliability will be impossible. Electronic machine equipment must be in accordance with the actual load characteristic required and load switching capability to choose the appropriate relays.

Reliable using of the relay

Multiple relay coil parallel and series to give power. When multiple relay coil in parallel to the power supply, relay with high peak reverse voltage in the instant power failure discharges to the relay that peak reverse voltage is low, making anti-peak voltage and low relay prolonged release, so it is best to control each relay separately and then parallel power supply to eliminate mutual influence. Correct connection mode shown in Figure 3, incorrect connection mode shown in Figure 4. Relay with different coil resistance and power consumption can not be series used to power, otherwise, the series circuit of large power relay coil does not work reliably, and only the same type of relay specification can be used in tandem.



Fi.3 correct connection mode

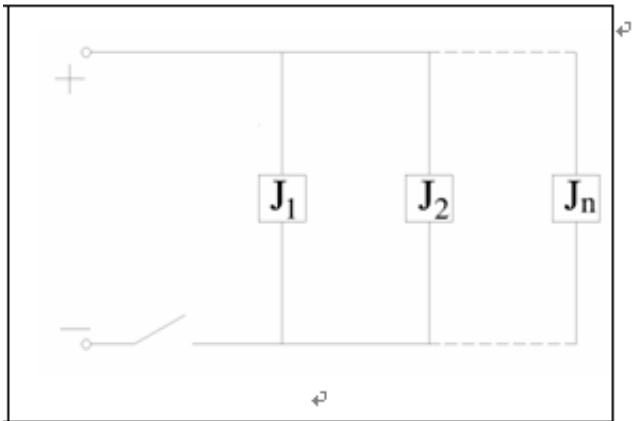


Fig.4 incorrect connection mode

Because there may be a reverse peak voltage higher over 30 times than rated working voltage coil on the power off instantly coil, it is pone to electrical breakdown between the winding turns, damage magnet wire insulation and metal wire, and coil break or short circuit also have great harm for electronic circuit relay connections. Therefore, it needs the relay coil transient suppression, on the one hand to suppress parallel diode approach, on the other hand, we can press a series resistor divider ratio to withstand supply voltage higher than the rated voltage of the relay coil voltage that part. If the product requires small, we can consider a relay with transient suppression, because the relay inside has suppression components, easy to use.

Combination and connection mode of the relay contacts. Contact arrangement and the contact number of groups should be determined according to the actual situation of accused circuit. Contact combination forms: H type move - make contact, D move - break contact and Z turn - in other contact. Large amount of compensation due to contact bounce after a few times and contact seizure when switched on, its load capacity and relatively high contact reliability than the fixed combination break contact changeover contact group break contact, the whole line contact position can be adjusted as much as possible contact with the moving together. Relay contact action of each group is absolutely not the same sex, the actual load is switched on and off contact, always the first to turn on and off after that group, that is still a set of contacts to improve after switching loads it is easy to make contact damage without touching or welding and can not be disconnected.

Contact action is absolutely not the same nature. The actual turning on and off of the contact load, is always turned on first, and after disconnecting of that group, i.e., it continues to be a set of contacts of the load after switching improving, easily to damage the contacts without contacting or welding can not be disconnected. Contact parallel can reduce the failure rate for the "off" mistakes, but is the opposite for the "stick" mistake. Contact series can increase its load voltage improving factor, the number of contacts in series. For example, the actual required relay 70V, 20A, and may preclude the use of 35V, 40A relay series. Contact series can improve the reliability on the "sticky" mistakes, but it is the opposite on the "off" mistakes.

Arc suppression of the relay contacts. When contacts open inductive load circuit, there is going to produce a multiple of the rated voltage back electromotive force at their coil ends, causing arcing, and the contacts welding adhesions. In order to eliminate and mitigate arcing damage to disconnect the inductive load, prolong the life of the contacts and eliminate or reduce electromagnetic interference relay, damage to the sensitive circuitry associated, it should use the arc suppress protection. The so-called arc suppression is to suppress the back electromotive force at an acceptable level, let inductive energy storage convert into heat energy through the freewheeling way, no way to arc energy. To this end, the measures taken by it is to parallel with a resistor or resistor-capacitor circuit or parallel with a diode on the inductive load and try to avoid the relay outputs and inputs to be colinear and communicate. Shown in Figure 5, it is two arc suppression circuit commonly used in DC inductive loads.

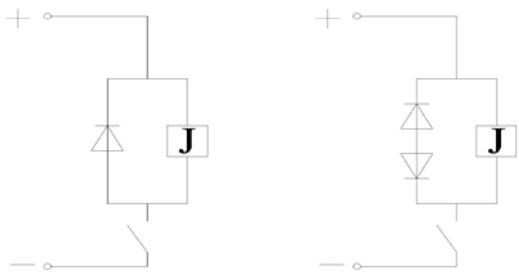


Fig.5 Two arc suppression circuit commonly used in DC inductive loads

Relay installation and welding. Relay installation ways has great influence on its vibration capability, in order to improve its vibration resistance and reliability, when installing, the direction of movement of the relay contacts armature and the direction of pulling-in should try not to be

consistent with the vibration direction. To avoid armature to shake, when installing, it should be fixed in the vicinity of the relay armature, so the relay should install screws to decline gravity of the center possible as close to the base, and take effective damping measures to maintain force balance on both sides of the legs of the relay.

Conclusions

Electromagnetic relay still has certain development space in new period due to low cost, mature technology. the main development direction is miniaturization, high power, high reliability and high ability of the environment, on the production side, as far as possible to reduce costs, increase productivity.This article analyzes the selection and reliability using of electromagnetic relays usually used in electronic machine equipment which is beneficial for designers to select and use proper relay. Meanwhile, in use process, it should pay attention to strengthen technical checking and maintenance to extend the life of the relay device, and effectively improve system reliability.

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