USING AUXILIARY CONTACT FOR THE DISPOSITION OF DROP-OUT FUSE FAULTS ---A NEW RESCUE MEASURES TO SHORTEN THE RESTORATION TIME AND INCREASE THE POWER SUPPLY RELIABILITY IN FAULT RESCUE

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ABSTRACT

Faults of the upper stationary contact on the commonly used drop-out fuse in distribution network often happen. The traditional method to repair the fault is to change the fault drop-out fuse by using hot line works, but it also has some problems in aspects of system reliability, schedule and safety of hot line works. After analyzing the main causes of the fuse faults on the PRW type drop-out fuse widely used in Shanghai China (shown in Fig. 1), a new rescue measures to dispose such faults are researched. The new measures can increase the power supply reliability and the safety of live working.

INTRODUCTION

Due to the improper installation or operation, product quality, environmental factor and other reasons, the drop-out fuse faults induced by high temperature on the electrical contact often happen.

In this paper a new rescue measures to dispose faults of the upper stationary contact of the drop-out fuse by using an auxiliary contact is presented. Through the application of the auxiliary contact, we can not only shorten the outage duration and restore power supply immediately caused by fuse faults thus improve the power supply reliability, but also can change such un-planned hot line rescue works into planned works to increase the safety of hot line works.

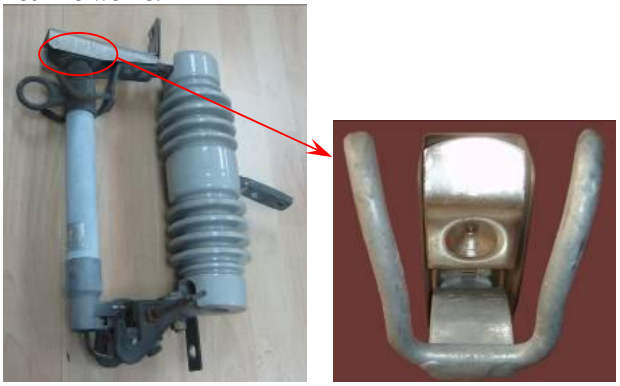

Fig. 1: PRW type drop-out fuse and its upper stationary contact

ANALYSIS OF THE CAUSES OF THE DROP-OUT FUSE FAULTS

After analyzing the main causes of the drop-out fuse faults, we can find that most of such troubles are caused by worst contact of the contactor which induced high temperature on the electrical contact (shown in Fig. 2), increasing the contact resistance and then the rate of temperature rise and finally causes burning, welding, arcing of the contact and progressing to drop out. Therefore, the main causes of drop-out fuse faults are from the high temperature of worst contact of the electrical contact.

Fig. 2: Burned-out of the upper stationary contact on PRW type drop-out fuse

PRINCIPLE AND STRUCTURE OF THE AUXILIARY CONTACT

When the upper stationary contact of the drop-out fuse is burned out, a special designed auxiliary contact is installed on the arc-extinguishing tube to form an auxiliary circuit. Such auxiliary contact can not only maintain the power supply until a new fuse set is substituted but also can reduce the temperature of the fault upper stationary contact.

When the auxiliary contact is installed on the drop-out fuse, there established two electric circuits, the fundamental circuit and the auxiliary circuit, on the fuse installation (refer to Fig. 3). The fundamental circuit is made up of the upper movable contact of arc-

extinguishing tube and the upper stationary contact of fuse, and the auxiliary circuit consists of the auxiliary contact and the upper stationary contact. Thus the auxiliary circuit and the fundamental circuit forming a shunt circuit, so the current on the fundamental circuit will be reduced and the temperature rise will be lowered.

Auxiliary contact is made up of three parts: the base, the left contact plate and the right plate. We can assemble the base of auxiliary contact and the upper contact of arc-extinguishing tube by using a bolt and the auxiliary contact will be located in the same central axis of the fuse tube. Two contact plates are tilted a certain angle in the opposite direction, so we can easily put the arc-extinguishing tube on the drop-out fuse using the hard pole. Because bulges of the contact plates of the auxiliary contact are separated from the burning part of the upper support of the drop-out fuse, the auxiliary contact can keep a good contact resistance and prevent the situation from deterioration in the event of maintaining the original effectiveness. In the meantime, the two sides contact plates can clamp the upper support of the fuse to instead the original contact that had been burned to keep the firm contact of the fuse tube with the upper support. So the auxiliary contact plays a role not only in shunting the current flow but also in firming circuit.

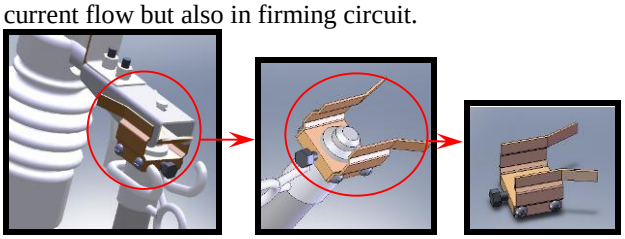

Fig. 3: Structure of the auxiliary contact for the PRW type drop-out fuse

ANALYTICAL TESTS

When the upper stationary contact of drop-out fuse cannot be used due to burn out, we install the auxiliary contact in the fuse to form an auxiliary circuit. Then the auxiliary circuit will be obtained as the only electric circuit, Table 1 shown the experimental value after installing the auxiliary contact (take the fuse that rated current is 100A for example).

Table 1: Test data when the upper contact of fuse cannot be used during burning out

Circuit Condition	Theoretical Contact Area (mm^2)	Loop Resistance ($\mu\Omega$)	Temperature Rise (K)
Original Circuit (Fundamental Circuit)	62	1204	24
Current Circuit (Auxiliary Circuit)	540	1986	32

The Table 1 illustrates the auxiliary circuit which is composed of the auxiliary contact and the upper stationary contact becomes the current circuit. The original circuit is made of copper and the current circuit is made of copper and stainless steel, so the resistance of current circuit increases. However, since the rate of heat dissipation increases because of decreasing of unit current density due to the contact area of current circuit is larger than the original circuit, the measured value of temperature rise meet the requirements of the national standard (GB/T 15166.4-94) [1]. So it means that the auxiliary circuit can well play a role in emergency response when the fundamental circuit cannot be used because of burning out.

If the auxiliary contact is installed just during the beginning of the red-hot phenomenon appears on the upper stationary contact then the fundamental circuit and the auxiliary circuit will form a shunt circuit. Table 2 shows the experimental value after installing the auxiliary contact (take the fuse that rated current is 100A for example).

Table 2: Test data when the upper contact can be used

Circuit Condition	Theoretical Contact Area (mm^2)	Loop Resistance ($\mu\Omega$)	Temperature Rise (K)
Original Circuit (Fundamental Circuit)	62	1204	24
Current Circuit (Fundamental Circuit + Auxiliary Circuit)	540+62	750	21

Table 2 illustrates the auxiliary circuit and the fundamental circuit will form a shunt circuit after the auxiliary contact is installed in the event that original circuit of the fuse can be used, so the current on the fundamental circuit will be reduced, the temperature rise of fundamental circuit will be lowered, the red-hot phenomenon of the upper stationary contact will be relieved and the total loop resistance will be decreased. In summary, the auxiliary circuit can well play a role in pre-emergency when the fundamental circuit can be used.

Figure 4 shows the case when the auxiliary contact is installed and operating in shunt with the original stationary contact thus the current on drop-out fuse is 200% of the rated current. At the moment the fuse-element is burned out and the leaf spring drops out, so the fuse can still protect the device and isolate faults (take the fuse that rated current is 100A for example).

Fig. 4: The case of the auxiliary contact has been installed and operates in parallel with the normal contact the current on drop-out fuse is then be 200% of the rated current

PRACTICAL APPLICATION

Since the auxiliary emergency contact of drop-out fuse was researched and developed successfully in 2009 in Songjiang Power Supply Company, Shanghai Municipal Electric Power, we have already applied the new rescue measures to dispose drop-out fuse faults about one hundred times in the 18 months. The average time for resume the power supply for each such fault is only 4 to 5 minutes. After running through a period of time, the auxiliary contact has no any heat generation or other abnormal phenomena and operates in good condition.

When faults of the upper stationary contact on the PRW type drop-out fuse happen, we can restore power supply in the shortest time by using auxiliary contact, so the reliability of power supply will be improved. In the mean time, it can also dispose fuse faults temporarily and maintain operation in period of time until the restoration of the fault fuse to a new one is carried on in the planned maintenance schedule. Especially, it can greatly decrease hot line rescue works at night, so it can not only reduce the labor intensity, but also greatly increase the safety of live working. During this time, the fuse can still protect the device and isolate faults by burning out the fuse-element except that the arc-extinguishing tube can not drop out.

CONCLUSIONS

The application of auxiliary contact is a new rescue measures to dispose the PRW type drop-out fuse faults. It can shorten the outage duration, improve the power supply reliability, reduce the labor intensity and increase the safety of live working. Moreover, the device is easy in construction and manufacturing cost is very low. So the new technique will have remarkable social benefit and economic benefit by the comprehensive application of drop-out fuse in distribution network.

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