

THE DEVELOPMENT OF ELECTRIC FUSES IN CHINA

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INTRODUCTION

Electric fuses are used as a typical protective device which are connected in series in the circuits. When the carrying current exceeds the rated value due to overload or short-circuit, the fuse-link will break the circuit to achieve protection. Although the fuse is blown, damage of other electrical equipments in the circuit due to overheating and strong dynamic force can be avoided. So the action of fuselink just like a local "weakness link" for fault protection.

In comparison with mechanical circuit breakers, the fuse is without moving mechanism and contact parts in construction. Thus the fuse may be belonged to the category of "static apparatus" or "contactless apparatus". It is simple construction and quick action. There are two essential parts or "organs" in automatic circuit breakers. One is for sensing and responding the fault current and the other is executive "organ" for breaking the fault current. The former function is accomplished by relays or released devices, the later function by contacts and arcing quenching elements. As to fuse, the two "organs" are combined in one body--fuselink. This may be an important reason to make the fuse simplified in construction and quick in action.

The fuselinks are suitable both for overload and short-circuit protection. It is rather difficult to chose the proper material for the fuselink to satisfy both requirements. In the early time low melting point metal or alloy was used to meet the requirement of overload protection. As the fault current was not too big to be safely cleared. Following the growth of fault current in power sys-

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tem, it is necessary to use high melting point metal and adopt narrow-neck form for the fuselink to obtain the current-limiting effect. Considering the requirement of overload protection, low melting point metal to yield a "metallurgical effect". The design of modern L.V. fuses is still following the "weak-chain" idea, i.e. applying variable section of the fuse neck for the high melting point fuse so that quick breaking is effected. In the case of quick-acting fuses for the protection of semiconductor devices, higher ratio of section variation for the fuselink is adopted.

The main advantages of modern cartridge fuses are high rupturing capacity, stable time/current characteristic and low cost. Of course, there are several disadvantages, namely the monotony of protective characteristic and poor discrimination. The fuses in the three poles can not open in all, in the case of single-phase short-circuiting, resulting single-phase operation of induction motor. However, these shortcomings of fuses do not exist in mechanical circuit breakers. Thus it is a problem to be solved to overcome these shortcomings in the development of modern fuses.

From the application point of view, it is necessary to develop 'a' type fuses for backup protection and 'g' type fuses for motor protection, so that better protection is assured and it would be more economical. At the same time, the development of combined switchgears, such as the incorporation of fuses with mechanical circuit breakers to form high current-limiting gears or the incorporation of fuses with knife switches to form compact switchgears is also needed. In such combined switchgears, interlock devices are provided to prevent single-phase running of induction motors.

From the design point of view, it is necessary to improve the construction of fuses. For instance, to reduce temperature of the fuse-body, to reduce the heat loss of the fuselink and its accessories, to lower I^2t and to prevent deterioration of the fuselink to ensure stable time/current characteristics should be considered. It is also necessary to improve the rupturing capacity, discrimination ability and reliability. In recent years, the development of self-recovery fuses basing on a new design idea has been quite successful which have high rupturing capacity and can recover their property after clearing the faults without replacing any part.

FUSE PRODUCTION IN CHINA

Fuses are widely used in L.V. power circuits in China. And many manufacturers are producing various types of fuses to meet the requirements of different users. Some typical type L.V. fuses are introduced as follows:

TABLE 1

No	Type	Rating Voltage V	Rating current A	Rating breaking capacity KA
1	RTO	AC 380	100,200,400,600,1000	50
		DC 440		25
2	RT10	AC 440	20,30,60,100	50
3	RT11	AC 440	100,200,300,400	50
4	RM7	AC 380	15,60,100,200,400,600	2-20
		DC 440		
5	RM10	AC 500	15,60,100,200,350,600	1.2-20
		DC 440	1000	
6	RLS	AC 500	15,20,25,30,40,50	80
		AC 250	50,100,200,350,500	50
7	RSO	AC 500	50,100,200,350,500	40
		AC 750	350	30
8	RS3	AC 500	50,100,200,300	25-50
		AC 750	200,300	50
9	RZ1-100	AC 380	100	100
10	HR3	AC 500	100,200,400,600	50

Note: No 1-3 powder filled cartridge fuse
 No 4-5 cartridge fuse
 No 6 screw type fuse
 No 7-8 quick-acting fuse or fuse for protecting semiconductor
 No 9 self-mending fuse or self-recovery fuse
 No 10 fuse switch

FUTURE WORK AND PROSPECT

The design of new type fuses and improvement of fuse characteristics should be based on a large amount of research work. The following problems have been considered in our research work.

1. The application of fuses There is close relationship between fuse production and application. The fuse must satisfy the protection requirements of networks or other objects, on the other hand,

the networks or other protective systems will push the fuse research to a new level. The research work includes the coordination of characteristics between protective devices and fuses, and combination of fuse with mcbs or contactors to form hybrid apparatus etc.

2. Reduce of silver consumption in fuses How to save silver which has limited resources should be studied in fuse manufacturing. As mentioned above L.V. fuses of type RT10, RT11, RSO and RS3 all use silver for fusebody. We are applying aluminum instead of silver in cartridge fuselink. The surface galvanized copper and copper-silver composed plate are also considered.

3. Selection of quartz sand for filling powder The purity of quartz, as well as its shape and size influence the breaking capacity and time/current characteristics of fuselink. China is rich in natural quartz sand resources. We have found several kinds of quartz which are as good as import products.

4. Renew of design and construction The improvements of fuse performances include the increase of voltage rating. Our manufacturers have produced fuselinks suitable for 660 V and 1140 V used in mine systems. The aluminum cartridge fuses are also produced. The quick-acting fuses on higher voltage and larger scale rating current for protection of semiconductor and protection of rotating machines are considered. The new type of fuse-switch and the domestic enclosed fuses in miniature are ready to produce.

5. Research work on basic theory and design method The heating and other prearcing phenomena, arcing period phenomena, aging and deterioration phenomena, mathematical and physical modelling and optimum CAD are interesting to study.

To conclude, I should emphasize that the fuses have keep unchallenged for over 100 years. Recent development shows that they will still play an important part in protective devices. Although other current limiting devices are said to approach the performance of cartridge fuses, recent developments show that fuses are expected to keep them to the fore. There should be a good prospect in the development of better fuses.

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