NEW CONCEPT IN DESIGN OF DROP-OUT TYPE FUSE WITH REPLACEABLE SAND-FILLED FUSE-ELEMENT AND VACUUM SWITCH COMBINATION

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ABSTRACT The configuration, basic principle, operation processes and advantages of new concept in design of drop-out type fuse with replaceable sand-filled fuse-element are described in this paper. The main process of solidfying technology for sand-filled fuse-element is recommended. To improve the performance and functions of this new designed fuse, a vacuum switch is combined to form "Drop-out type fuse and vacuum switch combination". Finally, the test results are given in the paper

1. TNTRODUCTION

The drop-out type fuse with a replaceable sand-filled fuse-element is a new conceptional design. The fuse-element in the common construction of this type is not replaceable, so that the maintenance is more expensive than that of the drop-out type fuse in expulsion construction. Therefore, no producer is willing to manufacture the drop-out fuse with sand-filled fuse-element.

In recent years the capacity of power system is rapidly increased. The maximum interrupting capacity of drop-out type fuse in expulsion construction is of 12. 5KA only that limits its scope of applications. The interrupting capacity of drop-out type fuse with replaceable sand-filled fuse-element is of 40KA more which can be used to meet the developing requirement in power system.

In addition, this new type of drop-out type fuse with replaceable sand-filled fuse-element possesses the following advantages:

(1)The fuse-element is made of pure copper instead of expensive pure silver, so that the product cost can be reduced;

(2)The sand-filled fuse-element is solidified by such material as water-glass(Na_2SiO_3)to make the sand-powder and fuse-element into a solid-state that is easy to be replaced.

(3)The sand-filled fuse-element after solidification is became in a sealed state, which prevents from the oxidation of copper element. Thus, it stabilizes working characteristics and enhances endurance of the fuse-element.

To improve the performance and functions of this new type fuse with replaceable sand-filled fuse-element, a vacuum switch is installed to break and close the load current, thus becoming what is called a "Drop-out type fuse with replaceable sand-filled fuse-element and vacuum switch combination."

2. CONFIGURATION DROP-OUT TYPE FUSE WITH SOLIDIFIED REPLACEABLE SAND-FILLED FUSE-ELEMENT.

A solidfied sand-filled fuse-element is shown in figure 1 in which there is a seven-star porcelain support-core 1 wound with pure copper-element 2. Both ends of the copper-element are welded to two metal caps 3 on the seven-star porcelain support-core. A striker 5 is installed on one end of seven-star porcelain support-core. As soon as the drop-out type fuse is operated, the pin of striker is pushed out, thus pushing the release-rod of drop-out type fuse and making the fuse drop-out.

Figure 2 shows the configuration of solidified sand-filled fuse element installed in a fuse-cartridge forming a drop-out type fuse with a solidified replaceable sand-filled fuse-element. The following are the steps for installation:

Step 1—Push the solidified sand-filled fuse-element into the fuse-cartridge with a special tool;

Step 2—Bend the conduct-plates 11 and 12 fitted on both metal-caps;

Step 3—Screw on the disk-frames 1 and 8 to both gates of fuse carridge.

3. SOLIDIFYING TECHNOLOGY FOR SAND-FILLED FUSE-ELEMENT

The solidifying technology is a key technique to the drop-out type fuse with replaceable sand-filled fuse-

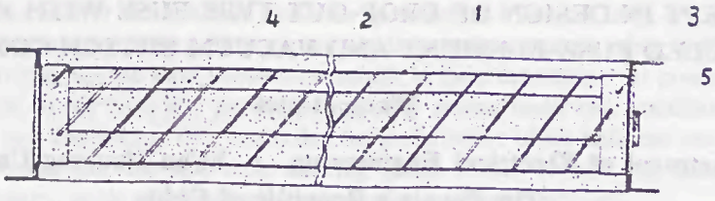


Figure 1. Solidified sand-filled fuse-element
1—seven-star porcelain support-core 2—pure copper-element
3—metal cap 4—silicon sand 5—striker

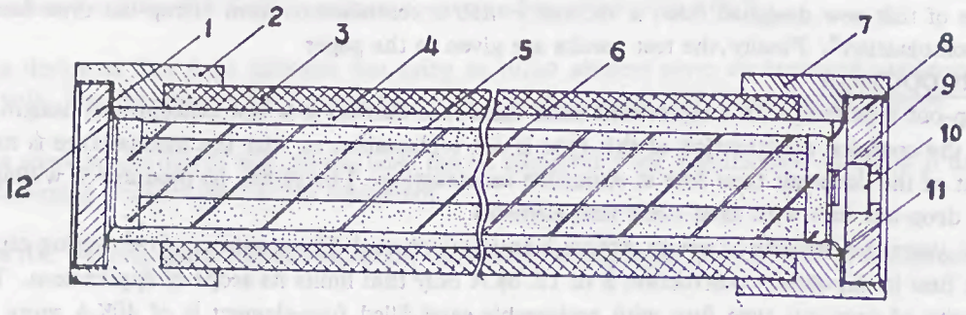


Figure 2. The configuration of drop-out type fuse
1—disk-frame 2—metal cap 3—fuse-cartridge 4—siclicon-sand
5—seven-star porcelain support-core 6—pure copper element 7—metal cap
8—disk-frame 9—striker 10—sealing copper film 11、12—conduct-plate

element. This will change the conventioal manufacturing process for current-limiting fuses by filling sand into the fuse-element cartridge. The main manufacturing process for the solidified sand-filled fuse-elememt is described as follows:

(1)Place seven-star porcelain support-core with winding fuse-element into a steel model-case as shown in figure3.

(2)Pour silicon-sand through the hole of steel-case into the steel body while vibrate on a vibrator till reaching to the required density;

(3)Inject a specified density of water-glass liquid through the hole of steel-case into the steel body with a vacuum pumping method;

(4)Dry and solidify the sand-filled fuse-element in an oven for 24 hours at 120℃,and then cool the steel-case to room temperature;

(5)Remove "the solidified replaceable sand-filled fuse-element"from the steel-case as shown in figure 1.

4. BASIC PRINCIPLE AND OPERATION OF THE DROP-OUT FUSE WITH REPLACEABLE SAND-FILLED FUSE-ELEMENT AND VACUUM SWITCH COMBINATION

A drop-out type fuse with replaceable sand-filled fuse-element and vacuum switch combination is shown in figure 4. Figure4(a) shows the fuse combination is situated at normal working condition. The load current led from the upper terminal 3 through the mechanism box 2 and the contact 11 flows to the fuse 8. Due to the two terminals of vacuum interrupter 1 being in short-circuit condition, only very small current flows by the vacuum interrupter. If the short-circuit or large overload current happens in a power system the fuse will be operated. At the same time ,the striker of fuse acts to push the striker-pin and operates to release the release rod 10. Thus it makes the fuse drop-out in counter clockwise and downward direction. Finally,the fuse is in a drop-out state as shown in figure 4(b).

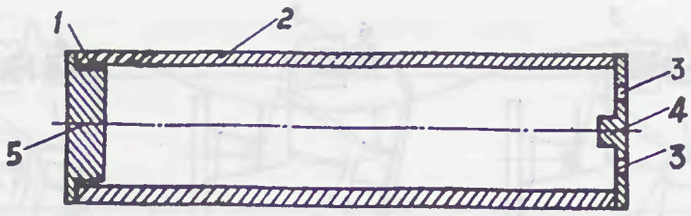


Figure 3. Configuration of steel model-case
1—gap for fixing fuse-element support-core 2—steel case body
3—holes for injection water-glass liquid and sand
4—head for fixing fuse-element 5—end plate

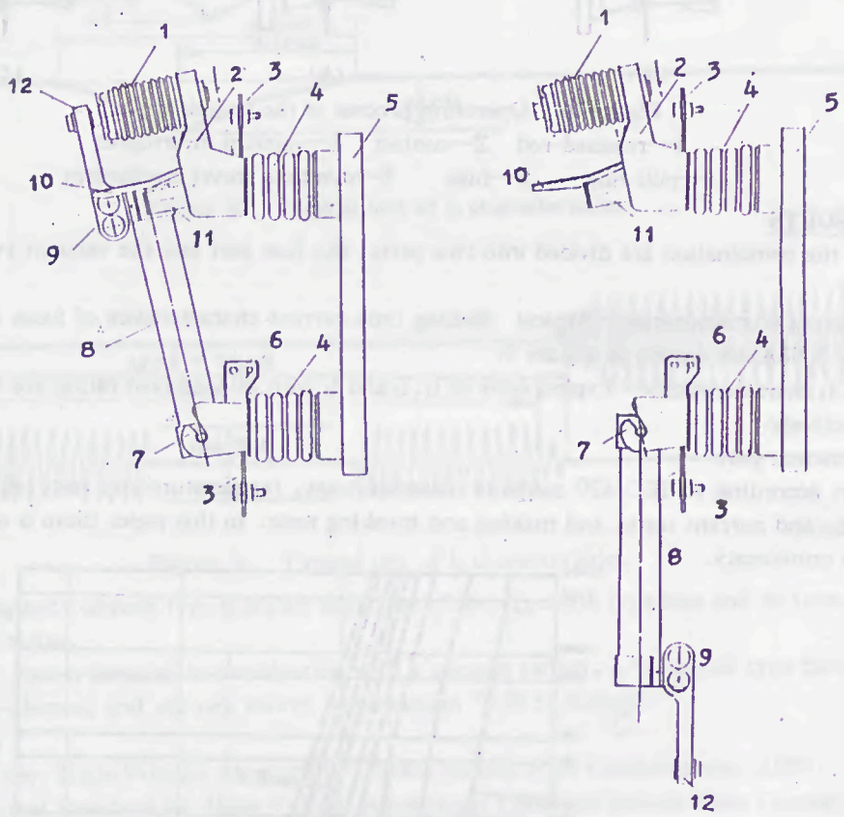


Figure 4. Drop-out type fuse with replaceable sand-filled fuse-element and vacuum switch combination

In a normal working condition, it is necessary to disconnect the load current, then the release-rod 1 can be pushed off, as shown in figure 5(a). At that time, it makes the contact 2 separated from the fuse 5, as shown in figure 5(b). The load current alters to flow the vacuum interrupter 3. The overtake travel mechanism 6 of switch is unceasingly moving to separate the contact of vacuum interrupter 3 and thereby the load current is interrupted, as shown in figure 5(c).

When the combination is under opening condition, it is necessary to close it in order to supply the load current. This can be done by means of an insulated hook to be inserted in the pull-ring 4, and then push upward to move the fuse into a closed position as shown in figure 5 (a). The whole process is that firstly the contact of vacuum interrupter closes, then the fuse terminal makes contact with the contact 2 and finally the released-rod 1 locks the fuse at a closed-position.

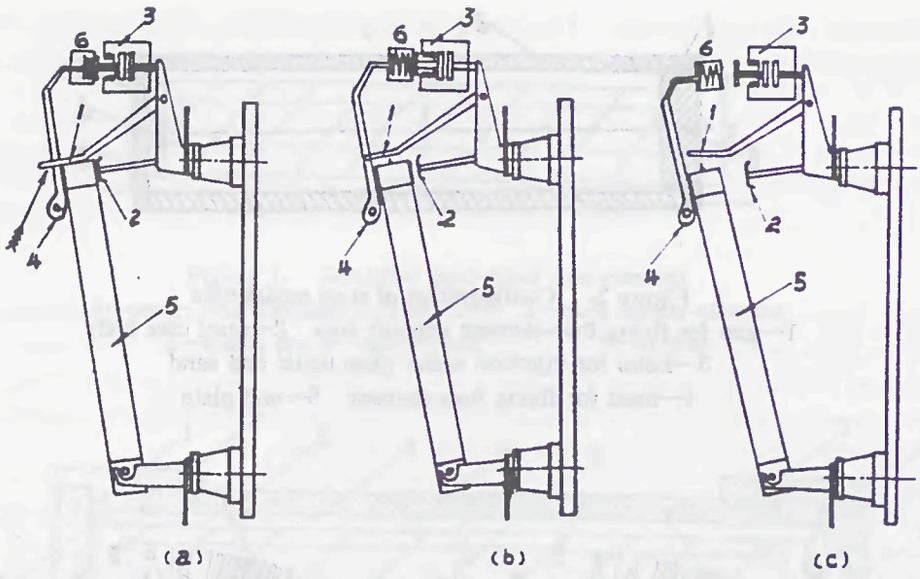


Figure 5. Operating process of the combination
1—released-rod 2—contact 3—vacuum interrupter
4—pull-ring 5—fuse 6—overtake travel mechanism

5. TEST RESULTS

The tests for the combination are divided into two parts: the fuse part and the vacuum switch part.

(1) Fuse part

(A) Time-current characteristics—Typical melting time current characteristics of fuses at different current rating from 6.3-63A are shown in Figure 6.

(B) I_1、I_2 and I_3 charactenristics—Typical tests of I_1、I_2 and I_3 with 50A current rating are shown in Figure 7. 8 and 9 respectively.

(2) Vacuum switch part

This part according to IEC-420 contents dielectric tests, temperature-rise tests、short-time withstand and peak withstand current tests, and making and breaking tests. In this paper there is not given above test results due to unnecesaty.

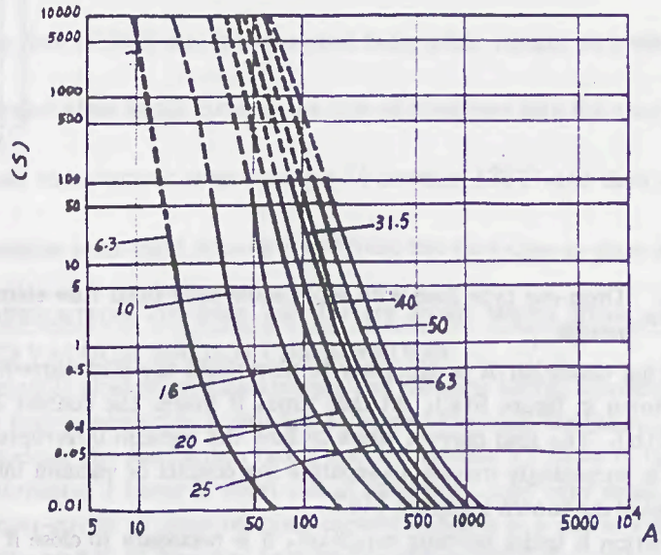
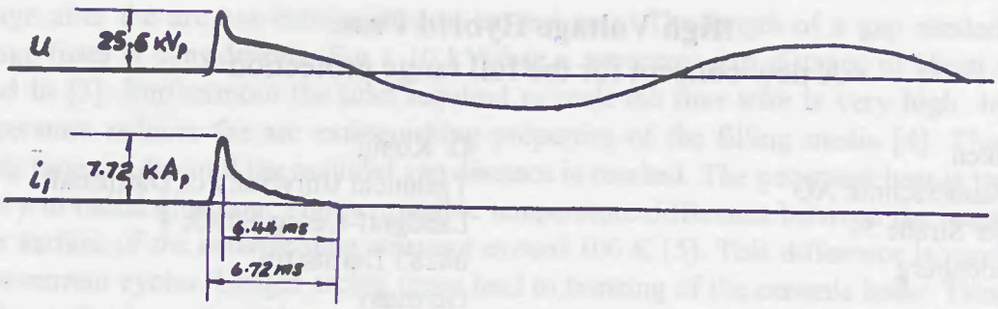


Figure 6. Time-current characterisitics of drop-out type fuse with sand-filled fuse-element.

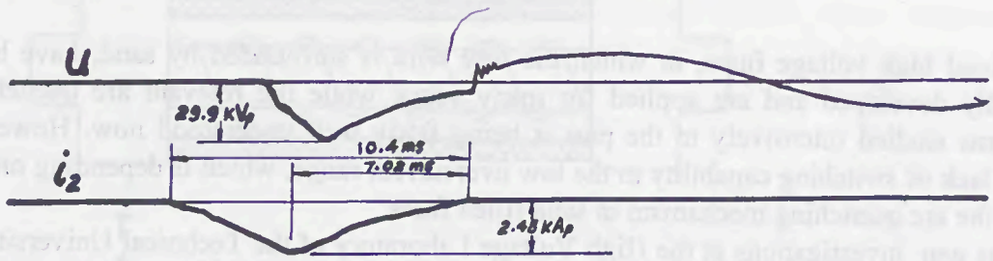
6. CONCLUSION

The drop-out type fuse with replaceable sand-filled fuse-element is a new concept fuse.

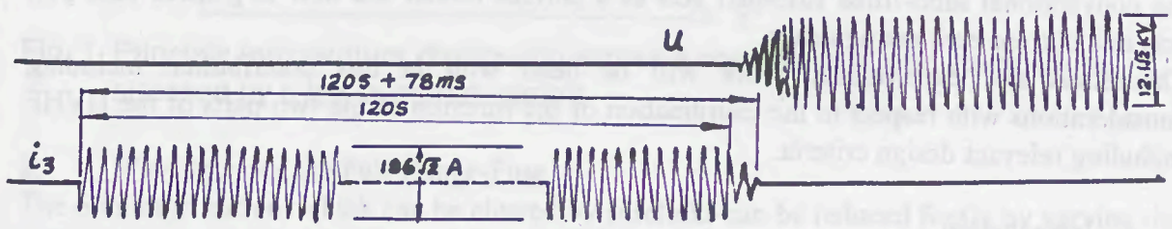
The sand-filled fuse-element in the fuse is solidified with water-glass to form a solid state that is easy to be replaced.



Figusr 7. Typical test of I_1 characteristics.



Figusr 8. Typical test of I_2 characteristics.



Figusr 9. Typical test of I_3 characteristics.

The interrupting capacity of such type is higher than that of the expulsion type fuse and its time-current characteristics are very stable.

This drop-out type fuse is installed in combination with a vacuum switch, a "drop-out type fuse with replaceable sand-filled fuse-element and vacuum switch combonation "will be formed.

7. REEERENCES

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