OPENING LECTURE OF THE DAY

Varistor fuse or fuse with integrated varistor

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Abstract

Metal-oxide varistors, or MOV's are well known solution for protection of electrical installations against transient over-voltage impulses, occurred as a consequence of lightning and switching processes. By experience we know, that the MOV's has to be protected by an overcurrent protection device to cut the abnormal current, occurred by improper behaviour of MOV caused by temporary over-voltage. One of such protection devices are special fuses, known as Surge Rated Fuses.

This contribution shows very new construction of integrated product, where both, MOV and a Fuse are incorporated in one product. Advantage of this idea is mainly in strongly reduced dimension.

Keywords: MOV, varistor, fuse, protection, integration.

Introduction

MOV's are very well known solution for protection against transient over-voltage impulses, caused by the lightning and other unexpected events in electrical network and installations. But on the other hand it is also known that the problems with overheating of the MOV body may occur. There are at least two reasons for this overheating. First reason could be a damaged varistor, which could represent conductive path with certain resistance already at rated voltage. The consequence is a current through the MOV varistor, which is over-heated and could lead to heavier damages. Second reason is an occurrence of frequency overvoltage of longer duration which causes the MOV to react and thus the MOV opens the path for short-circuit current. In both cases, the actual current through the MOV can be from the value less than 1A up to the value of several kA. In such cases fatal consequences can appear, namely, the MOV can explode.

Therefore, these cases have to be prevented in order to prevent the damage on installation where MOV is installed.

Protection principles already available

In this article only two or three existing typical solutions are taken into account. The first is very simple with soldered wire under spring force. In case of over-heating of the MOV, the solder is melted and spring opens the contact of the wire and thus the MOV is not any more in connection. The problem of this solution is, that the contact has no breaking capacity and is not capable to open correctly the short-circuit currents. An example of this solution is given on the market bay one of the MOV producers and it is presented on next picture.

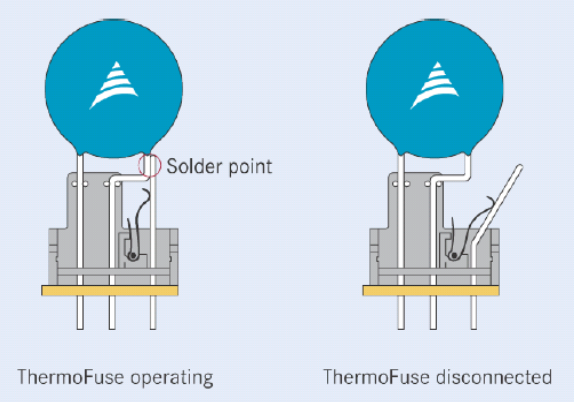


Fig. 1: Source: http://www.epcos.com/web/generator/Web/Sections/Components/Page,locale=en,r=263282,a=490608.html?_requestid=6566275

Next solution is a special fuse, connected in series with MOV. Such fuse, called SFR Surge Rated Fuse has to pass the transient over-voltage impulse of certain value, e.g. 10kA 8/20, but should open the circuit in case of over-current before the MOV would explode. A disadvantage of this solution is how to make SRF fuse for lower over-currents. Next disadvantage is also in the fact that additional wiring is needed to connect the MOV unit and SRF unit.

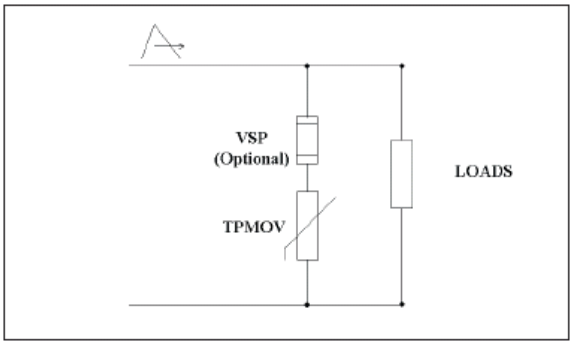


Fig. 2: Source: http://ep-us.mersen.com/catalog/surge-protection/mov-protection-fuses/surge-protective-devices-vsp-mov-fuses/

The next solutions are more advanced and compact and they are explained in technical papers of the producers. Some of them are using fuses and some of them are using some other means how to detect and to break any kind of a longer duration current through the varistor, before the MOV gets too hot and explode.

The Problem

To my opinion there are at least two problems which are connected with each other:

- How to extinguish an arc in the thermal switch after the solder has been melted?
  - The right solution is a fuse, because the fuse is the best way how to clear an arc followed by short-circuit current.
- But the fuse (SRF fuse) has difficulties to cover lower currents e.g. under the value of 1A, knowing the fact that also these current could damage the MOV.

So, basically, we should try to find a solution in a fuse, which will be able to react not only to the very low current, but also to react on the temperature, exposed from the MOV at the low current. Of course, such fuse has also cover high short-circuit currents.

Next problem is also how to make a product which is compact and the number of parts is as low as possible.

The solution

Solution is based on cylindrical shape of MOV with silver electrodes on the outside and inside wall of cylinder.

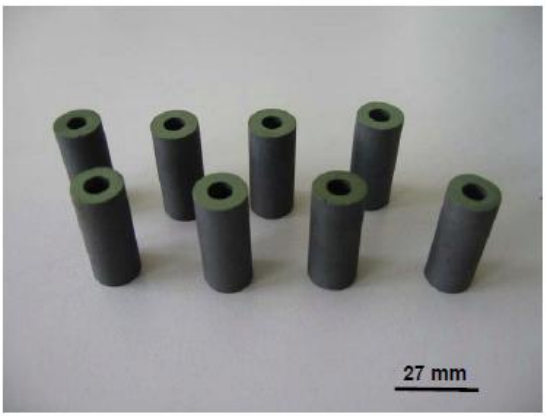


Fig. 3

MOV cylinders as a basis for next step. Below there is cylindrical MOV equipped with silver layers inside and outside of the cylinder. These silver layers are electrodes.

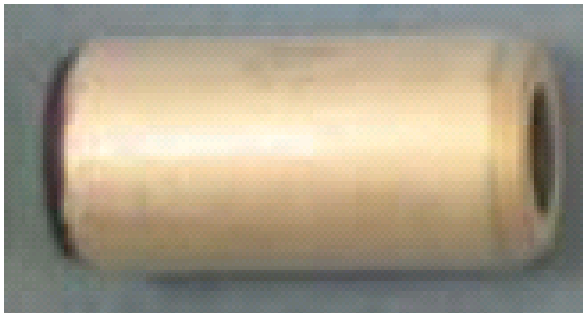


Fig. 4a

Fig. 4b

Next step of the solution is how to integrate cylindrical MOV and cylindrical fuse in one product. The picture below shows the innovative construction where the cylindrically shaped MOV is placed inside of the cylindrically shaped ceramic fuse body. One electrode of the MOV is connected with the contact cap of the fuse and the other, inner electrode is connected with the melting element.

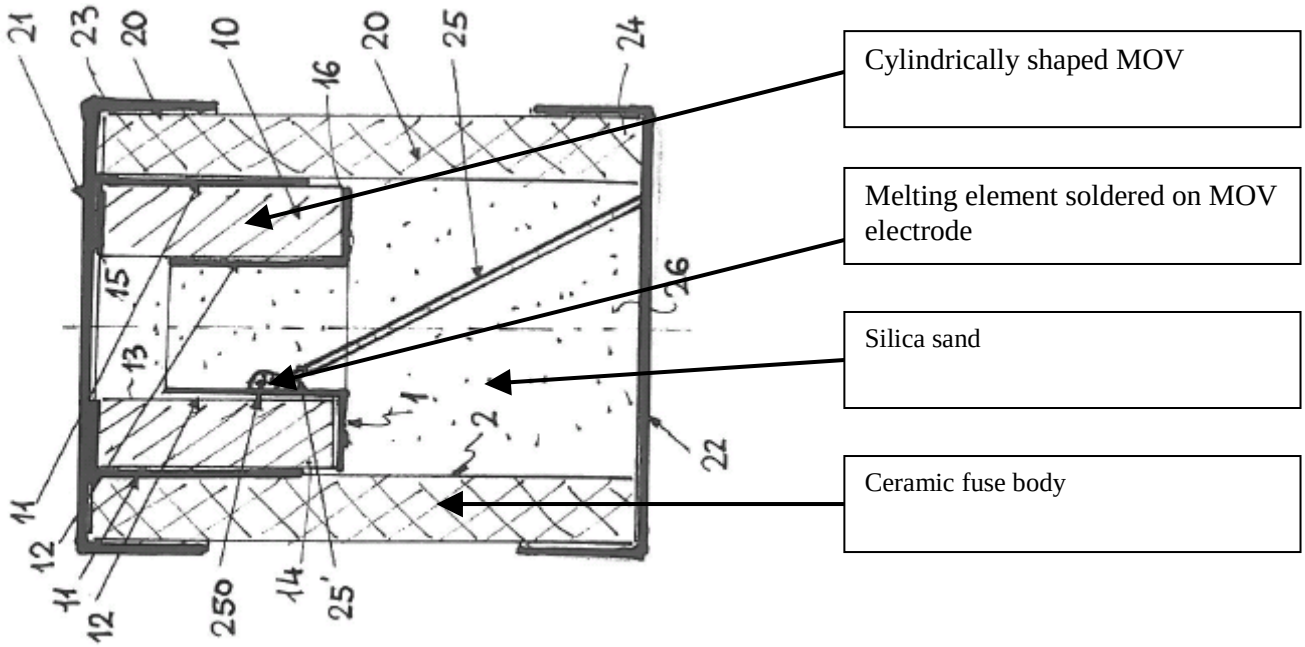


Fig. 5

The construction of melting element is meant to fulfil several functions. First of all has to pass the transient current impulse of certain value of kA, shape 8/20, very similar as SRF fuse.

Secondly, it has to cut the short-circuit current, when the power frequency over-voltage is so high that the MOV resistance is closed to zero for a longer period of time.

And the third function, probably most important, is how to cut the currents of lower values in order to cut the current before the MOV explodes. On Fig 6a we can see the connection part of melting element, where the solder layer has two roles. Firstly, it connects the melting element to the inner electrode of the MOV, and secondly to provide the well known M-effect on the first constriction nearby.

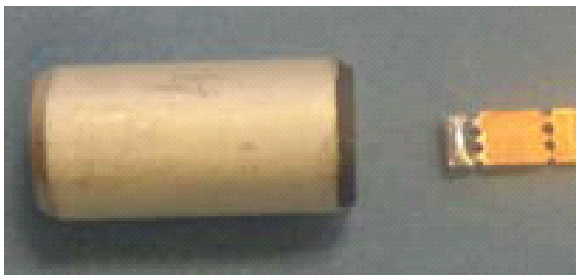
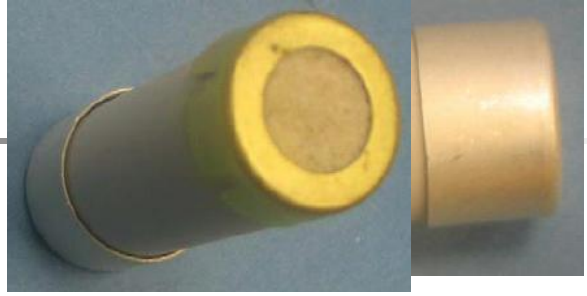


Fig 6a

Fig 6b

Fig6a shows the melting element just before it has been welded (soldered) inside of the MOV and fig6b shows the placement of the MOV with melting element inside of the body of cylindrical fuse size CH22x58.



Conclusion

This concept, called Varistor Fuse or Fuse with Integrated Varistor could be very convenient solution, especially in PV installation because of higher DC voltages and high exposure to the lightning.

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