NEW DESIGN ASPECTS OF SEMICONDUCTOR FUSES

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Abstract

Some main new design aspects of recently developed Polish semiconductor fuses has been described. Particular attention has been drawn on: fuse-link barrel made now from metal (aluminium), insulating bushings of fuse terminals and gas-evolving elements to improve the arc-quenching ability of small overcurrents. Also the better manufacturing reproducibility of new fuses is underlined. Examples of new fuses, corresponding oscillograms are attached.

1. General informations

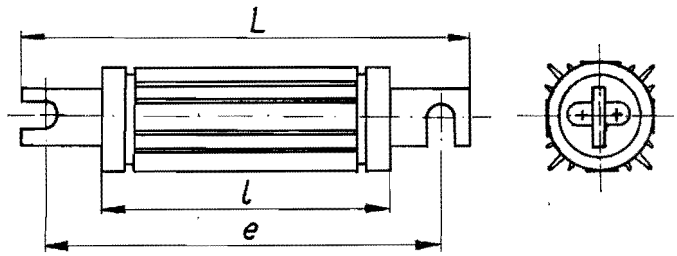
The range of recently developed by Institute of High Voltages and Electrical Apparatus Intitute of Gdańsk Technical University new semiconductor fuses type Btd is given in the Table 1. This range is expected to be extended in the future up to 6.3 kV rated voltage and 1000 A rated current. The rated breaking capacity of those fuses is 50 ÷ 100 kA(RMS), depending upon the rated voltage and rated current. The minimum breaking current corresponds to the prearcing time not less than 30 s.

Table 1 SIZES OF Btd FUSES

U (V)	Dimensions [mm]		
	e	l	L
250	80	50	110
400	80	50	110
630	110	80	140
1000	140	110	170
1600	170	140	200
Barrel dimensions [mm]	∅20	∅28	∅36

RATED CURRENT in A

2	10	16	20	32	40	50	80	100	125	200	250	315	400	500	630
W-0		W-I			W-II			W-III			W-IV		W-V		
∅20		∅28			∅36			∅48			∅60		∅76		



Some of design aspects of Btd fuses are new in comparison to the existing practice and to the inventions known from the patent documents. These aspects makes possible to improve the behaviour of new fuses during manufacturing and in service.

The aim of the paper is to describe mentioned design aspects in contrast to the existing practice.

2. List of new design aspects

Fig.1 shows longitudinal cross-section of Btd fuses just in order to demonstrate main aspects of the design and to point out the following elements which are relatively new in comparison with the known solutions.

2.1 The main new design point is the fuse-link barrel now made from a metalic(in this case

some aluminium alloy) body in the form of a good heat sink. It made possible to elevate the fuse-link rated current of 10÷15 % by this same fuse-element.

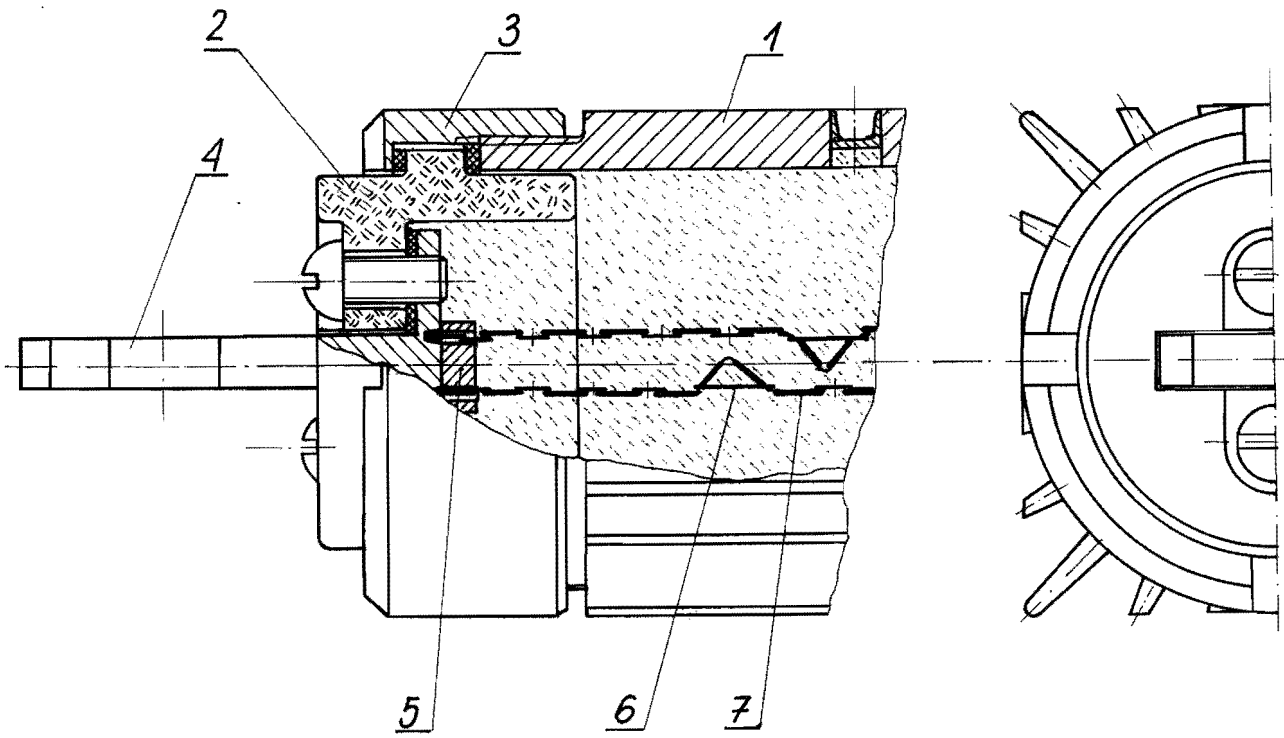


Fig.1 Partial cross-sectional view of Btd fuses
1 - aluminium body, 2 - ceramic bushing, 3 - aluminium nut, 4 - copper terminal,
5 - gas-evolving element, 6 - ring rubber to compensate elongation of fuse-element,
7 - fuse-element

2.2 Electrical insulation between terminals consists from the two ceramic bushings 2 (Fig.1) which replace usuall fuse-link end-caps. The bushings are fastened to the barrel 1 by means of metalic (again this same aluminium alloy) nuts 3.

2.3 The fuse-element 7 is made from silver-copper combination. Constricted parts are from silver, whereas shoulders from copper. The constrictions are partially punched and partially made by groove rolling process.

2.4 The reproducibility of the positioning of fuse-element is done in the following way: the both contacts 4 during manufacturing are connected together by means of two (not indicated in Fig.1) screws which then after assembling are removed. The assembly consisting from two terminals, fuse-element and mentioned screws form a kind of "clockwork" which then is protract through the barrel 1 and then is centred by the bushings 2 and fastened by shown in Fig 1 screws.

2.5 Multi-parallel fuse-element (Fig.2) is so collected that the loops for the elongation compensation 6 are directed inwardly. Shown in Fig 2 element consists from six partial elements with those loops disposed between them. The Figure also shows a magnified view of the fuse-element portion.

2.6 Gas-evolving elements 5 in Fig.1 placed close to the terminals prevent against arc burn-through of those contacts particularly in the region of interruption of small overload currents. The elements can be made from such materials as $Al_2O_3 \cdot 3H_2O$.

2.7 There are moreover some other special points, say like the compensation of fuse-element elongation, connection of the fuse-element to the terminals a.s.o.

Fig.3 gives a general view and Fig.4 a set of the barrels for different rated currents by the same rated voltage. Figs 5 and 6 demonstrate some exemplary oscillograms from the breaking capacity tests of 1000 V rated voltage fuses.

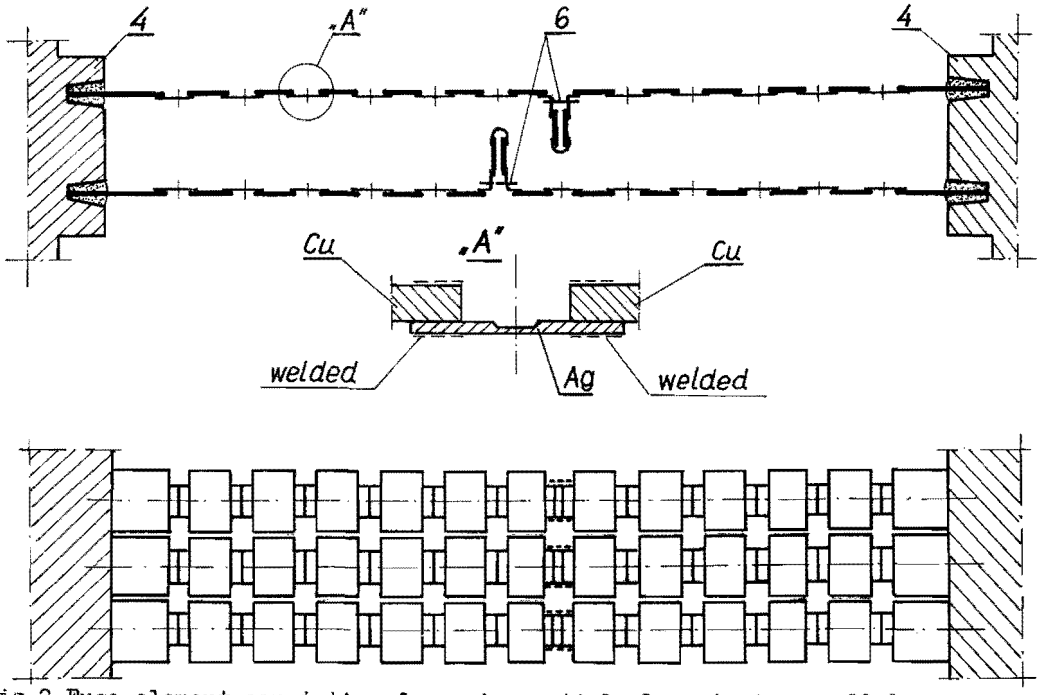


Fig.2 Fuse-element consisting from six partial elements in parallel

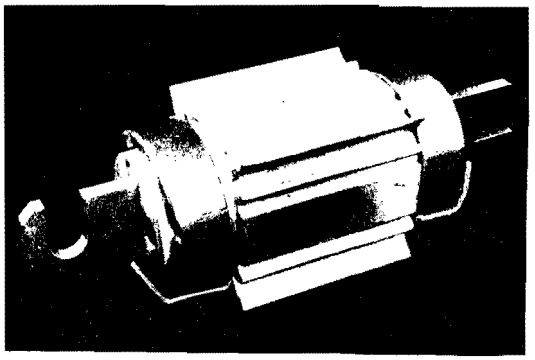


Fig.3 General view of a Btd fuse, 1000 V, 250 A

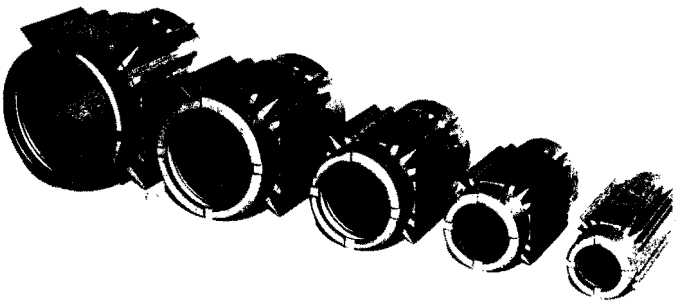


Fig.4 Aluminium barrels, 1000 V, size I÷V

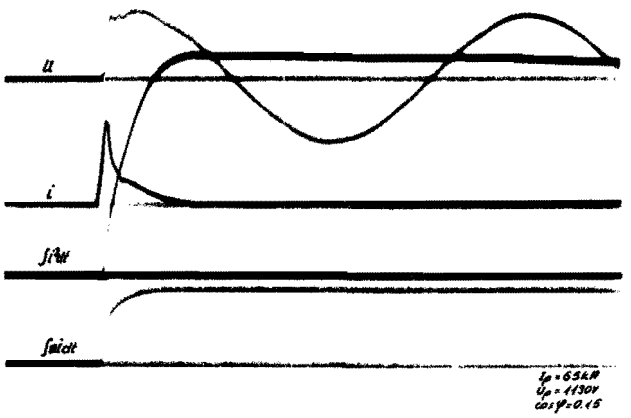


Fig.5 Oscillogram, fuse 1000 V, 250 A, 65 kA

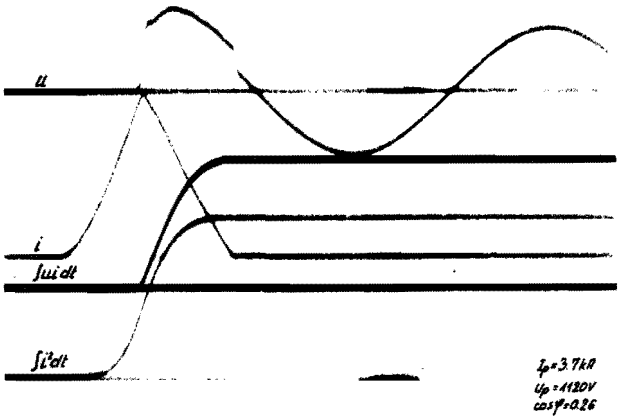


Fig.6 Oscillogram, fuse 1000V, 250 A, 3,7kA

3. Final remarks

Several described points of Btd fuses are claimed by the Polish patent documents. Author is of opinion that given new design aspects demonstrates some progress in the semiconductor fuses development.