# NEW HIGH BREAKING CAPACITY FUSES

P.Leonte, T.Ple• ca, E.Furnic•
"Gh. Asachi" Technical University
Ia• i – Romania

***Abstract***: A few new types of high breking capacity fuses able to carry out the protection functions of universal automatic circuitbreakers to overload and short-circuit fault conditions are shown in this paper.

## I. GENERAL CONSIDERATIONS

The nowadays universal automatic circuitbreakers with dynamic switching have thermal releasers (bimetallic release, easy fusing alloy release) to overload protection and electromagnetic releasers to short-circuit protection, and modern circuitbreakers have current protection transformer with electronic devices and microprocessor.

The protection function to overcurrents for some operating conditions could be take over by high breaking capacity fuses if these kind of fuses had a time-current characteristic, t(I), similar to automatic circuitbreaker protection characteristics which fulfils beneficiary requests.

There are already requests from some users which catch a glimpse of economic and operating advantages to new fuse type.

The universal automatic circuitbreakers could have only galvanic isolation function of electric circuits, with manual or automatic handling.

To meet halfway of new requests, the authors had investigated the using possibilities and this paper presents some solutions from obtained results [1].

## II. NEW TYPES OF HIGH BREAKING CAPACITY FUSES

For new types of high breaking capacity fuses it had in view to ensure a partial adjustable or full range currents of time-current characteristic, t(I), and the shape of this characteristic adapts to thermal characteristic of protected object.

So, fuses take over the thermal release functions to overload protections. It presents some examples:

### II.1 Replacing element with easy fusing alloy

The high breaking capacity (HRC) fuses structure is meant to short-circuit protection [2,4]. For an overload protection it is necessary a component part designed to this purpose.

The simplest solution means to section the fuse links, Fig.1, in the middle area then those two pieces are joined using easy fusing alloy which fulfils overload thermal release function.

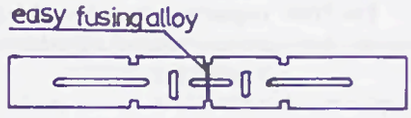


Fig.1 HRC fuse link with rated current $I_n$=100 A

The time-current characteristic is not adjustable and its shape is shown in Fig.2, curve 1, comparatively with conventional fuse , curve 2 (rated current, $I_n$ = 200 A). It can observe that it gets a non-adjustable time-current characteristic but it ensures overload protection.

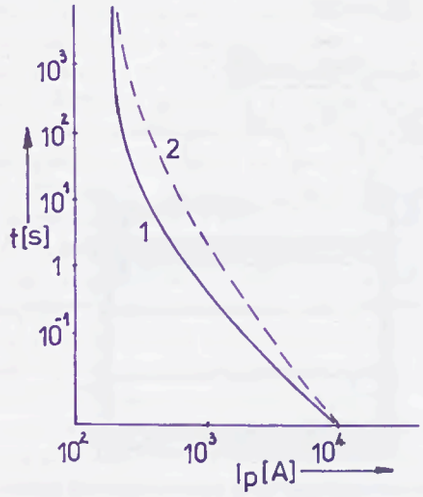


Fig.2 The time-current characteristics

A few experimental data are shown in the next table:

| $I_p$ [A] | 500 | 800 | 1000 |
|---|---|---|---|
| $t_1$ [s] | 2.50 | 1.10 | 0.66 |
| $t_2$ [s] | 50 | 6.23 | 2.20 |

where:
$I_p$ means the RMS prospective current;
$t_1$ – breaking time of new fuse;
$t_2$ – breaking time of conventional fuse.

In the given case the replacing element was with two fuse links, one of them was sectioned. As a result, those two fuse links work successively: first, the sectioned fuse link breaks off without arc and the second works with a period of time corresponding to breaking time. In the case of necessity it can section all fuse links, getting a shorter breaking time at overloads.

It established, experimentally, these new kind of fuses have a better behaviour at testing and operating conditions also because of small overvoltage levels when it recorded reestablishing voltage on a memory oscilloscope. Also, it observed a fuse working without noises and shining effects.

### II.2 The HRC replacing elements with time-current characteristic limited adjustable

The replacing element, Fig.3, has in parallel with fuse links F, outside of fuse body A, an elastic link Le soldered at one of end and sticked at the other end with an easy fusing alloy Af. The elastic link Le is jointly with a spring blade Sb. At overcurrents, the alloy is melting under thermal action of branched current and the elastic link Le sets free which is suddenly removed by spring blade Sb, without arc, the electric current being wholly directed through both fuse links F which finally will break off the electric current [1].

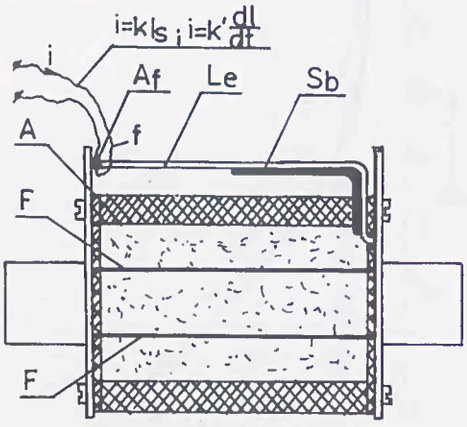


Fig.3 Low tension replacing element for HRC fuses

It can get a limited adjustable time-current characteristic. For instance, if resistance wire f melted the alloy Af in a negligible period of time and the electric currents on both branches were equally, then working time would reduce corresponding to double current and initial thermal state of fuse links and, so, the time-current characteristic to "cold state" will be the curve 2, Fig.4, comparatively with conventional fuse, curve 1.

Changing the currents ratio and heating current through resistance wire f, the time-current characteristic becomes limited adjustable.

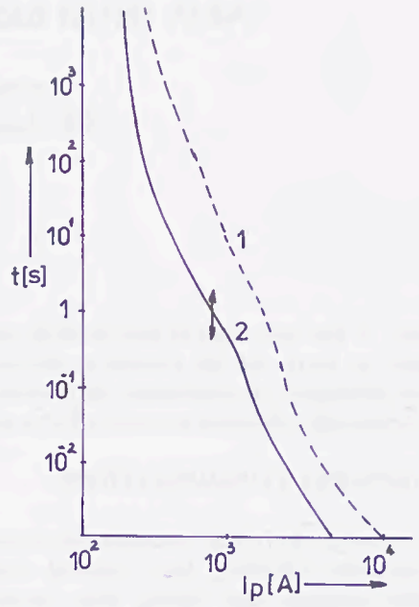


Fig.4 Semi-adjustable time-current characteristic

The outside parallel branch can be introduced into a compartment of fuse body or it can use two compartmented fuse bodies. Fixed joint through alloy can be replaced by a switch which belongs to a momentary primary current relay or a delay current relay adapted to given device.

Fig.5 presents the time-current characteristics of an universal automatic circuitbreaker with dynamic switching fitted out with thermal DT and electromagnetic DE releasers which points out the following aspects:

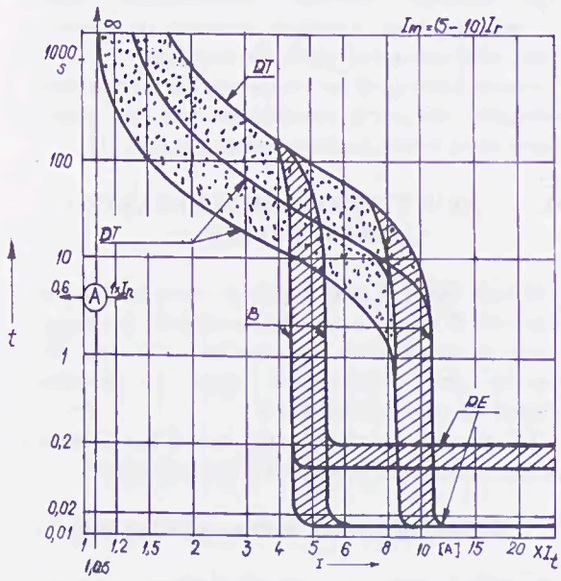


Fig.5 Time-current characteristic of an universal automatic circuitbreaker with thermal and electromagnetic releasers

- the time-current characteristic, t(I) is adjustabled;
- the cut-off current is variable in the range (5...10)$I_r$ or other prescribed range;
- it can provide for at least two variants of universal automatic circuitbreakers which allow selectivity in the range of electromagnetic releasers.

The achievement of alike time-current characteristic with HRC fuses it can make only using commanded fusing both overload and short-circuit ranges. An example is shown in Fig.6.

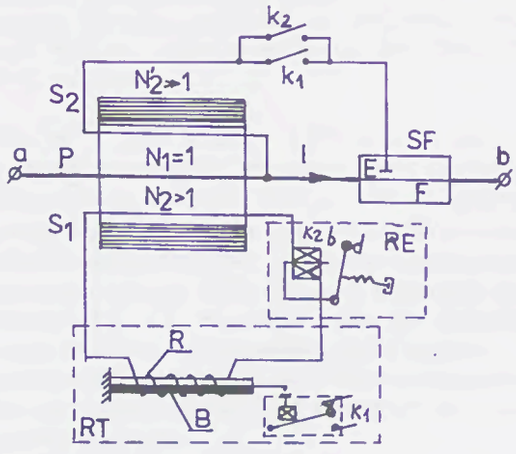


Fig.6 Fuse with self-commanded fusing

In this case the arc ignition into fuse SF is doing through electrode E about fuse link(s) F. At overloads it uses an adjustable thermal relay RT with bimetal B (direct, indirect or mixed heating by resistance R) and it is fitted out with a suddenly switching device.

This thermal relay RT is supplied from a current protection transformer TI through secondary $S_1$ with primary P in series with fuse SF. The switch $k_1$ turns on the second secondary $S_2$ which establishes commanded fusing through local fuse link(s) cut-off with an auxiliary arc. In these conditions the fuse breaking time has a negligible value in comparison with delay time of bimetallic thermal relay, actually overload protection is made in accordance with time-current characteristic of this relay.

Any electromagnetic or electronic current relay can fulfil this function with required time-current characteristics.

At short-circuits, it can be in series with thermal relay RT an electromagnetic or electronic relay RE with adjustable turn-on current to achieve the cut-off current at prescribed value and momentary or adjustable delay operating for a good selectivity. The relay RE achieves the commanded fusing through switch $k_2$ in the same way.

The three-phase variant results from three monophase units.

The command block remains after every operating stages being necessary only replacing elements changing with a new one or reconditioned element.

In this way it gets a primary adjustable commanded protection with fuses of electric circuits and consumers.

The improving of presented model can offer a competitive solution to universal automatic circuitbreakers in certain operating conditions.

The advantages which results from presented solutions are:
- removing of operating drawbacks because of universal automatic circuitbreakers with dynamic switching;
- benefitting by advantages to use HRC fuses;
- diminished global expenses;
- large limit adjustable possibilities through transformer ratio of current transformer TI and used relays.

## III. CONCLUSIONS

From new type fuses presentation results the following conclusions:
- it can be made new type of fuses with non-adjustable time-current characteristic adapted to overload protection with a better behaviour at overvoltages;
- the protection characteristic of universal automatic circuitbreakers with dynamic switching can be reproduced using fuses with commanded fusing; it preserves the adjustable possibilities of protection characteristic but in the larger limits;
- the ensemble of HRC fuse and commanded fusing block offers the advantage of current limiting effect which can be anticipated when it is necessary;
- the quality to reproduce the protection chracteristic of universal automatic circuitbreakers with overcurrent protection remains to any kind of used fuse, including resettable fuses;
- the commanded fusing can be initiated in momentary or delayed time;
- the fuses operating selectivity can be solved much better through commanded system which can be co-ordinated using microelectronic systems;
- it can command the working of any fuse from a given protection system when it is necessary;
- the commanded fusing can be achieved also with an independent auxiliary power source, in this case it can be started by any supervised parameter which could compromise the installation operating; in this way it achieves a generalized protection to a given installation;
- the commanded fusing can be started by any means what can ignition the local arc;
- the reconditioning is necessary only for replacing elements;
- in different operating conditions the command block can be the same only current protection transformer TI have to change (in some cases, only its primary);

- the circuitbreakers used for galvanic isolation of electric circuits and consumers can have a simplified design because they don't have to provide for short-circuit breaking capacity (fuses take over this function).

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