Multiple air gap switch for generation of nanosecond high voltage impulses

O.I. Kondratov*, I.P. Kuzhekin, K.I. Kudyakov, D.A. Kozlov
Moscow Power Engineering Institute (Technical University), Moscow, Russia.

For generation of nanosecond duration high voltage impulses a fast current commutation switch is needed (O.I. Kondratov, I.P. Kuzhekin, D.A. Kozlov, A.A. Nersesjan and L.L. Siniy. Generator of high-voltage impulses of nanosecond duration on the basis of double-forming line. The paper presented to Joint IEEE AP-S/URSI/AMEREM Symposium, 2006). The required current switch should have the following parameters: the amplitude of the switched current is in the kiloamperes range with nanosecond duration switch time, the voltage is of the order of 100-150 kV, the pulse repetition frequency is ~ 10^3 Hz and the lifetime of the switch is thousands of hours. Naturally, the switch should be cheap, simple in maintenance and reliable in operation. However the realization of the required characteristics in a working construction of the switch and its application meet a number of difficulties.

The possible solution of the problem of fast switching is the use of multiple air spark gap switches – devices with a number of electrodes connected in series to form spark gaps with initial uniform distribution of the voltage over the gaps. The fixed on the insulators electrodes with rounded edges forming electric field close to homogeneous compose sequentially jointed spark gaps. Thus, the total length of the gaps in the multiple spark gap switch can be less than in a single-gap switch at the same breakdown voltage. The total reduced gapped length will significantly increase the speed of current switching enabling higher front rise rate.

The switch can operate in the "self-triggering" mode or it can be triggered at triggering one of intermediate electrodes by application of a high-voltage trigger pulse. The purging by air of a spark gapped space may accelerate the electric strength recovery resulting in enlarging of lifetime and operation reliability of the switch.

The results of theoretical and experimental investigations for developed multiple spark gap switch units, which differ by the number of gaps and construction design, working in air with high pulse repetition frequencies and nanosecond duration pulses with front duration in the range of some nanoseconds are presented. The characteristics of switches are determined, the main parameters are analysed: the time of switching, recovery of the electric strength, the attainable pulse repetition frequency. It is shown, that at a distance between the electrodes of the multiple gap switch of ~ 1 mm, a pulse repetition frequency of 2 kHz is achieved, and at distances of 2.5 ÷ 3 mm, a frequency of 1 kHz can be maintained.

The recovery of electric strength depends on the number of gaps and the consumption energy amounts to approximately 8% of the total energy stored in a double-forming line.

Thus multiple gap air switches have parameters meeting the requirements of installations for simulation of nanosecond duration high voltage impulses.