CURRENT FAULT LIMITERS FOR HIGH VOLTAGE POWER SYSTEM

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ABSTRACT

In the last years with evolution high-temperature superconductivity the increasing popularity is gained with current-limiting circuit breakers on this base. High-temperature superconducting materials enable makings a superconduction current limit high-voltage and secondary networks. A principal cause making of the superconducting current-limiting circuit breaker consists in decrease of losses of an electrical power of the activity of an electrical network expended in a standard duty.

Keywords: current fault limiter, superconducting, HTS-(high-temperature superconducting), power system

I. INTRODUCTION

Unlike the usual chokes widely used to the present day, by normal activity the current-limiting circuit breaker is in a state of superconductivity and has almost insignificant resistance, in too time at a leakage of tall short-circuit currents he loses the superconductivity and sharply magnifies resistance [2].

The superconducting materials used in current limits chips or ceramics on the basis of a bismuth or yttrium. The fundamental difference between these materials is concluded in phase change to a slope of front of this junction and, therefore, in a small odds of an operating temperature.

There are the systems differing among themselves as and a principle of operation. So the first systems have been manufactured of bands of a superconducting material and directly sequentially were switched on under a high-voltage load. A virtue of such system is the ease and reliability, to a disadvantage of the yielded system that fact concerns, that superconduction materials badly tolerate an alternate current with further deterioration of the properts.

II. MAIN PART

The greatest perspectives have limiters of a transformer type. These systems are equipped by a secondary winding carried out of a superconduction material which one screens a current of normal activity of the system and in case of short circuit there is a following: critical density of current J_c exceeds acceptable values and the superconducting device transfers in a normal condition thereby terminates to shield a current, an induced drag of the limiter, starts to grow promptly, thereby limiting a short-circuit current. To receive essential current limiting, junction of superconducting material in a normal condition should be within the limits of 1 *mcsec* (or less) after originating short circuit. However, fast phases T_{heat} <1 *mcsec* are possible only at a material utilization with J_c> 25 kA/cm^2, as shown in [3]. Complete power losses on resistance (including and heat losses of Joule because of a current), are 0.1 % of rated power.

The circuit of the inductive superconduction current limiter alternating-current a transformer type with high-temperature superconducting material the non-linear resistor as a secondary load of the transformer is reduced on fig.1. The nonlinear component of a superconducting current limit is carried out in the form of the superconducting resistor with small inductance. In a standard duty of a web

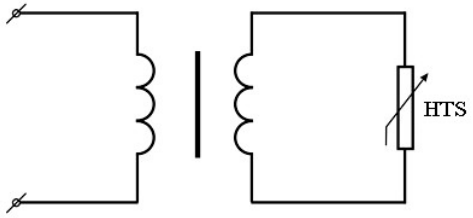

Fig. 1.
Electric circuit HTS of a transformer type.

The secondary coil of the transformer is closed on the resistor in a superconducting state, thus resistance of the limiter has low value. When in a web there is a short circuit, the resistor loses superconductivity and transfers in a resistance state. As a result of it the current of a short circuit is limited to an induced drag of a primary winding [5, 7, 24-36].

The hybrid construction of the limiter consists in the form of a toroidal transformer (fig. 2). The Primary winding as well as for all limiters is in-sequence with a web, the secondary coil is carried out from separate short-circuited turns and each of which of the formed half from superconducting and copper segments generated half from superconducting.

Superconducting material YBCO 123 [5-16] in the form of small bars, works at 77 K, and all secondary coil should be located in a cryostate. The copper unit of a winding works at low temperature, that considerably diminishes its electric resistance and helps to reach lower impedance of the limiter in a normal state. In emergency, when the current of a primary winding exceeds a defined value, the current through each turn will grow, overcoming a so-called critical current, and superconducting material will start to transfer in the transit state having resistance. [2, 5, 17-25, 32-44].

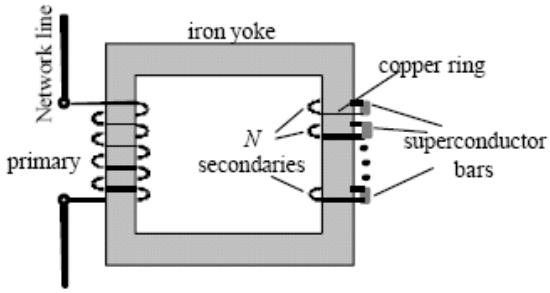

Fig. 2
Principal diagram of a hybrid current limit

Without magnetic core systems, making of the limiter in the yielded design really it represents an inductance coil (current-limiting coil) covered by a screen layer of superconducting material. Here on the foreground there is an economic force in connection with that the dimensions of a spool are rather imposing, it with вязано with necessity of arrival of an indispensable impedance. Cover of its choke by a layer of superconducting material and its room in cryostat applicable dimensions, and also noxious electrical action. All these factors establish impracticable conditions for embodying the yielded system.

These systems have two principal properts: capacity of limiting of a current and response. The first capacity is concluded that if any web or its device cannot be well defended by conventional systems or if this protection is much more expensive than superconducting than a current limit. To a true time, is almost always possible to defend any device of an electrical network the suitable electromechanical system, value superconducting a current limit seems, some times above, than classic solutions. This fact is more relevant than "superprotection", thus quality of power received is not refined by a customer.

The second capacity is principal advantage of this aspect of the system in front of the classic current-limiting circuit breaker it is its very fast capacity to action with a real running peak limiting. That enables widely to apply it on substantions. In case of switching on abreast enables to increase traffic of a link thus, not substituting commuting instrumentation. And at switching on between collecting buses this intercoupling refines reliability and the quality of a voltage which is not desirable harmonics components are deafened, the best energy distribution is reached.

Also utilization of superconducting current limits in the certain assemblies of a power system enables to extend time of a switchgear and will condition for its gradual replacement by the modern inventory.

If to survey grounding a neutral position of webs of the class-room of voltages 6 - 35 kV which one are exploited with the insulated neutral or with resistance grounding a neutral position or with grounding through the arc-suppression coil (coil of Petersen). The Circuit diagram of the current-limiting circuit breaker is reduced on fig 3.

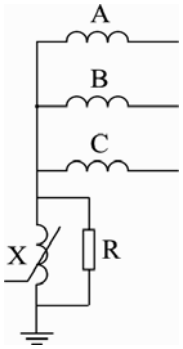

Fig. 3

At such switching on in a standard duty the web will work with almost dummy grounding a neutral position as the pure resistance will be зашунтировано practically null resistance of the limiter. In a standard duty we shall receive a following equivalent circuit of a web. As a corollary it is receivable new propert of a web of the yielded voltage class - zero a neutral shift, value for the sake of which one many measures were conducted at other aspects of grounding.

In a regimen of a ground fault we receive version of a shunt connection of an induced drag of the current-limiting circuit breaker and the resistor in a neutral position, figured on fig. 4. As a result we receive limiting a ground current due to an induced drag of the current-limiting circuit breaker and limiting of voltage surges due to a pure resistance of a neutral position.

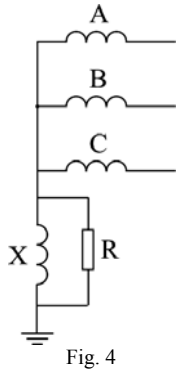

Fig. 4

Resistance R should be set up depending on an expansion of a web in the best way to scatter power of an electric arc, not having yielded her repeated to light up. [1, 2, 15, 27-46]

III. CONCLUSION

The fundamental problem of a heading is value and a upkeep of the similar equipments since the superconducting device is in operational temperature of liquid nitrogen or of its steams that requires a constant

upkeep of the system in an operation mode of the system. At the this moment of evolution of limiters it is produced and limiters on a voltage class, not exceeding 35 kV are exploited. But requiring of electric power industry require practical embodying of limiters on a voltage class 110 kV and above.

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