THE MULTIPURPOSE DEVICE FOR INCREASE OF THE OVERALL PERFORMANCE OF NETWORKS 6-10-35 кВ AT ARC EARTHINGS

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ABSTRACT

Used in networks 6·10 κV arc-suppressing coils both with smooth adjustment, and with incremental control of a current do not give due effect with the purpose of restriction of arc over voltage at single-phase ear thing. Methods improving an overall performance of networks 6-10-35 κV are offered with the purpose of restriction of arc over voltage at ear thing by inclusion active resistance in the circuit through the controlled switchboard. It is developed the device for physical modeling arc earthlings in a real network by means of which new ways for increase of an overall performance of networks 6-10-35 kV are realized. Use of the high-voltage controlled switchboard 6-35 κV allows sharply will lower emergencies.

Keywords: electrical networks 6-35 kV, modeling of arc short circuits, restriction of arc over voltage, the high-voltage controlled switchboard.

I. INTRODUCTION

Electrical networks 6-10-35 κV play the big role by transfer of the electric power to the consumer. The most part of breaks of electro supply of consumers by quantity and on duration occurs at damage of elements of these networks. However, the basic advantage of branch circuits 6-10-35 κV is their serviceability at long arc ear things. This circumstance, in turn results in occurrence of specific features as by kinds and character of proceeding transients, and on their consequences and a method of protection against them.

Used in networks 6·10 κV ground-fault neutralizer - GFN [1,2], both with smooth adjustment, and with incremental control of a current did not give due effect with the purpose of restriction of arc over voltage at single-phase ear thing.

In existing circuits of substations with indemnification of a capacitive current of single-phase ear thing at single-phase arc discharge in a circuit of the additional transformer switching of switching-off of the damaged network results in frequency rates over voltage on contacts of feeder circuit-breaker $U_{recovery}$ = (3,42-6.04) $U_{ph..м.}$, on the intact phases - U_{max2} = (3.65-4.5) $U_{ph..м.}$, and on neutral point the additional transformer which it is connected ground-fault neutralizer - $U_{мах}$ = (2,31-2,89) $U_{ph..м.}$. Such levels of voltage constantly resulted in development of failures and failure of an electric equipment of substations.

Difference of the offered methods improving, an overall performance of networks 6-10-35 κV from known [1], consists that true resistance is included in the circuit through the controlled switchboard. It enables management of a current proceeding through a place of short circuit which helps preset limit current protections from single-phase ear thing. As the power part of the switchboard is executed from two inverse-parallel connection included thrusters, the current proceeding through a place of short circuit will have harmonious components (thus the form of a current will be the cut off sinusoid) distinguishing from [2] that is dependent on a corner of opening of thrusters the harmonious structure of spectra is adjusted.

It is necessary to note, that as against other existing devices, resistance is included in a circuit by means of the switchboard only after short circuit of one phase on the ground (during 50-150 μs after short circuit), and is disconnected after disappearance “earth”.

II. TRANSIENT ANALYSIS AT EAR THINGS IN NETWORKS 6-35 KV

For the analysis of transient the equivalent circuit is specified. The attention is paid to sizes of parameters of an equivalent circuit for the analytical analysis of transient. Transient further is analyzed at single-phase metal ear thing. Being based on help given the mains transformers maintained in networks 6-35 κV and boundary sizes of currents of ear things; the limit of expected frequencies of free fluctuations is determined. It is shown, that at account of meaning of circuit angles of the short circuit appropriate to the maximal over voltage in case of metal ear thing, it is necessary to take into account changes of delta voltage& during a half-cycle of free fluctuations. Rated formulas for a case of short circuit of a phase “A” on the ground are given in view of frequency of free fluctuations of a network:

$$\varphi_{зlb} = \operatorname{arctg}\left[\frac{(1-k)(1-d)}{\sqrt{3}\sin(5\pi/6-\omega/2f_1)} - \operatorname{ctg}(5\pi/6-\omega/2f_1)\right]$$

$$\varphi_{з1c} = \operatorname{arctg}\left[\operatorname{ctg}(5\pi/6+\omega/2f_1) - \frac{(1-k)(1-d)}{\sqrt{3}\sin(5\pi/6+\omega/2f_1)} \right],$$

Where $\varphi_{з1b}$, $\varphi_{з1c}$ - corners of short circuit of a phase "A" on the ground, appropriate to the maximal voltage in phases "B" and smallpox's,

$$\omega=2\pi50=314 \text{ it rad / s},$$

κ - factor of a capacitive coupling between phases, f1 - frequency of free fluctuation of a circuit of short circuit, d - the factor which is taking into account attenuations of fluctuations.

Account by definition $\varphi_{з1b}$ and $\varphi_{з1c}$ is carried out, changing in limits (500-5000) Hz which results are submitted in the table.

Table

Circuit angles of short circuit for a phase "A", appropriate to the maximal over voltage in view of a natural frequency at (1-k) (1-d) =0,8

f_1, Hz	500	600	700	800	900
$\varphi_{з1b}$	56,6	58,8	60,3	61,4	62,3
$\varphi_{з1c}$	98,3	100,3	101,8	102,9	103,8

Continuation of table

f_1, Hz	1000	1500	2000	3000	4000	5000
$\varphi_{з1b}$	63,0	65,2	66,2	67,2	67,7	68,1
$\varphi_{з1c}$	104,5	106,5	107,6	108,3	109,1	109,4

The maximal meanings of frequency rates of over voltage and the appropriate corners of short circuit for a case k=d=0 and f1 >> 50 which have the following meanings $\varphi_{з1b}$ =710, $\varphi_{з1c}$ =1090, $[KV_{max}] = [K_{cmax}]$ =2,65 are appreciated.

Анализирован transitive process at unstable short circuits of one phase on the ground. Versions of behavior of an arch on hypotheses Petersen, Peters and Slepin, and also by Belyakov N.N. and Juvarli Ch are considered. Prominent features of each of hypotheses of instability of short circuits are listed and is specified, that more universal is Belyakov N.N.'s hypothesis and Juvarli Ch.

III. THE HIGH-VOLTAGE CONTROLLED SWITCHBOARD FOR INSULATION TEST OF A NETWORK 6-35 KB ON LOAD

On the basis of transient analysis at arc short circuits the device for physical modeling arc ear things in a real network by means of which new ways for increase of an overall performance of networks 6-10-35 kV are realized is developed, made, approved. The device consists of the block of switching, the control assembly and a control panel.

All components of the block of switching and the control assembly are mounted inside the special metal case having a high-voltage conclusion, a pain for grounding the case and the plug for a feed of the control assembly. The device is designed not only for application as model of arc short circuit, but also for insulation test of networks on load, protection against arc over voltage, increases of selectivity of existing relaying from single-phase ear things, the control of a condition of isolation on load and uses in the device of fault localization for the ground.

The high-voltage switchboard is intended for modeling unstable arc ear things in three-phase networks with the insulated neutral and with indemnification of capacitive current& of ear things. The switchboard is designed not only for application as model of arc short circuit, but also for: insulation tests of networks on load, and also anticipators from arc over voltage; increases of selectivity of existing relaying from single-phase ear things (tripping of faulted line); restrictions of arc over voltage; the control of a condition of isolation on load; uses in the device of fault localization on the ground on the radial overhead line (6-10) kV.

The switchboard consists of the block of switching, the control assembly and a control panel. All components of the block of switching and the control assembly are mounted inside the special metal case having a high-voltage conclusion, the bolt for grounding the case and the plug for a feed of the control assembly.

Specifications: rated voltage - 6,3 кV; as much as possible - allowably average current - 320,0 A; a make-time, no more - 25 μs; an off time, no more - 500 μs; voltage for the control assembly, no more - 100 V; capacity for management, no more - 10 W; an operating time to refusal - 10 000 hour; an allowable range of change of an environment temperature - from-40 up to +40 ^{0}C the sizes 600x600x90õ (mm); weight, no more - 40 kg; installation BUK-2 is recommended in the closed switching centers.

The device and principle of work. The switchboard is multipurpose. Regulation or installation of a circuit angle of opening of the switchboard is made by a manual way. The block the circuit of the switchboard is given on fig. 1

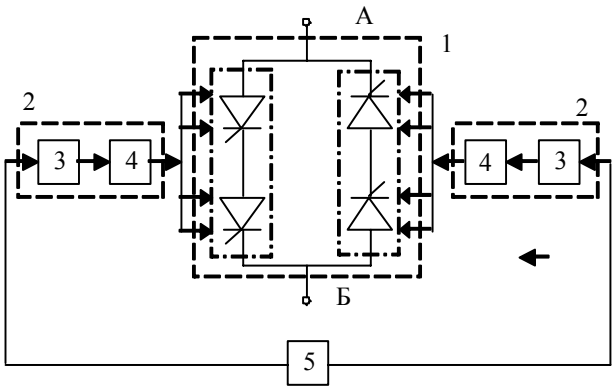

Fig. 1 Block the circuit of the switchboard.

The Device contains the block of the switching 1 executed as two inverse-parallel connection included chains of thrusters and two control assemblies 2, each of which consists of the purser 3, the amplifier - the

multiplier 4 and eats from the power unit 5. In the given development phase -pulse management of thruster blocks which provides sharp decrease of dimensions of a control system, power consumption is applied, and also promotes improvement of dynamic characteristics of inclusion of thrusters. For connection of high potential there is a conclusion through the bush established on a roof of the switchboard. The supply of the power supplies to the control assembly is carried out by means of a twin cable. Switched high potential is included between points and, on the control assembly the voltage no more than 100 moves. In result pulses for management are developed and move on the block of switching. Thus it is necessary to synchronize controlled pulses with a switched voltage.

Maintenance service. For maintenance of uninterrupted and long work of the switchboard, it is necessary to make periodic inspections for revealing malfunctions. Periodic service of the block of switching should be made once in 6 months, thus it is necessary: to clear the switchboard of a dust and dirties; to check up a condition of electric contacts from party HV and on the part of grounding; Periodic service of the control assembly should be made once in 6 months, thus it is necessary to clear of a dust and a dirty and also to check up a condition of electric contacts and a ration.

Connection diagram. The switchboard is connected permanently between a central point of a network and “earth” through resistance by means of the disconnect. The bolt of grounding of the case is necessary for connecting to the ground loop of a ï/item. The connection diagram of the switchboard is submitted on fig. 2. Work of the device occurs at short circuit of one phase of a network on the ground. After ear thing on a winding of the transformer of zero-sequence voltage (TZSV) connected разомкнутым by a triangle occurs 3U and the control assembly of the switchboard is started to. The switchboard is included and short circuit of a central point of a network on “earth” through resistance R is provided. Thus electric residue flow down on “earth” Therefore the arc voltage and a current on the faulted line is limited is increased up to the certain meaning, sufficient for operation of reacting body RB, selectivity of the relaying from 033. Thus rises. Connection of the switchboard in parallel with GFN is authorized, thus the control assembly of the switchboard can be had from alarm winding GFN. Installation of switchboards is recommended in head substations.

IV. RESULTS OF USE OF THE HIGH-VOLTAGE CONTROLLED SWITCHBOARD (BUK-2)

Used in networks 6·10 кV - GFN, both with smooth adjustment, and with incremental control of a current did not give due effect with the purpose of restriction of arc over voltage at single-phase ear thing.

Use BUK in networks "Omskenergo" has allowed sharply decrease breakdown susceptibility, and for deeper

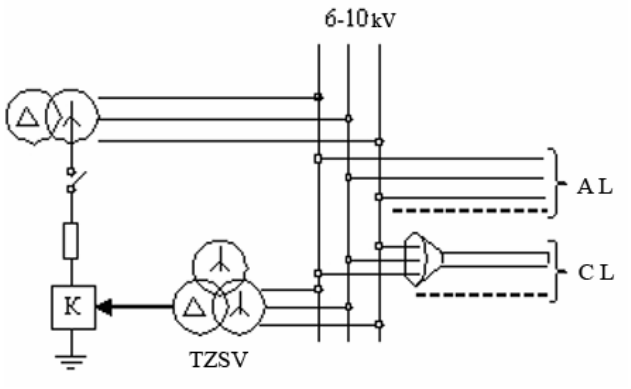

Fig. 2. Connection diagram of the switchboard.

restriction over voltage on size of a capacitive current of ear thing, it is possible to change size of resistance of the resistor which is included in complete set BUK -2. For example, for a network 10 кV with a capacitive current of ear thing up to 30 and optimum resistance is 750 Ohm, up to 80 and _ 225 Ohm. The given device with success may be maintained and in networks with small fault-to-ground currents without indemnification of a capacitive current of ear thing. In this case optimum resistance of the resistor is size 900 Ohm.

Advantage BUK-2 is not only restriction arc over voltage, but with its help it is possible to define the damaged feeder at single-phase ear things under condition of presence on each feeder of current transformers of a zero sequence, and also check of a condition of isolation on load.

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It is necessary to note, that as against other existing devices, resistance is included in a circuit by means of the switchboard only after short circuit of one phase on the ground (during 50-150 μs after short circuit), and is disconnected after disappearance “earth”.

V. CONCLUSION

1. Used in networks 6·10 кV arc-suppressing coils both with smooth adjustment, and with incremental control of a current do not give due effect with the purpose of restriction of arc over voltage at single-phase ear thing.

2. Methods improving an overall performance of networks 6-10-35 кV are offered with the purpose of restriction of arc over voltage at ear thing by inclusion

active resistance in the circuit through the controlled switchboard.

3. Developed the device for physical modeling arc ear things in a real network by means of which new ways for increase of an overall performance of networks 6-10-35 kV are realized. Use of the high-voltage controlled switchboard 6-35 κV allows sharply will lower emergencies.

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