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INTELLIGENT CONTROL SYSTEM BY SYNCHRONOUS VACUUM CIRCUIT-BREAKERS MIDDLE VOLTAGE

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Abstract

This paper presents the structure and concepts of intelligent control system synchronous vacuum circuit breakers medium voltage, and the test results of this system in conjunction with a prototype of such a switch. Flow and fundamental diagrams over of intellectual control system are in-process brought by synchronous vacuum switches of middle tension. Application of the guided commutation vacuum circuit breakers domains are certain. Advantages of vacuum switches guided by intellectual control system as compared to series-produce analogical vehicles are shown. The results of tests of the indicated system are described in totality with the pre-production model of such switch worked out in the Sevastopol State University. A flow and fundamental diagram over of foregoing control system and diagram of her work are brought.

INTRODUCTION

Recently, for the switching power circuits of medium voltage widespread vacuum circuit breakers having a number of advantages compared with other types of circuit breakers. To increase the switching of vacuum circuit breakers at their operation in difficult and emergency modes perform their synchronized with zero current to be interrupted and the connected voltage. For effective management of synchronous vacuum circuit breakers should be used intelligent control systems these switching devices. The control system of electric apparatus [1] is a set of elements that transmits control command signals to enable or disable the device with the capacity of the land to the elements having the highest potential.

Benefits circuit breakers controlled switching as follows:

- reduction of inrush current;
- reduction in the level of surge when performing on-off;
- increase resource switching apparatus;
- increase in the nominal parameters of the machine.

Intelligent control systems should ideally perform controlled switching, monitor and diagnose the vital units of the apparatus.

Currently, the most popular concept of combining protection and control functions. The first step in this direction can be considered the use of circuit breakers with controlled switching. It solves the problem of preventing dangerous inrush current and overvoltage, increase equipment life. When controlled switching takes into account not only the phase voltage is turned on and turned off when the current phase, but the residual magnetic flux when the transformer is idling, the residual stress on the switched capacitor bank, the recovery time of dielectric strength of arc gaps switch and a number of other parameters. In addition to the positive effect on the switching device, controlled switching reduces the harmful effects of switching parameters for servicing equipment, thereby increasing its service life.

INTELLECTUAL SYSTEMS MANAGEMENTS IN APPLICATION TO VACUUM CIRCUIT BREAKERS

Controlled switching of short-circuit allows to reduce the arc time to a minimum. For vacuum circuit breakers controlled switching of short-circuit provides the following positive attributes:

a. Decrease in electrical contact erosion;
b. Increasing the switching resource switch;
c. Increase the breaking capacity.

When choosing the moment of inclusion should take into account two parameters: the peak current in the arc and a dedicated switching energy.

Basic requirements for circuit breakers with intelligent control.

1.Insulation requirements arcing devices.

From the point of view of the dielectric characteristics of the switch controlled switching must have a sufficiently high rate of decrease of dielectric strength when the contact gap, small scatter of the breakdown voltage and a high rate of recovery of dielectric strength when disconnected.

2. Requirements to the mechanical characteristics of the device.

Apparates controlled switching must ensure high stability on-time and off-time (± 1 ... 2 ms). Furthermore, requires single-pole operation switch. Variation in the start and stop time must not exceed the permissible values for ambient temperature changes, with supply voltage variations, and as a result of wear and aging switch nodes.

3. Requirements for control systems.

One of the main requirements that apply to control systems consider the class of s circuit breakers is adaptive control. This means that changes settings of the apparate, due to various factors, should be largely offset control systems. In addition, the control system must be reliable, and the cost of their operation - minimal. Ideally, the system should be self-monitoring and self-tuning.

Finally, the control system must be designed and tested to meet its basic characteristics of all the available modes. As can be seen from the above requirements, modern commercially available devices are still very far from full implementation of these requirements, and controlled switching systems can only speak in the future tense.

REQUIREMENTS TO INTELLECTUAL SYSTEMS MANAGEMENTS CIRCUIT BREAKERS

For synchronized circuit breaker must have a control circuit capable of by measuring the current in the switched circuit to generate clock signals. They are characterized by a given moment of time preemption natural transition current zero. With synchronization signals when you turn off the unit provided the beginning of the process of divergence of contacts for some time to zero current. In forming the clock signals lead time should not depend on the following factors [2]:

- ambient temperature variations:
- frequency drift current switchable circuit of the nominal value;
- different size and rate of decay of the aperiodic component of short circuit current.

There are many ways to synchronize with different physical entity, the value of possible errors lead time and complexity of implementation tools. They can be divided into the following types:

1. A method, based on the reference time of the trip command of the basic zero

a) continuous output of the synchronizing signal;

b) with the output of the signal after the arrival of the team on the trip;

2. A method using the auxiliary current curve having a lead in relation to a switched current;

3. The method uses the measurement values of breaking current and its derivative (Chernyshyova method [3]);

4. The method using the characteristic points of the current curve;

5. The method using calculation-solving devices (controllers).

All the above methods can be implemented in various ways, and the implementation of features will depend on the error signal produced, cost and dimensions and weight control and stability of its operation.

The main difficulty in the successful implementation of simultaneous shutdown is necessary extrapolation of the nature of the batch process the rated breaking current. It is necessary to supply a signal to disable proactive, wherein the constant current waveform distortion component occurring in the emergency mode, as shown in figure 1. The exact solution of this problem is difficult, because the signal to disable synchronous system generates a differential analysis of the signal from the current sensor. However, the possible error which can not be avoided by traditional methods.

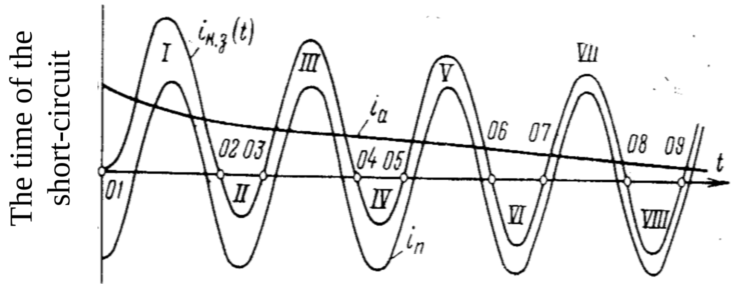

Figure 1. Distortion of short-circuit current DC component.

The proposed control system uses a Chernyshev, but has a higher accuracy and stability compared with the original version due to circuit design. The proposal to use a measurement technique for determining the expression of the synchronous off time $t_v = i/\frac{di}{dt}$ F.Griffitsom was first made in 1938.

APPLICATION OF THE GUIDED COMMUTATION VACUUM CIRCUIT BREAKERS DOMAINS

Controlled switching apparates can be applied in the following areas:

1. Switching of capacitor banks.

When operated switch are significantly reduced inrush current and overvoltage occurs, and at a controlled shutdown reduces the likelihood of repeated breakdowns. Optimal for inclusion is the time when the voltage across the open contacts switch passes through zero. When the switch to each pole-zero voltage deviation of no more than 0.1 ms inrush current and voltage is almost absent. When disconnecting the capacitor banks requirements for limiting torque scatter opening of the contacts are not as tight as when turned off.

2. Switching unloaded lines.

Uncontrolled switching unloaded lines can lead to overvoltages as when turned on, and when disconnecting lines. When operated switch, it is important to time the inclusion within ± 1 ms of the maximum voltage across the gap switch. Controlled switching is especially effective in the performance of the automatic restart when the line is the charge, and surges can reach high values.

Therefore a combination of controlled switching with the installation of surge arresters for long lines, you can restrict the multiplicity of overvoltage does not exceed 2.

3. Switching shunt reactors.

When operated switch avoids large current surges when switching is performed at the voltage maximum in each of the poles with accuracy ± (1 ... 2 ms). Disabling shunt reactors may be accompanied by surges caused by the current cut or re-ignition. To reduce the current cutoff switch contacts must diverge near the transition zero current. On the other hand reducing the likelihood of re-ignition is possible if arcing time of at least 5 ... 7 ms. For reactors second condition is more important, however, it may be performed only if an individual drive for each phase.

4. Switching of transformers.

When switching transformer switching time requirements basically identical to those of claim.

3. The peculiarity of the moment when the choice is the fact that when the unloaded transformers must be considered residual flux. Spreads circuit breaker closing time must not exceed ± 1 ms.

5. Switching short-circuit currents.

The guided commutation of currents of short circuit gives an opportunity to shorten time of burning of arc to the minimum values.

PRE-PRODUCTION MODELS OF VACUUM CIRCUIT BREAKERS WITH THE GUIDED COMMUTATION

At the laboratory of electric apparates of Sevastopol State University developed prototypes of high-speed vacuum circuit breakers with the following nominal parameters: rated voltage - 35 kV, rated current - 1600 A, as well as a system of intelligent control systems that provide a wide range of operations carried out by such switches, namely:

1. Synchronous off nominal and rated breaking current;
2. Synchronized with zero voltage switching loads;
3. Providing automatic reclosing in emergency conditions;
4. Per phase switching on and off of different loads;
5. Cutout at receipt of the respective signals.

The control system synchronous circuit breakers is the most responsible and challenging block-breaker and should provide the following operations:

1. Staffing synchronous off and on the power circuit breaker at rated load;
2. Emergency synchronous switching on and off of the main circuit;
3. Providing simultaneous automatic reclosing and rapid auto-reclosing.

A block diagram of the control system has the form shown in Figure 2.

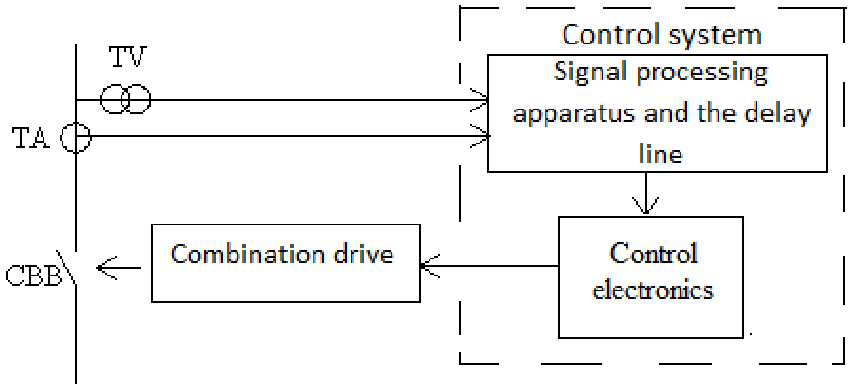

Figure 2. Block diagram of the synchronous control vacuum circuit breaker.

Control block diagram has the form shown in Figure 3.

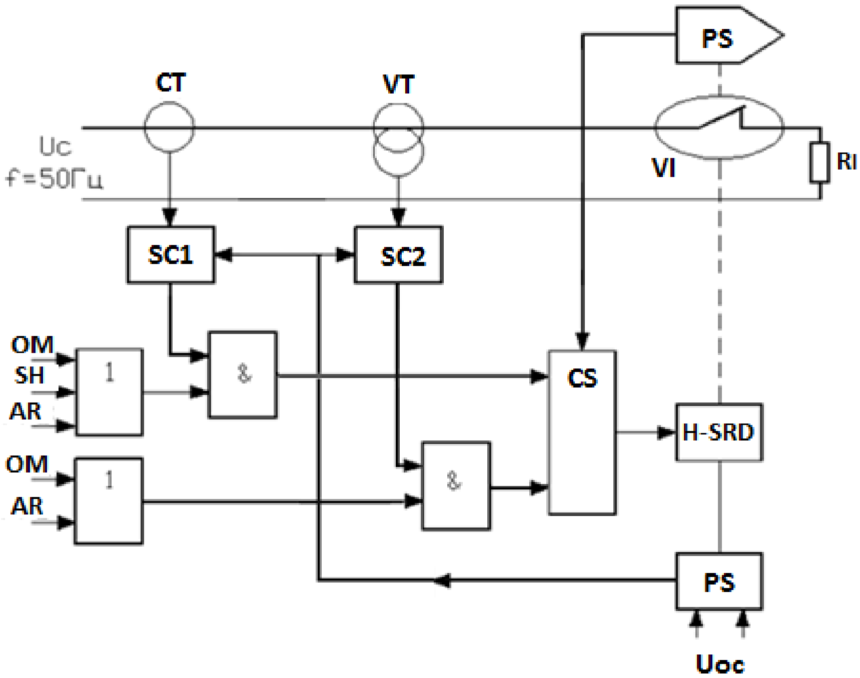

Figure 3. Block diagram of the control system synchronous circuit breakers: PS - position sensor, VI - vacuum interrupter, CT - current transformer, VT - voltage transformer, SC1 and SC2 - signal conditioners, OM - operational management, SH - safety shutdown, AR- automatic restart, CS - control system, H-SRD - high-speed reverse drive, PS - power supply, Rl - load, Uc, f - the parameters of the main circuit, Uoc - voltage operational circuit.

PRACTICAL REALIZATION OF CONTROL SYSTEMS BY VACUUM CIRCUIT BREAKERS

System synchronous control vacuum circuit breaker [5] provides an alarm trip ahead of the vacuum chamber Δt (in this case 2 ms) relative moment of transition current of the main circuit through zero. The control system comprises two identical channels forming slot Δt, working with a phase shift in the half period of the current power circuit, which is provided with a current transformer using two secondary windings included antiphase. To explain the operation of the device, consider a schematic diagram (Figure 4a) and the current and voltage waveforms (Figure 4b) as an example of one channel forming Δt.

The graph I provides the primary current of current transformer. Node at the transistor element VT1 DD 1.1 generates a voltage charge-discharge (Figure II) while the master of the capacitor C1. Due to the fact that the charge and discharge of the capacitor C1 occurs through a highly stable one resistor R5. The time constants of the charge and discharge circuit are equal (Figure III) and constant in time.

a)

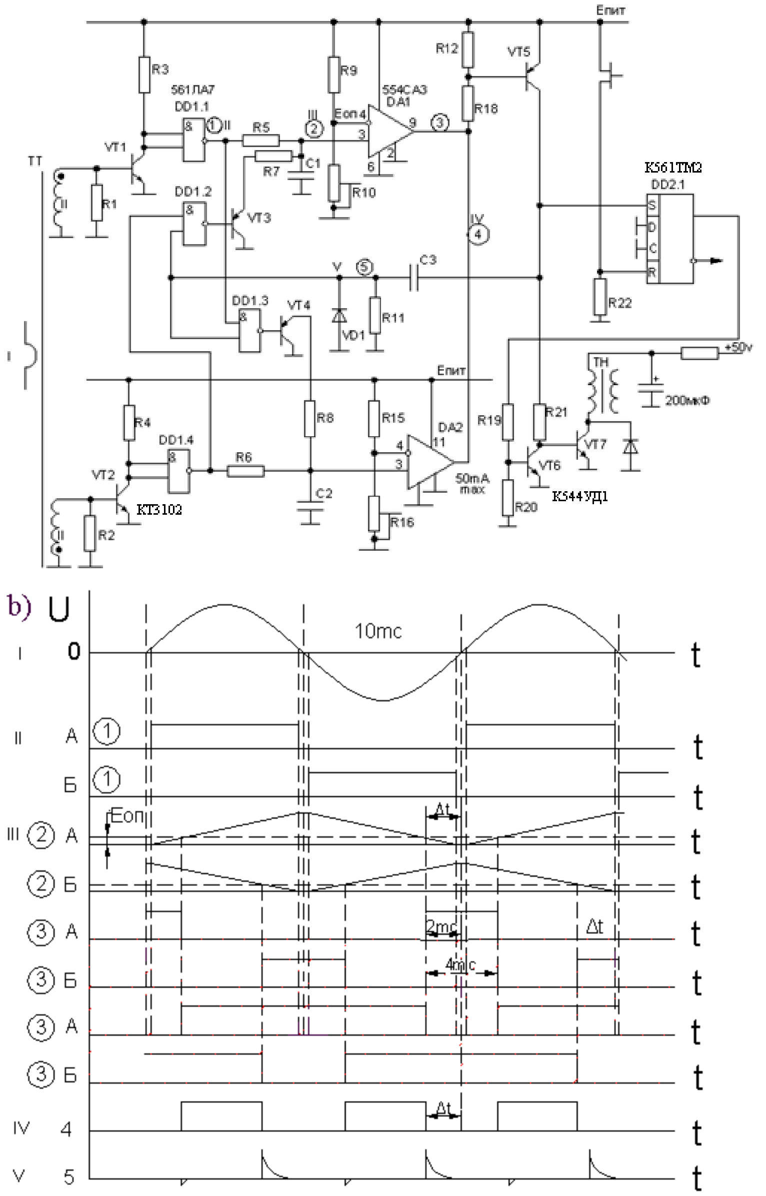

Figure 4. Schematic diagram of the synchronization of a) and b) charts her work.

Schedules control system clock pulses obtained by semi-natural experiment are shown in Figure 4b.

A signal proportional to the current supplied from the sensor part which carries a current transformer or a Hall sensor. Features of the current transformer to synchronize your device as follows:

1. Mode - a special, that is, in a wide range of primary magnetizing forces.
2. Nature of the load - chain management system.
3. Type of magnetic systems - exclusive, i.e. a nonmagnetic gap that stabilizes angle characteristics in a wide range of current switched switch.

The main drawbacks of the current transformer:
1. Large dimensions and weight.
2. The complexity of the isolation of high-voltage power circuit with chain controlled system.

Therefore, this design features a Hall sensor, which, along with the absence of these shortcomings, has a wide range of linear response.

CONCLUSIONS

On results undertaken studies next results are got :

1. Effective application of the guided commutation of power electric networks domains are educed.

2. Advantages of switches of middle tension are certain with intellectual control system.

3. The requirements produced to intellectual control system of switches are mine-out.

4. The pre-production models of vacuum switches are described with control system, and also flow and fundamental diagrams over of such systems are brought.

The proposed system during the test showed high accuracy and stability of response in all modes of synchronous vacuum circuit breakers.

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