SECTION 26. Radio-technique. Electronics. Telecommunications.

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DISCONNECTION OF THE ELECTRICAL CIRCUIT WITHOUT EMERGENCE OF THE ELECTRICAL ARC

Abstract: *The article describes the method of electrical circuit disconnection without electrical arc occurring by increasing the resistance of the circuit and reducing the current in it. It also suggests an upgrade for the design of breakers that will allow breaking the electrical circuit without using the arc blowout device.*

Key words: *High Voltage Universal switcher, plasma, without arc switcher.*

УДК 621.3

ОТКЛЮЧЕНИЕ ЭЛЕКТРИЧЕСКОЙ ЦЕПИ БЕЗ ВОЗНИКНОВЕНИЯ ДУГИ

Аннотация: *В статье предложен метод отключения электрической цепи без возникновения дуги способом увеличения сопротивления цепи и уменьшения тока соответственно. Также наводится пример общей схемы и конструкции даного выключателя с использованием рекуперационного модуля.*

Ключевые слова: *высоковольтный универсальный выключатель, плазма, бездуговой выключатель*

Breaking an electrical circuit causes an occurrence of the self-inductance electromotive force. A gap between two different contacts appears under the influence of this electromotive force and the electrical system voltage, and consequently an electrical arc occurs. This results in additional maintenance service; reduced switching durability; reduced reliability of the electrical apparatus while functioning in the conditions of high humidity and polluted air; emission of the chemically active and toxic substances during the arcing; generation the radio interference and acoustic noise in the process of the arcing; energy dispersion in the electrical arc during the commutation; increased copper and silver consumption due to the extra contact replacement. Therefore, in the age of the increasing electric power efficiency the method of electrical circuit disconnection causing an electric arc and its subsequent extinguishment is absolutely inefficient. According to the EU directive on the power efficiency of Oct 25, 2012 [1] and the European Investment Bank's program «Supporting Sustainable, Competitive and Secure Energy in Europe» [2], the purpose of the new technologies utilization with the view of power efficiency improvement is urgent.

The articles [3-4] suggest a method of reducing the electric arc impact on the contacts [3] and a method of avoiding the electrical arc by using a resonant loop [4]. The advantage of the first method [3] lies in the construction simplicity. The disadvantage is the arcing during the disconnection. The advantage of the second method [4] is the increased reliability and environmental friendliness. The drawback is the necessity of the precise adjustment of the resonant loop for each system and the design complexity.

It is well known that the parameters of the electrical arc depend on the current [5]. In order to create unfavorable conditions for the arcing it is necessary to reduce the current and raise, according to Ohm's law [6], the resistance value to that that tends to infinity. In this case the value of the current strength will tend to zero [6].

This condition is created by the connecting of the branch circuit 2 to the electrical circuit 1, fig.1. In the branch circuit the following elements are connected in consecutive order: interlocking key SQ3, alternating resistance (rheostat) RR1, and the recovery module. In such case, the switch contains two consecutively connected pairs of main contacts SQ1 and SQ2.

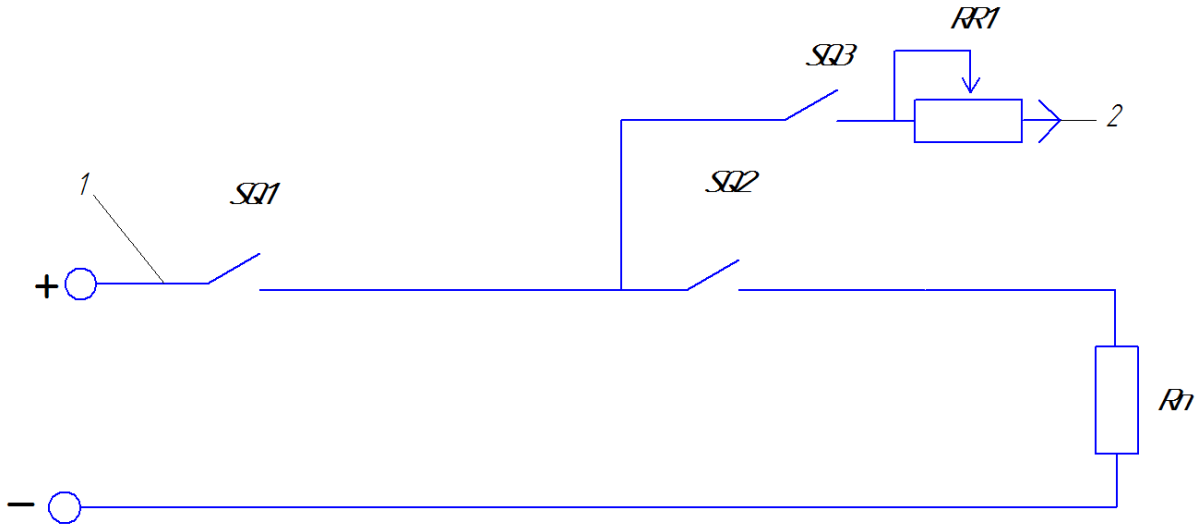

Figure 1 – The schematic diagram of the direct current breaker.

Thus, the electrical circuit disconnection is performed in the following order:

1) Closing the interlocking key SQ3. Alternating resistance at this point of disconnection tends to zero. The resistance of the branch circuit is less than the resistance of the electrical circuit to the point that after closing the interlocking key SQ3 all the electrical energy is directed from the electrical circuit to the branch circuit;

2) Disconnection of the main pair of contacts SQ2. As a result the consumer unit's power is removed;

3) Rheostat RR1 resistance increases to the value that tends to infinity;

4) Disconnection of the main pair of contacts SQ1. By this time the resistance of the electrical circuit tends to infinity, and therefore the current tends to 0, which allows unlocking the main two contacts SQ1 without arcing. The power from the switch is removed;

5) Opening the interlocking key SQ3. The rheostat RR1 is installed in the initial position.

The example of the design for the direct current breaker is illustrated in Figure 2.

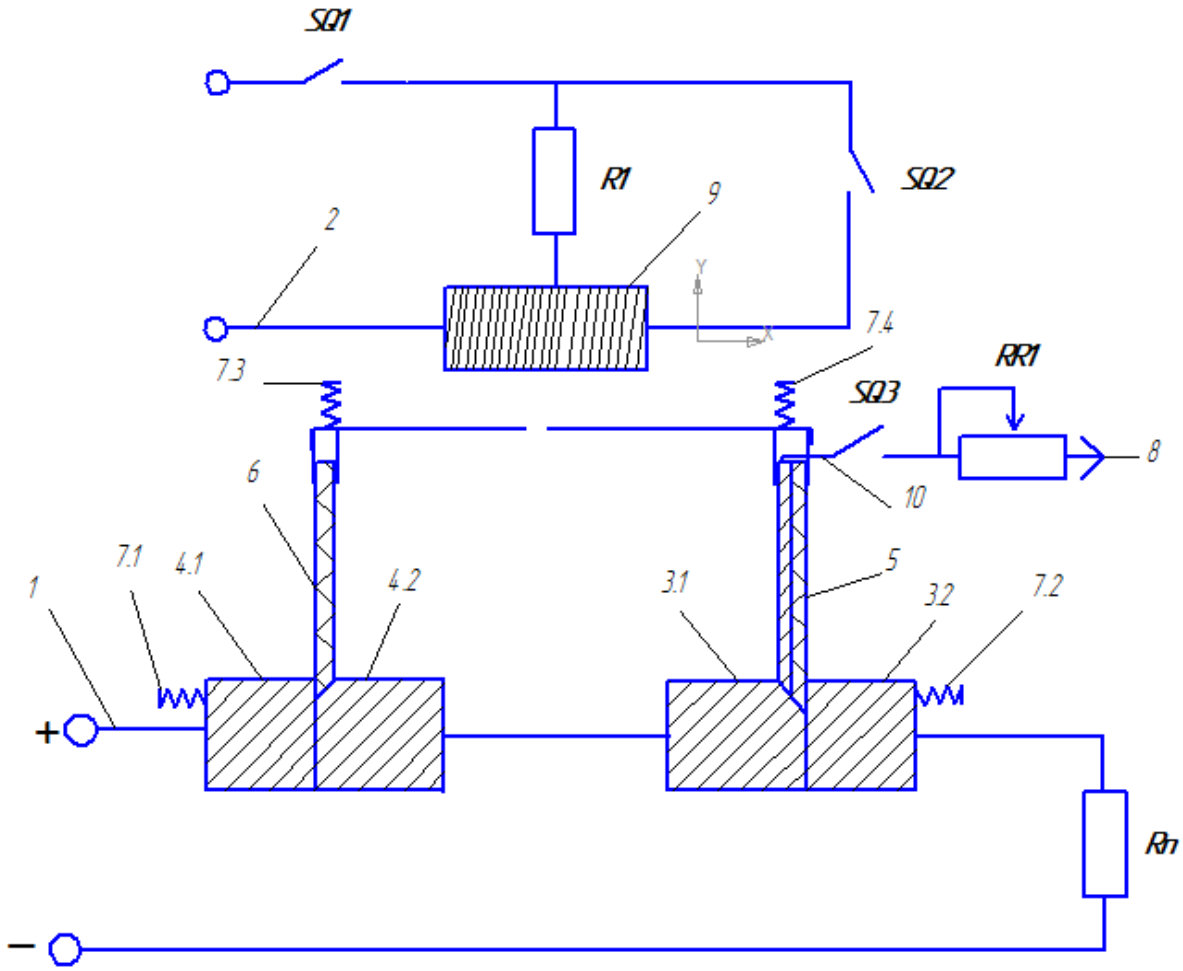

Figure 2 – The wiring diagram of the direct current breaker.

Circuit 1 is an electrical one. It consists of the two consecutively connected pairs of contacts 3 and 4, and the consumer unit Rn. The contacts are made of high-conductive material. In the off position of the switch the inserts 5 and 6 are above the contacts. The insert 6 of the second pair of contacts 4 is made entirely of dielectric material. The insert 5 of the first pair of contacts 3 consists of two bonded plates. The plate that is in the constant contact with the "+" of the circuit is made of conductive material. The plate that is located on the "-" side of the circuit is the dielectric. The conductive plate is electrically connected to the branch circuit 10. The next consecutively connected active elements are related to the branch circuit: the interlocking key SQ3, the rheostat RR1, and the recovery module 8. The control circuit 2 is powered by the low-voltage network. It includes the following elements: the interlocking locking keys SQ1 and SQ2, the latter is electrically connected to the top of the electromagnet winding, and the parallel to it resistor R1, which is electrically connected to the middle of the electromagnet winding and the electromagnet 9. In the on position of the switch the electrical circuit pair of contacts is compressed by the springs 7.1 and 7.2. In the control circuit the keys SQ1 and SQ2 are closed, the electromagnet is powered. The inserts are in the extracted position to the contacts. They are hold by the magnetic field of the control circuit electromagnet. The contact SQ3 is open; the voltage in the branch circuit is removed.

The switch disconnection is performed in the following order:

1) The key SQ3 is closed in the branch circuit. The resistance of the rheostat RR1 and the resistance of the branch circuit tend to 0. This causes the power redirection from the electrical circuit to the branch circuit and to the recovery module.

2) The key SQ2 is opened in the control circuit, which causes the release of the voltage from the top of the electromagnet winding. The voltage is applied to the middle of the electromagnet winding through the resistor R1. Thus, that part of the electromagnet which created the magnetic flux that held the first insert is not powered. The spring 7.4, returning to its normal position, pushes the first insert and unlocks the first pair of the contacts 3.

3) The resistance of the rheostat RR1 increases abruptly from the minimum to the maximum so that the current strength in the electrical circuit tends to zero. It creates the unfavorable conditions for arcing in the circuit.

4) The key SQ1 is opened in the control circuit, removing the power from the electromagnet. The spring 7.3 pushes the second insert 6 and unlocks the second pair of the contacts 4 without arcing.

5) The key SQ2 is closed; the key SQ3 is opened, going into the standby mode.

The alternating current breaker duplicates the schematic diagram of the direct current breaker from the both sides to the load.

Conclusions:

1) The article describes the arc-fault method of the electrical circuit breaking by redirecting the electric power to the branch circuit and increasing the electrical circuit resistance to the value that tends to infinity, and thus reducing the current to the value that tends to zero.

2) The article suggests the example of the direct current breaker construction that differs from the known breakers by the absence of the arc blowout device and the presence of the recovery module, which allows avoiding the problems arising due to the arcing and the energy dissipation during the circuit break.

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