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LINE PROTECTION DEVICE FROM SINGLE-PHASE EARTH FAULTS IN NETWORK WITH INSULATED NEUTRAL WITH VOLTAGE OF 6-10 KV

I.F.Suvorov[1] *Doctor of Technical Sciences, Professor,*
B.B.Utegulov[2] *Doctor of Technical Sciences, Professor*
A.B. Utegulov[2] *Candidate of Technical Sciences,*
[1]*Transvaikal State University, China city, RUSSIA*
[2]*S. Seifullin Kazakh Agro Technical University, Astana, Kazakhstan*

Annotation

A device has been developed for protection the line from a single-phase earth fault in a network with isolated neutral that provides selectivity and operating speed at a single-phase earth faults through a transient resistance in case, additionally, if the capacitive current of the protected line is commensurate with the total current of the remaining lines.

The developed device comprising the capacitors by number of phases connected in the junction of the primary windings of the main and additional zero sequence current transformers connected in series and having matching elements at the output, supplied with thyristor optocouplers, NAND logic elements connected in an RS-flip-flop circuit, transistor, performing the functions of the electronic key, optotiristor, which power electrodes commute the coil of a disconnection electromagnet of the line load breaker.

A device has been developed for protection the line from a single-phase earth fault in a network with isolated neutral that provides selectivity and operating speed at a single-phase earth faults through a transient resistance in case, additionally, if the capacitive current of the protected line is commensurate with the total current of the remaining lines.

Key words: current, neutral, network, protection, line, capacitance, transformer.

Introduction

In order to increase the selectivity at single-phase earth faults (s.p.e.f.) through the transient resistance in electrical networks with isolated neutral, line protection device from single-phase earth faults in three-phase electric networks with an isolated neutral has been developed.

At present, the widely used device from single-phase earth faults is which consists of capacitors by number of phases connected between the respective phases of the network and ground, the zero sequence current transformer and the executive relay, and also is equipped with two rectifying bridges and an additional zero sequence current transformer [1]. The disadvantage of this device is that the protection has a low selectivity at single-phase earth faults through a transient resistance in places where the capacitive current in the network is commensurate with the total capacitive current of the protected line.

Methods

The developed device comprising the capacitors by number of phases connected in the junction of the primary windings of the main and additional zero sequence current transformers connected in series and having matching elements at the output, supplied with thyristor optocouplers, NAND logic elements connected in an RS-flip-flop circuit, transistor, performing the functions of the electronic key, optotiristor, which power electrodes commute the coil of a

disconnection electromagnet of the line load breaker.

Figure 1 shows the scheme of the developed device, in Figure 2 - the time diagrams of the device.

The line protection device at single-phase earth faults in a network with an isolated neutral contains:

- source of power; an electric line with a single-phase earth fault in phase A;
- zero sequence current transformer TA1;
- additional zero sequence current transformer TA2;
- capacitors C, connected by the number of phases;
- matching elements EM1 and EM2;
- thyristor optocouplers VU1-VU2;
- resistors R1-R4;
- logical elements NAND E1-E5;
- transistor VT;
- optotiristor VU3;
- load break switch QF.

The time diagrams in Fig. 2 shows the currents at the output of the matching elements EM1 and EM2, where :

I_{sw} – the switching current of the thyristor optocoupler;

I_o – capacitive network current;

$I_к$ – the current generated by the capacitor C;

j – angle of phase shift between the I_c current and I_o .current vectors.

The total current is determined by the formula

$$I_c = I_o + I_к. \qquad (1)$$

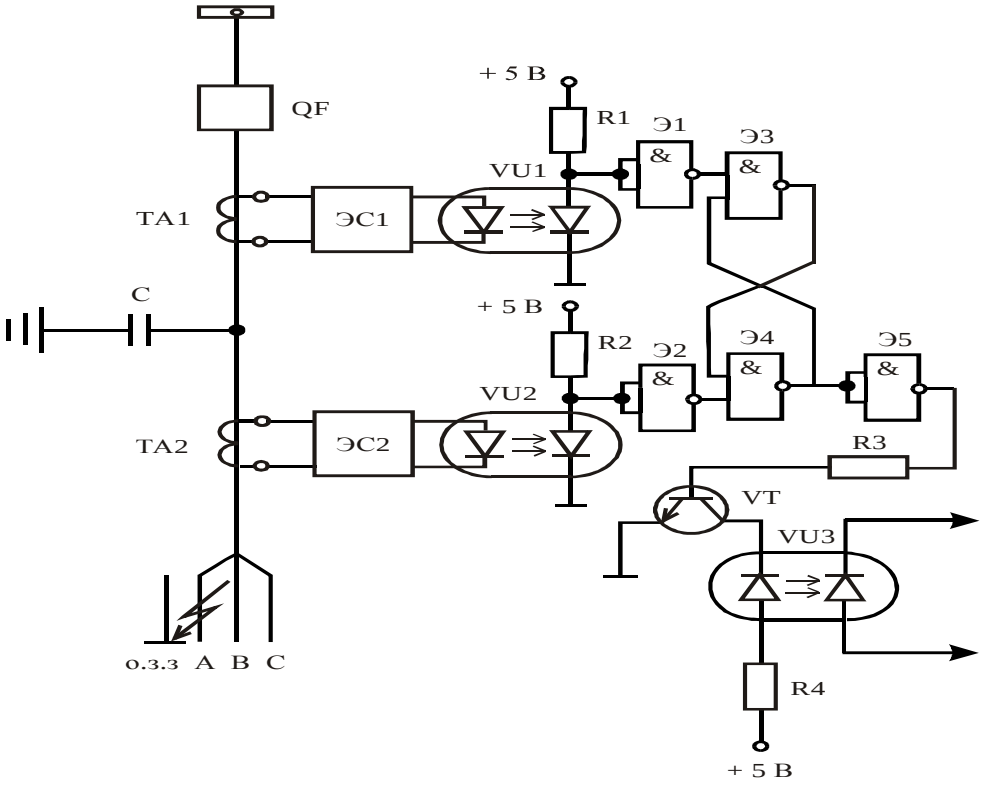

Figure 1

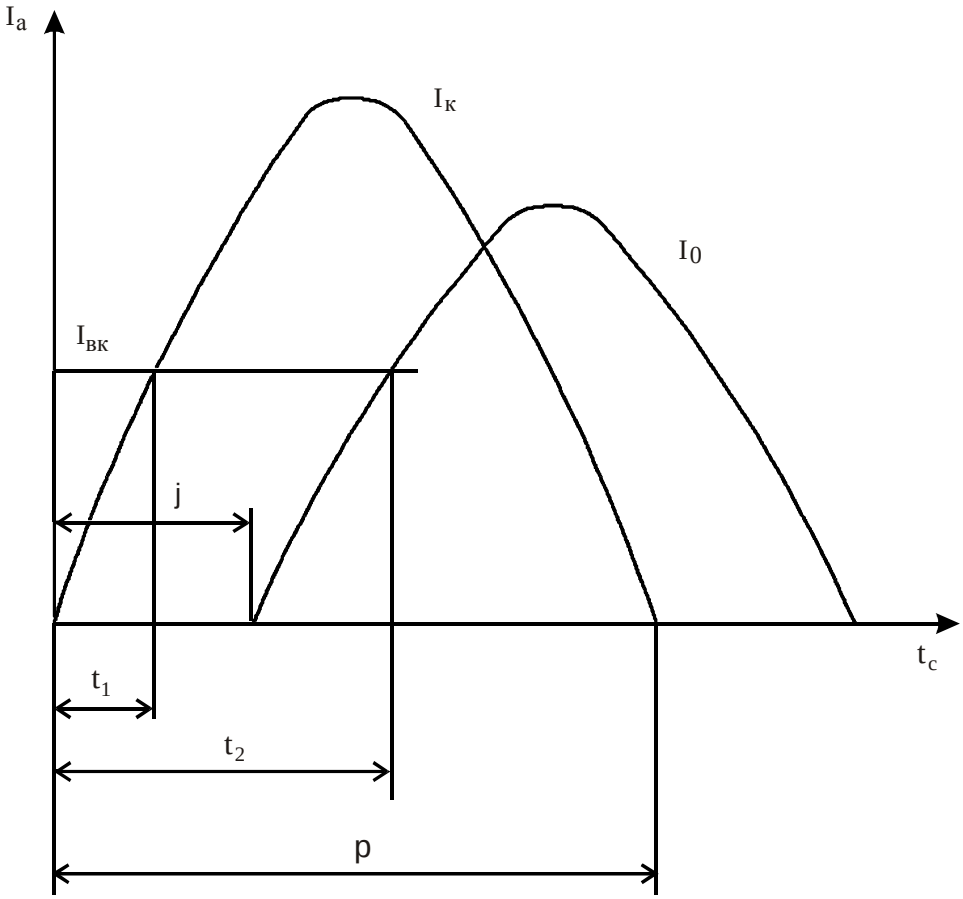

Figure 2

The device works as follows. The magnitude of the current $I_к$ provides a difference in the amplitudes of the currents I_c and I_o, and the angle of phase shift j between the current vectors I_c and I_o. The difference in the current amplitudes I_c and I_o and the phase angle of these currents is characterized by the capacitance C, the larger the capacitance C, the greater the phase shift angle between the currents I_c and I_o and the difference in the amplitudes of these currents, which increases the time difference between the switching signals of thyristor optocouplers and positively affects on the reliability of the developed line protection device from single-phase earth faults in networks with insulated neutral.

In the absence of a short circuit on the line and on the power supply side, the thyristor optocouplers VU1 and VU2 are closed and a high voltage is present at the inputs of the NAND elements E1 and E2. At the output of these elements and at the inputs of the NAND elements E3, E4 there is a low voltage. Accordingly, at the output of the NAND elements E3 and E4 - the high level voltage, at the inputs of the NAND element E5 the high level voltage, at the output - voltage is low, so the transistor VT is closed, the opto-chiristor VU3 is closed and the load switch QF of the line is in the on state.

In the event of a single-phase earth fault in lines through the current transformer TA1 flows I_o - the capacitive current of all

lines of the network, and I_c - the total current that consists of the currents I_o and $I_к$ and flows through the current transformer TA2.

As can be seen from Fig. 2, a larger control signal is applied to the control electrode of the thyristor optocoupler VT2, which is characterized by current I_c, which leads to its rapid opening in a time t_1, with the low-level voltage appearing at the inputs of the NAND element E2, at the output of this element and on one a high-level voltage appears from the inputs of the NAND element E4. At the second input of this element there is already a high voltage, therefore at the output of the NAND element E4 and on one of the inputs of the NAND element E3 and at the inputs of the NAND element E5 is the low level voltage. At the output of the NAND element E5 and on the base of the transistor VT, a high level voltage appears, so the transistor opens, the VU3 opens up, the shut-off electromagnet turns off and the load switch QF turns off.

If a single-phase earth fault occurs on the supply side, only the capacitive current I_o of the line flows through the current transformer TA2, and the value of the total current that consists of current I_o and current $I_к$ flows through the current transformer TA1.

According to Fig. 2, a large control signal is applied to the control cathode of the thyristor optocoupler VU1, which is characterized by current I_c, which leads to its rapid opening in time t_1. At the inputs of the NAND element E1, a low level voltage appears, at the output of this element and at the input of the NAND element E3 appears a high level voltage. Since another input of this element already has a high level voltage, then at the output of this element and at the input of the NAND element E4 there is a low voltage. At the other input of the NAND element E4, there is a low level voltage, so at the output of the NAND element E4 and at the input of the NAND element E5 is a high level voltage, at the output of the NAND element E5 – low level voltage. The transistor VT is closed, the optotiristor VU3 is closed, and the load switch remains in the ON state.

Since a low-level voltage appears at the input of the NAND element E4, this excludes the switching off of the QF switch when it is triggered through the time t_2 of the thyristor optocoupler VU2, because when a high level voltage appears on the second input of the NAND element E4 as a result of the operation of the thyristor optocoupler VU2, at the output of the NAND element E4 and at the input of the NAND element E5 there remains a high level voltage, at the output of the NAND element E5 the low level voltage , the transistor VT is closed, the opto-chiristor VU3 is closed, the QF switch is in the on state.

The matching elements are provided for the purpose of adjusting the device in such a way that all thyristor optocouplers are switched on at a certain current value of the zero sequence.

Conclusion

A device has been developed for protection the line from a single-phase earth fault in a network with isolated neutral that provides selectivity and operating speed at a single-phase earth faults through a transient resistance in case, additionally, if the capacitive current of the protected line is commensurate with the total current of the remaining lines.

References

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Түйін

Жер арқылы өтпелі кедергісі болған жағдайдағы бір фазалы тұйықталудан, оқшауланған нейтральді тораптағы қамтамасыз ететін селективтілігі мен жылдам әрекет ету кезіндегі желілерден қорғайтын құрылғы әзірленді.

Әзірленген құрылғы, конденсаторлар фазаларының саны бойынша енгізілген жерде қосылыстар бастапқы орамдардың негізгі және қосымша трансформаторлар тоғының нөлдік реттілігі қосылған дәйекті және шығуы бар келісетін элементтері, сонымен қатар тиристорлы оптрондармен қамтамасыз етілуі, ЖӘНЕ-ЕМЕС секілді логикалық элементтермен, RS - триггерлер сызбасы бойынша біріктіру, функцияларды орындайтын электрондық кілт, оптотристор, транзистор, желінің жүктемесінің қосылғышын ажырататын электромагниттің катушкасын каммутациялайтын күш электродтары

Резюме

Разработано устройство защиты линии от однофазного замыкания на землю в сети с изолированной нейтралью обеспечивающее селективность и быстродействие при однофазных замыканиях на землю через переходное сопротивление в случае, дополнительно, если емкостной ток защищаемой линии соизмерим с суммарным током остальных линий.

Разработанное устройство, содержащее по числу фаз конденсаторы, включенные в месте соединения первичных обмоток основного и дополнительного трансформаторов тока нулевой последовательности, включенных последовательно и на выходе имеющих согласующие элементы, снабжено тиристорными оптронами, логические элементы И-НЕ, соединенные по схеме RS-триггера, транзистор, выполняющий функции электронного ключа, оптотиристор, силовые электроды которого коммутируют катушку электромагнита отключения выключателя нагрузки линии.

Разработано устройство защиты линии от однофазного замыкания на землю в сети с изолированной нейтралью обеспечивающее селективность и быстродействие при однофазных замыканиях на землю через переходное сопротивление в случае, дополнительно, если емкостной ток защищаемой линии соизмерим с суммарным током остальных линий.