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ASYNCHRONOUS MOTOR PROTECTIVE RELAY WHEN ONE OF THE ROTOR PHASES GETS INTERRUPTED

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Abstract: The electronic relay for protecting the asynchronous motor rotor against remaining in two phases can be used in electrical driving with slip-ring asynchronous motors. It is meant to control and turn off the supply network when one of the phases is missing in the rotor circuit, respectively in the case of an unbalanced three-phase system.

Key words: asynchronous, motor, protection.

1. INTRODUCTION

The problem of diagnosis is indeed related to that of the maintenance, utilizing economic factors that are difficult to evaluate [4]. The issues of preventive and condition-based maintenance, online monitoring, system fault detection, diagnosis, and prognosis are of increasing importance [2], [3].

The key issues for a successful motor operation are a quality motor, understanding its application, choice of the proper one for the application, and its proper maintenance. The use of induction motors in today's industry is extensive and they can be exposed to different hostile environments, manufacturing defects, etc. [5]

These types of faults usually refer to the gradual deterioration of the motor that can lead to motor failure if undetected [5].

Monitoring of the current per phase can provide indications on the motors state. This is preferable, compared to other methods since it is easy for physical measurement. The fault affects the spectrum current signal while the induction machine is sufficiently loaded and generally, we can extract from that the number of the broken bars. The motor current based fault detection relies on interpretation of the frequency components in the current spectrum that are related to rotor asymmetries.

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2. ASYNCHRONOUS MOTOR ABNORMAL WORKING REGIMES

The overload and short-circuit currents produce the winding temperature increment above the maximum admissible value that leads to the motor break down [1]. It is necessary to take certain measures in order to avoid such situations.

An overload current may appear when [5]:

- the driven mechanism is over loaded, that is the load torque overpasses the maximum motor torque for a long time; in this case, the motor stalls and the current reach the starting current value;
- the supply voltage lowers, which determines the rotor, respectively stator current diminution; the speed goes down up to the motor stop; when the supply is reestablished, if the motor hasn't been disconnected, the current is high (starting current).
- one of the stator or rotor phase is interrupted, which determines 1.7 – 1.8 times increment of the other two currents.

The interruption of one of the rotor phases causes the following effects:

- the motor speed goes downward;
- some strange specific noise appears;
- the zero voltage in the rotor star connection shifts and a shift voltage appears;
- the rotor voltage frequency modifies;
- the currents in the other two phases grow by $\sqrt{3}$;
- the motor slip changes.

3. ELECTRONIC RELAY FOR PROTECTING THE SLIP-RING ASYNCHRONOUS MOTORS WHEN ONE OF THE ROTOR CIRCUIT PHASES IS INTERRUPTED

The belt conveyors in the lignite quarries are driven with 1 – 5 slip rings asynchronous motors.

The motors connection to the 6 kV network is made using an interrupter CA – 100 A, for one motor, or CA – 200 A for two simultaneously connected motors.

Measurements made in the lignite mining area of Oltenia showed that, when driving a belt conveyor with several motors, the motor power is over dimensioned, considering the heavy working regimes [2].

Practice highlighted that the asynchronous motors rotor circuit frequently remains in two phases due to the imperfect contact between the brush and the collecting rings or between the mobile electrodes and the stationary ones at the starting rheostat.

If the trouble appears during the motor running, the overload in the motor stator isn't sensed immediately by the existing protection because of the derivation connection of the two motors. When the conveyor restarts and one of the motors has the rotor circuit in two phases, the staring time being usually long and the torque and the starting current having high values, the collecting rings or the windings are destroyed.

To eliminate these defects and to reduce the electric energy consumption, we designed and achieved an electronic protection relay Re (figure 1).

In short, a protection relay is a device that receives inputs, compares them to set points, and provides outputs which prevent the system from breaking.

In our case, this relay senses the rotor circuit remaining in two phases during operation and does not allow restarting while the trouble is not solved.

The motors start is accomplished using a liquid rheostat, in star connection, whose neutral point has a null potential when the motor works normally.

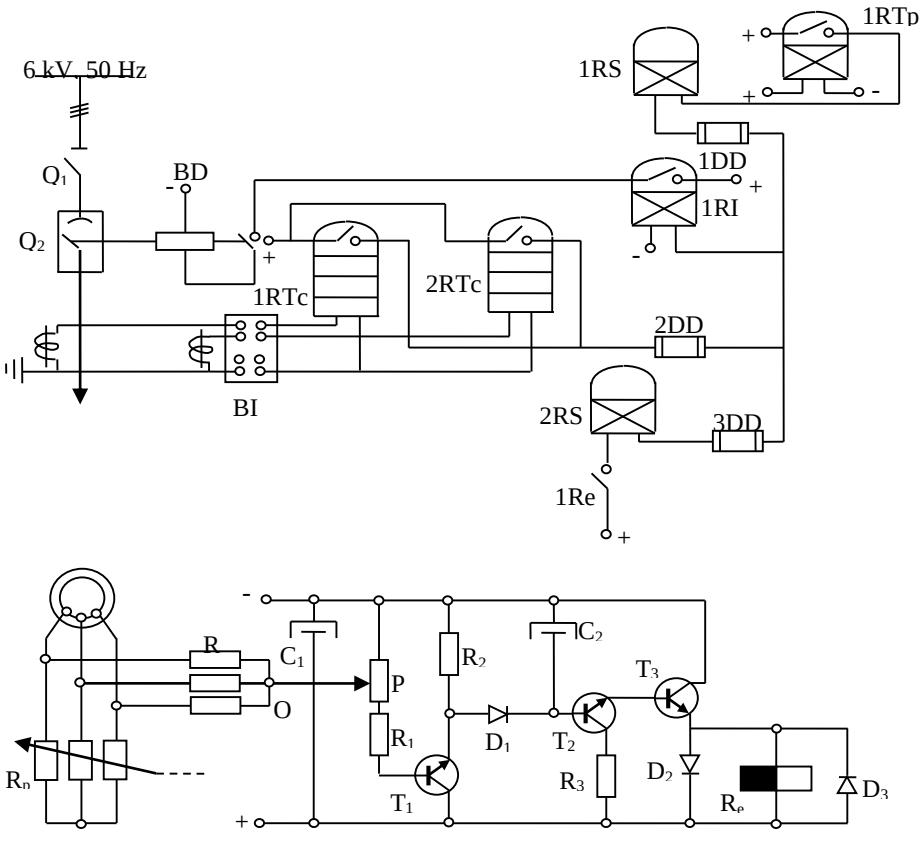

Fig. 1 Operating principle of the protection relay

When the rotor circuit remains in two phases, the null shifts and the protection relay is supplied. The use of the 2RS relay gives the warning “rotor in two phases” and, through the time relay 1RTp, it transmits the trip signal through the tripping coil BD to the interrupter Q2.

The potentiometer P resistance is modified depending on the zero-shifting voltage.

4. CONCLUSIONS

The asymmetrical working regime of the asynchronous motor raises important problems related to the operation and the integrity of the motors.

The protection against one of the supply phase interruption is solved in several options.

The interruption of a rotor phase isn't sensed by any of these solutions. So, it was necessary to design an adequate specific protection, which we managed.

Using the protective device that we made, important economic effects were obtained, related to avoiding the motors braking down.

The relay was achieved end experimented in our laboratory and some of the motors at the Rovinari opencast mining company.

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