WOUND-ROTOR SLIP RECOVERY SYSTEM EFFICIENCY UPGRADING

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The asynchronous motor rate control in the valve stage and double-fed motor schemes is performed by the sliding motion change of the motor at the constant electromagnetic field rotation rate. The main idea - is a beneficial use of the slip power stepped in to the rotor circuit. In the valve stage schemes the wound-rotor induction motor rotor current is rectified by means of the uncontrolled rectifier and a supplementary electromotive force of the DC current from the inverter is introduced into the rectified current circuit of the rotor. For the circuit and rotor voltage concord an impedance-matching transformer is used.

A wound-rotor slip recovery system [1] containing a wound-rotor induction motor, diode three-phase bridge connected by the alternating current outputs to the rotor rings and by the DC current outputs through the series-connected restrictor – to the corresponding outputs of the bridge thyristor inverter DC current outputs, is known. The abovementioned inverter is connected with the AC network through the impedance-matching transformer, and the inverter thyristors are controlled by the system of the pulse-phase control.

The demerits of this wound-rotor slip recovery system are in the following:

1. To increase the phase factor coefficient 4 the impedance-matching transformer 5, the relative capacity of which is equal to the motor speed relative control range, is needed. For example, if the rotation frequency is controlled within the range from the nominal to 70% of design the impedance-matching capacity will make some more than 30% of the motor output. At a wider control range the impedance-matching transformer capacity increases accordingly. It is for this very reason that the wound-rotor slip recovery system utilization area was traditionally restricted by turbo-mechanisms, wherein the required rotation frequency range is not that large.

2. Even in the presence of the impedance-matching transformer in the area of motor speed close to the nominal, when the inverter 4 electromotive force decreases with the sliding motion reduction, the phase factor decreases accordingly.

For diminishing the enumerated demerits it is offered [2] to perform the pulse control of the rotation frequency at small sliding motions of the motor by a short-time translating of the inverter into the mode of deep conversion, however, this very method is applicable in a small speed range only and, besides, results in torque pulsations of the motor and low-frequency harmonics production into the feeder line.

The author offers a scheme [3] quoted in Fig.1 allowing excluding the abovementioned demerits.

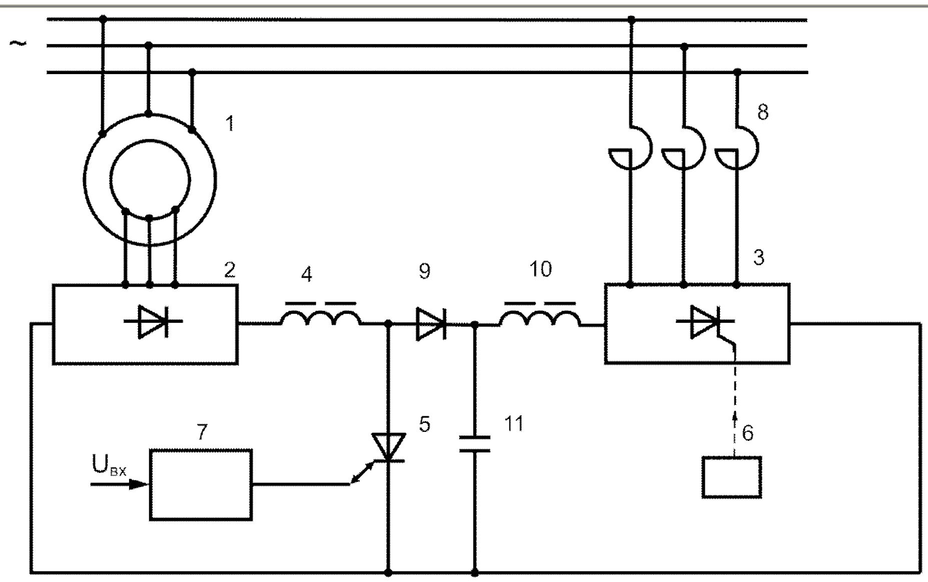

Fig. 1. 1 - asynchronous motor, 2 - three-phase diode bridge, 3 – thyristor inverter, 4-10 – smoothing inductors, 5 – key, 6 – pulse-phase control system, 7 – key 5 control system, 8 – current-limiting reactors, 9 –cut-off diode, 11 - capacitor.

The device functions as follows. At the input signal absence, i.e at $U_{in} = 0$ the key 5 is locked. The electromotive force of sliding motion of the blocked asynchronous motor 1 is maximal, but it is much less, than that of the back electromotive force of the bridge thyristor inverter 3, as the system of pulse-phase control 6 provides the minimal and constant switching on advance angle of the bridge thyristor inverter 3. This angle β min $\approx 20^0$, therefore, the bridge thyristor inverter back electromotive force

$$E_{dmax} \approx 1{,}35U_{л} \cdot \cos\beta \approx 1{,}27U_{л}, \quad (1)$$

wherein $U_{л}$ – is the line voltage of the supply main, 1,35 – the coefficient for the three-phase bridge, cosβ = cos 20^0 = 0,94. At the same time the rotor EMF in the wound-rotor induction motors is much less, it means that there is no current in the rotor circuit, and the capacitor 11 is charged up to the rectified diode three-phase bridge 2 EMF magnitude. At $U_{вх} > 0$ the key 5 begins to unlock periodically in the mode of pulse-time modulation. In the "on" condition moments of the key 5 the current through the restrictor 4 grows. At the key 5 break the restrictor 4 gives the condensed energy to the capacitor 11. When the capacitor 11 voltage exceeds the bridge thyristor inverter 3 back EMF the sliding motion energy output into the supply main starts. The smoothing inductor 10 provides the current continuous character, and the presence of the intermediate storage of energy in terms of the capacitor 11 allows refusing of the impedance-matching transformer and performing the slip energy inversion into the high and constant phase factor network irrespective of the asynchronous motor 1 rotation frequency.

Thus, the offered device makes the wound-rotor slip recovery system use efficient at any adjustable speed range of the asynchronous motor 1.

The device contains some supplementary elements; however, the current-limiting reactors are incomparably less both in price and mass-size factors compared to the impedance-matching transformer in the schemes of the known analogs, the cut-off diode 9 doesn't cause significant losses, and the mass-size factors of the restrictor 4 and capacitor 11 at the modulation frequency of 500 Hz already are rather small. The smoothing inductor 10 only is comparable on its parameters to the restrictor 3 in the "classical" wound-rotor slip recovery system, but the advantages of the offered device compensate this disadvantage.

References:

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2. Bystrov A.M., Shepelin V.F. Switching modes of wound-rotor slip recovery system thyristors with two-region rate control. "Electricity", 1971, N7, pp. 31-42.

3. Patent № 2314636 of RF. Wound-rotor slip recovery system. Magazinnik L.T. Published 10.01.2008. Bulletin № 1, priority 17.10.2006.

WELDING CURRENT THYRISTOR SWITCHES FOR CONTACT WELDING

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The duration of spot and seam welding fluctuates from several seconds to centiseconds, and the number of switching the welding transformer on and off can reach several thousands for one working shift. For such switching frequency the power contactors turn out to be unfit on their mechanical strength, and their own action time proves to be more than that necessary for one unit point welding. The requirements of practical non-persistence and high switching frequency were met by ignitron current switches, but they are of considerable gabarits, poor efficiency and need water cooling. So, it is advisable to use a thyristor commutation switch in the primary coil circuit of the welding transformer feeding the load. The use of the transformer load thyristor commutation switch has its own features, and the optimization of such controlling systems for the purpose of their work reliability enhancement is topical.

It is known that the cutting a transformer into mains is attended with magnetizing current inrush, the amount of which reaches a tenfold value from the current rating. For the minimization or virtual elimination of the current rush at the moment of the transformer switching on the thyristor commutation switch controlling system is synchronized with the feeder line, and the on-off trigger included in this system in the known devices [1] provides "remembering" the sign (plus or minus) of the last current half-period. The next switching on the transformer is possible only in the half-period reversed in sign. Thus, through the transformer an even number of current half-periods passes, and magnetic biasing of the transformer is excluded. The controlling system synchronization with mains guarantees also an optimal start switching angle of the thyristor commutation switch.

The analogous thyristor commutation switches controlling systems are used in developments of recent years [2]. Particularly, in the FORWEL firm catalogue, 2004, pp.1-6, there is a resistance (i.e. contact) welding machine control system given, the simplified functional scheme of which is given in Fig.1.

A disadvantage of the abovementioned controlling systems is the memory loss by the on-off trigger at the loss of voltage in mains owing to accidental or operational cutting off and, as a consequence, the magnetizing current inrush possibility, when the device is cut into mains after the interval in feeding.