

This paper presents a novel structure schemes of control systems for driving a three-phase non-synchronous electric motor with shunt rotor, by the method of suitable orientation of the motor magnetic field. The orienting principle and the formulas analysis, giving the connection between the most important variations are explained.

As is well-known three - phase induction motors are complicated objects for control by orientation of the magnetic field [1]. This control is based upon fixing of the current components in the three phases in the stator circuit [2]. Besides these three sinusoidal currents of the motor with rotation magnetic field could be unified in to one vector $\vec{i}_s(t)$, rotating with frequency ω_s :

$$i_s(t) = i_{su}(t) + i_{sv}(t) \cdot e^{j\frac{2\pi}{3}} + i_{sw}(t) \cdot e^{j\frac{4\pi}{3}} \quad (1)$$

In that case three current components $i_{su}(t)$, $i_{sv}(t)$, $i_{sw}(t)$ are space projects of the vector $\vec{i}_s(t)$ over the axes of the stators windings.

The same method could be used for stator's voltage \vec{u}_s and mutual magnetic flux of the stator $\vec{\Psi}_s$ and the rotor $\vec{\Psi}_r$. So all space vectors are rotating circular with constant angular speed ω_s . If particular vector is synchronized with the vectors mentioned above thus his components in the coordinate system with axes d and q have the following expression:

$$\vec{u}_s = u_{sd} + u_{sq} \quad (2)$$

$$\vec{i}_s = i_{sd} + i_{sq} \quad (3)$$

$$\vec{\Psi}_s = \Psi_{sd} + \Psi_{sq} \quad (4)$$

$$\vec{\Psi}_r = \Psi_{rd} + \Psi_{rq} \quad (5)$$

If the ax d is consulted with direction of the space vector of the rotor's mutual magnetic flux $\vec{\Psi}_r$ of the three phase induction motor, the reactive component Ψ_{rq} of the rotors flow, falls out and the active one Ψ_{rd} is given with following expression:

$$\Psi_{rd}(p) = \frac{L_m}{1 + pT_r} \cdot i_{sd} \quad (6)$$

The torque M_b of the asynchronous motor in this case is:

$$M_b = \frac{3}{2} \cdot \frac{L_m}{L_r} \cdot Z_p \cdot \Psi_{rd} \cdot i_{sq} \quad (7)$$

The symbols in the formulas above are:

i_{sd} , i_{sq} - active and reactive component of the stator's current;
 L_m , L_r - mutual and armature inductance;

T_r - time constant of the rotor's circuit and p is Laplasianian operator .

Formula (7) points main linear dependence between torque M_b of the three phase asynchronous motor from the reactive component i_{sq} of the stator's current and the active component Ψ_{rd} of the rotor's flow .

If Decart's coordinate system with axes d and q is oriented so ,that d is parallel to the stator's winding u , thus coordinate system is transformed into based on axes α and β . Besides three - axes system of the asynchronous motor with circular rotating magnetic field with appropriate transformation could be expressed with two-axes system α and β . On the figure 1 block scheme for control of the motor by orientation of the magnetic field is shown. It contains two proportional-integrated controllers for speed 9 and flow 1 . Quit the same are the controllers 2 and they are used also for formation of the magnetic field with components i_{sd} and i_{sq} . Corresponding components u_{sd} and u_{sq} of the stator's voltage are results of the functional converter 3 (Ek) . When angle between axes d and q is known by block 4 components of the stator's voltage are transformed into $u_{s\alpha}$ and $u_{s\beta}$. They are acting on the input of the space - vector's modulation block 5 . The block controls three phase inverter , which is powering AC motor M . Block 8 forms flow model [EM] is used to calculate real component Ψ_{rd} of the rotor's flow and angle ν between axes d and α . It can be pointed that transformed current components i_{sd} and i_{sq} are independent one from another while inside components d and q are dynamically connected in between. This allows the motor with circular rotating magnetic field to be observed as vector's area of regulation .

On fig. 2 and fig.3 , there are enhanced block schemes , which are using such kind of regulator 2. Coordinate transformation on fig. 2 is after regulation while on fig.3 is before regulation.

On fig. 4 there is similar scheme for field - oriented control of an AC motor.

Finally it could be said that proposed schemes appear to be base for precise analytic researches.

Literature

1. W. Leonard: „Field orientation AC-Drives“, ERE, 1991
2. F. Blaschke: „The principle of field orientation“, S.R. 1982.

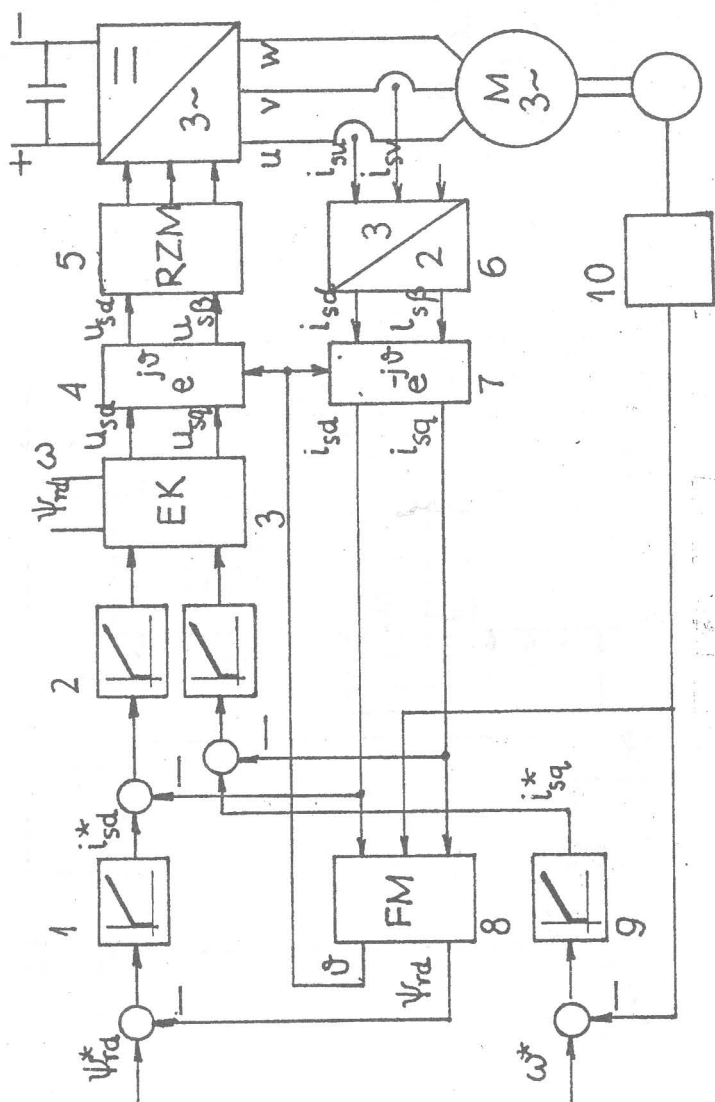


fig.1

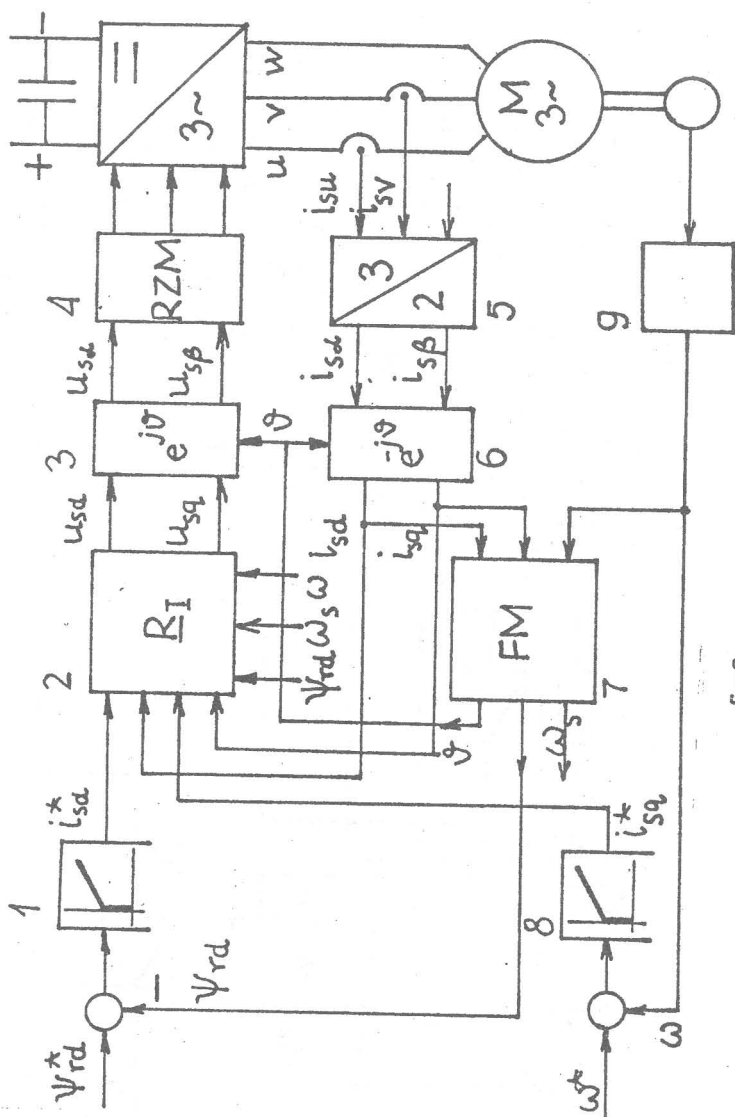


fig.2

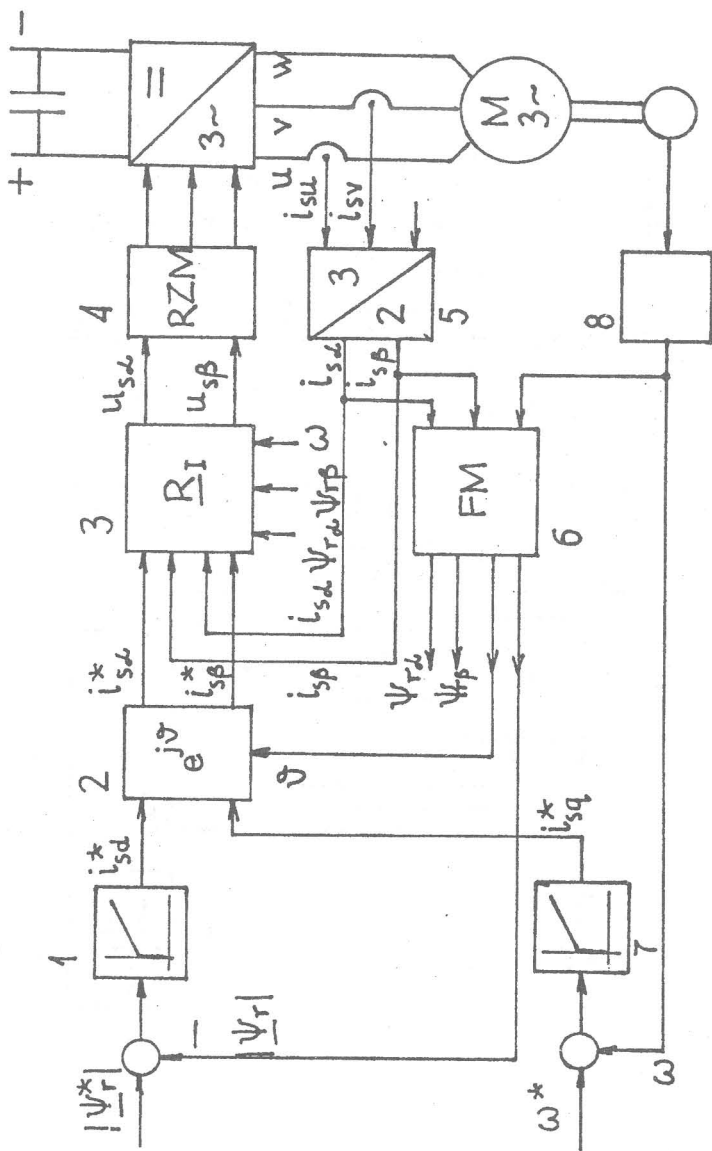


fig.3

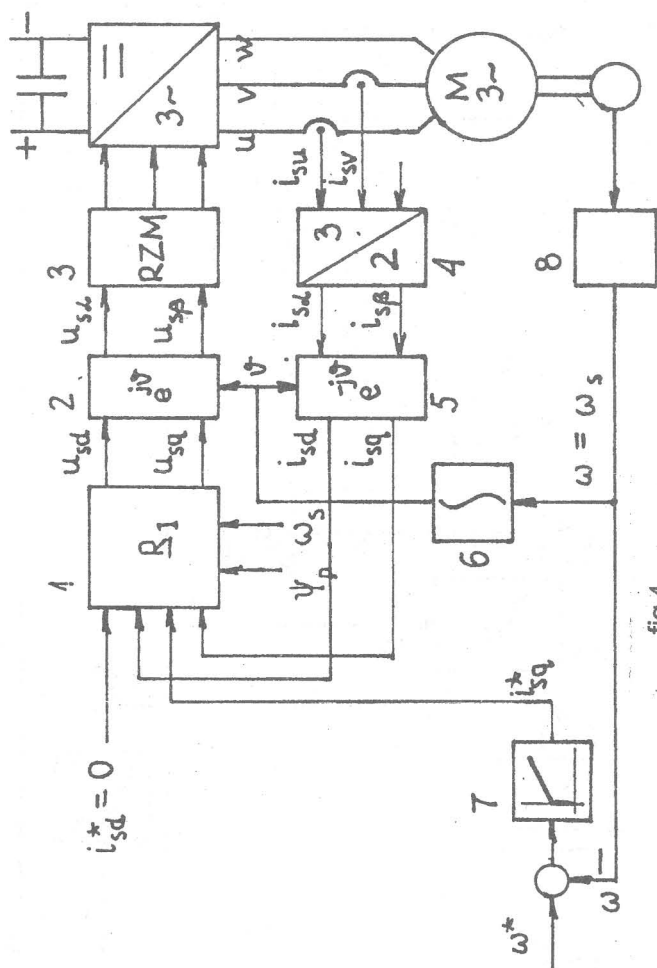


fig.4