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NEW POSSIBILITIES OF DRIVER OF PIVOTING MECHANISM OF THE ROTATIVE ARM FROM THE EXCAVATOR SRS TYPE 1400

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ABSTRACT: In this paper are presented some possibilities to modernize the driving and adjustment systems of the pivoting mechanism at a SRs 1400 excavator.
Keywords: static frequency converter, energy consumption, field orientation

НОВИ ВЪЗМОЖНОСТИ НА ВЪРТЯЩИЯ МЕХЪНИЗЪМ НА РОТАЦИОННОТО РАМО НА ЗАДВИЖВАЩОТО КОЛЕЛО НА БАГЕР ТИП sRs – 1400

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РЕЗЮМЕ: В доклада са представени някои възможности за модернизиране задвижването и регулиране системите на въртящия механизъм на ескаватора SRs 1400
Ключови думи: постоянно честотен конвертер, потребление на енергия, ориентация на полето

Introduction

As it results from using the ERC, in order to have optimal conditions for the excavation process and to have the width of the excavated splinter smaller or at least equal to the width of the excavator grab, it is necessary that the rapport between the speed of the grab wheel and the pivoting wheel to be constant, meaning that the two speeds to follow the same law:

$$v_p(\varphi)=\frac{v_{p_0}}{\cos\varphi};\ v_r(\varphi)=\frac{v_{r_0}}{\cos\varphi} \qquad (1)$$

where:

φ is the pivoting angle (made by the arm with the march axel)

v_{p0}, v_{r0} – basic speeds corresponding to φ=0.

The optimal diagrams are presented in figure 1.

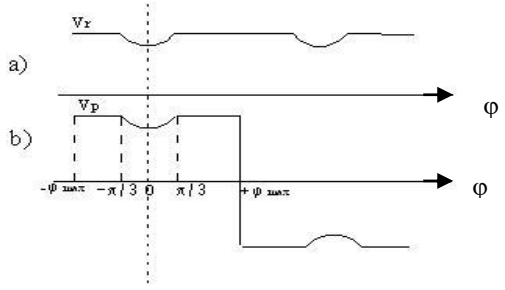


Fig. 1. The optimal diagrams of the speeds: rotation of the grab pivoting wheel function of the pivoting angle
a) Rotation (grab wheel); b) Pivotation

The variations laws (1) determined for the pivoting and rotation (of the wheel with grab) speed assures complete take over conditions of the material and lead to maintaining constant the maximum flow capacity, and also satisfy the optimality conditions under the aspect of energetic consumption and of the dimensioning power of the basic assembly of the excavator.

The scythe shape of the excavated splinter and the necessity to assure a constant flow are the essential elements which impose the driving choice of the pivoting mechanism.

The probability for obstacles to show in the working field, which may overtax the cinematic chain of the mechanism and the rotoric arm, impose a maximal current protection with momentary operation.

In other words, driving the pivoting mechanism must fulfill the following requirements:

- to defeat the maximum resistant moment in the conditions of the toughest working front to assure the maximum load of the grabs,
- to allow the pivoting speed variation for insurances of a constant flow on the whole circle arc of pivotation,
- to answer with high liability to the frequent direction switches imposed by the shuttling of the rotoric arm,
- to ensure a close correlation between the transitory processes (electrical, mechanical: starts and stops) and the arm ineptness, avoiding the mechanical shocks (important aspect),

- the driving engines should be robust, certain in functioning and to reclaim as few maintenance works as possible,
- combined with the wheel with grab driving, to offer permanently the maximum capacity for excavation of the equipment in full security environment.

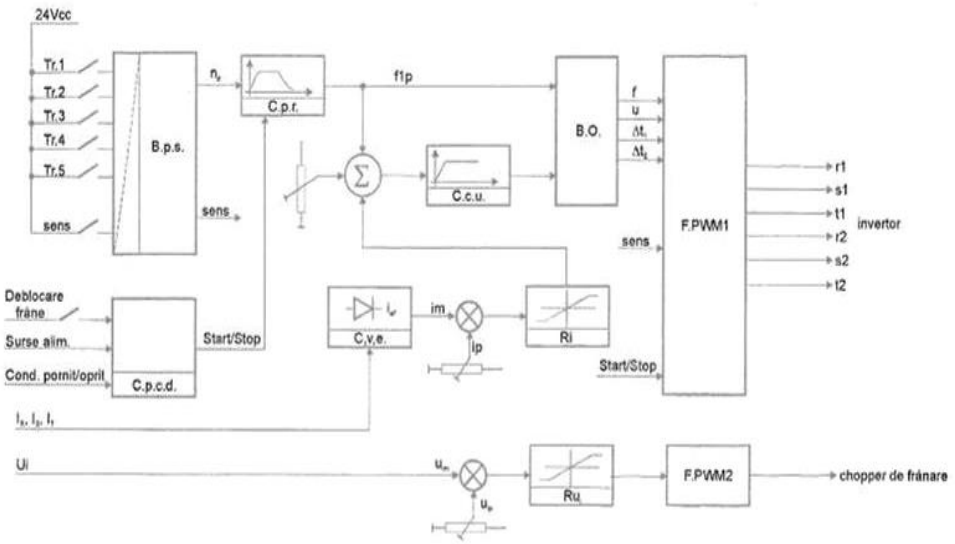
MODERN SYSTEMS FOR SPEED ADJUSTMENT FOR THE PIVOTING MECHANISM OF THE ROTORIC ARM AT THE SRS 1400 EXCAVATOR

Modernizing the driving for the pivoting mechanism of the rotoric arm at the SRs 1400 excavator requires the replacement of the Ward-Leonard group with frequency converters and of the continuous current motors with asynchronous motors with short circuited rotor (2x37 kW, 380V, or 2x45 kW, 380V).

In figure 2 is a variant of adjustment scheme for the pivoting mechanism driving, and in figure 3 there are the working characteristics for the Ward Leonard driving system (fig. 3a), and also for the proposed driving system (fig. 3b) [1].

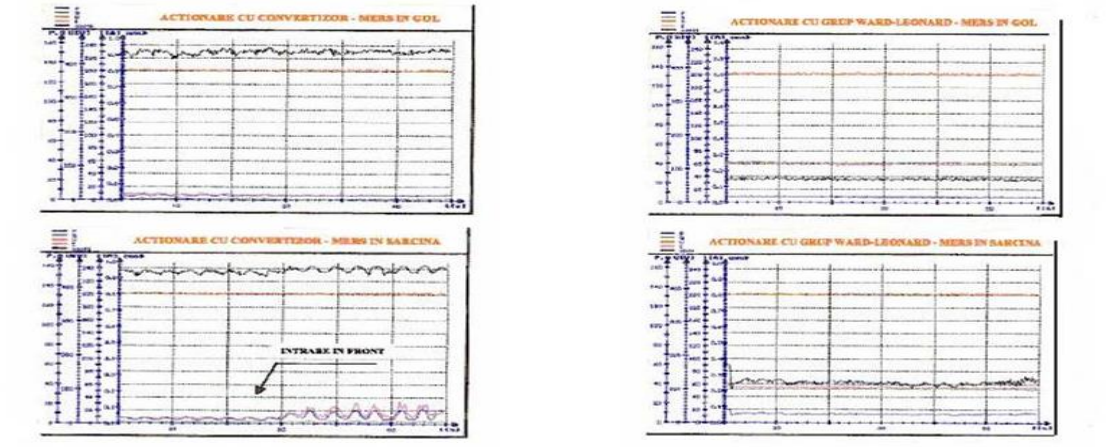
The revolution of the asynchronous motors is modified function of the output frequency from the inverter.

The switch of the revolution direction at the asynchronous motors alimented from the converter is made in the electronic unit through reversing the commands between two phases of the three-phased bridge from the inverter.



Bps – electronic block for prescription of rotation steps and galvanic separation of the signals received from installation
Cpr – circuit of processing ramp and frequency prescription
Ccn – the electronic block for output tension calculating
Cpcd – circuit of diagnosis and electrical signals processing
Cve – circuit of processing the effective value
Ri – current regulator
Rui – tension regulator in brake system
BO – command for frequency and tension oscillating block
F. PWM1, F. PWM2 – formatters of modulated impulses in time for inverter and chopper of braking

Fig. 2. The driving of the rotation mechanism with a static-asynchronous motor mechanism with the rotor in short-circuit. The block scheme of adjustment



a) Driving the pivoting mechanism with Ward-Leonard group **b) Driving the pivoting mechanism with asynchronous motors**

Fig. 3. Working characteristics of the driving system of the pivoting mechanism

Analyzing the variation diagrams in figure 3, it can be observed:

- At the idly working in the Ward-Leonard group driving variant, the active power is in average with 1kW higher than in the proposed driving variant, but the power factor has values between 0,14 ÷ 0,15, comparing with 0,91 ÷ 0,92 in the modern variant,
- As a consequence of a inadequate power factor, the absorbed current is of 60A in the classical variant compared with 9A in the modern one,
- When working under charge, the differences are maintained.

Out of the working characteristics of the Ward-Leonard group and the driving with asynchronous motors, powered by the frequency converters, it is observed the energetic advantage of the modernization of the driving pivoting mechanism with frequency converter (energy saving, power factor etc.). Also, from these diagrams results that there are certain possibilities to reduce the power of the driving motor of the pivoting mechanism.

In figure 4 there is another variant of scheme of adjustment of the asynchronous motors, and that is with field orientation (rotoric flux) [2], in figure 5 is the simulation scheme, and in figure 6, the scheme of the static converter is presented.

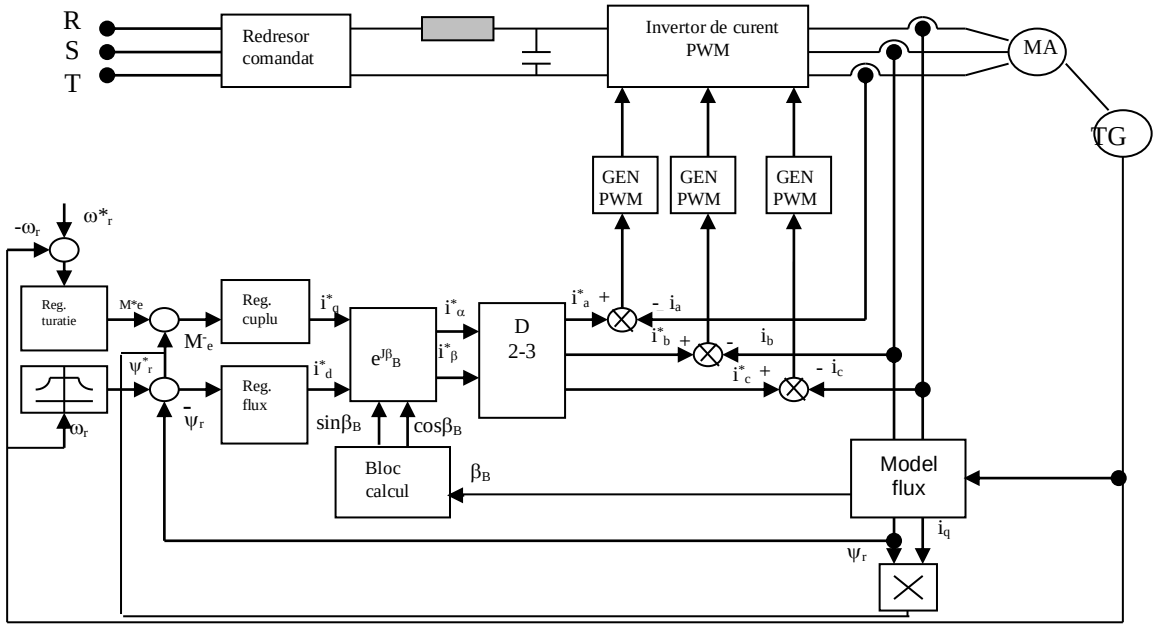
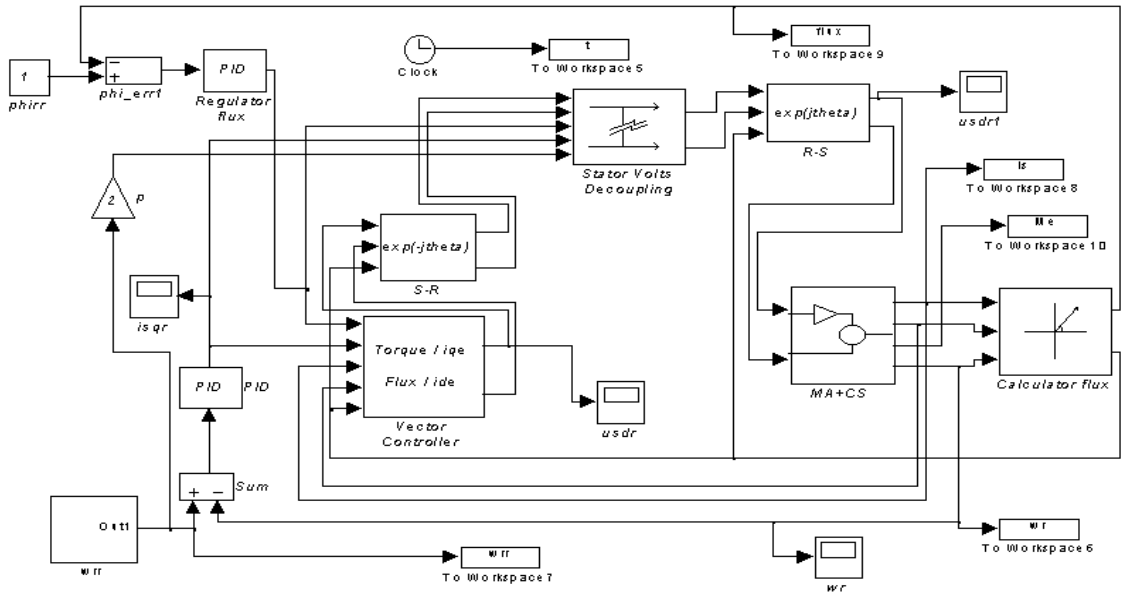


Fig. 4. The block scheme of adjustment with field orientation of the revolution of an asynchronous motor powered by a PWM current inverter



Schema de simulare cu orientare dupa fluxul rotoric

Fig. 5. The simulation scheme

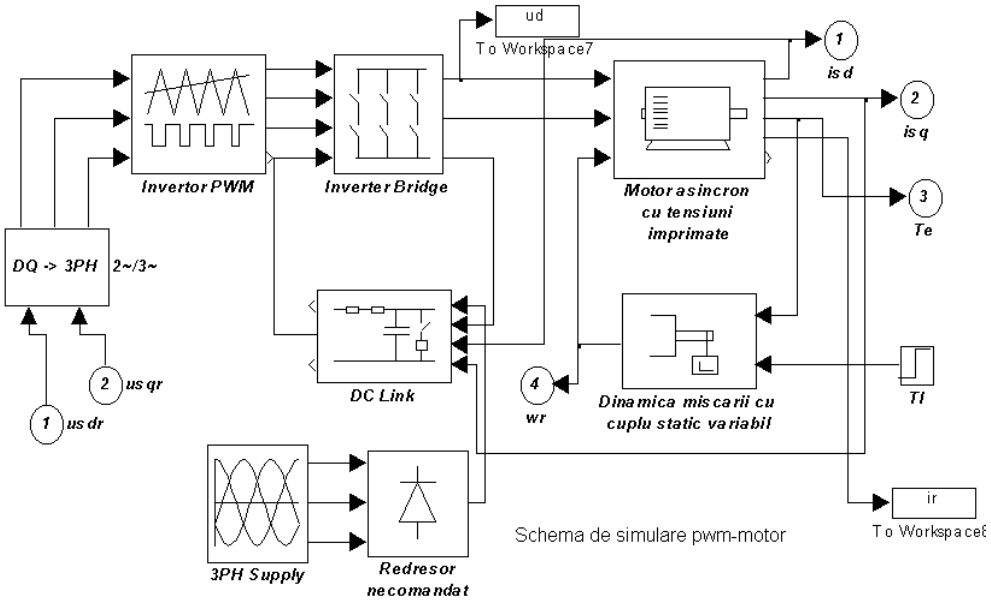


Fig. 6. The scheme of the assembly PWM static converter – asynchronous motor

In figure 7 a), with dotted line is the revolution reference and with continuous line is the reply of the system in revolution. It can be observed that when using this adjustment system, the revolution of the motor follows very faithfully the reference on both rotation directions. Also, a working without current shocks is assured, as seen in figure 7 b), and the couple and flux are maintained approximately constant (fig. 7 c şi d).

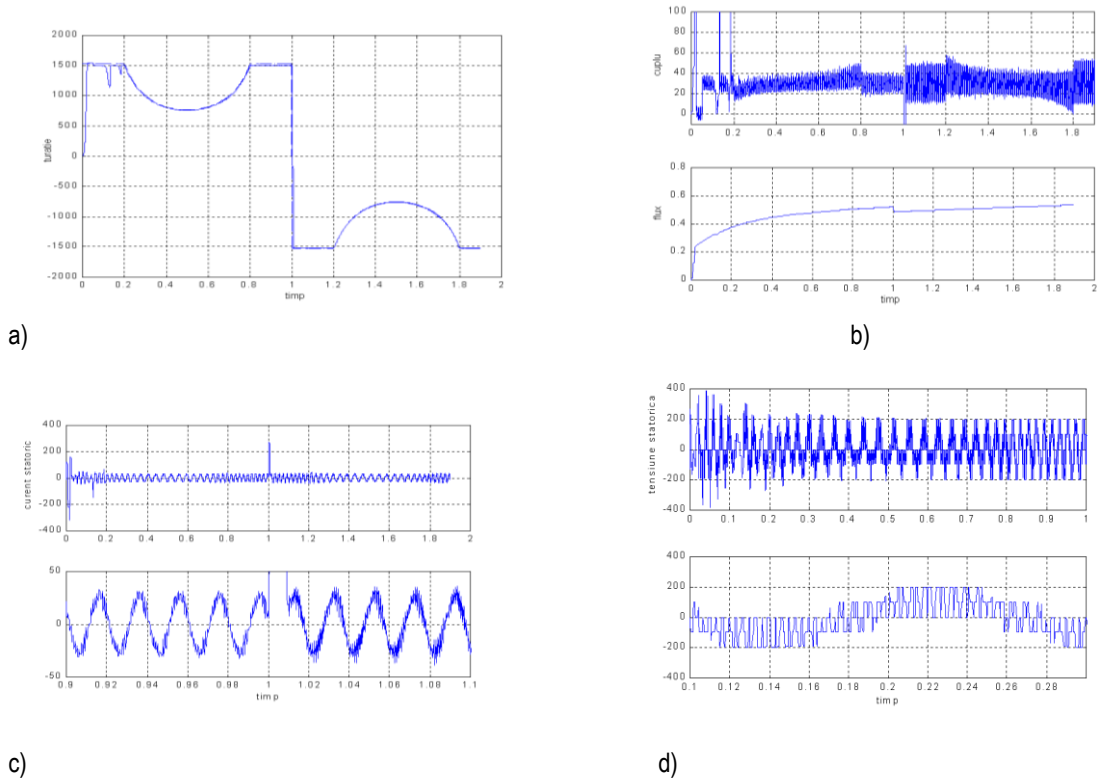


Fig. 7. The results of the simulation of the working system for revolution adjustment, rotoric flux oriented, for the ERC 1400 pivoting mechanism

Conclusions

Through the proposed modernizations at the driving system of the pivoting mechanism at the SRs 1400 excavator, the following advantages can be found:

- control of the start current,
- avoiding the mechanical shocks in the cinematic chain,
- better characteristics for revolution adjustment,
- symmetrical load of the motors phases,
- a simple electrical scheme,
- the start time is function of the resistant couple,
- the power factor is improved,
- the high liability of the cinematic and electric chain, as consequence of the lack of movement parts, which leads to the improvement of the use of the equipments index,
- the nominal couple is assured for the conditions of the toughest working front, and for the toughest march ("stick in the mud") conditions,
- electric break is assured at the shift of direction of the rotor arm,
- the improvement of the timetable capacity is assured through improvement of the characteristic for revolution adjustment and permanently combination of the parameters of the wheel with grabs with the parameters of the pivoting mechanism.

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