THE TACHOGENERATORLESS SPEED CONTROL SYSTEM

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Resumé

The speed control system of an externally-excited DC motor without tachogenerator (TG) is actually a discrete control circuit where the motor current is intentionally cut-off so that the induced armature voltage may be sensed. This voltage (proportional to the angular speed of a motor) is stored in analog memory during one sample period and processed by the speed controller. That's how the speed control of a motor without TG is carried out – angular speed is sensed by the motor itself.

Key words: Tachogenerator, analog memory, controller, control system, discrete control circuit.

1 Introduction

A feedback signal in speed control systems is usually provided by a tachogenerator. This solution is acceptable in most cases. However, there are applications in which using a TG is undesired or even impossible. This may be due to the following reasons:

- TG reduces the reliability of a system due to its fault,
- TG adds to the dimensions as well as the overall mass of a motor making it impractical for low-power drives,
- TG requires special supply circuit.

We know that externally-excited DC motor and tachogenerator are same as to their working principle and also their construction and we are trying to get a signal proportional to the angular speed from the motor itself.

2 The speed control without tachogenerator

In Fig. 1 important circuits of the speed control circuit without TG are depicted. An analog gate is connected between the speed controller and current controller. A gate-effect (Fig. 3) is provided by replacing a memory capacitor with R_H resistance connected between the terminal No. 6 and the zero-potential.

In case high-level voltage (H) is applied to the terminal No. 8, it is passed to the output proportionally. If low-level voltage is fed to the input No. 8, the output voltage is zero. Thus the periodic change of voltage on terminal 8 allows for periodic cut-off of the current fed to the current controller.

Operation of the analog memory is depicted in Fig. 2. The current controller provides a zero current (Fig. 1) as well as a zero rate of change. The terminal voltage of the motor is at the output of differential circuit. This voltage is stored to the analog memory only after the transients of a current control pass away. The voltage at the output of analog memory is then proportional to the angular speed and can be fed to the input of a speed controller. The runings of the kontrol signále of the analog gate (A) and anolg memory (B) are depicted in Fig. 4. In Fig. 5, the waveforms of TG voltage as well as the induced voltage at the output of analog memory are shown.

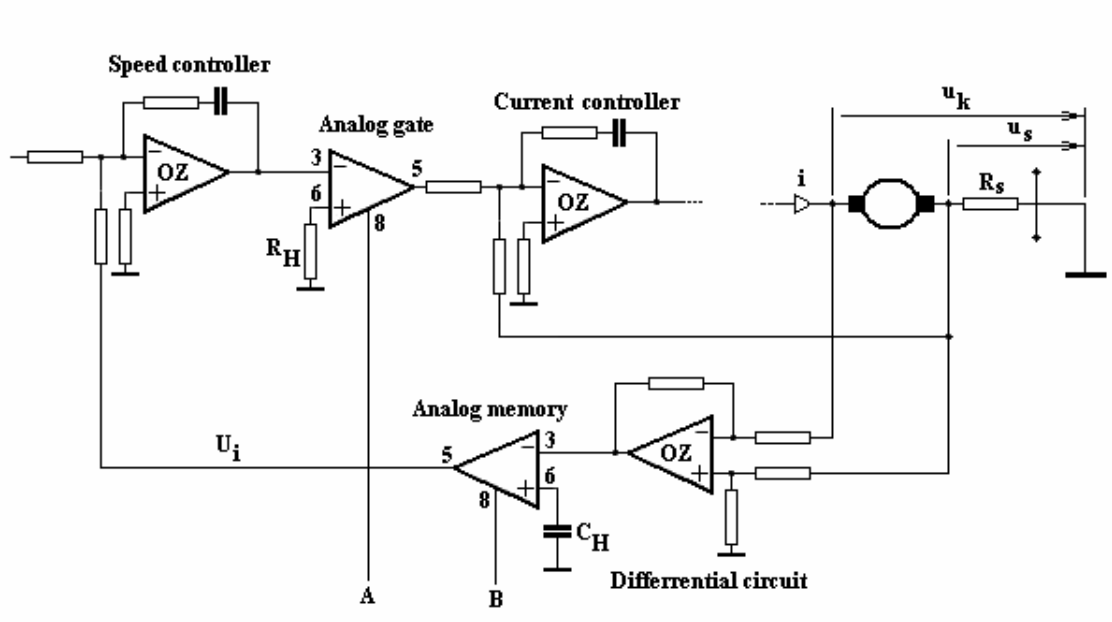

Fig.1: *The speed control system circuits without tachogenerator.*

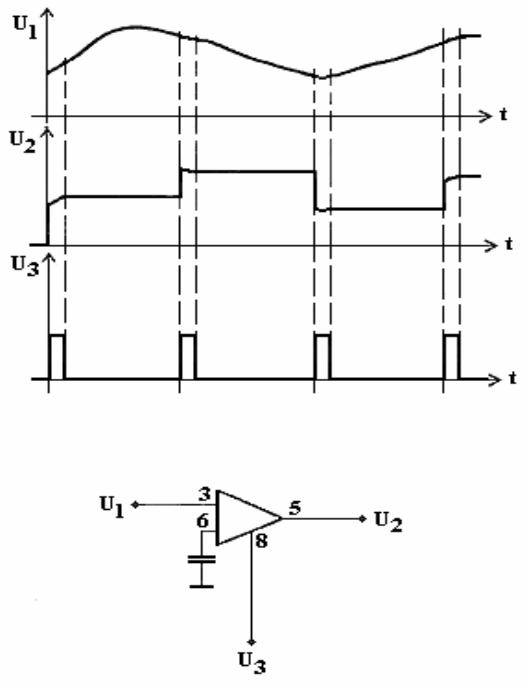

Fig. 2: *The operation of an analog memory.*

The utilization of this concept is probably possible even in converters with PWM voltage at the output as well as conventional motors. We suppose that in such case it would be necessary to decrease the frequency of A and B signals (700 Hz in our experiment).

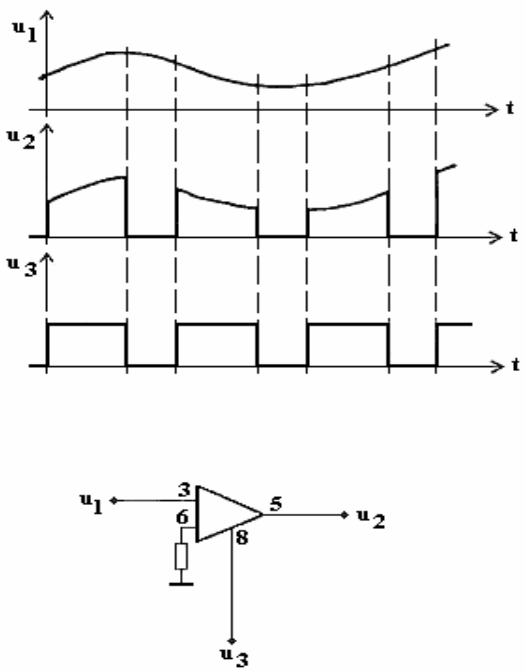

Fig. 3: *The operation of an analog gate.*

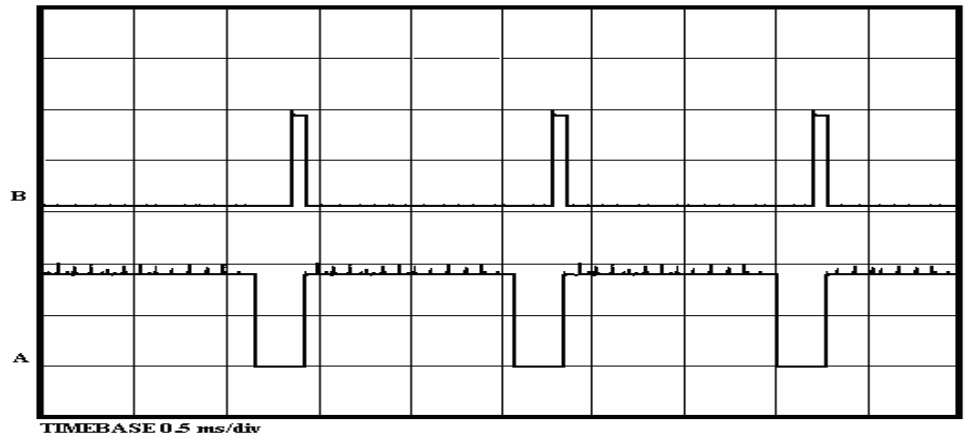

Fig. 4: *The analog gate (down) and analog memory (up) control signals.*

4 Conclusions

A DC motor speed control system without TG shows satisfactory properties. By removing a TG it was possible to suppress unwanted behavior mentioned in the beginning of this article. This proposal was verified experimentally by means of a continuous converter and a special motor with small electromagnetic coefficient (HSM60). The results are shown in Fig. 5.

The described speed control system doesn't require a tuning of larger number of controllers compared to usual case. If the voltages u_k and u_s are fed to the differential circuit correctly, there is no possibility of getting positive feedback of angular speed signal during the operation when any maintenance was done on the system.

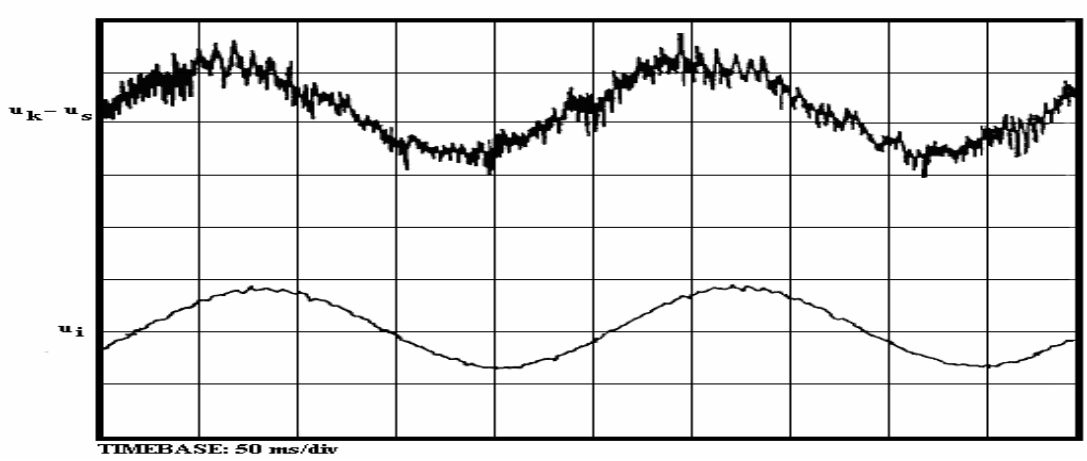

Fig.5: *The voltage at the motor terminals (up) and the output voltage of the analog memory (down).*

This type of a discrete control with specific frequency had an impact on the control range, which decreased from 1 : 6 000 (TG) to 1 : 1 500 (without TG), a fact almost certainly associated also with the lower quality of the angular speed signal (Fig. 5).

This work was supported by the Science grant agency of Ministry of Education of Slovak Republic, VEGA, grant No. 1/4077/07 and the Institutional task of the Faculty of Manufacturing Engineering of Technical University in Kosice, no. 1/2009

5 Reference

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