Highest level (the level of a consultation) provides a possibility of realization of the complex detailed analysis BMS with use of world data bases and powerful specialized computer programs at diagnostic centres. The information in this case is necessary to transmit through the modem on communication lines with use of the special standards of signaling.

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MECHATRONIC POSITIONING SYSTEM WITH THE VELOCITY CONTROL

This paper presents a mechatronic system for speed control in non-ferrous continuos foundry machine. This system uses a hydraulic cylinder with inductive displacement transducer, a proportional valve and an electronic module. The moving control uses a positioning closed loop. The electronic block assures position and velocity control and the stop time, too. The cylinder's displacement is cyclical due an automatic programmer that commands the fastening cylinder, too. User can program both directions' speed, stroke and pause time. A smooth starting move is assured by acceleration control.

The electronic control module is placed in case of proportional element. The program unit contains 8 multi-turn potentiometers for setting motions program, start/stop switch and light Indicator of moving status.

1. INTRODUCTION

A typical application of mechatronic systems consists in hydraulic positioning equipment using a closed displacement loop. The authors use such equipment for a control of non-ferrous continuos foundry machine.

The diagram particularity is to bring the work table in prescribed position, with a speed prescribed too, in a preordain time. The module described in this paper is so conceived to control two thus commands. The speed control is obtained with voltage controlled ramp generator. A sequential programmer provides the cyclic displacement command. Between this two movements exists a necessary pause to operate a hydraulics system of material catch. The displacement control function is the following: an error amplifier compares all the time the voltage which represents displacement with a reference voltage *Ui* which represents the reference size. As long as the two voltages are different, the error signal ΔU commands the hydraulic element so that it decreases error to zero to obtain a position equal with the prescribed one. Because at conception and execution of this system there were taken stability measures, it is obtained a precise operate of the system.

2. POSITIONING SYSTEM STRUCTURE

Because the system function is based to position closed loop control, it is very important to optimize it. The system transfer function is:

$$T(s) = \frac{1}{1 + \frac{1}{G_x} \cdot s(1 + \frac{2 \cdot \xi}{\omega_n} \cdot s + \frac{1}{\omega_n^2} \cdot s^2)} \quad (1)$$

Where ω_n is the natural throb, ξ is the attenuation coefficient, and K_V is the system gain, respectively product of regulation component gain:

$$K_V = K_I K_P K_Q \frac{K_X}{A} \quad (2)$$

K_Q =flow gain, K_I =electrical gain, K_P =proportional gain, K_X =transducer gain, K_{PQ} =flow-pressure gain, A = cylinder area

Adjustment error is:

$$\Delta X \le \frac{0.05 V_{max}}{K_V} \ \text{[mm]} \quad (3)$$

It was supposed it is necessary less than 5% from valve's flow to bring to zero the speed in a circuit for position adjustment, respective to compensate a perturbation force, because at most to 5 % from the existent signal exists already the entire pressure requisite to make the correction.

Rigidity in stationary regime is proportional to system gain and inversely proportional to flow-pressure gain K_{pQ}.

$$C = \frac{F_{perturb}}{X} = \frac{K_V A^2}{K_{pQ}} \quad (4)$$

For slowly systems, transfer function is the first order with **Time constant value**

$$T = \frac{1}{K_V} \quad (5)$$

From all which is showing until now, we can say than the for a certain system configuration in order to achieve a precise and rigid system has to be chosen the smallest value for the nominal flow, the greater piston area and a greater system gain as possible. On the other side, as the positioning systems is conceived to remain stable, the magnitude can not overlap a critical value K_{Vcrt}

$$K_V < K_{Vcrt} = 2\xi\omega_n \quad (6)$$

Figure 1 shows bloc diagram of position regulation circuit using a hydraulic cylinder.

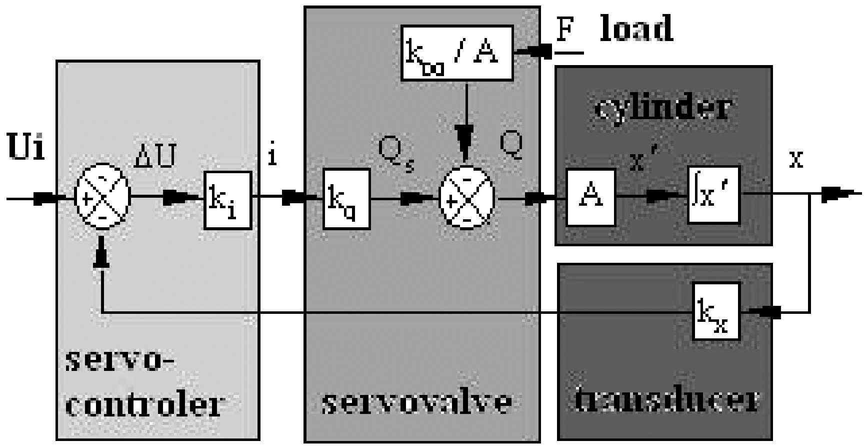

Fig. 1. Schematic diagram of a positioning system

3. ELECTRICAL STRUCTURE

The electronic block assures the control of the mass cylinder position by an automatic adjustment loop using an inductive displacement transducer, with 50 mm nominal stroke. Because proportional valve and positional transducer owns an included electronics, which admits a unified signal voltage by command/control, the diagram was designed for input/output voltage by ± 10V.

The diagram is showing in figure 2.

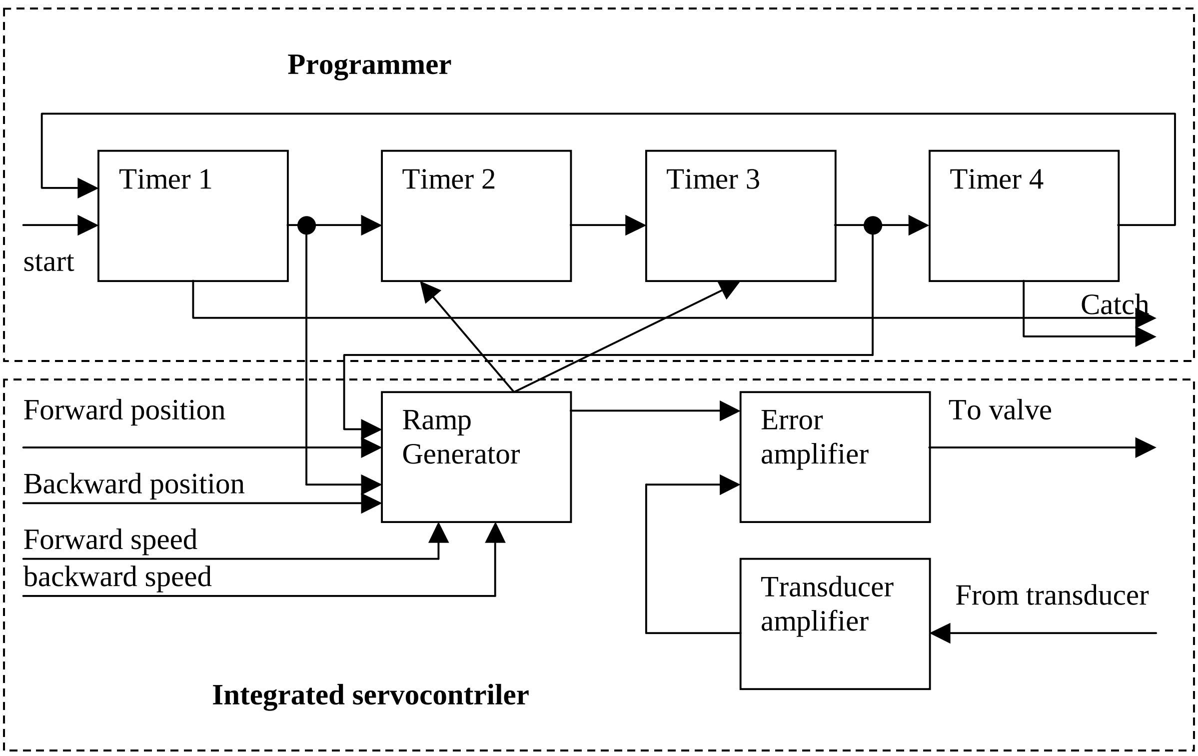

Fig. 2. Bloc diagram

The programmer module contains four timers connected in cascade, the output of the last constituting the signal to resume the cycle. The timers 2 and 3 that assure the stop time in position, are breaked out by a signal from the ramp generator. This is one of the principal blocks of the module, that assures the displacement command with a constant speed until it comes to the pre-established position. Depending on the input signal polarity, the displacement will be made forward or backward. In this two cases, the signal slopes and the input voltage size, that defines the pre-established position, can be regulated independent one by other. The signal generated in this mode is applied on command input of the error gain and compared with control voltage derived from displacement traducer. The error signal is amplified and commands the execution element. Two delay blocks are necessary to command the clench of the material, respective to deliverance this at the end of cycle. In fact the entire system assures a sequential advance of the material with prescribed step and constant speed. The module supply is made from a voltage by 24V.

In figure 4 is reproduced the programmer function cycle diagram.

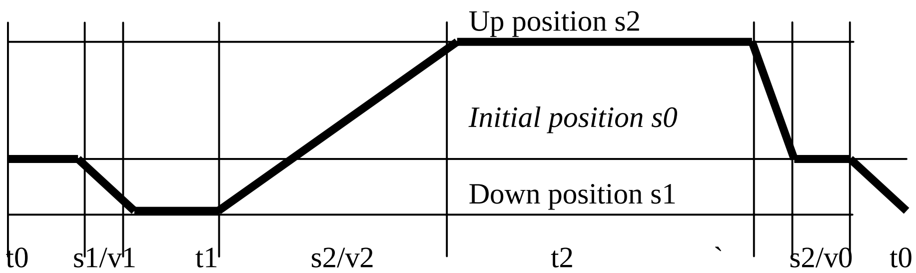

Fig. 3. Function cycle diagram

4.CONSTRUCTION

The electronically block command is realized on a printed circuit board, located in a case of proportional device shown in figure 4. The programmer is in a separated case and it contains on frontal panel 8 multiturn potentiometer with turns-counting dials, command button START/STOP and lighting indicators (LED) that indicates the execution phase.

In figure 3 is showed the integrated electronics.

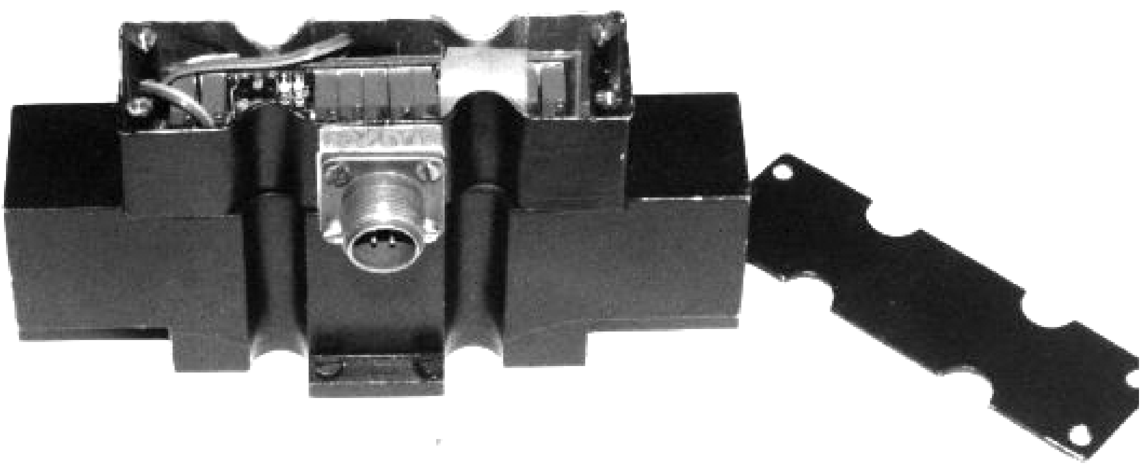

Fig. 4. Integrated electronics

5. EXPERIMENTS

The module that is described in this paper was tested on a checking stand from IHP laboratory. First it was verified the adjustment loop of the position and it was adjusted the gain PID to obtain an optimal response. Then there were effectuated some initial adjustments:

With the potentiometer PS0 it was adjusted the initial position of the table (zero point)

With the potentiometer PV0 it was adjusted the replace speed in the initial position.

With potentiometer PA it was adjusted the acceleration value of the table cylinder start.

Then it was checked the system functioning in automating cycle.

At START button starts the cycle, that executes the following phase:

1. Is activates the clench cylinder
2. Wait about one second (adjustable with PI1)
3. Is commands the table cylinder back to the position establish by the potentiometer PS1 (in range 0…20mm) and the speed selected by PS1 (in range 0,1…20mm/s).
4. The cylinder stops to the prescribe (S1) and waits a time while it is adjusted by the potentiometer PT1 (in range 0…10s)
5. Is commands the table cylinder to advance to the position established by the potentiometer PS2 (in range 0…20mm) with a speed selected by PV2 (in range 0,1…20mm/s)
6. Is stops the cylinder to prescribe (S2 and wait a time which is adjustment by potentiometer PT2 (in range 0…30s)
7. Is commands the deliverance for the clench cylinder
8. Wait about one second (adjustable with PI2)
9. Is commands the table cylinder movement to the initial position (S0) with a speed stabiles by PV0
10. Is picks up the cycle

The gain adjustment of the position adjustment loop, and also the null adjustment and transducer calibration are by multiturn timing type and are accessible from panel. This adjustments are made to put in function the installation, after them it will be sealed.

6. CONCLUSIONS

As this is the result of experiments and tests made in the laboratory, it proves that the electronic module in closed tested for regulation systems is necessary to be elaborated so that it can be included in the execution element. That is in fact the tendency in the world.

A problem, that was resolved in this paper, is the power stabilization supply included in electronic equipment. A second problem is the assurance regulation distance commands. If this does not constitute a problem for prescribed elements, for tuning adjustment are necessary in change the specialized circuits, in general with high costs. This adjustment is made usually to put in function of the system or after a system reconfiguration and so is not economical to complicate the diagram. Because the microcontrolers are at a lower cost day by day it is advisable to equip with microcontrolers so that the access to adjustments from the system can be effectuate from the computer.

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