

ROLE OF SERVO-VALVE IN AN ADAPTIVE CONTROL SYSTEM TO THE CIRCULAR SAW

SBÂRCIOG Ioan

Technical Counselor at SC JURIS CONSULTING SRL, Oradea
ioansbarciog@yahoo.com

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Abstract: The basic circuit of the FCA-810M circular saws' adaptive control of personal design and conception is presented. The exit size is modified depending on the command signal value (power, current), when a binding reaction occurs. The comparison results from the comparison element (a computer) between the reference bearing load and the active bearing load which is measured on the contact spot between the tool and the semi finished product to be debited, which, under the shape of the $\pm\Delta V$ load, is converted through a electric signal and serves to the servo-valve command. Depending on the sign and value of this load, the cutting feed is automatically modified, in order to maintain the equality between the two powers.

1. GENERAL CONSIDERATIONS

In compliance to [2] the servo-valve represents an adjustment system. The exit size (discharge, pressure) is modified in compliance to the value of the command signal (electric power, voltage) existing a reaction connection (mechanical, hydraulic, electrical). The structure of servo-valve is presented in figure 1.

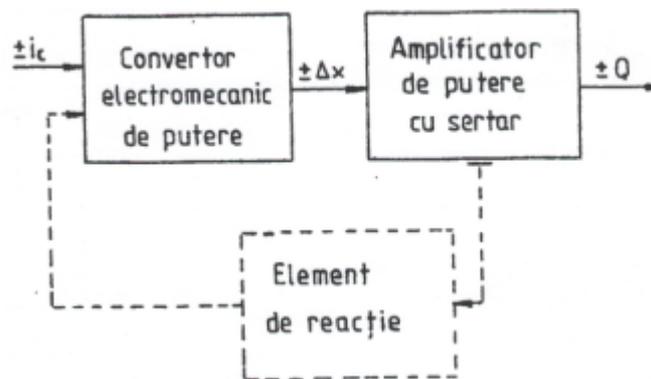


Figure 1: The structure of servo-valve [2]

It is composed of an electromechanical power converter, a power amplifier with drawer and a reaction element.

The servo-valve is done with magnets from rare grounds, at which the power developed on the mass unit is much larger, allowing the direct action of a distributor drawer.

In compliance to [2], the feature which defines the static behavior of the servo-valve is of a type discharge-pressure (figure 2) and represents the relation between the variation of the discharge and the pressure at charge for various values of the command electric power.

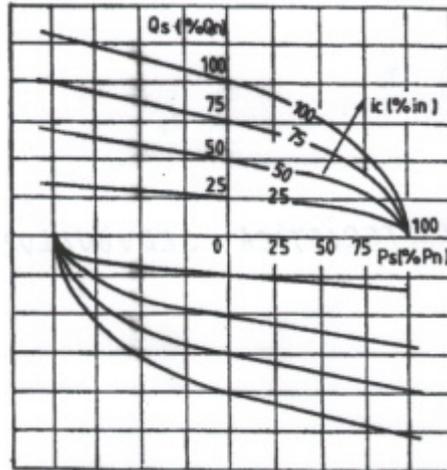


Figure 2: The characteristic of servo-valve [2]

Such servo-valve adjusts the discharge at charge, but, in the same time, through discharge insures also a control of the pressure, in connection to the resistance opposed to the charge.

The servo-valve SV represents a very important component of the adaptive command system - SCA to the circular saw FCA-810M [5], [7]. Its role is to modify the advance speed of the tool-holder slide so that it does not exceed the maximum pressure on the most used tooth of the web-disk.

In the adaptive command system [3] presented in figure 3, adapted on the circular saw FCA-810M in compliance to [2], in the element of comparison EC takes place the comparison between the power of reference P_{ref} and the active power P_a which is measured at the place of contact between the tool (web-disk) and discharge half-finished.

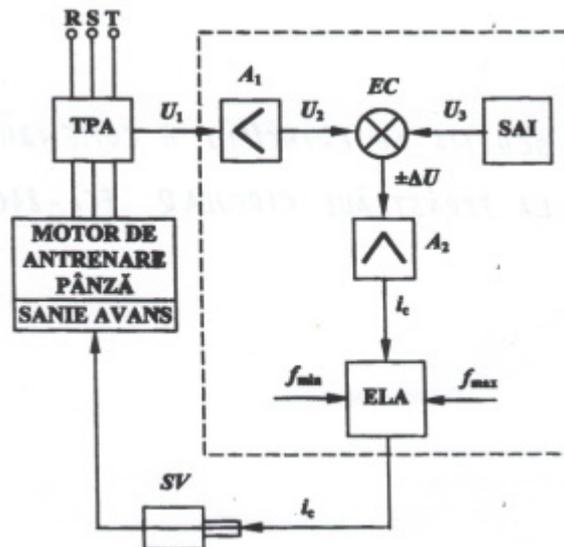


Figure 3: The principle of adaptive command for the circular saw FCA-810M [3]

The result of the comparison under the form of voltage “ $\pm\Delta U$ ” is converted through an electric signal and serves for the command of the servo-valve.

In connection to the sign and value of the voltage the advance speed is automatically modified so that the equality between the two powers is maintained.

2. CONSTRUCTION AND FUNCTIONING OF THE SERVO-VALVE

The basic scheme of the servo-valve is presented in figure 4.

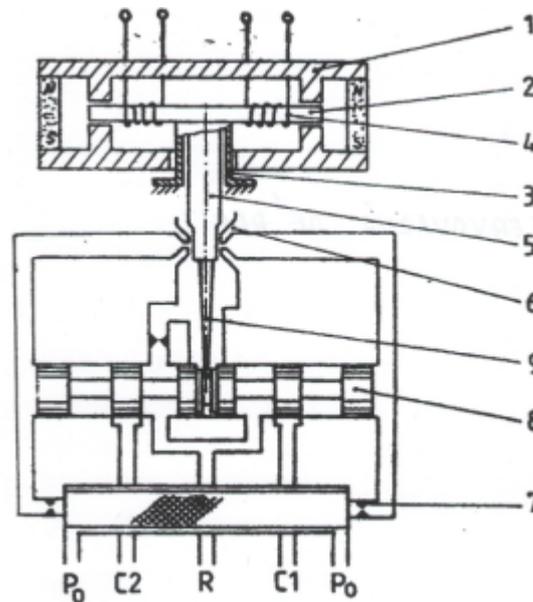


Figure 4: The basic scheme of the hydraulic servo-valve [4]

In compliance to [2], [4], the voltage " $\pm\Delta U$ " applies to the power converter which is the result of the comparison between the comparison element EC between the reference power P_{ref} and the active power P_a consumed at the entrance of the web-disk in the discharge material.

The voltage " $\pm\Delta U$ " is applied differentially (at one of the coils from the right is reduced and at the other one it is increased). As a consequence, at the coil from the left the voltage is increased and at the other one is decreased, in relation to the polarity of voltage. Thus, it is created an electric-engine force which displaces to the right the rigid lever 5 with the lever of the electromagnet.

Thus, it is closed one of the two nozzles 6 fact which determines the increase of pressure on the command circuit of the distributor 8.

At the moment of displacement of the cladding to the right, the rod 5 closes the nozzle 6 from the right, increases the pressure on the pipe P_o (from the right) until the nozzle. From this reason, the pressure pushes on the frontal surface of the distributor 8 from the right. As follows, the drawer 8 is displaced to the left.

As the command voltage " $\pm\Delta U$ " increases, the displacement speed of the drawer 8 is higher and vice-versa.

The link between the amplifier and the electromechanical converter is done through the elastic rod 9 linked to the pallet and having a spherical head introduced into a circular channel from the distributor drawer.

Through the elastic rod 9 it is achieved a reaction in force because the moment given of elastic force which appears due to the displacement of the drawer balances the moment given by the electromechanical converter. The elastic force from the flexible tube is cancelled by the magnetic elastic force of the converter, so that the balance is done between the moments given by the electromagnetic forces, the forces between the pre-amplifier and the force of reaction.

3. THE ROLE OF SERVO-VALVE IN THE ADAPTIVE COMMAND SYSTEM OF THE CIRCULAR SAW

The entire scheme of SCA is presented in figure 3.

The SCA principle of the circular saw is represented by the measurement of the active power of the electric engine of displacement of the web-disk and its comparison to an active power of reference, within an element of comparison EC which is a computer. The electric signal resulted " $\pm\Delta U$ " following the comparison (processing) from the computer is used for the command of servo-valve SV in order to adjust the advance speed.

Thus:

- With the power transducer TPA the active power is measured at the place of contact between the hand-tool (web-disk) and the half-finish of discharge
 - At the exit it results the continuous voltage U_2 which, amplified in A1 enters into the comparison element as the voltage U_2
 - The power transducer being analogical equipment, between it and the comparison element an analogical-numerical converter is positioned - CAN, transforming the continuous tension into digital signals
 - Into the comparison element, as the voltage " U_3 " enters the reference size generated by the automatic recharge system - "SAI". The power of reference " P_{ref} " is established with the help of an algorithm.
 - "EC" determines at any moment of entrance of the web-disk into the material of discharge the difference " $P_{ref} - P_a$ "
 - The result of comparison, under the form of " $\pm\Delta U$ " amplified in A2 is converted into an electric system ic, passes by the element of limitation of the advance ELA and command SV
 - We have to mention that this voltage is incremental. As follows, between EC and SV it is positioned a numerical analogical converter-CNA which transforms the digital signals into continuous voltage
 - The voltage " $\pm\Delta U$ " servo-valve command which will modify the advance speed of the hand-tool slide so that it does not exceed the maximum pressure on the most used tooth of the web-disk
- In relation to the sign and value of this tension the advance speed is automatically modified so that the equality between the two powers is maintained
- if P_a is smaller than P_{ref} , the servo-valve will command the increase of the advance speed
 - if P_a is larger than P_{ref} the servo-valve will command the decrease of the advance speed.

4. CONCLUSIONS

The basic circuit of the FCA-810M circular saws' adaptive control is of personal design and conception. Through the operating of the adaptive control system – ACS, one reaches the following outcomes:

- the circular saws' automation level is improved
- the conversion capacity per tooth is set function of tooth resistance and of the power developed by the conversion capacity of the machine
- both the machines' cutting-speed and the feed-speed increase and, consequently, its productivity raises.

In order to perform the adaptive control system - ACS - manufacturing, several automation components are used, amongst which the servo operated valve is of outmost importance. Its role is to modify the feed speed of the tool-holder slide in such a manner that the later would not overcome the maximum pressure on the tooth the most stressed on the whole band-saws.

It is worth mentioning that the automation components are of internal manufacturing.

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