

ADAPTIVE CONTROL FOR TOOLS OPERATING WITH SIMILAR WORKING PROCESS AS CUTTING MACHINES

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1. GENERAL CONSIDERATIONS

Among cutting processes, one distinguishes as follows:

- **Cutting through cutting tool** by turning. It is recommended only if the parts are processed out of bars or other similar billets, cutting being a final or intermediate process;
- **Sawing with disc blade**: on the milling machine. It is recommended for shaping small and medium size pieces made of soft and semi-hard metals, the cutting being a primary process;
- **Sawing with jacks**: It is recommended for cutting metal rods and profiles of soft and semi-hard rolled, of having medium and large sizes, in case of series production. The pieces obtained show geometric and good dimensional accuracy, making them appropriate for a subsequent processing through directly chip removing.

Machine tools for similar working processes as cutting machines ones, equipped with adaptive control are as follows:

- Corbel milling machines equipped with adaptive control (AC) for speed and feed;
- Common lathes equipped with AC for feed.

2. THE ROLE OF ADAPTIVE CONTROL

By Adaptive control one means achieving the basic cutting regime parameters in locked-loop, as follows:

- A strategy previously set within an algorithm;
- Information received from the cutting process by measuring some characteristics of that process.

Adaptive control has the following advantages:

- Optimization criterion that underlies the adaptive control strategy is the minimum cost of the process, provided that the requirements of quality, dimensional and shape accuracy and surface roughness are fulfilled;
- Adaptive control process is based on an algorithm inferred from scientific methods for determining the optimum target. In determining the optimum conditions one should consider both the tool capacity, and how placing certain restrictions on ETS strengths, available power, stability and precision
- Self-adjustment of one or more parameters of cutting system so that processing maintains the required economic optimum<
- Protects the tool and machine tool against overloading;
- Suppresses the disturbing factors influence;

The concrete structure of an adaptive control can be dealt with only for a certain type of machine-tools. While leading the processing operation, adaptive control will change depending on the cutting method and adjusted system parameters.

The basic adaptive control systems are those that regulate a parameter of cutting system.

3. ADAPTIVE CONTROL OF THE LATHE SPEED

The block diagram is shown in (see Figure 1).

When cutting with a knife at the lathe, the reference size, depending on which one commands and controls the process, can be one of the components of the cutting force. We consider the tangential component " F_c " of the cutting force when the aim is to use the maximum capacity of the car.

By analyzing the block diagram of adaptive control system - ACS – one concludes the following:

- "TR" transducer measures the tangential component of cutting force " F_{cr} " (real value) and converts it into electrical signal " U_1 " which is amplified in amplifier " A_1 ", becoming " U_2 ";
- Voltage signal " U_2 " is included in the comparison element "EC" where it is compared with the voltage " U_3 " corresponding to the component " $F_{c.ref}$ " (reference value);
- The comparison result, " U_4 ", amplifies in the amplifier " A_2 " and helps to adjust the speed with a servo-mechanism "SM"
- Speed will be changed so as to permanently ensure equality of two values " F_{cr} " si " $F_{c.ref}$ ";
- After having amplified the electrical signal " U_4 " in the amplifier " A_2 ", the tension " U_5 " corresponding to the speed to be installed in "STE", passes through the speed values limiter " f_{max} " si " f_{min} ";
- Prior penetrating the material, in order to approach the billet with " f_{max} ", induces a " U_{pt} " voltage in the comparing element in order to ensure a certain value of " f_{pt} " feed when the cutting tool reaches the billet to be cut.

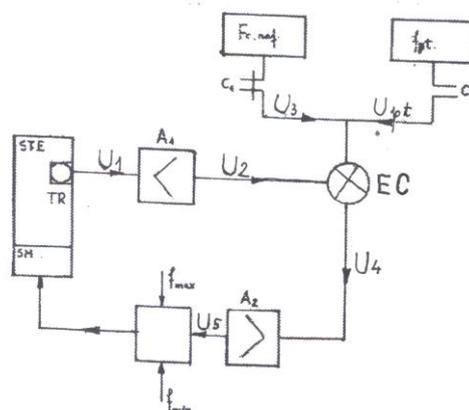


Fig. 1. Adaptive control system of the lathe

4. ADAPTIVE CONTROL OF SPEED AND FEED IN CASE OF THE CORBEL MILLING MACHINE

Adaptive control system block diagram is shown in (see Figure 2) and works as follows:

- The reference size is the tangential component of cutting force " F_c "
- Depending on this cutting force component, adaptive control adjusts two parameters: " n_{AP} " si " f "
- As a result, adaptive control has two control loops

4.1. AS CONCERNS THE FIRST LOOP CONTROL

- During processing, the transducer for main shaft speed " $TR_{n_{AP}}$ " measures the actual spindle speed "AP" of the main executive link "VEP" and emits a voltage signal proportional to speed " n_{AP} ";
- The calculations and decision block "CDB = EC" (comparison item) the optimal decision that sends "+ / -DU according to actuating pulse COA "after having compared measurements in the reference block" MRB";
- Through regulating the spindle "ACP", value " n_{AP} " gets its reference value.

4.2. AS CONCERNS THE SECOND CONTROL LOOP

- During processing, the transducer for horizontal component cutting force " F_f " measures this component at the head of the plain-miller head and emits a proportional voltage signal;
- At the level of calculations and decision block "CDB" the best decision is made which is sending the "+ / _DU" to the "DCs" drivers control after having compared measurements in the measurements reference block "MRB";
- Trough "DCs" driver controls, one control feed driving control "FDC", which adjusts the speed value so that the horizontal component of the cutting force " F_f " becomes equal to its reference value.

The meaning of other notations is:

- MEL – main executive link
- SEL - secondary executing link
- SCM – supporting component of MU

Phenomena detailed in sections 4.1 and 4.2 on the two circuits (loops) are carried out simultaneously. For this reason, the adjusted parameter values " n_{AP} " si " f " are set in "CDB", so that the real component of cutting force " F_c " to ensure equality with the reference tangential component.

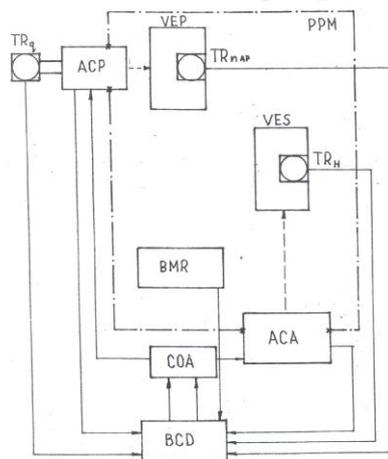


Fig.2. ACS block diagram of speed and feed rate in case of corbel milling machines

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