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STUDYS AND IMPLEMENTATION OF A AFFORTABLE AUTOMATION OF THE SPINDLE MOTOR OF A CLASSICAL LATHE

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Abstract: These paper discuses a way to resolve the problem of non equal cutting speed on a classical generic type of lathe. The discussed solution of this problem is the automation of the power supply of the existing 3 phase spindle motor with a variable frequency AC inverter. This Inverter receives information, according to the value of the machined diameter, from an encoder mounted on the transversal or „x" axis without any intervention from the operator. The result shod bee a beater quality surface, mostly on small worked diameter, by continuous variation of the rotation speed.

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1. INTRODUCTION

Classical type of lathes remained operational due to the robust construction and long life cycle. We still can find them in small workshops or factories, where is no need for a complex modern CNC machine. Also the cost of a new modern expensive machine is not worth for the small amounts of parts or for not so precise jobs.

The lathe spindle is driven, either by a belt or gear drive to a power source. In most lathes this power source is an integral electric motor, often either in the headstock or concealed in the stand. In addition to the spindle and its bearings, the headstock often contains parts to convert the motor speed into various spindle speeds. Various types of speed-changing mechanism achieve this, from a cone pulley or step pulley, to a cone pulley with back gear to an entire gear train. Manually controlled metalworking lathes are commonly provided with a variable ratio gear train.

Some motors have electronic rheostat-type speed controls, which obviates cone pulleys or gears. This variation of speeds is possible only between machining in a non linear pattern according to a medium machined diameter with the proper tool.

Because of the fix rotation speed during machining, and variable diameter of the machined part, the peripheral cutting sped will be greater and the central cutting speed will be too low. This problem due to the fix rotation speed creates variable rugosity (Figure 1.) on the machined face, and additional ware of the tool.

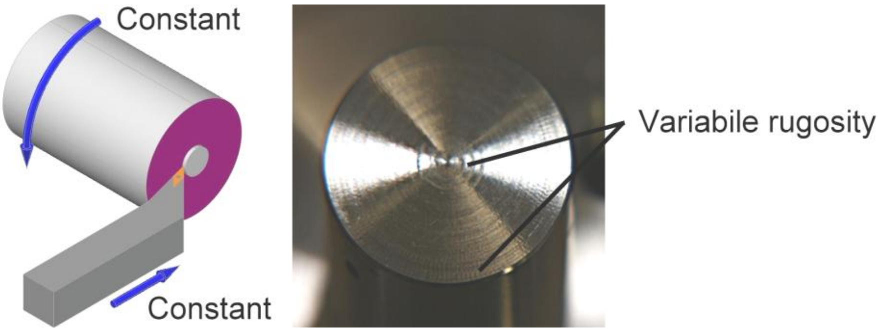

Figure 1. The fix rotation speed creates variable rugosity

In lathe work, the amount of power required to turn at a large diameter is much greater than at a small diameter, given equal depths of cut. Also an increased rotation velocity on a smaller worked diameter, to give constant cutting speed, is necessary. A lathe is not like a mill: in a mill, the cutter takes a constant amount of power per chip cut regardless of the rpm (in a given material). For any machining job there is a cutting speed that is just right. This right speed of a spindle lathe is archived by a full speed linear control that can always find the speed that gives no tool chatter and a perfect machined finish [1].

Ways to do this are using a dc brushed motor with a DC amplifier that will allow an encoder or a tachometer on the motor. These devices allow inputting a pwm frequency for programmed speed control, or from a pot, as well as a step and direction input. This will allow switching between velocity and axis control modes, thus giving the ability to have a spindle speed controller and the ability to lock the spindle in with the other axes on the lathe, and drive it as a rotary device for live tool milling or controlled thread cutting.

This is a way to change the rotation speed without having always to change the belt or gears. These methods works by selecting a proper gear ratio, and only control the rpm of motor with an electronic fervency inverter, according to the value of worked diameter.

2. APPLICATION AND EXPERIMENTAL

The application is tested on a classic manual lathe type SNA, common type of lathe present in small businesses or factories (Figure 2). These middle size lathes is a perfect candidate because is worth cheeping and improve. The improvement is by retrofitting the spindle drive from fixed speeds during machining to variable adaptive speed. This it must be done by a relative small investment, cheeping as many parts unchanged as possible.

The use of the machine must be as possible like before retrofitting. The functionality of buttons and hand wells must remain the same, to avoid an additional specialization of the operator. Adding a frequency inverter to the 3 phase AC motor, converts AC current into rectified DC, supplying 3 phase variable frequency output and the full potential of the lathe can be finally unleashed.

The automation is made by adding on the transversal lead screw back end, through a coupling, an optical incremental rotary encoder for precise value of the position (Figure 2.). This position will reflect in variable rotation speed to create constant cutting speed at same feed rate.

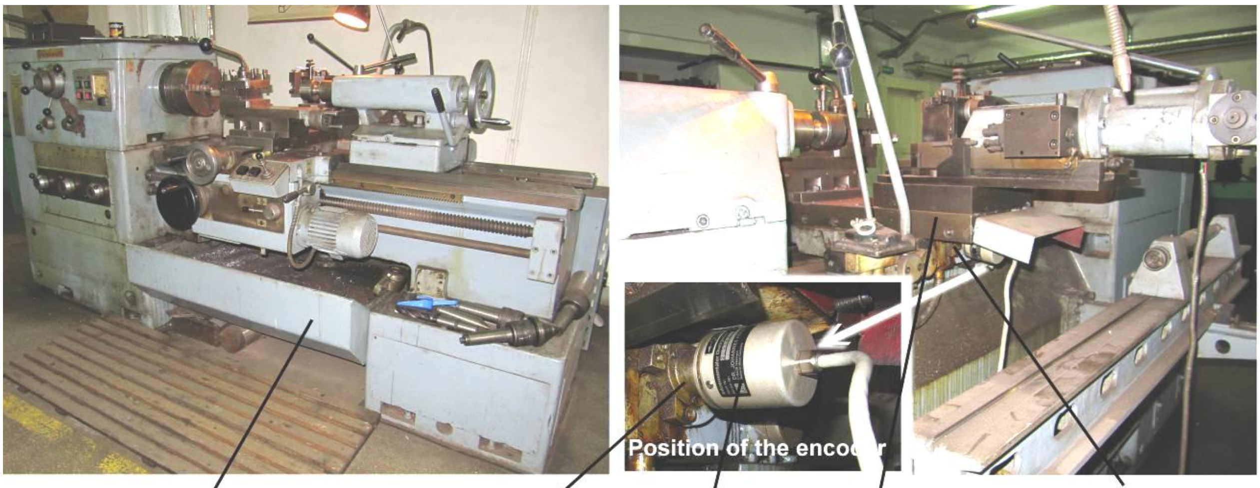

Figure 2. Common type of lathe used for the application with added optical rotary encoder

In the original electric box of the lathe, a proper power dimensioned frequency inverter is coupled to the existing installation, disconnecting thermal protection, startup time relay, the power factor improving capacitor and power surge absorber (where is the case). The function of these parts will be successfully replaced by the inverter (Figure 3.)

Figure 3. In the original electric box a proper frequency inverter is coupled to the existing installation

After that, will need a digital analog converter; 3-position switch; a potentiometer and maybe an E-stop button. These buttons are already installed from the original existing installation, and we will only add the potentiometer on the front buttons panel.

The schematics of the installation contain the added encoder, frequency inverter, a digital analog converter, a potentiometer for the frequency (rotation speed) domain and the command buttons. (Figure 4.)

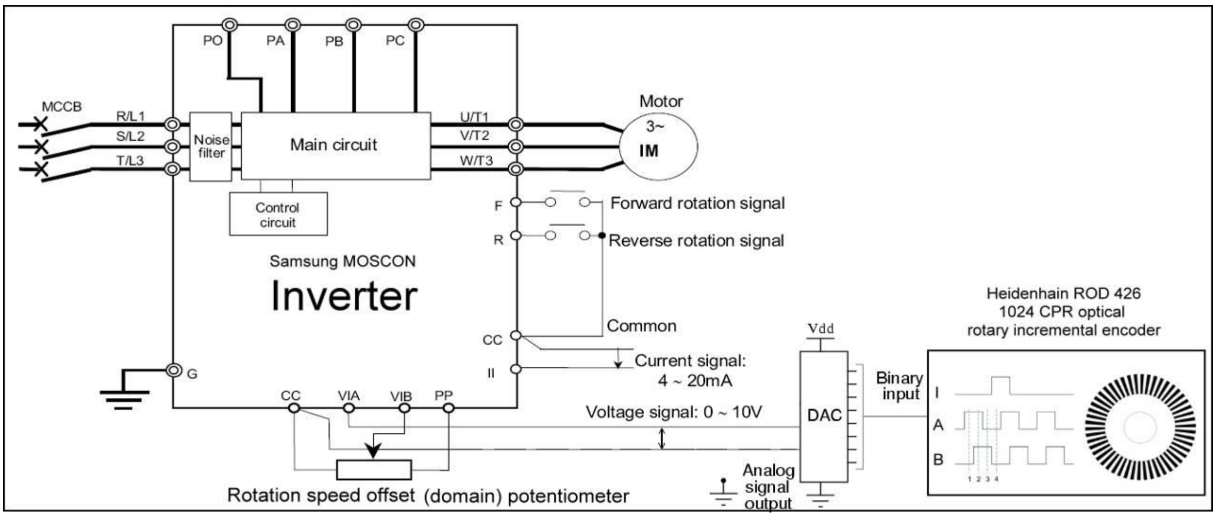

Figure 4. Schematics of the installation

3. RESOULTS AND CONCLUSIONS

The study resolved the problem of non constant cutting sped due to the variable diameter of the machined part, when a constant feed is applied, on a classic generic type of lathe. This was done under 800 Euros worth of parts, plus the labor. The result is an improved classic machine with the spindle motor automated for variable speed according to the machined diameter. The problem was putted also from the machinist point of view. Easy to use, the system has start; stop; reverse buttons and speed offset (domain) potentiometer. The resulted comparative surface after automation was obtained under same condition; tool and test material machined is illustrated in Figure 5.

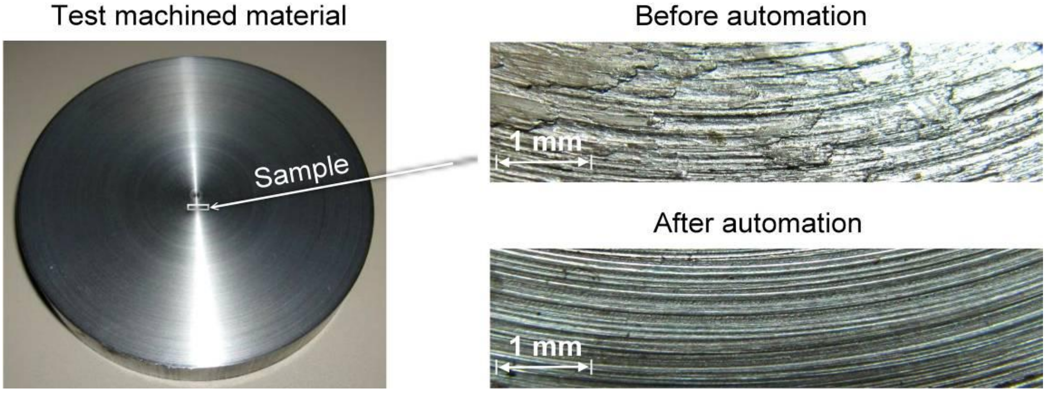

Figure 5. The resulted comparative surface after automation

Added frequency inverter is compatible to produce the roughing and finishing cuts required to turn the work piece to the desired shape and dimensions, or for cutting threads, worm gears, etc. Added features to the system are: lower power consumption, soft programmable start and stop, fully programmable electric protection parameters, selection of predefined load curbs (Figure 6.) and attaching a Rpm meter to one of the inverter outputs to indicate the speed in real time.

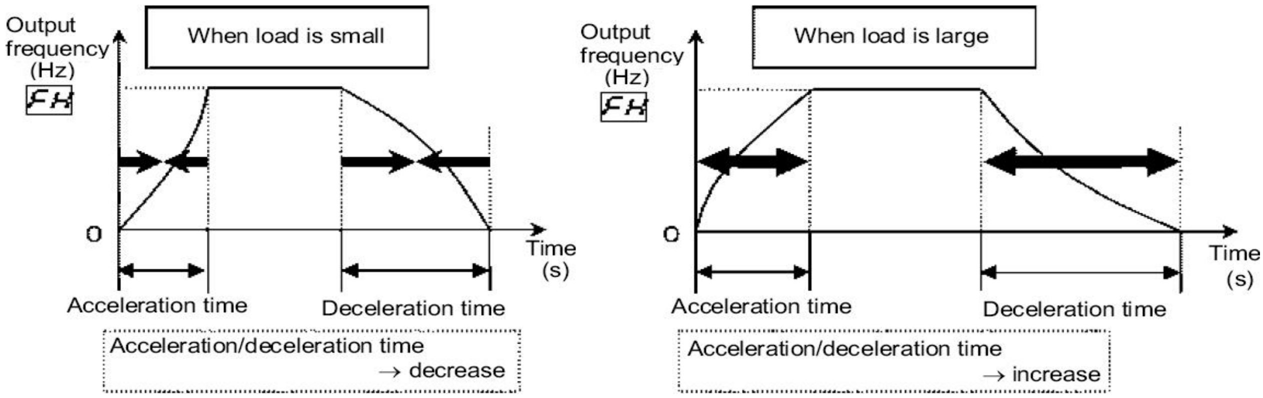

Figure 6. Fully programmable electric load curbs

A disadvantage is the lack of torque when attempting to run the lathe with a low rpm. This can be avoided by selecting a certain speed range from the lathe's gear box.

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