

RING GRINDER WITH AUTOMATIC WHEEL CHANGING SYSTEM¹

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Abstract

Automation in modern roll shops must increase machine productivity and reduce operator's costs, plus add benefits in terms of labor conditions and quality of the end products. The new ATOMAT grinding machine AT711E CNC, equipped with an advanced system to perform the automatic change of the wheels, represents a big leap forward in this direction. The wheel changing maneuver has always been regarded as the bottleneck within the grinding operations sequence, because of: The time required, weight and the ergonomics of positioning of the wheels, relevant operations setting and last but not least, the inaccuracy associated with the multiple handling and roll setup requirements. The new changing system overcomes all of these hurdles: an automatic arm transfers the wheels to and from a 12 position holding rack; then the operating wheel is positioned and locked on the grinding shaft without any operator intervention; the wheel dimension and zero setting controls are also performed automatically, thanks to a special and precise electronic probe; the work-piece zero setting is done in automatic as well, by another electronic probe that also certifies the accuracy of the finished groove profiles; finally, to achieve perfect concentricity and eliminate run-out, both the outside diameter and groove grinding are managed without moving the work-piece from the headstock (i.e. single roll setup). As a result, the machine can reach the target of redressing, with extreme accuracy, up to 16 rings per shift, reducing the operator's activity to approximately 10% of the overall machine time (i.e. 3 minutes per roll); creating an efficient and safe working environment. ATOMAT envisions a full automation of the whole process with the future installation of an external robot for the routine replacement of the work-pieces.

Keywords: Grinding; Wheel changing; Accuracy; Safety.

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1 INTRODUCTION

Automation in roll maintenance machines has undergone through tremendous improvements in the last twenty years. The introduction of CNC machines represented the major breakthrough both for raising the quality of the finished products as well as for decreasing workforce demand.

Today, the roll shops require a very limited number of skilled operators to run several machines simultaneously.

The time requested for machine programming has been reduced too, with the introduction of user friendly interfaces able to manage complex embedded software by means of a simple and intuitive data input.

Atomat machines may also share the same database of in-stock rolls so, even refreshing the roll data is not required anymore since this is automatically shared among all the machines that operate in sequence.

The processes are governed by sophisticated CNC controls (like the new SIEMENS 840 D Solution Line) which can run each operation automatically and with extreme accuracy.

Thus, further steps for automation of these processes must concentrate on the operations that still today require the workers' involvement. For the grinding and regrinding operations, that in general are carried out with CNC cylindrical grinders, such functions are the handling of both the work piece and the grinding wheel.

Also in this field Atomat is moving to propose advanced and innovative solutions. The first move in this direction has just been made with the new grinding machine AT711E featuring an automatic wheel storage and handling system. The grinding machine was chosen as a pioneer, for this futuristic automatic tool handling philosophy, due to specific reasons related to the advantage of this new system: not only time saving, but a significant improvement in the quality of the products and important benefits for the operator's working conditions as well.

2 AN INNOVATIVE CONCEPT DEVELOPED ON A PROVEN BACKGROUND

The new grinding machine, AT711E CNC with automatic wheel changing, is based on the well known and successful technology of our AT700 series machines of which approximately 100 units are today working in the roll shops of the major rolling plants.

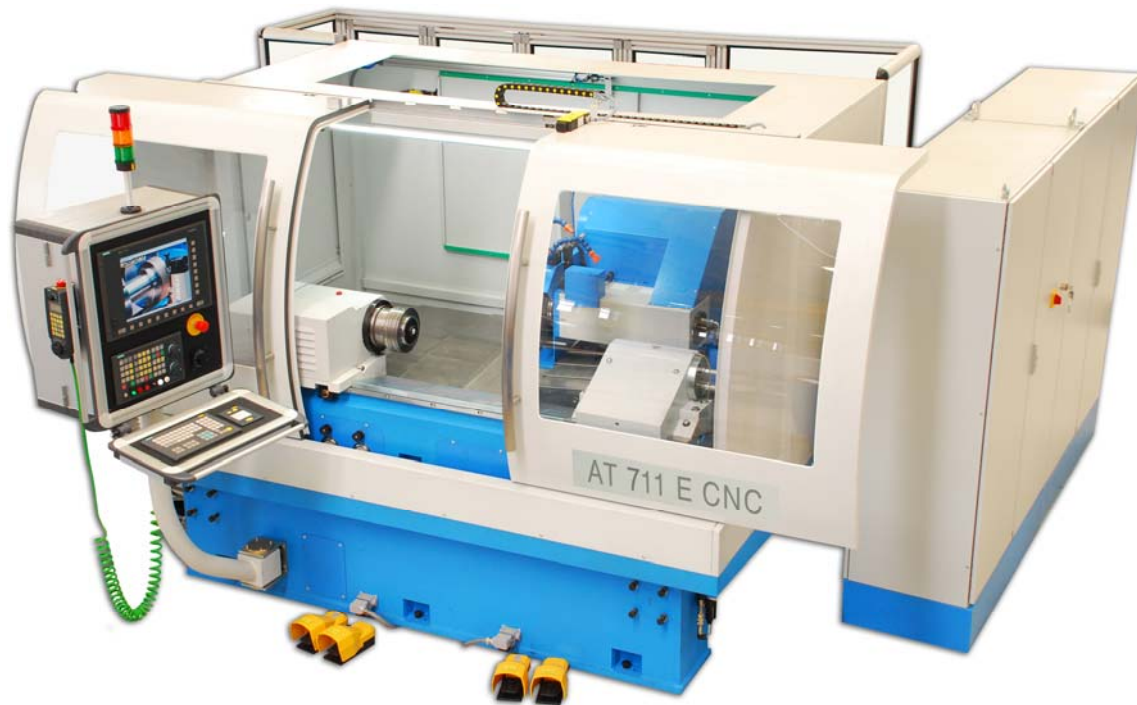


Figure 1: Machine AT711 E CNC.

All the concepts that made those models famous and appreciated are still present in the new AT711E CNC. In particular:

- Wheel-head traveling over two controlled axes and no need to move the headstock along its guides. This reduces the machine overall length and provides better stability and rigidity.
- Faculty of operating both in contour and plunge grinding.
- Siemens 840 DSL control, Siemens motors and components, all in the new Siemens version: Solution Line.
- Capability to install large wheels (up to 350mm - 14") which allows the use of cost effective electroplated diamond wheels that don't require expensive redressing machines and eliminates polluting and time demanding wheel redressing operations.
- Coolant system with relevant self maintenance clearing unit.
- Rollwork interface for machine setting, programming and roll data base administration. This special SW enables the operator to instruct the controller for the correct operations in an easy, safe and quick manner. The elimination of any kind of control programming makes unnecessary the hiring of highly-trained operators.

In addition to the above features, the new AT711E CNC includes the automatic wheel storing and changing capacity, better described in the following paragraphs.

3 AUTOMATIC WHEEL CHANGING SYSTEM

In the new grinding machine, AT711E CNC, the wheel changing operation is fully automatic. A CNC controlled arm selects the correct wheel from a 12 position rack and accurately positions it in the wheel axis thanks to a tapered support .

The same arm, after the grinding cycle is finished, removes the wheel and positions it back on its original place in the rack.



Figure 2: 12 position storing rack.

In detail, the automatic changing process consists of:

- removal of the previous wheel from the grinding head;
- deposit of the same into its assigned position within the storage rack;
- collection of a new wheel from its allocated slot in the storage rack;
- positioning of the new wheel in the grinding axis;
- verification that the wheel corresponds to that required by the working cycle
- automatic zero setting of the new wheel

Once that sequence is completed, the machine is ready to resume another automatic grinding cycle.

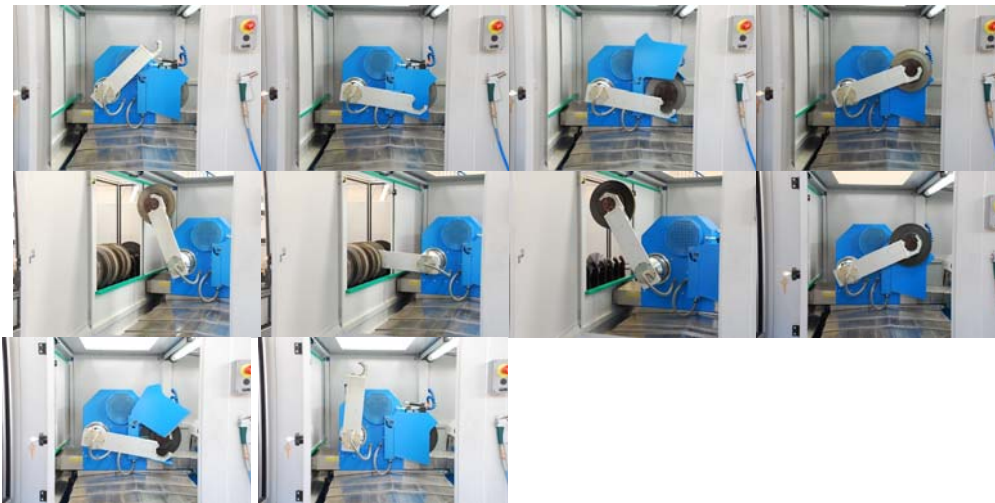


Figure 3: Wheel changing sequence.

The system is equipped with physical sensors in every one of the 12 seats to check the correct positioning of the wheels.

The two areas, storage and grinding, are physically separated. During the automatic grinding cycle the working area is completely isolated and inaccessible either from operator side or from the wheel storage cabinet. This, in order to grant the necessary safety requirements, but also to allow operations on the storage rack during the grinding cycle. So, the wheels in the storing rack can be changed or replaced whenever necessary without waiting for the end of the grinding operations.

The software that manages the wheel storage was entirely developed in Atomat and is specifically tailored for this application. This includes a diagnosis check of the wheel stock, before the grinding cycle starts, to evaluate if it matches the wheels requested by the programmed operations. Any incongruence or lack of wheels is indicated and can be amended without resetting the cycle.

A further verification is performed, on every wheel, during the wheel zero setting cycle. The same probe can detect the wheel radius and check whether it is correct for the requirements of the planned grinding operations.

The moving arm, as well as the grinding axis, is provided with an automatic expansion clamping specifically designed to grant rapid and safe clamping and un-clamping operations.

4 FAST, ACCURATE AND EASY

The wheel changing operation, including wheel zero setting, is performed completely in automatic in around 1 minute. The whole regrinding operation for a finishing block ring, including outside diameter and two groove grinding, can be performed in approximately 20 minutes.

That means that, if we include also the work piece change, the machine is able to fully regrind a ring in 30 minutes floor to floor. Hence, an average productivity of 16 rings per shift can be easily achieved.

The operator intervention is limited to the simple ring changing operation which, thanks to the hydraulic expanding mandrel, requires just few minutes. As a result, the man demand tallies approximately 10% of the total working time (man hours/machine hours).

The new system grants better roll grinding accuracy.

In fact, the general practice for this operation is to grind first the outside diameter of a whole batch of rolls in order to avoid the wheel changing operation, and then to proceed grinding the grooves of each roll. With the new system, the barrel and the grooves of every ring are fully ground without any handling in between. In such a way the outside diameter and the grooves are perfectly concentric because the ring is never moved from its axis.

The wheels, including their support, have a total weight of approximately 30 kg (66 lbs). For the operators, handling this weight -even with the help of maneuvering devices- is in general very uncomfortable, in particular because the wheel axis location is not very easy to reach.

Getting rid of this unpleasant task represents a tremendous improvement in the operators' working conditions and a long term benefit for their health.

The machine is provided also with the Automatic Profile Control Device (APCD) for quality check and data storage of the ground grooves.



Figure 4: APCD - Automatic profile control device.

An electronic probe, managed by the central control of the machine, can automatically and swiftly test the groove profile during grinding process. The collected data are processed by the machine computer to establish the groove positioning and to check the groove profile. Screen output is immediately available on the operator's panel and can be printed or stored on a file for quality control procedures.

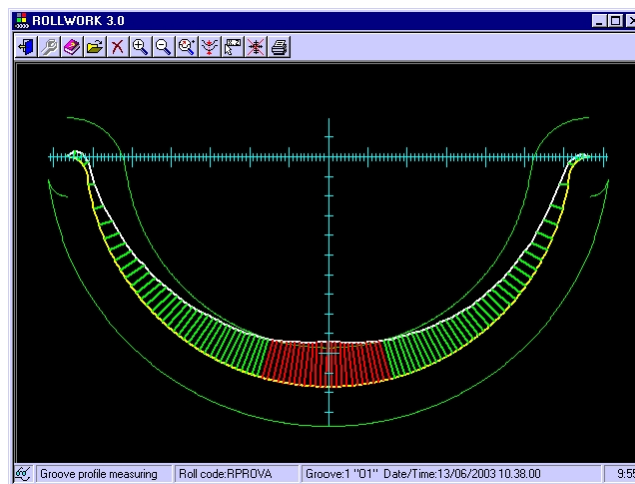


Figure 5: Figure presented by APCD - Automatic Profile Control Device.

The profile check is carried out by spot testing. The number of points to be tested is chosen by the operator and is proportional to the accuracy requested. The screen output will show the original groove profile, its tolerance and the position of each tested point, for an immediate and intuitive analysis of the results. The same output can be printed to integrate the quality control certification.

5 CONCLUSIONS

The new wheel handling system represents a big leap forward towards grinding operations improvement, because it means:



- *Reduced down time*: the full cycle that includes removing the old wheel, positioning the new one and the relevant zero setting takes approx. one minute and make it possible the target of regrinding 16 rings/shift
- *Lower labor costs*: all operations happen without human intervention, therefore the operator engagement is minimal. A single person can easily control up to 4 machines.
- *No handling of heavy weights*: establishing a safe and healthy workplace.
- *Better accuracy*: the outside diameter grinding and the groove grinding are performed without moving the work piece from its support to grant a perfect concentricity.

With this development, the last remaining manual activity of the entire grinding cycle is the work piece handling.

The next Atomat's target is to eliminate also such operation and make such unpleasant task completely automatic too.