COMBINED GRINDING AND NOCTHING MACHINE: A FLEXIBLE ALTERNATIVE [1]

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Abstract
A combined grinding, notching and marking machine can represent a valuable and economic alternative to a definite grinder for those wire producers with a limited rebar output or for larger manufacturers in search for a flexible back up unit. Our new AT710EN CNC combined machine is able to perform basically four different operations: a) notching according to all international standards with a quick and reliable technology, considering that the machine will be engaged 100% on tungsten carbide rings; b) fast marking of numbers, letters and logos and with the lowest possible tool costs; c) frinding with plunge or contour methods using either standard diamond bonded or larger electroplated wheels; d) centering the groove, the notches and logos and measuring the results of all these operations. These four different functions are performed by four different devices. The quick change of the functions and their accuracy and repeatability are granted by of a rotating head that travels on two digitally controlled axes and that is able to lodge the four dedicated equipment. The machine is governed by our renowned Rollwork® interface that is able to control, with a very user friendly approach, all the functions of the machine and to manage a useful roll database as well. This machine can execute each single task with the same efficiency and accuracy of the corresponding single machines. Therefore, also in this case, the choice between selecting this combined machine or two dedicated machines is just influenced by economic considerations and specific plant requirements.
Key words: Combined machine; Grinding; Notching; Marking.

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1 INTRODUCTION

Usually, the most significant CNC roll maintenance machines in rebar mills are: Lathes, Notching machines and Grinders. Separate specialized machines are generally preferred but, according to the plant capacity, also combined Turning and Notching machines are frequently chosen in order to reduce the investment costs.
The combined Grinding and Notching units appear to be less popular. This because such machines focus on carbide rolls only and also because, normally, Grinders have limited spare time available.
Nevertheless, there is a niche of mills for which a combined grinding, notching and marking machine can represent a valuable and economic alternative to the single machines. This may be the case of wire producers whose rebar output represents a limited percentage of their total production. Yet, other applications can include larger manufacturers looking for a flexible back up capable to boost the grinding and notching capacity of their existing specialized machines.
The necessity of an affordable machine able to grant the same accuracy, precision and speed of the single machines, but with a great flexibility for an easy and quick change of functions, has grown in recent years and in particular nowadays when budgets for new projects are very limited.

2 A NEW MULTIFUNCTIONAL MACHINE

The project for this new machine (Figure 1) was aimed to maximize the advanced notching and marking know-how, developed with the AT820E CNC, and to graft it in the proven and reliable technology of our Grinding machines, series AT700E CNC.

Figure 1 – Combined Grinding and Notching machine.

The resulting machine was planned to perform basically four different operations:

a) notching according to all the international standards with a quick and reliable technology, bearing in mind that the machine will operate 100% on tungsten carbide rolls and rings;
b) fast marking of numbers, letters and logos with lowest possible tool costs;
c) grinding with plunge or contour methods, using either diamond bonded wheels or larger electroplated wheels; and
d) centering the groove, the notches and the logo and precisely measuring the results of all these operations.

Since many different operations are involved, flexibility must be one of the main machine characteristics. In particular, switching from one to another function must be easy, quick and automatic, without requesting any operator intervention.
The major technical challenge of granting four different functions performed by four different devices, was overcome by the introduction of a rotating turret moved along two digitally controlled axes and able to lodge the four dedicated equipment.
The perfect and stable positioning of the turret is achieved thanks to a Hirth coupling.

2.1 Grinding Head

On one side of the turret is located the grinding wheel head (Figure 2), driven by a strong asynchronous electro-spindle regulated by inverter. It allows operating with 350 mm wheels, able to assure a longer working life and less down time due to wheel substitution.

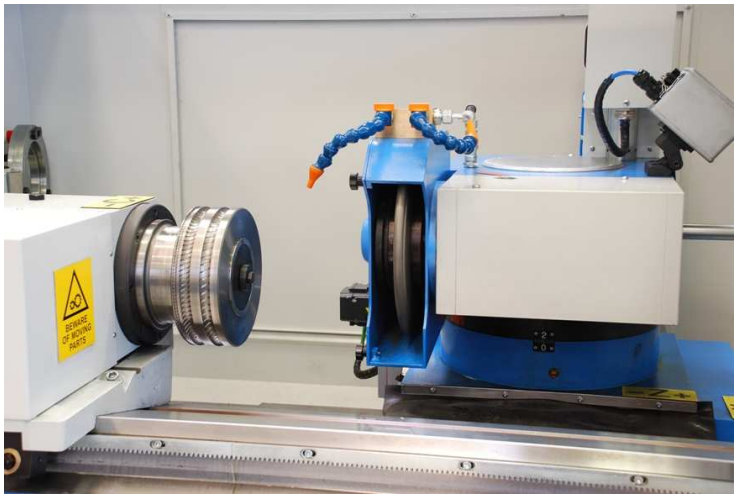

Figure 2 – Grinding head.

The 15 KW motor with variable speed (to grant the optimal speed for every kind of application) supplies all the power needed for Contour, Plunge or Creep Feed grinding techniques. Generally, the machine uses only a very small percentage of this power.
The Computer Controlled movements of the turret will allow the maximum flexibility during the Contour grinding (Figure 4). All type of profiles, including joining radius, can be achieved by the CNC and basically with the same wheels that the machine uses in contour grinding.
However, for a quicker job, the machine can also operate in Plunge grinding mode (Figure 3). Also in this case, our large electroplated wheels have proved to be the most cost effective tool.

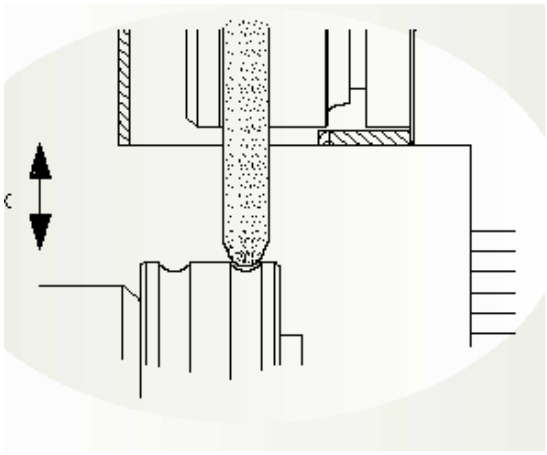

Figure 3 – Plunge.

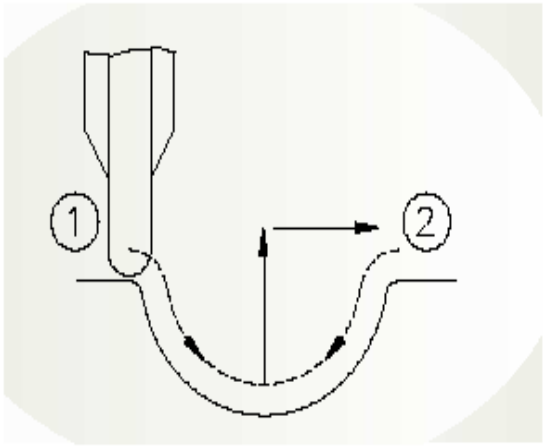

Figure 4 – Contour.

2.2 Notching Device

Another side of the turret supports the notching device (Figure 5). This is controlled by an additional 3.3 KW AC brushless servomotor with direct transmission to avoid any backlash. This device warrants the notching of any possible international standard, including notch skipping and enlarging.

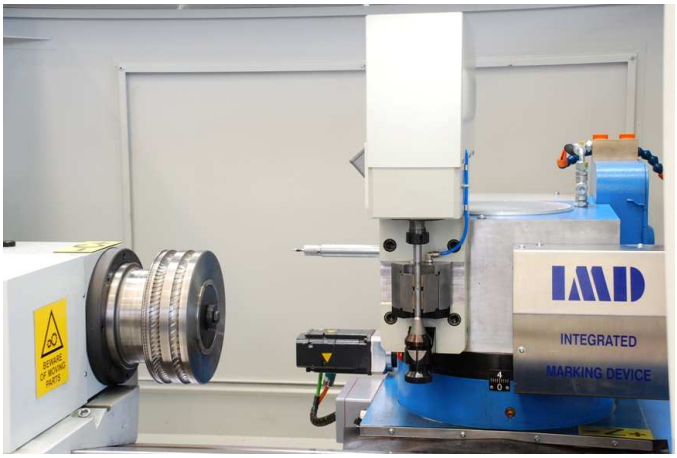

Figure 5 – Notching Head.

The technology of the notching structure is similar to that of the renowned AT820E CNC notch milling machine. The tool holder is fixed on the basis and its tailstock is able to assure precision and rigidity. It is also backed up by a support, designed with a tungsten carbide core to assure a long wear resistance. The tool holder is also coated in tungsten carbide and the lubrication between tool holder and support is performed by an automatic system.

2.3 Marking Device

The marking device (Figure 6) is located on another face of the rotating turret to perform the automatic roll marking, in one single cycle, after the notching operation is completed.

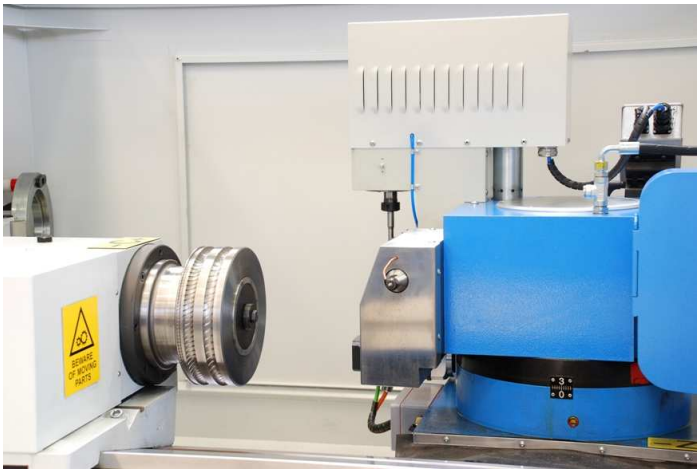

Figure 6 – Marking Device.

The accuracy of the device movement is guaranteed by a direct transmission on the tool axis while the marking technology, based on the ten year experience acquired on the Integrated Marking Device, guarantees a tool life of over 80 letters engraved on tungsten carbide at an extraordinary speed.
A dedicated video camera, displaying images on the panel screen, grants a continuous and detailed sight of the working area.

2.4 Measuring and Centering

Our automatic measuring and centering device (Figure 7 - AMCD) allows an easy, quick and accurate groove centering. The Renishaw touch probe can detect the groove position and the machine is automatically centered on the groove that has to be notched.
The same probe can also detect the notches position in order to indent the new ribs on the previous traces and to minimize the layer to be removed at each roll maintenance cycle. Detecting the position of existing marks for a new marking on the same path is another feature of this device.
As an extra benefit, by measuring the rib depth the AMCD provides the automatic compensation in case of tool wearing.

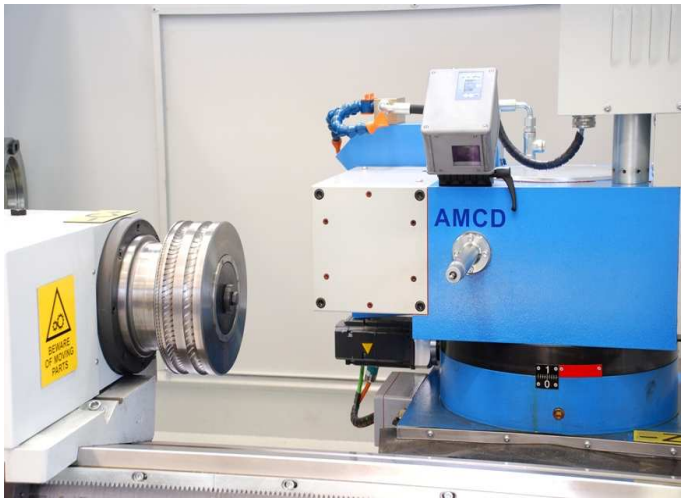

Figure 7 – A. M. C. D.

The same device operates as Automatic Profile Control too. In this case the ROLLWORK® software superintends the profile inspection and the data storage activities.
The measuring of roll grooves, on the machine, eliminates the need to transfer the roll to another station and provides an instant feedback of possible process problems. Moreover, it ensures and certifies that all grooves are in accordance to their manufacturing drawings.

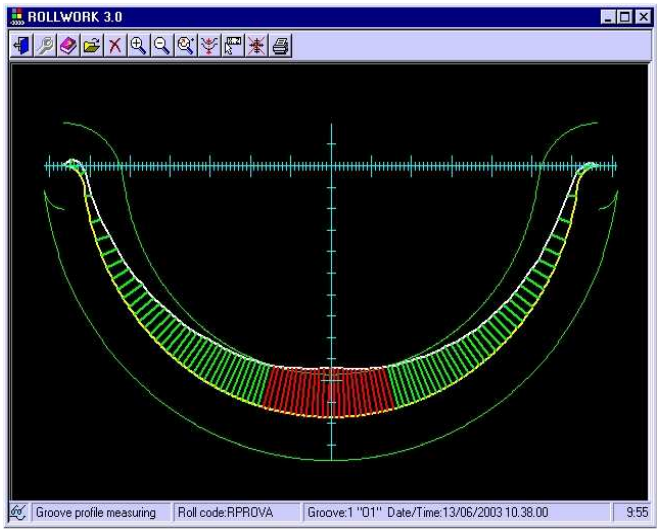

Figure 8 – Screen View.

The electronic probe, managed by the central control of the machine, can automatically and quickly check the groove profile after the grinding process. The data collected are processed by the machine computer, to establish the groove positioning and to check the groove profile. Screen output (Figure 8) is immediately available to the operator and can be printed or stored on a file for quality control procedures.

3 CONTROL AND INTERFACE

The machine uses a SIEMENS 840 D control, but the interface is the well tested ROLLWORK® software that integrates the operating features of the roll maintenance machine with a program designed to manage the roll shop inventory.

Figure 9 – Rollwork Window.

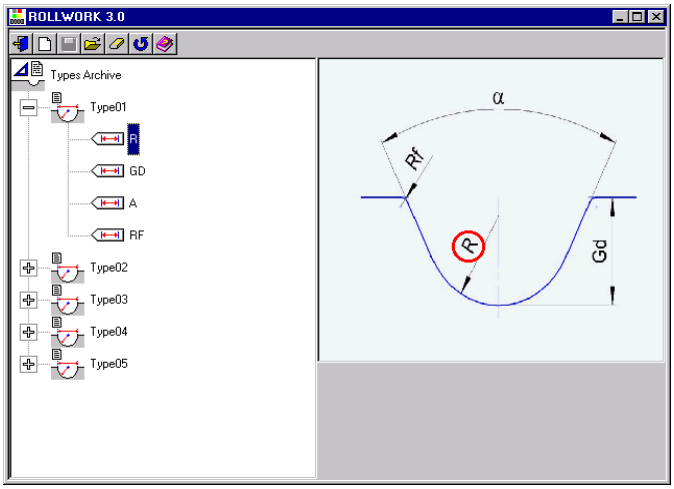

Figure 10 – Rollwork Window.

The ROLLWORK® software was developed by Atomat to give to its customers a simple and easy-to-use device readily accessible to any operator (even if unskilled in CNC programming or without any machine tool experience).
The Windows-based environment, using standard type dialogs, makes this software immediately familiar to all users (Figures 9 to 14).
While the machine is in operation, the user can save time by programming the successive steps assisted by a friendly and error-proof interface.
The same interface allows a network connection with other Atomat machines installed in the same workshop to keep the roll stock database updated.
Through a common Ethernet cable it is possible to link the machine to a Personal Computer and to pass on data and archives for further processing.
The interface that is used in each dedicated Atomat maintenance machines is the same for all functions (notching, marking, grinding, turning etc.) therefore, its integration on the combined machine was extremely simple and seamless.

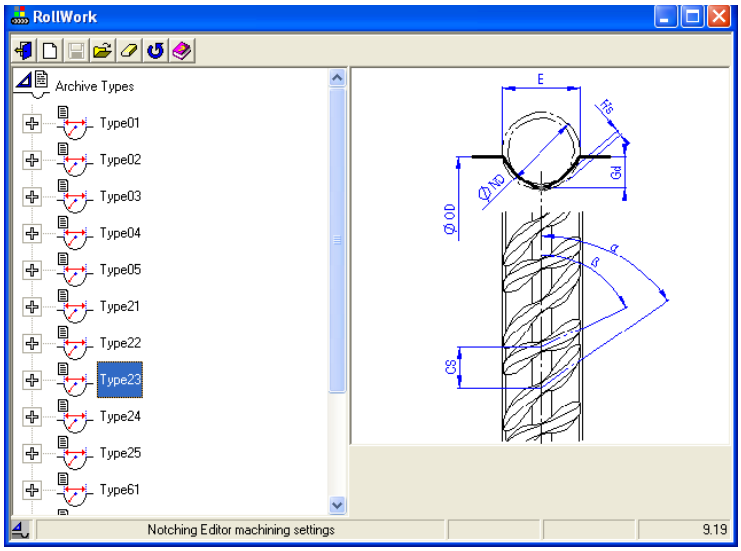

Figure 11 – Easy choice of the international standard.

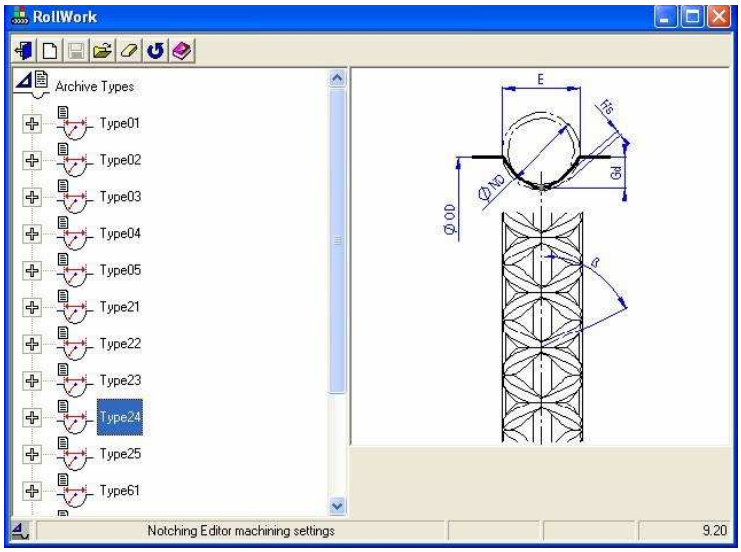

Figure 12 – Easy choice of the international standard.

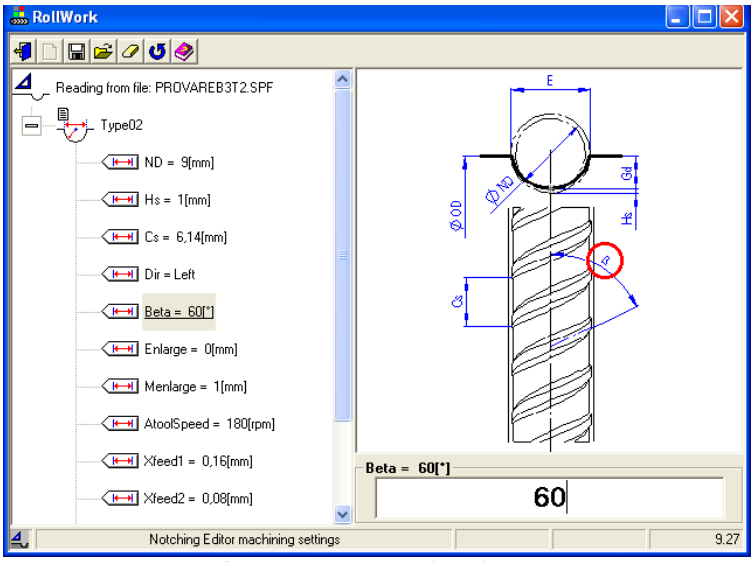

Figure 13 – Easy data input.

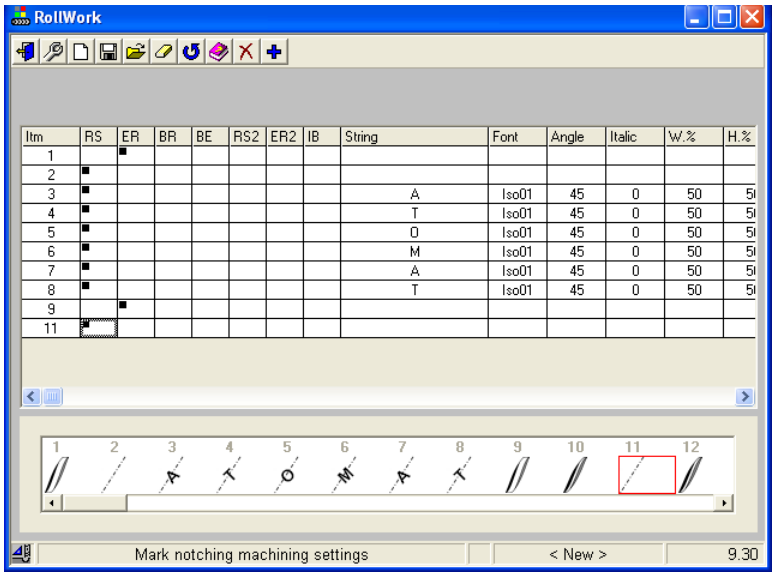

Figure 14 – Easy notch skipping and enlarging for trade mark.

4 RANGE OF APPLICATION

The choice of a combined grinding machine depends on several parameters and must be evaluated for each specific instance. The following simulation is just a guideline to define the range of production that could be covered by a single combined machine.
In this model, a 10 passes finishing block with carbide rolls is considered for rolling both smooth and ribbed wire.
The production mix was based on an average distribution ranging from 8 to 14 mm and the grinding and notching parameters used in order to calculate the time for each operation are the average values normally used in the feasibility studies for a new rolling mill.
Of course, the results may differ case by case according to the organization of each mill and of the skill level of their personnel.

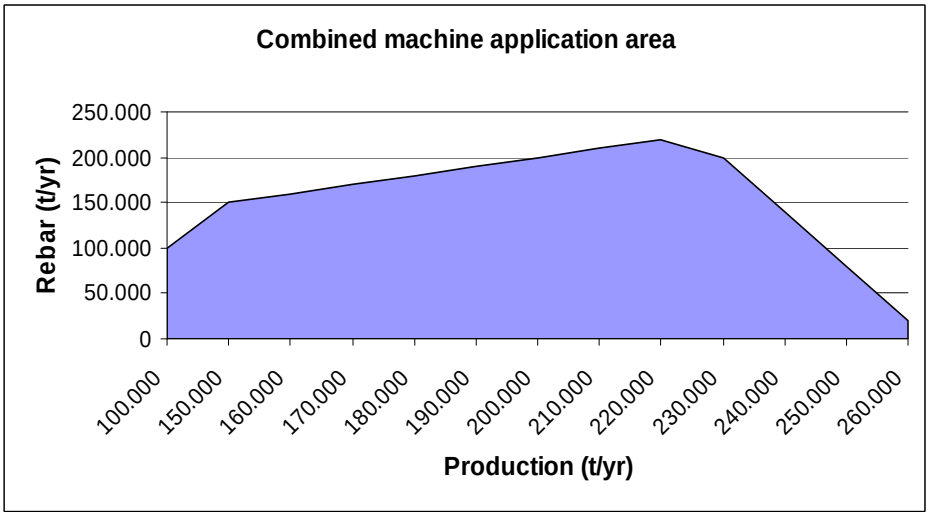

Figure 15 – Application Area.

The shadowed region in the graphic (Figure 15) represents the application area of a combined machine as it originates from the above mentioned simulation.

It has to be considered just as a first guiding value, starting from which a purposeful study on each specific plant should provide the required facts for the final equipment configuration.

5 CONCLUSIONS

- The combined grinding and notch milling machine is able to perform all the functions of any separated grinder or notching machine.
- Its rotating head is able to switch among the various production phases quickly and without any operator intervention.
- The Rollwork® interface makes it easy to operate the AT710EN, rendering it a valid alternative to the specialized machines.
- The specific number of machines and their type depend on the rolling mill configuration, its production mix and several other parameters.
- In this presentation, a simulation with a 10 stands finishing block for smooth and ribbed wire was taken into account in order to achieve an indicative area of application for our combined machine. It must be regarded just as a first guideline that certainly needs to be confirmed by an accurate and comprehensive feasibility study.