Title: INDEPENDENT MEASURING APPARATUS FOR GRINDING MACHINES

Abstract: The invention relates to a measuring apparatus for cylinders, rolls and similar elements to be measured during the grinding operation, equipped with detection systems of the geometrical and dimensional characteristics (for example roundness, shape, diameter, etc.) and/or structural characteristics (for example, the presence of cracks and work hardening, measurement of the hardness, etc.) and/or surface characteristics (for example roughness, states of surface tension, etc.). The measurement of the geometrical characteristics is performed with four detection points.
The present invention relates to an independent measuring apparatus for grinding machines.

In particular, the invention relates to a measuring apparatus for cylinders, rolls and similar elements to be measured during the grinding operation, equipped with detection systems of the geometrical and dimensional characteristics (for example roundness, shape, diameter, etc.) and/or structural characteristics (for example, the presence of cracks and work hardening, measurement of the hardness, etc.) and/or surface characteristics (for example roughness, states of surface tension, etc.).

Grinders of cylinders coming from rolling mills, for the production of strips of metallic material, are large dimensional machines which must guarantee high performances in terms of repeatability and accuracy of the measurements effected in addition to precision in revealing the geometrical shapes obtained.

These characteristics relating to precision, surface
quality and repeatability to be guaranteed on a wide range of dimensions (in diameter - up to and over 2 m - and in length - up to and over 10 m), are required in a whole range of sectors in addition to the rolling of flat metallic and non-metallic products, such as the paper and printed paper industry, the constructions of engines and large dimensional hydraulic systems, for example pistons, transmission shafts and elbow shafts for marine engines.

The use of these machines is generally indispensable whenever the large dimensions of elements are associated with sophisticated and restrictive geometrical and surface characteristics as well as structural integrity.

In the iron and steel industry, for example, it is common practice for the reconditioning operations of cylinders from rolling mills to be effected in areas adjacent to the rolling mill itself called "cylinder shapers" or in workshops dedicated to the service of various rolling mills. In these spaces, worn and/or damaged cylinders converge to be subjected to a grinding phase suitable for restoring the ideal conditions necessary for the rolling process.

Even tiny variations in the theoretical profile and roundness of the rolling cylinders cause undulations in the strips, surface marks and traces which reduce the commercial value of tons of steel, with obvious damage to
the plant which produces and commercializes them. Furthermore, deviations in the roughness requested cause problems in the subsequent surface protection phases of the strip. Finally, small surface defects (such as, for example cracks, work hardening etc.) jeopardize the structural integrity of the cylinder increasing the risk of accidents (for example catastrophic breakages) causing production blockages and enormous repair expenses, naturally also in addition to the most important aspect linked to the safety of the operators.

In order to optimize the reconditioning procedure of the cylinder, it is necessary to measure and subsequently correct its geometry during the grinding process. At the same time, it is necessary to identify the entity and position of defects in order to effect suitable grinding actions for eliminating them.

The present state of the art defines two alternative solutions for measuring these cylinders:
- in the paper industry systems have been developed based on 4 points capable of giving an excellent qualitative response with respect to the determination of the roughness characteristics of the cylinder. This solution, however, has the limitation of being assembled on the wheel-holder trolley and consequently operating in synchroniza-

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quality of the detection, the geometrical measurements and dimensions are satisfactory but cannot be effected during the grinding cycle whereas the structure and surface faults are subject to sampling. The various dimensions of the grinding wheel and sensors envisage that the measurement coil be of a lesser width than that generated by the grinding wheel, making it impossible for the sensor to cover the whole area to be analyzed. As this is consequently a non-exhaustive measurement, an identification of all the faults is not guaranteed;

- in the iron and steel industry, on the contrary, alongside the synchronous "traditional" measurement methods (gauge assembled on board the wheel-holder trolley) but with a geometrical and dimensional analysis effected with two sensors which have the same limitations described above, solutions have been developed based on asynchronous detection methods (independent gauge) which operate on two points to effect geometrical and dimensional measurements (shape, profile, diameter, etc.).

Regulations (for example ISO 4292) establish that a complete and exhaustive measuring of the roundness must be carried out with two measurements on three points and one on two points and that these determinations must be effected independently of each other. It is therefore evident that the procedure and equipment currently on the
market are not capable of providing exhaustive measurements. These apparatuses, on the other hand, are perfectly adequate for determining the structural and surface characteristics, as an asynchronous system adapts the pitch of the coil with the dimension of the sensors.

In the "traditional" cycle (synchronous), three phases are necessary for obtaining an exhaustive analysis of the whole processing area:
- passage of the grinding wheel,
- geometrical and dimensional and, optionally, structural control,
- definition of the new processing parameters.

These operations must be carried out sequentially increasing the cycle time required.

Furthermore, the fact of operating in different times, induces possible errors due to variations in the configuration of the system as a result of accidental events between the two passages.

A general objective of the present invention is therefore to provide a measurement apparatus for grinding machines suitable for overcoming the above drawbacks of the known art described above by introducing the measurement of the geometrical characteristics with 4 detection points which, among other things, responds to the requisites defined in the ISO regulations and operating, to-
gather with "structural" and/or "surface" sensors, on an asynchronous movement system.

This system is therefore also capable of operating contemporaneously with the grinding of the cylinder.

In view of the above objectives, according to the present invention, an independent measuring apparatus has been conceived for grinding machines, in particular a measuring apparatus for cylinders, rolls and the like, to be subjected to grinding, equipped with geometrical and/or dimensional and/or structural and/or surface control organs having the characteristics specified in the following claims.

The morphological and functional characteristics of the present invention as also its advantages with respect to the known art will appear more evident from the following description, referring to the enclosed figure which offers a non-limiting example of the invention and which schematically illustrates an independent measuring apparatus for grinding machines produced according to the innovative principles of the invention itself.

With reference to the figure, a grinding machine 10 for cylinders 11, rolls and similar elements comprises at least one base 12 along which a grinding trolley 20, carrying the grinding unit 21 equipped with a grinding wheel 22, and a supporting trolley 40 of the independent gauge
carrying a measuring apparatus 50, are moveably supported.

The measuring and detection apparatus 50 of the geometry of the cylinder 11 is used not only for cylinders coming from the rolling mill, to obtain strips made of metallic material, but also in other sectors comprising grinding processing of cylinders, rolls and other similar elements for the paper industry and, more generally, of flat non-ferrous rolled sections and/or fields such as the construction of marine engines and/or large dimensional hydraulic systems.

The measuring and detection apparatus 50 is therefore assembled on an independent system, the measuring trolley 40, and, as a first specific characteristic, is produced with a structure 51 similar to tongs, equipped with at least one upper arm 52 carrying upper sensors 54 and a lower arm 53, carrying at least one lower sensor 55.

This tong-like structure is designed to be opened/closed, by the translation and/or rotation of at least one of the arms 52, 53, in the direction indicated with the arrow F, so as to come into contact with the cylinder 11 during the measuring phase, at the same time, allowing it to be loaded and unloaded at the end of the processing.
The measuring apparatus 50 also has sensors 54, 55 positioned so as to effect a simultaneous measuring in at least four points, without any interference on the part of the grinding unit.

In particular, the upper sensors 54 are arranged along a suitable support 56 and are radially positioned on a perpendicular plane with respect to the axis of the cylinder 11 being processed.

One of the remaining sensors or lower detection points 55, also radial, can be situated in a diametrically opposite position to one of the positions of the upper sensors 54 of the support 56 and consequently also on a perpendicular plane with respect to the axis of the cylinder being processed in order to guarantee a direct reading of the diameter of the cylinder 11.

In other words, the measuring system according to the invention operating on a machine for the grinding of said cylinders with an autonomous movement, i.e. with a movement independent of the translation movement of the grinding wheel or other parts, comprises at least four sensors (54, 55), situated on a plane orthogonal to the cylinder (11) or roll and two of said sensors can be situated in positions diametrically opposite to each other.

The sensors are therefore positioned on at least two arms 52, 53 equipped with automatic movement means which
allow the sensors 54, 55 to approach and be roughly positioned on the surface of the cylinder 11.

The fine regulation is then managed by directly using the signals coming from the sensors.

In addition to the sensors 54, 55 cited above, it is also possible to add detection systems of structural faults, such as parasite currents and/or ultrasounds and/or durometers, and/or rugosimeters and similar systems for determining the surface characteristics.

This structural and/or surface analysis system is envisaged as being installed on the structure of the independent gauge 51 or on another dedicated structure, again situated on board the independent gauge.

Suitable rest supporting structures 60 carrying skids 61 are also envisaged on the base 12 to support the cylinder being processed.

The system obviously functions even if the cylinder is supported between the grinding points (centres), without any help of rests.

The presence of the sensors 54, 55 advantageously enables, if assisted by a specific algorithm implemented in the automatic management system of the grinding machine 10 and a suitable measurement strategy, the complete characterization of the roundness.

This allows a complete geometrical plotting of the
cylinder 11, producing a base on which the subsequent grinding operations can be optimized by means of a suitable information processing and feedback system on the processing parameters of the grinding wheel adjusting the roundness, profile, diameter and conicity of the ground cylinders.
CLAIMS

1) A measuring apparatus (50) of geometrical parameters of cylinders, rolls and similar elements (11), used for the rolling of flat products operating on a machine for the grinding of said cylinders with an autonomous movement, i.e. with a movement independent of the translation movement of the grinding wheel or other parts, characterized in that it comprises at least four sensors (54, 55), situated on a surface orthogonal to the cylinder (11) or roll and in that at least two of said sensors are situated in opposite positions.

2) The apparatus according to claim 1, characterized in that at least two of said sensors are situated in positions which are diametrically opposite each other.

3) The apparatus according to claim 1, characterized in that it is equipped with an arm (52) carrying at least one sensor (54) and an arm (53) carrying at least one sensor (55) and in that said sensors are positioned radially on a perpendicular plane with respect to the axis of the cylinder, roll or similar element (11) being processed so as to allow orthogonal positioning with respect to the surface of the cylinders, rolls and similar elements for all the processable forms and dimensions.

4) The apparatus according to claim 1, characterized in that it is equipped with an upper arm (52) carrying at
least three upper sensors (54) and a lower arm (53), carrying at least one lower sensor (55), and in that said sensors are positioned radially on a perpendicular plane with respect to the axis of the cylinder, roll and similar element (11) being processed so as to allow its orthogonal positioning with respect to the surface of the cylinders, rolls and similar elements for all the processable forms and dimensions.

5) The apparatus according to claim 4, characterized in that at least one lower sensor (55) is positioned diametrally opposite to at least one of said upper sensors (54).

6) The apparatus according to claim 1, characterized in that said apparatus is assembled on a structure (51) envisaged for being positioned, by the translation of at least one of the arms (52, 53), so as to come into contact with the cylinder, roll or similar element (11) during the measuring phase.

7) The apparatus according to one of the previous claims, characterized in that said structure (51) is envisaged for being opened/closed, by means of the translation and/or rotation of at least one of the arms (52, 53) to allow the loading and/or unloading of the cylinders, rolls and similar elements.

8) The apparatus according to at least one of the pre-
vious claims, characterized in that a detection system of structural and/or surface faults can also be envisaged (Parasite Currents and/or Ultrasounds and/or rugosimeters and/or durometers etc.) of the cylinders, rolls and/or similar elements positioned on the structure (51) in any case always integral with the supporting and/or translation system of the independent gauge system.

9) The apparatus according to any of the previous claims, characterized in that an automatic management system of the grinding machine (10) is also envisaged, which implements the measuring procedure for the complete geometrical plotting of the cylinder, roll and/or similar elements (11). Said automatic and/or plotting system is used for implementing a feedback process for updating the grinding parameters and/or for reporting purposes.

10) The apparatus according to claim 1, characterized in that it operates for the grinding of cylinders, rolls and similar elements for the paper industry and, more generally, of flat ferrous and non-ferrous rolled sections and/or fields such as the construction of marine engines and/or large dimensional hydraulic systems.

11) A grinding machine (10) for cylinders, rolls and similar elements, characterized in that it comprises a measuring apparatus according to one or more of the previous claims.
12) A grinding machine (10) for cylinders, rolls and similar elements, characterized in that it comprises a measuring apparatus according to one or more of the previous claims and that it consists of one or more bases.

13) A grinding machine (10) for cylinders, rolls and similar elements, characterized in that it comprises a measuring apparatus according to one or more of the previous claims arranged on three or more supporting arms of the sensors.
### A. CLASSIFICATION OF SUBJECT MATTER

According to International Patent Classification (IPC) or to both national classification and IPC:

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### B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols):

- G01B
- B24B
- B23Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched:

Electronic data base consulted during the international search (name of data base and, where practical, search terms used):

- EPO-Internal
- WPI Data

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>WO 03/102496 A (ROLLTEST OY [FI]; PAUNONEN RISTO [FI]) 11 December 2003 (2003-12-11) abstract page 5, line 28 - page 8, line 32 figures 1, 2</td>
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* Further documents are listed in the continuation of Box C.  

X See patent family annex.

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Name and mailing address of the ISA:

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