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Innovation of the device for clamping forces measurement on a balancing machine

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Abstract: A flawless clamping of a car wheel to the balancing machine is necessary for its perfect balancing. That depends on the correct force setting of the clamping segments. The measuring device with the special 10-axis force sensor for the clamping forces measurement was built eight years ago. A new variant of the force sensor must have been designed for a new type of a balancing machine with only 8-segment clamping head. More information about the clamping process can be obtained with the new multichannel amplifier and the new software version. This paper describes the new force sensor design and hardware and software innovation of the measuring device.

Keywords: Balancing machine, Force sensor, Strain Gauges

1. Introduction

A car wheel is clamped to the balancing machine by its central hole. A clamping principle and balancing machine are shown in the Fig. 1.

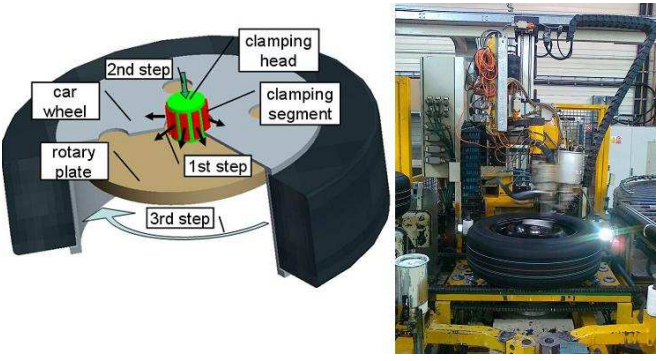

Fig. 1. Wheel clamping principle and an industrial balancing machine

A clamping head contents several radial clamping segments. In the first step these segments are moved out and the wheel is grasped in its central hole. In the second

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step, the clamping head goes down and the wheel is fixed to the rotary plate. Finally, the car wheel is balanced. If the radial clamping segments are not well adjusted, they are not moved equally and clamping forces of each segment are different. The wheel is badly clamped or deformed during its clamping process and the result of the balancing is bad. So, the checking of radial and axial clamping forces during the adjusting of clamping head is very important for good balancing results.

2. Clamping forces measuring device

The first measuring device was built eight years ago for balancing a machine with ten-segments clamping head [1]. A special multi-axis force sensor was designed for measuring of one axial and ten radial forces. Each measuring segment contains a full strain-gauge bridge. The sensor is connected to the measuring unit. As display of only the final value of forces was required in the original assignment, the measuring unit contained only one amplifier and A/D converter. The forces in segments were measured and displayed step by step. The results could be moved to a PC for further processing. A block diagram of the measuring device is shown in the Fig. 2.

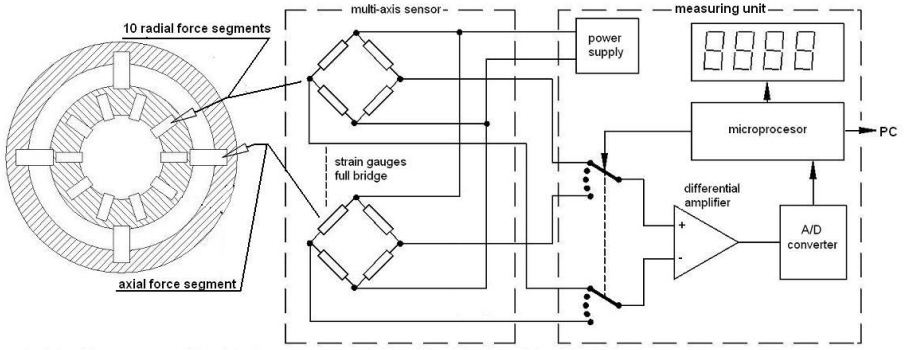

Fig. 2. Block diagram

This solution had two big disadvantages. Firstly, not well-arranged sequential display of forces on the measuring unit display; the data were preferably always immediately transferred to a PC for a lucid display of the results. And secondly, impossible measuring of the clamping forces waveforms; clamping is dependent not only on the final value of forces but also on their progress.

3. Measuring device innovation

The main reason for the measuring device innovation was the use of a new balancing machine with eight-segment clamping head. A new eight-axis force sensor had to be designed for this machine. Simultaneously the measure unit has been redesigned to eliminate the deficiencies of forces measuring.

3.1. New force sensor

An eight-axis force sensor is designed like the original ten-axis sensor, but it contains only eight segments for measuring the radial forces. Beams for measuring

of the axial force are the same as the original sensor. Full strain-gauge bridge is attached to each radial segment and strain gauges on the axial beams are connected to the full bridge too. The sensor is equipped with an identification chip for its automatic identification during connection to the measure unit. The same function is also added to the ten-axis sensor. The new eight-axis force sensor is shown in the Fig. 3.

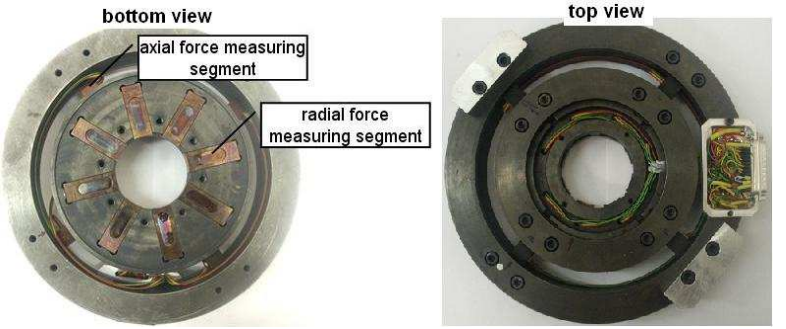

Fig. 3. Eight-axis force sensor

3.2. New measuring unit

Measuring unit had to be completely redesigned, because an input multiplexer could be used for measuring of forces waveforms. A new solution block diagram is shown in the Fig. 4.

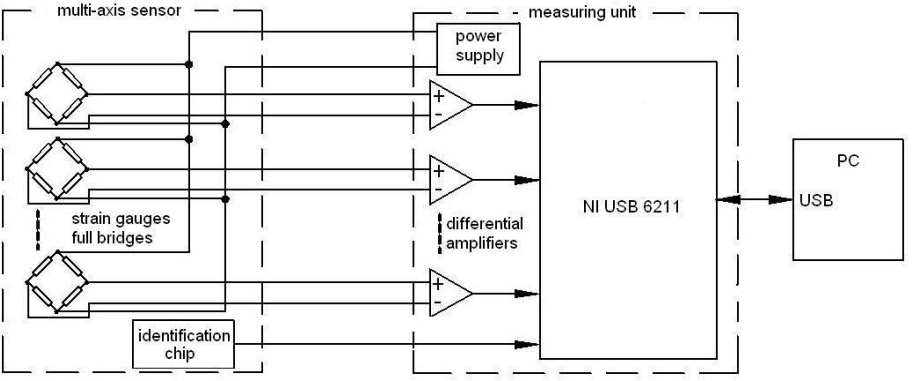

Fig. 4. New measure unit block diagram

Each measurement channel has its own one-chip instrumentation differential amplifier Analog Devices AD621. Sixteen-channel DAQ Card NI USB 6211 is used for A/D conversion, data transfer to PC and communication with the sensor identification chip. The measure unit is permanently connected to the USB port and all functions are controlled by software.

3.3. New software application

Software application is written in LabVIEW. Continuous measurement of all channels allows getting a complex information about the clamping process. This information is clearly displayed in three different ways on the PC. The chart shows a progress of forces during the clamping. Final clamping forces of all segments can be manually or automatically transferred to a table. The table also shows average values from several measurements and an average force of all the segments. The most comprehensive information of a distribution of forces in the segments is shown in a pie chart. Data from the table and the waveform chart can be saved to files and the table or charts can be printed. The application window is shown in Fig. 5.

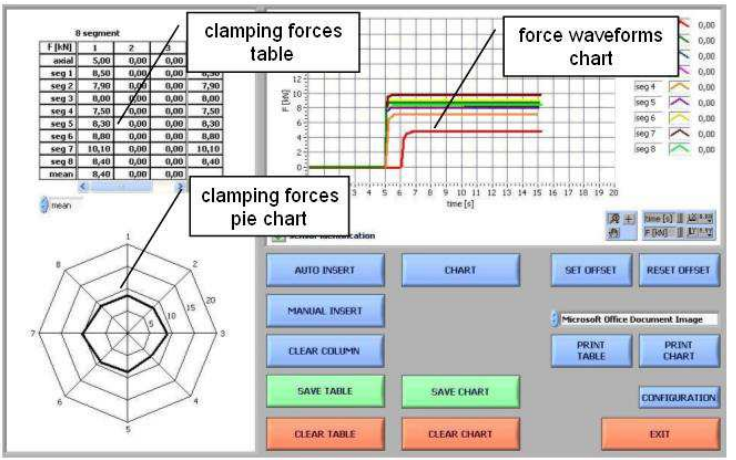

Fig. 5. New software application window

4. Conclusions

The measurement device innovation benefits:

- two sensors for the measurement of ten or eight segment head
- automatic detection of a sensor
- display of clamping forces waveform
- clear view of clamping forces in the table and pie chart

Acknowledgements

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References

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