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NONCONTACT LASER INSPECTION OF RUNNING FREIGHT CAR WHEEL PAIRS

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Abstract: *For safety increasing of Russian railways TDI SIE has developed and produced automatic laser diagnostic system Complex for inspection of geometric parameters of wagon wheel pairs for running train (speed up to 60 km/hr.), which is used successfully on Russian railways. The principle of inspection method, block-diagram for system COMPLEX and results of industrial application are presented.*
Key words: *automatic inspection, triangulation method, wheel pairs, railway industry, safety.*

1. INTRODUCTION

Ensuring the safety of running trains is the main condition of railways exploitation and transport of passengers and cargoes all over the world. This is determined by the growth of moving speed in railways and by the wear of the rolling stock. As the moving speed increases, the requirements of quality of railways and of the rolling stock become stricter. This entails the necessity of optimal use of rolling stock without decreasing the movement safety.

The problem of inspection of the cross profile geometrical parameters for running freight car wheel pairs is very important. In this case, the velocity of train may range from 5 to 60 km/hour, and the object under inspection has a complex shape. Besides, inspection of the wheel geometry may be performed under severe meteorological conditions (at a temperature ranging from -50°C to +50°C, rain, snow, etc.) (Venediktov et al., 2003).

The instrumentation and systems (including ones based on contact sensors) available at present does not fully meet the above requirements. The triangulation measurement method meets the stringent and often contradictory requirements listed above (Plotnikov et al., 2002). Triangulation systems allow one to measure distances directly up to the surface of the object under inspection, and the object may have a complex shape (Plotnikov, 1996; Plotnikov et al., 2002).

We have developed high-speed laser noncontact method and produced automatic laser diagnostic system Complex for noncontact inspection of geometric parameters of wheel pairs for raining trains (Baybakov et al., 2003; Baybakov et al., 2004). Measurements are fulfilled at freight cars speed up to 60 km/hr (the range of working temperatures is from –50° up to +50° C). Principle of self-scanning for running freight cars and testing results for system COMPLEX are given.

2. LASER SELF-SCANNING METHOD AND SYSTEM COMPLEX FOR WHEEL PAIRS INSPECTION

For regular dimension inspection of running wheels we have developed high-speed laser noncontact method and

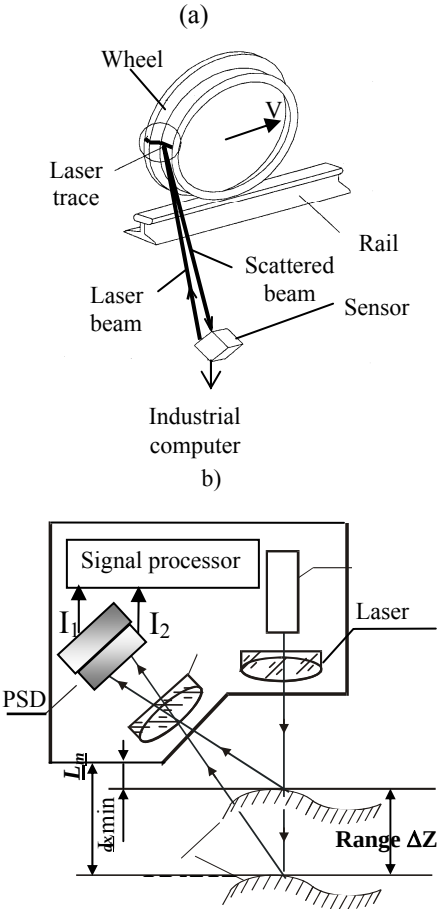
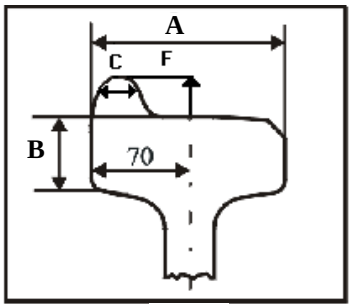
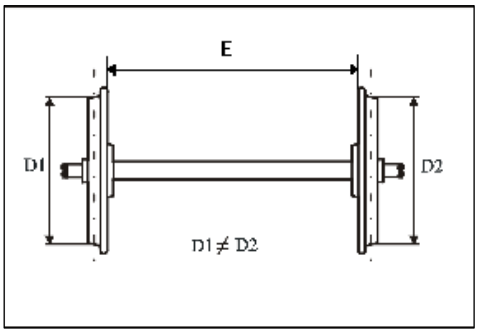


Fig. 1. The principle of self-scanning of running freight car wheel (a) using active measuring sensors of the triangulation type (b).



(a)



(b)

Fig. 2. Wheel parameters under inspection

measuring sensors of the triangulation type. In this case, a beam produced by a laser diode is focused on the surface of the moving object under inspection. The scattered beam is gathered by the aperture of a receiving objective. The objective forms an image of the illuminated surface zone in the PSD plane (Fig. 1b).

Using this method TDI SIE has produced automatic laser diagnostic system COMPLEX for noncontact inspection of geometric parameters of wheel pairs (Fig. 2), including: width (A) and thickness (B) of wheel rim; distance between inner sides of wheels (E); thickness of wheel flange (C); uniform rolling (F); wheel diameter (D); difference of diameters of wheels in a wheel pair $D=D_1-D_2$. Measuring error is about 0.5 mm. Measurements are fulfilled at freight cars speed up to 60 km/hr. The range of working temperatures is ±50°C.

COMPLEX system block-diagram is represented in Fig. 3. It includes in door and out door equipment, and also an automated workstation for operator. The out door equipment of the COMPLEX is installed in the railway in a common frame and includes wheel external pickups 1, wheel internal pickups 3, and clock pickups (magnetic pedals) 4. The in door equipment of COMPLEX installed in a heated room near the out door equipment includes control and clock unit 5, two independent data acquisition modules and server.

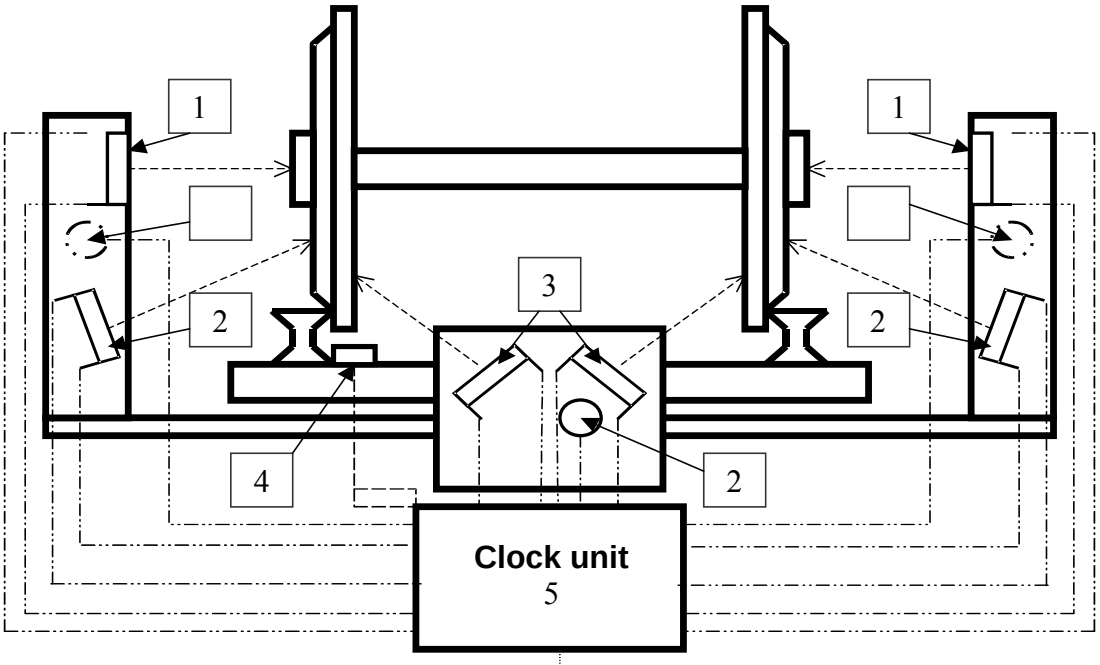


Fig. 3. Block diagram of the COMPLEX system

measuring technology for geometrical parameters inspection of moving 3D objects on the base of triangulation position sensors using fast-response position sensor detector PSD (50 000 meas/s) (Baybakov et al., 2003; Baybakov et al., 2004). This method is based on the principle of wheel self-scanning (Fig. 1a) by using active

3. RESULTS OF INDUSTRIAL APPLICATION

Figure 4 shows an example of the wheel reconstructed profile (cross-section). The required geometrical parameters are calculated from the reconstructed profile, in so doing, the algorithm of calculating the parameters follows the

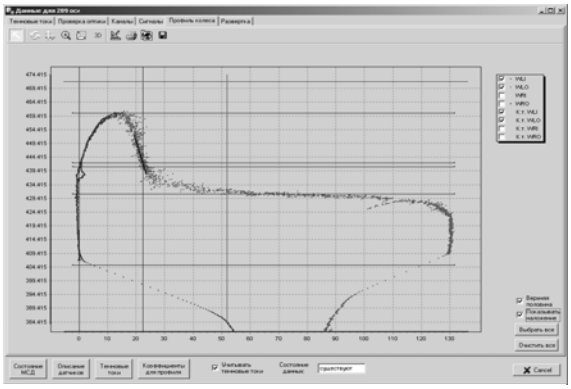


Fig. 4. A wheel reconstruction profile (cross-section)

method of their measurement by means of a standard contact meter.

Experimental study of the measurement accuracy and reliability of control was carried out by comparing results obtained by automatic measurements by system COMPLEX and by conventional manual contact measurements of wheel pairs of immobile trains. Numerous comparative measurements confirm the high stability and accuracy of automatic measurements in the range of train speeds in the controlled area up to 60 km/h. External view of this system COMPLEX is presented in Fig. 5, 6.

Fig. 5. Automatic laser system COMPLEX for noncontact wheel pairs freight car inspection for running trains (West-Siberian Railway)

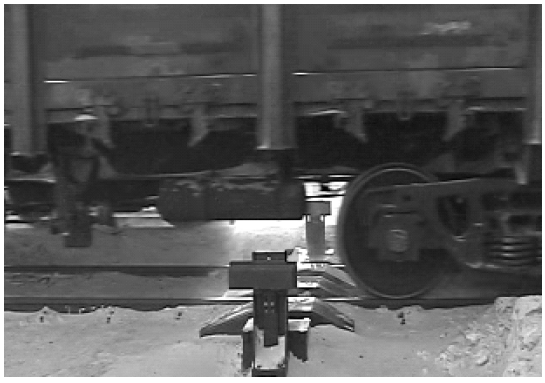


Fig. 6. System COMPLEX under operation in winter (West-Siberian Railway)

The COMPLEX systems have been tested during three years at West-Siberian Railway (Russia). At the present time 34 systems COMPLEX are in operation on 10 Russian regional Railways (from west to east frontiers of Russian Federation). There were inspected more than 50 million wheel pairs for the period of system COMPLEX exploitation. More than 20000 carriages were rejected. The application of these systems makes it possible to forecast the behavior of the tested parameters for long and short periods, determine the residual service period of each wheel pair, forecast measures for their repair reduce rolling-stock forecast exploitation costs. It allowed us to improve the safety of railway industry in Russia. The developed diagnostic system COMPLEX corresponds to the best world prototypes.

4. CONCLUSION

We have developed high-speed self-scanning triangulation method and the automatic diagnostic laser system COMPLEX for inspection of geometrical parameters of running freight car wheel pairs.

The COMPLEX automatically measures the thickness of wheel rim and flange, the wheel diameter, and other parameters of the wheel pair profile cross-section at speeds of up to 60 km/h in severe climatic conditions (from -50 up to +50° C), which absolutely meets the exploitation requirements. Results of testing confirmed the reliable operation of COMPLEX in different environmental conditions and with high inspection reliability.

Now 34 systems COMPLEX are in operation on Russian Railways. Application of the automatic laser diagnostic systems COMPLEX for noncontact wheel pairs dimensional inspection for running trains makes possible to increase substantially the safety of Russian railways.

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