Title: MACHINE FOR THE MAINTENANCE OF RAILWAY CARRIAGES

Abstract: The invention relates to a machine intended for the effective maintenance of complete wheel axles for railway carriages, characterized by a main frame (1), a drive system (2) for speed simulation combined with load simulation provided by a load bracket (3), piezo-resistive sensor (4), loading and unloading arm (5) for loading and unloading as well as sorting of wheel axles with the help of a loading/unloading ramp and holder (6) and a profile cutter (7) for the repair of damage to wheel rims and wheel flanges. A description is also given of a maintenance method for wheel axles involving the injection of new bearing grease in an interspace (37) without the need for dismantling the bearing housing nor the bearing for degreasing.
Machine for the maintenance of railway carriages

The present invention relates to a maintenance system for railway carriages. More precisely, the invention relates to a system which enables early discovery of damage on railway carriage wheels and thus avoid dangerous situations.

The development of the invention is the result of a wish to obtain a higher degree of safeguard against accidents due to carriage equipment on railway lines. The basis for the invention has been the survey of damages to railway carriages as well as the physical processes and the present-day maintenance processes which apply to railway carriage equipment. There has long been a wish to develop a system which can give an early forewarning of damage which, at worst, can create an accident situation.

Due to the extreme topographic conditions on the railway line section which runs between Kiruna in northern Sweden and Narvik in northern Norway, and to the climatic conditions, the railway equipment used for iron-ore transport is exposed to severe strains.

The direct cause of damage is the mass forces arising from the sheer tonnage transported and the problems encountered with the pneumatic braking system at present in use. The type of damage which occurs is in particular thermomechanical damage on the rotating components such as wheel disks and bearings. Asymmetrical or insufficient braking on sections of the train set belong to the same class of problems.

Next to the wish for improved safeguarding against accidents, one also has to admit that present day measures for early warning and protection against accidents do not function satisfactorily. This applies in particular to a stationary infrared detector system for monitoring the operating temperature in the bearings. Attempts at measuring the temperature by direct contact on the bearing housings have also been unsuccessful. Detector systems for beater wheels and wheel flats in the wheel rim due to braking have not been any more successful. One also has to take into account extensive work operations and uncertain manual methods for the maintenance of vital elements such as bearings, wheels, axles and braking systems.

Depending on the extent of the damage suffered by railway equipment, the financial and material consequences may be extensive.
The above calls therefore for continuous monitoring of the operation of vital elements, in order to give the engine driver early warning of dangerous situations, so that remedial action can be taken. There exists a parallel need for improvement and quality assurance of present-day maintenance methods and procedures.

The present invention is a part of a larger and complete concept for operational monitoring and maintenance of railway equipment.

This maintenance concept consists of three system modules and the invention relates to the first of those modules. The three modules are as follows:

1) Effective maintenance integrated in a machine which replaces today's incomplete maintenance procedures for wheel axles. The machine of the invention has an effectiveness and a quality assurance which surpass the methods in use today. The machine is to a large extent automated.

2) Continuous operational monitoring with early warning of abnormal conditions which may result in accidents. The functionality, lifetime and remaining operating time are kept updated in a "drive log". The system is intended to be preventive and is designed to give warning of upcoming need for maintenance.

3) Communication between the system modules and the various departments in the organisation which are concerned by the information exchange in the system.

Module 1) which is the object of the present invention and module 2) are self-contained modules which operate independently of each other. The communication module 3) links the remaining modules together to provide an efficient utilisation of the system and to organise the necessary information for the person in charge. The self-contained quality of the modules implies that the system can be extended as needed.

Various systems for the maintenance of railway wheels and other vehicles have been previously described:

US 4,898,026 describes an apparatus for testing the drive shaft of motor vehicles. The patent is mainly intended for truck wheels and there is no description of the maintenance of train wheels.
US 5,574,233 a contact-free testing apparatus used for the control of newly manufactured train wheels. The apparatus consists of sensors which compare the measured values of the brand new wheels with known reference parameters. It is thus possible to find out whether the quality of the new wheels meets the prescribed requirements and standards. The patent does not mention any corrective grinding or milling when the wheels are found to lack precision or exhibit manufacturing defects.

SU 473 080 mentions a test bench intended for the examination and simulation of train wheels under operating conditions.

SU 599 183 shows a test pit equipped with a chopper to evaluate the effect of vibrations on train wheels.

SU 700 801 concerns a test system for train wheels with alterable distance between the rails (track gauge).

SU 954 843 describes a simulation rig to test variable and strains on train wheels.

SU 1163 186 gives a description of a test rig equipped with friction rollers to rotate the wheels at given speeds, with registration of acoustic vibration signals. No mention is made of possible corrective action and repairs when the wheels do not come up to standard.

JP 9243518 deals with an apparatus comprising a sensor for the measurement of a tension value on the wheel axle.

None of those patents describe the combination system of the present invention. The system of the invention registers any damage to train wheels and flanges and effects repair of the damage with the help of the device of the invention.

More specifically, the invention consists of a machine for the effective maintenance of complete railway carriage wheel axles and is characterized by a main frame, a drive system for speed simulation combined with simulated loads through a load bracket, a piezo-resistive sensor, a loading and unloading arm which loads and unloads as well as sorts wheel axles with the help of a loading and unloading ramp/holder and a profile cutter for repairing damage to the wheel rim and the wheel flange.

The present invention concerns also a method of maintenance and cleaning of wheel axles, characterized in that the pair of bearings, the bearing housing and interspaces are automatically degreased with the help of a compressor and a suitable solvent connected to an injection nipple and a drain nipple situated respectively in the
side and the bottom of the bearing housing, while new bearing grease is automatically injected in the interspace between the pair of bearings with the help of a Hansen coupling in the side of the bearing housing.

Further details of the invention appear from the following illustrations where:

Fig. 1 shows the main frame consisting of a load bracket, a speed regulator, a profile cutter, loading and unloading arm and ramp and a wheel axle clamped in place, Fig. 2 shows a side view of the main frame, Fig. 3 illustrates details of the motor, the power transmission system and the drive wheel, Fig. 4 shows details of the load bracket used for simulation of loads on the bearings, Fig. 5 illustrates the combined loading and unloading arm, Fig. 6 shows details of the profile cutter system, Fig. 7 shows further details of the bearing housing for lubrication and maintenance of the wheels, Fig. 8 is a close-up view of Fig. 1, showing a wheel on an axle to illustrate the propagation of forces during the tests.

Figure 1 illustrates the complete machine module with the main frame 1 and a drive system 2 to simulate speeds in the range of 0 to 100 km/h. A load bracket 3 provides simulated loads in the range of 0 to 12.5 tons, thus covering the range of loads which a wheel is submitted to during normal operation. The figure also illustrates the loading and unloading ramp 6 for loading and unloading wheel axles. The wheel axle is removed from the railway carriage in a suitable manner and is placed on the ramp 6 to be transferred to the main frame 1. The main frame is also equipped with a piezo-resistive sensor 4 which measures speeds and loads. The profile cutter 7 will, in accordance with measurements, repair and correct defects on the wheel rim or on the flange.

The loading and unloading arm 5 effects the transfer of the wheel axle due for maintenance from the ramp 6 to the main frame 1. The figure illustrates a wheel axle complete with one wheel disk 8 while the second wheel disk has been removed to show the bearing housing 9. Hydraulic actuators 10 can apply a force to each wheel disk.
The main frame 1 is of a very robust construction and built in such a manner as to withstand severe cyclic loads during the speed and load simulations. In addition, the main frame reduces the dynamic forces which occur after the speed and load functions subside and it satisfies the requirements as to technical measurements and ergonomic qualities in regard to vibration reduction and noise.

Figure 2 shows a side view of the main frame of Fig. 1 with a drive system 2 equipped with an actuator 11 for speed simulation. On the side of the frame, a mounting point 14 is provided for mounting the load bracket 3.

Figure 3 is a detailed illustration of the drive system 2 which provides speed simulation. Figure 1 shows the drive system mounted on the main frame 1 with bearing blocks 20 equipped with a snap-in sliding clamp 21 and an actuator/damper 11. The entire drive system is encased inside a robust, compartmented support frame 22. The drive system consists of two profiled drive wheels 25 which provides the train wheels 8 with stable positioning and allows them to rotate on the axles under load. The two profiled drive wheels 25 are connected to each other through a power transmission belt, for example a toothed belt 24. A motor 23 is linked to one of the drive wheels 25 which is itself connected to the second wheel through the power transmission belt 24.

Figure 4 shows details of the device which provides simulation of a load on the wheel disks by the lever principle. The main frame 1 consists of two such simulation devices, one for each bearing. A load bracket 3 is mounted on the mounting point 14 on the main frame 1. A hydraulic actuator 13 applies a force. This force propagates from the base of the load bracket 3 through the bearing housing 9, the bearings 33, the axle 16, the wheel disk 8, the drive system 2, the main frame 1 and back to the load bracket, and can provide a simulated load on the bearing in the range of 0 to 12.5 tons. A piezo-resistive sensor 4 is fixed to the end of the base 27 of the load bracket 3 and measures all vibrations and excitations issuing from the pair of bearings 33, the wheel disk 8 and the axle 16 through the bearing housing 9. The piezo-resistive sensor 4 measures all vibrations occurring during the simulation of speeds and loads.

Figure 5 shows the combined loading and unloading arms 5 which provides safe handling of a complete wheel axle from the ramp 6 to the main frame 1. The arms 5 is controlled by two hydraulic actuators 15, 46. The arms 5 can thus be manoeuvred to lift up from or down to floor level. Safety devices 17 on the arms can be manoeuvred with actuator 15 and, when in the lifted position, they will ensure that the
wheel axle does not fall off during the transfer operation. The actuators 15, 46 are manoeuvred in such a manner that the wheel axle is transferred under controlled conditions to a stable position in the recess 18 at the opposite end of the arms 5 where the simulations take place.

Figure 6 shows details of the profile cutter system 7 which can repair defects and unevenness on the wheel rim 40 and the flange 41. The profile cutter system 7 is fixed to the main frame 1 with the help of bearing blocks 12 with a snap-in sliding clamp 45 and a hydraulic actuator 10, as shown in fig. 1. The profile cutter system 7 is encased inside a robust, compartmented support frame and consists of a motor 43, a power transmission belt 42 and two profiled milling wheels 40, 41 which effect the necessary repairs to the wheel rim and the flange respectively. The milling wheels can be adjusted with the help of the actuator 10, and can thus be brought in contact with the rotating wheel disk 8 on the clamped wheel axle 9. If the measurements effected on the wheels reveal unevenness, the milling wheels 40, 41 will effect the necessary repairs to the wheel rim or the flange respectively. The hydraulic actuator 10 which is mounted on the main frame 1 enables the positioning of the profile cutter system 7 in at least three operation modes, so that the two milling wheels 40, 41 can operate either for profiling of the wheel rim, the wheel flange or no operation.

The present invention also relates to a procedure for cleaning and maintenance of wheel axles involving the automatic degreasing of the pair of bearings 33, the bearing housing 9 and the interspaces 36, 37, 38. According to the cleaning procedure of the invention, a suitable solvent is injected by a compressor in an injection nipple 32 and a draining nipple 34 as illustrated on several detail drawings of figure 7. The procedure also includes the injection of new bearing grease in the interspace 37 between the pair of bearings 33, through couplings 32 provided in the side of the bearing housing 31. The whole process can be carried out without having to remove the bearing housing nor the bearings for degreasing, nor replacing them on the wheel axle after maintenance. The procedure also ensures that abrasion particles do not invade the bearings and that the new supply of bearing grease restores the correct lubricant thickness. The detergent oil used can be recuperated, recycled and used again.

Figure 8 shows the wheel disk 8 with details of the drive system 2, the bearing housing 9 and the actuators 11 and 13, to illustrate the power transmission during testing.
The present invention provides a very effective maintenance system which is much simpler and more precise than the maintenance procedures in use today. The invention will ensure that possible damage and irregularities are discovered and repaired at an early stage in order to avoid dangerous situations which, at worst, may result in accidents.
Claims

1. A machine intended for the effective maintenance of a complete wheel axle (8, 9, 16, 33) for railway carriages, characterized by a main frame (1), a drive system (2) for speed simulation combined with load simulation provided by a load bracket (3), a piezo-resistive sensor (4), a loading and unloading arm (5) for loading and unloading as well as sorting of wheel axles with the help of a loading/unloading ramp and holder (6) and a profile cutter (7) for the repair of damage to wheel rims and wheel flanges.

2. The machine of claim 1, characterized in that the drive system (2) is fixed to the main frame (1) by bearing blocks (20), a snap-in slide clamp (21), an actuator / damper (11) and is encased in a robust, compartmented support frame (22) for a motor (23), a toothed belt (24) and profiled drive wheels (25) enabling stable positioning and rotation of the wheel disks (8) on the wheel axle under load from a load bracket (3).

3. The machine of claim 1, characterized in that the load bracket (3) is based on the lever principle in that a force is applied to the mounting point (14) on the main frame (1) through a hydraulic actuator (13) in such a manner that a propagation of force from the base (27) of the load bracket (3) via the bearing housing (9), the bearings (33), the wheel axle (16), the wheel disk (8), the drive system (2), the main frame (1) and back to the load bracket (3) provides a simulated load in the range of 0 to 12.5 tons on the bearing.

4. The machine of claim 1, characterized by two piezo-resistive sensors (4) mounted on the base (27) of the load bracket (3) so that all vibrations and excitations from the bearings (33), the wheel disk (8) and the axle, via the bearing housing (9) are measurable.
5. The machine of claim 1, characterized in that the loading/unloading arms (5) which loads and unloads the complete wheel axle (8, 9, 16) in need of checking, is controlled by two hydraulic actuators (15, 46) enabling a lift operation from/to floor level and securing of the wheel axle in a stable position (17) under this operation as well as during the loading and unloading operations to the position (18) where the simulation operations are taking place.

6. The machine of claims 1 to 5, characterized in that the profile cutter system (7) is mounted on the main frame (1) with the help of bearing blocks (12), a snap-in slide clamp (45), a hydraulic actuator (10), encased in a robust support frame (7) for a motor (43), a power transmission device (42) and two rotating milling wheels (40, 41) which, with the help of the actuator (10) are brought into contact with the rotating wheel disks (8) on the clamped wheel axle to enable milling of the wheel rim (40) or of the flange (41).

7. The machine of claim 6, characterized in that the hydraulic actuator (10), the bearing blocks (12) and the sliding clamp (45) enable positioning of the profile cutter system (7) in at least three operation modes, so that the two milling wheels (40, 41) can operate either for profiling of the wheel rim, the wheel flange or no operation.

8. A method for maintenance and cleaning of bearings, characterized in that the pairs of bearings (33), the bearing housing (9), the interspaces (36, 37, 38) are degreased through an automatic cleaning process with the help of a compressor and a suitable solvent connected to an injection nipple (32) and a drain nipple (34) situated respectively in the side (31) and in the bottom (35) of the bearing housing, new bearing grease being automatically injected into the interspace (37) between the pair of bearings (33) through a Hansen coupling (32) provided in the side of the bearing housing.
9.
The method of claim 8, characterized in that the wheel axle (9) is continually rotated and the vibrations and excitations from the bearing pairs (33) are monitored by a piezo-resistive sensor (4) during the degreasing of the bearings, so that abrasion particles do not invade the bearings (7) and that a new supply of bearing grease is injected to restore the correct lubricant thickness and full function of the bearing.

10.
The method of claims 8 and 9, characterized in that the detergent oil and the bearing grease are automatically recuperated so that they can be used again.