

MODERN TECHNOLOGIES OF TECHNICAL SERVICE OF CATERPILLAR RUNNING PART

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Abstract. Many kinds of agricultural tractors, combines and road-building machines are equipped with a caterpillar running part. It gives the machines advantage in stability and cross-country ability, but possesses low operating life. During operation of the machine it is necessary to give special attention to diagnosing of the technical condition of the track assembly, and also bearing units of the basic rollers and the adjuster wheel. Usage of metal plated additives in lubrication promotes increasing of wear resistance of the parts working in cavities, protected from environment. For restoration of the worn surfaces and assembly landings it is recommended to use technologies of thermoplastic deformation and induction-metallurgical welding. The article presents description of technologies and equipment developed by the authors, supported by the results of tests and recommendations in the choice of optimum technological modes, contents of welding powders and metal plated additives for liquid and plastic lubrications.

Keywords: track assembly, plug, drive wheel, thermoplastic deformation, metal plated additive.

Introduction

The crawler carrier ensures tractors, combines and road-building machines advantage in cross-country ability and stability, but it simultaneously possesses low reliability, receiving significant alternating loads under a constant influence of dust, moisture and mud. The machine, which malfunctioned because of the failure of any element of carrier, cannot be even delivered to the location of the repair and maintenance enterprise. Therefore, it is necessary to carry out all works under the field conditions.

To maintain the working capacity of the carrier as well as the whole machine, it is necessary to have a complex of technical measures, which include timely and reliable diagnosis, lubricant application in the friction pairs, which ensure maximum protection of the contact surfaces and even their re-metallization and also fulfillment of reconstructive processes of the worn elements with the minimum expenditures of energy and supplies.

Materials and methods

Diagnosing of the technical condition of the caterpillar chains can be made by measurement of the 10 links length on a site of the top branch. For increasing accuracy and productivity of estimation of the technical state of the bushing-pin type crawler chains, there was a special measuring device developed [1], which consists of two half-frames of triangular form connected by hinges. A fixed measuring jaw and a device for its keeping in contact with the surface of the bushing of the crawler chain are installed on one of the half-frames. The rod with marked line scale is connected to the second half-frame. A movable measuring jaw is installed on the rod with the possibility of moving and locking.

The measuring device brings from below to the chain. In this case the fixed measuring jaw is installed in contact with the first bushing of the chain section. For the retention of the entire device and guarantee of stable contact of the chain bushing with the measuring jaw, the locking lever is transferred via the cranking of the cam into the position, which ensures stable contact with the adjacent bushing. According to the calculation the movable measuring jaw is brought into contact with the surface of the eleventh bushing of the chain. The length of the controlled chain section is determined by indications of the basic and vernier scales, marked on the rod and frame of the movable jaw. Since both measuring jaws touch the edge bushings on similar sides, no additional measurements and calculations should be carried out. The conclusion about the technical state of the crawler chain is carried out through comparison of the measured values with the parameters of the technical requirements [2].

The supporting and tension wheels and the rollers, each of them having site of rotation, usually presented as a pair of roller antifriction bearings, are used for construction of the chain contour in the

scheme of propulsive agent. The technical state of the bearings is the most important detail, which determines the intensity of wear of the rollers and wheels external surfaces, and the crawler carrier working capacity as a whole.

For evaluation of the technical state and timely defect detection in the bearing supports of the roller there was their vibro-troubleshooting (vibro-diagnosing) proposed. Antifriction bearings, having damages on the paths, rolling bodies (solid of revolution) or separator, generate forces, which are transferred to the roller axis and to its surrounding construction. According to their nature these forces can be periodic, acyclic or random and often appear at high vibration frequencies. Sufficiently large volume of diagnostic information is contained in the vibration signal of the bearing. These are - the overall level of vibration, vibration levels in specific frequency bands, the relationship between these levels, amplitudes, frequencies and the initial phases of each detail of frequency spectrum, relationship between the amplitudes and the frequencies.

The change in properties of the lubricants, utilized in transmission and in the crawler carrier, can be achieved by introduction of metal-plated additives. Possessing high water and soil-repellant properties, they can substantially decrease the wear and temperature in the zone of friction, including the open units. For transmission oils there is no danger of decomposition of additive, its precipitation into sediment and obstruction of filters. Therefore, the application of lubricants on the basis of molybdenum disulfide, graphite and other laminar modifiers is sufficiently effective.

Recently metal-plated lubricants, which form a servovite film on the copper basis, are widely used. Presence of the servovite film prevents penetration of oxygen and hydrogen to the rubbing surfaces and repeatedly increases the true contact area of the gears and slits in transmission. As a result, the materials of the touching parts are subjected only to elastic deformations. The surfaces oxidations do not occur, that considerably decreases their wear [3].

The plating process of transmission rubbing connections is achieved as a result of restoration and deposition of soft metals from salts in the presence of the surfactants, which are contained in the lubricating composition. In this case a protective film with high antifriction properties is formed on the rubbing surfaces.

One of the means, increasing the quality of the basic lubricants, used in the units and transmission of the crawler propelling, that should be recommended, is a metal-plated additive containing olein, stearin and linoleic acids, oleates, stearates and the linoleates of copper, iron and nickel, and also ethers $C_4 - C_8$ [4]. The additive contains completely oil-soluble nanocomplexes in hydrocarbon foundation. They create a protective film and promote restoration of micro-defects on the rubbing surfaces under the conditions of boundary friction.

Usage of qualitative lubricants is possible only in the cavities isolated from the external space. However, larger part of the carrier elements is not protected from the contact with soil and undergoes abrasive wear. For restoring of the initial form and tightness of the assembly-line connections the reduction processes are necessary. Taking into account the analysis of the wear state of the working surfaces of the crawler part components, for their restoration, it is possible to recommend thermoplastic deformation and induction- metallurgical hard-facing.

The performance of plastic deformation of the parts under restoration, should be accompanied by their heating to the temperature, which comprises 75...85 % of the absolute melting point of steel, that is 1050-1250 °C. For thermal equipment, operating in the technological process, the most important properties are a possibility of rapid through heating of the worn parts and guarantee of protection from oxidation processes on their surfaces - formation of slag. While heating the parts of cylindrical forms (bushings and pins), installations of induction heating by high-frequency current (HFC), combined with the inert gas superchargers, which force out atmospheric oxygen from the part surface, completely meet these requirements. The bath furnaces, filled with liquefied slag, can also be used for the oxidation-free heating of the complex form parts (drive sprockets, flanges of crawler chain).

After heating of the billet it is necessary to place it into the stamp for realization of hot deformation. In order to reduce pre-deformational cooling of the billet to minimum, the technological equipment, intended for the thermal action, should be located next to the press equipment, which acts upon puncheon of the stamp. The stamp construction must contribute to moving of the deformed metal into those zones of the billet, which dimensional state determines the validity of the part.

Restoration of crawler chains bushings of compound type with worn external and internal surfaces to necessary sizes is achieved by the fact that redistribution of material to the side of an increase of the outer diameter and decrease of the internal due to the decrease of the billet length is performed in the closed stamp during one punch stroke. Elimination of the bushing decreasing is performed due to compensators, made of the other former details. In this case thickness of the compensator must correspond to the size of shortening of the bushing length, obtained as a result of thermoplastic sagging in the stamp. The compensating rings can be installed during the assembling in the grooves of labyrinth seals of flanges [5].

Usage of plastic deformation as a restoration method is acceptable for the parts not only of cylindrical, but also any other form, including drive sprockets. The form of some models casting is such, that the toothed crown is located on the ledge, which under the influence of puncheon will change its form, in this case the metal will be redistributed to the side of the worn zone (Fig. 1).

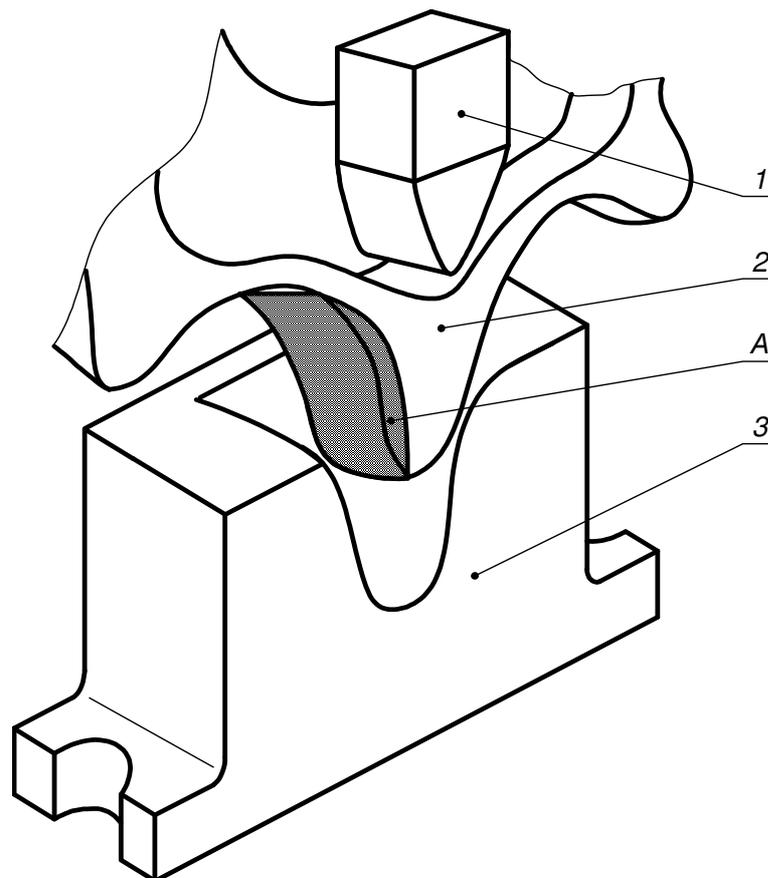


Fig. 1. Example of restoration of form of drive sprocket tooth by plastic deformation:

1 – puncheon; 2 – fragment of gear; 3 – matrix; A – demanded redistribution of volume of material

Usage of the method of induction-metallurgical welding of hard-alloy powder materials is also possible for restoring the worn teeth of the driving wheel of the crawler propelling. Restoration of parts by metal coating occurs when the material of the base layer remains solid. In this case a number of advantages are revealed: high efficiency, possibility of regulating in wide limits of chemical and phase composition of coating and its properties, relatively low level of thermal influence upon the part under restoration, and thus, low level of residual stresses at alias.

A layer of powder charge, which is practically transparent for the electromagnetic field, created by the inductor of the installation of high-frequency currents, is applied on the part worn surface. Electromotive power, which leads to heating of base metal, appears under the action of the electromagnetic field of the inductor. The metallic part granules are isolated from each other by the particles of flux, therefore electrical conductivity of the powder layer and respectively allocation of energy in it are very small. Electrical conductivity of the metal liquid layer formed during fusion of charge granules in this case grows abruptly.

For increasing the speed and quality of welding, and abrasive wear resistance of the applied coatings there was a new welding composition on the basis of powder iron developed, which includes ferro-chrome, carbon, chromium, silicon, manganese, boric acid, soda ash, calcium hydroxide, silicocalcium, flux welding, sodium tetraborate and nickel powder alloy [6].

Operations Process CP is performed in the following sequence. The sprocket mounted on the rotating assembly of a special manipulator with which the hardened surface is placed in a horizontal position and lead to high frequency inductor. After heating the tooth surface to the temperature of 700-800 °C, it is covered by a layer of developed charge consisting of granular solid alloy and flux containing boron. The thickness of the filling is determined by calculation of the shrinkage of charge after welding to 1/3 heights; therefore the filling thickness must be 5...6 mm, for obtaining the layer with a thickness of 2 ± 0.5 mm.

Preheating gives the possibility to bake charge to the surface of the sprockets tooth, excluding its shedding and improving the distribution of the layer thickness of the substituted wear-resistant alloy. While putting charge, it is formed according to the item configuration by a specially profiled ramming scraper. Then heating and welding are produced, placing the welding pool in the horizontal plane. For this purpose one should bring the tooth surface under the inductor, powered from the high-frequency generator with a power of 60 kW and with a frequency of 440 kHz and treat the tooth surface during 80-120 seconds. The charge is melted, and after crystallization of alloy the sprocket tooth is derived from under the inductor, the wheel is turned for installation of the following surface for hardening in the horizontal position. The operations given above should be repeated until all teeth are processed. The final working profile of the sprocket is ensured by polishing of small roughness with the use of manual small polishing machines [7].

Results and discussion

As a result of the conducted investigations of the quality indicators of lubricating compositions, there was obtained the wear - reconstruction dependence of connections of the crawler propelling transmission on the concentration of the metal-plated restorer, which allows making forecast of conditions of the reconstruction effect presence. It was found that when the weight percentage of the additive is 0,5 ... 0.6 % and partially 1.0 %, in that case the restoring effect is possible. That is formation of protective copper servovite films, which are determined by weight and X-ray methods, on friction surfaces. The weight concentration of 1,5 ... 1.7 % is recommended for effective running-in with minimum wear and maximum preservation of the connections overhaul service resource. The weight concentration of 0.15 % should be used for further exploitation of transmission compounds for minimum wear rate in steady friction conditions.

High efficiency of the recommended additive was proved by the results of the laboratory and running tests. Application of lubricating composition, which includes the metal-plated additive, ensures reduction in the friction moment to 25 % and temperature stabilization in the zone of the actual contact, which is explained by a change in micro-geometry of the rubbing surfaces. The comparative analysis of the tests of pure transmission oil and lubricating composition, which are located in the left and right onboard reducers of the drive axle of the crawler rice-harvesting combine, revealed that due to usage of the metal-plated additive, the content of wear products in the tests was decreased more than three times.

While testing it was determined, that the bushings sagging of the crawler chain is possible at temperatures 800...1200 °C. When the heating temperature goes down lower than 750 °C crack formation appears in the bushing upper part. In the time of preparatory and basic operations on hot sagging the billet manages to be cooled to 240...250 °C. The process optimum conditions are considered as follows: heating temperature of 1150 °C, deformation speed of $0.05 \text{ m}\cdot\text{s}^{-1}$, deforming force of 150 kN. In this case after pulling from the stamp the bushing will have a temperature in the range 900 ... 950 °C. The presence of lubricant on the basis of glass ensures the coefficient of friction 0.2 and significant reduction of the force in comparison with the usage of graphite lubricant, which ensures the coefficient of friction 0.3.

Conclusions

Testing of the carrier elements, of tractors combines and other mobile power means is the integral part of guarantee of its efficiency, prevention of failures, increasing of resource, contribution to its retention, the expenditure reduction. Timely testing of the technical state of the carrier elements prevents downtime of machines in the field work period. Special measuring tools and vibration diagnosis should be used for diagnosing the units and individual connections.

Due to the modification of the base liquid and plastic lubricants by the metal-plated additives it becomes possible not only to reduce the intensity of wear of the friction surfaces, but also to achieve remetallization.

As the generalized results of using the method of thermoplastic deformation for restoring the parts the following should be noted. This method does not require usage of additional welding or feeding concomitant repairs. Correction of the worn surface form occurs due to usage of directed redistribution of the part material. To fill in the missing part volume it is possible to use the compensators prepared from similar worn-out parts. According to the strength properties the restored parts are not inferior to new parts. The energy- and metal content of the technological process of reduction is considerably below in comparison with the process of manufacturing of new parts.

Application of charge with the boron-containing flux, which facilitates the formation of fusible compounds on the restoring part surface, is necessary in the induction- metallurgical method of welding. Varying the composition of the powder fillers it is possible to create coatings with different physical and chemical properties and ensure the necessary hardness of the welding layer.

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