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(54) Titre : METHODE ET DISPOSITIF DE CONTROLE D'UNE STRUCTURE PORTEUSE
(54) Title: METHOD AND DEVICE FOR MONITORING A BEARING STRUCTURE

(57) Abrégé/Abstract:
The present invention relates to a method and a device for monitoring a bearing structure (1) with at least one bearing (2, 3, 4, 5) in a housing (6) of the roller journals bearing for a supporting (8), intermediate (9), or working roller (10) in a two-high, four-high, or six-
(57) *Abrégé(suite)/Abstract(continued):*

high stand (11) of a one or multi-stand rolling train. In order to make it possible to initiate maintenance or repair measures in a timely fashion, the present invention provides for the following: a) measurement of a process variable (W) in the bearing (2, 3, 4, 5) or in an area adjacent to the bearing (2, 3, 4, 5); b) transmission of the measured value of the process variable (W) with an analysis unit (13); comparison of the measured value (W) with a predetermined value (W_{max/min}); d) provision of a signal as soon as the measured value (W) exceeds or falls below the predetermined value (W_{max/min}) that is stored in memory.
Abstract

The present invention relates to a method and a device for monitoring a bearing structure (1) with at least one bearing (2, 3, 4, 5) in a housing (6) of the roller-journals bearing for a supporting (8), intermediate (9), or working roller (10) in a two-high, four-high, or six-high stand (11) of a one or multi-stand rolling train. In order to make it possible to initiate maintenance or repair measures in a timely fashion, the present invention provides for the following: a) measurement of a process variable (W) in the bearing (2, 3, 4, 5) or in an area adjacent to the bearing (2, 3, 4, 5); b) transmission of the measured value of the process variable (W) with an analysis unit (13); comparison of the measured value (W) with a predetermined value (\(W_{\text{max/min}}\)); d) provision of a signal as soon as the measured value (W) exceeds or falls below the predetermined value (\(W_{\text{max/min}}\)) that is stored in memory.

(Figure 2)
Method and Device for Monitoring a Bearing Structure

The present invention relates to a method for monitoring a bearing structure that incorporates at least one bearing in the housing of a roller-journal bearing for a supporting, intermediate, or working roller that is part of a two-high, four-high or six-high roll stand of a one or multi-stage rolling train. The present invention also relates to a device for monitoring a bearing structure.

In most instances, a rolling train that is preferably used for rolling metal, consists of a series of roll stands through each of which the material that is to be rolled is passed between at least two of the rollers. At both of their ends, the rollers have a journal that is supported in a so-called insert or housing. The insert is the housing that supports the rollers, a bearing structure being arranged between the roller journals and the housing.

The quality of the rolling process as well as the economy with which it can be completed are essentially determined by the functionality of the bearing structure. For this reason, it must be ensured that no damage is done to the bearings in the course of time; this can be avoided by performing preventive maintenance at specified intervals. One disadvantage of this is the fact that preventive maintenance tasks will be carried out even though the bearing does not necessarily require such work.

Thus, it is the objective of the present invention to create a method and an associated device for monitoring a bearing structure in a supporting, intermediate, or working roller of a rolling stand, with which it is possible to manage repair and maintenance or the replacement of a bearing structure as well as its associated environment in such a way
that such measures are initiated only if there is an actual need for them.

According to the present invention, this objective has been achieved by the following steps:

1) Measuring a process variable in the bearing or in an area that is adjacent to the bearing;

2) Transmitting the process variable so measured to an analysis device;

3) Comparing the measured value with a stored, predetermined value;

4) Triggering a signal as soon as the measured value exceeds or falls below the predetermined value that has been stored in memory.

The present invention is based on the concept that a process variable that is characteristic of the functionality or operational stability of the bearing arrangement of a roller-journal bearing in a rolling stand is monitored by means of a suitable sensor, and constantly compared with the maximum or minimum value that is stored in memory as a possible boundary value for the correct operation of the bearing structure. Then, in the event of a departure from a permissible range of tolerances, comparison of the actual value with the required value can trigger a signal that informs the operator of the rolling train that maintenance or replacement operations are required with respect to that particular roller-journal bearing or its associated surroundings.

A first development of the present invention provides that the process variable relates to a force acting on the bearing. This force can be one that acts in the axial direction of the bearing as well as one that acts in the radial
direction of said bearing. The prior art describes numerous methods for measuring these forces. The limiting value for the maximum possible bearing force that has been stored in memory is such that the monitoring system will respond, i.e., by triggering a signal if, for example, there is wear in the bearing environment, or if there are other irregularities, such as the bearing being tilted in the stand, which may cause forces that reach an unacceptable size to act on the roller bearing.

Alternatively, or in addition to this, provision can also be made such that the process variable that is used represents moisture within the bearing or the moisture content of the lubricant used for the bearing. It has been shown that damage to the bearing can occur if there is an unacceptably high moisture content within the bearing. For this reason, a moisture sensor of the kind known in
the prior art can be used to measure and monitor the moisture at a suitable location within the bearing, or within its surrounding area.

Alternatively, or in addition to this, it is also possible to monitor the temperature within the bearing itself. When this is done, it is preferred that the temperature of the outer race be measured, since this can be done in a particularly simple manner.

It is also proposed that the process variable that is to be monitored be the elastic or plastic deformation of the housing. This deformation can be measured both in the peripheral direction of the housing, which will then provide the value for the ovality of the housing, or in the axial direction of the housing; in the latter case, it is the cylindricity of the housing that is monitored. The deformation of the housing that is to be measured is preferably obtained by combining the elastic and optionally the existing plastic deformation. It has been established that when a specific boundary value for the deformation of the housing has been reached, the service life or the bearing is greatly reduced. This provides a reliable indication with respect to repair or maintenance work that has to be done up on the housing.

In a similar way, in addition to this, or as an alternative, provision can be made such that the process variable is the vibration amplitude and/or the vibration frequency in a predetermined area of the bearing. Furthermore, the vibration acceleration of a selected area of the bearing can also be monitored. Monitoring of the vibration characteristics of the bearing and its statistical evaluation (amplitudes, frequencies, and acceleration rates) can be used as an indication as to
when it is necessary to maintain or replace the bearing. According to another development of the present invention, the measured value is transmitted by wireless means, with transmission by induction or by radio being preferred.

According to the present invention, the device to monitor a bearing structure with at least one bearing in a housing of a roller-journal bearing is characterized by:

- one or more sensors that record a process variable in the bearing or in an area adjacent to the bearing;
- means to pass the measured value for this process variable to an analysis unit;
- means to compare the measured value with a predetermined value that is stored in memory;
- means to trigger a signal as soon as the measured value either exceeds or falls below the predetermined value stored in memory.

Depending on the particular application, the sensors that are used to monitor the process variable in question can be a force sensor, a moisture sensor, a temperature probe, a deformation recorder (in particular in the form of one or a plurality of strip tensometers), and/or a velocity meter or an accelerometer.

It is preferred that the bearing be a roller bearing, and more particularly a multi-row, tapered roller bearing or a multi-row cylindrical-roller bearing.
According to one development of the present invention, the means that are used to pass the measured value of the process variable to the analysis unit transmit this value by wireless means, preferably by induction or by radio.

The concept according to the present invention makes it possible to monitor various process variables in a roller-journal bearing structure of a rolling stand and to make informed decisions about when steps must be taken in order to maintain or replace the bearing. In this way, suitable activities can be initiated at the proper time in order that a bearing structure can be replaced at the onset of damage to the bearing. The overall manufacturing process that is performed in the rolling train can thus be optimized. The same applies to the housing itself, and to its surroundings within the rolling stand. Here, too, the steps discussed above can ensure that a replacement part is installed in good time. By measuring and observing the process variables considered here, wear in the area of the roller-journal bearing can be rendered visible and a warning that maintenance measures must be initiated can be provided promptly.

This provides a greater level of security with respect to unscheduled downtime and also makes it possible to identify sources of error correctly.
According to one aspect of the present invention, there is provided a method for monitoring a bearing structure with at least one bearing in a housing of the roller-journal bearing for a supporting, intermediate, or working roller in a two-high, four-high, or six-high stand of a one or multi-stand rolling train, comprising: a) measuring a process variable $W$, at the bearing or at in an area that is adjacent to the bearing wherein the process variable $W$ is one of the moisture in the bearing, the moisture content in the lubricant used for the bearing; b) passing the measured value of the process variable $W$ to an analysis unit; c) comparing the measured value with a predetermined value $W_{\text{max/min}}$ that is stored in memory; d) triggering a signal as soon as the measured value $W$ exceeds or falls below the predetermined stored value $W_{\text{max/min}}$.

One embodiment of the present invention is shown in the drawings appended hereto. These drawings show the following:

Figure 1: a diagrammatic cross section through a six-high stand in a rolling train.
Figure 2: a diagrammatic section through a roller-journal bearing and other elements that are used for monitoring.

Figure 1 shows a six-high stand 11 of a rolling train in which material 12 is rolled. The material 12 is moved in the direction indicated by the arrow. To this end, the stand 11 incorporates a total of six rollers 8, 9, 10 that roll either on each other or on the material 12 that is to be rolled. The working rollers 10 are connected to the intermediate rollers 9 and these, in their turn, work in conjunction with a supporting rollers 8.

Figure 2 shows the end of one of the rollers 8, 9, 10, with its roller journal 7. This is supported in a housing 6. The bearing structure 1 which, in the present case, comprises a bearing with four rollers 2, 3, 4, 5, provides this support.

A sensor 14 is integrated into the bearing structure 1 and/or into the housing 6 at a suitable location. Sensors of this kind in the area of the bearing are sufficiently well known. Thus, for example, force measurement bearings that are provided with the appropriate sensors are already known. In a similar manner, moisture or temperature sensors can be integrated into the bearing. Is also possible to record the deformation of the bearing structure by appropriate arrangement and connection of strip tensometers. Finally, accelerometers or path sensors can be integrated into the bearing in order to display vibration.
The sensor 14 passes the recorded process variable $W$ to the analysis unit 13. Means 15 to pass the measured value are used to do this. The dashed arrow in Figure 2 indicates that transmission of the value for the process variable $W$ can also be effected by wireless means, i.e., by radio or by induction.

In addition to the measured value $W$ for the process variable, the analysis unit 13 also contains a stored and predetermined value $W_{\text{max/min}}$. The means 16 that are used to compare the measured value $W$ with the predetermined value $W_{\text{max/min}}$ establish whether or not the measured value (actual value) is still within the acceptable range of tolerances (desired value), i.e., is still smaller than an acceptable maximal value or is still greater than an acceptable minimal value. In the present invention, it is preferred that the measured value be compared with the predetermined maximal value for force, moisture, temperature, or deformation.

If the predetermined range of tolerances or the predetermined maximal value for the measured process variable is exceeded, means 17 trigger a signal. This can be done in a variety of ways, for example, by indicator lights or by acoustic signals. What is important is that the operator of the rolling train be informed of the fact that acceptable operating parameters for the bearing area have been exceeded. Then, maintenance operations can be undertaken with respect to the bearing, so that failure of the bearing is avoided.

The embodiment that is used as an example illustrates a solution in which - as is frequently the case - each end of the roller incorporates a journal that is supported by the bearing structure. In
exactly the same way, though, it is possible that at both its ends the roller incorporate a bore that accommodates a journal, said journal then being attached to the housing. In this case, the bearing is arranged between this journal and the cylindrical inside surface of the bore.
Reference numbers for drawings:

1. bearing structure
2, 3, 4, 5 rows of rollers within the bearing
6. housing
7. roller journals
8. supporting roller
9. intermediate roller
10. working roller
11. stand in a rolling train
12. material to be rolled
13. analysis unit
14. sensor
15. means to pass the measured value to the analysis unit
16. means to compare the measured value with the predetermined value
17. means to trigger a signal

\( W \) process variable (value)

\( W_{\text{max/min}} \) stored, predetermined value for the process variable.
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CLAIMS:

1. A method for monitoring a bearing structure with at least one bearing in a housing of the roller-journal bearing for a supporting, intermediate, or working roller in a two-high, four-high, or six-high stand of a one or multi-stand rolling train, comprising:
   a) measuring a process variable \( W \), at the bearing or at in an area that is adjacent to the bearing wherein the process variable \( W \) is one of the moisture in the bearing, the moisture content in the lubricant used for the bearing;
   b) passing the measured value of the process variable \( W \) to an analysis unit;
   c) comparing the measured value with a predetermined value \( W_{\text{max/min}} \) that is stored in memory;
   d) triggering a signal as soon as the measured value \( W \) exceeds or falls below the predetermined stored value \( W_{\text{max/min}} \).

2. The method of claim 1, wherein the deformation of the housing is measured in the peripheral direction of said housing.

3. The method of claim 1, wherein the deformation of the housing is measured in the axial direction of the housing.

4. The method of any one of claims 1 to 3, wherein the measured value \( W \) is transmitted by wireless means.

5. The method of claim 4, wherein the wireless transmission is effected by induction.
6. The method of claim 4, wherein the wireless transmission is effected by radio.

7. A device for monitoring a bearing structure with at least one bearing in a housing of a roller-journal bearing for a supporting, intermediate, or working roller in a two-high, four-high, or six-high stand for a single or multi-stand rolling train, in particular for carrying out the method as defined in any one of claims 1 to 6, wherein:

one or a plurality of sensors that record a process variable \( W \) in the bearing or in the area that is adjacent to the bearing;

wherein the sensor is one of a moisture sensor and a deformation recorder;

means for passing the measured value of the process variable \( W \) to an analysis unit;

means to compare the measured value \( W \) with a predetermined value \( W_{\text{max/min}} \) that is stored in memory;

means to trigger a signal as soon as the measured value \( W \) exceeds or falls below the predetermined value \( W_{\text{max/min}} \) that is stored in memory.

8. The device of claim 7, wherein the recorder is a strip tensometer.

9. The device of claim 7, wherein the bearing is a roller bearing.

10. The device of claim 9, wherein the bearing is a multi-row tapered-roller bearing.

11. The device of claim 9, wherein the bearing is a multi-row cylindrical roller bearing.
12. The device of any one of claims 7 to 11, wherein the means for passing the measured value of the process variable W to the analysis unit pass this value by wireless means, preferably by induction or by radio.

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