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(54) Title: METHOD FOR SENSING START AND STOP OF BELT CONVEYOR

(57) Abstract: Provided is a method for sensing start and stop of a belt conveyor, the method involving sensing the start and stop of the belt conveyor using a start-stop sensor of at least one kind selected from the group consisting of a vibration sensor and a sound sensor, each of which is installed at a position in non-contact with an operating part of the belt conveyor.

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DESCRIPTION

Title of Invention

METHOD FOR SENSING START AND STOP OF BELT CONVEYOR

Technical Field

[0001]

The present invention relates to a method for sensing start and stop of a belt conveyor.

Background Art

[0002]

Conventionally, the following techniques have been used for sensing start and stop of a belt conveyor.

(1) Merrick belt scale (conveyor scale) (NPL1)

(2) Roller encoder (rotary encoder) (NPL2)

(3) Electric current value of motor that operates belt conveyor

Citation List

Non Patent Literature

[0003]

NPL1: JAPAN TAPPI JOURNAL, Volume 23, Issue 4, P. 36 to 43, "Simple Lesson on Instrument for On-site Operator (7)", https://www.jstage.jst.go.jp/article/jtappij1955/23/4/23_4_36/_pdf

NPL2: HP of Meltec Corporation, "About encoder", https://e-meltec.jp/about-encorder

Summary of Invention

Technical Problem

[0004]

Of (1) to (3) described above for the start-stop sensing of the belt conveyor, (1) and (2) require a start-stop sensor, such as a belt scale or an encoder, to be in contact with the belt conveyor, and include operating parts operated with the movement of the belt, thus causing operation defect due to corrosion or powder dust, or causing deterioration due to friction. In addition, it is necessary, for example, to adjust the degree of contact between the belt conveyor and the start-stop sensor, which is complicated. Further, it is necessary to perform

installation or adjustment in a state where the belt conveyor is stopped and hence, the operation of the factory is required to be stopped.

The above-mentioned (3) involves danger in measuring an electric current value, and thus is not suitable for monitoring.

[0005]

It is an object of the present invention to provide a method for sensing start and stop of a belt conveyor, the method not causing deterioration due to friction with the operation of the belt conveyor, not requiring the belt conveyor to be stopped at the time of performing installation or adjustment, and allowing start-stop sensing to be safely performed.

Solution to Problem

[0006]

The present invention provides the following [1] to [3].

[1] A method for sensing start and stop of a belt conveyor, the method involving sensing the start and stop of the belt conveyor using a start-stop sensor of at least one kind selected from the group consisting of a vibration sensor and a sound sensor, each of which is installed at a position in non-contact with an operating part of the belt conveyor.

[2] The method for sensing start and stop of a belt conveyor described in the above-mentioned [1], the method including a start-stop determination step of determining that the belt conveyor is in a stopped state when data obtained from the start-stop sensor is less than a threshold, and determining that the belt conveyor is in an operating state when the data obtained from the start-stop sensor is equal to or more than the threshold.

[3] The method for sensing start and stop of a belt conveyor described in the above-mentioned [2], wherein an operation of another facility is controlled based on a determination result obtained in the start-stop determination step.

Advantageous Effects of Invention

[0007]

The method for sensing start and stop of a belt conveyor according to the present invention can provide a method for sensing start and stop of a belt conveyor, the method not causing deterioration due to friction with the operation of the belt conveyor, not requiring the belt conveyor to be stopped at the time of performing installation or adjustment, and allowing start-stop sensing to be safely performed.

Description of Embodiment

[0008]

Hereinafter, a method for sensing start and stop of a belt conveyor according to the present invention will be described.

The method for sensing start and stop of a belt conveyor according to the present invention is a method for sensing start and stop of a belt conveyor, the method involving sensing the start and stop of the belt conveyor using a start-stop sensor of at least one kind selected from the group consisting of a vibration sensor and a sound sensor, each of which is installed at a position in non-contact with an operating part of the belt conveyor.

Vibration and sound are generated when the belt conveyor is in an operating state, and vibration and sound are not generated when the belt conveyor is in a stopped state. According to the present invention, start and stop of the belt conveyor is sensed by the start-stop sensor of at least one kind selected from the group consisting of the vibration sensor and the sound sensor and hence, the start and stop can be surely detected. Vibration or sound that is not derived from the belt conveyor is also present around the start-stop sensor. However, the vibration or the sound of this kind from the surroundings is weaker than vibration or sound derived from the target belt conveyor, and thus is distinguishable.

According to the present invention, the start-stop sensor is not in contact with the operating part of the belt conveyor and hence, there is no deterioration due to friction with the operation of the belt conveyor, and it is not necessary to stop the belt conveyor at the time of performing installation or adjustment. In addition, the start-stop sensor does not measure the electric current value of the operating part of the belt conveyor, thus safely performing start-stop sensing.

[0009]

In the present invention, it is preferred that the start-stop sensor not be installed at the operating part of the belt conveyor, such as a belt, a roller, or a pulley, but be installed, for example, on a casing for a motor or the like, on a frame disposed around the operating part, or on a passage located in the vicinity of the belt conveyor. In particular, in the case where the start-stop sensor is a sound sensor, it is preferred to install the sound sensor in the vicinity of where sound is generated, such as in the vicinity of the motor or the roller. In the case where there is a non-target belt conveyor around the target belt conveyor, and in particular in the case of a sound sensor, it is preferred to install the sound sensor at as proximate a position as possible to the target belt conveyor.

For a method for mounting the start-stop sensor, the start-stop sensor may be mounted on a facility around the belt conveyor by an adhesive agent or by screws or the like. Alternatively, the start-stop sensor may also be mounted on a fence or the like provided to

inhibit a contact with the belt conveyor, the fence or the like being installed on a passage located in the vicinity of the belt conveyor. A start-stop sensor installed on a board may also be mounted on the facility around the belt conveyor or on the fence provided to inhibit a contact with the belt conveyor.

[0010]

Although any of an electrodynamic sound sensor, an electrostatic sound sensor, a piezoelectric sound sensor, and other sound sensors may be used as the sound sensor, it is particularly preferred to use an electrostatic sound sensor because the electrostatic sound sensor has high stability and can be reduced in size.

Vibration sensors are classified into an acceleration detection vibration sensor, a rate detection vibration sensor, a displacement detection vibration sensor, and other vibration sensors, and any of the vibration sensors may be used as the vibration sensor. Among these vibration sensors, it is particularly preferred to use an acceleration detection vibration sensor. Although examples of the acceleration detection vibration sensor include a piezoelectric vibration sensor, an electrodynamic vibration sensor, a strain gauge vibration sensor, and other vibration sensors, it is preferred to use a piezoelectric vibration sensor because the piezoelectric vibration sensor can cover a wide frequency range.

[0011]

In the present invention, it is preferred to include a start-stop determination step of determining that the belt conveyor is in a stopped state when data obtained from the start-stop sensor is less than the threshold, and determining that the belt conveyor is in an operating state when the data obtained from the start-stop sensor is equal to or more than the threshold.

By setting the threshold as described above, it is possible to surely inhibit the start-stop sensor from being erroneously actuated due to vibration or sound generated from a facility other than the target belt conveyor.

[0012]

Data obtained by the start-stop sensor may be transmitted to a PC through wired or wireless communication.

In the present invention, the operation of other facilities may be controlled based on the determination result obtained in the start-stop determination step. The data may also be used for, for example, controlling the turning on and off of a beacon lamp that indicates a condition of the BC (belt conveyor) operation.

[0013]

One start-stop sensor may be provided at a position in non-contact with the operating part of the belt conveyor, or two or more start-stop sensors may be provided at positions in

non-contact with the operating part of the belt conveyor. In the case where one start-stop sensor is provided, cost reduction can be achieved. In the case where two or more start-stop sensors are provided, even when some of the plurality of start-stop sensors are in malfunction, it is possible to continue start-stop sensing of the belt conveyor. In the case where two or more start-stop sensors are provided, it is preferred that "start" be determined when, for example, two or more start-stop sensors sense "start", and "stop" be determined when only one start-stop sensor senses "start" and other start-stop sensors sense "stop". Consequently, it is possible to inhibit the start-stop sensor from making an erroneous determination due to vibration or sound generated from objects other than the target belt conveyor. It is preferred that "stop" be determined when, for example, no start-stop sensors sense "start" and all of the start-stop sensor senses "stop".

In the case where one start-stop sensor is used, it is preferred that sound or vibration be sensed a plurality of times at time intervals within a predetermined time period, and "start" be determined when "start" is sensed a plurality of times, and "stop" be determined when "start" is sensed only one time and "stop" is sensed for the remaining times. It is preferred that "stop" be determined when "start" is sensed none of times and "stop" is sensed for all of the times.

Further, a configuration may be adopted in which, irrespective of the number of start-stop sensors, sound or vibration is sensed a plurality of times at time intervals or continuously within a predetermined time period, and "start" or "stop" is determined based on the average value within a certain time period. Consequently, it is possible to inhibit the start-stop sensor from making an erroneous determination due to vibration or sound generated from objects other than the target belt conveyor.

[0014]

It is preferred that the frequency band of vibration of the target belt conveyor be measured in advance, and "start" be determined when the start-stop sensor senses the frequency band, and "stop" be determined when the start-stop sensor does not sense the frequency band. Consequently, it is possible to inhibit the start-stop sensor from making an erroneous determination due to vibration generated from objects other than the target belt conveyor.

It is also preferred that the frequency band of sound of the target belt conveyor be measured in advance, and "start" be determined when the start-stop sensor senses the frequency band, and "stop" be determined when the start-stop sensor does not sense the frequency band. Consequently, it is possible to inhibit the start-stop sensor from making an

erroneous determination due to sound generated from objects other than the target belt conveyor.

[0015]

It is preferred that the waveform pattern of vibration of the target belt conveyor be measured in advance, and "start" be determined when the start-stop sensor senses the waveform pattern, and "stop" be determined when the start-stop sensor does not sense the waveform pattern. Consequently, it is possible to inhibit the start-stop sensor from making an erroneous determination due to vibration generated from objects other than the target belt conveyor.

It is also preferred that the waveform pattern of sound of the target belt conveyor be measured in advance, and "start" be determined when the start-stop sensor senses the waveform pattern, and "stop" be determined when the start-stop sensor does not sense the waveform pattern. Consequently, it is possible to inhibit the start-stop sensor from making an erroneous determination due to sound generated from objects other than the target belt conveyor.

[0016]

To reduce the influence from objects other than the target belt conveyor, it is preferred to install the start-stop sensor at a position apart from other operation facilities. In this case, determination of "start" and "stop" is facilitated.

However, the start-stop sensor may be installed in the vicinity of a connection part of the target belt conveyor.

In this case, start and stop of the belt conveyor may be sensed as described below, for example.

(1) A sound volume V1, a sound volume V2, and a sound volume V3 are measured in advance, the sound volume V1 being a sound volume for a case where, of a belt conveyor disposed upstream of the connection part and a belt conveyor disposed downstream of the connection part, only a belt conveyor having a smaller sound volume during starting is in an operating state, the sound volume V2 being a sound volume for a case where, of the belt conveyor disposed upstream of the connection part and the belt conveyor disposed downstream of the connection part, only a belt conveyor having a larger sound volume during starting is in an operating state, the sound volume V3 being a sound volume for a case where both of the belt conveyor disposed upstream of the connection part and the belt conveyor disposed downstream of the connection part are in an operating state.

(2) A first threshold T1, a second threshold T2, a third threshold T3, and a fourth threshold T4 are set as follows.

T1 < V1 < T2 < V2 < T3 < V3 < T4

(3) When the start-stop sensor senses sound of less than the first threshold T1, or does not sense sound, it is determined that "both of the belt conveyor having a smaller sound volume and the belt conveyor having a larger sound volume are in a stopped state",

when the start-stop sensor senses sound of equal to or more than the first threshold T1 and equal to or less than the second threshold T2, it is determined that "only the belt conveyor having a smaller sound volume is in an operating state" (an abnormal state is determined),

when the start-stop sensor senses sound of more than the second threshold T2 and equal to or less than the third threshold T3, it is determined that "only the belt conveyor having a larger sound volume is in an operating state" (an abnormal state is determined), and

when the start-stop sensor senses sound of more than the third threshold T3 and equal to or less than the fourth threshold T4, it is determined that "both of the belt conveyor having a smaller sound volume and the belt conveyor having a larger sound volume are in an operating state".

The setting of the above-mentioned fourth threshold T4 may be omitted. In such a case, when the start-stop sensor senses sound of more than the third threshold T3, it is determined that "both of the belt conveyor having a smaller sound volume and the belt conveyor having a larger sound volume are in an operating state".

Further, when the start-stop sensor senses sound of more than the above-mentioned fourth threshold T4, it may be determined that "at least one of the belt conveyor disposed upstream of the connection part and the belt conveyor disposed downstream of the connection part is in an abnormal state". Consequently, it is possible to timely detect abnormality of each of the belt conveyor disposed on the upstream side and the belt conveyor disposed on the downstream side.

[0017]

The start-stop sensor may be installed in the vicinity of the connection part of the target belt conveyor, and the start and stop of the belt conveyor may be sensed as described below.

(1) The sound volume V1, the sound volume V2, and the sound volume V3 are measured in advance, the sound volume V1 being the sound volume for the case where, of the belt conveyor disposed upstream of the connection part and the belt conveyor disposed downstream of the connection part, only the belt conveyor having a smaller sound volume during starting is in an operating state, the sound volume V2 being the sound volume for the case where, of the belt conveyor disposed upstream of the connection part and the belt conveyor disposed downstream of the connection part, only the belt conveyor having a larger

sound volume during starting is in an operating state, the sound volume V3 being the sound volume for the case where both of the belt conveyor disposed upstream of the connection part and the belt conveyor disposed downstream of the connection part are in an operating state.
(2A) A first A threshold T1A, a second A threshold T2A, and a third A threshold T3A are set as follows.

$T1A < V1 < V2 < T2A < V3 < T3A$

(3A) When the start-stop sensor senses sound of less than the first A threshold T1A, or does not sense sound, it is determined that "both of the belt conveyor having a smaller sound volume and the belt conveyor having a larger sound volume are in a stopped state",

when the start-stop sensor senses sound of equal to or more than the first A threshold T1A and equal to or less than the second A threshold T2A, it is determined that "only one of the belt conveyor having a smaller sound volume and the belt conveyor having a larger sound volume is in an operating state" (an abnormal state is determined), and

when the start-stop sensor senses sound of more than the second A threshold T2A and equal to or less than the third A threshold T3A, it is determined that "both of the belt conveyor having a smaller sound volume and the belt conveyor having a larger sound volume are in an operating state".

The setting of the above-mentioned third A threshold T3A may be omitted. In such a case, when the start-stop sensor senses sound of more than the second A threshold T2A, it is determined that "both of the belt conveyor having a smaller sound volume and the belt conveyor having a larger sound volume are in an operating state".

Further, when the start-stop sensor senses sound of more than the above-mentioned third A threshold T3A, it may be determined that "at least one of the belt conveyor disposed upstream of the connection part and the belt conveyor disposed downstream of the connection part is in an abnormal state". Consequently, it is possible to timely detect abnormality of each of the belt conveyor disposed on the upstream side and the belt conveyor disposed on the downstream side.

[0018]

The start-stop sensor may be installed in the vicinity of the connection part of the target belt conveyor.

In this case, start and stop of the belt conveyor may be sensed as described below, for example.

(1) A vibration intensity S1, a vibration intensity S2, and a vibration intensity S3 are measured in advance, the vibration intensity S1 being a vibration intensity for a case where, of the belt conveyor disposed upstream of the connection part and the belt conveyor disposed

downstream of the connection part, only a belt conveyor having a smaller vibration intensity during starting is in an operating state, the vibration intensity S2 being a vibration intensity for a case where, of the belt conveyor disposed upstream of the connection part and the belt conveyor disposed downstream of the connection part, only a belt conveyor having a larger vibration intensity during starting is in an operating state, the vibration intensity S3 being a vibration intensity for a case where both of the belt conveyor disposed upstream of the connection part and the belt conveyor disposed downstream of the connection part are in an operating state.

(2) A first threshold T1, a second threshold T2, a third threshold T3, and a fourth threshold T4 are set as follows.

$T1 < S1 < T2 < S2 < T3 < S3 < T4$

(3) When the start-stop sensor senses a vibration intensity of less than the first threshold T1, or does not sense a vibration intensity, it is determined that "both of the belt conveyor having a smaller vibration intensity and the belt conveyor having a larger vibration intensity are in a stopped state",

when the start-stop sensor senses a vibration intensity of equal to or more than the first threshold T1 and equal to or less than the second threshold T2, it is determined that "only the belt conveyor having a smaller vibration intensity is in an operating state" (an abnormal state is determined),

when the start-stop sensor senses a vibration intensity of more than the second threshold T2 and equal to or less than the third threshold T3, it is determined that "only the belt conveyor having a larger vibration intensity is in an operating state" (an abnormal state is determined), and

when the start-stop sensor senses a vibration intensity of more than the third threshold T3 and equal to or less than the fourth threshold T4, it is determined that "both of the belt conveyor having a smaller vibration intensity and the belt conveyor having a larger vibration intensity are in an operating state".

The setting of the above-mentioned fourth threshold T4 may be omitted. In such a case, when the start-stop sensor senses a vibration intensity of more than the third threshold T3, it is determined that "both of the belt conveyor having a smaller vibration intensity and the belt conveyor having a larger vibration intensity are in an operating state".

Further, when the start-stop sensor senses a vibration intensity of more than the above-mentioned fourth threshold T4, it may be determined that "at least one of the belt conveyor disposed upstream of the connection part and the belt conveyor disposed downstream of the connection part is in an abnormal state". Consequently, it is possible to timely detect

abnormality of each of the belt conveyor disposed on the upstream side and the belt conveyor disposed on the downstream side.

[0019]

The start-stop sensor may be installed in the vicinity of the connection part of the target belt conveyor, and start and stop of the belt conveyor may be sensed as described below.

(1) The vibration intensity S1, the vibration intensity S2, and the vibration intensity S3 are measured in advance, the vibration intensity S1 being the vibration intensity for the case where, of the belt conveyor disposed upstream of the connection part and the belt conveyor disposed downstream of the connection part, only the belt conveyor having a smaller vibration intensity during starting is in an operating state, the vibration intensity S2 being the vibration intensity for the case where, of the belt conveyor disposed upstream of the connection part and the belt conveyor disposed downstream of the connection part, only the belt conveyor having a larger sound volume during starting is in an operating state, the vibration intensity S3 being the vibration intensity for the case where both of the belt conveyor disposed upstream of the connection part and the belt conveyor disposed downstream of the connection part are in an operating state.

(2A) The first A threshold T1A, the second A threshold T2A, and the third A threshold T3A are set as follows.

$T1A < S1 < S2 < T2A < S3 < T3A$

(3A) When the start-stop sensor senses a vibration intensity of less than the first A threshold T1A, or does not sense a vibration intensity, it is determined that "both of the belt conveyor having a smaller vibration intensity and the belt conveyor having a larger vibration intensity are in a stopped state",

when the start-stop sensor senses a vibration intensity of equal to or more than the first A threshold T1A and equal to or less than the second A threshold T2A, it is determined that "only one of the belt conveyor having a smaller vibration intensity and the belt conveyor having a larger vibration intensity is in an operating state" (an abnormal state is determined), and

when the start-stop sensor senses a vibration intensity of more than the second A threshold T2A and equal to or less than the third A threshold T3A, it is determined that "both of the belt conveyor having a smaller vibration intensity and the belt conveyor having a larger vibration intensity are in an operating state".

The setting of the above-mentioned third A threshold T3A may be omitted. In such a case, when the start-stop sensor senses a vibration intensity of more than the second A

threshold T2A, it is determined that "both of the belt conveyor having a smaller vibration intensity and the belt conveyor having a larger vibration intensity are in an operating state".

Further, when the start-stop sensor senses a vibration intensity of more than the above-mentioned third A threshold T3A, it may be determined that "at least one of the belt conveyor disposed upstream of the connection part and the belt conveyor disposed downstream of the connection part is in an abnormal state". Consequently, it is possible to timely detect abnormality of each of the belt conveyor disposed on the upstream side and the belt conveyor disposed on the downstream side.

CLAIMS

[Claim 1]

A method for sensing start and stop of a belt conveyor, the method involving sensing the start and stop of the belt conveyor using a start-stop sensor of at least one kind selected from the group consisting of a vibration sensor and a sound sensor, each of which is installed at a position in non-contact with an operating part of the belt conveyor.

[Claim 2]

The method for sensing start and stop of a belt conveyor according to claim 1, the method comprising a start-stop determination step of determining that the belt conveyor is in a stopped state when data obtained from the start-stop sensor is less than a threshold, and determining that the belt conveyor is in an operating state when the data obtained from the start-stop sensor is equal to or more than the threshold.

[Claim 3]

The method for sensing start and stop of a belt conveyor according to claim 2, wherein an operation of another facility is controlled based on a determination result obtained in the start-stop determination step.

INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
INV. B65G43/00 G05B19/418
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B65G G05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2021/179362 A1 (DEVRIES BRETT E [US] ET AL) 17 June 2021 (2021-06-17) paragraphs [0062], [0068], [0201], [0202], [0152], [0153]; figures 1a-c	1-3
X	LIU YI ET AL: "Research on the fault analysis method of belt conveyor idlers based on sound and thermal infrared image features", MEASUREMENT, INSTITUTE OF MEASUREMENT AND CONTROL. LONDON, GB, vol. 186, 20 September 2021 (2021-09-20), XP086849814, ISSN: 0263-2241, DOI: 10.1016/J.MEASUREMENT.2021.110177 [retrieved on 2021-09-20] pages 1-2; figure 2	1-3

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[x] Further documents are listed in the continuation of Box C.

[x] See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Pedersen, Henrik

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INTERNATIONAL SEARCH REPORT

International application No
PCT/JP2024/080085

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	WO 2022/087592 A1 (BASTIAN SOLUTIONS LLC [US]; GREYSON TIFFANY LEE [US] ET AL.) 28 April 2022 (2022-04-28) page 43, lines 13-19	1-3

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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