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(54) Title: CONVEYOR WEAR MEASUREMENT

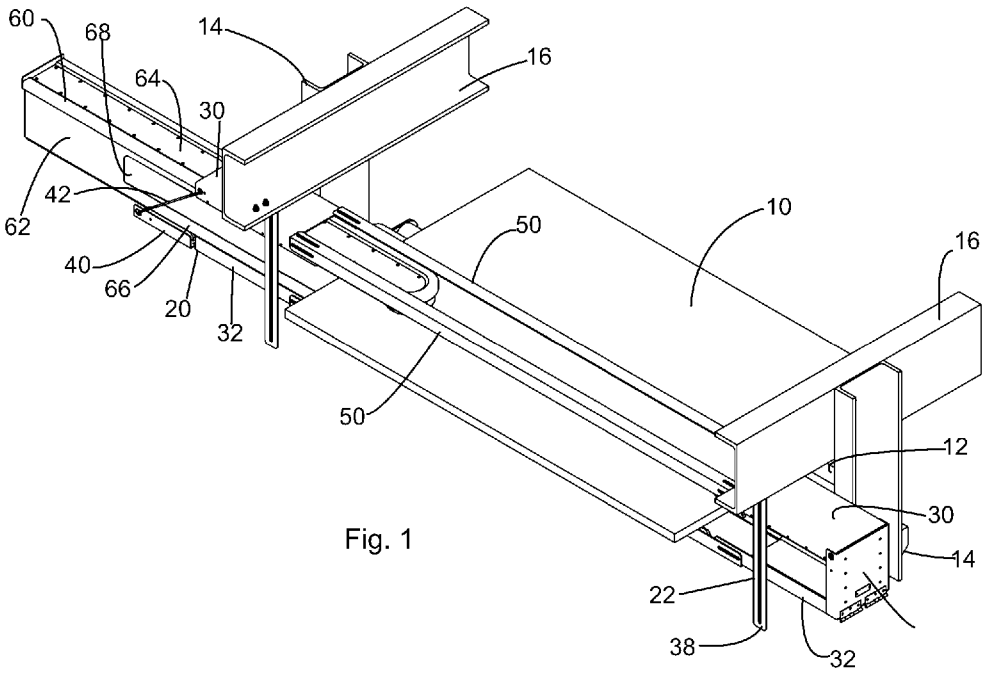

Fig. 1

(57) Abstract: A conveyor belt condition monitoring apparatus is U-shaped, with two parallel arms arranged to extend across a conveyor belt from the side. The arms include ultrasonic sensors arranged to measure the distance to respective surfaces of the conveyor belt. One arm includes an eddy-current sensor arranged to measure the distance to a metallic core of the belt. The apparatus is arranged to be moved across the belt to provide a profile of belt condition across the width of the belt.

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[Continued on next page]

Published:
— *with international search report (Art. 21(3))*

"CONVEYOR WEAR MEASUREMENT"

Field of the Invention

[0001] The present invention relates to the measurement of wear on conveyor belts. In particular, the present invention relates to a re-deployable tool for measuring wear.

Background to the Invention

[0002] Australian patent number 2012321080 describes an apparatus for measuring wear on a conveyor. The apparatus includes sensors for measuring overall conveyor belt thickness, and also thickness from an outer surface to a central core.

[0003] This system, while efficacious, represents a significant cost in fixed condition monitoring equipment for a single conveyor belt. In a mineral processing environment where there may be many conveyors in operation, the use of fixed monitoring systems in relation to each conveyor may be cost-prohibitive.

[0004] It is therefore desirable to provide a system for conveyor belt condition monitoring which may be deployed across a number of different conveyors. Such a system must be sufficiently lightweight for ready deployment, it must be reasonably easy to calibrate, it must produce results which are repeatable and consistent, and it must not introduce hazards into the conveyor environment.

[0005] The present invention seeks to provide a system for deploying a portable conveyor belt condition monitoring apparatus in light of these considerations.

Summary of the Invention

[0006] According to a first aspect of the present invention there is provided a conveyor belt condition monitoring apparatus having a body portion and two arms, the arms being parallel to each other and extending away from the

body portion, a gap being defined between the two arms, each arm including at least one first sensor, such that the apparatus can be located with a portion of a conveyor belt located in the gap, with one first sensor oriented towards an upper face of the conveyor belt and one first sensor oriented towards a lower face of the conveyor belt, the apparatus being moveable relative to the conveyor belt.

[0007] Preferably, the apparatus is arranged to move relative to the conveyor belt in a direction perpendicular to a direction of motion of the conveyor belt.

[0008] The first sensors may be arranged to determine a distance from the arm to a respective face of the conveyor belt. In a preferred embodiment of the invention, the first sensors are ultrasonic sensors.

[0009] At least one arm may include a second sensor arranged to determine a distance from the arm to a core of the conveyor belt. The second sensor is preferably an eddy-current sensor.

[0010] It is preferred that the second sensor locates around at least one first sensor. In a preferred embodiment, the second sensor is annular, with at least one first sensor directed through a centre of the second sensor.

[0011] In its broadest sense, the second sensor defines a boundary of a two-dimensional area (that is, a plane boundary), with the first sensor being located within this boundary. It will be appreciated that the second sensor may, for instance, be C-shaped.

[0012] At least one arm may include a third sensor arranged to determine the temperature of the belt. The third sensor is preferably an infra-red pyrometer.

[0013] The apparatus may include an additional edge detecting sensor. The edge detecting sensor may be associated with the body portion of the

apparatus, and is preferably arranged to determine a distance from the body portion to an edge of the conveyor belt. In a preferred embodiment of the invention the edge detecting sensor is an ultrasonic sensor.

[0014] According to a second aspect of the present invention there is provided a conveyor belt condition monitoring apparatus supporting structure, the supporting structure including a first mount arranged to locate on one lateral side of a conveyor belt and a second mount arranged to locate on the opposing lateral side of the conveyor belt, the first mount and the second mount being connected by upper tracks passing over an upper surface of the conveyor belt and lower tracks passing over a lower surface of the conveyor belt, whereby a conveyor belt condition monitoring apparatus can be introduced into the first mount or the second mount and then moved laterally across the belt by engagement with at least one of the upper and lower tracks.

[0015] Preferably each of the first and second mounts have an outer aperture within which the monitoring apparatus can be introduced. The outer aperture may be closed by a cover when not in use.

[0016] It is preferred that the cover is hinged to its mount, and moveable between a closed position wherein it limits access into the mount, and an open position whereby it provides a support surface for monitoring apparatus.

[0017] According to a third aspect of the present invention there is provided a method of monitoring conveyor belt condition, the method including the steps of providing a monitoring apparatus supporting structure, the supporting structure including a first mount arranged to locate on one lateral side of a conveyor belt and a second mount arranged to locate on the opposing lateral side of the conveyor belt, the first mount and the second mount being connected by upper tracks passing over an upper surface of the conveyor belt and lower tracks passing over a lower surface of the conveyor belt; introducing a monitoring apparatus into the first mount and

moving it along the tracks to monitor part of the conveyor belt surface; removing the monitoring apparatus from the first mount; introducing the monitoring apparatus into the second mount and moving it along the tracks to monitor another part of the conveyor belt surface.

[0018] According to a fourth aspect of the present invention there is provided a sensor arrangement for determining conveyor belt thickness, the arrangement including at least one first sensor arranged to determine a distance from a base position to a face of the conveyor belt and a second sensor arranged to determine a distance from the base position to a core of the conveyor belt, wherein the second sensor is located around the first sensor.

[0019] The first sensor may be an ultrasonic sensor, and the second sensor is preferably an eddy-current sensor.

[0020] It is preferred that the second sensor is annular, with the first sensor directed through a centre of the second sensor.

Brief Description of the Drawings

[0021] It will be convenient to further describe the invention with reference to preferred embodiments of the present invention. Other embodiments are possible, and consequently the particularity of the following discussion is not to be understood as superseding the generality of the preceding description of the invention. In the drawings:

[0022] Figure 1 is a perspective of a conveyor belt monitoring apparatus and associated supporting structure in accordance with the present invention;

[0023] Figure 2 is an enlarged view of an end of a mount within the supporting structure of Figure 1;

[0024] Figure 3 is a cross section through the apparatus and supporting structure of Figure 1;

[0025] Figure 4 is a plan view of the apparatus and supporting structure of Figure 1;

[0026] Figure 5 is a perspective of a sensor unit from within the apparatus of Figure 1;

[0027] Figure 6 is an underview of the sensor unit of Figure 5; and

[0028] Figure 7 is a cross section through the sensor unit of Figure 5.

Detailed Description of Preferred Embodiments

[0029] Referring to the Figures, there is shown a portion of a conveyor belt 10. The conveyor belt 10 is supported on rollers 12, which are mounted on riser support bars 14. Horizontal supporting channels 16 extend above the conveyor belt 10 on either side, running parallel with a direction of travel of the conveyor belt 10.

[0030] A supporting structure for conveyor belt monitoring equipment has a first mount 20 located on a first side of the conveyor belt 10, and second mount 22 located on a second side of the conveyor belt 10. The first mount 20 is directly opposite the second mount 22 across the conveyor belt 10. The second mount 22 is a mirror-image of the first mount 20, and the following description applies equally to both mounts 20, 22.

[0031] The mounts 20, 22 are generally C-shaped in cross section, with each having an upper flange 30, a lower flange 32, and a connecting web 34 at the rear of the respective mount 20, 22. The connecting web 34 is fixed to a riser support bar 14 by means of a bracket 36.

[0032] A vertical guide 38 extends across a front of each mount 20, 22, being bolted to outer lips of the upper flange 30 and the lower flange 32. The vertical guide 38 has an attachment portion at an upper end thereof, arranged to bolt to a horizontal supporting channel 16.

[0033] In this way, the first mount 20 and the second mount 22 can be fixed to the supporting structure of the conveyor belt 10 such that the respective upper flanges 30 and the lower flanges 32 are held in horizontal orientation.

[0034] A respective cover 40 is mounted at an outer end of each mount 20, 22. The cover 40 is hinged to the lower flange 32, and is moveable between a closed configuration as shown in relation to the second mount 22 and an open configuration as shown in relation to the first mount 20.

[0035] In the closed configuration, the cover 40 extends from the lower flange 32 to the upper flange 30. In the open configuration, the cover 40 acts as a continuation of the lower flange 32. Supporting tensile elements 42 are provided to extend from the upper flange 30 to an outer edge of the cover 40 in its open configuration, ensuring that the cover 40 is held in a horizontal position in the open configuration.

[0036] A pair of upper tracks 50 extend between the upper flange 30 of the first mount 20 and the upper flange 30 of the second mount 22. The upper tracks 50 are spaced apart by the width of the upper flanges 30.

[0037] Similarly, a pair of lower tracks 52 extend between the lower flange 32 of the first mount 20 and the lower flange of the second mount 22. The lower tracks 52 are parallel to, and vertically spaced from, the upper tracks 50.

[0038] It will be appreciated that the upper and lower tracks 50, 52 combine with the first and second mounts 20, 22 to form a four-sided 'box' through which the conveyor belt 10 travels.

[0039] The arrangement is such that the supporting structure for conveyor belt monitoring equipment can be maintained in position around the conveyor belt 10 permanently, with both covers 40 retained in their closed positions.

[0040] When monitoring is required, a conveyor belt monitor 60 can be introduced.

[0041] The conveyor belt monitor 60 is generally elongate, with a body portion 62 at a first elongate end and two arms, an upper arm 64 and a lower arm 66, extending away from the body portion 62 towards the second elongate end.

[0042] The body portion 62 has a cross sectional size and shape similar to the cross sectional shape of the mounts 20, 22. The upper arm 64 and the lower arm 66 are parallel to each other, and spaced apart by a gap 68. The he lower arm 66 is arranged to engage with the lower tracks 52.The upper tracks 50 act to hold the supporting structure steady during movement of the conveyor belt monitor.

[0043] The conveyor belt monitor 60 is preferably made from a material which will maintain its size and rigid shape despite changes in surrounding temperature. The conveyor belt monitor 60 of the preferred embodiment is made from a composite carbon fibre material.

[0044] The upper arm 64 has a sensor unit 70 located on a lower face thereof, near the second elongate end. The sensor unit 70 is shown in greater detail in Figures 5 to 7.

[0045] The sensor unit 70 has a first sensor 72 centrally located on the sensor unit 70. The first sensor 72 is an ultrasonic sensor, directed towards the lower arm 66.

[0046] The sensor unit 70 has an annular second sensor 74 located on a lower face thereof. The second sensor 74 is an eddy-current sensor, which has been formed in an annulus. The arrangement is such that the first sensor 72 is located at the centre of the annulus formed by the second sensor 74.

[0047] The sensor unit 70 has a third sensor 76 located at a periphery thereof, outside the annulus of the second sensor 74. The third sensor 76 is an infra-red pyrometer.

[0048] The lower arm 66 has an additional first sensor 78 located on an upper face thereof, near the second elongate end. The additional first sensor 78 is an ultrasonic sensor similar to the first sensor 72, directed towards the upper arm 64.

[0049] The body portion 62 includes a further sensor (not shown), which is an ultrasonic sensor directed between the upper arm 64 and the lower arm 66.

[0050] In use, the cover 40 of the first mount 20 is opened, and the monitor 60 introduced into the first mount 20 with the upper and lower arms 64, 66 pointed across the conveyor belt 10. The upper arm 64 locates under the upper flange 30, and engages with the upper tracks 50. The lower arm 66 locates atop the lower flange 32 and the opened cover 40, and engages with the lower tracks 52.

[0051] The monitor 60 can then be moved across the conveyor 10. During this movement the first sensor 72 and the additional first sensor 78 can be used to determine the overall thickness of the conveyor 10 by the simple mechanism of subtracting the two sensor-to-surface measurements from a known, fixed distance between the sensors 72, 78. The second sensor 74 can be used in conjunction with the first sensors 72, 78 to measure the thickness of the upper side of the conveyor belt 10. The lateral position of the thickness measurements, that is the distance from an edge of the conveyor belt to the measurement being taken, can be determined using the further sensor to determine the distance from the body portion 62 to an edge of the conveyor belt 10. It will be appreciated that lateral distance from the first sensor 72 to the further sensor is fixed.

[0052] It will be appreciated that the second sensor 74 determines a distance from the second sensor 74 to a central metallic core of the conveyor belt 10. This distance is determined as an average distance of an area approximately three times the diameter of the second sensor 74, centred at a point corresponding to the first sensor 72. Once the first and second sensors 72, 74 are calibrated, the distance from the first sensor 72 to a surface of the belt 10 can be subtracted from the distance measured by the second sensor 74 to provide a measurement of thickness from core to belt surface. The use of an annular eddy current sensor allows the sensor unit 70 to calculate an average thickness from core to belt surface accurately even if the belt 10 is angled relative to the upper arm 64. It is preferred that the first sensor 72 and the second sensor 74 are calibrated together using a base of the second sensor 74 as a measurement zero point of reference.

[0053] The third sensor 76 provides a measurement of belt temperature. This allows for a calculation of expected thermal expansion of the belt, so that this can be taken into account when evaluating belt condition based on thickness measurements.

[0054] Once measurement is completed (generally of one half of the conveyor belt 10), the monitor 60 can be removed from the first mount 20, and inserted instead into the second mount 22. The same process will record measurement of the second half of the conveyor belt 10.

[0055] The monitor 60 can then be moved to another supporting structure for another belt, to carry out measurements accordingly.

[0056] Modifications and variations as would be apparent to a skilled addressee are deemed to be within the scope of the present invention.

Claims

1. A conveyor belt condition monitoring apparatus having a body portion and two arms, the arms being parallel to each other and extending away from the body portion, a gap being defined between the two arms, each arm including at least one first sensor, such that the apparatus can be located with a portion of a conveyor belt located in the gap, with one first sensor oriented towards an upper face of the conveyor belt and one first sensor oriented towards a lower face of the conveyor belt, the apparatus being moveable relative to the conveyor belt.

2. A conveyor belt condition monitoring apparatus as claimed in claim 1, wherein the apparatus is arranged to move relative to the conveyor belt in a direction perpendicular to a direction of motion of the conveyor belt.

3. A conveyor belt condition monitoring apparatus as claimed in claim 1 or claim 2, wherein the first sensors are arranged to determine a distance from the arm to a respective face of the conveyor belt.

4. A conveyor belt condition monitoring apparatus as claimed in any preceding claim, wherein the first sensors are ultrasonic sensors.

5. A conveyor belt condition monitoring apparatus as claimed in any preceding claim, wherein at least one arm includes a second sensor arranged to determine a distance from the arm to a core of the conveyor belt.

6. A conveyor belt condition monitoring apparatus as claimed in claim 5, wherein the second sensor is an eddy-current sensor.

7. A conveyor belt condition monitoring apparatus as claimed in claim 5 or claim 6, wherein the second sensor locates around at least one first sensor.

8. A conveyor belt condition monitoring apparatus as claimed in claim 7, wherein the second sensor is annular, with at least one first sensor directed through a centre of the second sensor.

9. A conveyor belt condition monitoring apparatus as claimed in any preceding claim, wherein at least one arm includes a third sensor arranged to determine the temperature of the belt.

10. A conveyor belt condition monitoring apparatus as claimed in claim 9, wherein the third sensor is an infra-red pyrometer.

11. A conveyor belt condition monitoring apparatus as claimed in any preceding claim, wherein the apparatus includes an additional edge detecting sensor.

12. A conveyor belt condition monitoring apparatus as claimed in claim 11, wherein the edge detecting sensor is associated with the body portion of the apparatus, and is arranged to determine a distance from the body portion to an edge of the conveyor belt.

13. A conveyor belt condition monitoring apparatus as claimed in claim 12, wherein the edge detecting sensor is an ultrasonic sensor.

14. A conveyor belt condition monitoring apparatus supporting structure, the supporting structure including a first mount arranged to locate on one lateral side of a conveyor belt and a second mount arranged to locate on the opposing lateral side of the conveyor belt, the first mount and the second mount being connected by upper tracks passing over an upper surface of the conveyor belt and lower tracks passing over a lower surface of the conveyor belt, whereby a conveyor belt condition monitoring apparatus can be introduced into the first mount or the second mount and then moved laterally across the belt by engagement with at least one of the upper and lower tracks.

15. A conveyor belt condition monitoring apparatus supporting structure as claimed in claim 14, wherein each of the first and second mounts have an outer aperture within which the monitoring apparatus can be introduced.

16. A conveyor belt condition monitoring apparatus supporting structure as claimed in claim 15, wherein the outer aperture may be closed by a cover when not in use.

17. A conveyor belt condition monitoring apparatus supporting structure as claimed in claim 16, wherein the cover is hinged to its mount, and moveable between a closed position wherein it limits access into the mount, and an open position whereby it provides a support surface for monitoring apparatus.

18. A method of monitoring conveyor belt condition, the method including the steps of providing a monitoring apparatus supporting structure, the supporting structure including a first mount arranged to locate on one lateral side of a conveyor belt and a second mount arranged to locate on the opposing lateral side of the conveyor belt, the first mount and the second mount being connected by upper tracks passing over an upper surface of the conveyor belt and lower tracks passing over a lower surface of the conveyor belt; introducing a monitoring apparatus into the first mount and moving it along the tracks to monitor part of the conveyor belt surface; removing the monitoring apparatus from the first mount; introducing the monitoring apparatus into the second mount and moving it along the tracks to monitor another part of the conveyor belt surface.

19. A sensor arrangement for determining conveyor belt thickness, the arrangement including at least one first sensor arranged to determine a distance from a base position to a face of the conveyor belt and a second sensor arranged to determine a distance from the base position to a core of the conveyor belt, wherein the second sensor is located around the first sensor.

20. A sensor arrangement as claimed in claim 19, wherein the first sensor is an ultrasonic sensor, and the second sensor is an eddy-current sensor.

21. A sensor arrangement as claimed in claim 19 or claim 20, wherein the second sensor is annular, with the first sensor directed through a centre of the second sensor.

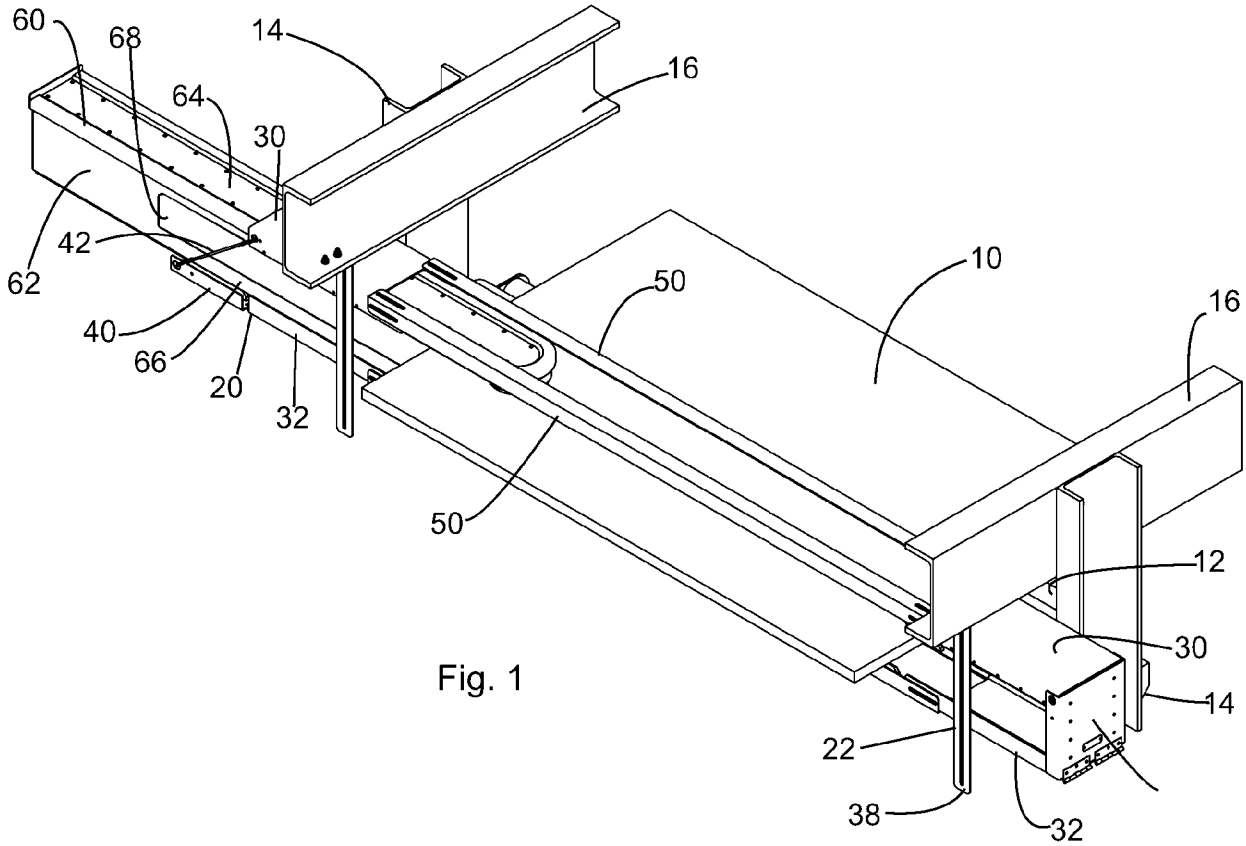
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Fig. 1

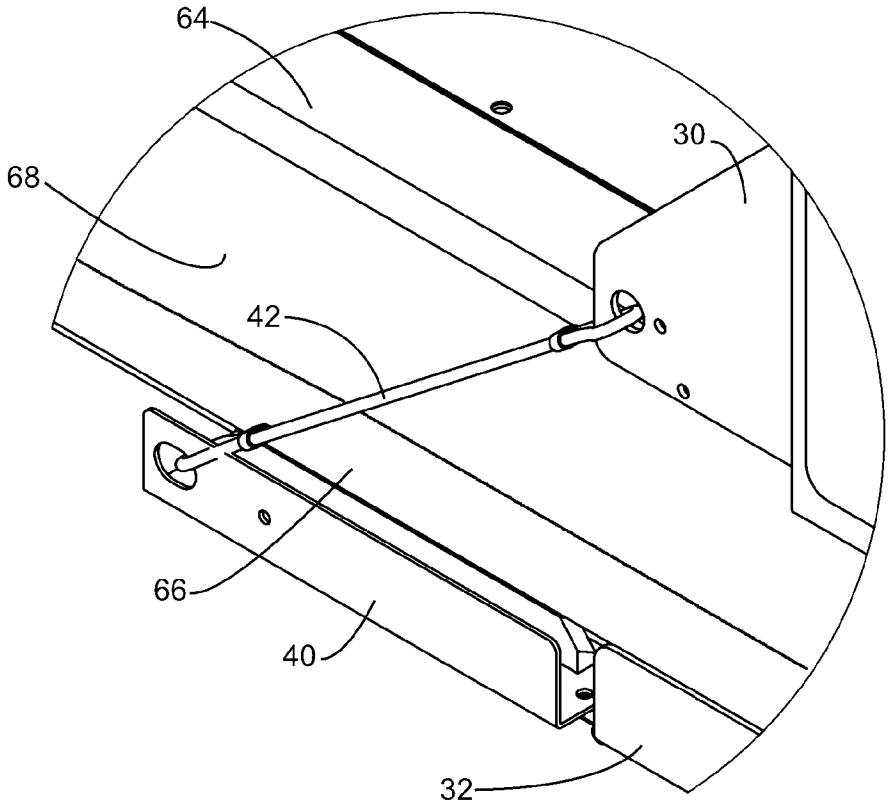
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Fig. 2

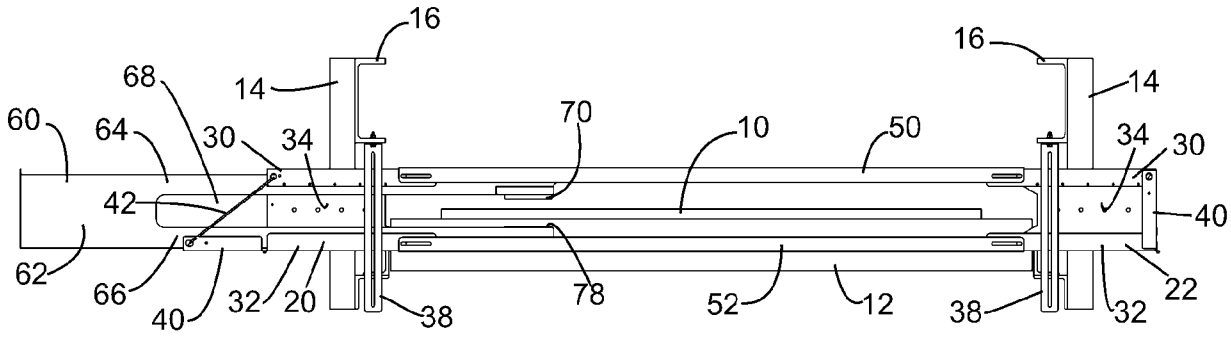
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Fig. 3

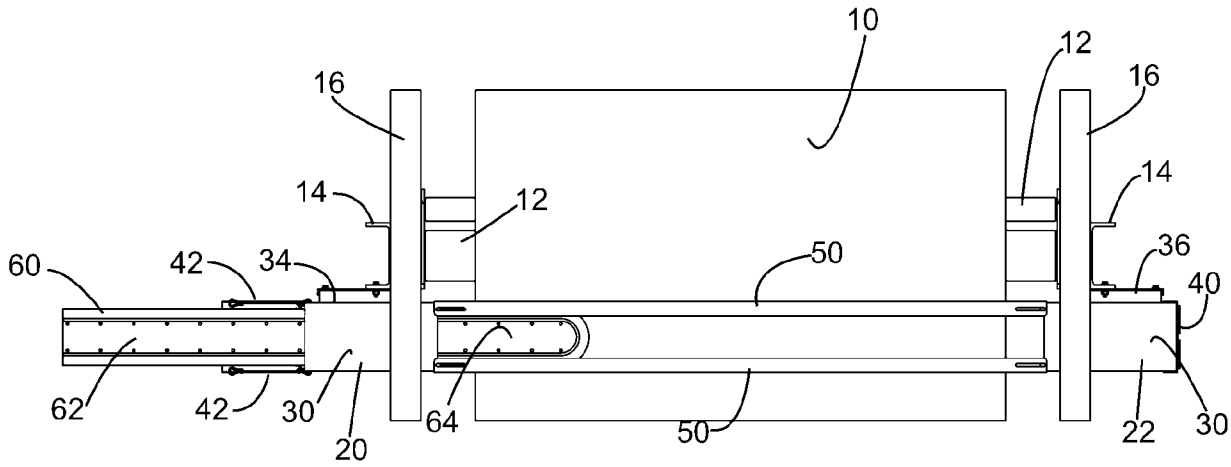
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Fig. 4

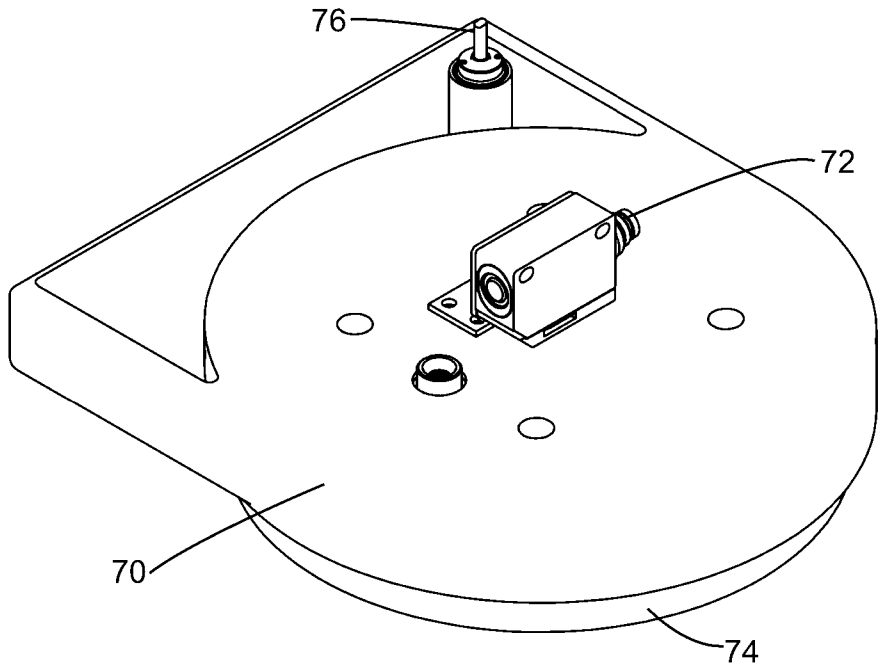

Fig. 5

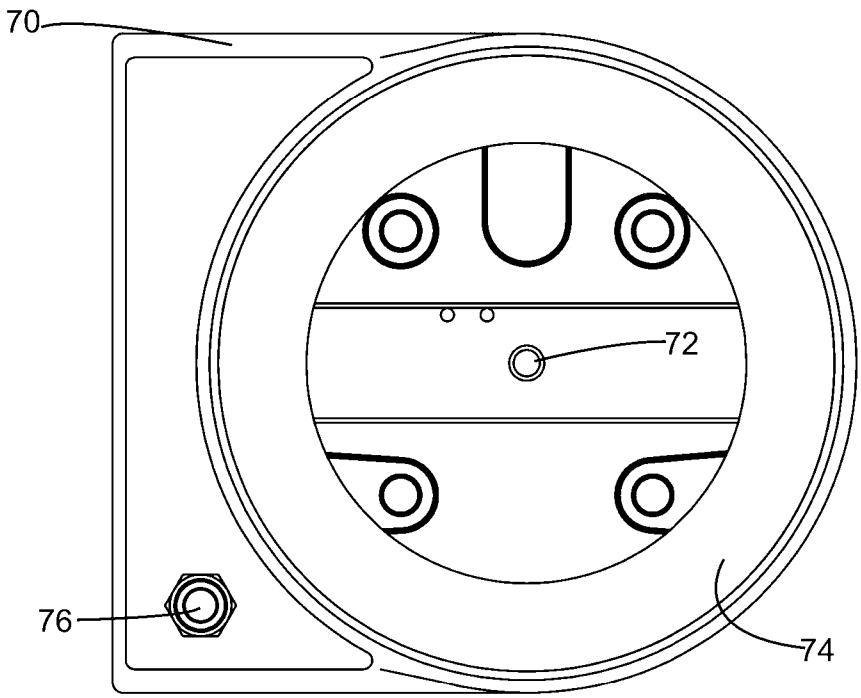

Fig. 6

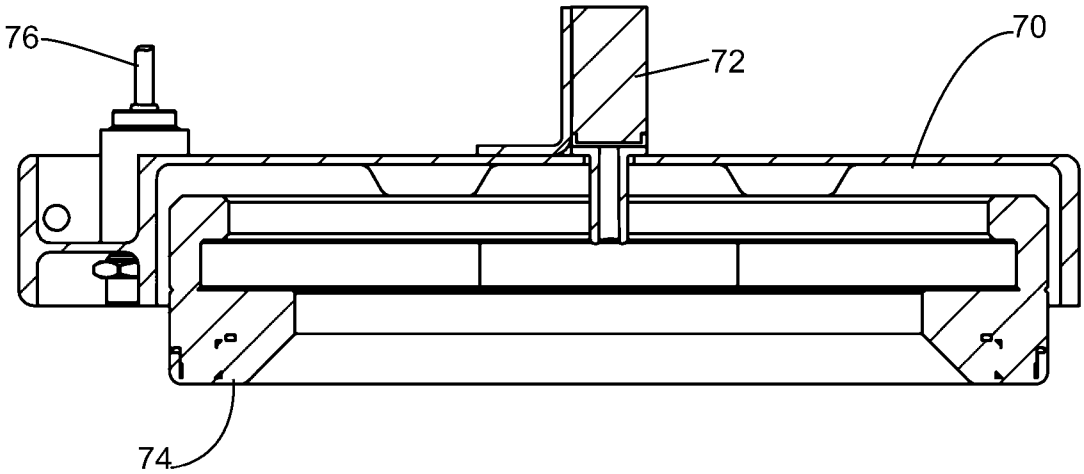

Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2018/051318

A. CLASSIFICATION OF SUBJECT MATTER

B65G 43/02 (2006.01)

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)

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)

PATENW - IPC/CPC: /LOW B65G43/02, B65G2203/0266, B65G2203/042; Keywords: UPPER+, LOWER+, ARM+, TRACK+, MEASUR+, MONITOR+, BELT+, CONVEYOR+, LATERAL+, PERPENDICULAR+, SENS+, TRANSDUCER+, ULTRA_SONIC+, EDDY+, TEMP+ & similar terms (see SIS for details);

PATENW / Internal Databases provided by IP Australia - Applicant/Inventor Name(s): "BASELINE ASSET TECHNOLOGIES PTY LTD", "BASELINE ASSET TECHNOLOGIES", "WRIGHT KELVIN"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

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

[X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 March 2019	27 March 2019

Name and mailing address of the ISA/AU

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2018/051318

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:

because they relate to subject matter not required to be searched by this Authority, namely:

the subject matter listed in Rule 39 on which, under Article 17(2)(a)(i), an international search is not required to be carried out, including

2. ☐ Claims Nos.:

because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos:

because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See Supplemental Box for Details

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-13

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		International application No. **PCT/AU2018/051318**
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 105692120 B (HEBEI MECHATRONICS INTERMEDIATE PILOT PRODUCTION BASE) 14 November 2017 Fig. 1-8; [0034]-[0036], [0049]-[0050]	1-13
A	CN 206417548 U (NINGXIA UNIVERSITY) 18 August 2017 Whole document	1-13
A	US 2017/0313523 A1 (THE YOKOHAMA RUBBER CO., LTD.) 02 November 2017 Whole Document	1-2
A	JP H02-266381 A (CANON INC) 31 October 1990, English abstract provided by Espacenet Abstract; Fig. 1, 6	1-2

Supplemental Box

Continuation of: **Box III**

This International Application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept.

This Authority has found that there are different inventions based on the following features that separate the claims into distinct groups:

- Claims 1-13 are directed to a conveyor belt condition monitoring apparatus. The feature of a body portion, two parallel arms extending away from the body with a gap defined between the two arms, each arm including at least one first sensor, with one first sensor oriented towards an upper face of the conveyor belt and one first sensor oriented towards a lower face of the conveyor belt, and the apparatus being moveable relative to a conveyor belt is specific to this group of claims.

- Claims 14-18 are directed to a conveyor belt condition monitoring apparatus supporting structure. The feature of a first mount and a second mount located on opposing lateral sides of a conveyor belt, the first and second mounts being connected by upper tracks passing over a surface of the conveyor belt and lower tracks passing over a lower surface of the conveyor belt and whereby a conveyor belt conditioning monitoring apparatus can be introduced into the first or second mount and moved laterally by engagement with at least one of the upper and lower tracks is specific to this group of claims.

- Claims 19-21 are directed to a sensor arrangement. The feature of at least one first sensor to determine a distance from a base position to a face of a conveyor belt and a second sensor to determine a distance from the base position to a core of the conveyor belt, wherein the second sensor is located around the first sensor is specific to this group of claims.

PCT Rule 13.2, first sentence, states that unity of invention is only fulfilled when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding special technical features. PCT Rule 13.2, second sentence, defines a special technical feature as a feature which makes a contribution over the prior art.

When there is no special technical feature common to all the claimed inventions there is no unity of invention.

In the above groups of claims, the identified features may have the potential to make a contribution over the prior art but are not common to all the claimed inventions and therefore cannot provide the required technical relationship. Therefore there is no special technical feature common to all the claimed inventions and the requirements for unity of invention are consequently not satisfied *a priori*.

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/AU2018/051318**

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document/s Cited in Search Report		**Patent Family Member/s**	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
CN 105692120 B	14 November 2017	CN 105692120 A	22 Jun 2016
		CN 105692120 B	14 Nov 2017
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		CN 107074456 A	18 Aug 2017
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		JP 2016088722 A	23 May 2016
		JP 6432291 B2	05 Dec 2018
		WO 2016075981 A1	19 May 2016
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End of Annex

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.