

Device for moving people and/or objects

5 The invention relates to a conveying device having at least one continuous conveyor, which comprises conveying elements, for people and/or objects according to the definition of the independent patent claims.

10 WO 2004/014774 discloses a conveying device for people having a handrail, wherein at least one transponder is integrated in the handrail. A communication device which is arranged in the vicinity of the handrail has a transmitter and a receiver. The transmitter transmits energy and data in the form of electromagnetic waves to the transponder. The transponder transmits measurement data relating to physical parameters, for example temperature or speed or acceleration of the handrail, to the receiver. Transponders which are integrated in the handrail are only suitable for belt-like or strap-like handrails. Handrails of this type can be monitored
15 with a few transponders. However, said transponders are unsuitable for other types of handrail.

The device claimed in claim 1 achieves the object of monitoring continuous conveyors, which comprise conveying elements, of a conveying device for people and/or objects using simple means.
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Advantageous developments of the invention are specified in the dependent patent claims.

The advantages achieved by the invention are substantially that metallic or non-metallic conveying elements of a continuous conveyor can be detected. The conveying elements which
25 are to be detected are, for example, handrail elements, wherein a handrail can also comprise one handrail element, steps, pallets or chain elements. The conveying elements form a segmented continuous conveyor, for example a handrail, a step belt, a pallet belt or a transportation chain for the steps or the pallets or the handrail elements. It is also advantageous that the sensor which is required for detecting the conveying elements detects the conveying elements from a very
30 short distance. As a result, the monitoring device is of compact and slim construction. The monitoring device detects each individual conveying element and, from this, generates operating variables, for example speed and/or acceleration/deceleration. Missing or damaged conveying elements can also be detected. In this case, the continuous conveyor in question is stopped and/or a fault is signaled. The monitoring device is also suitable for counting conveying
35 elements which form the segmented continuous conveyor.

The present invention will be explained in greater detail with reference to the following detailed description and the appended figures.

In the drawing:

5 fig. 1
shows an example of a conveying device for people and/or objects,

fig. 2
shows a section through the conveying device of fig. 1 along line A-A,

10 fig. 3
shows a cross section through a handrail in the return path,

fig. 4
15 shows a side view of the handrail according to fig. 3,

fig. 5
shows the handrail with a missing handrail element,

20 fig. 6
shows the handrail with a damaged handrail element,

fig. 7
shows a block diagram of an electrical circuit for monitoring a continuous conveyor,

25 fig. 8
shows an electrical representation of a segmented handrail which is provided with handrail elements,

30 fig. 9 and fig. 10
each show an electrical representation of a damaged handrail,

fig. 11, fig. 12 and fig. 13
each show output signals from the electrical circuit depending on the operating state of the
35 continuous conveyor.

An exemplary embodiment of a conveying device for people and/or objects having conveying elements which are combined to form continuous conveyors will be explained below with reference to an escalator having a handrail, a step belt and transportation chains. The explanations correspondingly apply to a moving walkway with pallets or a conveying belt too.

5 In the case of an escalator, a conveying element is a handrail element, wherein a handrail can also comprise one handrail element, is a step or is a chain element. The handrail elements form the handrail, the steps form the step belt and the chain elements form the transportation chains of the step belt. In the case of a moving walkway, a conveying element is a handrail element, a pallet or a chain element. The handrail elements form the handrail, the pallets form the pallet belt and the chain elements form the transportation chains of the pallet belt or of the handrail.

Fig. 1 schematically shows a conveying device using the example of an escalator 1 with a balustrade 2 and with a step belt 3 with steps 3.1 for transporting people and/or objects in the forward path VL from a first level E1 to a second level E2, or vice versa. The continuous step belt 3 returns in the return path RL. A framework 4 serves as a support for the step belt 3 and the balustrade 2 and is supported at the levels E1, E2. A handrail 5 which is supported by the balustrade 2 serves, in the forward path VL, as a continuous conveyor for the hands of the person being transported.

20 Fig. 2 shows a section through the conveying device of fig. 1 along line A-A. Each step 3.1 has step rollers 3.2 and chain rollers 3.3, wherein the rollers 3.2, 3.3 roll on guides 3.4. The guides are arranged on frames 4.1 of the framework 4. As a continuous conveyor, a first transportation chain 3.5 with chain elements 3.51 transports the steps 3.1 in the forward path VL and in the return path RL. The handrail 2 is guided in the return path RL by means of return rollers 6 and in the forward path VL by means of a first guide profile 7.

Fig. 3 shows a cross section through a handrail 5 in the return path RL, wherein the handrail 5 is constructed from individual, for example hollow-body-like, handrail elements 5.1. The handrail elements 5.1 are transported by means of a second transportation chain 8 and guided along the first guide profile 7 of the balustrade 2 on the guide grooves 9. A clip 11 is fastened to a bracket 14 by means of a bolt 12 and nut 13, wherein, for example, a sensor support 11.1 having sensors 10 for monitoring the handrail elements 5.1 is arranged on the clip 11. The sensor support 11.1 is equipped with three sensors 10, it also being possible to provide only two or just one sensor.

35 Fig. 4 shows a side view of a handrail 5 according to fig. 3, wherein the handrail elements 5.1 are moved past the sensor support 11.1. For the sake of improved clarity of the monitored handrail element 5.1, figs 4 to 6 do not show the entire sensor support 11.1 shown in fig. 3. An

articulation means 16 is provided on the clip 11, wherein a damaged handrail element 5.1 with projecting parts pivots away the sensor support 11.1, the sensors 10 remaining intact in the process. Each handrail element 5.1 has a collar 5.11 which extends into the adjacent handrail element 5.1. The handrail elements 5.1 which are fastened to the second transportation chain 8 in an articulated manner can move relative to one another in relation to the adjacent handrail elements 5.1, without a gap being formed between two adjacent handrail elements 5.1 in the process. Only a segment channel 5.12 with a depth which is so low that fingers cannot be trapped is produced between two adjacent handrail elements 5.1. The segment channel 5.12 has, for example, a depth of approximately 2 mm to 4 mm and a width of approximately 4 mm to 8 mm.

Fig. 5 shows the handrail 5 with a missing handrail element 5.1. A handrail element 5.1 has, for example, broken or fallen out or been forcibly removed by vandals. The sensors 10 detect each present and also each missing handrail element 5.1.

Fig. 6 shows the handrail 5 with a damaged handrail element 5.1. In one handrail element 5.1, parts have been, for example, broken off or forcibly removed as a result of vandalism. The sensors 10 detect each present and also each damaged handrail element 5.1. Damaged handrail elements 5.1 have, for example, craters, cracks and/or holes 5.13.

Sensors 10 which operate in accordance with different operating principles can be considered, depending on the material properties of the conveying elements. By way of example, antennas 10.1 of which the emission characteristics can be changed by virtue of the proximity to the antenna and by virtue of the segmentation of the handrail 5 or of the step/pallet belt 3 or of the transportation chains 3.5, 8 are suitable for monitoring a segmented handrail 5 which is formed from handrail elements 5.1, or for monitoring step/pallet belts 3 which are formed from steps 3.1 or pallets, or for monitoring a first transportation chain 3.5, which is formed from chain elements 3.51, or a second transportation chain 8, as is explained in further detail below. Sensors which operate using the radar principle can also be considered, wherein an antenna transmits electromagnetic signals to the continuous conveyors with conveying elements, wherein the signals are reflected depending on the contour of the continuous conveyor, and the reflected signals are measured. Sensors which operate using the capacitive principle are also possible. In this case, the capacitance of a capacitor is changed by the segmentation of the continuous conveyor. The capacitor forms a resonant circuit together with an inductance, the resonant frequency of said resonant circuit changing depending on the capacitor capacitance and determining the frequency of an oscillator.

A sensor 10 having an antenna 10.1, of which the emission characteristics can be changed by virtue of the proximity to the antenna and by virtue of the segmentation 5.12 of a continuous conveyor, for example, of a handrail 5, of a step/pallet belt 3 or of a transportation chain 3.5, 8, will be explained in greater detail below.

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A short distance, in particular in the near-field of the antenna 10.1, between the antenna 10.1 and conveying elements, for example handrail elements, steps/pallets, chain elements, leads to interference signals which are superimposed on a desired payload signal. There is no interaction with objects in the far field; the antenna emits freely, wherein the far field is determined as follows: $d/\lambda > 1$. (d = distance of the antenna from the continuous conveyor, λ = wavelength of the signal which is emitted by means of the antenna).

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An object in the near-field detunes the antenna and changes its resistance, wherein the near-field is determined as follows: $d/\lambda < 1$.

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The distance d shown in fig. 3 of the antenna 10.1 from the handrail element 5.1 is, for example, fixed at 1.5 mm to 3.5 mm in a near-field, in which cracks with, for example, a length of approximately 5 mm and/or holes 5.13 with, for example, a diameter of approximately 5 mm can still be exactly detected. Holes 5.13 and cracks detune the antenna 10.1 less than bulges and projecting parts, for example, of the handrail 5. The sensor (10) used is an antenna which operates in the radiofrequency range, for example a commercially available 2.4 GHz WLAN antenna. (WLAN means Wireless Local Area Network).

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ϵ_r is a material constant of the conveying elements and is greater than 1. (ϵ_r for vacuum equals 1). Intermediate spaces between the conveying elements, for example the segment channels 5.12 between two adjacent handrail elements 5.1 or slots between two adjacent steps or pallets or step-like transitions from one chain element 3.51 to the adjacent chain element 3.51, result in a sequence of changes in the dielectric constant ϵ_r . For example, in the case of a segmented handrail, the sequence comprises handrail element - segment groove - handrail element - segment groove - handrail element... etc., wherein a handrail element has a greater ϵ_r than a segment channel (ϵ_r close to 1).

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A change in the electrical field in the near-field of the antenna 10.1 can be used advantageously. Changes in the dielectric constant ϵ_r of the conveying elements which are located in the immediate vicinity of the antenna 10.1, for example handrail elements, steps/pallets, chain elements, lead to detuning or to a change in the resonant frequency of the antenna 10.1. These changes cause energy to be reflected, it being possible to measure this in the feed lines of the

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antenna. Changes in the dielectric constant ϵ in the immediate vicinity of the antenna 10.1 are caused by the conveying elements which are guided past the antenna.

5 The compact construction of the antenna and the small distance d of the antenna from the conveying elements are also advantageous.

Fig. 7 shows a block diagram of an electrical circuit 20 for conditioning the sensor signal which is generated by the sensor 10. A voltage converter 21 is fed with a first supply voltage VS_1 , for example 24 V of the escalator 1. The voltage converter 21 generates a second supply voltage
10 VS_2 , for example 5 V, from the first supply voltage VS_1 , a control system 22, an oscillator 23, a radiofrequency amplifier 24 and a measurement-value amplifier 25 being supplied with said second supply voltage.

The control system 22 prespecifies a frequency which corresponds to the antenna 10.1, wherein
15 the oscillator 23 generates a signal at this frequency and with a predetermined shape and amplitude, for example a sinusoidal signal, and supplies said signal to the radiofrequency amplifier 24. The amplified radiofrequency signal S_1 is supplied to a measurement quadripole network 26 and, from this, to an antenna coupler 27 to which the antennas 10.1 which are arranged on the sensor support 11.1 are connected. When there are no objects in the near-field
20 of the antenna 10.1, the antenna operates in a purely resistive manner (for example 50 ohms) and all the energy of the first signal S_1 is emitted without reflection. If objects, as explained above, are located in the near-field of the antenna 10.1, the resonant frequency of the antenna 10.1 is detuned by the interaction with the objects and some of the energy of the first signal S_1 is reflected by the antenna 10.1 to the measurement four-terminal network 26 and appears on
25 the measurement quadripole network 26 as a second signal S_2 which maps the surface of the continuous conveyor. The second signal S_2 is supplied to the measurement-value amplifier 25. Said measurement-value amplifier amplifies the second signal S_2 and supplies it to the control system 22 for evaluation.

30 If continuous conveyors without a contour or without visually identifiable points of damage on the surface or without a member structure or without segmentation in the near-field of the antenna 10.1 are moved past the antenna 10.1, a second signal S_2 , also called an "interference signal" here, is produced, but without a "payload signal". The payload signal which is superimposed on the interference signal is first produced with a change in the surface of the
35 continuous conveyor or with contouring of the continuous conveyor or with visually identifiable structures, such as holes or cracks or notches or slots etc., on the surface or with the segment channels 5.12 between the handrail elements 5.1 or with the slots between the steps or with the

step-like transitions from one chain member to the other, wherein the change in the surface of the continuous conveyor causes a change in the emission characteristics of the antenna.

Visually identifiable changes in the surface of the continuous conveyor, for example segment channels between the handrail elements, an unsegmented handrail which is provided with slots, a unsegmented handrail which is provided with cracks, damaged handrail elements with holes and/or cracks, missing handrail elements, missing steps or pallets, step-like transitions from one chain element to the other, missing chain elements, projecting parts of the continuous conveyor, slots between conveying elements etc., can be identified by the sensor 10.

Fig. 8 shows an electrical representation of a segmented handrail 5 according to fig. 4 which is provided with handrail elements 5.1. The second signal S2 is illustrated as a function of time t. The intact handrail 5 which is moved past the antenna 10.1 generates a wave-like payload signal S2.1, which is superimposed on the interference signal, with each segment channel 5.12, wherein each wave S2.1 is recorded by the control system 22.

In order to suppress interference effects, an average value is calculated by the control system 22 from the last-measured waves S2.1 (for example from the last 64 measured waves), and the average value is compared with the measurement value of the current wave S2.1. If the deviation between the current measurement value and the average value is within a specific tolerance band, the handrail element 5.1 currently being measured is considered to be intact.

Fig. 9 shows an electrical representation of a segmented handrail 5 according to fig. 5 which is provided with handrail elements 5.1 and has a missing handrail element 5.1. The second signal S2 is illustrated as a function of time t. The missing handrail element 5.1 forms the associated signal wave S2.2 only to a stunted extent. The control system 22 identifies the damaged point and generates a fault signal.

Fig. 10 shows an electrical representation of a segmented handrail 5 according to fig. 6 which is provided with handrail elements 5.1 and has a handrail element 5.1 which is provided with holes 5.13 and/or cracks. The second signal S2 is illustrated as a function of time t. The damaged handrail element 5.1 forms the associated signal wave S2.3 only to a stunted extent. The control system identifies the damaged point and generates a fault signal.

The control system 22 of fig. 7 generates a third signal S3 which corresponds to the operating state of the continuous conveyor, by means of an output stage 28. The output stage can contain, for example, a semiconductor switch, an optocoupler or a bus system.

Fig. 11 shows a continuous conveyor using the example of a segmented handrail 5 with handrail elements 5.1. At the nominal speed, the handrail generates the shown signal S3 as a function of time t. The signal S3 changes from logic 0 to logic 1 and vice versa, for example, after each third handrail element 5.1. At, for example, half the speed, the signal S3.1 is generated as a function of time t. The signal S3, S3.1 is supplied, for example, to the escalator control system for speed regulation and/or for speed monitoring. The number of pulses per unit time is used to determine operating variables, for example conveying speed, acceleration during start-up or deceleration during stopping.

Fig. 12 shows the output signal S3 given a partially or completely missing handrail element 5.14 or given a handrail element 5.1 with cracks and/or holes 5.13. The third signal S3 is set to logic 0 for a specific time T, for example 30 seconds. The escalator control system identifies this state and generates at least one corresponding fault message.

Fig. 13 shows the handrail 5 with a damaged handrail element 5.1 with projecting parts 5.15 which pivot away the sensor support 11.1 by means of the articulation means 16, the sensors 10 remaining intact in the process. In the pivoted-away position, the sensor 10 cannot identify any handrail elements 5.1, the signal S3 remaining at logic zero. The escalator control system identifies this state, stops the escalator 1 and generates at least one corresponding fault message.

Patent Claims

1. Conveyor equipment, comprising:
an endless conveyor, the endless conveyor comprising at least one conveyor element;
at least one non-contact surface detection sensor for the endless conveyor; and
a sensor signal imaging circuit coupled to the at least one surface detection sensor; the non-contact surface detection sensor comprising an antenna tuned to operate in an ultra-high frequency range, the at least one conveyor element being movable in a near field of the antenna, the sensor signal imaging circuit being responsive to changes in the near field of the antenna resulting from the presence of the conveyor element in the near field.
2. The conveyor equipment of claim 1, the at least one conveyor element comprising a segmented handrail.
3. The conveyor equipment of claim 1, the at least one conveyor element comprising a non-segmented handrail.
4. The conveyor equipment of claim 1, a spacing of the antenna from the at least one conveyor element being approximately 1.5 millimeters to 3.5 millimeters.
5. The conveyor equipment of claim 1, the antenna comprising a wireless local area network (WLAN) antenna.
6. The conveyor equipment of claim 5, the antenna being tuned for 2.4 GHz.
7. The conveyor equipment of claim 1, the antenna being pivotably deflectable by one or more protruding parts of the at least one conveyor element.
8. A conveyor equipment monitoring method, comprising:
positioning a non-contact sensor comprising an antenna tuned to operate in an ultra-high frequency range proximate a surface of an endless conveyor, the endless conveyor comprising at least one conveyor element, whereby the surface is within a near field of the antenna;
and
analyzing, using a circuit, changes in the antenna near field generated by the surface of the endless conveyor.
9. The conveyor equipment monitoring method of claim 8, the sensor comprising an antenna operating in an ultra-high-frequency range.
10. The conveyor equipment monitoring method of claim 9, further comprising:

sending an ultra-high-frequency signal from the circuit to the antenna; and

sending a reflected signal from the antenna to the circuit.

11. The conveyor equipment monitoring method of claim 10, further comprising generating, using the circuit and based on the reflected signal, an indication of an operating magnitude of the endless conveyor.

12. The conveyor equipment monitoring method of claim 11, the operating magnitude comprising one or more of speed of the endless conveyor, acceleration of the endless conveyor, and deceleration of the endless conveyor.

13. The conveyor equipment monitoring method of claim 10, further comprising generating, using the circuit and based on the reflected signal, an indication of a risk-laden operating state of the endless conveyor.

14. The conveyor equipment monitoring method of claim 13, the risk-laden operational state comprising one or more of a missing conveyor element, a damaged conveyer element, and a protruding conveyor element.