

System for the contactless inspection of containers, particularly ISO-containers, within a loading and unloading plant

The invention relates to a system for the contactless inspection of containers, particularly ISO-containers, within a loading and unloading plant, having at least one screening device arranged in an inspection station, wherein the container to be inspected can be transported to and away from the inspection station by means of a driverless transport vehicle.

A manned mobile platform for contactless inspection of containers is already known from the German laid-open document DE 103 13 248 A1, these containers being loaded and unloaded in ports by means of a container bridge. As far as function is concerned, the platform can be compared to a gantry crane and can be moved along a quay via a gantry frame on rails in parallel with and below a container bridge and independently of the container bridge. In order to be able to pick up containers to be inspected from the quay and to be able to set them down after inspection, the platform has a lifting device and a set-down location for the containers, which is arranged on the gantry crane. A screening device is arranged in the region of the set-down location and consists essentially of a radiation source, an oppositely arranged radiation detector and a shield. By means of the radiation source the container is screened substantially horizontally using X-rays or gamma-rays. The shield serves to protect the people operating the platform or the screening device.

Furthermore, from the German laid-open document DE 11 2004 001 701 T5 a system for the inspection of goods in a container in port areas is already known. The container is located in that case on a transport surface of a lorry. The system consists essentially of a screening device and a towing device for the lorry. The screening device is stationary and has a radiation source, a first collimator, a second collimator and a detector. The radiation source is pivotable in order to orientate the screening rays emitted therefrom in respect of the vertical position of the container on the lorry. In this way it is possible to adapt the screening device to different vertical heights of the transport surfaces of the lorries. The container is screened substantially horizontally. Since the screening device is stationary, the lorry is towed by the towing device along a screening channel and past the screening device. The towing device consists of a

towing carriage which is pulled along the screening channel via a winch and a steel cable. The lorry is connected in a clamping manner to the towing vehicle via its front wheels.

5 Furthermore, the German laid-open document DE 10 2009 025 051 A1 describes a driverless heavy goods transport vehicle for containers. The areas where this transport vehicle is said to be used are the loading and unloading of containers in port areas and intermodal transport between road and rail, in which the transport vehicle carries out its transport tasks in unmanned automatic operation. The floor-bound heaving goods transport vehicle has rubber tyres and is a four-wheeled vehicle. It consists essentially of a vehicle chassis on which two front wheels are
10 mounted on a front axle and two rear wheels are mounted on a rear axle. The vehicle chassis carries a level platform which serves to receive the containers to be transported. This platform can be designed to be passive, i.e. the containers must be picked up or set down thereon by a suitable handling device. This platform can also be designed to be active. In that case the platform can be raised and lowered by a lifting device and can pick up the containers from a
15 stationary support frame and set them down thereon. This transport vehicle is driven by one electric motor per axle, these motors being powered by a lead battery suspended on and below the vehicle chassis.

Furthermore, patent application US 2008/0025825 A1 describes a system for screening
20 containers in a port area. The containers loaded and unloaded by a quay crane are unloaded onto driverless transport vehicles. The driverless transport vehicles then travel with the containers through a screening device, in which the containers are screened horizontally. The containers are then conveyed in a transfer device through a fence into an area of the quay where manned vehicles can travel and are there picked up by manned container transport vehicles.

25 The further German patent application DE 10 2007 063 201 A1 relates to a screening device for freight containers through which a lorry can travel and which has horizontally and vertically oriented detectors.

30 German patent application DE 101 60 928 A1 discloses a further screening device for freight containers, which is arranged on an intermediate support of a container-handling bridge having a

crane trolley. The screening device has, in addition to an X-ray device, support frameworks for setting down the containers to be screened. The containers are set down on the support frameworks and picked up therefrom by the crane trolley. The screening device can travel horizontally as a whole on the intermediate support.

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The object of the present invention is to create a safe system for the contactless inspection of containers, particularly ISO-containers, within a loading and unloading plant.

10 This object is achieved by a system for the contactless inspection of containers, having the features of claim 1. Advantageous embodiments of the invention are given in claims 2 to 6.

In accordance with the invention, in a system for the contactless inspection of containers, particularly ISO-containers, within a loading and unloading plant, having at least one screening device arranged in an inspection station, wherein the container to be inspected can be
15 transported to and away from the inspection station by means of a driverless transport vehicle, safe inspection is achieved in that for the inspection process the container can be set down in the inspection station by means of the transport vehicle, the container can be inspected by means of at least one screening device which can be moved along the container, and the container can be picked up after the inspection process in the inspection station by means of the transport vehicle.
20 The moveable screening device can include a gantry scanner. In addition, a moveable detector can be provided, wherein the moveable detector can travel below the container in the inspection station. For this purpose, it may be e.g. a rail carriage or a driverless transport vehicle with rubber tyres. The movements of the gantry scanner and possibly of the moveable detector are then synchronised.

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By means of this system it is advantageously achieved that the inspection or screening or scanning process in the inspection station is integrated on the one hand into the operation of automatically moveable transport vehicles and the scanning of the container can be effected without people being present in the vicinity of the container. Therefore, no additional protective
30 measures for drivers of transport vehicles or lorries are required. Containers which are recognised as hazardous can also be disposed of without human intervention.

Provision is advantageously made that the container can be screened horizontally by means of at least one first screening device.

- 5 Moreover, provision is advantageously made that the container can be screened vertically by means of a second screening device. This further increases the level of safety.

10 In a constructionally advantageous embodiment, provision is made that for the inspection process the container can be set down on a stationary support frame by means of the transport vehicle and, after the inspection process, can be picked up from the stationary support frame by means of the transport vehicle.

15 The system in accordance with the invention is particularly suitable for a loading and unloading plant in a port area, for containers which are sea freight containers and driverless transport vehicles which are floor-bound and have rubber tyres.

The invention will be described hereinunder with the aid of an exemplified embodiment illustrated in a drawing in which :

20 figure 1 shows a water-side section of an overview plan of a loading and unloading plant for containers in a port area,

figure 2 shows an enlargement of a section of figure 1 from the region of an inspection station,

25 figure 3 shows a front view of a container in an inspection station according to figure 2, and

figure 4 shows a front view of a transport vehicle with a container.

30 Figure 1 shows a water-side section of an overview plan of a loading and unloading plant 1 in a port area, in which containers 2 are loaded and unloaded. In respect of the invention, containers 2 are understood to be ISO-containers. ISO-containers weigh up to about 38 t and are generally

understood to be standardised large-capacity boxes with standardised pick-up points or corners for load picking-up means. ISO-containers are conventionally 20, 40 or 45 feet long. ISO-containers with a length of 53 feet are already available. In the field of ISO-containers, refrigerated containers – so-called reefers – and a number of other container types are also known in addition to closed containers.

The overview plan shows only a section of the loading and unloading plant 1 but allows some of the essential components to be seen. The loading and unloading plant 1 consists essentially of a land-side loading and unloading area, not shown, a store 3 and a water-side loading and unloading area 4.

The store 3 consists of a plurality of storage areas 3b arranged in parallel next to each other and in lines, each being allocated a water-side area 5 for placement into and out of storage at its water-side end 3a. Each storage area 3b has one or more container stacking cranes 6 – preferably two – which can travel along the storage areas 3b on shared or separate rails 7. The container stacking cranes 6 transport the containers 2 between the storage area 3b and a land-side loading and unloading region, not shown, and the water-side area 5 for placement into and out of storage. Each storage area 3b also has a set-down area 3c for the containers 2 in addition to the one or more container stacking cranes 6. The set-down area 3c has a rectangular and elongate base surface on which the containers 2 can be arranged in rows and columns and can be intermediately stored, stacked one on top of another.

Each of the water-side areas 5 for placement into and out of storage is an interface between the store 3 and the water-side loading and unloading area 4 which, in the present case, corresponds substantially to a quay 8 where the ships to be loaded and unloaded (not shown) are moored. For the purpose of loading and unloading the ships, the containers 2 are conveyed by driverless transport vehicles 10 between the areas 5 for placement into and out of storage and handling bridges 9 arranged along the quay 8. These driverless transport vehicles 10 can generally be described as travelling platforms on which the containers 2 are set down for transportation. This platform can be passive and therefore the containers 2 must then be loaded and unloaded by the container stacking crane 6, the handling bridge 9 or other available handling devices. The

driverless transport vehicles 10 can also have an active platform – i.e. one which can be raised and lowered – in order to actively set down or pick up the container 2 onto/from stationary support frames, not shown, in the region of the areas 5 for placement into and out of storage of intermediate storage locations and/or the handling bridges 9. The transport vehicles 10 can be battery-operated or have a diesel-electric drive and are guided by automatic operation. Accordingly the transport vehicles 10 are operated unmanned. Figure 1 shows virtual lanes 11 for the transport vehicles 10 in order to indicate the usual travel routes thereof. However, the transport vehicles 10 can be navigated freely.

- Furthermore, in the region of the water-side loading and unloading area 4, an inspection station 12 is arranged in which the containers 2 and their content can be subjected to contactless inspection for the purpose of discovering banned and/or hazardous objects or substances in the container 2.
- This inspection station 12 is at the edge of, and outside, the conventional lanes 11 for the transport vehicles 10 in the water-side loading and unloading area 4 and is designed as a stationary building 12a. In order for the transport vehicles 10 to be able to reach the inspection station 12, the outermost of the lanes 11 is adjoined by a departure lane 13a which ends at an entry 12b of the inspection station 12. The opposite end of the inspection station 12 is adjoined by an exit 12c which is connected via an approach lane 13b to the outermost of the lanes 11. The inspection station 12 is therefore arranged in parallel, outwardly offset with respect to the outer lane 11.

- Figure 2 shows an enlargement of a section of figure 1 from the region of the inspection station 12. The inspection station 12 includes a cuboidal building 12a, the roof thereof not being shown for the sake of the clarity of figure 2 so that the other components of the inspection station 12 in the building 12a can be seen. The inspection station 12 for the contactless examination of the containers 2 and/or the load in the container 2 has a screening device 14 known from the prior art, which consists essentially of a first horizontally oriented radiation source 14a for X-ray and/or gamma-radiation, the rays of which are indicated by the lines S, and of an oppositely arranged radiation detector 14b. The screening device 14 along with the radiation source 14a

and the radiation detector 14b oppositely adjoin a screening channel 14d formed as a lane for the transport vehicles 10. By means of the radiation source 14a the container 2 and the load are screened substantially horizontally by X-rays and/or gamma-rays. The stationary building 12a serves with its outer wall as a shield 14c.

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This arrangement and design of the inspection station 12 has the advantage that the container 2 to be inspected is already located on a driverless transport vehicle 10 in the water-side loading and unloading area 4 and therefore can easily be moved by the driverless transport vehicle 10 to the inspection station 12 for examination. Since the transport vehicle 10 is driverless, it is not
10 necessary for drivers to get in or out or to protect them against the inspection radiation, and unmanned conveyance of the transport vehicle 10 or of the container 2 is not required.

In this inspection station 12, in addition to contactless inspection of the containers 2 in the horizontal direction, inspection in the vertical direction is also possible. For this purpose the
15 container 2 in the inspection station 12 is set down by the driverless transport vehicle 10 onto a stationary support frame 15. The support frame 15 consists essentially of eight pillars 15a arranged in the travel direction F of the automated transport vehicle 10 to the right and left of an inspection channel 14d. The container 2 rests with short, narrow portions of its lateral right and left lower surface 2c on the pillars 15a. For the set-down process and the subsequent pick-up
20 process, the transport vehicle 10 is fitted with a platform-like lifting table 10b which can be raised and lowered. For the set-down process the transport vehicle 10 with the raised lifting table 10b travels into the support frame 15a, and so the lower surface 2c is located over contact surfaces 15b of the pillars 15a and then lowers the container 2 onto the support frame 15. For the pick-up process, the transport vehicle 10 with the lowered lifting table 10b travels into the
25 support frame 15 until it comes to a stop below the container 2 to be picked up. The lifting table 10b is then raised in the direction of the lower surface 2c of the container 2 until the lifting table 10b lifts the container 2 from the contact surfaces 15b of the pillars 15a. The dimensions of the lifting table 10b and of the pillars 15a are selected such that the lifting and lowering process can be effected unhindered.

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Since the support frame 15 supports the container 2 only from below in the region of its long

sides and the transport vehicle 10 is moved out from under the container 2, the container 2 can now also be scanned in the vertical direction. For this purpose, a second screening device 16 is provided as a moveable gantry 16e.

- 5 The gantry 16e includes a radiation source 16a above the container 2 on a cross-beam, the radiation source 14a of the first screening device 14 on one side and the radiation detector 14b on the opposite side.

The radiation detector 16b is shown in a broken line below the container 2, this detector being
10 able to travel on a rail-bound carriage 16f.

Since the container 2 to be inspected now rests in the inspection station 12 on the support frames 15, the first and second screening devices 14, 16 are designed to be able to move along the container 2 and therefore the support frame 15 in an inspection direction K, wherein their
15 movements are synchronised.

Rails 16c are provided for the gantry 16e and rails 16d are provided for the carriage 16f, these extending on a floor of the inspection station 12 and in parallel with the travel direction F.

- 20 Since the lower rails 16c and 16d extend in the region of the screening channel 14d so that the radiation detector 16b can be guided closely along the lower side 2c of the container 2, the radiation detector 16b arranged on the carriage 16f must be moved out of the screening channel 14d after the inspection process. For this purpose, the lower rails 16d bend at a right angle outside the support frame 15 and so the radiation detector 16b can be moved into a parking
25 position in a parking direction P. It will be understood that the rails 16c, d can also extend in a curve. The use of a rubber-tyred driverless transport vehicle (AGV) for the detector 16b is also feasible.

The travel paths for the radiation source 14a of the first screening device 14, the radiation
30 detector 14b of the first screening device 14 and the radiation source 16a of the second screening device 16 are located outside the screening channel 14d through which the transport

vehicle 10 with the container 2 travels, and so the rails 16c thereof do not have to bend but only extend in the travel direction F.

5 A container 2 classed as hazardous or a container 2 with a banned load can then be transported by the driverless transport vehicle 10 directly into a safety area, not shown, and automatically unloaded at that point. This safety area can also be protected against explosions.

Figure 3 shows a front view of a container 2 in an inspection station 12 according to figure 2, the container being set down on a support frame 15. For reasons of clarity, the building 12a of
10 the inspection station 12 is not shown.

At this time, the transport vehicle 10 has already moved out from under the container 2 and the carriage 16f of the radiation detector 16b of the second screening device 16 has travelled out of its parking position via the rails 16d into the screening channel 14d in which the transport
15 vehicle 10 has previously travelled. The container 2 rests with its lower surface 2c in the region of the lateral edges on the contact surfaces 15b of the pillars 15a of the support frame 15.

Since, in this embodiment, the container 2 rests in an inspection position for the horizontal and vertical inspection process, the first and second screening devices 14 and 16 are to be moved in
20 synchronism along the container 2 in the inspection direction K.

For this purpose, the radiation source 14a, the radiation detector 14b of the first screening device 14 and the radiation source 16a of the second screening device can travel together by means of the gantry 16e via wheels on the rails 16c.

25 The fourth driven carriage 16f of the radiation detector 16b runs via its wheels on the two lower rails 16d. The rails 16d in the region of the screening channel can also be let into the floor 12d in order not to impair the travelling movement of the transport vehicle 10.

30 In order to scan the container 2, the gantry 16e and the carriage 16f travel in synchronism along the container in order gradually to cover the whole container 2 and in so-doing to screen it. In a

corresponding manner, the radiation sources can be weaker and the detectors smaller since the whole container does not have to be screened at once.

5 It is clear from figure 3 that the radiation source 14a of the first screening device 14 is arranged laterally next to the screening channel 14d and at a height which corresponds approximately to the middle height of a container 2 on the transport vehicle 10 and so the X-rays or gamma-rays of the radiation source 14a screen the whole container 2 as shown by the lines S. Starting from the radiation source 14a, the X-rays or gamma-rays pass through the right-hand long side 2b of the container 2 into the container 2, migrate through it and exit on the opposite, left-hand long
10 side 2b of the container 2. At that location they reach the radiation detector 14b which is arranged in parallel with the opposite long side 2b of the container 2 and at a slight distance therefrom. The size of the radiation detector 14b therefore corresponds at least to the size of the long side 2b of the container 2 to be inspected. The radiation detector 14b is connected in a conventional manner to evaluation devices, not described in more detail, in order finally to
15 obtain the desired screening image of the contents of the container 2. The same is true for the vertical radiation source 16a and the radiation detector 16b thereof.

In figure 4, a front view of the driverless transport vehicle 10 with a container 2 is shown. In respect of the transport vehicle 10 it can be seen that this consists essentially of a vehicle chassis
20 10c which can travel on the floor 12d in an automatically guided manner via a total of four rubber tyres 10a on a front and a rear axle. A first lifting table 10d, which can be raised and lowered, and, therebehind against the travel direction F, a second lifting table 10e, which can be raised and lowered, are arranged on the vehicle chassis 10c. A long 40 or 45 foot container 2 or two 20 foot containers one behind the other rest on the lifting tables 10d and 10e. Each
25 substantially cuboidal container has, in a conventional manner, corner fittings 2a, long sides 2b and a lower surface 2c, with which the container 2 rests on the lifting table 10d, 10e. For this purpose, [lacuna]

The inspection station 12 can fundamentally also be designed as a mobile housing unit and can
30 be arranged at other suitable sites in the water-side loading and unloading area 4. An arrangement in the region of the handling bridges 9 is particularly suitable. The inspection

station 12 can then be moved independently of the handling bridges 9 but, if necessary, also jointly with the handling bridge 9 along the quay 8. This inspection station 12 then also preferably adjoins the lane 11 closest to the water. Furthermore, the inspection station 12 can be foldable. The operation of the inspection station 12 is therefore optimally adaptable to the
5 operating conditions of the container terminal.

In respect of the moveable first and second screening devices 14 and 16, the first to the fourth carriages or gantries 14g, 14h, 16e and 16f are described as able to travel on rails. Alternatively any types of displacement along guides are feasible as long as they produce little shaking so as
10 not to impair the screening result. Linear or sliding guides are feasible. Rubber-tyred running gears are also feasible.

Reference list

- 1 loading and unloading plant
- 2 container
- 5 2a corner fitting
- 2b long side
- 2c lower surface
- 3 store
- 3a water-side end
- 10 3b storage area
- 3c set-down area
- 4 water-side loading and unloading area
- 5 area for placement into and out of storage
- 6 container stacking crane
- 15 7 rails
- 8 quay
- 9 handling bridge
- 10 driverless transport vehicle
- 10a rubber tyres
- 20 10b lifting table
- 10c vehicle chassis
- 10d first lifting table
- 10e second lifting table
- 11 lane
- 25 12 inspection station
- 12a stationary building
- 12b entry
- 12c exit
- 12d floor
- 30 13a departure lane
- 13b approach lane

- 14 first screening device
- 14a radiation source
- 14b radiation detector
- 14c shield
- 5 14d screening channel
- 15 support frame
- 15a pillar
- 15b contact surface
- 16 second screening device
- 10 16a radiation source
- 16b radiation detector
- 16c rail
- 16d rails
- 16e gantry
- 15 16f fourth carriage
- 17 lorry
- 18 transfer station
- F travel direction
- 20 K inspection direction
- P parking direction
- S line

Claims

- 1 System for the contactless inspection of containers (2), particularly ISO-containers, within
a loading and unloading plant (1), having at least one screening device (14, 16) arranged
5 in an inspection station (12), wherein the container (2) to be inspected can be transported
to and away from the inspection station (12) by means of a driverless transport vehicle
(10), characterised in that for the inspection process the container (2) can be set down in
the inspection station (12) by means of the transport vehicle (10), the container (2) can be
10 inspected by means of at least one screening device (14, 16) which can be moved along
the container (2), and the container (2) can be picked up after the inspection process in the
inspection station (12) by means of the transport vehicle (10).
- 2 System as claimed in claim 1, characterised in that the container (2) can be screened
horizontally by means of at least one first screening device (14).
- 15 3 System as claimed in claim 1 or 2, characterised in that the container (2) can be screened
vertically by means of a second screening device (16).
- 4 System as claimed in any one of claims 1 to 3, characterised in that for the inspection
20 process the container (2) can be set down on a stationary support frame (15) by means of
the transport vehicle (10) and, after the inspection process, can be picked up from the
stationary support frame (15) by means of the transport vehicle (10).
- 5 System as claimed in any one of claims 1 to 4, characterised in that the loading and
25 unloading plant (1) is arranged in a port area and the containers (2) are sea-freight
containers.
- 6 System as claimed in any one of claims 1 to 5, characterised in that the driverless transport
vehicles (10) are floor-bound and have rubber tyres.