(12) STANDARD PATENT (11) Application No. **AU 2020426864 B2**
(19) AUSTRALIAN PATENT OFFICE

(54) Title
Mobile transport system

(51) International Patent Classification(s)
B62B 3/00 (2006.01) ***B62B 5/02*** (2006.01)

(21) Application No: **2020426864** (22) Date of Filing: **2020.12.17**

(87) WIPO No: **WO21/151587**

(30) Priority Data

(31) Number	(32) Date	(33) Country
10 2020 000 522.5	**2020.01.28**	**DE**

(43) Publication Date: **2021.08.05**
(44) Accepted Journal Date: **2024.07.04**

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(56) Related Art
DE 102017201108 A1
US 5871218 A
EP 3130522 A1
EP 2236391 A2
DE 102017221375 A1

(12) NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES PATENTWESENS (PCT) VERÖFFENTLICHTE INTERNATIONALE ANMELDUNG

(19) Weltorganisation für geistiges Eigentum
Internationales Büro

(43) Internationales Veröffentlichungsdatum
05. August 2021 (05.08.2021)

WIPO | PCT

(10) Internationale Veröffentlichungsnummer
WO 2021/151587 A1

(51) Internationale Patentklassifikation:
B62B 3/00 (2006.01) *B62B 5/02* (2006.01)

(21) Internationales Aktenzeichen: PCT/EP2020/086751

(22) Internationales Anmeldedatum:
17. Dezember 2020 (17.12.2020)

(25) Einreichungssprache: Deutsch

(26) Veröffentlichungssprache: Deutsch

(30) Angaben zur Priorität:
10 2020 000 522.5
28. Januar 2020 (28.01.2020) DE

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(81) Bestimmungsstaaten *(soweit nicht anders angegeben, für jede verfügbare nationale Schutzrechtsart)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, IT, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW,

(54) **Title:** MOBILE TRANSPORT SYSTEM

(54) **Bezeichnung:** MOBILES TRANSPORTSYSTEM

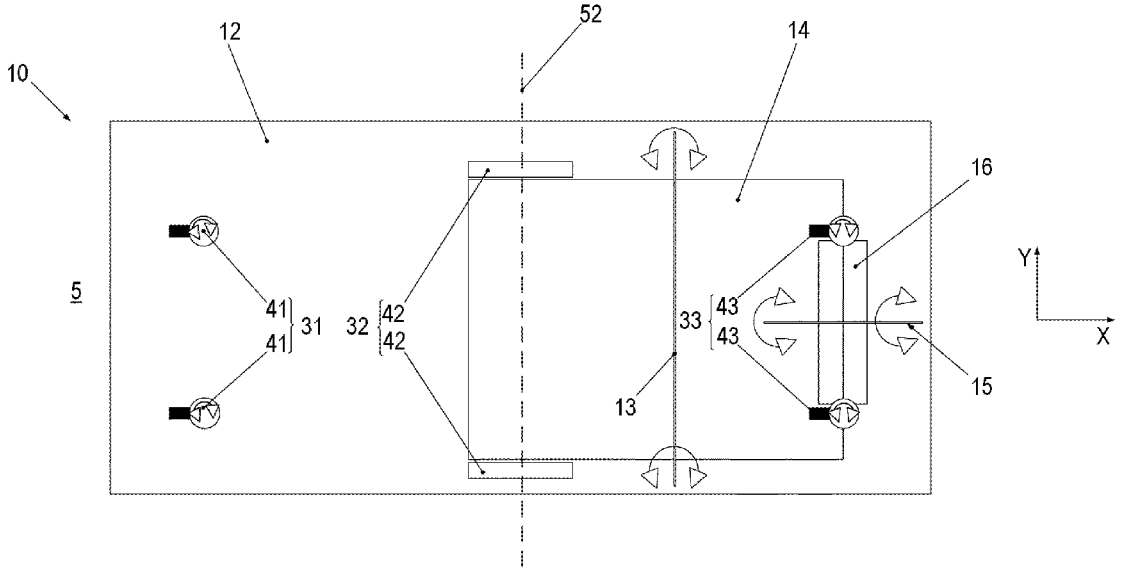

Fig. 1

(57) **Abstract:** The invention relates to a mobile transport system (10) for transporting objects in a technical facility, comprising a vehicle frame (12), a first wheel pair (31), a second wheel pair (32), and a third wheel pair (33) with two respective wheels (41, 42, 43) which can be rotated relative to the vehicle frame (12) and comprising a pendulum frame (14) which can be pivoted relative to the vehicle frame (12) about a pendulum axis (13) running in a transverse direction (Y), wherein the first wheels (41) of the first wheel pair (31) are secured to the vehicle frame (12), and the second wheels (42) of the second wheel pair (32) are secured to the pendulum frame (14). The third wheels (43) of the third wheel pair (33) are secured to a tilting frame (16) which can be pivoted relative to the pendulum frame (14) about a tilt axis (15) running at least approximately in the longitudinal direction (X).

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[Fortsetzung auf der nächsten Seite]

SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) **Bestimmungsstaaten** *(soweit nicht anders angegeben, für jede verfügbare regionale Schutzrechtsart)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), eurasisches (AM, AZ, BY, KG, KZ, RU, TJ, TM), europäisches (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Veröffentlicht:

— *mit internationalem Recherchenbericht (Artikel 21 Absatz 3)*

(57) Zusammenfassung: Die Erfindung betrifft ein mobiles Transportsystem (10) zum Transport von Gegenständen in einer technischen Anlage, umfassend einen Fahrzeugrahmen (12), ein erstes Räderpaar (31), ein zweites Räderpaar (32) und ein drittes Räderpaar (33) mit jeweils zwei Rädern (41, 42, 43), welche relativ zu dem Fahrzeugrahmen (12) drehbar sind, und einen Pendelrahmen (14), welcher um eine in Querrichtung (Y) verlaufende Pendelachse (13) relativ zu dem Fahrzeugrahmen (12) schwenkbar ist, wobei die ersten Räder (41) des ersten Räderpaars (31) an dem Fahrzeugrahmen (12) befestigt sind, und die zweiten Räder (42) des zweiten Räderpaars (32) an dem Pendelrahmen (14) befestigt sind. Die dritten Räder (43) des dritten Räderpaars (33) sind an einem Kipprahmen (16) befestigt, welcher um eine zumindest annähernd in Längsrichtung (X) verlaufende Kippachse (15) relativ zu dem Pendelrahmen (14) schwenkbar ist.

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Mobile transport system

Technical Field

The invention relates to a mobile transport system for transporting objects in a technical system.

Background Art

In technical systems, for example in production plants, mobile transport systems, particularly autonomously driving mobile transport systems, are used for transporting objects such as small parts or crates. Said mobile transport systems bring components, among other things, from logistics areas, such as a material warehouse, to workstations where the components are processed. Generic mobile transport systems are able to overcome slight rises or drops and small ground sills or similar obstacles.

A generic mobile transport system is known from the document DE 10 2017 201 108 A1 and implemented as an industrial truck, comprising a first support wheel at a front end, a second support wheel at a rear end, and a drive wheel disposed between said support wheels. The first support wheel is disposed on a driving frame, while the second support wheel and the drive wheel are disposed on a swing frame. The swing frame is thereby hinged on the driving frame by means of a horizontal swing axis.

The document EP 2 826 693 A2 discloses a transport cart for transporting objects. The transport cart comprises a front chassis part for mounting two front wheels of a front wheel pair each rotatably about the high axis thereof. The front chassis part is connected to a rear chassis part implemented as a rocker and mounting two rear wheels of a rear wheel pair each rotatably about the high axis thereof, and mounting a middle wheel pair each rotationally fixedly about the high axis thereof between the front wheel and the rear wheels.

It would be desirable to provide a mobile transport system for transporting objects capable of compensating uneven ground areas transverse to a direction of travel.

It is to be understood that, if any prior art is referred to herein, such reference does not constitute an admission that the prior art forms a part of the common general knowledge in the art, in Australia or any other country.

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Summary

The invention generally relates to mobile transport systems for transporting objects in a technical system. The system may comprise a vehicle frame, a first wheel pair, a second wheel pair, and a third wheel pair, each having two wheels rotatable relative to the vehicle frame, and a swing frame pivotable about a swing axis running in a transverse direction relative to the vehicle frame.

In some embodiments, there is provided a mobile transport system for transporting object in a technical system comprises a vehicle frame, a first wheel pair, a second wheel pair, and a third wheel pair, each having two wheels. The wheels are thereby rotatable relative to the vehicle frame. By rotating the wheels making contact with a ground, the transport system is displaceable relative to the ground. The mobile transport system further comprises a swing frame pivotable about a swing axis running in a transverse direction relative to the vehicle frame. The first wheels of the first wheel pair are attached to the vehicle frame, and the second wheels of the second wheel pair are attached to the swing frame. The third wheels of the third wheel pair are attached to a tilt frame pivotable relative to the swing frame about a tilt axis running approximately in the longitudinal direction. The tilt axis preferably runs precisely in the longitudinal direction.

The longitudinal direction corresponds at least approximately to the usual travel direction of the mobile transport system. The longitudinal direction runs perpendicular to the transverse direction. The longitudinal direction and the transverse direction are horizontal directions and run parallel to the ground on which the mobile transport system is present. A vertical direction is perpendicular to the ground and runs perpendicular to the longitudinal direction and perpendicular to the transverse direction.

In one aspect, the present invention provides a mobile transport system for transporting objects in a technical system. The system comprises: a vehicle frame; a first wheel pair, a second wheel pair, and a third wheel pair, each wheel pair having two wheels rotatable relative to the vehicle frame; a swing frame pivotable about a swing axis running in a transverse direction relative to the vehicle frame; and a tilt frame pivotable relative to the swing frame about a tilt axis running approximately in a longitudinal direction of the vehicle frame. The wheels of the first wheel pair are attached to the vehicle frame, the wheels of the second wheel pair are attached to the swing frame, and the wheels of the third wheel pair are attached to the tilt frame.

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The embodiments of the mobile transport system are configured so that the wheels of the second wheel pair, the wheels of the third wheel pair, and at least one wheel of the first wheel pair are continuously contacting the ground. When overcoming rises at the same time as uneven ground areas transverse to a direction of travel, at least five wheels of the mobile transport system are thus continuously contacting the ground. The wheels of the second wheel pair may be provided so that they always have the same contact pressure on the ground. The wheels of the third wheel pair may also be provided so that they always have the same contact pressure on the ground. The use of springs is not necessary in order to achieve contact pressure of the wheels on the ground. Depending on the condition of the ground, no more than one of the wheels of the first wheel pair loses contact with the ground. The mobile transport system is thus capable of compensating for uneven ground areas transverse to the direction of travel.

In some embodiments, the wheels of the first wheel pair are implemented as support wheels and are supported pivotably relative to the vehicle frame about a pivot axis running in a vertical direction, and are supported rotatably relative to the vehicle frame about an axis of rotation running in a horizontal direction. The wheels of the third wheel pair may also be implemented as support wheels, supported pivotably relative to the vehicle frame about a pivot axis running in a vertical direction, and supported rotatably relative to the vehicle frame about an axis of rotation running in a horizontal direction. Support wheels implemented in such a manner are relatively inexpensive and also facilitate the mobile transport system traveling around curves.

In some embodiments, the wheels of the second wheel pair are implemented as drive wheels, and are rotatably supported relative to the swing frame about a drive axis running in the transverse direction, and can be driven by a drive unit. The drive unit may comprise, for example, an electric motor, a differential gearbox, and an electrical energy store. The drive wheels are thus continuously contacting the ground in operation. Displacing the mobile transport system is thus possible at all times, substantially independently of the condition of the ground.

In some embodiments, one braking device is disposed on each of the wheels of the third wheel pair, by which a rotation of the corresponding third wheel about an axis of rotation running in the horizontal direction can be braked. The braking devices can be electromagnetically actuated, for example. The wheels of the third wheel pair having the braking devices thus continuously make contact with the ground. Braking of the mobile transport system is thus possible at all times,

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independently of the condition of the ground. Additional braking devices at the wheels of the first wheel pair and/or at the wheels of the second wheel pair are not necessary.

The wheels of a wheel pair may be disposed offset to each other in the transverse direction.

In some embodiments, a distance between the wheels of the second wheel pair in the transverse direction is greater than a distance between the wheels of the first wheel pair in the transverse direction. In some embodiments, a distance between the wheels of the second wheel pair in the transverse direction is also greater than a distance between the wheels of the third wheel pair in the transverse direction. The six wheels of the three wheel pairs may be disposed in the shape of a hexagon, for example, arranged symmetrically to a longitudinal axis. The four wheels of the first wheel pair and the second wheel pair form the corners of a rectangle. The second wheels of the second wheel pair are outside of said rectangle in the transverse direction.

In some embodiments, the wheels of the second wheel pair are disposed between the wheels of the first wheel pair and the wheels of the third wheel pair, in the longitudinal direction.

In some embodiments, a distance from the wheels of the second wheel pair in the longitudinal direction to the swing axis is at least equal to a distance from the third of the third wheel pair to the swing axis in the longitudinal direction. The swing axis may thus be disposed at least approximately centered in the longitudinal direction between the wheels of the second wheel pair and the wheels of the third wheel pair. The wheels of the second wheel pair thereby have approximately the same contact pressure on the ground as the wheels of the third wheel pair. This is particularly advantageous when the wheels of the second wheel pair are implemented as drive wheels and a braking device is disposed at each of the wheels of the third wheel pair.

In some embodiments, a receiving unit is disposed on the swing frame, between the second wheels of the second wheel pair, to which energy can be transferred inductively from a charging unit. The charging unit is implemented as a linear conductor or as a coil, for example, and is stationary and present in the ground. The energy inductively transmitted from the charging unit to the receiving unit serves, for example, for charging an electrical energy store of the mobile transport system.

In some embodiments, at least one inductive sensor for detecting a magnetic field is disposed on the swing frame. When the magnetic field is generated by a linear conductor laid down in the ground, for example, then the inductive sensor enables the reaching of a particular destination by following the linear conductor.

In some embodiments, the mobile transport system comprises a first angle meter configured to detect a pivot angle of the swing frame relative to the vehicle frame about the swing axis. By detecting the pivot angle of the swing frame relative to the vehicle frame about the swing axis, it is possible to determine an amount of an impending rise present in the travel direction. When a permissible pivot angle is exceeded, it can be assumed that an impermissibly large rise is present and a warning message may be output or the mobile transport system is stopped.

In some embodiments, the mobile transport system comprises a second angle meter configured to detect a pivot angle of the tilt frame relative to the swing frame about the tilt axis. By detecting the pivot angle of the tilt frame relative to the swing frame about the tilt axis, it is possible to determine how large an imminent uneven ground area transverse to the travel direction is. When a permissible pivot angle is exceeded, it can be assumed that an impermissibly large uneven ground area is present, and a warning message is output or the mobile transport system is stopped.

Further advantages may result from the subclaims. The invention is not limited to the combination of features of the claims. Further sensible potential combinations of claims and/or individual claim features and/or features of the description and/or of the figures are clear to the person skilled in the art, particularly from the object of the invention and/or the object presented by comparing with the prior art.

Brief Description of the Drawings

The invention is explained in greater detail with reference to drawing figures. The invention is not limited to the embodiment examples depicted in the figures. The figures depict the object of the invention merely schematically. Shown are:

Figure 1: a schematic plan view of a mobile transport system,

Figure 2: a schematic side view of the mobile transport system,

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Figure 3: a schematic front view of the mobile transport system,

Figure 4: a schematic side view of the mobile transport system when traveling on a rise,

Figure 5: a schematic side view of the mobile transport system when traveling on a drop,

Figure 6: a schematic side view of the mobile transport system when traveling on a laterally rising ramp,

Figure 7: a schematic side view of the mobile transport system when traveling on a laterally dropping ramp, and

Figure 8: a detailed side view of the mobile transport system.

Detailed Description

Figure 1 shows a schematic plan view of a mobile transport system 10. The mobile transport system 10 serves particularly for transporting objects in a technical system. The technical plant is an industrial application, such as a production plant. Here the mobile transport system 10 is an automated guided vehicle. In the depiction shown here, the mobile transport system 10 is present on a flat ground 5 within said technical plant.

The mobile transport system 10 comprises a vehicle frame 12, a swing frame 14, and a tilt frame 16. The vehicle frame 12 thereby comprises an approximately rectangular cross section and extends predominantly in a longitudinal direction X and in a transverse direction Y.

The longitudinal direction X thereby corresponds at least approximately to the usual travel direction of the mobile transport system 10. The transverse direction Y runs perpendicular to the longitudinal direction X. The longitudinal direction X and the transverse direction Y are horizontal directions and run parallel to the flat ground 5. A vertical direction Z is perpendicular to the flat ground 5 and thus runs perpendicular to the longitudinal direction X and perpendicular to the transverse direction Y. Each direction perpendicular to the vertical direction Z is a horizontal direction.

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The swing frame 14 is pivotable about a swing axis 13 relative to the vehicle frame 12. The swing axis 13 runs in the transverse direction Y. The tilt frame 16 is pivotable relative to the swing frame 14 about a tilt axis 15. The tilt axis 15 runs in the longitudinal direction X in the depiction shown in Figure 1.

Two first support wheels 41 of a first wheel pair 31 are disposed on the vehicle frame 12 and rotatable relative to the vehicle frame 12. The first wheels 41 are disposed offset to each other in the transverse direction Y. Two first second wheels 42 of a second wheel pair 32 are disposed on the swing frame 14 and rotatable relative to the vehicle frame 12. The second wheels 42 are disposed offset to each other in the transverse direction Y. Two first third wheels 43 of a third wheel pair 33 are disposed on the swing frame 16 and rotatable relative to the vehicle frame 12. The third wheels 43 are disposed offset to each other in the transverse direction Y.

A distance between the second wheels 42 of the second wheel pair 32 from each other in the transverse direction Y is greater than a distance of the first wheels 41 of the first wheel pair 31 from each other in the transverse direction Y. A distance between the second wheels 42 of the second wheel pair 32 from each other in the transverse direction Y is also greater than a distance of the third wheels 43 of the third wheel pair 33 from each other in the transverse direction Y. The six wheels 41, 42, 43 are disposed here in the shape of a hexagon implemented symmetrically to a longitudinal axis running in the longitudinal direction X.

The second wheels 42 of the second wheel pair 32 are implemented as drive wheels and are rotatably supported relative to the swing frame 14 about a drive axis 52 running in the transverse direction Y. The mobile transport system 10 comprises a drive unit, not shown here, by means of which the second wheels 42 can be driven. The drive unit comprises, for example, an electric motor, a differential gearbox, and an electrical energy store.

Figure 2 shows a schematic side view of the mobile transport system 10. The second wheels 42 of the second wheel pair 32 are thereby disposed between the first wheels 41 of the first wheel pair 31 and the third wheels 43 of the third wheel pair 33 in the longitudinal direction X.

The first wheels 41 of the first wheel pair 31 are implemented as support wheels and are each pivotable relative to the vehicle frame 12 about a first pivot axis 61 running in the vertical direction Z. The first wheels 41 are each further supported rotatably relative to the vehicle frame

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12 about a first axis of rotation 51 running in a horizontal direction. In the depiction shown here, the first axes of rotation 51 run in the transverse direction Y. Depending on a pivoting of the first support wheels 41 about the first pivot axis 61, the first axes of rotation 51 run in the longitudinal direction X, for example, or in a different horizontal direction. The first pivot axis 61 and the first axis of rotation 51 of a first wheel 41 do not intersect here.

The third wheels 43 of the third wheel pair 33 are implemented as support wheels and are each pivotable relative to the vehicle frame 12 about a third pivot axis 63 running in the vertical direction Z. The third wheels 41 are each further supported rotatably relative to the vehicle frame 12 about a third axis of rotation 53 running in a horizontal direction. In the depiction shown here, the third axes of rotation 53 run in the transverse direction Y. Depending on a pivoting of the third wheels 43 about the third pivot axis 63, the third axes of rotation 53 run in the longitudinal direction X, for example, or in a different horizontal direction. The third pivot axis 63 and the third axis of rotation 53 of a third wheel 43 do not intersect here.

A distance here from the second wheels 42 of the second wheel pair 32 in the longitudinal direction X to the swing axis 13 is at least approximately equal to a distance from the third wheels 43 of the third wheel pair 33 to the swing axis 13 in the longitudinal direction X. The distance from the second wheels 42 to the swing axis 13 in the longitudinal direction X thereby corresponds to the distance from the drive axis 52 to the swing axis 13 in the longitudinal direction X. The distance from the third wheels 43 to the swing axis 13 in the longitudinal direction X thereby corresponds to the distance from the third pivot axis 63 to the swing axis 13 in the longitudinal direction X.

Figure 3 shows a schematic front view of the mobile transport system 10. The first wheels 41 of the first wheel pair 31 are thereby covered by the third wheels 43 of the third wheel pair 33 and therefore are not visible.

Figure 4 shows a schematic side view of the mobile transport system 10 when traveling on a rise inclined by an angle A with respect to the flat ground 5. In the depiction shown here, the first wheels 41 are present on the flat ground 5, the third wheels 43 are present on the rise, and the second wheels 42 are present at the transition from the flat ground 5 to the rise. The swing frame 14 is pivoted about a swing axis 13 relative to the vehicle frame 12. The first wheels 41, the second wheels 42, and the third wheels 43 make contact with the ground.

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Figure 5 shows a schematic side view of the mobile transport system 10 when traveling on a drop inclined by an angle A with respect to the flat ground 5. In the depiction shown here, the first wheels 41 are present on the flat ground 5, the third wheels 43 are present on the drop, and the second wheels 42 are present at the transition from the flat ground 5 to the drop. The swing frame 14 is pivoted about a swing axis 13 relative to the vehicle frame 12. The first wheels 41, the second wheels 42, and the third wheels 43 make contact with the ground.

When the swing frame 14 is pivoted about the swing axis 13 relative to the vehicle frame 12, as shown in Figure 4 and Figure 5, the tilt axis 15, not visible here, runs slightly inclined to the longitudinal direction X. Said inclination of the tilt axis 15 is, however, relatively slight. The tilt axis 15 thus runs approximately in the longitudinal direction X in the present case as well. The third pivot axes 63 also run slightly inclined to the vertical direction Z in the present case as well. Said inclination of the third swing axes 63 is also relatively slight.

Figure 6 shows a schematic side view of the mobile transport system 10 when traveling on a laterally rising ramp, inclined by an angle A with respect to the flat ground 5. In the depiction shown here, the first wheels 41, hidden here, are present on the flat ground 5. The second wheels 42 are also present on the flat ground 5. One of the third wheels 43 is also present on the flat ground 5, and the other of the third wheels 43 is present on the laterally rising ramp. The tilt frame 16 is pivoted relative to the swing frame 14 about a tilt axis 15. The first wheels 41, the second wheels 42, and the third wheels 43 make contact with the ground.

Figure 7 shows a schematic side view of the mobile transport system 10 when traveling on a laterally dropping ramp, inclined by an angle A with respect to the flat ground 5. In the depiction shown here, the first wheels 41, hidden here, are present on the flat ground 5. The second wheels 42 are also present on the flat ground 5. One of the third wheels 43 is also present on the flat ground 5, and the other of the third wheels 43 is present on the laterally dropping ramp. The tilt frame 16 is pivoted relative to the swing frame 14 about a tilt axis 15. The first wheels 41, the second wheels 42, and the third wheels 43 make contact with the ground.

When the tilt frame 16, as shown in Figure 6 and Figure 7, is pivoted relative to the swing frame 14 about the tilt axis 15, the third pivot axes 63 run slightly inclined to the vertical direction Z. Said inclination of the third swing axes 63 is, however, thereby relatively slight. The third axes of rotation 53 also run slightly inclined to a horizontal direction in the present case. Said inclination of the third axes of rotation 53 is also relatively slight.

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Figure 8 shows a detailed side view of the mobile transport system 10. The depiction corresponds to the depiction in Figure 2, wherein, however, additional details of the mobile transport system 10 are shown.

The mobile transport system 10 comprises a receiving unit 20 disposed on the swing frame 14 and to which energy can be transmitted inductively from a charging unit. The charging unit is implemented as a linear conductor or as a coil, for example. The energy inductively transmitted from the charging unit to the receiving unit 20 serves, for example, for charging an electrical energy store of the mobile transport system 10. The receiving unit 20 is thus present between the second wheels 42.

The mobile transport system 10 further comprises a first inductive sensor 21 and a second inductive sensor 22 disposed on the swing frame 14. The inductive sensors 21, 22 serve for detecting a magnetic field. When the magnetic field is generated by a linear conductor laid down in the ground, for example, then the inductive sensors 21, 22 enable following said linear conductor in order to reach a particular destination. The inductive sensors 21, 22 are disposed offset to each other in the longitudinal direction X. The first inductive sensor 21 is present between the drive axis 52 and the first pivot axis 61 in the longitudinal direction X. The second inductive sensor 22 is present between the drive axis 52 and the third pivot axis 63 in the longitudinal direction X. The inductive sensors 21, 22 are present approximately centered between the two wheels 42 in the transverse direction Y.

The mobile transport system 10 also comprises two braking devices 73, wherein one braking device 73 is disposed at each of the third wheels 43. The rotation of each third wheel 43 about the third axis of rotation 53 running the horizontal direction can be braked by means of the braking device 73. The braking devices 73 are electromagnetically actuatable here.

In the claims which follow and in the preceding description of the invention, except where the context requires otherwise due to express language or necessary implication, the word “comprise” or variations such as “comprises” or “comprising” is used in an inclusive sense, i.e. to specify the presence of the stated features but not to preclude the presence or addition of further features in various embodiments of the invention.

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List of reference numerals

5	Flat ground
10	Mobile transport system
12	Vehicle frame
13	Swing axis
14	Swing frame
15	Tilt axis
16	Tilt frame
20	Receiving unit
21	First inductive sensor
22	Second inductive sensor
31	First wheel pair
32	Second wheel pair
33	Third wheel pair
41	First wheel
42	Second wheel
43	Third wheel
51	First axis of rotation
52	Drive axis
53	Third axis of rotation
61	First pivot axis
63	Third pivot axis
73	Braking device

A	Angle
X	Longitudinal direction
Y	Transverse direction
Z	Vertical direction

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Claims

1. A mobile transport system for transporting objects in a technical system, comprising:

a vehicle frame;

a first wheel pair, a second wheel pair, and a third wheel pair, each pair having two wheels rotatable relative to the vehicle frame;

a swing frame pivotable about a swing axis running in a transverse direction relative to the vehicle frame; and

a tilt frame pivotable relative to the swing frame about a tilt axis running approximately in a longitudinal direction of the vehicle frame,

wherein the wheels of the first wheel pair are attached to the vehicle frame, the wheels of the second wheel pair are attached to the swing frame, and the wheels of the third wheel pair are attached to the tilt frame.

2. The mobile transport system according to claim 1, wherein the wheels of at least one of the first wheel pair and the third wheel pair are implemented as support wheels, being pivotable relative to the vehicle frame about a pivot axis running in a vertical direction, and supported rotatably relative to the vehicle frame about an axis of rotation running in a horizontal direction.

3. The mobile transport system according to any one of the preceding claims, wherein the wheels of the second wheel pair are implemented as drive wheels, and are rotatably supported relative to the swing frame about a drive axis running in the transverse direction, and are arranged to be driven by a drive unit.

4. The mobile transport system according to any one of the preceding claims, wherein a braking device is disposed on each of the wheels of the third wheel pair , each braking device adapted to brake a rotation motion of a corresponding third wheel of the third wheel pair about the axis of rotation running in the horizontal direction.

5. The mobile transport system according to any one of the preceding claims, wherein the wheels of the first wheel pair, the second wheel pair, and/or the third wheel pair are each disposed offset to each other in the transverse direction.

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6. The mobile transport system according to any one of the preceding claims, wherein a distance between the wheels of the second wheel pair in the transverse direction is greater than a distance of the wheels of the first wheel pair in the transverse direction.

7. The mobile transport system according to any one of the preceding claims, wherein the distance between the wheels of the second wheel pair in the transverse direction is greater than a distance between the wheels of the third wheel pair in the transverse direction.

8. The mobile transport system according to any one of the preceding claims, wherein the wheels of the second wheel pair are disposed between the wheels of the first wheel pair and the wheels of the third wheel pair in the longitudinal direction.

9. The mobile transport system according to any one of the preceding claims, wherein a distance from the wheels of the second wheel pair to the swing axis in the longitudinal direction is at least equal to a distance from the wheels of the third wheel pair to the swing axis in the longitudinal direction.

10. The mobile transport system according to any one of the preceding claims, wherein a receiving unit is disposed on the swing frame, adapted to receive energy transferred inductively from a charging unit.

11. The mobile transport system according to any one of the preceding claims, wherein at least one inductive sensor is disposed on the swing frame and is adapted to detect a magnetic field.

12. The mobile transport system according to any one of the preceding claims, comprising a first angle meter, adapted to detect a pivot angle of the swing frame relative to the vehicle frame about the swing axis.

13. The mobile transport system according to any one of the preceding claims, comprising a second angle meter adapted to detect a pivot angle of the tilt frame relative to the swing frame about the tilt axis.

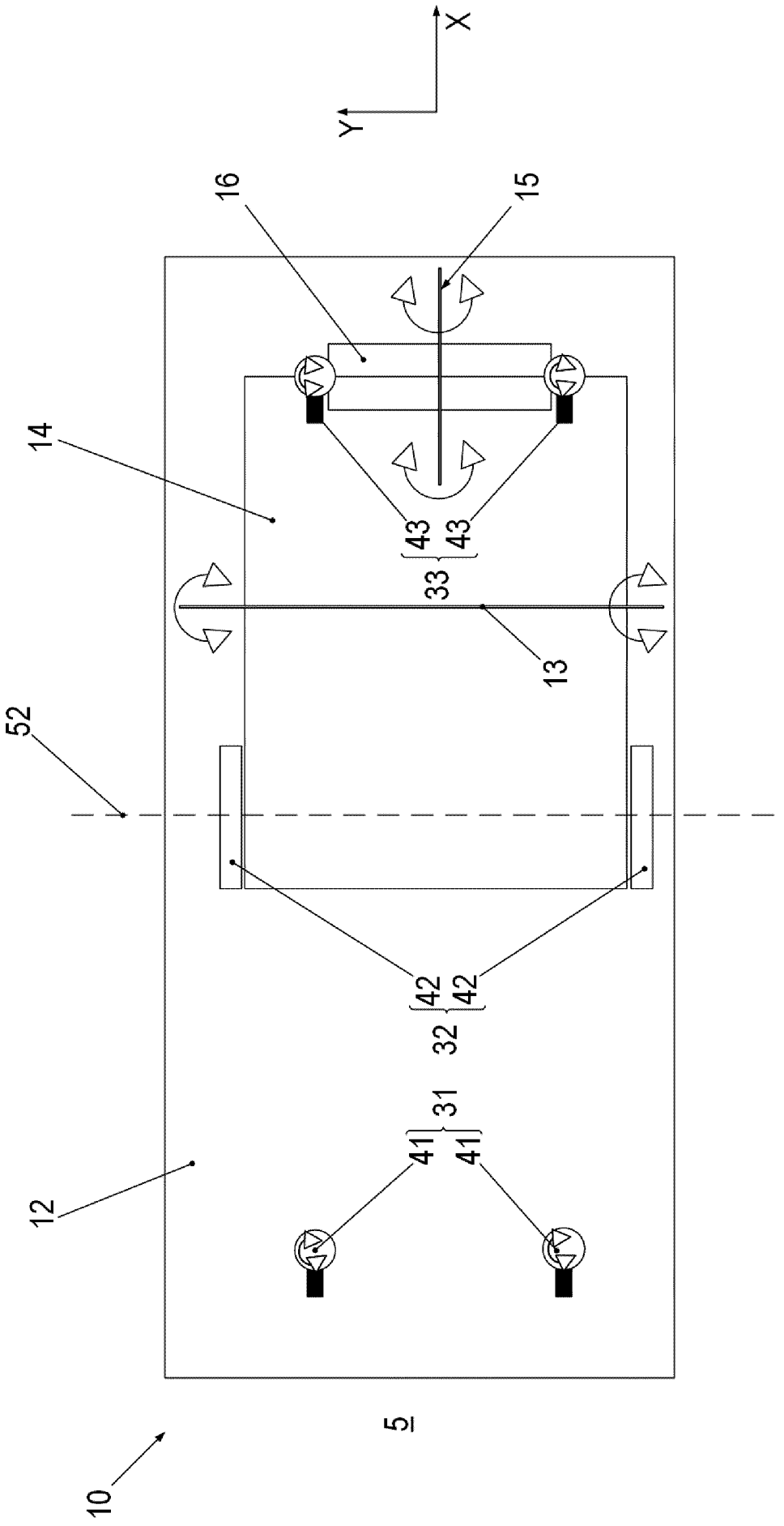

Fig. 1

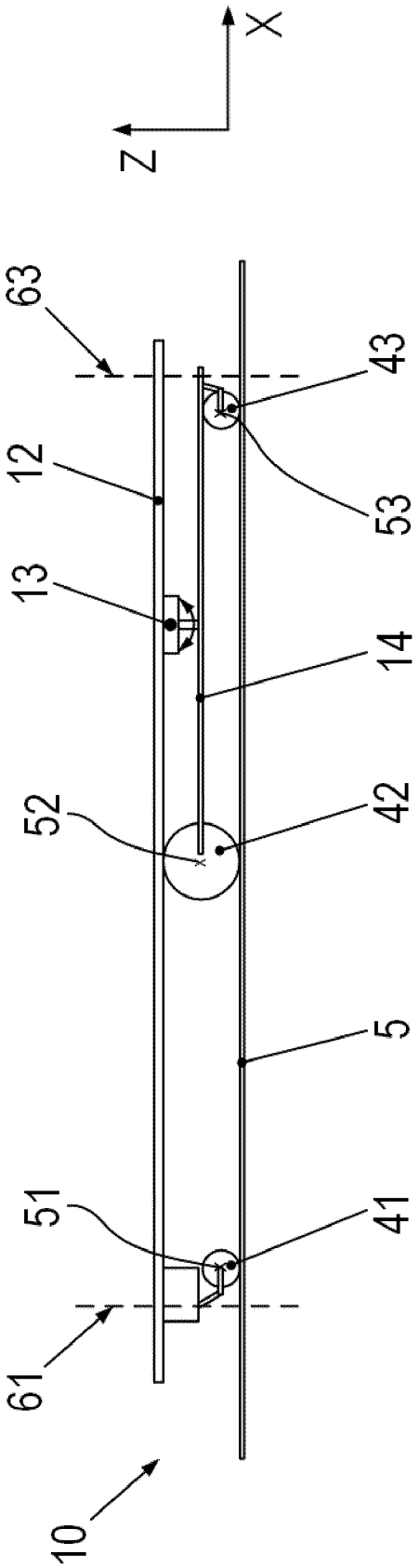

Fig. 2

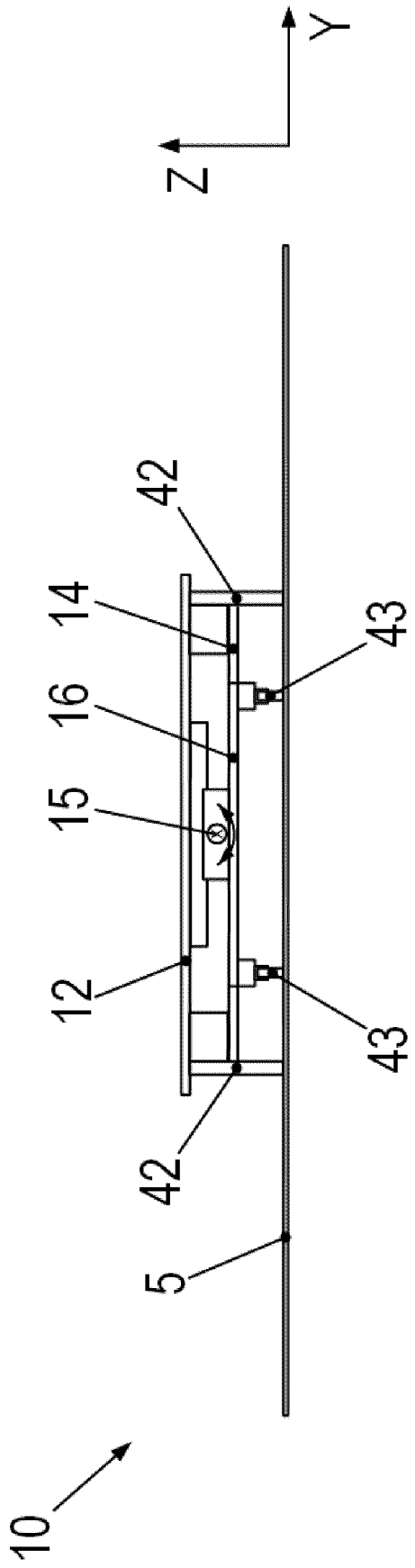

Fig. 3

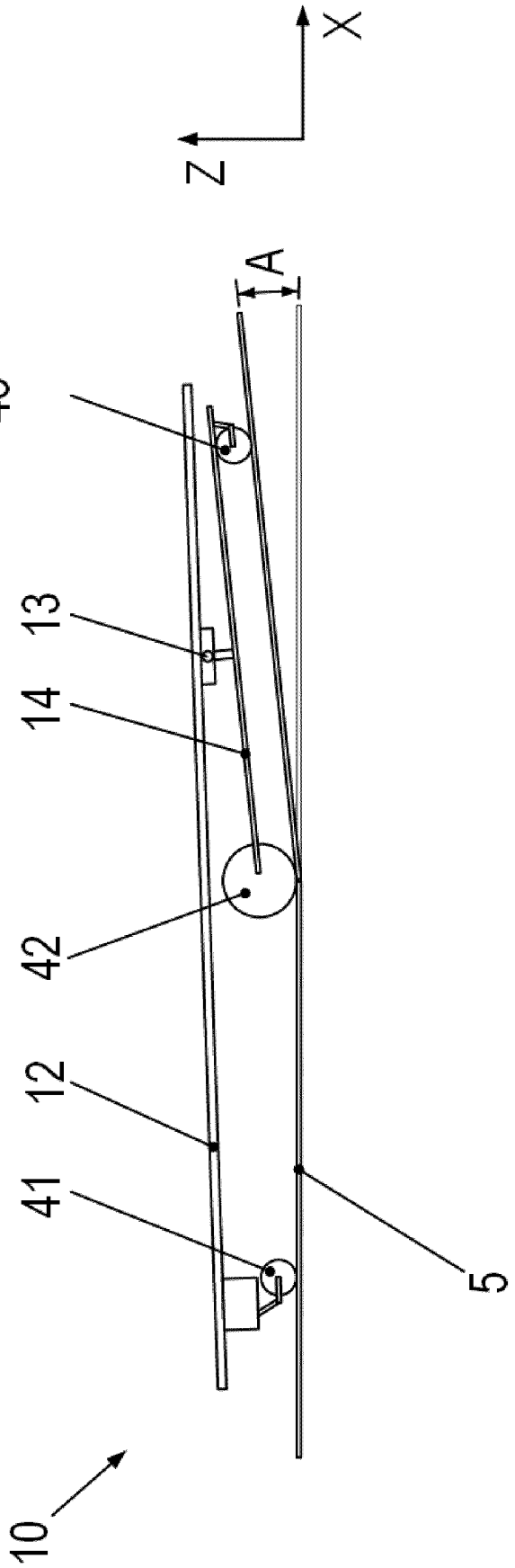

Fig. 4

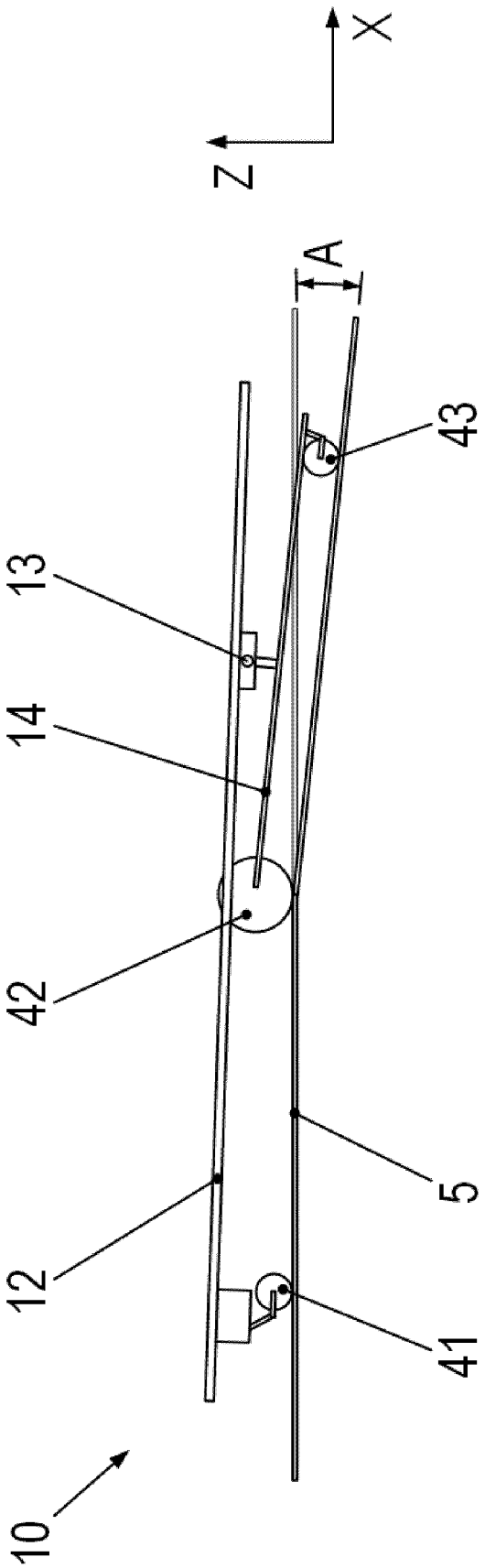

Fig. 5

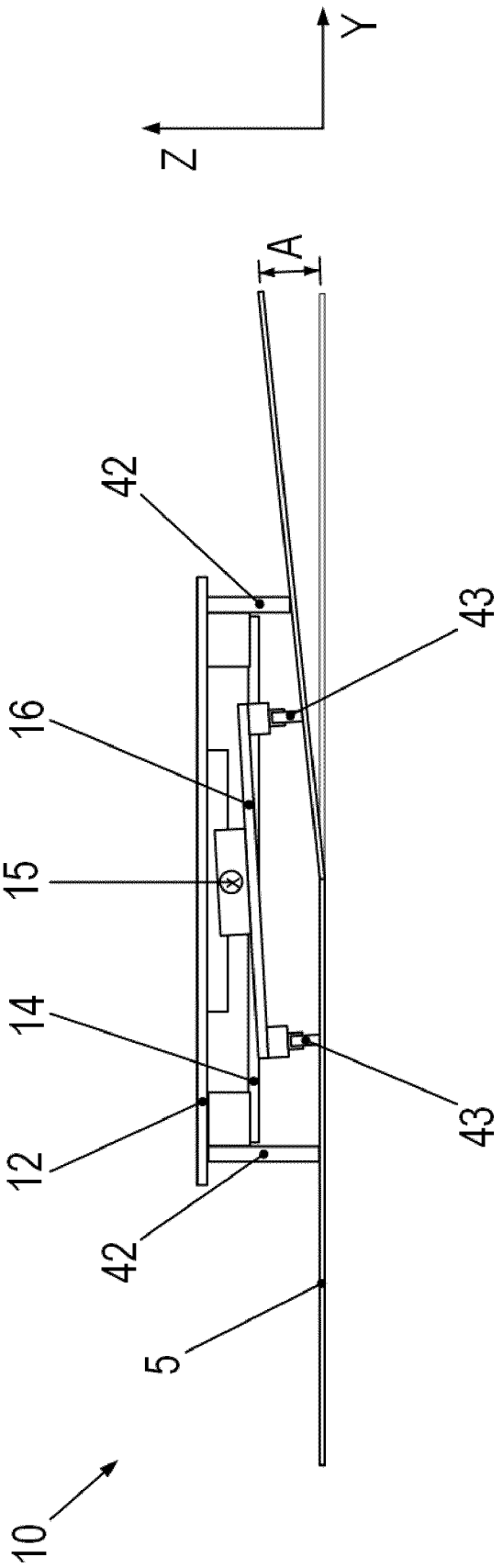

Fig. 6

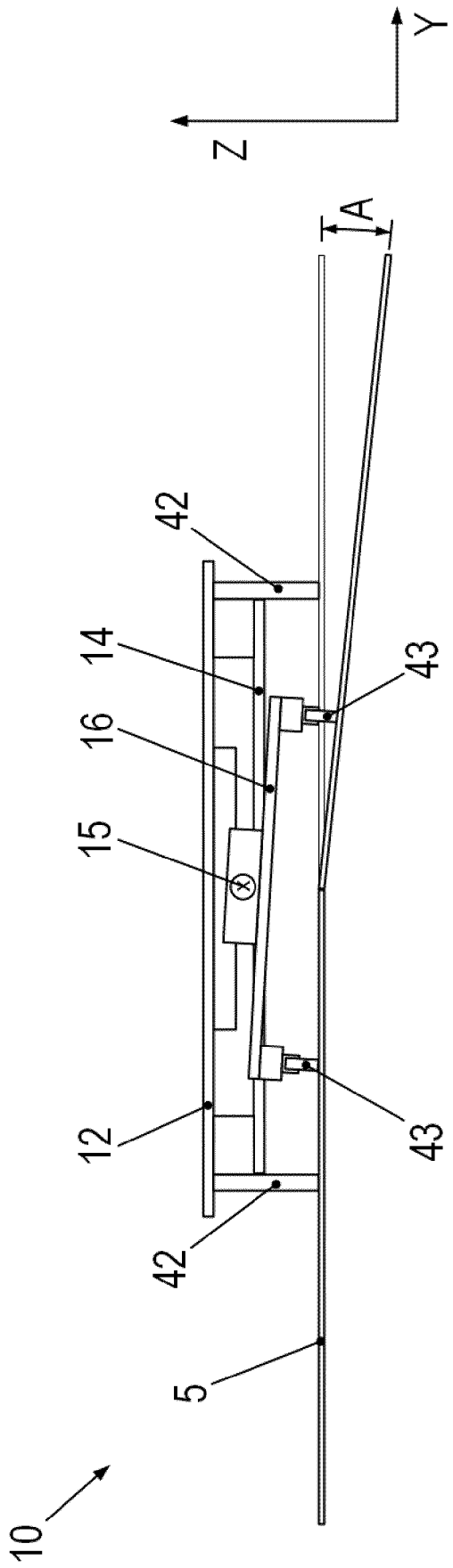

Fig. 7

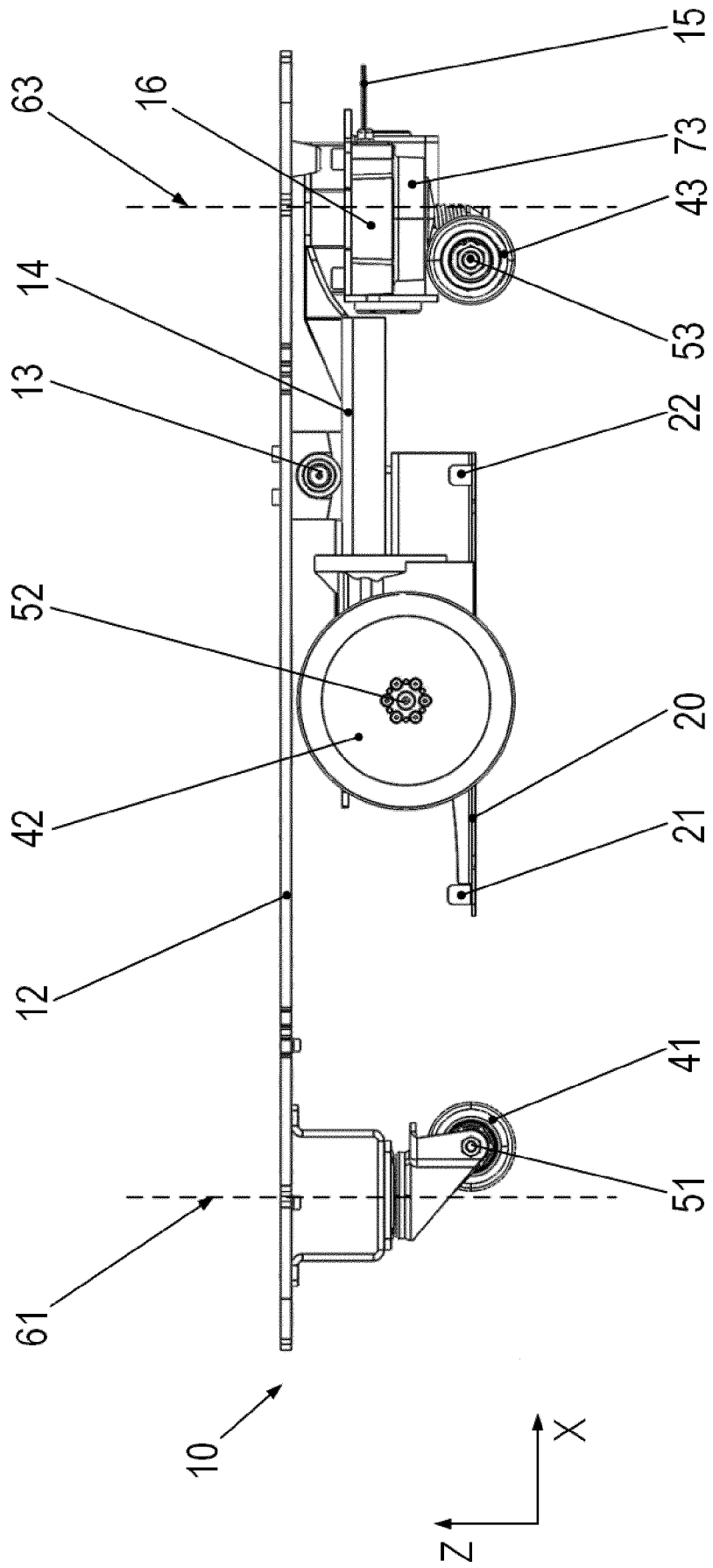

Fig. 8