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(54) Benævnelse: **FØRERLØST TRANSPORTSYSTEM**

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Field of the invention

The present invention relates to a driverless transport system.

Prior art

Driverless transport systems are known per se and are for example used in manufacturing companies for the transport of components, containers or other transported goods, for example from one workstation to the next workstation or from a warehouse to a workstation, for example in automobile manufacture.

Driverless transport systems typically have a load-bearing chassis and a superstructure connected to the chassis that allows the transport of the transported goods, for example loading surfaces or work surfaces. In order to drive, the transport systems typically have wheels driven by a motor, for example an electric motor, and often also additional, non-driven support wheels.

For example, such a transport system may have centrally located drive wheels and be supported by four rollers mounted at the corners. In this case the four support rollers are usually mounted rotatably on a component fixed to the chassis. The document JP H03 186468 A, for example, discloses a driverless transport system according to the preamble of claim 1.

In such vehicles, it can happen that, due to the ground conditions (holes, grooves, unevenness), the drive wheels lose contact with the ground, since the vehicle is supported on the fixed wheels.

A similar behaviour can occur on inclines. The greater the gradient angle and the distance between the front and rear support wheels, the greater the likelihood that the drive wheels will lose contact with the ground.

Since all the wheels are firmly connected to the chassis, on a level floor surface the total weight is distributed between all the wheels, for example six wheels. As soon as the ground is uneven, this balance can be disturbed and can lead to a reduction in static friction on the drive wheels. This can cause the wheels to spin.

Moreover, due to the usual undercarriage geometries, it is not possible to compensate for vibrations that are absorbed via the ground. The rigidly mounted support wheels absorb the shocks undamped and transmit these to the chassis of the vehicle. This can cause damage to both the hardware of the vehicle and the transported goods.

Summary of the Invention

It is an object of the invention to improve a driverless transport system in this respect, and in particular to specify a driverless transport system in which the drive wheels remain in permanent contact with the ground even on uneven and sloping surfaces and which is better able to compensate or dampen the vibrations.

This object is achieved by a driverless transport system comprising a chassis, drive wheels and support wheels, wherein, on a first side of the chassis and on a second side of the chassis opposite the first side, a first and second floating axle, arranged in the longitudinal direction, is in each case connected in a swivelling manner to the chassis, wherein a drive wheel is in each case arranged at one end of the floating axles and a support wheel is in each case arranged at the opposite end of the floating axles, wherein the driverless transport system has in addition a third floating axle, arranged in the transverse direction, which is aligned transversely to the two first and second floating axles arranged in the longitudinal direction and which is likewise connected in a swivelling manner to the chassis at an assigned third

connection point, wherein a support wheel is arranged at both ends of the floating axle arranged in the transverse direction. The first, second and third floating axles are structurally integrated so that all wheels of the transport system are connected to three connection points and the chassis.

According to the invention, two floating axles are in each case used to mount a drive wheel and a support wheel. The orientation of these floating axles, and thus of the drive and support wheels which are arranged one behind the other, defines as it were the longitudinal axis of the transport system. A usual forward movement of the transport vehicle takes place in the direction of these floating axles "arranged in the longitudinal direction". By in each case connecting one drive wheel to one support wheel via its own assigned floating axle, each drive wheel can maintain contact with the ground, even on uneven and steeply inclined ground surfaces.

A further separate floating axle is provided for two additional support wheels and extends transversely to both other floating axles, i.e. essentially serving as a connection between the two floating axles arranged in the longitudinal direction, and preferably normally to these. As a result, these two support wheels also remain in contact with the ground on uneven surfaces.

The use of the two drive wheels is sufficient to drive the transport system. However, in further embodiments of the invention, some or all of the wheels referred to as "support wheels" may be driven.

Due to the geometric arrangement of the three floating axles - one in the transverse axis and two in the longitudinal direction - it can be ensured that the drive wheels and also the support wheels are permanently in contact with the ground under normal ground conditions. Vibrations can also be compensated through this arrangement, which has a positive effect on the service life of the hardware. In addition, due to the damping which is achieved,

the transported goods are protected against damage or unwanted slipping due to vibrations.

Due to the arrangement of the three floating axles, one in the transverse direction, preferably at the front of the vehicle, and two in the longitudinal direction, the transport vehicle can typically cope with unevenness and gradients of up to 7%, depending on the design, without the drive wheels losing contact with the ground.

Further developments of the invention are disclosed in the dependent claims, the description and the accompanying drawings.

Preferably, at least in normal operation with the transport system moving in a forward direction, the two floating axles arranged in the longitudinal direction are aligned parallel to each other.

The floating axle arranged in the transverse direction is preferably aligned normally to the two floating axles arranged in the longitudinal direction.

The floating axle arranged in the transverse direction is preferably located in the front of the transport system and thus forms a front axle of the transport system.

Preferably, the drive wheels of the floating axles arranged in the longitudinal direction are in each case arranged at that end of the floating axles which is closer to the floating axle arranged in the transverse direction. The drive wheels are preferably located near the middle of the transport vehicle in the longitudinal direction.

Preferably, the four support wheels of the three floating axles form a rectangle.

Preferably, the chassis is rectangular in form. The special case square is covered by the term "rectangular in form".

The four support wheels are preferably located in the corners of the chassis or of the transport vehicle.

Preferably, the respective connection points at which the floating axles arranged in the longitudinal direction are connected in a swivelling manner to the chassis are closer to the respective drive wheel of the floating axle than to the respective support wheel of the floating axle. The connection points can also be located in the middle of the respective floating axle.

Brief description of the drawings

The invention is described in the following by way of example with reference to the drawings.

Fig. 1 **is a schematic representation of a driverless transport system, not according to the invention, viewed from below.**

Fig. 2a and 3a **are schematic representations of a driverless transport system, not according to the invention, in different driving situations, viewed from the side.**

Fig. 4a **is a schematic representation of a driverless transport system, not according to the invention, in a further driving situation, viewed from the front.**

Fig. 2b and 3b **are schematic representations of a driverless transport system according to the invention in the driving situations according to Fig. 2a and 2b, viewed from the side.**

Fig. 4b **is a schematic representation of a driverless transport system according to the invention in the further driving situation according to Fig. 4a, viewed from the front.**

Fig. 5 **is a schematic representation of a driverless transport system according to the invention, viewed from below.**

Detailed description of the invention

Fig. 1 shows a driverless transport system, not according to the invention, viewed from below.

The transport system of Fig. 1 comprises a chassis 1 on which two centrally located drive wheels 2 are arranged laterally and centrally in the longitudinal direction of the transport system. In addition, the transport system has four support wheels 3 or support rollers which are arranged at the corners of the transport system. The drive wheels 2 and the support wheels 3 are rigidly connected to the chassis 1.

The transport system of Fig. 1, not according to the invention, is shown from the side in Figs. 2a and 3a and from the front in Fig. 4a, in different problematic driving situations.

For comparison, a vehicle according to the invention is shown in Figs. 2b, 3b and 4b in the same driving situations, in each case viewed from the same side.

The advantageous effect of a chassis or transport system according to the invention is achieved through the combination of the 3 floating axles 4, 6. The front floating axle 6 arranged in the transverse direction and the rear floating axles 4 arranged in the longitudinal direction are first considered separately in Figs. 2b, 3b and 4b and their interaction is then explained.

In Figs. 2 and 3, which compare the prior art with the newly developed undercarriage geometry, one can see the optimised driving behaviour which is achieved through the rear floating axles 4.

This makes it possible for the rear axle to compensate for irregularities in the ground surface (see Figs. 2a and 2b) and to perform vertical movements. As a

result, a permanent ground contact of all wheels 2, 3, as well as a damping of vibrations is achieved. The undercarriage geometry also allows steeper gradients (see Figs. 3a and 3b) to be overcome without the support wheels 3 setting down prematurely and without the drive wheels 2 losing contact with the ground.

In Fig. 4 too, the prior art (Fig. 4a) is compared with the new undercarriage geometry (Fig. 4b) of the front axle. Irregularities in the ground surface such as holes can be compensated by the undercarriage mounted centrally at the front (Fig. 4b). The floating axle 6 allows the support wheels 3 to perform a vertical movement and thus descend into the hole in the floor surface. The opposite support wheel 3 remains on the ground. In comparison, with a rigid front axle or with fixed support wheels 3, the drive wheel 2 would not descend into the hole, but would lose contact with the ground (Fig. 4a). This would result in unstable driving behaviour. Even small irregularities or objects which are present on the floor surface would be transmitted undamped to the chassis of the vehicle. For clarification, it should also be mentioned here that the floating axle 6 which connects the two support wheels 3 is preferably designed as a rigid element.

Only through the combination of the arrangement of the three floating axles 4 and 6 in a driverless transport system is it possible to ensure permanent traction with all wheels 2, 3 on inclines or uneven surfaces. In addition, damping is realised without the use of shock absorbers.

A driverless transport system according to the invention - as for example shown from above in Fig. 5 - therefore comprises a chassis 1, drive wheels 2 and support wheels 3, wherein, on a first side of the chassis 1 and on a second side of the chassis 1 opposite the first side of the chassis 1, a first and second floating axle 4, arranged in the longitudinal direction, is in each case connected in a swivelling manner to the chassis 1 at a respectively assigned first and

second connection point 5, a drive wheel 2 is in each case arranged at one end of the floating axles 4 and a support wheel 3 is in each case arranged at the opposite end of the floating axles 4, wherein the driverless transport system has in addition a floating axle 6, arranged in the transverse direction, which is aligned transversely to the two floating axles 4 arranged in the longitudinal direction and which is also connected in a swivelling manner to the chassis 1 at an assigned connection point 5, wherein a support wheel 3 is arranged at both ends of the floating axle 6 arranged in the transverse direction.

The two floating axles 4 arranged in the longitudinal direction are aligned parallel to each other and the floating axle 6 arranged in the transverse direction is aligned normally to the two floating axles 4 arranged in the longitudinal direction.

The drive wheels 2 of the floating axles 4 arranged in the longitudinal direction are in each case arranged at the end of the floating axles 4 which is closer to the floating axle 6 arranged in the transverse direction, i.e. at the "front" of the transport system and thus closer to the middle of the vehicle in the longitudinal direction of the vehicle.

The floating axle 6 arranged in the transverse direction is located in the front of the transport system and thus forms a front axle of the transport system. The floating axles 4 arranged in the longitudinal direction form the rear axle of the transport system.

The chassis 1 is rectangular in form.

The four support wheels 3 of the three floating axles 4, 6 together form a rectangle.

The four support wheels 3 are located in the corners of chassis 1.

The respective connection points 5 at which the floating axles 4 arranged in the longitudinal direction are connected in a swivelling manner to the chassis 1 are closer to the respective drive wheel 2 of the floating axle 4 than to the respective support wheel 3 of the floating axle 4.

As described, the structural integration of three floating axles 4, 6 in a driverless transport system according to the invention allows better properties with regard to the driving behaviour of the transport system to be achieved. Three axles 4, 6 are used and the wheels 2, 3, i.e. all wheels of the transport system, are connected to the chassis 1 at three points - namely the connection points 5. This ensures that usually all (six) wheels are always in contact with the ground/floor surface. It would only be possible for a wheel to lose contact in extreme situations, or only if the holes in the floor surface are so deep that the structurally or mechanically possible height/compensation travel of the floating axles is exceeded. In practice, this could for example happen if the descent of one wheel into a deep unevenness in the floor surface would cause the wheel arranged on the opposite side of the floating axle to deflect upwards so strongly that this opposite wheel strikes the chassis, which is usually arranged above this.

Due to the floating axles 4, 6, both the drive wheels 2 and the support wheels 3 can perform a vertical movement in both directions and thus, under normal conditions, compensate for unevenness of the floor surface. Only through the combination of the three floating axles is this driving behaviour possible.

List of reference symbols

1	**chassis**
2	**drive wheel**
3	**support wheel**
4	**floating axle arranged in the longitudinal direction**
5	**connection point**
6	**floating axle arranged in the transverse direction**

Patentkrav

1. Førerløst transportsystem omfattende et chassis (1), drivhjul (2) og støttehjul (3),
idet en i længderetningen anbragt første og anden pendulaksel (4) hver især på en første side af chassiset (1) og på en over for den første side liggende anden side af chassiset (1) er forbundet svingbart med chassiset (1) i et hver især tilordnet første og andet forbindelsespunkt (5), et drivhjul (2) er anbragt ved en ende af hver pedulaksel (4), og et støttehjul (3) er anbragt ved den overfor liggende ende af hver pedulaksel (4), det førerløse transportsystem endvidere har en i tværretningen anbragt tredie pendulaksel (6), der er rettet på tværs af de to i længderetningen anbragte første og anden pendulaksler (4), og som ligeledes er forbundet svinngbart med chassiset (1) i et tilordnet tredie forbindelsespunkt (5), et støttehjul (3) er anbragt i begge ender af den i tværretningen anbragte pendulaksel (6), **kendetegnet ved, at** den første, den anden og den tredie pendulaksel (4, 6) er konstruktivt integreret, at alle transportsystemets hjul er forbundet på tre forbindelsespunkter (5) og chassiset.

2. Førerløst transportsystem ifølge krav 1,
kendetegnet ved, at de to i længderetningen anbragte pendulaksler (4) i det mindste under normal drift ved en bevægelse af transportsystemet i en fremadgående retning er rettet indbyrdes parallelt, og/eller den i tværretningen anbragte pendulaksel (6) er rettet normalt på de to i længderetningen anbragte pendulaksler (4).

3. Førerløst transportsystem ifølge mindst et af de foregående krav,
kendetegnet ved, at hvert af de i længderetningen anbragte pendulakslers (4) drivhjul (2) er anbragt i den ende af hver pedulaksel (4), som ligger nærmest den i tværretningen anbragte pendulaksel (6).

4. Førerløst transportsystem ifølge mindst et af de foregående krav,
kendetegnet ved, at den i tværretningen anbragte pendulaksel (6) ligger i

forenden af transportsystemet og således danner en foraksel i transportsystemet.

5. Førerløst transportsystem ifølge mindst et af de foregående krav, **kendetegnet ved, at** de tre pendulakslers (4, 6) fire støttehjul (3) danner et rektangel.

6. Førerløst transportsystem ifølge mindst et af de foregående krav, **kendetegnet ved, at** chassiset (1) har rektangulær form.

7. Førerløst transportsystem ifølge krav 6, **kendetegnet ved, at** de fire støttehjul (3) ligger i hjørnerne af chassiset (1).

8. Førerløst transportsystem ifølge mindst et af de foregående krav, **kendetegnet ved, at** de pågældende forbindelsespunkter (5), i hvilke de i længderetningen anbragte pendulaksler (4) er forbundet svingbart med chassiset (1), ligger nærmere ved pendulakslens (4) pågældende drivhjul (2) end ved pendulakslens (4) pågældende støttehjul (3).

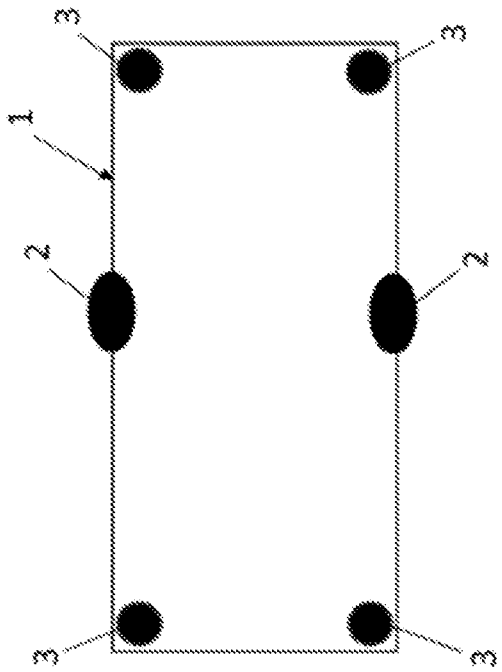

Fig. 1

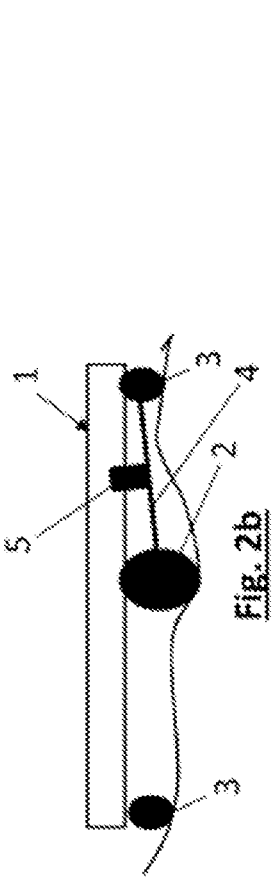

Fig. 2b

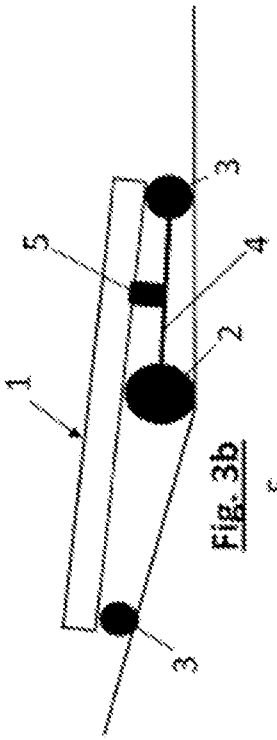

Fig. 3b

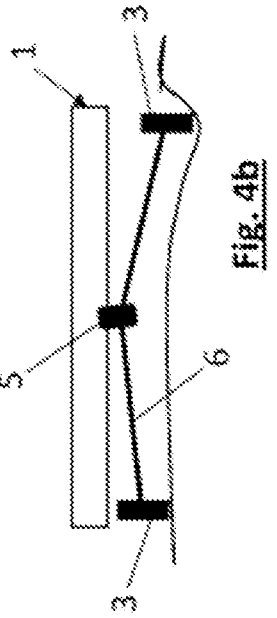

Fig. 4b

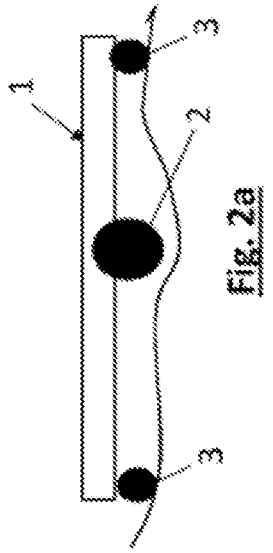

Fig. 2a

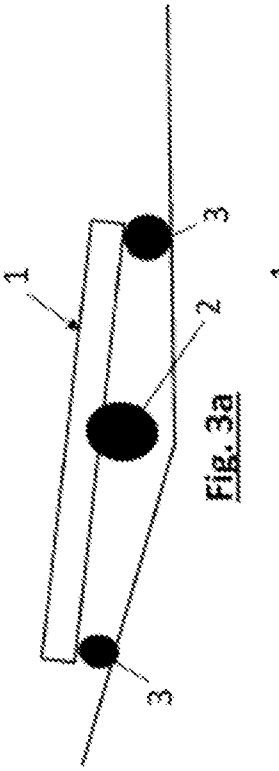

Fig. 3a

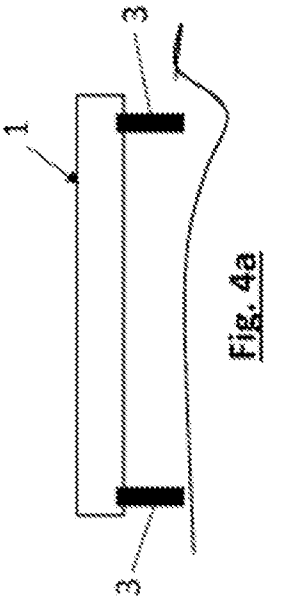

Fig. 4a

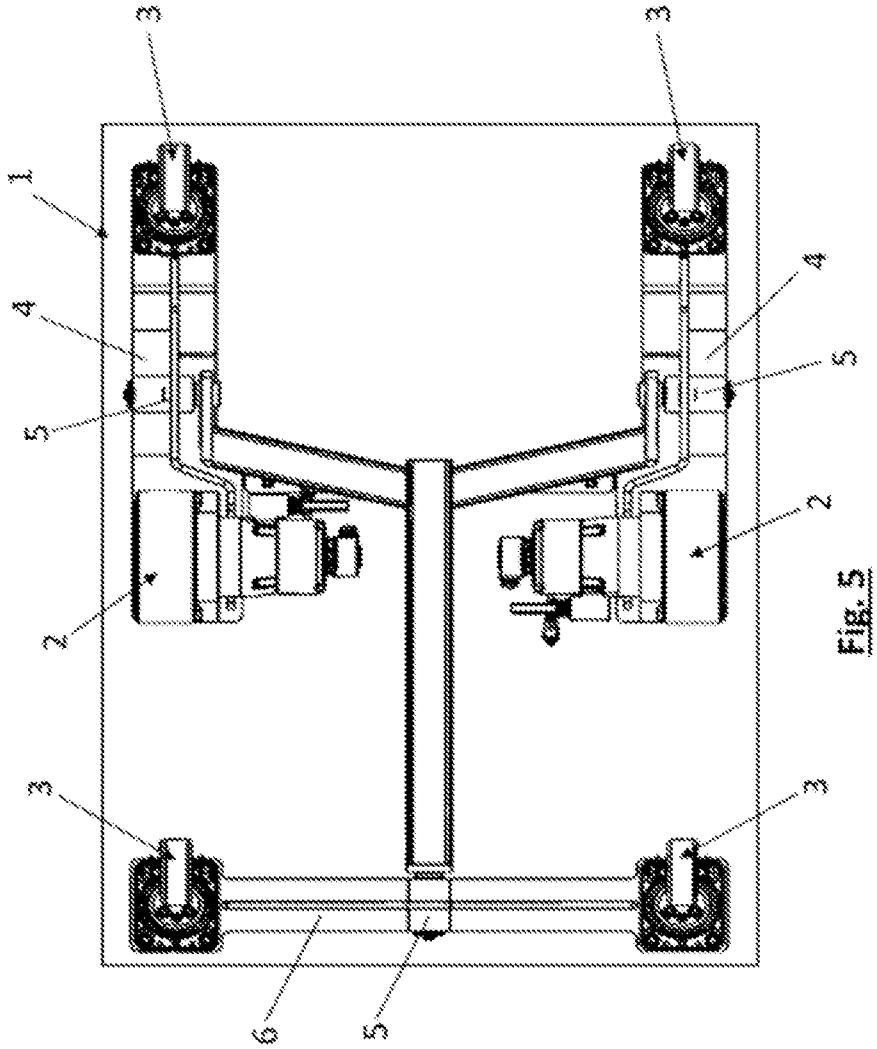

Fig. 5