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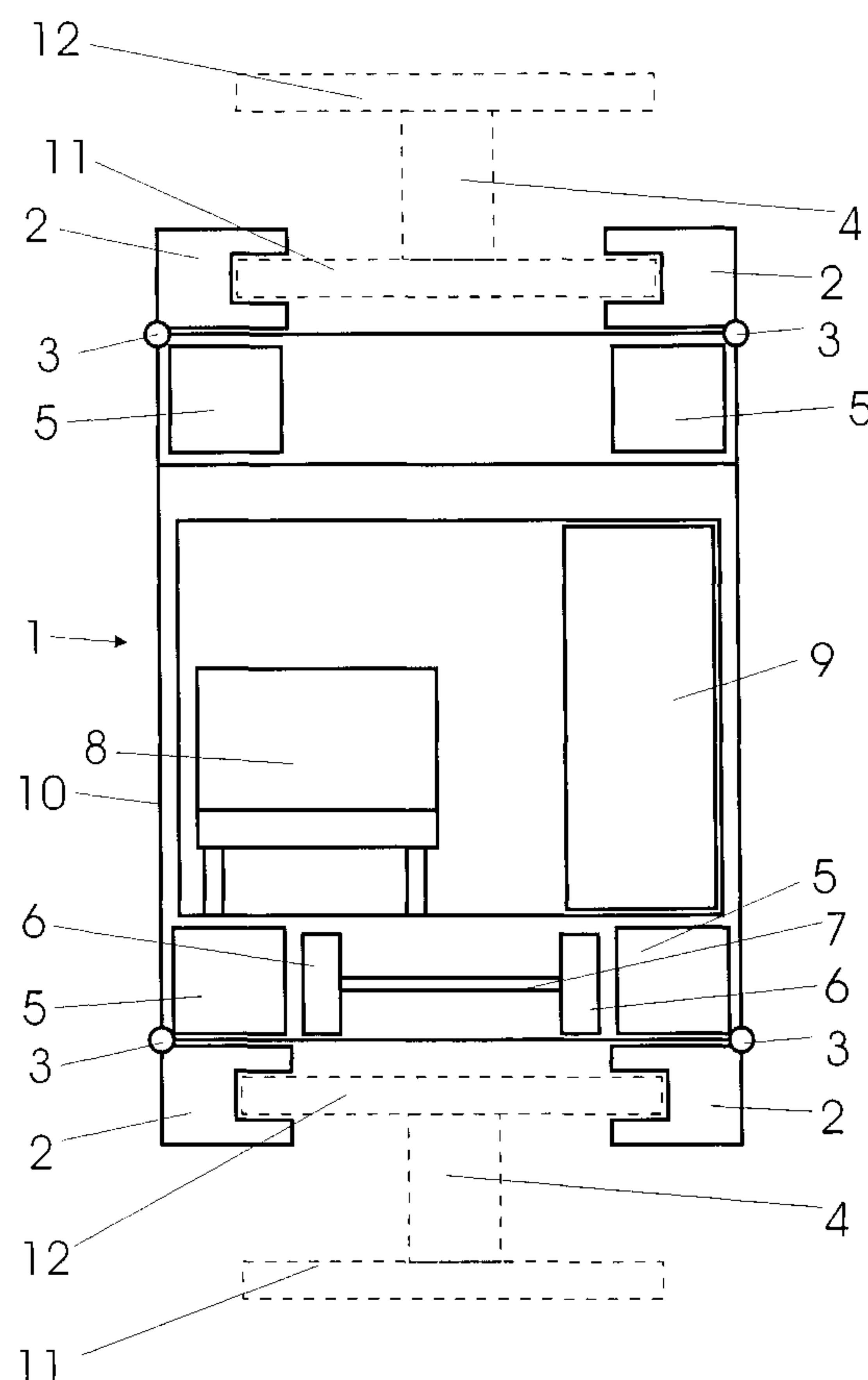
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(71) Demandeurs/Applicants:
SCHRAMEK, DIETER-WOLFGANG, DE;
SCHWAGER, HARTMUTH, DE;
FIGGER, AXEL, DE;
GAGZOW, MICHAEL, DE;
SCHANZ, TORSTEN, DE

(72) Inventeurs/Inventors:
SCHRAMEK, DIETER-WOLFGANG, DE;
SCHWAGER, HARTMUTH, DE;
FIGGER, AXEL, DE;
BRANDHERM, ULRICH, DE

(74) Agent: FETHERSTONHAUGH & CO.

(54) Titre : SYSTEME DE TRAIN MAGNETIQUE A GRANDE VITESSE A PISTE DE DEPLACEMENT A DEUX ETAGES
(54) Title: HIGH-SPEED MAGNETIC TRAIN SYSTEM WITH TWO-TIER TRACKS



(57) Abrégé/Abstract:

The invention relates to a high-speed magnetic train system with two-tier tracks, comprising a guide system (4), mounted on struts, whereby above the guide system (4) an upper track (12) and below it a lower track (11) are disposed on which vehicles (1) are displaced by means of magnetic train technology. Every vehicle (1) comprises at least two drive and guide units (2), disposed

(57) **Abrégé(suite)/Abstract(continued):**

opposite each other above and below the vehicle (1) and associated pair-wise. These drive and guide units are used to optionally place the vehicle (1) on the upper track (12) or suspend it from the lower track (11) and displace it on the respective track (11, 12), thereby allowing an orbital operational mode of the vehicles (1). The vehicles (1) travel on the upper track (12) exclusively in the one direction of travel (18) and on the lower track (11) exclusively in the other direction of travel (18').

ABSTRACT

The invention relates to a high-speed magnetic train system with two-tier tracks, comprising a guide system (4), mounted on struts, whereby above the guide system (4) an upper track (12) and below it a lower track (11) are disposed on which vehicles (1) are displaced by means of magnetic train technology. Every vehicle (1) comprises at least two drive and guide units (2), disposed opposite each other above and below the vehicle (1) and associated pair-wise. These drive and guide units are used to optionally place the vehicle (1) on the upper track (12) or suspend it from the lower track (11) and displace it on the respective track (11, 12), thereby allowing an orbital operational mode of the vehicles (1). The vehicles (1) travel on the upper track (12) exclusively in the one direction of travel (18) and on the lower track (11) exclusively in the other direction of travel (18').

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High-Speed Magnetic Train System with Two-Tier Tracks**Specification**

The invention relates to a high-speed magnetic train system with two-tier tracks, in accordance with the preamble of claim 1.

High-speed magnetic train systems are viewed as an alternative to the wheel/rail system of conventional trains, for the transport of passengers and freight, since travel speeds that cannot be reached with the wheel/rail system, or can only be reached with difficulty, are achieved with such high-speed train systems. Speeds higher than 400 km/h have already been achieved with the German Transrapid system, in particular, but also with other high-speed magnetic train systems.

However, a disadvantage of the high-speed magnetic train systems known until now is their low capacity utilization with regard to the passenger capacities that can be achieved, since the lines are actually planned for only a single track, in some parts, because of the high costs for the track on struts. This makes it necessary to plan passing points for the oncoming traffic, and to drive at lower cycle sequences, and to coordinate the travel directions accordingly. As a result, the advantages of the high travel speeds are lost again, to some extent.

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It is therefore known, for example from DE 196 38 578 A1, to equip a transport system for rail-guided trains with a configuration of the track in which trains can travel on a track on struts, above and below the guide system, whereby here a separation is provided between high-speed train traffic that runs on the line above the guide system, and train traffic that makes constant stops, for example local passenger transit, that runs on the line below the guide system. In this way, uncoupling of the two separate lines is achieved, which clearly improves the capacity utilization of the track. However, it is a disadvantage in this connection that the problem of the oncoming traffic is still unresolved, to a great extent, so that here again, corresponding passing points have to be provided, or a second line with the corresponding high track costs has to be built, in parallel.

Furthermore, it is known from DE 198 58 066 A1 to arrange a rail system also for magnetic suspended trains, rotated by quasi 90 degrees, so that the trains run to the left and the right of the guide system. While it is possible to achieve a corresponding doubling of capacity here, too, with only a single rail system, the mechanical stresses on the trains are significantly higher, and the problem of the oncoming traffic continues to be unresolved, to a great extent.

It is therefore the task of the present invention to further develop a high-speed magnetic train system of the type as stated in the preamble, in such a manner that the use of the vehicles can be handled significantly more flexibly than in the case of known systems.

The solution of the task according to the invention is evident from the characterizing features of claim 1, in interaction with the characteristics of the preamble. Further advantageous embodiments of the invention are evident from the dependent claims.

The invention proceeds from a high-speed magnetic train system with two-tier tracks, consisting of a guide system mounted on struts, in which an upper track is arranged above the guide system, and a lower track is arranged below it, on which vehicles can be displaced using the magnetic train technology. Such a high-speed train system is developed further, in a manner according to the invention, in that every vehicle has at least two drive and guide units, arranged opposite one another above and below the vehicle, and assigned to one another in pairs, with which the vehicle can be optionally set onto the upper track or suspended from the lower track, and can be displaced on the respective track. The result achieved by this is that every vehicle can run optionally on the lower track or the upper track, and therefore can be used more flexibly than in the case of the

known two-tier magnetic train systems. As a result, in a further embodiment, a vehicle that is being driven on the lower track in the one direction, for example, can be used in the opposite direction again, immediately, on the other track, thereby making it possible for the vehicles to be run in circulating operation, so that the vehicles on the track arranged at the top, on a structure that has approximately a double-T profile, exclusively run in the one direction of travel, and those on the lower track exclusively run in the other direction of travel. As a result, a significant savings potential is achieved as compared with conventional transport systems, since the track can be used in significantly better manner, and the investment costs for the track on which the traffic can run in two directions at the same time are significantly reduced as compared with two lines that run parallel to one another.

In a first embodiment, it is possible that the drive and guide units that belong to one another in pairs, in each instance, are arranged fixed in place on the top and the bottom of the vehicle.

Another embodiment provides that the drive and guide units that belong to one another in pairs, in each instance, are arranged on the vehicle in such a manner, preferably so that they can be flipped in or out, so that only the drive and guide units that are required, in each instance, at the top or the bottom of the

vehicle, respectively, are in use during operation, i.e. are flipped out. In particular, if the drive and guide units that are not needed can be pivoted in behind paneling components of the vehicle, so that they are covered, the aerodynamics of the vehicles, which make up a high proportion of the energy consumption of the entire system, are advantageously influenced, while at the same time allowing full flexibility of the use of the vehicles on the lower track or, alternatively, on the upper track. Of course the drive and guide units can also be brought into and out of engagement with the guide system in a way other than flipping them.

It is advantageous if, at the end of the track, the vehicles can be switched to the other track, in each instance, by means of a switching station. In this way, it can be assured that a vehicle that arrives at the end of a track can be used again on the other track, in the opposite direction, immediately, and does not have to be returned to the starting point of travel, with the known problems of oncoming traffic and capacity utilization of the line. It is advantageous, in this connection, if the vehicles are switched at the end of the track by means of a vertical elevator between the upper track and the lower track, which elevator can be formed, for example, from a horizontal track segment that can be changed in height by way of lifting devices, with which the vehicle is switched between the upper track and the lower track, after it drives onto this segment.

Such an elevator is a configuration of the switching movement that is simple in design and technically reliable.

It is also possible that the vehicles are switched between the upper track and the lower track, at the end of the track, by means of ramp-shaped switching segments having rising or falling track segments, which switch the upper track to the lower track, and vice versa, in the form of an X-switch. In this connection, care is necessary to ensure that an appropriate switch position for the vehicles is guaranteed within these switching segments.

It is furthermore possible that the vehicles are turned at the end of the track, by means of a turning device, in such a manner that they are turned into the opposite direction of travel by means of rotation about their height axis. Such a turning device, for example in the form of a turntable that can also be adjusted in height, makes it possible for every vehicle to be equipped only in such a manner that a single driver's station must be provided for a train, which can then be rotated into the new direction of travel, in each instance, by turning the train. In this way, the control technology of the vehicles is significantly more simple and cost-effective. Of course it is also possible, in a different embodiment, that the vehicles have driver's stations on both sides, in their end regions, and can be run in both directions, without being turned.

Another advantageous embodiment provides that the vehicles are equipped with separate traveling mechanisms, preferably traveling mechanisms with tires, which can be moved in and out, for leaving the tracks or being moved onto the tracks, respectively, with which they can be uncoupled from the track, in each instance, at special transfer-in and transfer-out regions. In this way, it is possible to pull out individual vehicles, or even entire trains composed of the vehicles, from circulating traffic, or to put them in, at appropriate platform-shaped transfer-in and transfer-out regions, separate for each of the two tracks. Such traveling mechanisms, which can also be combined with appropriate steering devices, if necessary, therefore allow each vehicle to become drivable even independent of the track of the magnetic train system, particularly if corresponding drives act on the traveling mechanism.

In one embodiment, it is possible that the vehicles are fitted out for passenger transport. Of course it is also possible that the vehicles are fitted out for freight transport, for example if they have accommodation devices for common transport units such as containers and the like, which can be accommodated in the transport spaces of the vehicles. In this way, point-to-point transport of goods also becomes possible, in the form of a type of freight drone, which transport guides the vehicles by means of remote control, if applicable also under automatic control.

Another improvement in the utilization of the high-speed magnetic train system can be achieved in that other transport systems for freight or passenger transport are provided in the region of the track, with which the required construction space in the course of constructing the line can be utilized even more intensively. These can be, for example, transport systems that run in transport pipes, or small-volume transport systems. In this way, complete combination systems for transport purposes can be built up, which require only a single line for their implementation.

Another embodiment provides that the track can be divided up into two spatially separate track segments over its course, particularly at stops, and then brought together again, whereby the upper track and the lower track can be brought to essentially the same height level by means of ramp-shaped switching segments having rising or falling track segments. This configuration can be utilized, for example, in train stations, so that both tracks can be laid in such a manner that both the vehicles that run on the upper track and those that run on the lower track can stop at the same platforms, so that it is not necessary to provide separate platform levels for each track. Of course, such a configuration can also be utilized at other locations of the course of the track, where it is not possible.

to arrange the tracks on top of one another due to geographic conditions or the like, for example.

A particularly preferred embodiment of the high-speed magnetic train system according to the invention, having a two-tier track, is shown in the drawing.

This shows:

- Figure 1 - a first embodiment of the high-speed train system according to the invention, with a vehicle having drive and guide units for a guide system, arranged at the top and the bottom,
- Figure 2 - track change of a vehicle of the high-speed magnetic train system according to the invention, using an elevator device,
- Figure 3 - a schematic representation of the arrangement of vehicles on the guide system supported on struts,
- Figure 4 - circulating operation of the high-speed magnetic train system according to the invention, with elevator devices arranged at the ends of the guide system.

Figure 1, in a very schematic representation, shows how a high-speed train system according to the invention, with a vehicle 1, can be arranged on two guide systems 4, shown with a broken line, approximately in a double-T shape, using the drive and guide units 2. In this connection, each guide system 4 consists of a lower track 11 and an upper track 12, which are connected with one another by way of a center piece. Such guide systems are fundamentally known, from the development of the Transrapid high-speed magnetic train system, and therefore will not be described further than what is relevant here. For every line, only one guide system 4 is provided, so that the vehicle 1 is arranged to be displaceable either standing on the lower guide system 4 shown in Figure 1, or suspended from the upper guide system shown in Figure 1.

In this connection, every vehicle 1 is equipped with at least two drive and guide units 2, which belong to one another in pairs and are arranged above and below the bogies 10 of the vehicle 1; as a rule, two such drive and guide units 2 will be arranged in the front region of the vehicle 1, and in the rear region of the vehicle 1, in each instance, as is evident, for example, from Figure 2 and Figure 4, respectively. In this connection, the drive and guide units 2 grip around the upper track 12, or the lower track 11, respectively, from the outside, and thereby establish the magnetic migration field together with the track 11 or 12. Such drive and guide units 2 can be

arranged both above the passenger cabin 10 and below the passenger cabin 10, as indicated, whereby only one pair of drive and guide units 2 is in engagement with the tracks 11 or 12, depending on the assignment of the vehicle 10 to the tracks 11 or 12.

In this connection, the drive and guide units 2 are arranged on the vehicle 1 by way of revolute joints 3, not shown in detail, and are configured to rotate relative to the former, so that the drive and guide units 2 can be flipped away from the track 11 or 12, for example, as is evident in the case of the upper vehicle 1 of Fig. 3. Here it is, of course, also possible that the drive and guide units 2 can be flipped into assigned cavities on the vehicle 1, so that they do not project relative to the outer shape of the vehicle 1.

In this connection, the upper drive and guide units 2 are intended to interact with the lower track 11, and the lower drive and guide units 2 are intended to interact with the upper track 12. Figuratively speaking, the vehicle 1 is suspended from the upper drive and guide units 2 during travel on the lower track 11, while it stands on the lower drive and guide units 2 during travel on the upper track 12. As is particularly evident in Figure 3, double utilization of the guide system 4, which is constructed on the ground, supported on struts 17, can therefore be achieved. As a result, circulating operation of

the vehicles 1 on the guide system 4 is possible, as will be evident in greater detail in Figure 4, so that the problems of oncoming traffic on the same line, which could not be avoided until now, can be avoided. Within the struts 17 or adjacent to these struts 17, other transport systems, not shown here, can also be arranged, which allow additional utilization of the space required for the line of the high-speed magnetic train system, and thereby also make it possible to construct combination systems.

Above and below the passenger compartment 10, which has seats 8 for transporting passengers or accommodations for transport freight 9, drive units 5 for establishing the electromagnetic field are only indicated schematically. In the center region of the vehicle 1, there are two sets of traveling mechanisms 6 with tires, below the passenger compartment 10, which are connected with one another by way of an axle 7. By means of these traveling mechanisms 6, 7, it is possible to release vehicles 1 from the guide system 4, in a manner that will be described in greater detail below, in that the traveling mechanisms 6, 7 are moved out through openings, not shown, downward, under the bottom of the vehicle 1, and thereby can come into rolling contact with a substratum. If the vehicle 1 is passed over such a substratum at transfer-out and transfer-in stations specially provided for this purpose, on the track 11 or 12, the traveling mechanism 6, 7 can be brought into engagement with the

substratum and then the connection with the track 11 or 12 can be released, for example by means of flipping away the drive and guide units 2. In particular, if the traveling mechanism 6, 7 is also driven, the vehicle 1 can then be moved away from the guide system 4 like a normal vehicle 1. In this way, it is possible to newly combine corresponding vehicles 1, to load them, or to take them out of circulating operation for repair purposes.

In Figure 3, and again in Figure 4, it can be better seen that the vehicles 1 run in circulating operation on the guide system 4 and the tracks 11 and 12 arranged on it, in such a manner that the vehicles 1 on the upper track 12 run in the direction of travel 18, and those on the lower track 11 run in the direction of travel 18'. Of course, the guide system 4 indicated only schematically here, as a short track 11, 12, can have appropriate lengths.

At the ends 19 of the guide system 4, elevators 20 can be seen, in each instance, with which the vehicles 1 can be switched from the upper track 12 to the lower track 11 and vice versa, in a manner that will be described in greater detail below. As a result, a vehicle 1 can be in almost constant use, without the vehicles 1 having to be brought back to a starting point or the problem of oncoming traffic on the same line coming up. Also, the area requirement, i.e. space requirement for the devices for switching the vehicles 1 is extremely slight.

In this connection, the vehicles 1 are in engagement with the guide system 4 only with the drive and guide units 2 that are assigned to the track 11 or 12, in each instance. The other drive and guide units 2 are flipped in, as already described, or are simply left in their starting position.

Switching of the vehicles 1 is shown schematically, in detail, once again in Figure 2, and the sequence can be seen in greater detail in Figure 4. Here, the vehicle 1 that is supposed to be switched is driven onto an elevator device or turning device 13, in the form of a segment of the guide system 4, in the incoming or outgoing direction 15, which segment is long enough to be able to carry the vehicle 1 in its entire length. Depending on whether the vehicle 1 was currently being run on the upper track 12 or the lower track 11, it is moved onto the corresponding track 11 or 12 of the elevator/turning device 13. This elevator/turning device 13 then performs a vertical lifting movement 16 or lowering movement, using devices not shown in greater detail, and can also rotate about an axis of rotation 14, similar to a turntable. This can be utilized to change the direction of travel 18, 18' of the vehicle 1, so that only one driver's station has to be provided for every vehicle 1. It is understood that not only individual vehicles 1, but also entire trains composed of vehicles 1 can be switched or turned in the same manner.

After the lifting or lowering movement 16 has been carried out and, if applicable, after the turning movement 14 has been carried out, the vehicle 1 is then brought back to the corresponding height of track 11, 12, on which the vehicle 1 is now supposed to run. Then the vehicle 1 can be transferred to the guide system 4 again, in the incoming/outgoing direction 15.

Reference Number List

- 1 - vehicle
- 2 - drive and guide unit
- 3 - revolute joint
- 4 - guide system
- 5 - drive
- 6 - traveling mechanism
- 7 - axle
- 8 - passenger seat
- 9 - transport freight
- 10 - passenger cabin
- 11 - lower track
- 12 - upper track
- 13 - elevator/turning device
- 14 - turning device
- 15 - incoming/outgoing direction
- 16 - lifting/lowering device
- 17 - struts
- 18, 18' - direction of travel
- 19 - end of track
- 20 - switching station/elevator

Amended Claims

1. High-speed magnetic train system with two-tier tracks, consisting of a guide system (4) mounted on struts, in which an upper track (12) is arranged above the guide system (4), and a lower track (11) is arranged below it, on which vehicles (1) can be displaced using the magnetic train technology,

characterized in that

every vehicle (1) has at least two drive and guide units (2), arranged opposite one another above and below the vehicle (1) and built up essentially identically, and assigned to one another in pairs, with which the vehicle (1) can be optionally set onto the upper track (12) or suspended from the lower track (11), and can be displaced on the respective track (11, 12).

Claims

1. ~~High-speed magnetic train system with two-tier tracks, consisting of a guide system (4) mounted on struts, in which an upper track (12) is arranged above the guide system (4), and a lower track (11) is arranged below it, on which vehicles (1) can be displaced using the magnetic train technology,~~

characterized in that

~~every vehicle (1) has at least two drive and guide units (2), arranged opposite one another above and below the vehicle (1), and assigned to one another in pairs, with which the vehicle (1) can be optionally set onto the upper track (12) or suspended from the lower track (11), and can be displaced on the respective track (11, 12).~~

2. High-speed magnetic train system as recited in claim 1, **characterized in that** the drive and guide units (2) that belong to one another in pairs, in each instance, are arranged fixed in place on the top and the bottom of the vehicle (1).

3. High-speed magnetic train system as recited in claim 1, **characterized in that** the drive and guide units (2) that

belong to one another in pairs, in each instance, are arranged on the vehicle (1) in such a manner, preferably so that they can be flipped in or out, so that only the drive and guide units (2) that are required, in each instance, at the top or the bottom of the vehicle (1), respectively, are in use during operation, preferably flipped out,

4. High-speed magnetic train system as recited in claim 3, **characterized in that** the drive and guide units (2) that are not needed can be pivoted in behind paneling components of the vehicle (1), so that they are covered.
5. High-speed magnetic train system as recited in one of the preceding claims, **characterized in that** the vehicles (1) can be run in circulating operation, whereby the vehicles (1) on the upper track (12) exclusively run in the one direction of travel (18), and those on the lower track (11) exclusively run in the other direction of travel (18').
6. High-speed magnetic train system as recited in one of the preceding claims, **characterized in that** at the end (19) of the track (11, 12), the vehicles 1 can be switched to the other track (11, 12), in each instance, by means of a switching station (20).

7. High-speed magnetic train system as recited in claim 6, **characterized in that** the vehicles (1) are switched at the end (19) of the track (11, 12) by means of a vertical elevator (20) between the upper track (12) and the lower track (11).
8. High-speed magnetic train system as recited in claim 7, **characterized in that** the vertical elevator (20) is formed from a horizontal track segment (13) that can be changed in height by way of lifting devices, with which the vehicle (1) is switched between the upper track (12) and the lower track (11), after driving (15) onto this track segment (13).
9. High-speed magnetic train system as recited in claim 6, **characterized in that** the vehicles (1) are switched between the upper track (12) and the lower track (11), at the end (19) of the track (11, 12), by means of ramp-shaped switching segments having rising or falling track segments.
10. High-speed magnetic train system as recited in one of the preceding claims, **characterized in that** the vehicles (1) are turned at the end (19) of the track (11, 12), by means of a turning device, in such a manner that they are turned

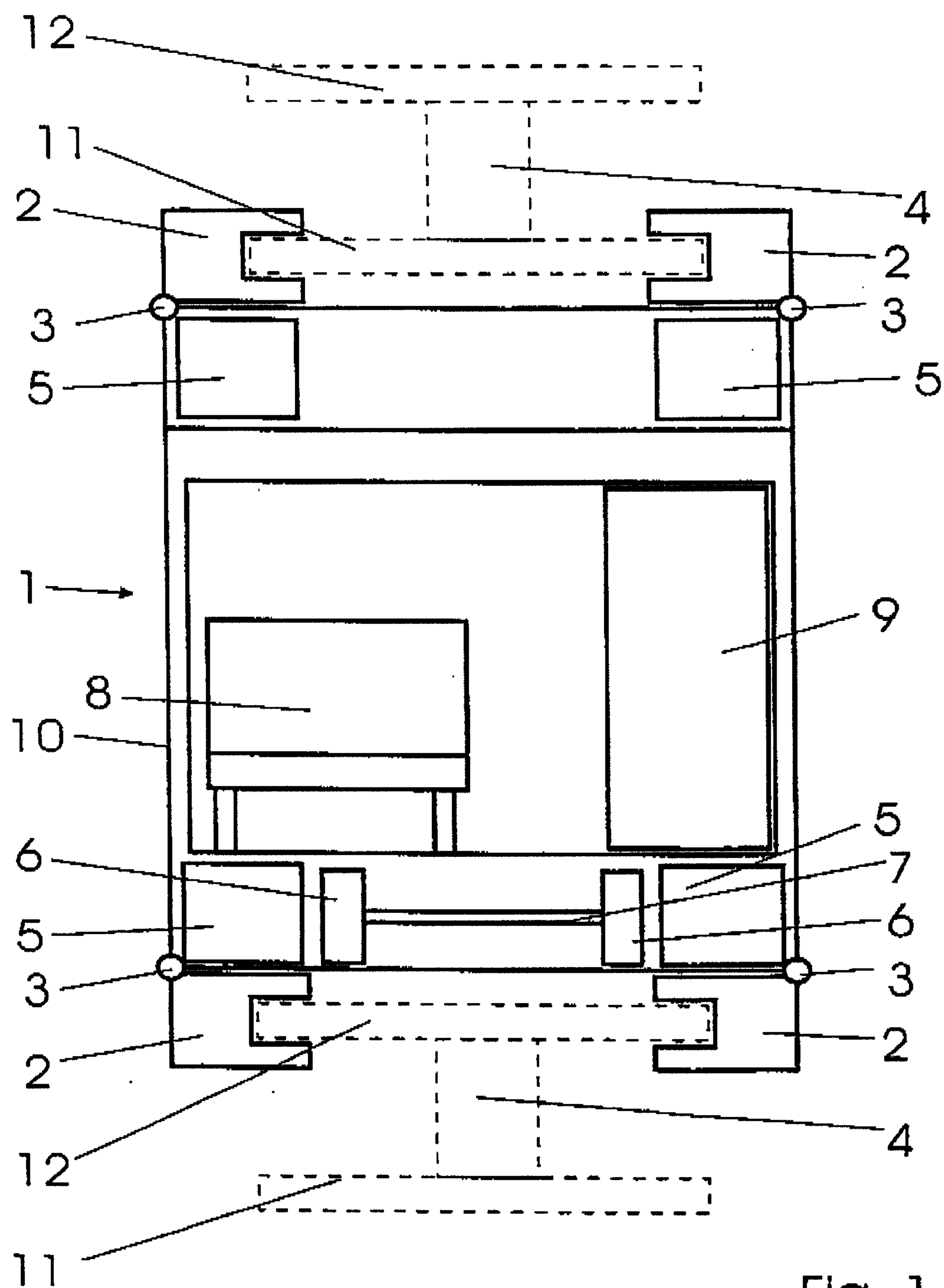
into the opposite direction of travel (18, 18') by means of rotation (14) about their height axis.

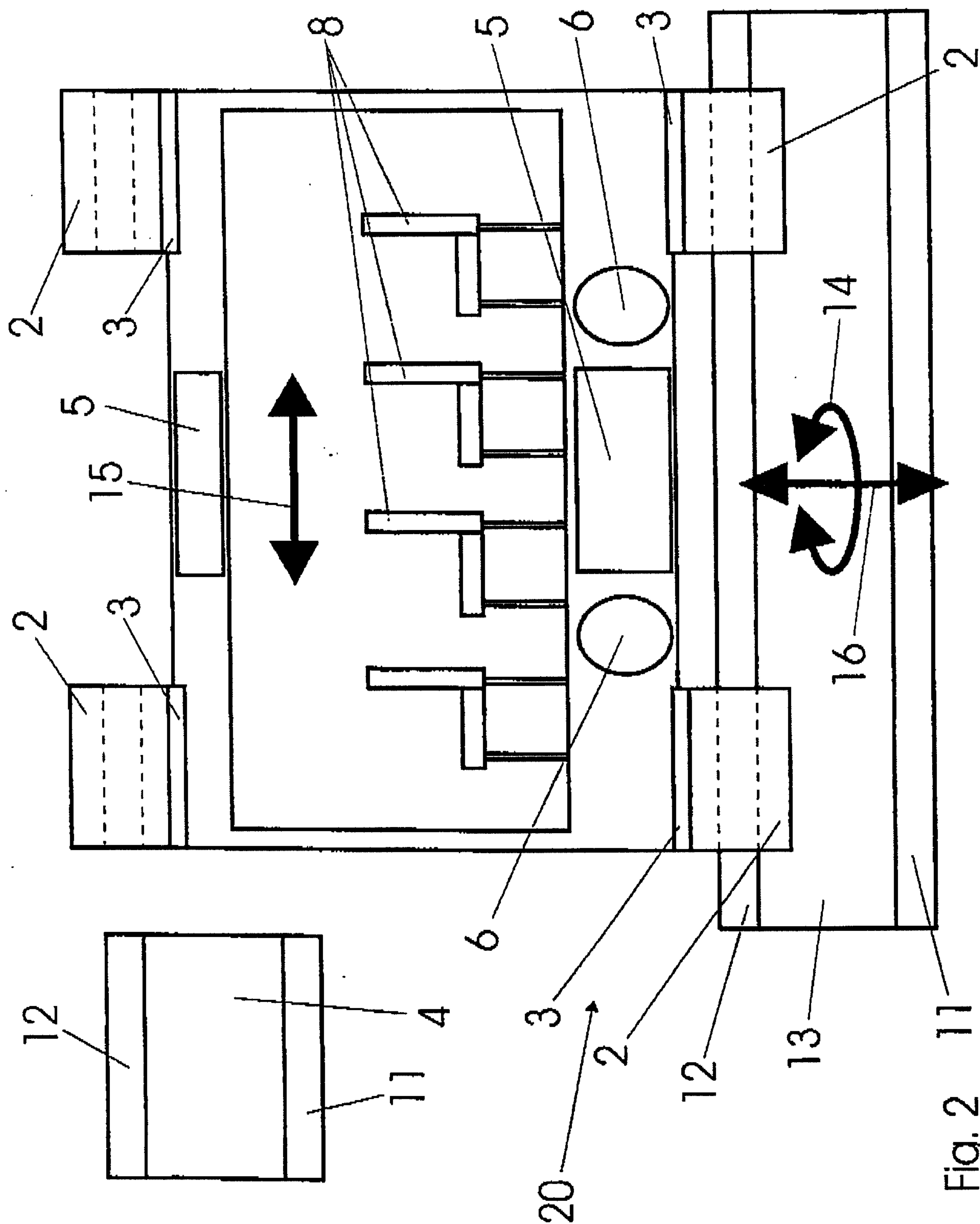
11. High-speed magnetic train system as recited in claim 10, **characterized in that** the turning device is configured in the form of a turntable that can preferably be adjusted in height.
12. High-speed magnetic train system as recited in one of the preceding claims, **characterized in that** the vehicles (1) have driver's stations on both sides, in their end regions, and can be run in both directions (18, 18').
13. High-speed magnetic train system as recited in one of the preceding claims, **characterized in that** the guide system (4) has a structure that has approximately a double-T profile.
14. High-speed magnetic train system as recited in one of the preceding claims, **characterized in that** the vehicles (1) are equipped with separate traveling mechanisms (6, 7), preferably traveling mechanisms with tires, which can be moved in and out, for leaving the tracks (11, 12) or being moved onto the tracks (11, 12), respectively, with which they can be uncoupled from the track (11, 12), in each instance, at special transfer-in and transfer-out regions.

15. High-speed magnetic train system as recited in one of the preceding claims, **characterized in that** the vehicles (1) are fitted out for passenger transport.
16. High-speed magnetic train system as recited in one of claims 1 to 14, **characterized in that** the vehicles (1) are fitted out for freight transport.
17. High-speed magnetic train system as recited in claim 16, **characterized in that** the vehicles (1) fitted out for freight transport have accommodation devices for common transport units (9) such as containers, which can be accommodated in the transport spaces (10) of the vehicles (1).
18. High-speed magnetic train system as recited in one of claims 16 or 17, **characterized in that** the vehicles (1) fitted out for freight transport, transport goods (9) fully automatically, by means of point-to-point transport.
19. High-speed magnetic train system as recited in one of the preceding claims, **characterized in that** the automatic control of the vehicles (1) can be carried out by means of remote control.

20. High-speed magnetic train system as recited in one of the preceding claims, **characterized in that** other transport systems are provided in the region of the track (11, 12, 17).
21. High-speed magnetic train system as recited in one of the preceding claims, **characterized in that** the track (11, 12) can be divided up into two spatially separate track segments (11, 12) over its course, particularly at stops, and then brought together again, whereby the upper track (12) and the lower track (11) can be brought to essentially the same height level by means of ramp-shaped switching segments having rising or falling track segments.

Fetherstonhaugh
Ottawa, Canada
Patent Agents





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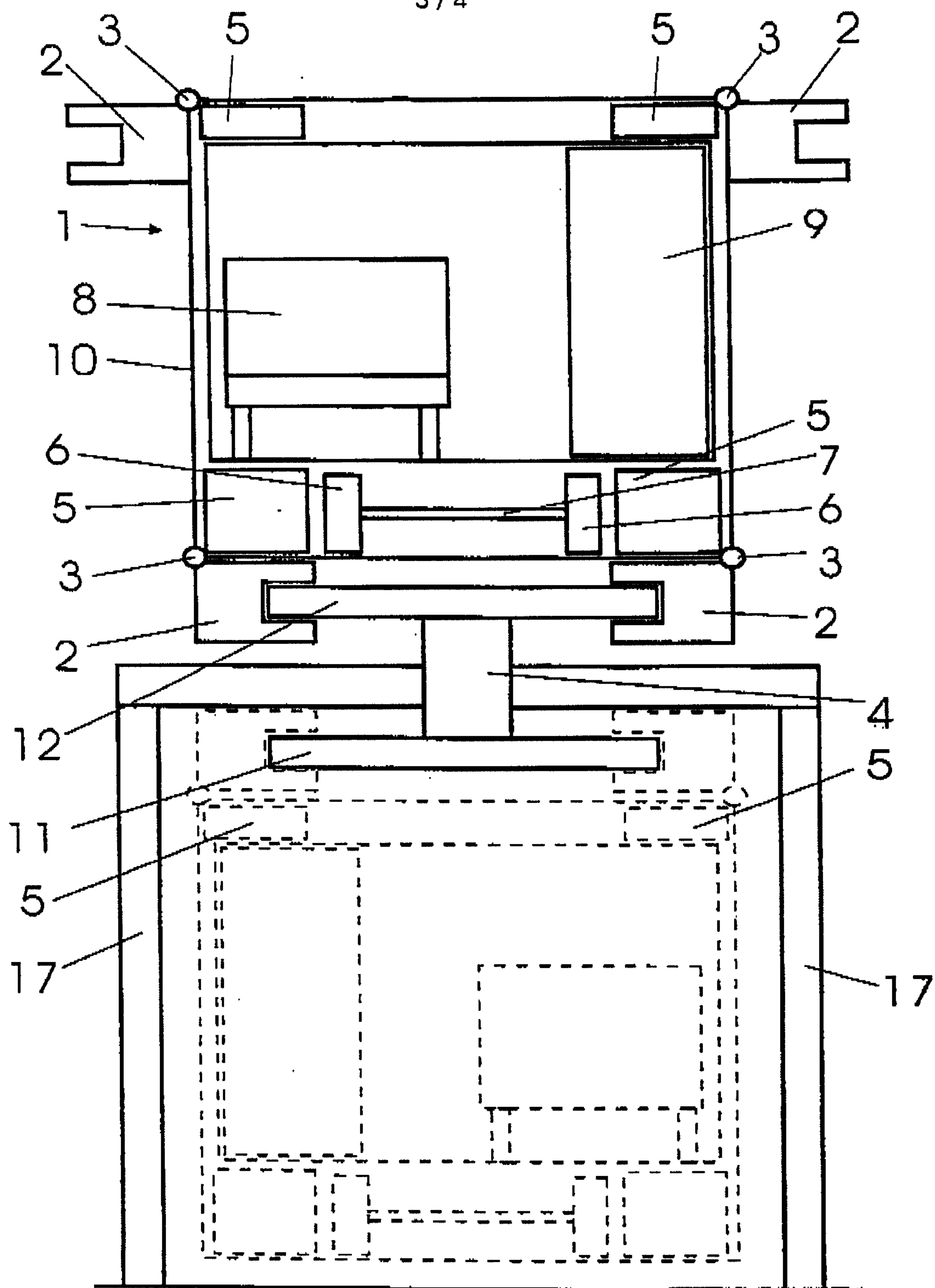


Fig. 3

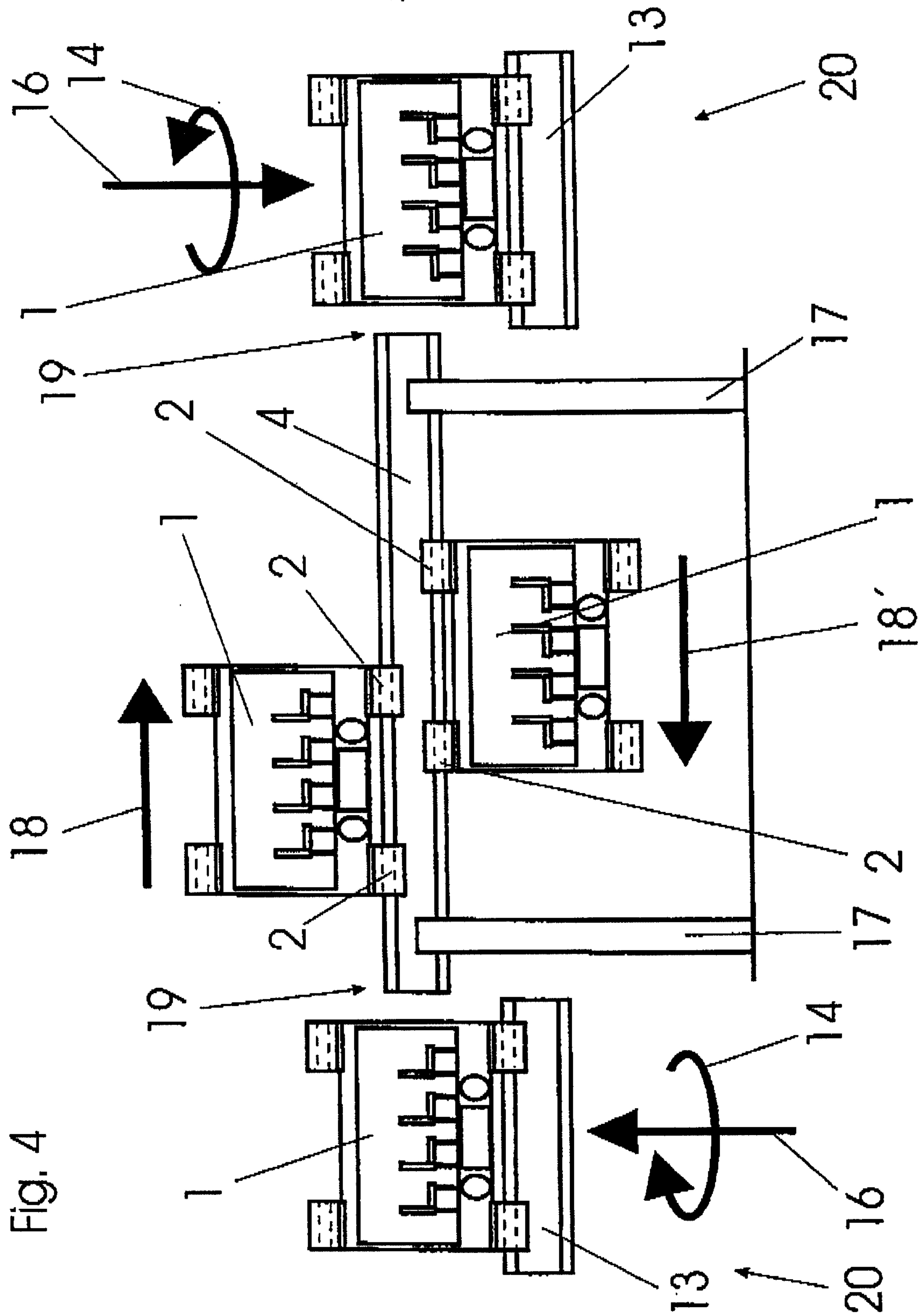


Fig. 4

