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(54) A TRAIN STATION FOR A TUNNEL

(57) The present invention relates to a train station for a tunnel can be applied in the people transport industry, and more specifically in the area of commuter transport, in an arrangement in a tunnel of station platforms which are offset vertically and horizontally one relative to the other and a complementary arrangement of transport paths which are offset vertically and horizontally one relative to the other.

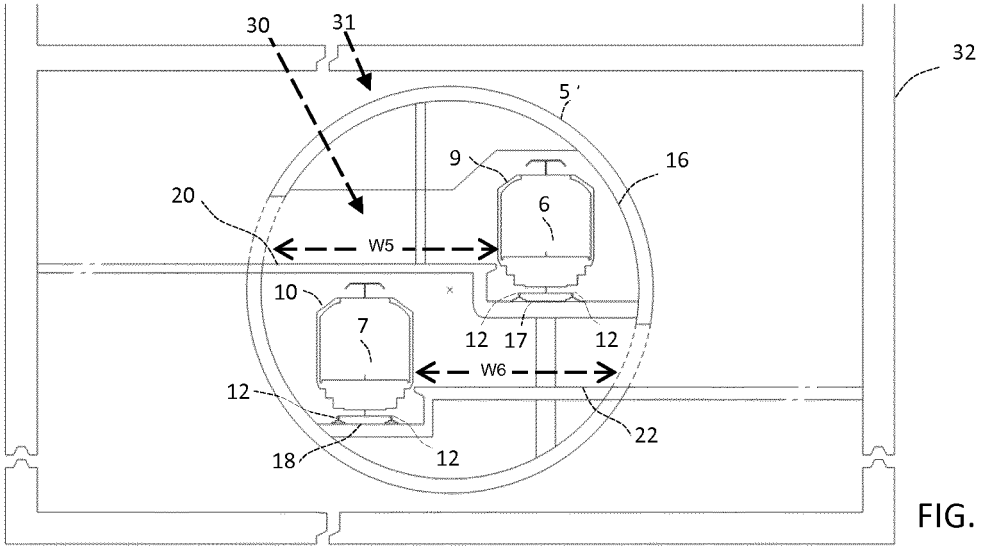

FIG. 7

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Description

[0001] The present invention relates to a train station, and in particular, to a train station located in a tunnel, and the invention also relates to a tunnel comprising a train station, and can be applied in the people transport industry, and more specifically in the area of commuter transport.

[0002] The term tunnel as used in this specification is intended to include a tunnel formed by a tunnel boring machine or a cavern tunnel excavated from underground or a mined tunnel excavated from the surface or by any combination of these methods all in a non-limiting character thereof.

[0003] The term train station as used in this specification is intended to include a station for any type of train system, be it a light rail or a heavy rail system or a train system which runs without the use of rails, such as, for example, a train system which runs on paved tracks of the type used in the Paris underground system.

[0004] According to the invention there is provided a train station located in a tunnel wherein the tunnel defines at least a first transport path and a second transport path for accommodating trains through the tunnel, the first and second transport paths being spaced apart transversely relative to each other in the station, the first transport path being at a level in the station above the level of the second transport path in the station, a first passenger platform corresponding to the first transport path being located in the station above the second transport path, with the second transport path configured to accommodate a train beneath the first platform, a second passenger platform corresponding to the second transport path located in the station below the first transport path with the second platform configured to accommodate passengers thereon beneath the first transport path, the first platform being at a level higher than the level of the second platform.

[0005] In one aspect of the invention the first and second transport paths are configured to accommodate trains travelling in one of the same direction and respective opposite directions.

[0006] In one aspect of the invention the first and second transport paths extend through the station substantially parallel to each other, and preferably, the first and second platforms extend through the station substantially parallel to each other.

[0007] In another aspect of the invention the first and second transport paths extend through the station within an envelope defined by the internal transverse cross-section of the tunnel.

[0008] In another aspect of the invention the first and second platforms are located within the envelope defined by the internal transverse cross-section of the tunnel.

[0009] In another aspect of the invention a third transport path extends through the station, and preferably, the third transport path extends through the station at a level similar to the level of one of the first and second transport paths, and preferably, the third transport path is located relative to the one of the first and second transport paths with which the third transport path is at the same level, such that the said one of the first and second transport paths is located between the third transport path and the corresponding one of the first and second platforms.

[0010] In a further aspect of the invention the third transport path extends through the station within the envelope defined by the internal transverse cross-section of the tunnel.

[0011] In a further aspect of the invention a fourth transport path is provided extending through the station, and preferably, the fourth transport path is located in the station at a level similar to the level of the other one of the first and second transport paths, which is not at the same level as the level of the third transport path. Advantageously, the fourth transport path is located relative to the one of the first and second transport paths, with which it is at the same level so that the said one of the first and second transport paths is located between the fourth transport path and the corresponding one of the first and second platforms.

[0012] In another aspect of the invention the first and second transport paths transition from the station into the tunnel, so that the first and second transport paths are located at a common level in the tunnel, and preferably, the first and second transport paths extend through the tunnel parallel to each other.

[0013] In another aspect of the invention the third transport path transitions from the station into the tunnel to the first common level, and preferably, the first, second and third transport paths extend through the tunnel parallel to each other.

[0014] In one aspect of the invention the four transport paths extend through the tunnel at the first and second common levels with one pair of the pairs of the transport paths at one of the first and second common levels being located above the other pair of the transport paths at the other one of the first and second common levels.

[0015] In another aspect of the invention a communicating passageway is provided for accommodating passengers between the first and second platforms.

In a further aspect of the invention the tunnel extends from the station at respective opposite ends thereof.

[0016] Preferably, an access shaft extends from ground level to the station for accommodating passengers to the first and second platforms.

[0017] In another aspect of the invention one or both of a lift and a plurality of rescue access shafts, escalators and protected stairs are provided for passenger rescue and moving passengers between ground level and the first and second platforms.

Drawings

[0018]

Fig. 1 is a transverse cross-sectional end elevational

view of a train station according to the invention located in a tunnel also according to the invention,

Fig. 2 is a transverse cross-sectional end elevational view of the tunnel of Fig. 1,

Fig. 3 is a partly cut away perspective view of a portion of the station of Fig. 1 illustrating an access shaft connecting the station to ground level,

Fig. 4 is a view similar to Fig. 3 of the station of Fig. 1 at a different level to that of Fig. 3 and the access shaft of Fig. 3,

Fig. 5 is a partly cut away perspective view of a portion of a station similar to the station of Figs.1 to 4 and an access shaft connecting the station to ground level,

Fig. 6 is a view similar to Fig. 5 of the station of Fig. 5 at a different level to that of Fig. 5 and the access shaft,

Fig. 7 is a transverse cross-sectional end elevational view of a station according to another embodiment of the invention in a tunnel also according to the another embodiment of the invention,

Fig. 8 is another transverse cross-sectional end elevational view of a station of Fig. 7,

Fig. 9 is a transverse cross-sectional elevational view of a station according to another embodiment of the invention in a tunnel also according to the another embodiment of the invention,

Fig. 10 is another transverse cross-sectional end elevational view of a station of Fig. 9,

Fig. 11 is a transverse cross-sectional elevational view of a station according to another embodiment of the invention in a tunnel also according to the another embodiment of the invention,

Fig. 12 is another transverse cross-sectional end elevational view of a station of Fig. 11,

Fig. 13 is a transverse cross-sectional elevational view of a station according to another embodiment of the invention in a tunnel also according to the invention.

Fig. 14 is a transverse cross-sectional elevational view of a station according to another embodiment of the invention in a tunnel also according to the invention, and

Fig. 15 is another transverse cross-sectional end elevational view of the stations of Figs. 13 and 14.

[0019] Referring to the drawings and initially to Figs. 1 to 4 thereof, there is illustrated a tunnel according to the invention indicated generally by the reference numeral 1 comprising a train station, also according to the invention and indicated generally by the reference numeral 3. The tunnel 1 and the train station 3 typically are suitable for an underground passenger transporting system. The tunnel 1 is a single bore tunnel defining an elongated bore 5 extending therethrough and defining a first transport path 6 and a second transport path 7 extending longitudinally therethrough for accommodating first and second trains 9 and 10, respectively, through the tunnel 1 in either the same or opposite directions. In this embodiment of the invention the first and second transport paths 6 and 7 are typically configured to accommodate first and second trains in opposite directions. The first and second transport paths 6 and 7 are defined by respective pairs of rails 12 which are mounted on a base 14 extending through the tunnel 1. The rails 12 of the respective first and second transport paths 6 and 7 are located on the base 14 in the tunnel 1 at a first common level 13. The first common level 13 is spaced apart downwardly a distance of approximately 1.8 metres from the level of a horizontal plane containing the central geometrical axis of the bore 5 of the tunnel 1. The rails 12 are conventional type rails for rollably supporting and guiding wheels of the first and second trains 9 and 10. The first and second trains 9 and 10 may be any type of trains, such as a single carriage or multiple carriage trains, trains of a light rail system or a heavy rail system, trams or the like. Furthermore, the trains may be powered by any suitable means, and in this case, the trains 9 and 10 are electrically powered by overhead cables. The rails 12 are mounted on the base 14 of the tunnel 1, so that the transport paths 6 and 7 extend through the tunnel substantially parallel to each other, and at the same level.

[0020] Turning now to the train station 3, the train station 3 is configured so that the train station 3 is contained within an envelope 15 defined by the internal transverse cross-section of the tunnel 1, in other words defined by the bore 5 of the tunnel 1. The first and second transport paths 6 and 7 continue from the tunnel 1 through the station 3, and transition from the first common level 13 in the tunnel 1 to first and second levels 17 and 18, respectively, within the station 3, so that the first level 17 of the first transport path 6 in the station 3 is higher than the second level 18 at which the second transport path 7 extends through the station 3.

[0021] A first passenger platform 20 extends the length of the station 3, and corresponds with the first transport path 6 for accommodating passengers embarking on and disembarking from the first train 9 in the first transport path 6. The first platform 20 is located within the envelope 15 defined by the bore 5 of the tunnel 1, and is at a level above the second transport path 7 for accommodating second trains 10 in the second transport path 7 beneath

the first platform 20.

[0022] A second passenger platform 22 of the station 3 is also located within the envelope 15 defined by the bore 5 of the tunnel 1 and corresponds with the second transport path 7 for accommodating passengers embarking on and disembarking from second trains 10 in the second transport path 7. The second passenger platform 22 is located sufficiently below the first level 17 of the first transport path 6 to accommodate passengers thereon.

[0023] As can be seen by transitioning the first and second transport paths 6 and 7 from the first common level 13 in the bore 5 of the tunnel 1 to the first and second levels 17 and 18 within the station 3, the first and second transport paths 6 and 7 and the first and second passenger platforms 20 and 22 are all contained within the envelope 15 defined by the bore 5 of the tunnel 1.

[0024] In this embodiment of the invention the bore 5 of the tunnel 1 is 10.8 metres in internal diameter, the difference in height between the first and second levels 17 and 18 of the first and second transport paths 6 and 7 within the envelope 15 defined by the bore 5 of the tunnel 1 is 3.87 metres, while the first level 17 of the first transport path 6 is at a level of approximately 0.13 metres below a horizontal plane containing the internal diameter of the envelope 15. The first passenger platform is of width W_1 of 5.7 metres, while the second passenger platform 22 is of width W_2 5.2 metres.

[0025] Referring now in particular to Figs. 1, 3 and 4 an access shaft 25 of circular transverse cross-section extends, in this embodiment of the invention, vertically downwardly from ground level to the station 3 for accommodating passengers between ground level and the first and second passenger platforms 20 and 22. Rescue access shafts 19, lifts 21, escalators 28 and protected stairs 29 are provided in the access shaft 25 for accommodating the passengers upwardly and downwardly through the access shaft 25. Air ducts 26 and other service ducts 27 extend downwardly through the access shaft 25 for accommodating air and other services to the station 3 and the tunnel 1. A communicating passageway (not shown) extending beneath the first and second passenger platforms 20 and 22 is also provided for communicating the first and second platforms 20 and 22 for accommodating passengers therebetween. In this embodiment of the invention the external diameter D_1 of the vertical access shaft 25 is approximately 44 metres, and extends vertically downwardly from ground level by approximately 28 metres. However, this latter dimension will be dependent on the level of the tunnel 1 below ground level.

[0026] Referring now to Figs. 5 and 6 there is illustrated an alternative access shaft indicated generally by the reference numeral 33 to a station 3a, which is similar to the station 3 described with reference to Figs. 1 to 4. In this embodiment of the invention the access shaft 33 extends downwardly from ground level to the station 3a. The access shaft 33 is substantially similar to the access shaft 25 described with reference to Figs. 3 and 4, and similar components are identified by the same reference numerals. The main difference between the access shaft 33 and the access shaft 25 is that the access shaft 33 is of rectangular transverse cross-section, and is of length L of 54 metres and of width W_3 of 26 metres, and extends substantially vertically downwardly from ground level by approximately 28 metres to its base. However, this latter dimension will be dependent on the level at which the tunnel is located below ground level.

[0027] Otherwise the access shaft 33 is substantially similar to the access shaft 25. Referring now to Figs. 7 to 12 there is illustrated a station and there is illustrated a tunnel according to another embodiment of the invention indicated generally by the reference numeral 30 located in a tunnel 31 also according to the invention. The tunnel 31 is substantially similar to the tunnel 1 and similar components are identified by the same reference numerals, while the station 30 is substantially similar to the station 3 and similar components are also identified by the same reference numerals. The main difference between the tunnel 31 and the tunnel 3 is that the bore of the tunnel 31 is of 11.9 metres in internal diameter, and defines three transport paths, namely, first and second transport paths 6 and 7 which are similar to the first and second transport paths 6 and 7 of the tunnel 1, and a third transport path 43, all three of which extend through the bore 5 of the tunnel 31 at a first common level 44 and parallel to each other. Referring to Figs 9 and 10, the third transport path 43 accommodates a first train 9 side by side with the second and third trains 10 and 49 on the first and second transport paths 6 and 7 within the tunnel 31. The first and second transport paths 6 and 7 transition from the first common level 44 in the tunnel 31 to first and second levels 17 and 18 in the station 30 in a similar manner as the first and second transport paths 6 and 7 transition from the first common level 13 in the tunnel 1 to the first and second levels 17 and 18 in the station 3 described with reference to Figs. 1 to 4. The third transport path 43 is configured within the tunnel to join either or both the transport path 6 and 7, and thus, transitions from the first common level 44 with either the first transport path 6 or the second transport path 7 through the station 30. Additionally, it will be appreciated that the first and second transport paths 6 and 7 may also be configured within the tunnel 31 to join each other, and to join the third transport path 43. In another aspect of the invention, referring to Figs. 10 and 11, the third transport path 43 accommodates a train 10 side by side with the first and fourth trains 10 and 49 on the first and second transport paths 6 and 7 within the tunnel 31. The first and second transport paths 6 and 7 transition from the first common level 44 in the tunnel 31 to first and second levels 17 and 18 in the station 30 in a similar manner as the first and second transport paths 6 and 7 transition from the first common level 13 in the tunnel 1 to the first and second levels 17 and 18 in the station 3 described with reference to Figs. 1 to 4. The third transport path 43 is configured within the tunnel to join either or both the

transport path 6 and 7, and thus, transitions from the first common level 44 with either the first transport path 6 or the second transport path 7 through the station 30. Additionally, it will be appreciated that the first and second transport paths 6 and 7 may also be configured within the tunnel 31 to join each other, and to join the third transport path 43.

[0028] The main difference between the station 30 and the station 1 is largely in the width of the first and second passenger platforms 20 and 22. The first passenger platform 20 of the station 30 is of width W_5 of 7.3 metres, while the second passenger platform 22 is of width W_6 of 6.3 metres. The extra widths of the first and second platforms 20 and 22 over the widths of the first and second platforms 20 and 22 of the station 3 of Figs. 1 to 4 is achieved by virtue of the diameter of the tunnel 31. In this embodiment of the invention an access shaft 32 extends vertically downwardly from ground level to the station 30, and is of circular transverse cross-section, substantially similar to the access shaft 25 of the station described with reference to Figs. 1 to 4.

[0029] In this embodiment of the invention while there are three transport paths, namely, the transport paths 6, 7 and 43 extending through the tunnel 31 between stations, due to the fact that the transport paths can join within the tunnel, as illustrated in Fig. 7 trains 9 and 10 which for example would have been travelling on the first and second transport paths 6 and 7 can stand in the station 30 at the first and second platforms 20 and 22. Similarly, a train, for example referring to Figs 9 and 10, a third train 45 travelling on the third transport path 7 through the tunnel could stand in the station at the second platform 22, while one of the trains 9 and 10 travelling on the first and third transport paths 6 and 43 could proceed and stand on the first platform 20 simultaneously with the third train 45 on platform 22. It will also be appreciated that since there are three transport paths 6, 7 and 43 in the tunnel 31, by scheduling the trains on the three transport paths, an express train could be run on one of the three transport paths through the tunnel 31 and preferably on transport path 6 or on transport path 7, and would only stop at selected ones of the stations 30 in the tunnel 31, and would pass non-stop through the other stations on a selected one of the two transport paths in those stations.

[0030] Otherwise, the station 30 and the tunnel 31 are similar to the station 3 and the tunnel 1 described with reference to Fig. 1 to 4.

[0031] Referring now to Figs. 13 to 15, there is illustrated a station 40 according to another embodiment of the invention located in a tunnel 41, also according to the invention. The tunnel 41 and the station 40 and the access shaft 35 are substantially similar to the tunnel 1 and the station 3 and the access shaft 25 described with reference to Figs. 1 to 4, and similar components are identified by the same reference numerals. In this embodiment of the invention the bore 5 of the tunnel 41 is of internal diameter 12.5 metres approximately. Additionally, because of the larger diameter of the bore 5 of the tunnel 41, the tunnel 41 is capable of defining four transport paths, namely, first and second transport paths 6 and 7 and third and fourth transport paths 43 and 48, respectively. The first and fourth transport paths 6 and 48 are located at the first common level 42, while the second and third transport paths 7 and 43 are located at a second common level 62 located beneath the first common level 42. The spacing between the first and second common levels is such as to allow clearance for trains 10 and 45 travelling along the second and third transport paths. Additionally, the first common level 42 is at a level in the bore 5 of the tunnel 41 to provide clearance for trains 9 and 49 travelling in the bore 5 of the tunnel 41 in the first and fourth transport paths 6 and 48 on the first common level 42.

[0032] Turning now to the station 40, there are two types of stations 40 in the tunnel 41, one of the stations, namely, the station40a 40a, illustrated in Fig. 13, comprises two upper transport paths therethrough, and one lower transport path, while the station 40b, illustrated in Fig. 14 comprises two lower transport paths, and one upper transport path.

[0033] The first and fourth transport paths 6 and 48 are configured to transition into the two upper transport paths 6 and 48 extending side by side through the station 40a at the level 17, while the second and third transport paths 7 and 43 join each other in the tunnel 41 adjacent the station 40a and transition into the single second transport path 7 at the level 18 in the station 40a. However, in the station 40b the first and third transport paths 7 and 43 transition to the level 18 in the station 40b and run side by side through the station 40b at the level 18. The fourth transport path 48 joins with the first transport path 6 in the tunnel adjacent the station 40b and the first transport path 6 passes through the station 40b at the level 17. Accordingly, in the station 40a an express train on either the first or the fourth transport path can pass on the transport path 48 through the station 40a which is remote from the first platform 20, while a train from the other one of the first and fourth transport path in the tunnel 41 is standing in the station 40a adjacent the first platform 20. In the station 40b an express train on either one of the second and third transport path 7 and 43 can pass through the station 40b on the transport path 43 extending through the station 40b which is remote from the second platform 22 while a train on the other one of the second and third transport paths 7 and 43 is standing in the station 40b adjacent the second platform 22.

[0034] Accordingly, typically, the tunnel 41 will be provided with the stations 40a and 40b at sequentially alternate locations.

[0035] In this embodiment of the invention the width W_7 of the first platform 20 in the station 40a is 4.8 metres, while the width W_8 of the second platform 22 in the station 40a is 8.9 metres. In the station 40b the width W_9 of the first platform 20 is 8.9 metres, while the width W_{10} of the second platform 22 is 4.8 metres. All three transport paths

and the platforms in the stations 40a and 40b are contained within the envelope defined by the bore 5 of the tunnel 41. Also, in this embodiment of the invention an access shaft 35 extends vertically downwardly from ground level to the station 30, and is of circular transverse cross-section, substantially similar to the access shaft 25 of the station described with reference to Figs. 1 to 4.

[0036] The advantages of the invention are many. In particular, station platforms and transport paths, in general can be accommodated in the station within the envelope of the tunnel, thereby avoiding the need to form the tunnel of larger internal diameter in order to accommodate stations. Furthermore, schedules of local trains stopping at all stations and express trains which may stop at only selected ones of the stations are also accommodated.

[0037] A further advantage of the invention is that by virtue of the fact that the stations, including the transport path extending through the stations and the platforms in the stations, are all contained within the envelope defined by the bore of each tunnel, the entire platforms can be constructed underground without the requirement of having to excavate an opening from ground level to the tunnel, the width and the length of platforms of the station, which may be in congested areas where disruptions need to be kept to a minimum, in order to facilitate construction of the stations. The only opening required to be excavated from ground level to each station is the service opening for accommodating rescue access shafts, escalators, protected stairs, , lifts and other services to and from the stations.

[0038] It will be appreciated that the tunnels according to the invention may be mined or built by tunnel boring machines. It will also be appreciated that the size of the tunnel is governed by the gauge of the trains and that the trains may be any type of trains, be they trains suitable for rolling on rails, or trains with pneumatic tyres suitable for rolling on paved tracks, as for example in the Paris underground or any other type.

[0039] While the tunnels and the platforms and access shafts have been described as being of specific dimensions, tunnels of other dimensions and platforms of other dimensions and access shaft of other configurations and dimensions may be provided.

[0040] While the tunnels and the platforms have been described as being of specific dimensions, tunnels of other dimensions and platforms of other dimensions may be provided.

[0041] While the tunnels have been described as defining two or more transport paths, whereby at least one of the transport paths accommodates trains travelling in one direction, and at least another one of the transport paths accommodates trains travelling in the opposite direction, it is envisaged in certain cases, that the transport paths in each of the tunnels may accommodate two or more trains travelling in the same direction.

[0042] Additionally, it is envisaged that in certain cases, where the tunnels according to the invention and the train stations according to the invention are configured to accommodate express trains not stopping at every station, as well as trains travelling in the first and second transport paths, the transport path or paths for the express trains may be configured to accommodate reversal of the direction of the express trains at different times of the day.

[0043] It will of course be appreciated that the stations of Figs 13 and 14 could be incorporated into a tunnel in which the three transport paths passed through the tunnel on a first common level, as for example illustrated in the tunnel of Fig. 10.

[0044] The invention is not limited to the embodiments hereinbefore described which may be varied in construction and detail.

Claims

1. A station in a metropolitan transport system comprising an arrangement in a tunnel of station platforms which are offset vertically and horizontally one relative to the other and a complementary arrangement of transport paths which are offset vertically and horizontally one relative to the other.

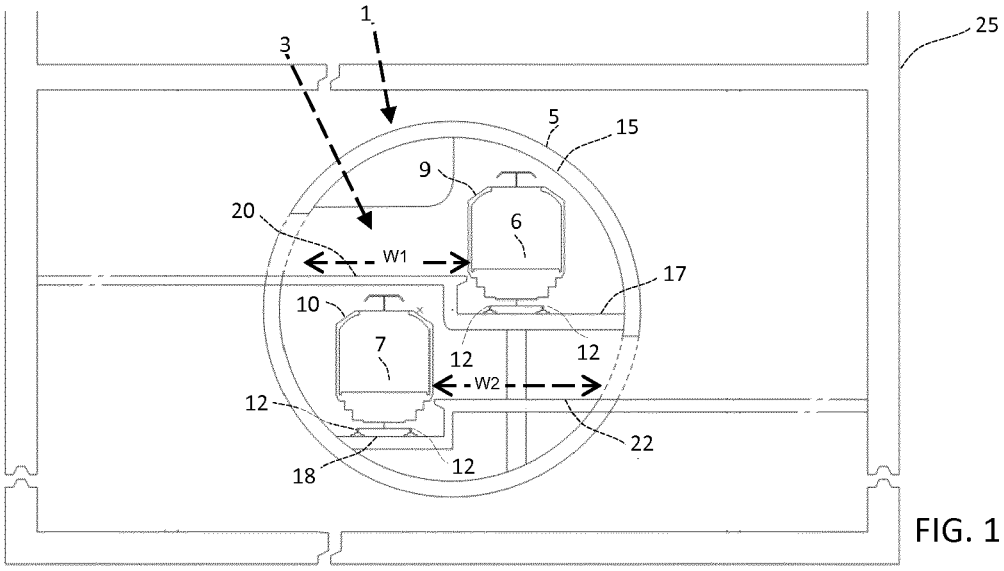
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FIG. 1

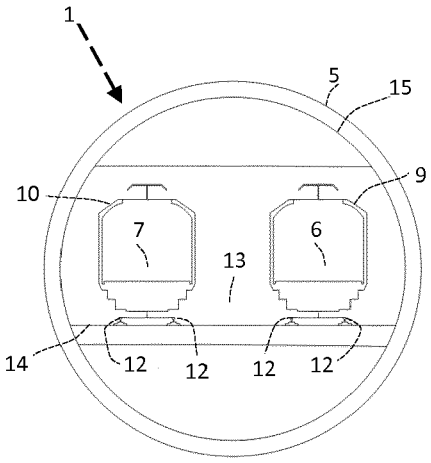
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FIG. 2

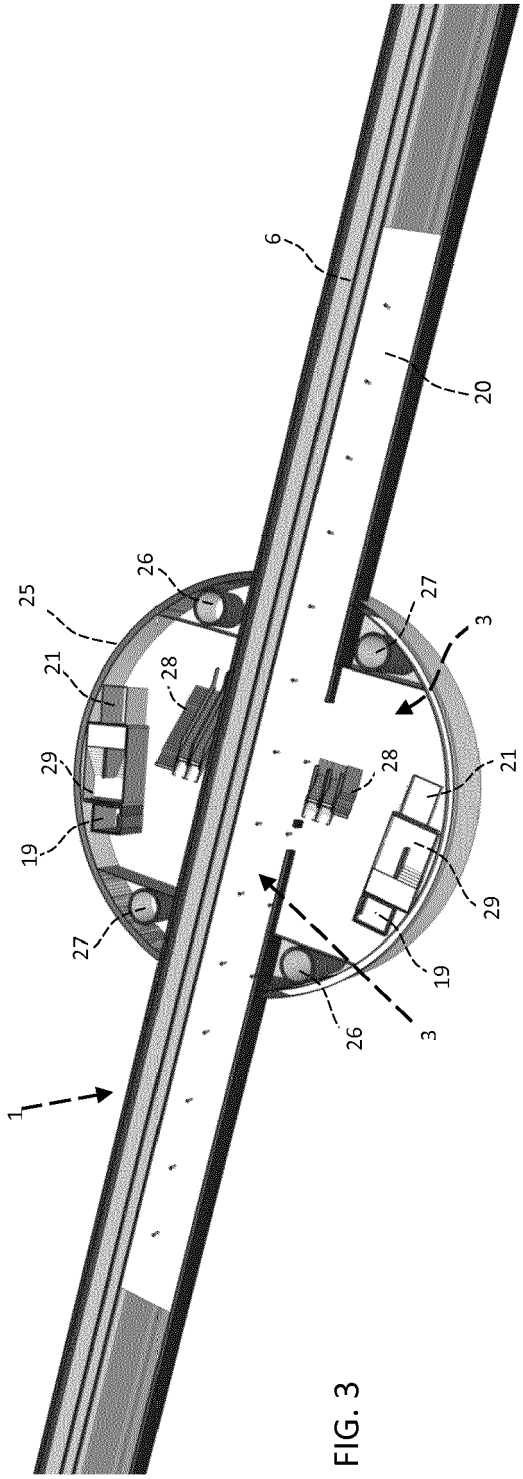

FIG. 3

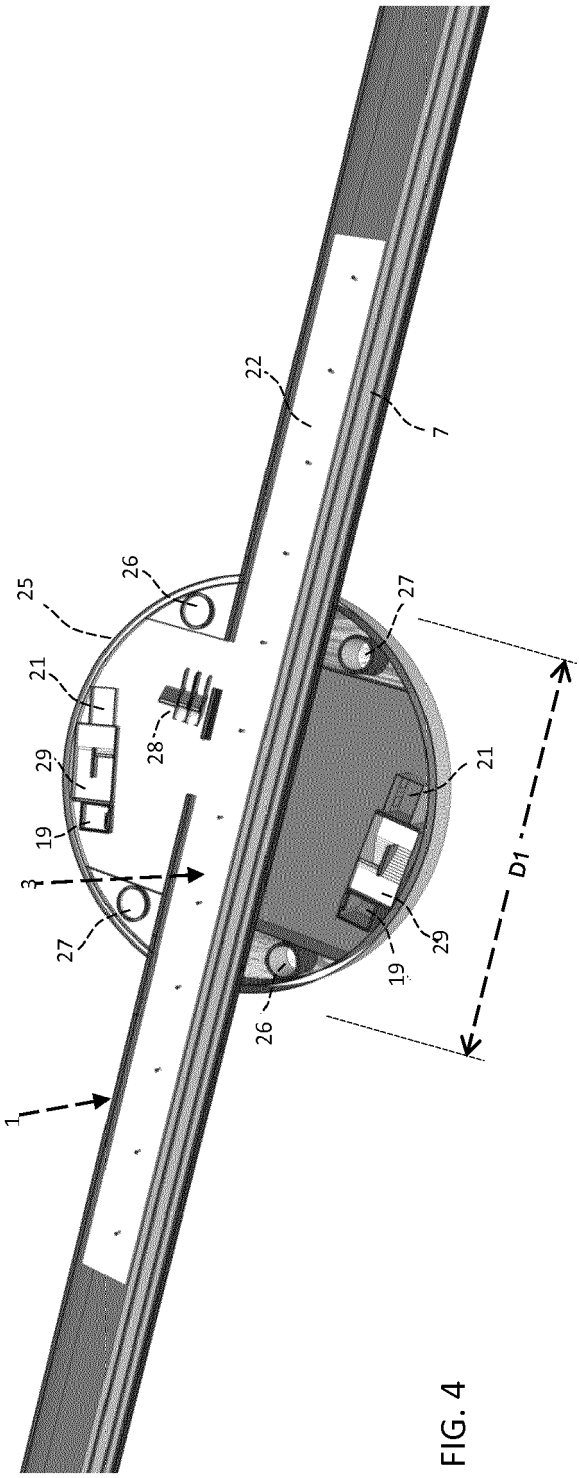

FIG. 4

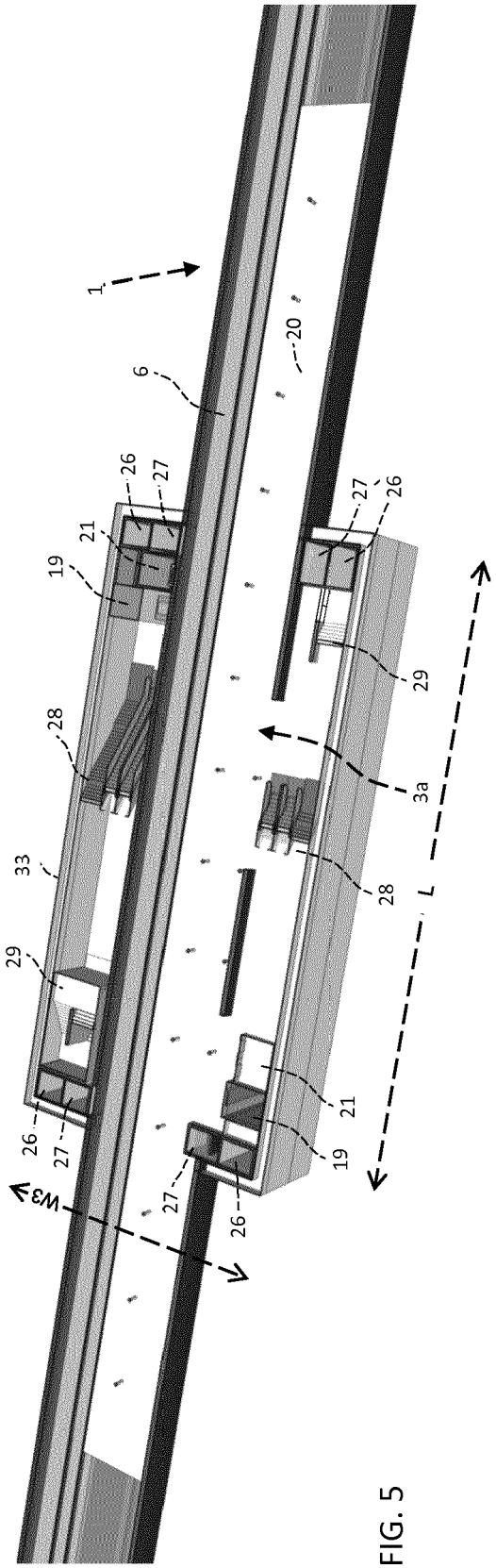

FIG. 5

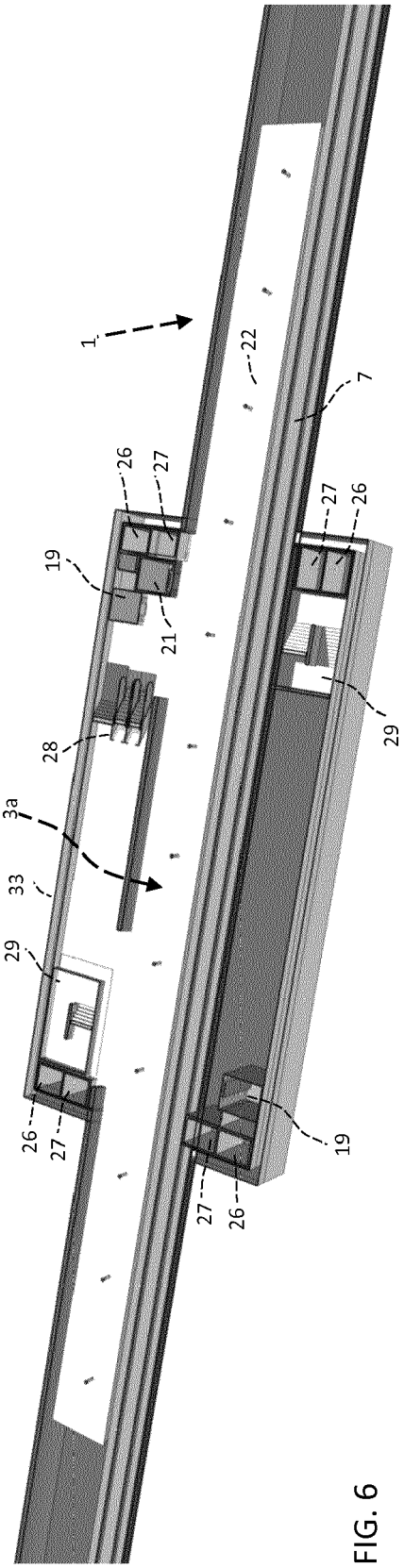

FIG. 6

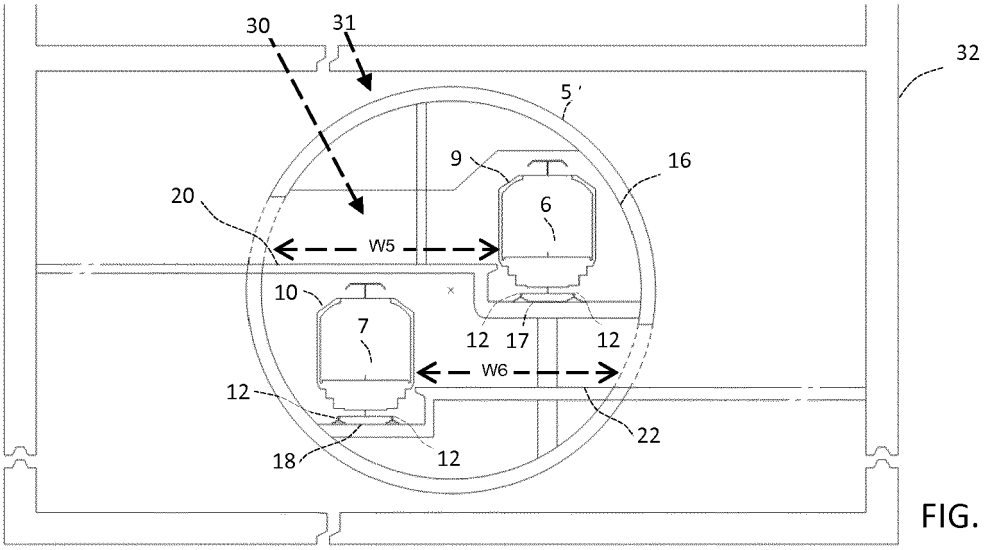
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FIG. 7

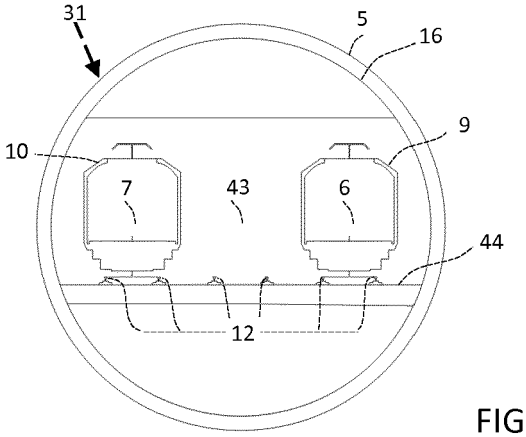
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FIG. 8

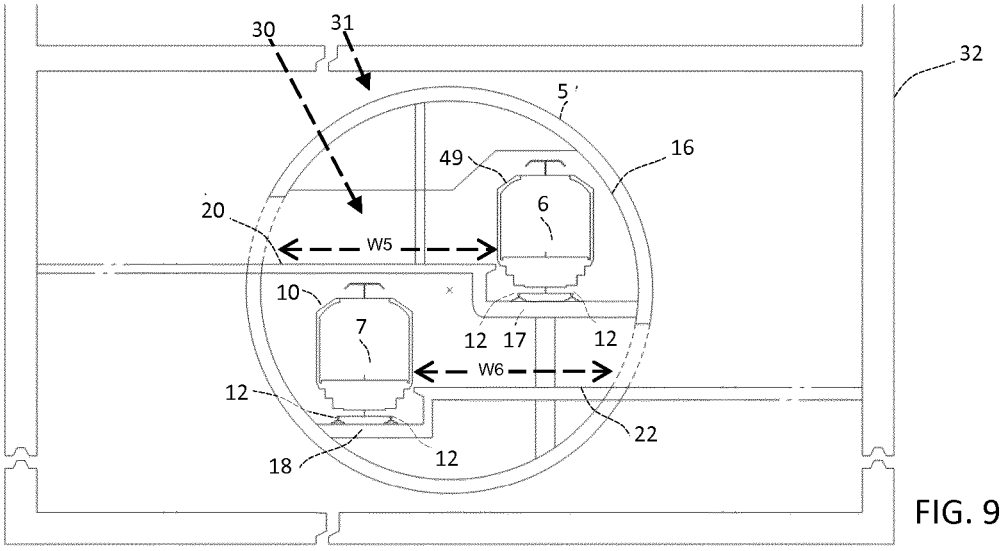
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FIG. 9

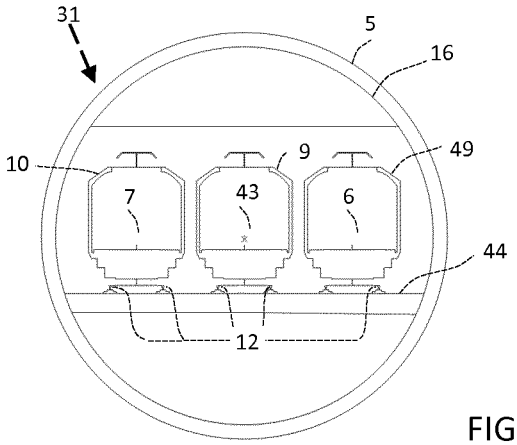
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FIG. 10

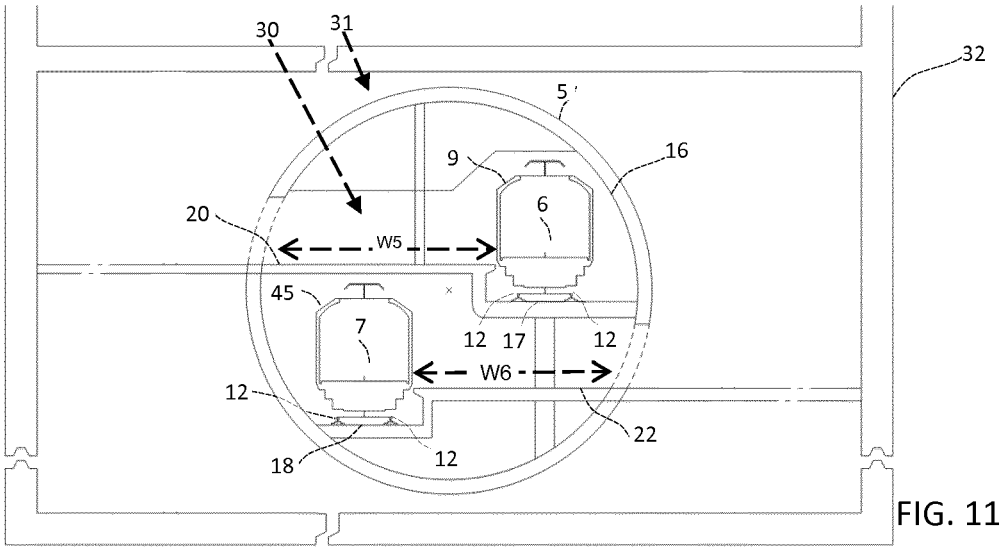
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FIG. 11

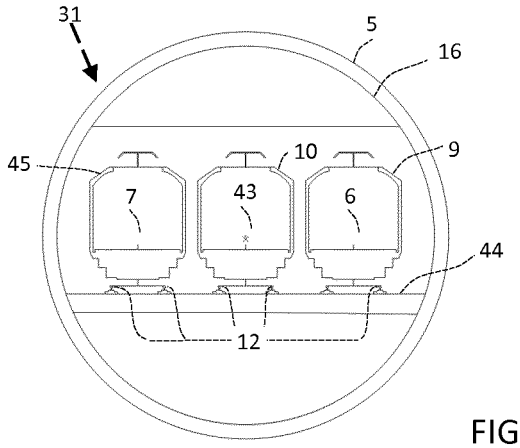
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FIG. 12

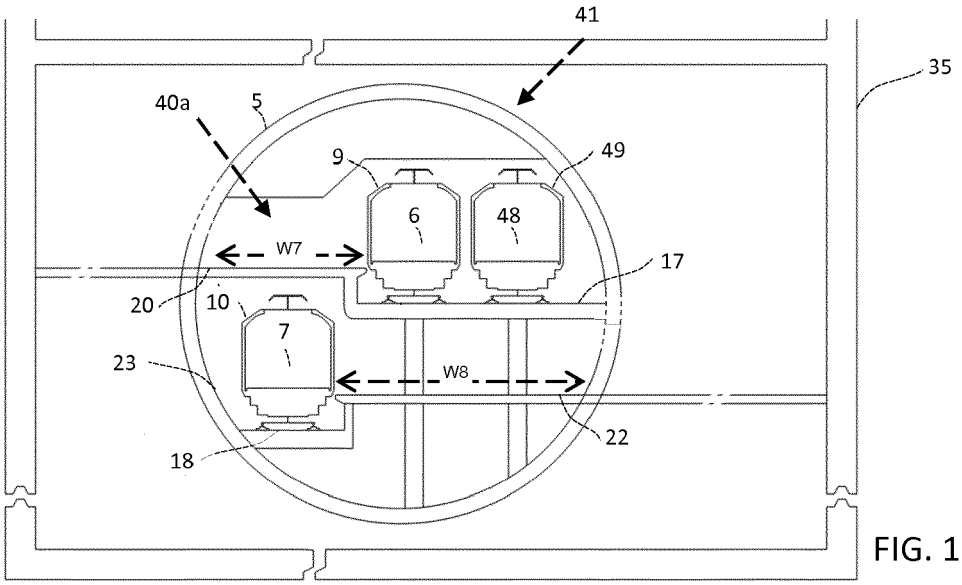

FIG. 13

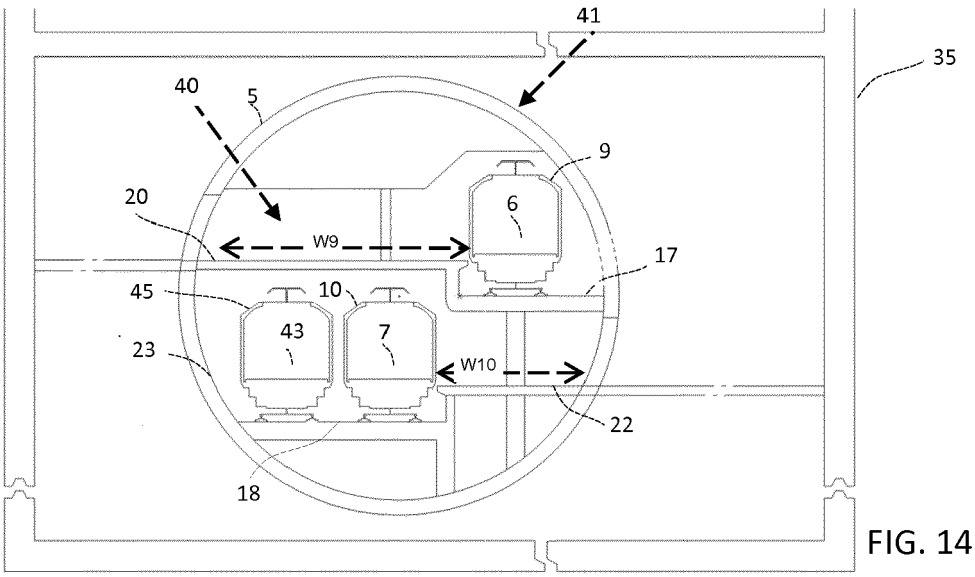

FIG. 14

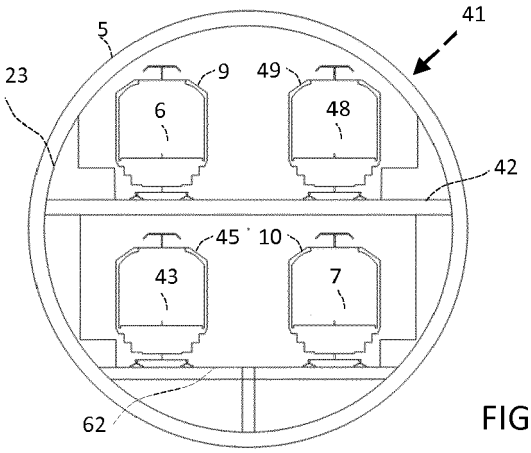

FIG. 15

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EUROPEAN SEARCH REPORT

Application Number
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	4 October 2017	Awad, Philippe

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