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(54) **METROPOLITAN TRANSPORT SYSTEM AND METHOD**

(57) Metropolitan transport method and system that allows maximizing journey time commitment and network coverage by running a first train (1) in a first direction, defined from a starting point to a finishing point of a route comprising a plurality of stopping stations (2, 2'), where said first train (1) runs through a tunnel (3) comprising

two levels (4, 5), said first train (1) running on a first level (4) of the tunnel (3) and stopping at all the stopping stations (2, 2') on the route; the method also comprising running a second train (6) in the first direction of the route on the second level (5) of the tunnel (3), where said second train (6) does not stop at all the stopping stations (2, 2') on the route.

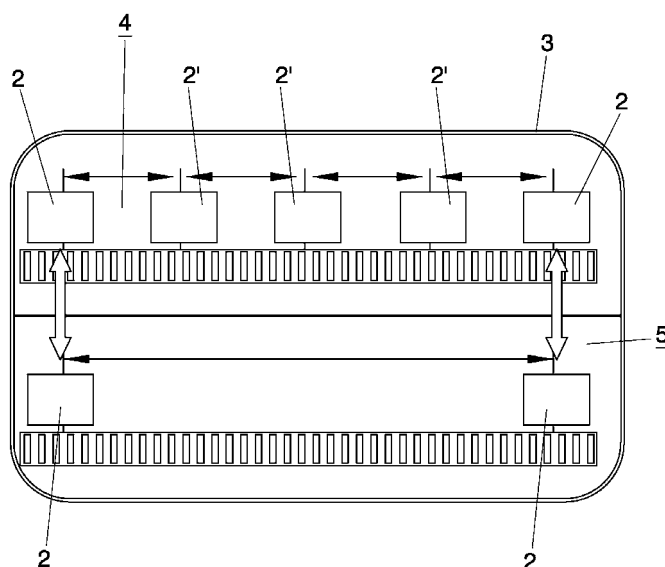


FIG. 2

Description

Technical Field of the Invention

[0001] The present invention relates to a metropolitan transport method and system that can be applied in the people transport industry, and more specifically in the area of commuter transport, that allows maximizing journey time commitment and network coverage by using at least two rail transport lines located at a different level in the same tunnel.

Background of the Invention

[0002] Demographic trends indicate that the current process of concentrating a large majority of the world population in large cities will continue. In this sense, prognoses indicate that in the year 2025 there will be over 20 cities exceeding 10 million inhabitants and another 20 more cities exceeding 5 million inhabitants. Overcrowded cities are expected to cover areas of hundreds of square kilometers, so said cities correspond with polycentric models with urban routes and transport thoroughfares that can be up to 100 km long.

[0003] At the same time, given that territorial and urban policies cannot be altered in the short- or mid-term, the necessary number of journeys and/or the distance to be traveled in each journey by part of the population, with the subsequent journey time increase this entails, is also expected to continue increasing.

[0004] However, in order to meet transport requirements in the aforementioned scenarios, the time used for the mobility necessary for carrying out economic activity in large cities is must to be reduced, which today is a fundamental objective of metropolitan rail transport. Therefore, in this situation metropolitan rail transport systems clearly prove themselves to be absolutely necessary tools to continue solving the mobility problems that are raised.

[0005] It is necessary to consider that a greater economic growth entails greater mobility needs and more time used in trips, with the subsequent increase in the social cost this entails. The time used in the mobility of people in big cities therefore becomes as key aspect to assure sustainability, and as explained, this factor will be even more important in the future.

[0006] Various solutions have been proposed today for the purpose of considering the mobility problems that are used in overpopulated major cities, some of which are described, for example, in Japanese patent application no. JP-1304294-A, where a rail transport system comprising a tunnel split into two heights for running one line at each height is described, or in international application no. WO-2004/094785-A1, where a tunnel having divisions at two levels for different transport paths or flows in general is described.

[0007] In this sense, the solutions described both in Japanese patent application no. JP-1304294-A and in

British patent application no. GB-913736 refer to tunnels suitable for a railway passages where said passages are superimposed in height, these solutions being aimed at a single line in the upper part of the passage and another in the lower part.

[0008] However, none of these solutions approaches the drawbacks described above in depth in relation to the growth of urban areas and the subsequent increase in distances traveled on journeys, which entails the need to increase speed in trips as a means of reducing journey time, while at the same time taking into consideration the expectations of the users of subway networks, which include assuring high capillarity of the metropolitan area assuring a high degree of network coverage, understanding this aspect as the existence of a subway station in a radius of several hundred meters, which entails a schedule speed penalization due to the need of a high number of stops, making it impossible to reduce journey times.

Description of the Invention

[0009] A first aspect of the present invention relates to a metropolitan transport method that allows maximizing journey time commitment and network coverage.

[0010] The metropolitan transport method proposed by the invention comprises running at least one first train in a first direction defined from a starting point to a finishing point of a route comprising a plurality of stopping stations.

[0011] Routes of those normally referred to as "circular" or closed routes in which the starting point coincides with the finishing point are obviously contemplated, actually comprising a plurality of stations in which a starting station and a finishing station are not distinguished.

[0012] Said first train runs through a tunnel comprising at least two levels, said first train running on a first level of the tunnel and stopping at all the stopping stations on the route.

[0013] On the other hand, the method comprises running at least one second train in the first direction of the route on the second level of the tunnel, where said second train does not stop at all the stopping stations on the route.

[0014] The main advantage of the invention is that the commitment between the increase in schedule speed, which allows reducing journey times, while at the same time maintaining high capillarity that allows assuring a large subway network coverage, for which purpose there is a local line on the first level and an express line on the second level, sharing the stations where both have a stop, and arranged vertically in the same tunnel section is met.

[0015] The express line allows giving the resulting line higher schedule speed with respect to a conventional subway line while at the same time the local line assures coverage of the conventional line. This technical solution is therefore innovative and allows maximizing journey time commitment and network coverage by means of two lines.

[0016] The local line is a conventional wide coverage line, i.e., a line with trains stopping at all the stations on the route, whereas the express line has fewer stops than the local line, i.e., trains running on the express line do not stop at all the stations all to enhance a faster schedule speed.

[0017] The possibility of the method comprising running at least one third train in a second direction defined from the finishing point to the starting point of the route, running on the first level of the tunnel and stopping at all the stopping stations on the route, is contemplated. The method comprising running at least one fourth train in the second direction of the route running on the second level of the tunnel, where said fourth train does not stop at all the stopping stations on the route, is also contemplated.

[0018] Both directions of the same subway line on each level would thereby be covered, one line being arranged on the first level and another line on the second level, each with their two running directions for the same route.

[0019] A second aspect of the present invention relates to a metropolitan transport system working according to any of the methods described above.

[0020] According to the invention, the system comprises a plurality of first stopping stations operatively configured so that the trains running on said first level and second level stop.

[0021] The system also comprises a plurality of second stopping stations operatively configured so that only the trains running on the first level stop.

[0022] The possibility of the second stopping stations being able to be converted into first stopping stations by incorporating installations is contemplated.

[0023] The geometry, structure and configuration of the second stopping stations, i.e., of the stations where only the trains from the local line stop, and of the first stopping stations, i.e., of the stations where trains from both the local line and from the express line stop, are the same. However, the equipment of both types of stations for the lower level or express level is different according to the type of station, so the stopping stations have two different typologies.

[0024] The fact that both types of stations have the same geometry allows converting the second stopping stations into first stopping stations by simply equipping them with the necessary installations and equipment. The design of the access aids in entering the vestibule as directly as possible.

[0025] Being able to switch trains between the local line and the express line is also contemplated to assure greater rolling stock availability, such that the rolling stock of both lines is of the same type, having the same signaling and the same power supply system.

[0026] The second stopping stations on the second level, i.e., on the express line running level, can be considered as emergency stations, for which reason they do not have the same vertical mechanical transport elements on said level as in the first stations, where express

line trains do stop.

Description of the Drawings

[0027] To complement the description being made and for the purpose of aiding to better understand the features of the invention according to a preferred practical embodiment thereof, a set of drawings is attached as an integral part of said description, where the following has been depicted with an illustrative and nonlimiting character:

Figure 1 shows a schematic cross-section view of the metropolitan transport system proposed by the invention.

Figure 2 shows a schematic longitudinal section view of the tunnel of the system of the invention, where a two-level configuration of the stopping stations of the tunnel according to a preferred embodiment of the method and the system of the invention can be seen. Figure 3 shows a schematic perspective view of the first level of a second stopping station.

Figure 4 shows a schematic perspective view of the second level of the second stopping station depicted in Figure 3.

Figure 5 shows a schematic perspective view of the first level of a first stopping station.

Figure 6 shows a schematic perspective view of the second level of the first stopping station depicted in Figure 5.

Preferred Embodiment of the Invention

[0028] In view of the discussed drawings, it can be seen how in all the possible embodiments of the invention the metropolitan transport method proposed by the invention comprises running a first train (1) in a first direction defined from a starting point to a finishing point of a route comprising a plurality of stopping stations (2, 2').

[0029] Said first train (1) runs through a tunnel (3) comprising two levels (4, 5), said first train (1) running on a first level (4) of the tunnel (3) and stopping at all the stopping stations (2, 2') on the route.

[0030] On the other hand, the method comprises running a second train (6) in the first direction of the route on the second level (5) of the tunnel (3), where said second train (6) does not stop at all the stopping stations (2, 2') on the route.

[0031] A local line is on the first level (4), and an express line is on the second level (5), both lines being interconnected at certain stations and arranged vertically in the same tunnel section (3).

[0032] Both the express and the local lines travel through the same tunnel (3) which, according to a preferred embodiment, has an outer diameter of 13 m and an inner diameter of 12 m. Auxiliary stationary and dynamic clearance studies have been conducted which confirm that running trains in tunnels (3) with an inner

diameter of 11.5 m, which turns out to be the one that could be obtained per se, is possible.

[0033] The method comprises running a third train (7) in a second direction defined from the finishing point to the starting point of the route, running on the first level (4) of the tunnel (3) and stopping at all the stopping stations (2, 2') on the route. The method also comprises running at least one fourth train (8) in the second direction of the route running on the second level (5) of the tunnel (3), where said fourth train (8) does not stop at all the stopping stations (2, 2') on the route.

[0034] The train (6, 8) running on the second level (5) stopping every four stopping stations (2) is also contemplated. According to a preferred embodiment, an inter-station distance of 700 m, which is the mean European metropolitan network inter-station distance, is selected for the local line.

[0035] A second aspect of the present invention relates to a metropolitan transport system working according to any of the methods described above.

[0036] As can be seen in Figure 2, the system comprises a plurality of first stopping stations (2) operatively configured so that the trains (1, 6, 7, 8) running on said first level (4) and second level (5) stop. The system also comprises a plurality of second stopping stations (2') operatively configured so that only the trains (1, 7) running on the first level (4) stop.

[0037] The possibility of the second stopping stations (2') being able to be converted into first stopping stations (2) by incorporating installations is contemplated.

[0038] The fact that both types of stations (2, 2') have the same geometry allows converting second stopping stations (2') into first stopping stations (2) by simply equipping them with the necessary installations and equipment. The design of the access aids in entering the vestibule as directly as possible. The platform length is 120 m, but other lengths are contemplated depending on the rolling stock used in the operation.

[0039] Being able to switch trains between the local line and the express line is also contemplated to assure greater rolling stock availability, such that the rolling stock of both lines is of the same type, having the same signaling and the same power supply system.

[0040] As can be seen in Figure 4, the second stopping stations (2') on the second level (5), i.e., on the express line running level, can be considered as emergency stations, for which reason they do not have the same vertical mechanical transport elements on said level as in the first stopping stations (2), depicted in Figure 6, where express line trains (6, 8) do stop. The signaling system is the same in the local line and in the express line to assure interoperability of the trains between both lines.

[0041] According to a preferred embodiment, the first level (4) of the tunnel (3) is above the second level (5). Since it is a vertical arrangement, the local line occupies the upper level as it has a larger number of user accesses. The express line also occupies the lower level because the trains reach a higher speed, giving rise to more noise

and vibrations, so the farther the emitting source is from building foundations, the fewer disturbances will be induced in said buildings.

[0042] In view of this description and set of drawings, a person skilled in the art will understand that the embodiments of the invention which have been described can be combined in many ways within the object of the invention. The invention has been described according to several preferred embodiments thereof, but it will be evident for the person skilled in the art that many variations can be introduced in said preferred embodiments without exceeding the object of the claimed invention.

15 Claims

1. Metropolitan transport method, **characterized in that** it comprises running at least one first train (1) in a first direction, defined from a starting point to a finishing point of a route comprising a plurality of stopping stations (2, 2'), where said at least one first train (1) runs through a tunnel (3) comprising at least two levels (4, 5), said at least one first train (1) running on a first level (4) of the tunnel (3) and stopping at all the stopping stations (2, 2') on the route; the method also comprising running at least one second train (6) in the first direction of the route on the second level (5) of the tunnel (3), where said at least one second train (6) does not stop at all the stopping stations (2, 2') on the route.
2. Metropolitan transport method according to claim 1, **characterized in that** it comprises running at least one third train (7) in a second direction defined from the finishing point to the starting point of the route running on the first level (4) of the tunnel (3) and stopping at all the stopping stations (2, 2') on the route; the method also comprising running at least one fourth train (8) in the second direction of the route running on the second level (5) of the tunnel (3), where said at least one fourth train (8) does not stop at all the stopping stations (2, 2') on the route.
3. Metropolitan transport method according to any of the preceding claims, **characterized in that** said at least one train (6, 8) running on the second level (5) stops every four stopping stations (2).
4. Metropolitan transport system working according to the method defined in any of the preceding claims, **characterized in that** it comprises a plurality of first stopping stations (2) operatively configured so that the trains (1, 6, 7, 8) running on said first level (4) and second level (5) stop; comprising a plurality of second stopping stations (2') operatively configured so that only the trains (1, 7) running on the first level (4) stop.

5. Metropolitan transport system according to claim 4, **characterized in that** the second stopping stations (2') can be converted into first stopping stations (2) by incorporating installations.

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6. Metropolitan transport system according to any of claims 4 and 5, **characterized in that** the first level (4) of the tunnel (3) is above the second level (5).

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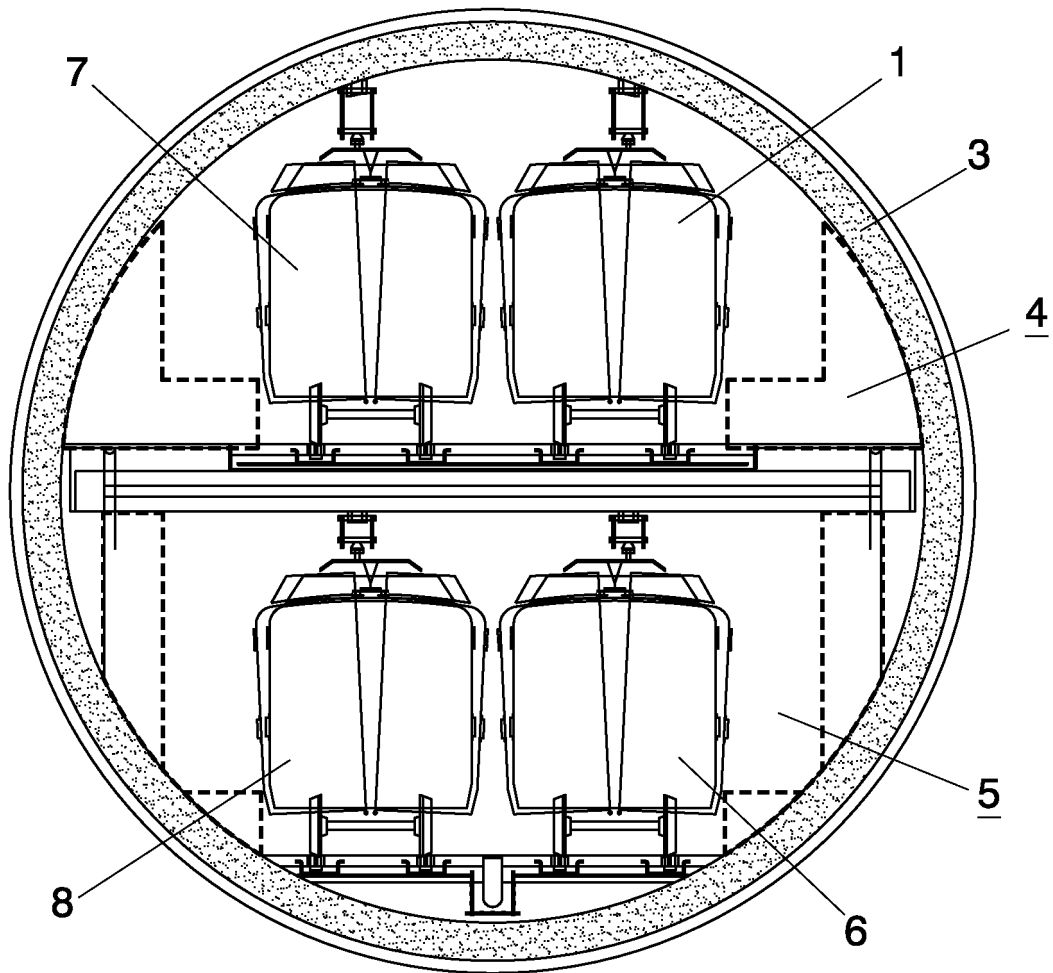


FIG. 1

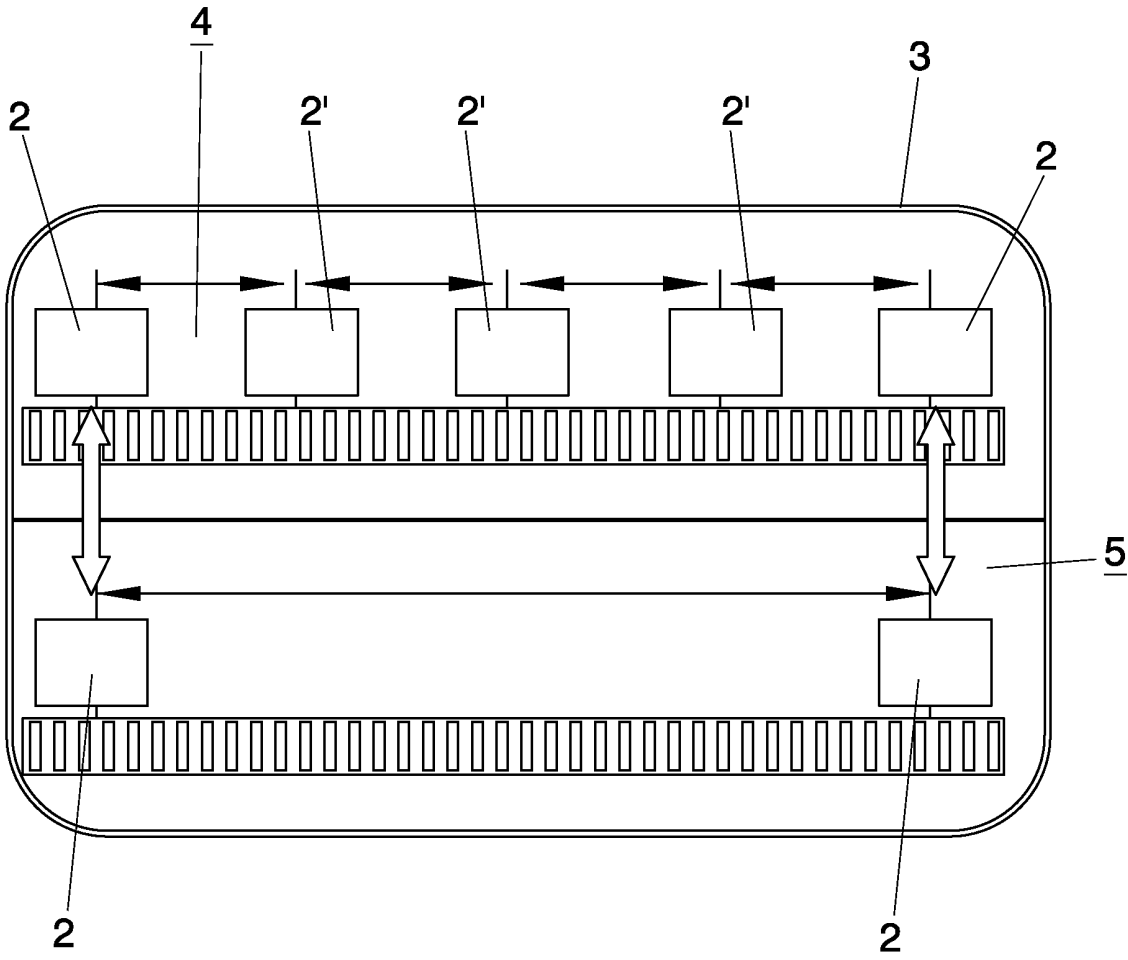


FIG. 2

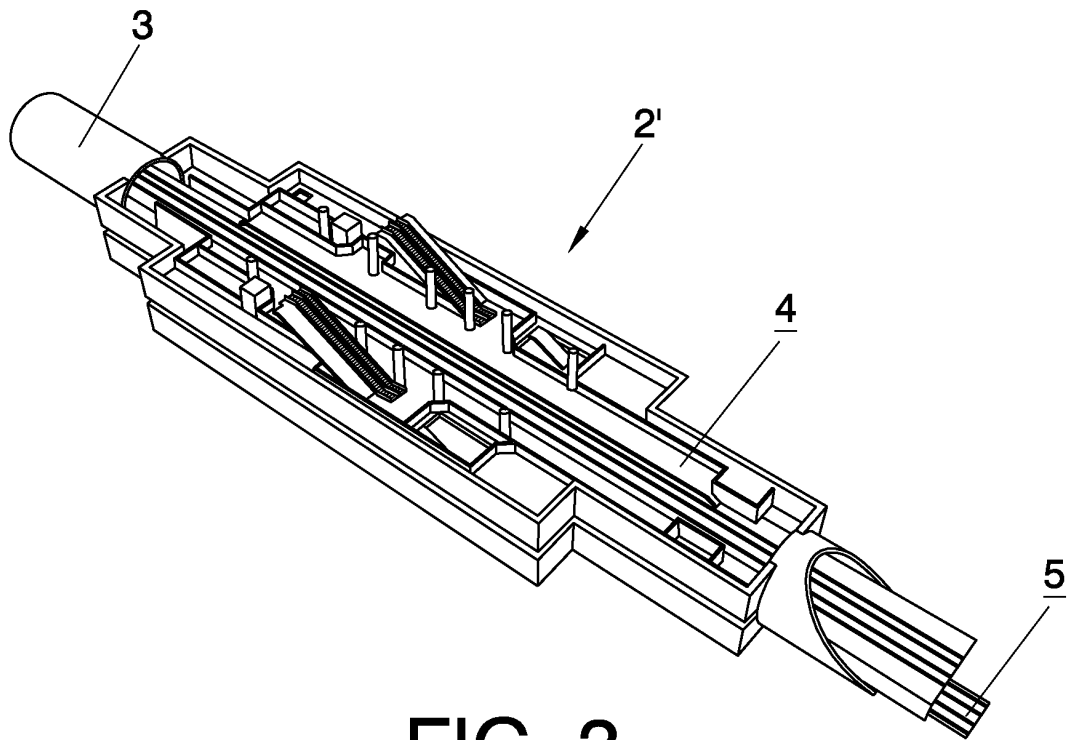


FIG. 3

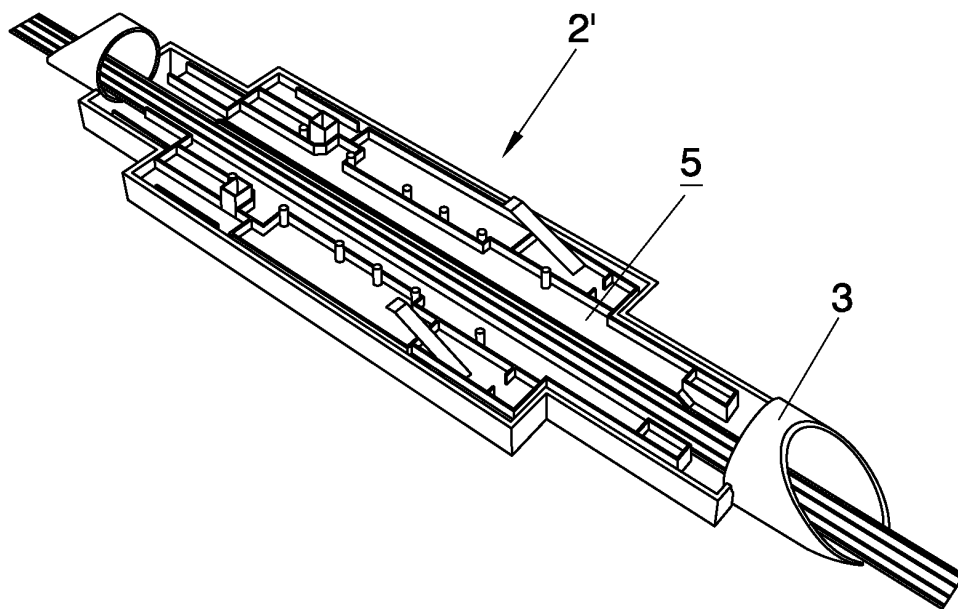


FIG. 4

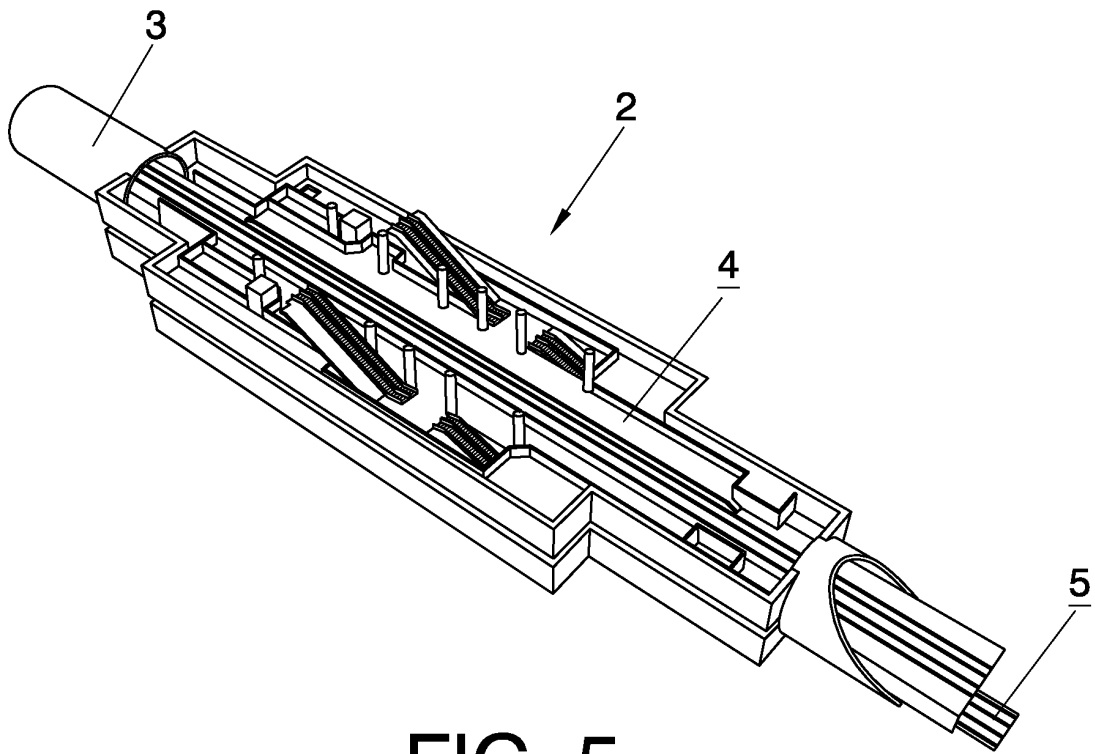


FIG. 5

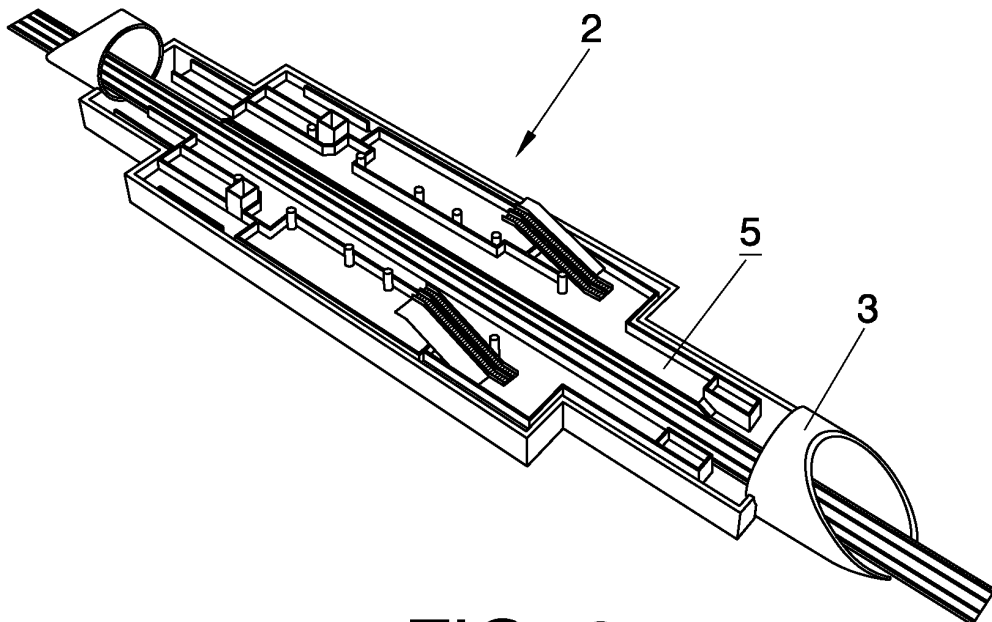


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/ES2011/070030

A. CLASSIFICATION OF SUBJECT MATTER

E21D9/14 (2006.01)*B61B13/10* (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E21D, B61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, INVENES

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	ES 391632 A1 (MINING EQUIPMENT MANUFACTURING) 01/06/1974, page 3, lines 20-27; page 5, line 1 - page 6, line 11; page 7, lines 8-21; page 9, line 16 - page 10, line 12; figures 1-3,5-7	1-6
A	JP 1304294 A (HARA SHUSAKU) 07/12/1989, figures & Abstract from DataBase EPODOC. Retrieved from EPOQUE; AN JP-13395888-A	1

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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Date of the actual completion of the international search

28/03/2011

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/ES2011/070030

C (continuation).		DOCUMENTS CONSIDERED TO BE RELEVANT
Category *	Citation of documents, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2005023765 A (HARA SHUSAKU) 27/01/2005, figures & Abstract from DataBase EPODOC. Retrieved from EPOQUE; AN JP-2003287193-A	1
A	DE 2127156 A1 14/12/1972, figures 1-7	1

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/ES2011/070030

Information on patent family members

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----- JP2005023765 A	----- 27.01.2005	----- JP4186061B2 B	----- 26.11.2008
----- DE2127156 A	----- 14.12.1972	----- NONE	----- -----

Form PCT/ISA/210 (patent family annex) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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- WO 2004094785 A1 [0006]
- GB 913736 A [0007]