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(54) Improved material conveyance system using powered trolleys on a suspended rail.

(57) A conveyance system (10) with suspended rail (11) comprises trolleys (12) with an upper drive wheel (13) and lower bucking rollers (15,16). The wheel and the rollers are supported rigidly so as not to have reciprocating translation movements.

Each trolley (12) has a geometry such as to cause a rotation moment around the upper wheel (13) when the trolley negotiates sloped sections of rail so as to increase the force of contact of the driving wheel (13) on the rail. The rail (11) has a cross section of variable height along its extension to allow holding uniform the distance between the wheel and the rollers despite curves for changing altitude.

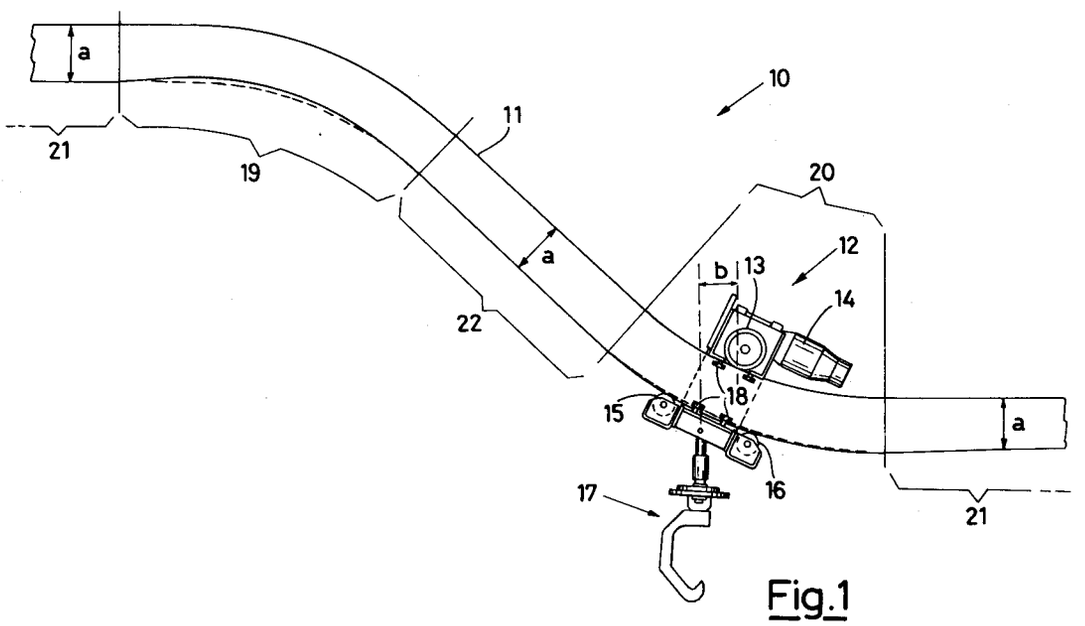

Fig.1

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In the art of internal transportation in factories there are known systems called "self-powered" which consist of a monorail suspended on which there run powered trolleys supplied through an electrical distribution line arranged along the monorail.

The trolleys usually have a drive wheel placed above the rail and bucking rollers place below it. Adherence of the powered upper wheel on the monorail is generally sufficient for level movement and along slight rises.

For inclined sections with relatively steep slope there have been proposed lower pressing rollers equipped with a generally sprung system thrusting toward the rail so as to increase adherence of the drive wheel on the rail as for example described in Italian patent n. 202807 in the name of FATA European Group.

The use of pressing wheels, in addition to being costly, has the drawback of increasing the space occupied by the trolleys with the resulting greater sizing of the entire transportation line. In addition said solution calls for very accurate selection and regulation of the pressures on the rollers to achieve a compromise between ensuring adherence of the drive wheel along the steeper rises of the path with the maximum load transportable and excessive generation of stresses on the structure during level running. Even if the optimal compromise is achieved the pressing rollers are provided to ensure substantially uniform operation and hence supply the friction necessary for running on the steepest rises even when running on level sections or with slight slopes with evident useless stressing of the mechanical parts of the trolley and increase of wear on the rolling gear and the rail. To obviate this last shortcoming there has been proposed, as described in Italian patent application no. 21977 B/90 in the name of the same applicant a system of handling using cars with a pressing device which is loaded only in the sloping sections thanks to thickening thereof in relation to the thickness of the rail in the level sections. Said solution, while achieving its ends, is however still encumbered to a certain degree by the cost of the pressing devices and by their construction complexity and their need for adjustment.

Another drawback of the solutions of the known art is that assembly of the lower rollers with elastic pressure means allows the trolleys to swing in the direction of travel. Said swinging is detrimental in the case of transportation systems along which is performed processing of the loads carried. For this reason in the known art there are generally used self-powered trolleys capable of negotiating sloping sections independently as described above in the case of systems where processing is performed on the loads moving along the line of transportation.

The general object of the present invention is to obviate the above mentioned drawbacks by supplying a transportation system of the self-powered type which would allow ascending and descending ramps with relatively steep slopes with trolleys of limited size and complexity free from swinging and with thrust of the drive wheel on the rail substantially a function of the slope negotiated.

In view of said object it has been sought to provide in accordance with the present invention a suspended rail system for the transportation of loads hung on trolleys each having an upper drive wheel and a plurality of lower bucking rollers running on the upper surface and on the lower surface respectively of the rail, said rail having level sections and sloped sections, and characterized in that in combination the upper wheel and the lower rollers are rigidly connected to each other, the wheel, rollers and point of application of the load bearing on the trolley are mutually arranged so that, when running in sloping sections, the straight line of application of the total weight bearing on the trolley does not pass through the centre of the wheel, to produce a rotation moment opposed by at least one of said plurality of wheels. The rail has uniform thickness substantially equal to the distance between the rollers and the wheel in the horizontal sections and in sloped straight sections, in curved sections with upward convexity decreasing in thickness in a filleted manner to maintain contact between the rollers and the wheel and the respective surfaces of the rail along said curved sections with minimal play and no interference.

To further clarify the explanation of the innovative principles of the present invention and its advantages as compared with the known art there is described below with the aid of the annexed drawings possible embodiments as nonlimiting examples applying said principles. In the drawings -

- FIG. 1 shows a schematic side view of a section of the system in accordance with the present invention, and
- FIG. 2 shows a variant embodiment of the trolley of FIG. 1.

With reference to the figures FIG. 1 shows schematically a sloping section of a system provided in accordance with the innovative principles claimed herein and indicated generally by reference number 10 with independently powered trolleys running on a rail 11.

Reference number 12 indicates one of the trolleys of the system; said trolleys being substantially identical, only one of them is described and illustrated below. Each trolley comprises an upper wheel 13 for drive and support and kinematically connected to an electric motor 14 and a pair of lower bucking idling rollers 15 and 16. The lower idling rollers and the upper wheel are supported on

the trolley frame rigidly so as to be positioned at the angles of an imaginary, invariable and substantially isosceles triangle.

Advantageously beside the trolley there are also placed idling rollers 18 for guiding along the side profile of the rail.

Below, the trolley 12 comprises articulated means of support 17 on which to hang transported loads, e.g. automobiles parts along an assembly line.

The point of application of the total load bearing on the trolley, the rollers 15, 16 and the wheel 13 are mutually arranged so that when running in the sloping sections the vertical straight line passing through the centre of gravity of the load does not pass through the centre of the wheel. In particular said straight line passes upstream of the upper wheel and of the lower wheel further downstream, with reference to the inclination of the rail and hence, in the case of the annexed figure, passes to the left of the wheel and the roller 16. Advantageously during level travel said centre of gravity is substantially arranged on the vertical of the upper wheel.

The reasons for such arrangements will be given below. In the level sections 21 and sloping straight sections 22 the rail has a uniform thickness "a" equal to the distance between the lower rollers and the upper wheel. In the curved sections with upward convexity as for example that indicated by reference number 19 in the figure the rail decreases in thickness in a filleted manner so as to maintain contact between the rollers and the wheel with the respective surfaces of the rail with minimum play and without the interference which there would be otherwise, The reduced thickness can be obtained simply by milling a normal rail with uniform thickness.

Similarly in the curved sections with upward concavity as for example that indicated by reference number 20 in the figure the rail increases in thickness in a filleted manner so as to recover the play which there would otherwise be between the lower rollers and the rail. In this case also the variation in thickness can be obtained starting with a rail with uniform thickness by fixing thereto appropriate shimming.

To further clarify said thickness variations the figure shows in broken lines the development of a rail of the know art with uniform thickness. The exact shape of the rail in accordance with the present invention is easily obtained with trajectories described by the rollers and by the wheel during movement of the trolley along a line representing its path.

In use when running on the level the trolley is merely hung on the wheel 13 and the rigid geometry of the rollers 15 and 16 supplies reaction simply to prevent swinging of the trolley in the direction of travel. There is therefore no useless friction caused by pressure means as in the known art.

As stated above, in negotiating sloping sections the vertical of the point of application of the weight transported no longer passes through the upper wheel.

There is thus produced an arm "b" which generates a moment which tends to cause the trolley to rotate (e.g. counter-clockwise as shown in the drawing). Said moment is opposed by one of the two rollers and this pushes the upper wheel against the rail. With the arrangement shown in the figure the roller bucking rotation will be the roller 16 while the roller 15 will have a virtual contact with the rail.

The thrust on the wheel tends to increase the adherence thereof proportionately to the load of the trolley. At the same time the rigid geometry of the wheels and the rollers and the form of the rail continue to prevent undesirable swinging of the trolley and this also prevents jumping of the trolleys when starting on slopes.

It is now clear that the objects of the invention are achieved. Thanks to the above described principles it has been surprisingly found possible to perform a movement, even with changes in the slope of the rail, without using pressing rollers but, on the contrary, using trolleys with rollers and wheels rigidly interconnected.

Running on rises is thus assured with a very simple mechanical embodiment of the trolleys which is small and truly economical. In addition the trolleys are prevented from any swinging movement in the direction of travel, whether in level or rising travel, allowing processing of the objects transported at any point of the path even with the trolley moving.

Finally, within ample limits of weight carried and inclination of the rail the thrust on the drive wheel is practically self-adjusting without generating useless stresses and friction as happened with embodiments of the known art.

Naturally the above description of an embodiment applying the innovative principles of the present invention is given merely by way of example and therefore is not to be taken as a limitation of the patent right claimed here.

For example, it is obviously possible to provide in accordance with the present invention, as readily imaginable by those skilled in the art, multiple trolleys, i.e. made up of two or more trolleys as described above and interconnected by a hinged joint.

In addition, the variations in thickness of the rail, even though indicated as being made on the lower side thereof, can obviously be made on the top.

Naturally, if in the concave sections it is not considered necessary to prevent jumping on restarting of the trolley and swinging during travel it is possible to omit thickening of the rail.

Finally, the physical structure of the trolleys can be different from that shown by way of example, e.g. the rollers could be in a number different from that shown; it is sufficient that during ascending travel the straight vertical line passing through the centre of gravity of the total weight bearing on the trolley does not pass through the centre of the upper wheel and that at least one lower roller be in a position such as to oppose the moment thus generated in such a manner as to increase the thrust of the wheel on the rail. The point of application of the load transported on the trolley must be selected to supply the arm "b" at least enough to produce the necessary adherence of the wheel according to the slope of the rail.

For example, to increase the arm "b" for equal inclination of the rail the joint to which the trolley load is hung could be placed at a greater distance downward from the lower rollers.

FIG. 2 shows a construction variant of the trolley which furnishes an arm b' greater than the arm b of FIG. 1 without substantially increasing the overall vertical dimension of the trolley. In this variant the trolley 12' (otherwise similar to the trolley 12 of FIG. 1) is equipped at the bottom with two pins 23 24 respectively arranged in a plane parallel to the rail. On the pins 23 and 24 is rested a reticulated structure 25 bearing at the bottom a support 26 for the load to be transported. During level travel the plane containing the pins is horizontal and the reticulated structure rests on the pins 23 and 24 with the inside of the edges 27 and 28 respectively. In this position the vertical passing through the centre of gravity of the load is substantially on the centre line between the two pins.

When travelling on a slope the weight of the load tends to cause rotation of the reticulated structure around the upstream pin so that the centre of gravity of the load is brought onto the vertical of said pin. In this position as shown in FIG. 2 the arm of the moment of rotation of the trolley is b' which is greater than arm b which would be obtained by hanging the load from the centre line between the pins as shown in FIG. 1.

It is obvious that if the trolley covers a section with the opposite slope the pin involved with the load will be the other one with generation of an opposite arm.

With the embodiment just described there is obtained the further advantage than when running level the load support is hung from two points and thus assures better stability.

Claims

1. Suspended rail system for the transportation of loads hung on trolleys each having an upper drive wheel and a plurality of lower bucking rollers running on the upper surface and on the lower surface respectively of the rail, said rail having level sections and sloped sections, and characterized in that in combination the upper wheel and the lower rollers are rigidly connected to each other; the wheel, rollers and point of application of the load bearing on the trolley are mutually arranged so that, when running in sloping sections, the straight line of application of the total weight bearing on the trolley does not pass through the centre of the wheel, to produce a rotation moment opposed by at least one of said plurality of wheels; the rail has uniform thickness substantially equal to the distance between the rollers and the wheel in the horizontal sections and in sloped straight sections, in curved sections with upward convexity decreasing in thickness in a filleted manner to maintain contact of the rollers and the wheel with the respective surfaces of the rail along said curved sections with minimal play and no interference.

2. System in accordance with claim 1 characterized in that the rail increases in thickness in a filleted manner in curved sections with upward concavity to maintain contact of the roller and the wheel with the respective surfaces of the rail along said curved sections with minimal play and without interference.

3. System in accordance with claim 1 characterized in that the straight line of application of the total weight bearing on the trolley when running on sloping sections passes upstream of the upper wheel and of the downstream lower roller.

4. System in accordance with claim 1 characterized in that the rail decreases in thickness in the curved sections with upward convexity by removal of material from their lower surface.

5. System in accordance with claim 2 characterized in that the rail increases in thickness in said curved sections with upward concavity by removal of material from their lower surface.

6. System in accordance with claim 1 characterized in that the lower rollers and the upper wheel are arranged in accordance with the verticals of an isosceles triangle.

7. System in accordance with claim 1 character-

ized in that the straight line of application of the total weight bearing on the trolley passes substantially through the centre of the upper wheel when running on level sections.

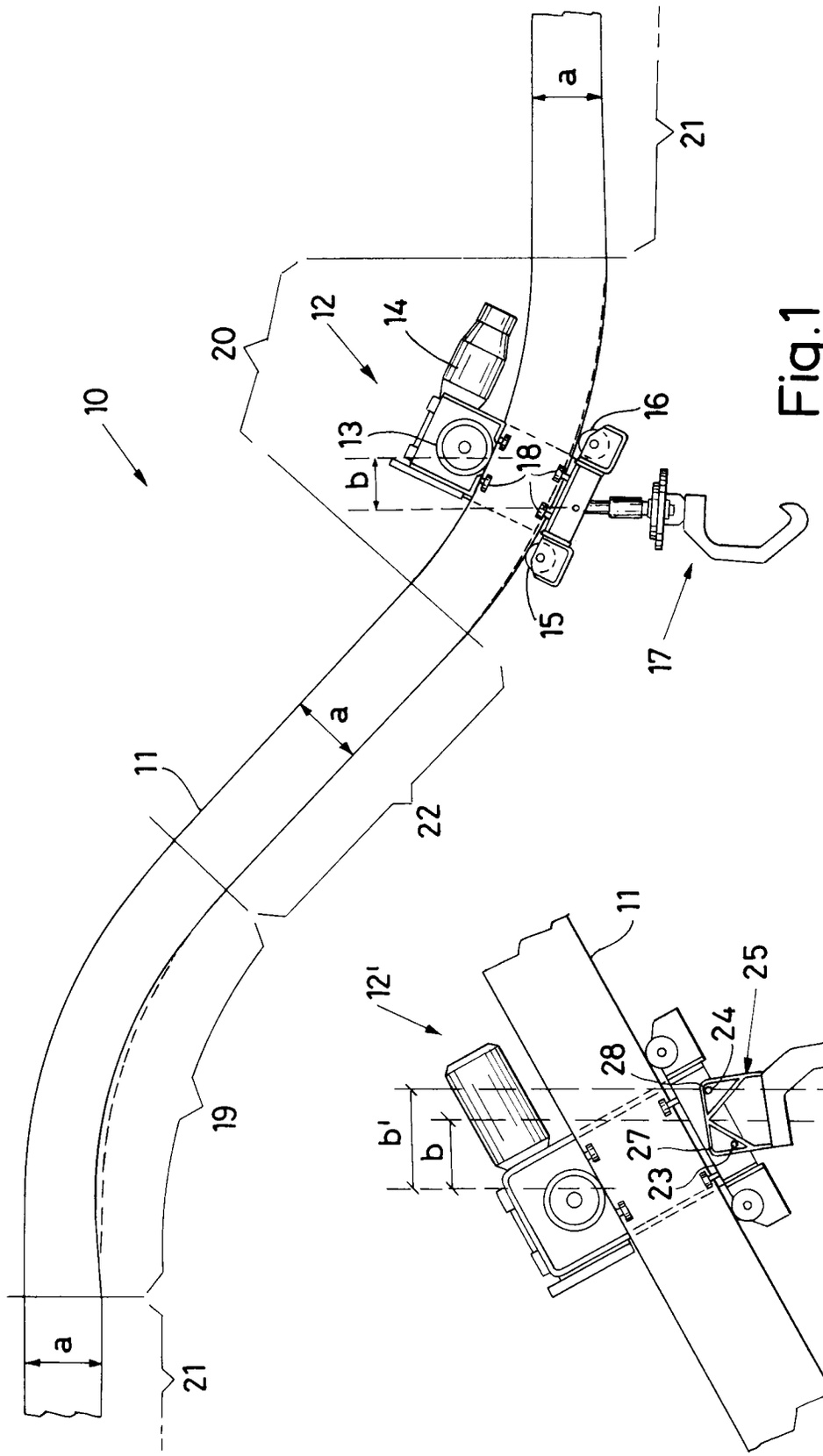

Fig.1

Fig.2

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 91 20 3096

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	GB-A-1 323 892 (STIERLEN - WERKE AG) * page 2, line 93 - page 3, line 105; figures 1,2 *	1	B61C13/04
A		3,6,8	

Y	EP-A-0 151 965 (G. UTTSCHEID) * page 10, line 23 - page 12, line 22; figures 7,8 *	1	
A		2	

A	FR-A-2 242 277 (DEMAG AG) * page 4, line 3 - page 5, line 2; figures 1-3 *	1	

			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			B61C B61B E01B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	24 FEBRUARY 1992	CHLOSTA P.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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