(12) INNOVATION PATENT (11) Application No. **AU 2011101754 A4**
(19) AUSTRALIAN PATENT OFFICE

(54) Title
A Suspended Rail System

(51) International Patent Classification(s)
B61B 3/02 (2006.01) ***B66D 3/00*** (2006.01)
B61B 3/00 (2006.01) ***E01B 33/00*** (2006.01)
B61B 13/04 (2006.01) ***E21F 17/00*** (2006.01)

(21) Application No: **2011101754** (22) Date of Filing: **2011.06.23**

(30) Priority Data

(31) Number	(32) Date	(33) Country
2010904290	**2010.09.23**	**AU**
2010903035	**2010.07.08**	**AU**

(45) Publication Date: **2015.05.14**
(45) Publication Journal Date: **2015.05.14**
(45) Granted Journal Date: **2015.05.14**

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ABSTRACT

A rail system suspended from the roof of a mine for transport of one or more loads within the mine, comprising:

a plurality of spaced apart upper support trolleys secured to anchor points along the roof of the mine, the support trolleys having rollers;

at least one rail suspended from the upper support trolleys and being formed by a number of rail sections connected end on end to one another; and

a plurality of spaced apart lower support trolleys for supporting the load from the rail, the lower support trolleys being suspended from the rail and arranged to move along the rail on rollers of the lower support trolleys, and the rail being selectively moveable along the rollers of the upper and the lower support trolleys.

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A SUSPENDED RAIL SYSTEM

FIELD OF THE INVENTION

The invention relates to a suspended rail system for transporting load(s). The rail system has particular, but not exclusive, application to an underground mine, such as a coal mine. A suspended rail system embodied by the invention can, for example, be utilized in the development of mine roadways and/or for purposes where there is a need to transfer the location of a load.

BACKGROUND OF THE INVENTION

The success of an underground mining operation is highly dependent upon the safety and efficiency of transporting equipment and materials within the mine. Modern underground longwall coal mining operations typically involve first excavating a number of parallel roadways for providing access to the coal seam and allowing transport of coal from the developed coal face and the roadway development panels. In a longwall operation coal is sheared from the coal face of the mine by a mechanized coal cutting machine, and the working area at the coal face is protected by hydraulic jacks (commonly referred to as powered roof supports). The hydraulic jacks are retreated as needed from the mine allowing the ceiling of the resulting void and overlying strata known as the goaf to collapse behind. The coal sheared from the coal panel is collected on an armoured face conveyor (AFC) and transported to a suspended or floor mounted conveyor in an adjacent roadway within the mine for transport of the coal from the mine.

A longwall mining operation and the prior roadway development into the mine require services such as power supply, water supply, hydraulic pressure, pneumatic pressure and communications provided by cabling and hoses, to be carried to the coal face. Typically, this is managed by a suspended services monorail. Load items such as electrical switching equipment, first aid equipment, filter stations, machinery, tool boxes and spare

parts for machinery can also be transported into the mine on carriages of the services monorail. Services and conveyor monorail systems are for instance described in United States Patent No.s US 5,810,134, US 4,339,031, and US 4,896,764.

The rails of suspended conveyor and services monorail systems conventionally used in mining operations are fixed in stationary positions to roof bolt attachment points along the roadway(s), and trolleys carrying the services cabling and/or hoses, suspended carriages or conveyor belt assemblies are mounted to the rail to be moved along the rail as required. It is common practice for rail sections to be manually transported to the leading end and from the trailing end of the rail during the extension and disassembly of the conveyor and services monorail rails. In particular, the extension of the rail requires the rail sections to be disconnected from the trailing end of the rail, lowered to the ground, and raised and connected at the leading end of the rail. As a consequence, the rail sections are necessarily carried through the mine, sometimes up to hundreds of meters. This process of assembly and disassembly of the rail is repeated many times during the mining of a typical longwall panel. Hence, there is significant risk of injury to workers during lifting of the rail sections as well as when carrying the rail sections.

Roadway development is a necessary but relatively time burdensome and hazardous process that must be undertaken in preparation for the harvesting of the coal from the coal face of the associated longwall panel. As such, reducing the time associated with roadway development and improving the efficiency of advancing the required conveyor systems(s) to provide services within the mine can add substantially to the economic return and the safe operation of the mine.

SUMMARY OF THE INVENTION

In one aspect of the invention there is provided a rail system suspended from the roof of a mine for transport of one or more loads within the mine, comprising:

a plurality of spaced apart upper support trolleys secured to anchor points along the roof of the mine, the support trolleys having rollers;

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at least one rail suspended from the upper support trolleys and being formed by a number of rail sections connected end on end to one another; and

a plurality of spaced apart lower support trolleys for supporting the load from the rail, the lower support trolleys being suspended from the rail and arranged to move along the rail on rollers of the lower support trolleys, and the rail being selectively moveable along the rollers of the upper and the lower support trolleys.

In another aspect of the invention there is provided a rail system for being suspended from the roof of a mine for transport of one or more loads within the mine, comprising:

a plurality of upper support trolleys for being secured to spaced apart anchor points along the roof of the mine, the support trolleys having rollers;

a number of rail sections for being connected end on end to one another to form at least one rail for being suspended from the upper support trolleys; and

a plurality of lower support trolleys for supporting the one or more loads and being suspended from the rail, the lower support trolleys being adapted to move along the rail on rollers of the lower support trolleys and the rail being selectively moveable along the rollers of the upper and the lower support trolleys.

Various configurations of rails can be employed in a rail system embodied by the invention. In one or more embodiments, the rail is provided with interconnected upper and lower flanges along which the rollers of the upper and lower trolleys respectively travel. Typically, the rail rests on the rollers of respective of the upper trolleys, and the rail supports the rollers of respective of the lower trolleys. The upper and lower flanges of the rail may be interconnected by one or more web portions.

Hence, in another aspect of the invention there is provided a rail system suspended from the roof of a mine for transport of one or more loads within the mine, comprising:

a plurality of spaced apart upper support trolleys secured to anchor points along the roof of the mine;

a rail having interconnected upper and lower flanges, the rail being formed by a number of rail sections connected end on end to one another, and the rail rests on rollers of the upper support trolleys; and

a plurality of spaced apart lower support trolleys for supporting the load from the rail, the lower support trolleys being arranged to move along the rail on rollers of the lower support trolleys, and the rail being selectively moveable along the rollers of the upper and the lower support trolleys.

Typically, the rail system further comprises at least one securing arrangement adapted to secure the rail against movement along the rollers of the upper and lower trolleys.

Typically, at least one lower trolleys is arranged to be moved along the rail when the rail is secured by the securing arrangement. The movement of the trolleys (e.g., pulling or pushing of the trolleys) along the rail may be achieved by any suitable shunting means such as one or more shunting trolleys mounted on the rail.

The rail is moveable along the rollers of the upper and lower support trolleys upon the rail being released from the securing arrangement. In at least some embodiments, the shunting means is operable to drive (e.g., push or pull) the rail along the rollers of the upper and the lower support trolleys when being advanced into, or withdrawn from, the mine. However, in other embodiments, the rail may be drawn along such as by a manually operated or motorized winch or, for example, by a motorized vehicle or by physical attachment to advancing or retreating mining equipment.

Typically, the rail system also comprises at least one locking arrangement adapted to selectively lock one or more lower support trolleys against movement with the rail when the load is to be held stationary or the rail is to be moved along the rollers of the upper and lower support trolleys.

In at least some embodiments, a rail system of the invention may also comprise at least one locking arrangement adapted to selectively lock one or more upper support trolleys in position when the rail is to be held stationary.

In some embodiments, the rail system can comprise a single rail (e.g., a monorail system). In other embodiments, the rail system can include more than one rail (i.e., two or more rails) arranged alongside relative to one another. In this instance, the rails can be connected to one another by interconnecting member(s) spanning between the rails from one to the other.

The load carried by the rail system can comprise one or more flexible cables and/or hoses for the provision of one or more services to at least one location along the rail system, the cables and/or hoses being carried by the lower trolleys. Moreover, the load and/or services provided by the rail system can further be selected from, for instance, power supply, water supply, hydraulic pressure, pneumatic pressure, fire fighting services, first aid equipment, electrical enclosures, switching devices, and communications. The load may also, or alternatively, comprise at least one carriage for transporting one or more load items along the rail and which is suspended from at least one of the lower support trolleys. Typically, when provided, respective such carriages are suspended from a pair of consecutive ones of the lower support trolleys.

In addition, a load can be carried directly by the rail itself without being suspended from, or supported by, the lower trolley(s). In this instance the load is moved as the rail moves. Typical loads that may be moved in this manner in, for example, a roadway development application include ventilation systems such as ventilation fans and ventilation ducting.

In other embodiments, the rail system may carry a conveyor belt and associated conveyor structures for transporting the load. As will be understood, the load in this instance can be mined coal, ore, or for example, mineral or gem bearing rock. In these embodiments, respective of the lower support trolleys can include suspended top and bottom belt roller assemblies, the conveyor belt passing through the belt roller assemblies and being supported by the upper belt roller assemblies for travel of the conveyor belt in one direction and by the lower belt roller assemblies for return travel of the conveyor belt in the opposite direction.

In another aspect there is provided a method for advancing or withdrawing a suspended rail system embodied by the invention, comprising moving the rail(s) of the rail system forward or backward along the rollers of the upper and the lower support trolleys.

In at least some embodiments, the rail is moved forward or backward by at least one telescopic device, the device comprising a said rail section of the rail and being connected to rail sections of the rail disposed forward and rearward of the device, wherein the device has an outer section and an underlying inner section and at least one hydraulic cylinder

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mounted to the inner section and the outer section, the hydraulic cylinder including a ram and the inner and outer sections of the device being longitudinally slideable relative to one another with operation of the hydraulic cylinder to extend or retract the ram, and wherein the rail is moved either forward or backward by sequential extension and retraction of the ram. By this means the entire rail can be progressively moved along the roof of the mine, carrying the load with it.

Advantageously, as the lower trolleys of the rail system are moveably supported on the rail(s) and the one or more rails of the rail system are moveably supported by the upper trolleys, the rail(s) can be selectively moved in the longitudinal direction to advance the rail(s) such as during roadway development into the mine or alternatively to withdraw it such as, for example, during the mining of a coal panel in a longwall coal mining operation on retreat from the mine. This can permit rapid deployment of the rail system and the load transported by it in the mine as, and when, required.

Moreover, by being able to selectively move respective of the rails of the rail system along, the need for additional rail sections to be transported to the leading end of the rail(s) for the purpose of extending the rail(s) into the mine may be avoided. Likewise, the need to dismantle the rail sections and transport them along the roadway when retreating the mine may also be avoided. By avoiding manual transport of the rail sections, the efficiency of the mining process and productivity may be improved and the risk of injury to workers, particularly lower back injury, may be reduced.

The features and advantages of the invention will become further apparent from the following description of a number of exemplary, non-limiting embodiments.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

Figure 1 is schematic end view of the rail and an upper and a lower support trolley arrangement of a rail system embodied by the invention;

Figure 2 is a schematic diagram showing side views of upper and lower trolleys of a rail system embodied by the invention;

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Figure 3 is a schematic end view of a lower support trolley of a services monorail system embodied by the invention with a suspended carriage for placement of load items for transport along the rail;

Figure 4 is a schematic end view of a lower support trolley with a suspended conveyor assembly of a conveyor monorail system embodied by the invention;

Figure 5 is a schematic partial side view of a services monorail system embodied by the invention;

Figures 6a and 6b are schematic partial side views of a conveyor monorail system embodied by the invention;

Figure 7 is a schematic end view of illustrating another rail system embodied by the invention;

Figure 8 is a schematic end view illustrating another rail system embodied by the invention;

Figure 9 is a schematic end view showing another rail system embodied by the invention;

Figure 10 is a close up schematic end view of an upper trolley, lower trolley and one of the rails of the rail system of Fig. 9;

Figure 11 is a schematic partial side view of the trolleys and one of the rail arrangements of Fig. 9;

Figure 12 is a schematic end view of another rail and trolley arrangement embodied by the invention;

Figure 13 is a schematic end view of another rail and trolley arrangement embodied by the invention;

Figure 14 is a partial schematic side view of the trolley and rail arrangement of Fig. 13;

Figure 15 is a schematic side view of yet another rail system embodied by the invention; and

Figure 16 is an end view of a telescopic extension device of the rail system of Fig. 15 for advancing or withdrawing the rail of the system.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS OF THE INVENTION

A number of embodiments of the invention are described below in relation to the use of a rail system embodied by the invention in the context of a coal longwall mining operation. However, it is to be understood the invention is not limited thereto and rail systems of the invention can be employed in other types of mining operations where there is a need to transfer a load from one location to another including, but not limited to, short wall coal mining and roadway development systems. For convenience, at least some like components of different embodiments are numbered the same in the following description.

In particular, Fig. 1 provides a partial end view of a rail system of the invention and in particular, a monorail system 10 comprising a rail 12 suspended from a plurality of upper support trolleys 14. A plurality of lower support trolleys 16 are mounted on the rail. The rail 12 has an essentially "I" shaped cross section with upper and lower flanges 18 and 20 that are interconnected by a web portion 22 of the rail and each upper trolley 14 is secured to an anchor point in the form of a respective end of a roof bolt 24 protruding from mine roof 26 either directly or by a short anchoring device in the form of a chain 28 which provides for height adjustment.

Each upper trolley 14 includes two pairs of opposed rollers 30 that are respectively rotatably mounted to the corresponding side plate 34 or 32 of the trolley bracket 35 (e.g., see Fig. 2) via respective axles (not shown). The anchoring chain 28 is fixed at one end to a spacer bar 36 that extends between the side plates 34 and 32. Moreover, as can be seen in Fig.1, the rail passes through respective of the upper trolleys such that the upper flanges 18 of the rail rest on the rollers 30 whereby one roller of each roller pair is disposed to one side of the rail web 22 and the other rollers are disposed to the other side of the web.

Each lower support trolley 16 comprises a trolley bracket 38 provided with two pairs of rollers 40 mounted to opposite side plates of the bracket 38 also via axles. However, here, the rollers 40 rest on the lower flanges 20 of the rail 12, allowing the rail 12 to be moved (i.e., slid) in its longitudinal direction along the rollers 30 and 40 of the upper and lower trolleys 14 and 16.

The rail 12 is assembled from a plurality of steel rail sections connected end on end to one another. The connection of respective adjacent rail sections is achieved via the mating of male and female clevises and the insertion of a hinge pin to hold the rail sections together, the connection restricting vertical and horizontal articulation of the rail sections relative to one another to prevent buckling of the rail when the rail is moved along in use. However, any suitable connection system for fastening the rails sections to one another can be employed. To construct the monorail 10, respective of the upper support trolleys 14 are first anchored to the protruding ends of aligned rock bolts in the mine roof 26 by anchoring chains 28, and an initial rail section is fed on to the upper support trolleys. Subsequent rail sections are individually connected to the respective preceding rail section and the rail 12 is progressively moved along the upper support trolleys as the rail is constructed. The lower support trolleys 16 can then be mounted on the rail and moved along the rail into position. Alternatively, the lower trolleys can be progressively fed onto the rail as each individual rail section is connected. As will also be understood, rail sections of any suitable configuration can be employed in a rail system embodied by the invention.

A load in the form of one or more flexible cables and/or hoses generally indicated by the numeral 43 for providing service(s) at locations along the length of the rail to the inbye mining equipment and/or to the inbye end of the rail can be festooned between consecutive ones of the lower trolleys (e.g., see Fig. 5) as is known in the art. To this end, respective of the lower trolleys can be provided with fittings (e.g., clamps or suitable brackets or clips) for fixedly securing the cable(s) and hoses to the trolleys. One or more of the lower trolleys can also be provided with manifold(s) for connecting of hose sections together to facilitate hose replacement and maintenance. Similarly, terminal blocks enclosed in mine rated junction boxes or the like can be also be provided on ones of the lower trolleys for connection of cables (e.g., electrical supply and communication cabling). In addition, service take off points (e.g., electrical power, pneumatic power outlets etc.) can be provided on one or more of the lower trolleys to permit access to one or more of the provided services.

At least some of the lower trolleys 16 can also or alternatively, carry a suspended carriage 42 for carrying load items as generally shown in Fig 3. In this instance, the

carriage can include a platform for placement of the load items to be transported along the rail into, or from, the mine. In some embodiments, the carriage 42 can be suspended from a single lower trolley 16 although generally, each carriage is normally suspended at one end by one lower trolley 16 and at an opposite end by a consecutive lower trolley 16 as further described below. Heavier loads can be suspended by a plurality of the lower trolleys 16, thereby spreading the load along the rail. Where a carriage is provided, manifold(s) and or terminal block(s) for connection of cables and/or hoses can be provided on the carriage itself rather than the lower support trolley(s) from which it is suspended. Likewise, the carriage can be provided with brackets or clips for fixedly securing service cables and/or hoses carried on the monorail to the carriage. A service monorail 44 including a number of carriages 42 is illustrated in Fig. 5.

In an another embodiment, the rail system of the invention can be a conveyor monorail 46 incorporating a conveyor belt 58 for transporting mined coal (or e.g., ore, mineral bearing material or the like) out of the mine from the "inbye" end of the monorail as shown in Fig. 6a and Fig. 6b. As best illustrated in Fig. 4, the lower support trolleys 16 in this embodiment further comprise a conveyor assembly 48 which incorporates top and bottom belt roller assemblies 50 and 52 having rotatably mounted rollers 54 and 56. The conveyor belt 58 passes through respective of the lower support trolleys 16 and is supported by the top roller assemblies 50 for travel of the conveyor belt in one direction and by the bottom roller assemblies 52 for return travel in the opposite direction.

Turning to the service monorail 44 shown in Fig. 5, a number of upper support trolleys 14 are suspended from the ends of substantially aligned roof bolts 24 protruding from the strata of the overhead roof 26 of a mine roadway by anchoring chains 28 in the manner described above. In the embodiment shown, a respective upper support trolley is secured to every second one of the roof bolts. However, it will be understood that the frequency with which the upper trolleys are secured to the roof bolts is not critical to the invention. For example, embodiments can be provided in which a respective upper trolley is secured to each consecutive one of the roof bolts or, for instance, to only every third roof bolt, or any other combination of frequency, the final anchorage configuration to the roof

bolts being site specific and dependent upon the particular mining application and conditions.

Respective of the carriages 42 of the embodiment shown in Fig. 5 comprise a tray 62 suspended from consecutive pairs of the lower trolleys 16. Linkers in the form of rigid tie bars 64 are disposed between the carriages 42 coupling the respective lower trolleys to one another for drawing the lower trolleys along and maintaining the spacing between the carriages to ensure no pulling force is applied to service cables and/or hoses 43 festooned between ones of the lower trolleys and/or the carriages. Rather than rigid tie bars, steel chain linkers can be festooned between consecutive lower trolleys/carriages 16 and 42 to couple them together. As with the rigid tie bars 64 where provided, the chain linkers are shorter than the free length of the cabling and hoses extending between the trolleys to prevent any pulling force being applied to services cabling and hoses 43 between the lower trolleys.

The tray 62 of each carriage 42 provides a platform on to which load items can be placed to be transported along the rail 12 above the mine floor 65. The load item(s) can essentially be anything that may be desired to be transported into, or from, the mine and may, for instance be selected from, but not limited to, filter stations, tools, tool boxes, fire fighting and fire suppression equipment, pumps, pump equipment, breathing apparatus, first aid kits, first aid apparatus, mining equipment, mining machinery, electrical enclosures and switching devices, spare parts for the mining machinery being utilized, air quality monitoring equipment, hoses, cables, roof bolts, roof bolting equipment, and resin or epoxy cartridges for roof bolting purposes.

Rather than carriages 42 in the form of suspended trays, one or more of the carriages can consist of a frame structure to which is mounted a load in the form of an air or water pump, power supply or control system, or for instance, a filter station or the like, connected to the appropriate cables and/or hoses carried on the monorail.

The lower trolleys 16 are moveable along the rail 12 on their rollers 40 to transport cables and/or hoses 43 and carriages 42 suspended from them along the mine road way. Likewise, the rail 12 of the service monorail 44 is moveable along on rollers 30 and 40 of

the upper and lower trolleys 14 and 16 so as to be advanced or withdrawn along the mine roadway.

To advance or withdraw the rail 12, at least one locking arrangement is employed to lock at least one of the lower trolleys 16 (e.g., a lower trolley or corresponding carriage 42 at the inbye or outbye end of the rail system) to a trolley anchor point such as a roof bolt or fixed attachment such as a post anchored to the mine roof or floor. The locking arrangement can consist of a chain, wire tendon or rigid tie bar coupling attached at one end to the lower trolley (or a carriage suspended from the lower trolley) and at an opposite end to the respective anchor/attachment point to limit or prevent movement of respective lower trolleys/carriages with travel of the rail. In some embodiments, a plurality of such locking chains or couplings can be provided for locking respective of the lower trolleys 16 and/or corresponding carriages 42 against travel with the rail. The rail 12 can then be drawn along by mining equipment disposed within the mine in the vicinity of the leading end of the rail, a winch system attached between the rail and a suitable anchoring point such as a roof bolt (as shown by the numeral 86 in Fig. 5), a motorized (e.g., battery or diesel powered) mine vehicle to which the rail is coupled.

Normally, shunting means in the form of one or more shunting trolleys 66 (also known as "mules") are provided on the rail 12 to drive (i.e., push or pull) the lower trolleys 16 and carriages 42 along the rail for advancing or withdrawing the rail 12, as generally illustrated in Fig. 5. In the embodiment shown, respective of the shunting trolleys comprise rollers for rolling along the lower flange of the rail, a brake system for braking and/or preventing travel on the rail 12 as required, and a pneumatic or hydraulic motor for providing rotational drive to at least one pair of opposed drive wheels. The web of the rail is gripped by the nip of the drive wheel pair such that counter rotation of the drive wheels drives the shunting trolley along the rail, upon the shunting trolley being operated and while the rail 12 is secured against travel by at least one securing arrangement. The securing arrangement can be a securing chain or a steel tendon coupling or the like for releasably connecting the rail to a fixed rail anchor point. Again, the rail anchor point can be a roof bolt or fixed post provided for this purpose.

When the rail is to be advanced or withdrawn along the mine roadway the rail is released from respective of the rail securing chains/couplings, the lower trolleys/carriages 16, 42 are locked against travel with the rail by the locking chains/couplings, and the shunting trolleys are operated to drive the rail 12 along in the required direction. Various shunting trolleys/mules are known and any suitable such shunting trolley can be utilized in a rail system embodied by the invention.

The conveyor monorail 46 shown in Fig. 6a and Fig. 6b comprises a plurality of lower trolleys 16 with suspended conveyor assemblies 48 supporting an extended conveyor belt 58. The lower trolleys of the monorail are coupled together by linkers 66 in the form of chains for drawing one behind the other. As shown, a trailing end lower trolley 16 of the monorail is tethered to a roof bolt by an anchor chain 67 while a lower trolley is coupled by respective connectors in the form of a connection bars 68 (only one is shown) to a tracked mechanized crawler 70 for advancing the conveyor belt 58. The mechanized crawler can be releasably anchored in position by any suitable means such as through an anchoring plate by anchoring stakes as described in US 4,896,764. Rather than a mechanized crawler, one or more of the lower trolley(s) can be connected to mining equipment present (e.g., an armoured face conveyor (AFC) or self-advancing hydraulic roof supports), for being advanced along the rail with the mining equipment.

The conveyor belt 58 returns about conveyor roller(s) indicated by the numeral 71 and receives coal that has been sheared from the coal panel work face from an armoured face conveyor (AFC) as generally indicated by 72 in Fig. 6b. As illustrated in Fig. 6b, in the embodiment shown, the conveyor feeder section 72 is coupled to further of the lower trolleys 16 of the conveyor monorail 46. Drive and tension is applied to the conveyor belt 58 by conventionally known conveyor mechanisms located in the outbye direction of the rail system.

In at least some conveyor rail systems embodied by the invention, shunting trolleys can be provided at regular intervals along the rail 12 between ones of the lower trolleys 16 to selectively drive the lower trolleys or the rail along, when the lower trolleys or the rail are released from provided locking and securing arrangements as applicable as in the service monorail 44 described above. Moreover, the longitudinal travel of the rail and/or

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the lower trolleys 16 in a rail system as described herein can be controlled manually or by proximity switches located at regular intervals. That is, the rail 12 can be moved respective predetermined distances in its longitudinal direction determined by the spacing of selected such proximity switches under computer control. However, it will be understood that any suitable control systems for monitoring and controlling the advancement (and retraction) of the rail and/or lower trolleys can be employed.

Whilst embodiments of the invention have been described above in the context of a monorail incorporating a single rail, it will be understood the invention is not limited thereto. In some embodiments, the rail system can incorporate more than one rail. For example, the rail system can have a pair of rails arranged alongside one another at a predetermined spacing so as to be parallel, and which are connected together by interconnecting member(s) 74 spanning between the rails from one to the other as generally shown in Fig. 7 and Fig. 8. In this embodiment, respective rows of upper support trolleys are suspended from fixed attachment points provided along the mine roof, each rail being suspended from a corresponding row of the upper support trolleys, and respective lower support trolleys are in turn suspended from each of the rails.

In still further embodiments, aligned pairs of lower support trolleys can be connected together and support a load such as a conveyor assembly as generally shown in Fig. 9. In this embodiment, parallel rails 12 are again securely connected together by brace members indicated by the numeral 74. In Fig. 8, each of the rails is formed by top and bottom pipe sections interconnected by a web portion 22. Moreover, in this embodiment, the upper and lower trolleys 14 and 16 are provided with rollers indicated by the numerals 80 and 82 spaced about the respective pipe. In the rail system of Fig. 9, each rail 12 comprises opposed generally inverted "Z" shaped side members each with upper and lower flanges 18, 20 interconnected by a respective web portion 22, the lower regions of the opposed side members being joined together by spacer bars 36 to form the rail. A closer view of this rail and trolley arrangement is shown in Fig. 10, and a side view is shown in Fig. 11. As best shown in Fig. 10, the rollers 30 of the upper trolleys 14 are disposed on the inside of the rail 12 and roll along on the underside of the inwardly directed upper

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flanges 18 of the rail, whilst the rollers 40 of the lower trolleys 16 are arranged on the outside of the rail and roll along the outwardly directed lower flanges 20 of the rail.

In the embodiment shown in Fig. 12, the upper and lower rollers 30 and 40 of the upper and lower trolleys 14 and 16 are provided with flanges 92, 94 that overhang or otherwise project about the associated flange of the rail to guide the trolleys along the rail and *vice versa*.

Yet another trolley and rail arrangement is shown in Fig. 13. In this embodiment, the rail 12 comprises an upper section in which the rollers 30 of the upper trolleys are rotatably mounted and which is provided with inwardly direct flanges which rest on the rollers 30 of the upper trolleys 14. An inverted "T" shaped section of the rail depends therefrom and provides the lower flanges 20 of the rail on which the rollers 40 of the lower trolleys rest. A side view of this trolley and rail arrangement is shown in Fig. 14. Hence, a range of different trolley and rail configurations may be utilized in embodiments of the invention.

Likewise, various means for effecting the advance or withdrawal of the rail within the mine can be employed as described above. In at least some embodiments, the rail 12 can incorporate a telescopic device constituting a rail section of the rail and which is provided with hydraulic cylinders 84 for advancing or withdrawing the rail as exemplified in Fig. 15, one hydraulic cylinder being arranged on each side of the device, respectively. More particularly, the telescopic device 78 shown is interposed between forward and rearward rail sections of the rail and comprises an outer section 80 and an underlying inner section 82, the inner section 82 of the device being connected to the immediately preceding rearward rail section and the outer section being connected to the rail section immediately forward of the extension device in the same manner as the other rail sections of the rail are coupled together. One end of each hydraulic cylinder 84 is mounted to the inner section of the extension device and the ram 86 of each hydraulic cylinder is connected to a forward region of the outer section 80 of the device 78, the inner and outer sections 82, 80 being longitudinally slidable relative to one another one another. As better shown in Fig. 16, the upper support trolleys 14 are received within the inner section 82 of the device and the rollers 40 of the lower support trolley(s) 16 rest on the lower flanges of the device as for

the remainder of the rail 12. Supply hoses for providing hydraulic pressure to the hydraulic cylinder are festooned between lower trolleys 16 or carriages suspended from ones of the lower trolleys as generally described above.

To advance the rail 12 independently of the respective upper and lower trolleys 14 and 16 as in other of the embodiments described above, the rams 86 of the hydraulic cylinders are extended as illustrated in Fig. 15(b) whilst the rail to the rear of the extension device is secured in position by suitable securing means (e.g., one or more rigid tie bars). The rail rearward of the hydraulic cylinders 84 is subsequently released from the securing means, and the rail 12 forward of the hydraulic cylinder is then held in position by securing means such as further rigid tie bar(s) disposed at the leading end region of the rail 12. The cylinders 86 are then retracted. With the retraction of the cylinders, the rail rearward of the hydraulic cylinder is drawn forwardly as illustrated in Fig. 15(c). This process is repeated stepwise as many times as necessary until the entire rail 12 is advanced the desired distance. To withdraw the rail from the mine, the above process is carried out in reverse. A typical such services rail system in, for example, a longwall mining operation can incorporate any number of telescopic devices 78, the total number being dependent upon the particular application for the rail system, the mass of the load(s) to be transported by the rail system, and/or the overall length of the rail 12 itself.

From the above, it will be apparent that at least some rail systems embodied by the invention provide a number of significant advantages such as one or more of the following.

- Rapid deployment of the rail system allowing rapid roadway development into a mine, eliminating lost production time waiting on coal haulage vehicles;
- Assembly and dismantling of the rail(s) of the rail system at the same location;
- The avoidance of the need to disassemble or assemble respective of the rails during a production cycle and to transport heavy rail sections for connection to the leading or trailing end to advance the rail(s) or during dismantling of the rail(s); and
- The lessening of the risk of related injuries to workers associated with carrying/transporting rail sections and when assembling or dismantling the rail(s) of the rail system.

Although the invention has been described in relation to a number of embodiments, the skilled addressee will understand that numerous variations and modifications can be made without departing from the invention. The present embodiments are, therefore, merely illustrative and not restrictive.

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CLAIMS

1. A rail system suspended from the roof of a mine for transport of one or more loads within the mine, comprising:

a plurality of spaced apart upper support trolleys secured to anchor points along the roof of the mine, the support trolleys having rollers;

at least one rail suspended from the upper support trolleys and being formed by a number of rail sections connected end on end to one another; and

a plurality of spaced apart lower support trolleys for supporting the load from the rail, the lower support trolleys being suspended from the rail and arranged to move along the rail on rollers of the lower support trolleys, and the rail being selectively moveable along the rollers of the upper and the lower support trolleys.

2. A rail system according to claim 1 wherein the rail has upper and lower flanges along which the rollers of the upper and lower trolleys travel.

3. A rail system according to claim 2 wherein the rail rests on the rollers of respective of the upper trolleys, and the rail supports the rollers of respective of the lower trolleys.

4. A rail system according to any one of claims 1 to 3 further comprising at least one securing means adapted to secure the rail against movement along the rollers of the upper and the lower trolleys.

5. A rail system according to claim 4 further comprising shunting means operable to shunt one or more of the lower trolleys along the rail when the rail is secured by the securing means.

6. A rail system according to claim 5 wherein the shunting means comprises at least one shunting trolley mounted on the rail, the shunting trolley being operable to drive the rail along the rollers of the upper and the lower support trolleys upon the rail being released from the securing means.

7. A rail system according to claim 4 or 5 wherein the shunting trolley has at least one pair of opposed drive wheels, the rail being gripped by the nip of the drive wheels.

8. A rail system according to any one of claims 1 to 7 further comprising at least one locking arrangement adapted to lock at least one of the lower support trolleys against travel

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with the rail when the rail is to be moved along the rollers of the upper and lower support trolleys.

9. A rail system according to any one of claims 1 to 8 further comprising linkers disposed between consecutive ones of the lower support trolleys connecting the lower support trolleys together from one to the next, for drawing the lower trolleys along the rail.

10. A rail system according to claim 9 wherein the linkers are respectively selected from the group consisting of rigid linkers and flexible linkers.

11. A rail system according to claim 10 wherein the linkers are flexible linkers festooned between the lower support trolleys.

12. A rail system according to any one of claims 1 to 11 wherein the at least one load comprises one or more flexible cables and/or hoses for provision of one or more services to at least one location along the rail system, the cables and/or hoses being carried by the lower trolleys.

13. A rail system according to claim 12 wherein the one or more services are selected from the group consisting of electricity supply, lighting, water supply, hydraulic pressure supply, air supply, pneumatic pressure supply, and communication points.

14. A rail system according to any one of claims 1 to 11 wherein the at least one load comprises at least one carriage for transporting one or more load items along the rail and which is suspended from at least one of the lower support trolleys.

15. A rail according to claim 14 wherein the carriage is suspended from consecutive said lower support trolleys.

16. A rail system according to claim 15 wherein the carriage provides a platform for placement of the one or more load items on the carriage.

17. A rail system according to claim 16 wherein the one or more load items are selected from the group consisting of filter stations, tools, tool boxes, fire fighting and fire suppression equipment, pumps and pump equipment, breathing apparatus, first aid kits, first aid apparatus, mining equipment, mining machinery, electrical enclosures, electrical switching devices, air quality monitoring equipment, hoses, cables, roof bolts and roof bolting equipment.

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18. A rail system according to any one of claims 1 to 11 further comprising a conveyor belt and associated conveyor structures for transporting the load and wherein respective of the lower support trolleys include top and bottom belt roller assemblies, the conveyor belt passing through the lower support trolleys and being supported by the upper belt roller assemblies for travel of the conveyor belt in one direction and by the lower belt roller assemblies for return travel of the conveyor belt in an opposite direction.

19. A rail system according to claim 18 wherein the load is coal, ore or mineral bearing material.

20. A rail system according to any one of claims 1 to 19 wherein the anchor points are roof bolts anchored in the roof of the mine and the upper trolleys are suspended from the roof bolts.

21. A rail system according to any one of claims 1 to 20 being a suspended monorail system.

22. A rail system according to any one of claims 1 to 21 wherein the mine is a coal mine.

23. A rail system for being suspended from the roof of a mine for transport of one or more loads within the mine, comprising:

a plurality of upper support trolleys for being secured to spaced apart anchor points along the roof of the mine, the support trolleys having rollers;

a number of rail sections for being connected end on end to one another to form at least one rail for being suspended from the upper support trolleys; and

a plurality of lower support trolleys for supporting the one or more loads and being suspended from the rail, the lower support trolleys being adapted to move along the rail on rollers of the lower support trolleys, and the rail being selectively moveable along the rollers of the upper and the lower support trolleys.

24. A method for advancing or withdrawing a rail system suspended from the roof of a mine for transport of one or more loads within the mine, comprising:

providing the rail system, the rail system including a plurality of spaced apart upper support trolleys secured to anchor points along the roof of the mine and the support trolleys having rollers, at least one rail being suspended from the upper support trolleys and formed

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by a number of rail sections connected end on end to one another, and a plurality of spaced apart lower support trolleys for supporting the load from the rail, the lower support trolleys being suspended from the rail and arranged to move along the rail on rollers of the lower support trolleys, wherein the rail is selectively moveable along the rollers of the upper and the lower support trolleys; and

moving the rail forward or backward along the rollers of the upper and the lower support trolleys.

25. A method according to claim 24 further comprising releasing the rail for said movement of the rail and locking at least one said lower trolley to a trolley anchor point to limit movement of the trolley with the rail.

26. A method according to claim 24 or 25 wherein the rail is moved forward or backward by at least one shunting trolley mounted on the rail.

27. A method according to claim 26 wherein the shunting trolley includes a pair of drive wheels engaged with the rail for driving the rail forward or backward.

28. A method according to claim 27 wherein the rail has upper and lower flanges interconnected by a web portion of the rail, and the drive wheels are opposed to one another, the web portion of the rail being gripped by the nip of the drive wheels.

29. A method according to any one of claims 26 to 28 wherein at least some of the lower carriages are moved along the rail by the shunting trolley upon the rail being secured against travel.

30. A method according to claim 24 or 25 wherein the is moved forward or backward by at least one telescopic device, the device comprising a said rail section of the rail connected to rail sections of the rail disposed forward and rearward of the device, wherein the device has an outer section and an underlying inner section and at least one hydraulic cylinder mounted to the inner section and the outer section, the hydraulic cylinder including a ram and the inner and outer sections of the device being longitudinally slideable relative to one another with operation of the hydraulic cylinder to extend or retract the ram, and wherein the rail is moved either forward or backward with sequential extension and retraction of the ram.

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31. A method according to any one of claims 24 to 30 wherein one or more suspended carriages or a suspended conveyor belt are carried by the lower trolleys of the rail system.

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FIGURE 1

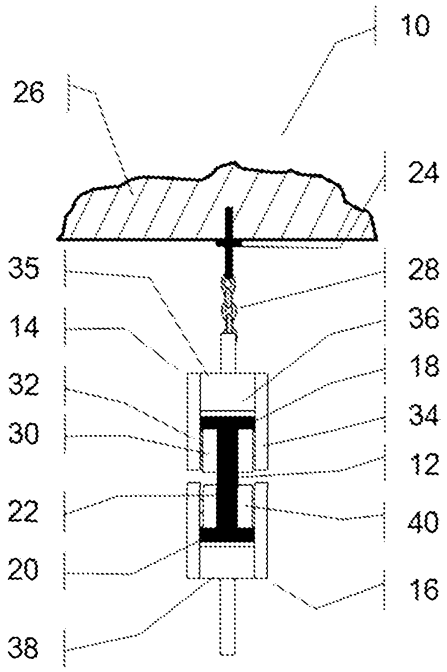


FIGURE 2

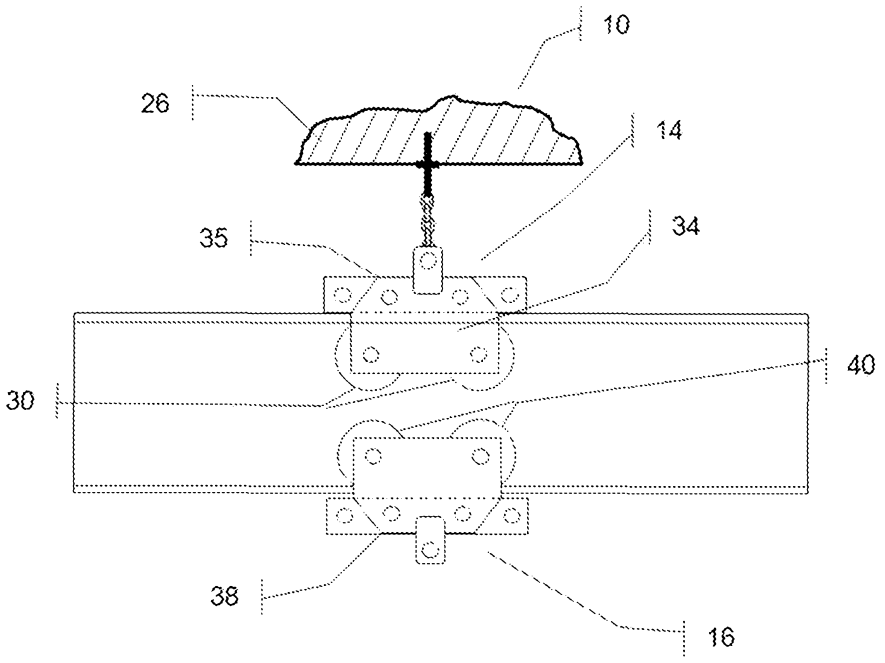


FIGURE 3

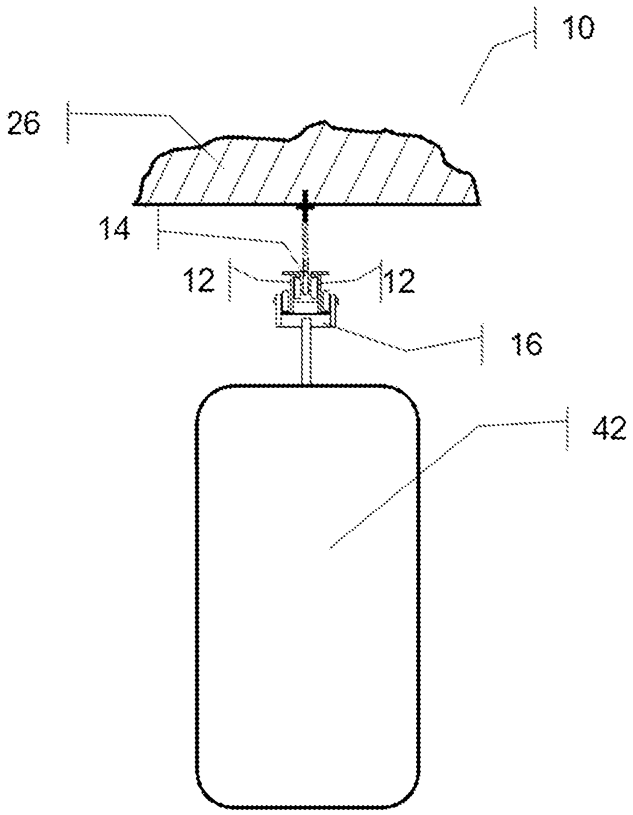
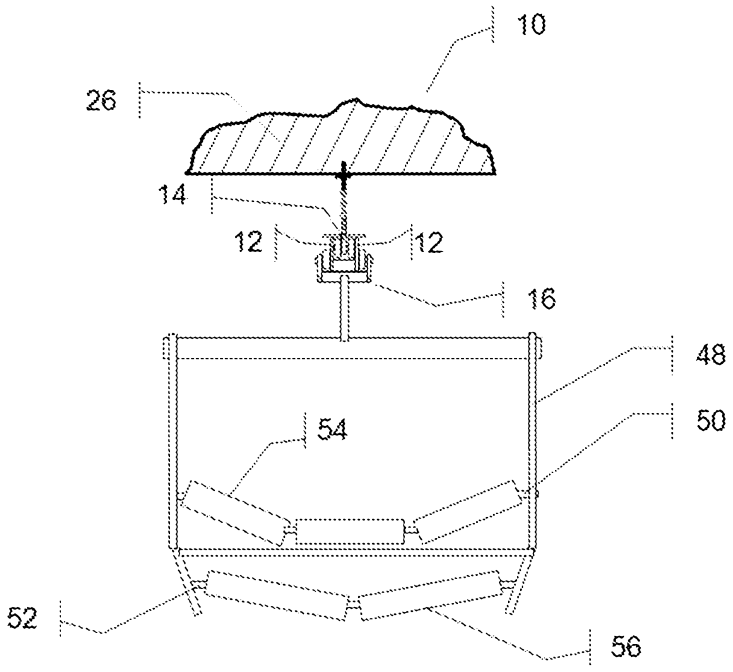


FIGURE 4



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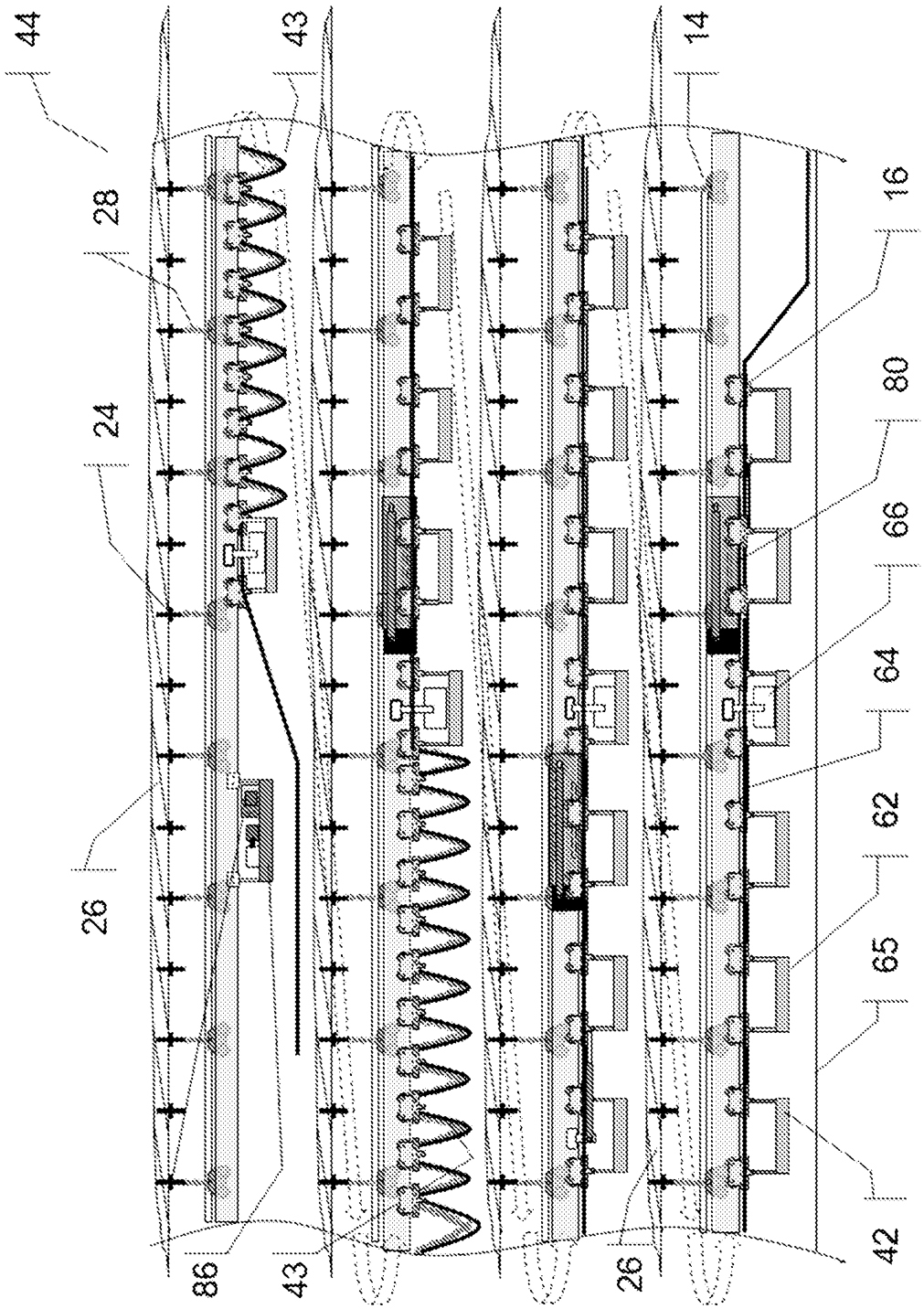

FIGURE 5

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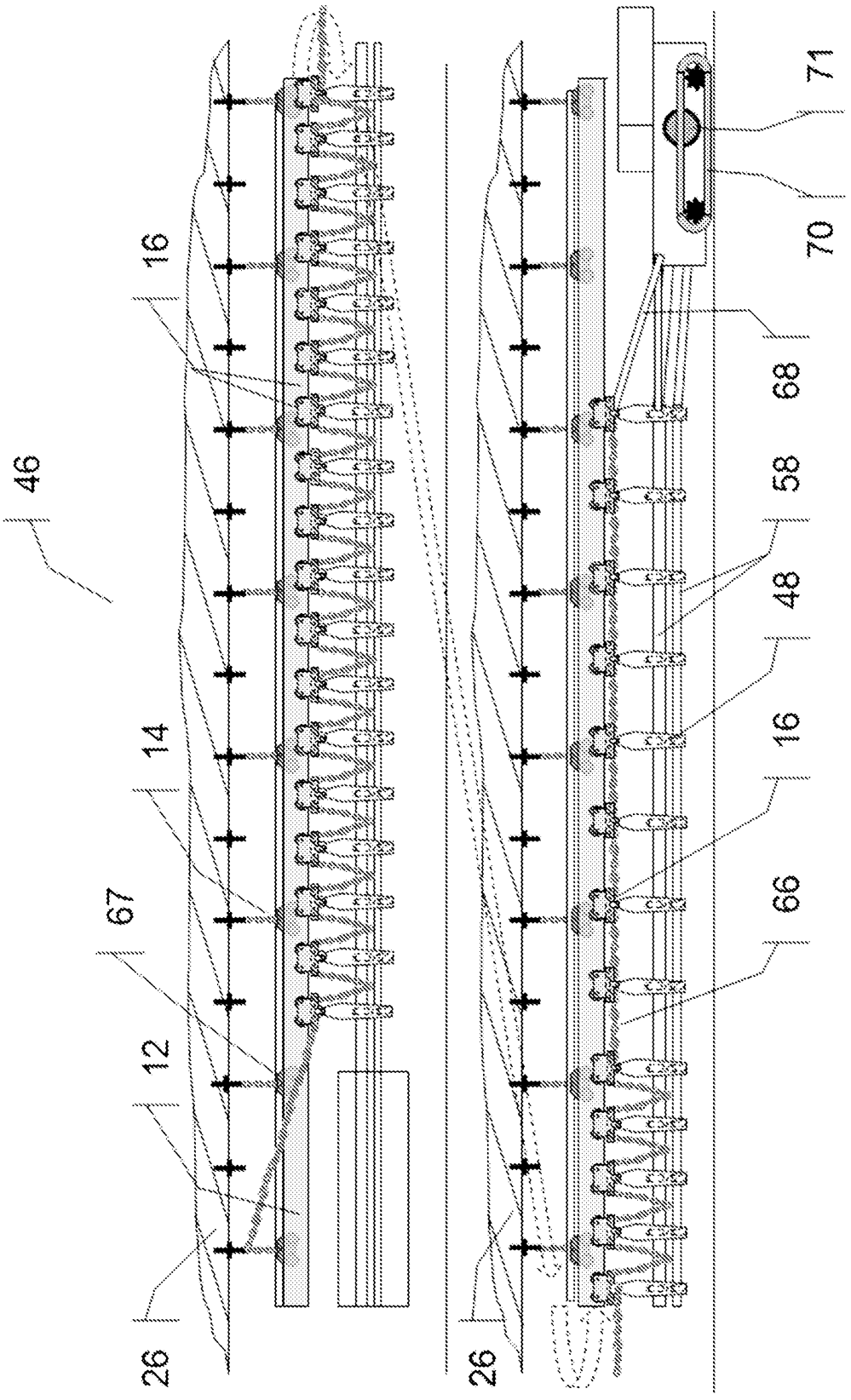

FIGURE 6a

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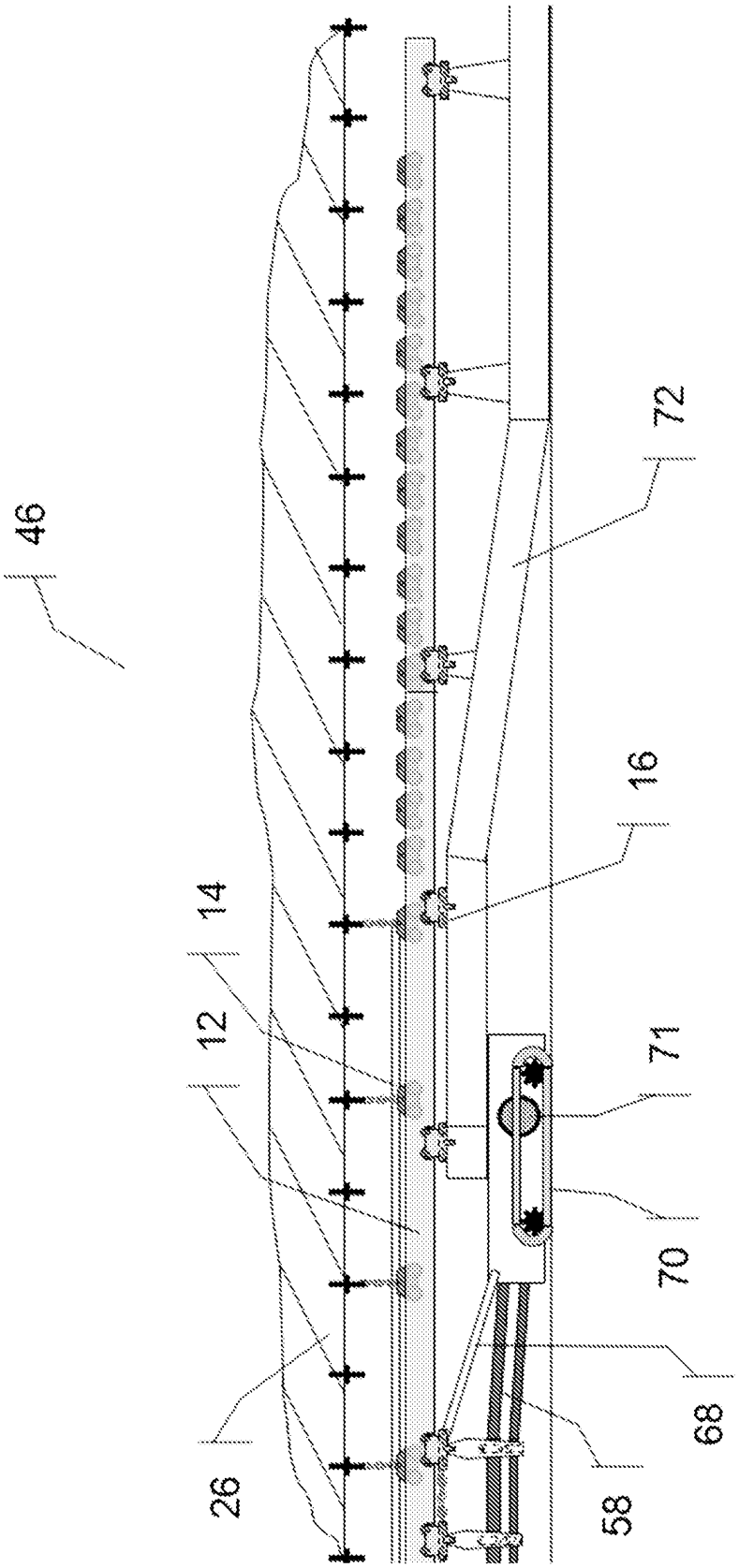

FIGURE 6b

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FIGURE 7

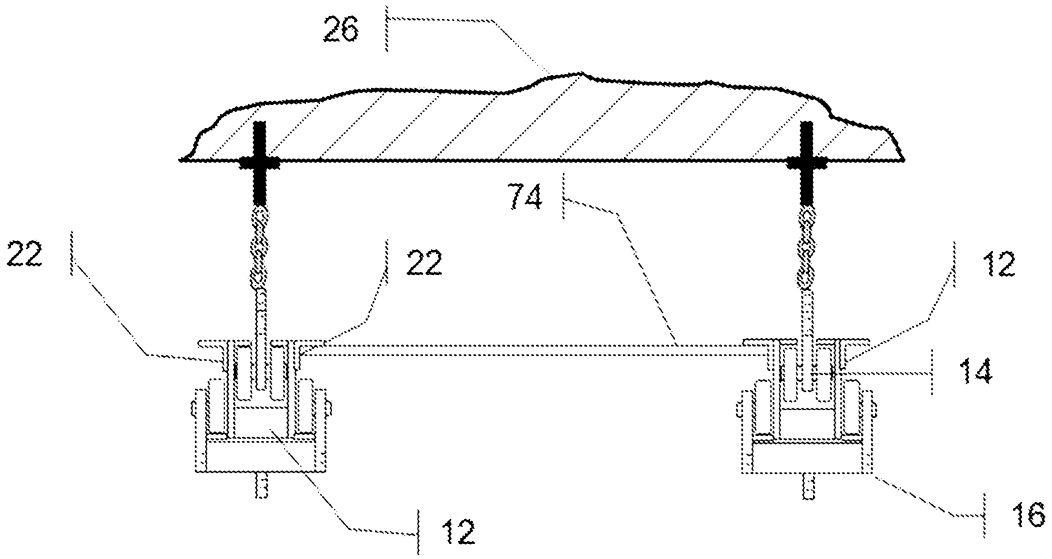

FIGURE 8

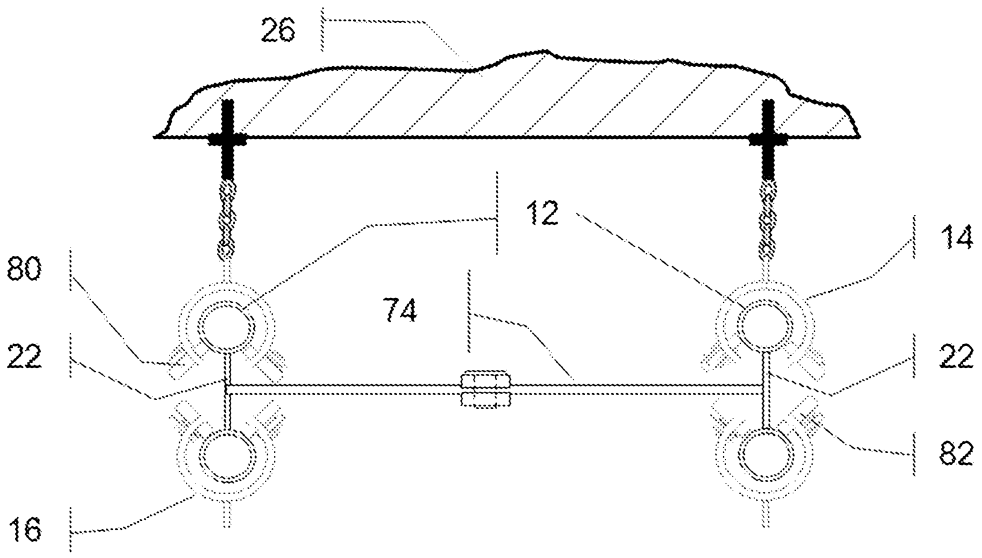

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FIGURE 9

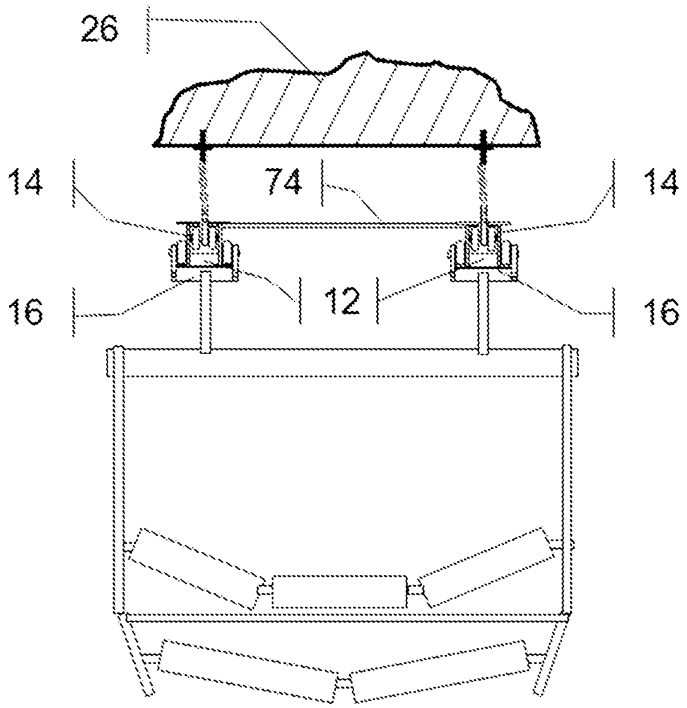

FIGURE 10

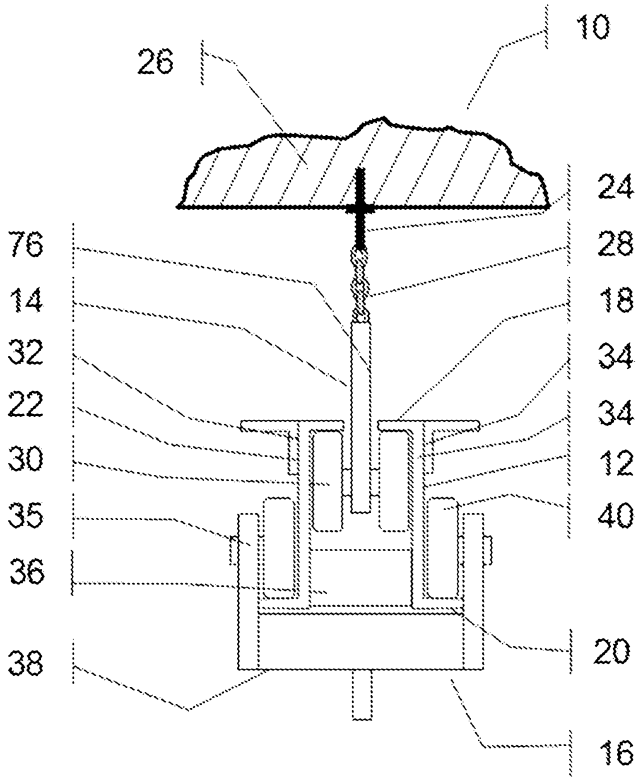

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FIGURE 11

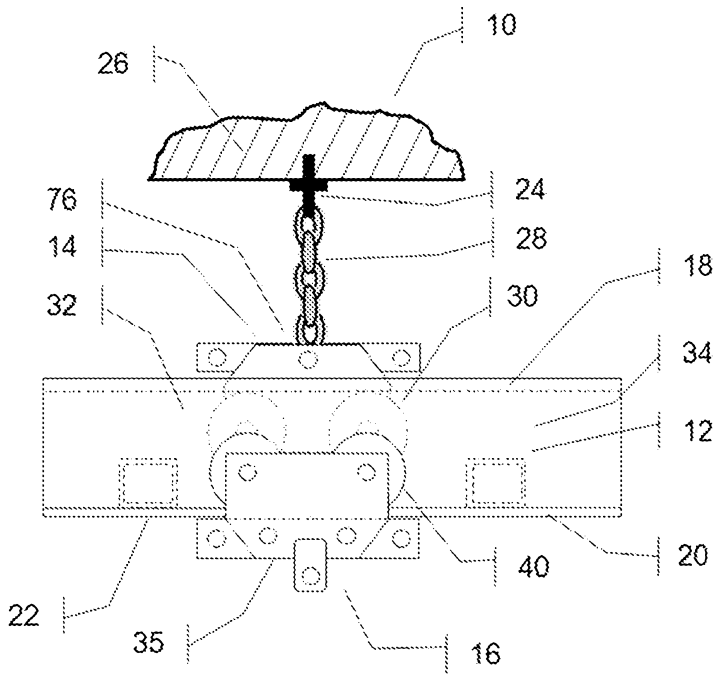

FIGURE 12

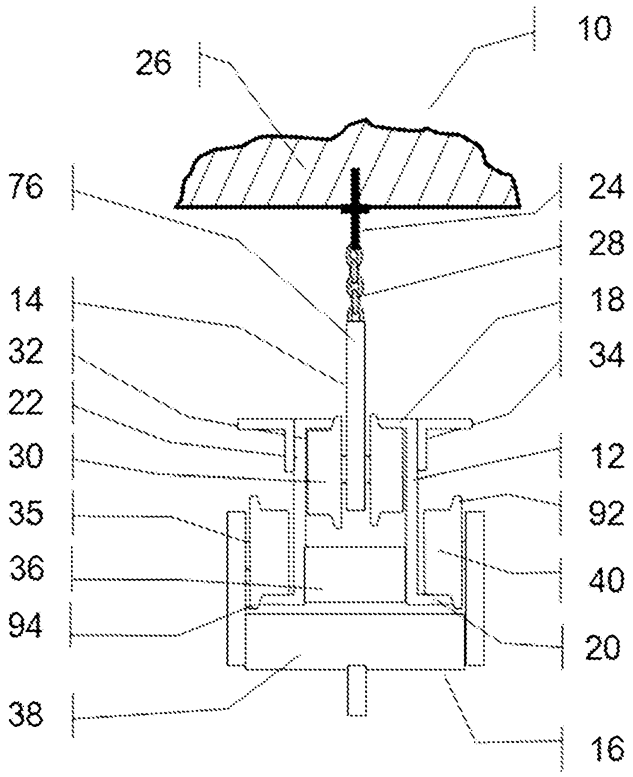

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FIGURE 13

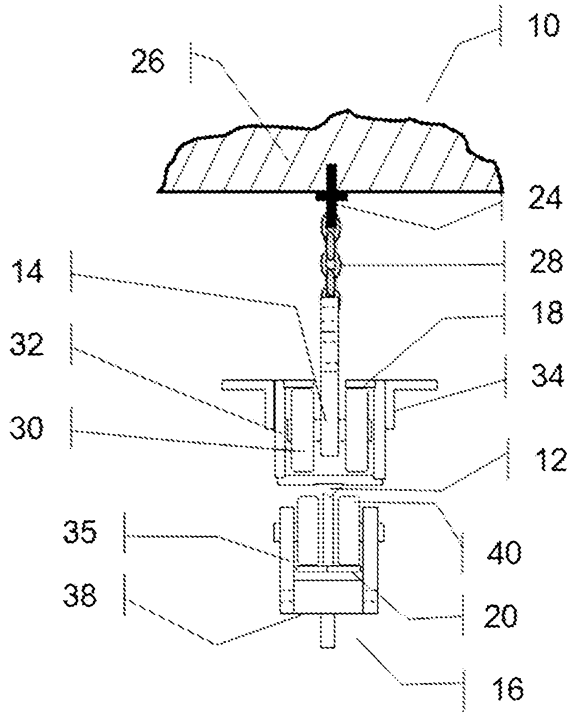
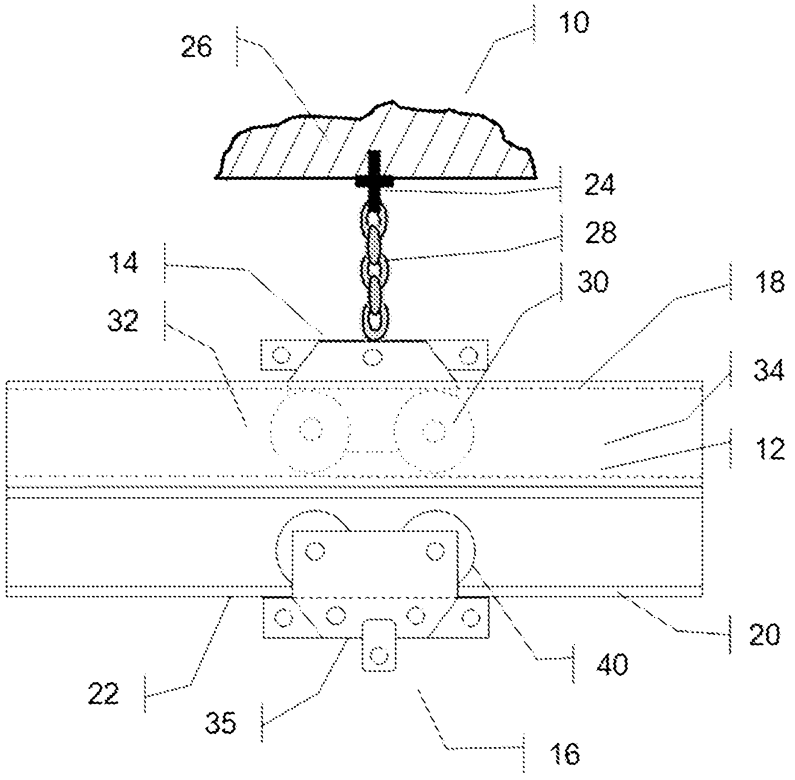


FIGURE 14



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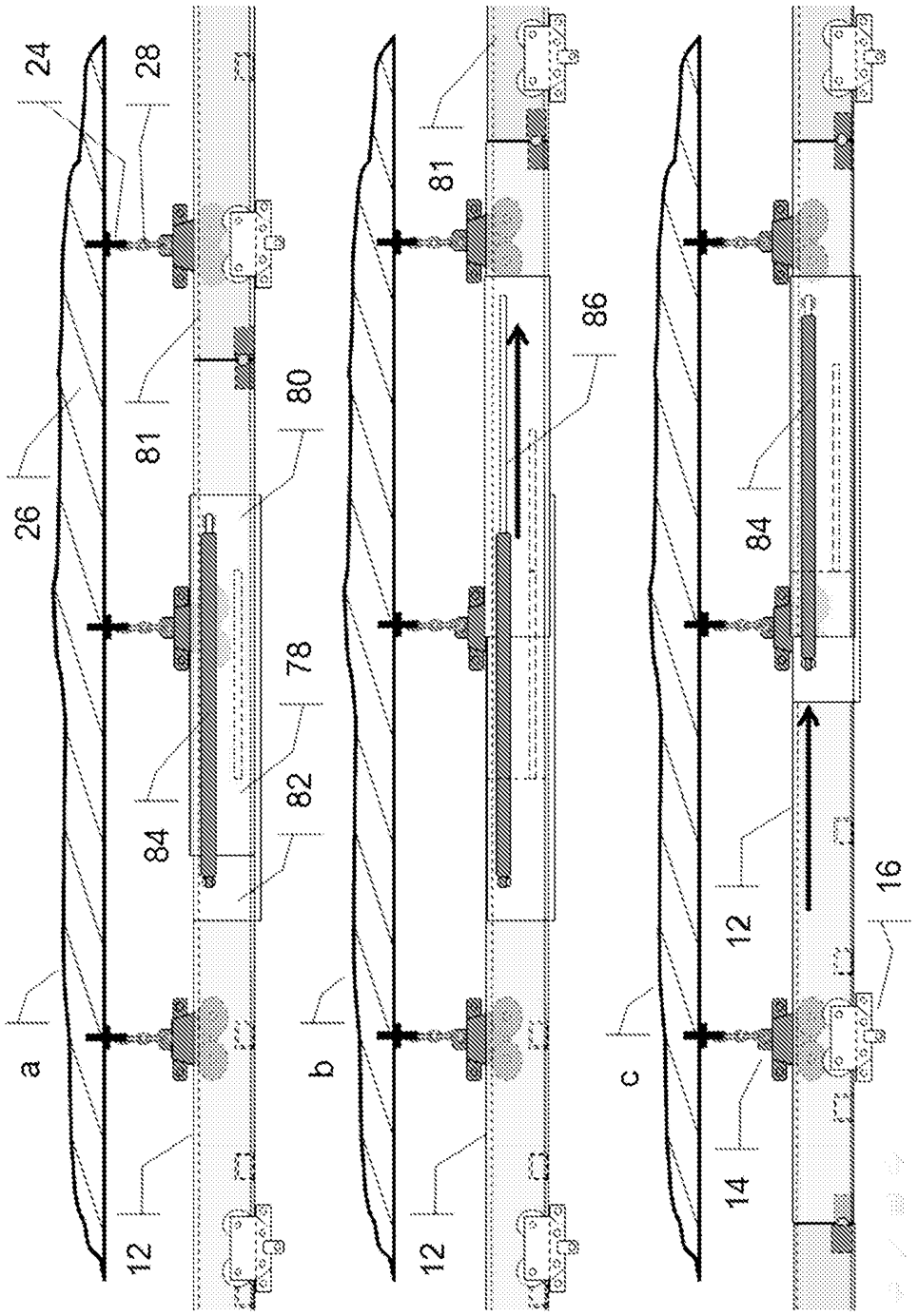

FIGURE 15

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FIGURE 16