

SYSTEM FOR PLACING A CABLE INTO A TROUGH

Technical Field

The present disclosure relates to a system or apparatus for conveying, lifting / elevating,
5 and placing, feeding, or depositing portions of one or more cables into a cable trough disposed at or mounted on a wall, e.g., of an underground tunnel.

Background

Many cities, large-scale power plants, and the mining industry make use of underground
10 cable tunnels, e.g., to supply electricity by way of electrical power cables placed in the cable tunnels. The use of underground cable tunnels frees up the open ground above for roads and architectural space, thus aiding above-ground space utilization. Underground cable tunnels also prevent potentially dangerous accidents associated with overhead powerlines. In densely populated cities, underground cable tunnels may be constructed
15 well below the surface of the earth, e.g., up to 60 meters or possibly more below the earth's surface, to avoid congestion with other existing underground infrastructure, such as underground train systems, expressways, drainage pipes, etc...

In a typical underground cable tunnel, multiple tiers of cable troughs are mounted on the
20 wall(s) of the cable tunnel. Each trough is structured for carrying at least one cable, which can be heavy or very heavy. For instance, electrical utility power cables commonly have a mass of 20 to 60 kg per metre. A given cable may need to be deposited into a trough mounted at a significant height away from the bottom of the cable tunnel, for instance, a height of 1.5m or more. Owing to the restricted space available in the cable tunnel, the
25 heavy mass of the cables, and the curvature of the walls of the cable tunnel, the installation and placement of the cables into different tiers of troughs can be undesirably time consuming and labor intensive. Conventionally, multiple chain blocks and a pulley system, along with 30-50 onsite workers, are used to manually lift and drop a power cable into a wall-mounted trough. The pulley system must be hung from overhead steel pipes having

an inverted L-shaped structure, and the steel pipes and the L-shaped structure need to be assembled and constructed onsite, incurring additional time and expense for the cable placement operation. Moreover, the workers maneuvering the pulley system are subjected to increased risk of injury. Consequently, there exists a need for a system which can at least partially overcome the shortcomings present in the conventional approach for elevating and installing cables (e.g., electrical utility power cables) in troughs within underground cable tunnels.

Summary

- 10 A cable conveying and placement system or apparatus includes a cable conveying track or path corresponding to a set of platform structures; a set of hauling machines corresponding to or establishing portions of the cable conveying track; a front, lower, or bottom track extendable or extending forward away from a hauling machine ingress; and a rear, higher, or top track extendable or extending rearward away from a hauling machine egress.
- 15 Particular portions of the system are adjustable to different: heights away from a reference or base surface that carries the system; vertical (e.g., up – down) cable offloading angles; and lateral (e.g., left – right) cable offloading angles for placing portions of a cable into a trough, e.g., on a progressive, ongoing, or cyclically repeated, and automated or semi-automated basis across the majority of the length of the cable to thereby significantly
- 20 reduce the number of personnel and time required for placing a cable in a cable trough compared to conventional approaches.

- In accordance with an aspect of the present disclosure, a system for lifting portions of a cable away from a lower surface that supports the cable, and conveying lifted portions of the cable toward a vertically elevated target destination, includes: a frame structure extending upwardly relative to the lower surface and displaceable along a direction parallel to the lower surface, wherein the frame structure includes a front portion, a back portion rearwardly opposite the front portion, a left side, a right side laterally opposite the left side, a bottom portion that is closest to the lower surface, and a top portion that is furthest from
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the lower surface; a set of track or ramp elements carried or provided by or coupled to the frame structure, wherein the set of track or ramp elements establishes relative to portions of the frame structure a cable transportation path that is elevated relative to the lower surface such that the cable transportation path is vertically further away from the lower surface at the back portion of the frame structure than at the front portion of the frame structure; and a cable conveying machine coupled to the frame structure, wherein the cable conveying machine is configured for progressively displacing the lifted portions of the cable away from the front portion of the frame structure toward the back portion of the frame structure along the cable transportation path.

The system can further include a set of lateral displacement guides coupled to the frame structure or the set of track or ramp elements, wherein each lateral displacement guide is configured for retaining particular portions of the cable at a selected lateral position relative to the left side and the right side of the frame structure as the lifted portions of the cable are displaced toward the target destination.

The set of lateral displacement guides can include at least one lateral displacement guide that is laterally repositionable at multiple locations relative to the left side and the right side of the frame structure.

The cable conveying machine can include or be a cable hauling machine having an ingress facing toward the front portion of the frame structure at which portions of the cable are drawn into the hauling machine, and an egress facing toward the back portion of the frame structure at which portions of the cable are output from the hauling machine.

The egress can be vertically further away from the lower surface than the ingress.

The set of track or ramp elements can include a plurality of cross bars that extend lengthwise parallel to each other, and which are configured for supporting particular lifted

portions of the cable between the front portion of the frame structure and the back portion of the frame structure.

5 The set of track or ramp elements can include a plurality of rollers configured for rotating in response to displacement of particular portions of the cable therealong.

The set of track or ramp elements can include a first track or ramp element disposed between the front portion and the back portion of the frame structure, and a second track or ramp element disposed beyond the back portion of the frame structure.

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The second track or ramp element can be pivotally coupled to the frame structure such that the second track or ramp element is laterally displaceable relative to the left side and the right side of the frame structure.

15 The second track or ramp element can be coupled to the frame structure by way of a hinge structure such that the second track or ramp element is upwardly and downwardly displaceable relative to the frame structure.

20 In accordance with an aspect of the present disclosure, a modular system for lifting portions of a cable away from a lower surface that supports the cable, and conveying lifted portions of the cable toward a vertically elevated target destination, includes: a plurality of frame structures disposed serially relative to each other with respect to the lower surface, wherein each of the plurality of frame structures extends upwardly relative to the lower surface and is displaceable along a direction parallel to the lower surface, wherein each of
25 the plurality of frame structures includes a front portion, a back portion rearwardly opposite the front portion, a left side, a right side laterally opposite the left side, a bottom portion that is closest to the lower surface, and a top portion that is furthest from the lower surface, and wherein the plurality of frame structures includes: a first frame structure; and a last frame structure coupled to the first frame structure and having a top portion that is

further away from the lower surface than the top portion of the first frame structure; a set of track or ramp elements carried or provided by or coupled to the plurality of frame structures, wherein the set of track or ramp elements establishes a cable transportation path that is elevated relative to the lower surface such that the cable transportation path is vertically further away from the lower surface at the back portion of the last frame structure than at the front portion of the first frame structure; and at least one cable conveying machine coupled to the plurality of frame structures, wherein the at least one cable conveying machine is configured for progressively displacing the lifted portions of the cable away from the front portion of the first frame structure toward the back portion of the last frame structure along the cable transportation path.

Such a module system can include a set of lateral displacement guides coupled to the plurality of frame structures or the set of track or ramp elements, wherein each lateral displacement guide is configured for retaining particular portions of the cable at a selected lateral position relative to the left side and the right side of a particular frame structure within the plurality of frame structures as the lifted portions of the cable are displaced toward the target destination.

The plurality of lateral displacement guides can include at least one lateral displacement guide that is laterally repositionable at multiple locations relative to the left side and the right side of a particular frame structure within the plurality of frame structures.

The at least one cable conveying machine can include or be a cable hauling machine having an ingress facing toward the front portion of the first frame structure at which portions of the cable are drawn into the hauling machine, and an egress facing toward the back portion of the last frame structure at which portions of the cable are output from the cable hauling machine.

The egress can be vertically further away from the lower surface than the ingress.

The set of track or ramp elements can include a plurality of cross bars that extend lengthwise parallel to each other, and which are configured for supporting particular lifted portions of the cable between the front portion of a particular frame structure within the plurality of frame structures and the back portion of the particular frame structure within the plurality of frame structures.

The set of track or ramp elements can include a plurality of rollers configured for rotating in response to displacement of particular portions of the cable therealong.

The set of track or ramp elements can include a first track or ramp element disposed between the front portion and the back portion of a particular frame structure within the plurality of frame structures, and a second track or ramp element disposed beyond the back portion of the last frame structure within the plurality of frame structures.

The second track or ramp element can be pivotally coupled to the last frame structure such that the second track or ramp element is laterally displaceable relative to the left side and the right side of the last frame structure.

The second track or ramp element can be coupled to the last frame structure by way of a hinge structure such that the second track or ramp element is upwardly and downwardly displaceable relative to the last frame structure.

In accordance with an aspect of the present disclosure, a process or method for lifting portions of a cable away from a lower surface that supports the cable, and conveying lifted portions of the cable toward a vertically elevated target destination, includes: providing a frame structure extending upwardly relative to the lower surface and displaceable along a direction parallel to the lower surface, wherein the frame structure includes a front portion, a back portion rearwardly opposite the front portion, a left side, a right side laterally

opposite the left side, a bottom portion that is closest to the lower surface, and a top portion that is furthest from the lower surface; providing a set of track or ramp elements carried or provided by or coupled to the frame structure, wherein the set of track or ramp elements establishes relative to portions of the frame structure a cable transportation path that is elevated relative to the lower surface such that the cable transportation path is vertically further away from the lower surface at the back portion of the frame structure than at the front portion of the frame structure; providing a cable conveying machine coupled to the frame structure; and activating the cable conveying machine to progressively lift portions of the cable away from the lower surface and displace the lifted portions of the cable away from the front portion of the frame structure toward the back portion of the frame structure along the cable transportation path in an automated manner.

In accordance with an embodiment of the present disclosure, a system for placing portions of a cable into a cable trough, such as a target cable trough that is mounted horizontally along a wall of a cable tunnel, includes: (a) a set of platforms; a set of hauling machines carried by the set of platforms; a bottom track that extends forward of the set of platforms; and a top track that extends rearward of the set of platforms, where the top track is vertically (re)positionable and horizontally or laterally (re)positionable, such that a rearward portion, segment, or end of the top track, e.g., corresponding to a position or location along the top track at which the cable is or is intended to be offloaded from the top track, can be selectively (re)positioned both vertically and laterally relative to the location of the target cable trough.

In accordance with a further aspect of the present disclosure, the bottom track is also vertically (re)positionable, and in certain embodiments the bottom track is both vertically (re)positionable and laterally re(positoinable). The bottom track and top track can be structurally coupled to or include analogous, similar, or counterpart, structural elements, e.g., which are structurally coupled to or carried by the platform(s), that enable vertical

(re)positioning thereof, and/or lateral (re)positioning thereof, depending upon embodiment details.

Each hauling machine has an input or ingress for receiving the cable and an output or egress for outputting the cable. Each hauling machine can displace or transport portions of the cable between the hauling machine's ingress and egress. Each hauling machine is carried by a platform such that the hauling machine can progressively or repeatedly convey portions of the cable from the front track toward the rear track along an intended cable conveying path toward the target cable trough, e.g., an upward and rearward cable conveying path or trajectory.

During system operation, the bottom track is disposed closest to a surface on which portions of the cable initially reside or rest prior to being drawn into or passing through the hauling machine(s); and the top track is disposed closest to the target cable trough. The aforementioned surface on which portions of the cable initially reside can include or be, for instance, a floor or ground surface (e.g., a cable tunnel floor), or even another cable trough, such as a first or source cable trough that is different from the target cable trough (e.g., a first cable trough disposed horizontally along the cable tunnel wall at a vertical level that is below that of the target cable trough).

Portions of the bottom track, the cable conveying track corresponding to the platform(s), and the top track can include a set of friction-reducing elements such as one or more rollers against or on which portions of the cable pass, and/or one or more frame structures, which themselves can include rollers, through which portions of the cable pass. The rollers / frame structures aid or provide reduced-friction displacement of portions of the cable toward and to the target cable trough, thereby reducing mechanical energy losses. At least some of such rollers / frame structures can be laterally or horizontally (re)positionable, e.g., to aid or enable adjustable lateral or horizontal routing or guiding of the cable's displacement toward and to the target cable trough. The lateral (re)positionability of the

top track, in combination with the lateral (re)positionability of the rollers / frame structures, can establish a laterally or horizontally curved or non-linear (e.g., piecewise non-linear) cable displacement path or trajectory along or across portions of the top track's width relative to or toward the target cable trough.

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Brief Description of Drawings

FIG. 1 is a schematic illustration showing a representative underground cable tunnel and a corresponding above-ground utility building.

10 FIG. 2A is a cross-sectional view showing a cross-sectional view of a representative underground cable tunnel having a plurality of cable troughs disposed at different heights therein, and showing a back or rear portion of a cable placing system (CPS) in accordance with an embodiment of the present disclosure on a floor structure of the cable tunnel.

15 FIG. 2B is a photograph showing a portion of a representative type of utility power cable that is commonly installed in a cable tunnel.

FIG. 3 is a schematic side view of a cable placing system in accordance with an embodiment of the present disclosure.

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FIG. 4 is a schematic side view of a modular cable placing system in accordance with an embodiment of the present disclosure.

FIGs. 5A and 5B are schematic illustrations respectively showing (a) a back view of
25 portions of a cable placing system without preferential lateral or outward positioning of a top track toward a target trough mounted at a predetermined height on a side wall of a cable tunnel; and (b) a back view of portions of such a system with the top track preferentially laterally or outwardly (re)positioned toward the target trough, such that a

cable can be more easily, reliably, and rapidly fed or offloaded from a portion of the top track into the target trough.

FIGs. 5C and 5D are schematic illustrations showing back views of another cable placing system analogous to that shown in FIGs. 5A and 5B, but which has different dimensions.

FIG. 6A is a photograph showing a side view of a cable placing system in accordance with an embodiment of the present disclosure.

FIG. 6B is a photograph showing a front view of the cable placing system of FIG. 6B, with a top track thereof extending upwardly and rearwardly, and preferentially laterally or outwardly offset in a rightward direction, and an arrangement of frames carried by an intermediate track and the top track that can provide a lateral, outward, or rightward displacement of a cable toward a target trough.

FIG. 7A and 7B are photographs showing a front view and a perspective rear view, respectively, of the cable placing system of FIGs. 6A – 6B, with portions of a power cable being elevated toward, to, and above a target cable trough along an upward, rearward, and laterally, outwardly, or rightwardly shifted, angled, curvilinear, or curved path.

FIG. 8 is a schematic side view showing portions of a platform that includes a set of wheels as well as a set of platform guide rollers in accordance with an embodiment of the present disclosure.

FIG. 9 is a top view illustrating portions of a cable hauling machine having an egress that is laterally or horizontally offset with respect to its ingress, and which includes a plurality of cable hauling wheels and/or belts that are laterally offset relative to each other in accordance with an embodiment of the present disclosure.

Detailed Description

The detailed description set forth below and the FIGs. associated therewith are intended to describe and show representative embodiments of cable placing systems in accordance with the present disclosure, and are not intended to represent the only manner or manners in which embodiments in accordance with the present disclosure can be constructed, function, or be utilized. The description sets forth particular structural and functional aspects of representative cable placing systems for purpose of illustration and aiding understanding. It is to be understood that the same or equivalent structures and/or functions may be realized in other manners in different embodiments, which are also encompassed by the scope of the present disclosure.

As denoted elsewhere herein, like element numbers are intended to be indicate like or similar elements or features.

As used herein, the terms “approximately” or "about", in the context of concentrations of components, conditions, other measurement values, etc., means +/- 5% of the stated value, or +/- 4% of the stated value, or +/- 3% of the stated value, or +/- 2% of the stated value, or +/- 1% of the stated value, or +/- 0.5% of the stated value, or +/- 0% of the stated value.

For purpose of brevity and simplicity, in the text that follows, an electrical utility line power transmission cable can simply be referred to as a power cable or a cable; and a system for mechanically displacing / conveying, lifting / elevating, and transferring, laying, or placing a cable into a cable trough in accordance with an embodiment of the present disclosure can be referred to as one or more of (i) a cable conveying, lifting, and placing system or machine; (ii) a cable placing or placement system or machine; or (iii) a cable placer.

Various embodiments of cable placing systems or machines in accordance with the present disclosure are directed to automatically or semi-automatically displacing / conveying,

lifting / elevating, and transferring, laying, positioning, or placing a cable into a horizontal cable trough. Typically, cable troughs are mounted to the wall(s) of an underground cable tunnel, such as a cable tunnel of the type shown in FIG. 1. The cable tunnel is associated with an above-ground electrical utility building.

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FIG. 2A is a cross-sectional illustration of a representative underground cable tunnel 10 having a plurality of cable troughs 20 disposed at different positions on the cable tunnel's inner wall(s) (e.g., side walls, or left and right sides). The cable troughs 20 can be disposed at different heights or vertical levels within the cable tunnel 10, as well as
10 different lateral or outward positions or locations relative to a vertical reference plane 12 defined through the cable tunnel 10, such as a vertical plane that divides, approximately bisects, or bisects the cable tunnel 10 into left and right halves. FIG. 2A also shows a portion of a representative cable placing system (CPS) 100, 200 in accordance with an embodiment of the present disclosure, which can operate inside the cable tunnel 10 to
15 convey and lift a power cable toward or to a particular, selected, designated, or target cable trough 20T within the cable tunnel 10; and offload, transfer, or deposit the power cable into the target cable trough or target trough 20T. In FIG. 2A, each cable trough 20 includes a removable / replaceable cover, in a manner readily understood by individuals having ordinary skill in the relevant art.

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FIG. 2B is a photograph showing a portion of a representative type of power cable 70, which can be installed in a cable trough 20 by way of a cable placing system 100, 200 in accordance with an embodiment of the present disclosure. A lengthwise, longitudinal, or central axis 72 can be defined through an approximate midpoint or centroid of the cable 70,
25 in a manner readily understood by individuals having ordinary skill in the relevant art.

Notwithstanding the foregoing, a cable placing system or machine 100, 200 in accordance with an embodiment of the present disclosure need not be limited to operation in an underground cable tunnel 10. A cable placing system 100, 200 in accordance with an

embodiment of the present disclosure can deposit a cable 70 in a channel, recess, or trough 20 that resides in essentially any type of environment in which the cable placing system 100, 200 can move and operate, in a manner that individuals having ordinary skill in the relevant art will readily comprehend from the disclosure herein.

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With further reference to FIGs. 3 and 4, aspects of cable placing systems 100, 200 in accordance with particular representative embodiments of the present disclosure are shown. Such cable placing systems 100, 200 can convey, lift, and deposit, position, or place a cable 70, e.g., a power cable, into a section of a cable trough 20 that is at least generally
10 horizontal, e.g., a target trough 20T for which at least portions thereof are carried, mounted, installed, or formed horizontally, such as along a wall of an underground cable tunnel 10 (e.g., the left wall along leftward or leftmost portions of a vertical reference plane 12 of the cable tunnel 10, or a right wall along rightward or rightmost portions of the vertical reference plane 12).

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In general, a cable placing system 100, 200 includes at least one frame, platform structure, or platform 110; at least one cable conveying or hauling machine 115 carried, supported, held by, or secured / mounted to the platform 110; and a plurality of ramps or tracks, including ramps or tracks projecting away from the platform(s) 110 in opposite or
20 opposing directions for guiding the cable 70 along an inclined angle from an initial, lower, lowest or floor level, toward and to the front of the platform(s) 110, into the hauling machine(s) 115, away from the hauling machine(s) 115 toward the rear or back of the platform(s) 110, upward and away from the rear of the platform(s) 110 to a final elevated level, and into the target trough 20T, which is typically disposed below the final elevated
25 level. The system 100 shown in FIG. 3 includes a single platform 110, and the modular system 200 shown in FIG. 4 includes a pair of platforms 210.

In various embodiments, the platform 110 includes or is defined by a bottom portion, section, or bottom 111; and an opposing top portion, section, or top 114; a front portion,

section, or front; a back portion, section, or back; and two opposing lateral side portions, sections, or sides, e.g., right and left sides, which correspond to or establish a width of the platform 110. In the disclosure herein, the front of the platform 110 is defined as that portion of the platform 110 that is closest to a location at which the cable 70 is lifted or
5 picked up from the floor level at which it initially resides; the rear of the platform 110 is defined as that portion of the platform that is closest to a location at which the cable 70 is offloaded into the target trough 20T; the bottom 111 of the platform 110 is defined as that portion of the platform 110 that is closest to the floor level; and the top 114 of the platform 110 is defined as that portion of the platform 110 that is furthest from the floor level, or
10 closest to the target trough 20T. In several embodiments, the top 114 of the platform 110 can correspond to, include, or be defined as portions of one or more rail, rod, or bar structures that extend lengthwise or horizontally between the front and rear of the platform 110, and which resides at a highest height or distance away from the floor level. It can be noted that the top 114 of the platform 100 can also correspond to or include, or
15 alternatively be defined as, one or more structures between the front and rear of the platform 110 that project upwards to a highest height or distance away from the floor level (e.g., the top(s) of rail(s), rod(s) or bar structure(s) that extend along a vertical direction to a highest level or point away from the floor level).

20 With respect to the embodiment shown in FIG. 3, the platform 110 is commonly fabricated from a metal (e.g., steel), a metal alloy, and/or other material(s) strong enough to support the weight of the cable 70 and hauling machine 115. In various embodiments, the mass of the platform 110 is reduced or minimized to correspondingly reduce or minimize the overall mass of the system 100, which aids swift and easy (re)positioning and movement of
25 the system 100 inside the cable tunnel 10. In such embodiments, the platform 110 can be constructed with bars, rods, columns, and/or shafts (e.g., hollow shafts) to reduce mass, without sacrificing platform structural integrity. The bars, rods, columns and/or shafts can be coupled or joined together by way of fastening devices or fasteners, such as conventional bolts and nuts, such that the sections, pieces, or materials from which the

platform 110 is constructed can be conveniently transported into and assembled within the tunnel 10, particularly considering the restricted space available in the tunnel 10.

The bottom 111 of the platform 110 can be shaped or formed as a rectangular, square, polygonal or other type of structure, for instance, corresponding to or defining a frame constructed from multiple hollow metal (e.g., steel) shafts. The platform 110 has coupled or attached thereto a plurality of wheels 118 at its bottom 111, which contact a floor or ground surface. At least some of the wheels 118 can be swivel type wheels, allowing the system 100 to be readily (re)positioned and moved inside the tunnel 10. Also, at least one of the swivel wheels 118 can be integrated with a lock mechanism or lock to secure the platform 110 in place when workers are assembling, setting up, or using the system 100. In various embodiments, the wheels 118 can be detachably coupled to the bottom 111 of the platform 110, as can other components of the system 100, to facilitate rapid and convenient on-site or in-tunnel system assembly.

In several embodiments, the platform 110 includes at least two pairs of columns 112 vertically extending or rising upwards from the bottom 111 of the platform 110. In the embodiment shown in FIG. 3, the system 100 includes three pairs of columns 112, i.e., a front pair of columns 112, a middle pair of columns 112, and a rear or back pair of columns 112, respectively corresponding to a frontal portion or region, a middle portion or region, and a rear or back portion or region of the platform 110. Each pair of columns 112 is typically installed away, offset, or set apart from another pair of columns 112 by a predetermined distance. A mount joint 119 can be used to secure each column 112 to the bottom 111 of the platform 110. Each pair of columns 112 includes a first or right and a second or left column that are disposed on opposite or opposing lateral sides of the platform 110 from each other. Collectively, the pairs of columns 112 correspond to or define the sides of the platform 110, and establish or approximately establish the platform's height.

The hauling machine 115 is carried or supported by or between particular pairs of columns 112, for instance, by way of support rails or a tray 116 disposed between such pairs of columns 112. In several embodiments, each column 112 has a plurality of apertures 113 formed at different locations along its length or vertical distance across which the column
5 upwardly extends away from the platform 110. The locations and number of apertures 113 on each column 112 substantially correspond to one another for a given right – left pair of columns 112, such that the tray 116 on which the hauling machine 115 is carried or positioned can be mounted to the platform 110 by releasably locking the tray 116 into selected apertures 113 using devices such as bolts and nuts. An operator assembling or
10 using the system 100 in an underground tunnel 10 can select or adjust the height of the hauling machine 115 over or above the bottom 111 of the platform 110 by way of selecting or adjusting the vertical position or height at which the tray 116 is carried by the columns 112 to which the tray 116 is coupled by the apertures 113. The tray 116 and hauling machine 115 are typically installed or established an upward angle of inclination relation to
15 a horizontal plane corresponding to the bottom 111 of the platform 110, such that a front or portion of the hauling machine 115 is lower or closer to the bottom 111 of the platform 110 than a rear portion of the hauling machine 115. The hauling machine 115 can progressively mechanically displace or pull and/or push the cable 70 from a lower or ground level near the front of the platform 110, through the hauling machine 115 toward
20 and to the rear of the platform 110, such that a given portion of the cable 70 being conveyed through the hauling machine 115 is progressively displaced rearwardly and upwardly towards the elevated rear portion of the hauling machine 115.

The hauling machine 115 can be conventional (e.g., in particular non-limiting
25 representative implementations, the hauling machine 115 can be a Xing Jia Pte Ltd. 1200 kgf hauling machine, or a Showa MC500A hauling machine), and generally includes an ingress facing the front of the platform 110 for receiving the cable 70, and an egress opposite to the ingress, facing the rear of the platform 110 for outputting the cable 70. The hauling machine 115 can progressively, repeatedly, and/or cyclically pull and/or push

portions of the cable 70 along the cable's length, such that portions of the cable 70 along the cable's length are progressively or incrementally lifted or picked up from a lowest starting location (e.g., the floor of the tunnel 10); pulled toward and into the hauling machine's ingress; displaced, drawn, or pulled and/or pushed upwardly and rearwardly through the hauling machine 115 to the hauling machine's egress; and further displaced or pushed upwardly and rearwardly beyond the egress toward and beyond the rear of the platform 110, toward the target trough 20T.

In various embodiments, the system 100 further includes a lower or bottom ramp or track 120 and an upper or top ramp or track 130 that are coupled to and which project away from a front portion or front end 122 of the platform 110 (i.e., corresponding to or at the front of the platform 110) and a rear portion or rear end 132 of the platform 110 (i.e., corresponding to or at the rear of the platform), respectively, to aid guiding the cable 70 into the ingress and away from the egress of the hauling machine 115. The bottom or lower track 120 can also be referred to or defined as a front track or a front lower track; and the top track 130 can also be referred to or defined as a rear track or rear upper track.

The bottom track 120 and top track 130 respectively provide or define a bottom path and a top path along which the cable 70 is displaced towards the target trough 20T. In a number of embodiments (though not necessarily all embodiments), each of the bottom track 120 and the top track 130 has a generally ladder-like design to reduce the mass of the system 100. Particularly, the bottom and top tracks 120, 130 include a pair of bars, rods, or poles that extend lengthwise parallel to each other. In certain embodiments, the parallel poles of the top track 130 need not be straight along their entire lengths, but can be curved or bent along one or more portions of their lengths, e.g., to facilitate positioning of the top track 130 close(r) to the target trough 20T. The parallel poles are coupled or joined to each other by way of a plurality of perpendicular cross bars or rungs. The cross bars or rungs are organized to establish portions of the bottom path corresponding to the bottom track 120, and portions of the top path corresponding to the top track 130. In several embodiments,

the bottom track 120 includes a leading or front edge or end 122 that corresponds to or forms a portion of the bottom track 120 that is furthest away from the platform 110; and the top track 130 includes a rear or trailing edge or end 132 that corresponds to or forms a portion of the top track 130 that is furthest away from the platform 110.

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In several embodiments, the system 100 also includes an intermediate ramp or track 117 disposed between the egress of the hauling machine 115 and a portion of the top track 130 that couples or joins the top track 130 to the platform 110. Thus, the intermediate track 117 is carried by or on the platform 110 behind the hauling machine 115 and forward of
10 the top track 130, and is angled upwardly and rearwardly at a given, selectable, selected, or predetermined angle. The intermediate track 117 can also include a pair of bars, rods, or poles that extend lengthwise parallel to each other, and which are coupled or joined to each other by way of a plurality of perpendicular cross bars or rungs. The intermediate track 117 forms portions or of provides an additional or intermediate path along which portions
15 of the cable 70 are guided or transferred from the hauling machine's egress to the top track 130, in a manner readily understood by individuals having ordinary skill in the relevant art.

Particular portions of the cable 70 are supported by or rest on the bottom, intermediate, and/or top path while the cable 70 is being displaced or moved toward the elevated level of
20 the target trough 20T. In order to reduce friction acting on the cable 70 when it is carried by the bottom track 120, the intermediate track 117, and the top track 130 while the cable 70 is displaced along the bottom path, the intermediate path, and the top path, respectively, in several embodiments the rungs of the bottom track 120, the intermediate track 117, and the top track 130 include or are formed as rotatable rollers 104. Thus, the bottom path, the
25 intermediate path, and/or the top path can include or provide a plurality of rollers 104, each of which is spaced apart by a selectable or predetermined distance. The rollers 104 rotate corresponding to the displacement of the cable 70, as the hauling machine 115 displaces the cable 70 upwardly and rearwardly toward the target trough 20T. Additionally, in some embodiments the intermediate track 117 can carry or include one or more subframe

structures that elevate the intermediate track's roller(s) 104 toward or to the underside of the cable 70, in accordance with a height or vertical level at which the cable 70 is output from the egress of the hauling machine 115.

- 5 The bottom track 120 and/or the top track 130 can be rotatably displaceable or pivotable with respect to the platform 110. More particularly, the in various embodiments the bottom track 120 and the top track 130 are pivotally coupled to the front of the platform 110 and the rear of the platform 110, respectively. Still more particularly, in a number of
 10 embodiments the bottom track 120 is coupled to the front of the platform 110 by way of a vertical or up – down pivot apparatus, assembly, mechanism, device, structure, or element, which enables vertical (re)angulation or (re)positioning of the bottom track 120 relative to the bottom 111 of the platform 110; and the top track 130 is coupled to the rear of the platform 110 by way of each of (i) a vertical or up – down pivot apparatus, assembly, mechanism, device, structure, or element, which enables vertical (re)angulation or
 15 (re)positioning of the top track 130 relative to the bottom 111 of the platform 110 (and thus vertical selection or adjustment of the height to which the top track 130 extends relative to the target trough 20T); and (ii) at least one lateral or left – right pivot apparatus, assembly, mechanism, device, structure, or element, which enables lateral or left-right (re)angulation or (re)positioning of one or more portions of the top track 130 relative to the platform's left
 20 and right sides (and thus lateral selection or (re)adjustment of the position of the top track 130 relative to the target trough 20T).

For instance, in various embodiments, the bottom track 120 is coupled or joined to the platform 110 by way of a front hinge assembly 140 that extends across frontal portions of
 25 the platform's width proximate to or at the front of the platform 110. The front hinge assembly 140 can include a horizontal support bar that carries one or more hinge elements, in a manner readily understood by individuals having ordinary skill in the relevant art. The front hinge assembly 140 enables the bottom track 120 to be swingably displaced (e.g., within a particular angular range about a horizontal axis of the front hinge assembly 140)

across or to multiple vertical positions with respect to the bottom 111 of the platform 110. The cable placing system 100 also includes a pair of front retaining devices or bars 127 that are selectively couplable or coupled to a frontal or front upper portion of the platform 110 and the bottom track 120 to securely retain or hold the bottom track 120 in a selected
5 or intended vertical orientation relative to the bottom 111 of the platform 110. In certain embodiments, the bottom track 120 can be raised or folded upwards by way of the front hinge assembly 140, such that it can be disposed in a near-vertical or vertical position adjacent to the front of the platform 110, thereby enhancing the compactness of the cable placing system 100 when not in use.

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In several embodiments, the top track 130 is coupled or joined to the platform 110 by way of a positioning assembly 150 that includes a rear hinge assembly 142 that extends across rearward portions of the platform's width, and a lateral pivot assembly 152 that is coupled to each of the top track 130 and the rear hinge assembly 142. The positioning assembly
15 150 enables vertical or up – down as well as lateral, outward, or left – right (re)adjustment of the position of the top track 130. More particularly, the rear hinge assembly 142 enables vertical or upward and downward (re)positioning of the top track 130 (and typically also the positioning assembly 150 coupled thereto), including vertical positioning of a rearward or rearmost portion of the top track 130 (e.g., the rear end 132 of the top
20 track 130) above an uppermost or topmost trough 20 in the cable tunnel 10, e.g., which can be the target trough 20T. The rear hinge assembly 142 can include a horizontal support bar that carries one or more hinge elements, in a manner readily understood by individuals having ordinary skill in the relevant art.

25 As indicated in FIG. 4, the lateral pivot assembly 152 can include a support plate or bar 154 that extends across a portion of the platform's width, and which carries or includes a lateral or left – right pivot or hitch structure, element, pin, or joint 156 (e.g., a pivot structure 156 that is centrally disposed along the support plate or bar 154) to which the top track 130 can be securely pivotally coupled. The top track 130 can include a receiver,

fitting, aperture, or opening with which the pivot pin 156 can securely matingly engage. In other embodiments, the top track 130 carries the pivot pin 156, and the support bar 154 includes the receiver, fitting, aperture, or opening into which the pivot pin 156 is insertable for secure pivotal mating engagement with the top track 130.

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Referring again to FIG. 3, in several embodiments, the cable placing system 100 also includes a pair of rear retaining devices or bars 137 that are selectively couplable or coupled to a lower rearward or rear portion of the platform 110 and the top track 130, and a retaining wire or wire rope 139 that is selectively couplable or coupled to an upper
10 rearward or rear portion of the platform 110 to securely retain or hold the top track 130 in a selected or intended vertical and lateral orientation or orientation, e.g., relative to or over the target trough 20T. In certain embodiments, the top track 130 can be folded downwards by way of the rear hinge assembly 142, such that it can be disposed in a near-vertical or vertical position adjacent to the rear of the platform 110, thereby enhancing the
15 compactness of the cable placing system 100 when not in use.

The rear hinge assembly 142 enables the top track 130 and the lateral pivot assembly 152 to be swingably displaced (e.g., within a particular angular range about a horizontal axis of the rear hinge assembly 142) across or to multiple vertical positions with respect to the
20 bottom 111 of the platform 110. The lateral pivot assembly 152 enables the top track 130 to be swingably displaced (e.g., within a particular angular range about a central axis of the pivot pin 156) across or to multiple lateral, outward, or left – right positions with respect to a vertical plane that divides or bisects the platform 110 width-wise, or analogously, with respect to the left and right sides of the platform 110. Thus, the lateral pivot assembly 152
25 enables the top track 130 to swing laterally such that a rearward portion, section, or segment of the top track 130 at which the cable 70 is offloaded into the target trough 20T can be laterally positioned close or very close to or directly over the target trough 20T.

The bottom track 120, the hauling machine 115, the intermediate track 117, and the top track 130 collectively form a transportation route or path for the cable 70, along which the cable 70 progressively moves from a floor or lowest level towards and to the target trough 20T, with low or reduced friction by way of the rollers 104. The bottom track 120, the hauling machine 115, the intermediate track 117, and the top track 130 are collectively arranged to incline the cable 70 to effectively reach the target trough 20T by way of upward and rearward displacement of the cable 70, e.g., in a manner indicated shown in FIG. 3.

The bottom track 120 is disposed relatively lower than the ingress of the hauling machine 115 to facilitate lifting, raising, or scooping of the cable 70 from a lowest or initial resting level, e.g., on the floor of the tunnel 10. The bottom track's front end 122 enables the system 100 to concurrently lift or scoop a next portion, section, or segment of the cable 70 while previously lifted or scooped portions, sections, or segments of the cable 70 are progressively displaced along other portions of the bottom track 120 closer to the platform 110, toward and through the hauling machine 115, along the intermediate track 117 and the top track 130, and toward and into an open recess of the target trough 20T. As a result of the hauling machine's progressive or repeated upward and rearward displacement of the cable 70, successive portions of the cable 70 are displaced from, beyond, or off of the top track 130 and into the target trough's open recess.

In various embodiments, the bottom track 120 is disposed or aligned relative to the left and right sides of the platform 110 such that when portions of the cable 70 are carried by or being displaced along the bottom track 120, the central axis 72 of the cable 70 is generally or approximately laterally aligned at a left – right midpoint or midway between the platform's left and right sides. In several (though not necessarily all) embodiments, the bottom track 120 is not laterally or left – right pivotable.

The ingress and egress of the hauling machine 115, and thus the cable's central axis 72 along portions of the cable 70 that are being conveyed through the hauling machine 115, are also generally or approximately disposed or laterally aligned at the left - right midpoint or midway between the platform's left and right sides.

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When the position of the top track 130 is selectively or preferentially laterally or outwardly established or adjusted such that portions of the top track 130 laterally or outwardly extend toward, approach, and/or reside over the target trough 20T, portions of the cable 70 along the length of the top track 130 are progressively laterally shifted closer to the target trough 20T in association or conjunction with the upward and rearward displacement of the cable 70 along the top track 130. Hence, with respect to portions of the cable 70 that are being carried by or displaced along the top track 130, the central axis 72 corresponding to such portions of the cable 70 does not remain generally aligned at the left – right midpoint or midway between the platform's left and right sides, but is rather progressively laterally shifted away from the left – right midpoint or midway between the platform's left and right sides, toward, to, and/or over the target trough 20T.

In order to ensure that the cable 70 does not laterally slide or fall off of the top track 130 during cable conveyance (e.g., due to the cable's lateral momentum as it is displaced upwardly, rearwardly, and laterally along the top track 130 toward the target trough 20T), the top track 130 typically includes a set of lateral displacement guides structured for ensuring that each portion of the cable 70 that is being carried or displaced along the top track 130 remains within an intended or predetermined lateral position range or lateral position on the top track 130 until reaching an intended top track exit position at which such portions of the cable 70 are fed or placed into the target trough 20T. Such lateral displacement guides include at least a set of posts or rails that extend along a vertical direction corresponding to at least a significant portion of the cable's diameter.

In various embodiments such as shown in FIGs. 3 and 4, the lateral displacement guides include or are formed as a plurality of frames 160 disposed at particular top track locations (e.g., the frames are separated from each other by particular or predetermined distances along the length of the top track 130), where each frame 160 is disposed around or over a segment of the cable 70 as the cable 70 passes thereunder or therethrough. Each frame 160 has a top edge, a bottom edge and a pair of opposing side edges (e.g., left and right edges) surrounding an aperture or space through which the cable 70 passes during cable displacement along the top track 130. The side edges of a given frame 160 restrict or limit the lateral or sideways movement of the cable 70 when the cable 70 is being displaced towards the target trough 20T.

Each frame 160 typically carries a plurality of rollers 104 for reducing friction as the cable 70 passes therethrough. Each roller 104 of the top path along the top track 130 can correspond to or provide the bottom edge of a corresponding frame 160. Further, at least the opposing side edges of the frame 160 carry one or more side rollers 104 that are rotatable upon contact with the cable 70 during cable displacement. The side rollers 104 can convert the force(s) exerted against them by the displacement of the cable 70 into rotational motion, thereby aiding guided motion of the cable 70 toward target trough 20T. In various embodiments, each frame 160 includes a bottom or lower roller 104; a pair of left and right rollers 104; and an upper or top roller 104. Each such frame 160 is typically rectangular, and is configured for carrying the cable 70 between an aperture or opening formed by its rollers 104.

In several embodiments, one or more frames 160 are also disposed at one or more positions along the intermediate track 117. A given frame 160 disposed along the intermediate track 117 or the top track 130 can be secured to a cross bar of the intermediate track 117 or the top track 130, respectively.

In multiple embodiments, one or more frames 160 are selectively or selectably laterally or outwardly (re)positionable, such as by way of incremental frame (re)positioning, or slidable frame motion along a top track cross bar or intermediate track cross bar to which the frame 160 is coupled (e.g., left and right or inward and outward motion with respect to the midpoint between the platform's left and right sides, or a vertical mid-plane or the middle of the cable tunnel 10). More particularly, at least some of the cross bars of the top track 130 and typically (though not necessarily always) one or more cross bars of the intermediate track 117 include or are fabricated to provide a plurality of frame mounts or a frame guide extending laterally therealong. Each frame 160 is paired with a corresponding plurality of frame mounts or a frame guide. Additionally, each frame 160 and/or its corresponding plurality of frame mounts or frame guide includes or provides a fastening or locking mechanism to secure or fix the frame 160 in place along the cross bar once the frame 160 has been moved to an intended or required position therealong. For instance, frame mounts can include or be apertures formed at particular or predetermined positions along a cross bar, plus fasteners (e.g., bolts and nuts) to secure the frame 160 to the cross bar. A frame guide can include or be a channel or recess formed in a cross bar, plus typically a fastener or locking mechanism (e.g., a set of bolts and nuts) to secure the frame 160 at a particular lateral or outward position along the frame guide.

A laterally or outwardly (re)positionable frame 160 can be positioned at a desired lateral or outward location along a cross bar (e.g., by way of a plurality of frame mounts or a frame guide carried by the cross bar, as indicated above). A sequence or series of successive laterally or outwardly (re)positionable frames 160 can establish a generally smooth or smooth curve or turn for guiding the cable 70 to and into the target trough 20T. The selectable or customizable lateral or outward (re)positionability of the frame(s) 160 along the intermediate track 117 and the top track 130 aids or enables lateral or outward shifting or displacement of portions of the cable 70 carried by the intermediate track 117 and the top track 130, respectively, and can enable lateral or outward displacement of such portions of the cable 70 along a set of straight or curved paths as the cable 70 is being

displaced rearwardly and upwardly away from the egress of the hauling machine 115, toward, to, and into the target trough 20T.

In multiple embodiments, portions of the hauling machine 115 along and/or through which the cable 70 is displaced or transported, and structures corresponding to the intermediate track 117 (including elements such as one or more rollers 104 and/or frames 160) along or through which the cable is displaced, correspond to or establish a platform-based or platform-resident cable conveying track that resides internal to or within predetermined borders of the platform 110, e.g., between the bottom 111 and the top 114 of the platform 110, and between the platform's left and right sides.

In various embodiments, the system 100 can place a power cable 70 into the target trough 20T at a rate between approximately 1 – 6 meters / minute. The repeated and/or cyclical cable displacement forces intermittently generated by the hauling machine 115 drives the platform 110 and hence the system 100 in a forward direction towards portions of the cable 70 that still reside or lay on the floor or lowest level, and which need to be picked up and transferred, fed, or loaded into the target trough 20T. The speed of the system 100 as it moves in a forward direction along the floor of the tunnel 10 is proportional to the power or force generated by the hauling machine 115. In some embodiments, the system 100 further includes an electric motor coupled to the wheels 118 to assist motion of the platform 110, e.g., when the system 100 is not carrying a cable 70. The hauling machine 115 and/or the electric motor can be powered by line power, or a portable power generator or a set of batteries carried by or near the platform 110 without the need for plugging in at power points, which may not be conveniently available in the underground tunnel 10.

FIG. 4 is a side schematic illustration of a modular cable placing system 200 in accordance with particular embodiments of the present disclosure, which includes at least one hauling machine 115, and which is constructed from a plurality of modular units 210 that are disposed sequentially or in series relative to each other. In various embodiments described

below, each modular unit 210 includes a platform 110, a hauling machine 115 carried by the platform 110, and an intermediate track 117 carried by the platform 110. More particularly, in the embodiment shown in FIG. 4, the system 200 is formed from a first, forward, front, or frontmost modular unit 210a; a second, rearward, rear, or rearmost modular unit 210b; and no other modular units (e.g., no intermediate modular units are present between the front and rear modular units). However, individuals having ordinary skill in the relevant art will understand that other embodiments can include additional modular units 210 (e.g., three or more modular units). Such individuals will also understand that in some embodiments, each modular unit 210 need not carry a hauling machine 115 (e.g., a system 200 formed of three modular units 210 can carry only two hauling machines 115 such as by way of a first or front modular unit 210 and a third or rear modular unit 210, without a hauling machine 115 carried by a second or middle modular unit 210; or possibly a single hauling machine 115, such as by way of the second or middle modular unit 210, without either of the first or the third modular units 210 carrying a hauling machine 115).

With respect to the embodiment shown in FIG. 4, for a given modular unit 210 its platform 110 is structured in a manner analogous, essentially identical, or identical to that described above with respect to FIG. 3, e.g., the platform 110 can include each of the platform elements indicated above; and the modular unit 210 carries an intermediate track 117 in a manner analogous, essentially identical, or identical to that described above for FIG. 3. In an embodiment such as that shown in FIG. 4, or alternatively in an embodiment such as that shown in FIG. 3, one or more platforms 110 can be coupled to additional (e.g., larger) wheels 118.

The modular units 210 are arranged in a sequential or serial manner (e.g., a serial linear manner) relative to each other, with the rear or back of one modular unit 210 (e.g., a first, preceding, forward, or front-most modular unit 210a) facing and positioned proximate or adjacent to the front of a successive or serially next modular unit (e.g., a second, following,

rearward, or rear-most modular unit 210b). Hence, with respect to FIG. 4, the platform 110 of a preceding modular unit 210a has a height that is shorter or lower than that of the immediately following modular unit 210b, such that the ingress of the hauling machine 115 of the following modular unit 210b is positioned higher than the egress of the hauling machine 115 of the immediately preceding modular unit 210a. More specifically, the ingress of the hauling machine 115 of the following modular unit 210b is configured to receive portions of the cable 70 that were displaced out of the egress of the hauling machine 115 of the immediately preceding modular unit 210a.

In a manner analogous to that described above, the system 200 includes a bottom track 120 and a top track 130, where the bottom track 120 extends forward of the frontmost modular unit 210, e.g., in front of the first modular unit 210a of FIG. 4, and is disposed at a given, selected, or selectable angle of inclination such that the cable 70 can be displaced along a bottom path provided by the bottom track 120, and fed upwardly and rearwardly into the ingress of the hauling machine 115 of the frontmost modular unit 210a. The top track 130 is disposed rearward of the rearmost modular unit 210, e.g., behind the second modular unit 210b in FIG. 4, at a given, selected, or selectable angle of inclination such that the cable 70 can be received from the intermediate track 117 of this modular unit 210b and guided or displaced upwardly and rearwardly along a top path toward, to, and into the target trough 20T.

Each of the bottom track 120 and top track 130 typically has a structure as set forth above, and each of the bottom track 120, the intermediate track 117, and the top track 130 carries rotatable rollers 104 to reduce friction during displacement of the cable 70 along the bottom path, the intermediate path, and the top path, respectively.

The bottom track 120 and/or the top track 130 can be rotatably displaceable or pivotable relative to the platforms 110 of the frontmost modular unit 210, e.g., the first modular unit 210a of FIG. 4, and the rearmost modular unit 210, e.g., the second modular unit 210b of

FIG. 4, respectively. More particularly, in various embodiments such as that shown in FIG. 4, the bottom track 120 and the top track 130 are pivotally coupled to the platform 110 of the front of the first or front modular unit 210a and the rear of the platform 110 of the second or rear modular unit 210b, respectively. In a number of embodiments the bottom track 120 is coupled to the front of the first modular unit's platform 110 by way of a vertical or up – down pivot apparatus, assembly, mechanism, device, structure, or element, which enables vertical (re)angulation or (re)positioning of the bottom track 120 relative to the bottom 111 of the platform 110; and the top track 130 is coupled to the rear of the second modular unit's platform 110 by way of each of (i) a vertical or up – down pivot apparatus, assembly, mechanism, device, structure, or element, which enables vertical (re)angulation or (re)positioning of the top track 130 relative to the bottom 111 of the platform 110 (and thus vertical selection or adjustment of the height to which the top track 130 extends relative to the target trough 20T, including vertical adjustment of the height of portions of the top track 130 (e.g., at least its rear end 132) above the target trough 20T); as well as (ii) at least one lateral or left – right pivot apparatus, assembly, mechanism, device, structure, or element, which enables lateral, outward, or left-right (re)angulation or (re)positioning of one or more portions of the top track 130 relative to the platform's left and right sides (and thus lateral, outward, or left - right selection or (re)adjustment of the position of the top track 130 relative to the target trough 20T).

For instance, in various embodiments, the bottom track 120 is coupled or joined to the platform 110 of the first modular unit 210a by way of a front hinge assembly 140 that extends across frontal portions of the platform's width proximate to or at the front of this platform 110, where the front hinge assembly 140 can be structured as indicated above with respect to FIG. 3. The front hinge assembly 140 enables the bottom track 120 to be swingably displaced (e.g., within a particular angular range about a horizontal axis of the front hinge assembly 140) across or to multiple vertical positions with respect to the bottom 111 of its corresponding platform 110. The cable placing system 200 also includes a pair of front retaining devices or bars 127 that are selectively couplable or coupled to a

frontal or front upper portion of this platform 110 and the bottom track 120 to securely retain or hold the bottom track 120 in a selected or intended vertical orientation relative to the bottom 111 of this platform 110. In certain embodiments, the bottom track 120 can be raised or folded upwards by way of the front hinge assembly 140, such that it can be disposed in a near-vertical or vertical position adjacent to the front of the platform 110 of the first modular unit 210a.

In several embodiments, the top track 130 is coupled or joined to the platform 110 of the second modular unit 210b by way of a positioning assembly 150 that includes a rear hinge assembly 142 that extends across rearward portions of the platform's width, and a lateral pivot assembly 152 that is coupled to each of the top track 130 and the rear hinge assembly 142, in a manner indicated above with reference to FIG. 3. The positioning assembly 150 enables vertical or up – down as well as lateral or left – right (re)adjustment of the position of the top track 130, such that the rear or trailing edge or end 132 end of the top track 130 can be vertically (re)positioned at an intended height above the target trough 20T, and rearward portions of the top track 130 can be laterally or outwardly (re)positioned over the target trough 20T to enable offloading of the cable 70 into the open recess of the target trough 20T.

As described above, the rear hinge assembly 142 can include a horizontal support bar that carries one or more hinge elements. As shown in FIG. 4, the lateral pivot assembly 152 can include a support plate or bar 154 that extends across a portion of its corresponding platform's width, and which carries or includes a lateral or left – right pivot or hitch structure, element, pin, or joint 156 to which the top track 130 can be securely pivotally coupled. The top track 130 can include a receiver, fitting, aperture, or opening with which the pivot pin 156 can securely matingly engage. In other embodiments, the top track 130 carries the pivot pin 156, and the support bar 154 includes the receiver, fitting, aperture, or opening into which the pivot pin 156 is insertable for secure pivotal mating engagement with the top track 130.

In several embodiments, the modular cable placing system 200 also includes a pair of rear retaining devices or bars 137 that are selectively couplable or coupled to a lower rearward or rear portion of the second module's platform 110 and the top track 130, and a retaining wire or wire rope 139 that is selectively couplable or coupled to an upper rearward or rear portion of this platform 110 to securely retain or hold the top track 130 in a selected or intended vertical and lateral orientation or orientation, e.g., relative to or over the target trough 20T. In certain embodiments, the top track 130 can be raised or folded downwards by way of the rear hinge assembly 142, such that it can be disposed in a near-vertical or vertical position adjacent to the rear of its corresponding platform 110.

The rear hinge assembly 142 enables the top track 130 and the lateral pivot assembly 152 to be swingably displaced (e.g., within a particular angular range about a horizontal axis of the rear hinge assembly 142) across or to multiple vertical positions with respect to the bottom 111 of the platform 110 of the second modular unit 210b, in a manner analogous to that set forth above. The lateral pivot assembly 152 enables the top track 130 to be swingably displaced (e.g., within a particular angular range about a central axis of the pivot pin 156) across or to multiple lateral, outward, or left – right positions with respect to a vertical plane that divides or bisects this platform 110 width-wise, or analogously, with respect to the left and right sides of this platform 110. Thus, the lateral pivot assembly 152 enables the top track 130 to swing laterally or outwardly such that a rearward portion, section, or segment of the top track 130 at which the cable 70 is offloaded into the target trough 20T can be laterally positioned close or very close to or directly over the target trough 20T.

The bottom track 120, each hauling machine 115, each intermediate track 117, and the top track 130 collectively form a transportation route or path for the cable 70, along which the cable 70 progressively moves from a floor or lowest level towards and to the target trough 20T, with low or reduced friction by way of the rollers 104. The bottom track 120, the

hauling machine 115, the intermediate track 117, and the top track 130 are collectively arranged to incline the cable 70 to effectively reach the target trough 20T by way of upward and rearward displacement of the cable 70, e.g., in a manner indicated shown in FIG. 4.

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The bottom track 120 is disposed relatively lower than the ingress of the first modular unit's hauling machine 115 to facilitate lifting, raising, or scooping of the cable 70 from a lowest or initial resting level, e.g., on the floor of the tunnel 10. The bottom track's front end 122 enables the system 200 to concurrently lift or scoop a next portion, section, or segment of the cable 70 while previously lifted or scooped portions, sections, or segments of the cable 70 are progressively displaced along other portions of the bottom track 120 closer to the platform 110 of the first modular unit 210a, toward and through this modular unit's hauling machine 115, along this modular unit's intermediate track 117, toward and to the next modular unit 210b, toward and to and the top track 130, and toward and into an open recess of the target trough 20T. As a result of the progressive or repeated upward and rearward displacement of the cable 70 by the hauling machines 115, successive portions of the cable 70 are displaced from, beyond, or off of the top track 130 and into the target trough's open recess.

20 In various embodiments, the bottom track 120 is disposed or aligned relative to the left and right sides of the first modular unit's platform 110 such that when portions of the cable 70 are carried by or being displaced along the bottom track 120, the central axis 72 of the cable 70 is generally or approximately laterally aligned at a left – right midpoint or midway between the platform's left and right sides. In several (though not necessarily all) 25 embodiments, the bottom track 120 is not laterally or left – right pivotable.

Typically, the ingress and egress of each hauling machine 115, and thus the cable's central axis 72 along portions of the cable 70 that are being conveyed through each hauling machine 115, are also generally or approximately disposed or laterally aligned at the left -

right midpoint or midway between left and right sides of each platform 110 that carries a hauling machine 115.

When the position of the top track 130 is selectively or preferentially established or adjusted such that portions of the top track 130 laterally or outwardly extend toward, approach, and/or reside over the target trough 20T, portions of the cable 70 along the length of the top track 130 are progressively laterally or outwardly shifted closer to the target trough 20T in association or conjunction with the upward and rearward displacement of the cable 70 along the top track 130. Hence, with respect to portions of the cable 70 that are being carried by or displaced along the top track 130, the central axis 72 corresponding to such portions of the cable 70 does not remain generally aligned at the left – right midpoint or midway between the platform’s left and right sides, but is rather progressively laterally or outwardly shifted away from the left – right midpoint or midway between the platform’s left and right sides, toward, to, and/or over the target trough 20T.

As above, in order to ensure that the cable 70 does not laterally slide or fall off of the top track 130 at an unintended top track location during cable conveyance, the top track 130 typically includes a set of lateral displacement guides structured for ensuring that each portion of the cable 70 that is being carried or displaced along the top track 130 remains within an intended or predetermined lateral position range or lateral position on the top track 130 until reaching an intended top track exit position at which such portions of the cable 70 are fed or placed into the target trough 20T. Such lateral displacement guides include at least a set of posts or rails that extend along a vertical direction corresponding to at least a significant portion of the cable’s diameter.

In various embodiments, the lateral displacement guides include or are formed as a plurality of frames 160 disposed at particular top track locations. Each frame 160 has a structure such as that described above, and each frame 160 typically carries a plurality of rollers 104, e.g., bottom, top, left, and right rollers 104, for reducing friction as the cable

70 passes therethrough. Each roller 104 of the top path along the top track 130 can correspond to or provide the bottom edge of a corresponding frame 160.

5 In several embodiments, one or more frames 160 are also disposed at one or more positions along one or more of the intermediate tracks 117. A given frame 160 disposed along an intermediate track 117 or the top track 130 can be secured to a cross bar of the intermediate track 117 or the top track 130, respectively.

10 In a manner analogous, essentially identical, or identical to that described above, one or more frames 160 of the top track 130, as well as one or more frames 160 of the intermediate track 117 of the second or rear modular unit 210b, are selectively or selectably laterally (re)positionable, such as by way of frame (re)positioning or slidable frame motion along a top track cross bar or intermediate track cross bar to which the frame 160 is coupled (e.g., left and right or inward and outward motion with respect to the
15 midpoint between the platform's left and right sides, or a vertical mid-plane or the middle of the cable tunnel 10). More particularly, at least some of the cross bars of the top track 130 and typically (though not necessarily always) one or more cross bars of this intermediate track 117 include or are fabricated to provide a plurality of frame mounts or a frame guide extending laterally therealong, in a manner set forth above, where each frame
20 160 is paired with a corresponding plurality of frame mounts or a frame guide, such as in a manner previously described.

A sequence or series of successive laterally (re)positionable frames 160 can establish a generally smooth or smooth curve or turn for guiding the cable 70 to and into the target
25 trough 20T. The selectable or customizable lateral or outward (re)positionability of the frame(s) 160 along the aforementioned intermediate track 117 and the top track 130 aids or enables lateral or outward shifting or displacement of portions of the cable 70 carried by this intermediate track 117 and the top track 130, respectively, and can enable lateral or outward displacement of such portions of the cable 70 along a set of straight or curved

paths as the cable 70 is being displaced rearwardly and upwardly away from the egress of the hauling machine 115 of the second modular unit 210b, toward, to, and into the target trough 20T.

- 5 Considering that multiple hauling machines 115 are commonly deployed in modular systems 200 in accordance with several embodiments of the present disclosure, such hauling machines 115 are preferably synchronized in their operation. The synchronization of the hauling machines 115 can be carried out by way of coupling each hauling machine 115 to a common controller or control unit or panel, which can regulate each hauling
10 machine's power output and hauling speed, e.g., as a function of time. Communication between each hauling machine 115 and the control unit can be wire-based or wireless.

In such a modular system 200, the forward movement speed of the system 200 along the tunnel 10 during a given time interval is proportional to the power output or force
15 generated by each hauling machine 115 that is active during the time interval under consideration. Thus, the speed at which the modular system 200 moves forward in the underground tunnel 10 during cable displacement toward, to, and into the target trough 20T can be regulated by way of the control unit. In a manner analogous to that described above, at least one electric motor 180 can be coupled to the wheels 118 of one or more
20 modular units 210 to provide extra driving power to move the modular system 200 along the tunnel 10. The electric motor(s) 180 can also function to move or drive the modular system 200 from one location to another in the underground tunnel 10 when the hauling machines 115 are not activated or not carrying the cable 70. The hauling machines 115 and the electric motor(s) 180 can be powered by line power, or a portable power generator
25 or battery 190 carried by a platform 110.

FIGs. 5A and 5B are schematic illustrations respectively showing (a) a back view of portions of a cable placing system 100, 200 without preferential lateral or outward positioning of its top track 130 toward a target trough 20T mounted at a predetermined

height on a side wall of a cable tunnel 10; and (b) a back view of portions of such a system 100, 200 with the top track 130 preferentially laterally or outwardly (re)positioned toward the target trough 20T, such that the cable 70 can be more easily, reliably, and rapidly fed or offloaded from a portion of the top track 130 into the target trough 20T.

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It should be noted that the physical or spatial measurements or dimensions indicated in various FIGs. described herein are representative, and are provided for purpose of illustration to aid understanding. Depending upon a cable installation environment (e.g., cable tunnel 10) under consideration, different versions of cable placing systems 100, 200 or portions thereof can readily be assembled or constructed to have different physical or spatial dimensions. Additionally or alternatively, different versions of cable placing systems 100, 200 can readily be assembled or constructed to provide different angular ranges across which the top track 130 can be vertically and/or laterally (re)positioned. Hence, particular cable placing systems, 100, 200 or portions thereof can have dimensions suitable for placing or installing cables 70 into troughs 20 within cable tunnels 10 having a certain size / diameter, size / diameter range, or geometry, or certain working area(s) available therein, or a certain configuration of troughs 20 therein; and other cable placing systems 100, 200 or portions thereof can have dimensions suitable for placing or installing cables 70 into troughs 20 within cable tunnels 10 having a different size / diameter, size / diameter range, or geometry, or which provide other internal working area(s), or other trough configurations (e.g., larger diameter cable tunnels 10, which have cable troughs 20 mounted higher than smaller diameter cable tunnels 10). As a representative non-limiting example, FIGs. 5C and 5D are schematic illustrations showing back views of another representative cable placing system 100, 200 having a width of 1300 mm and a height of 3600 mm, in a manner analogous to the back views shown for the narrower and shorter embodiment of a cable placing system 100, 200 shown in FIGs. 5A and 5B.

FIG. 6A is a photograph showing a side view of a cable placing system 100 in accordance with an embodiment of the present disclosure.

FIG. 6B is a photograph showing a front view of the cable placing system 100 of FIG. 6B, with the top track 130 thereof extending upwardly and rearwardly, and preferentially laterally or outwardly offset in a rightward direction (as defined from the front view of the cable placing system 100), and an arrangement of frames 160 carried by an intermediate track 117 and the top track 130 that can provide a lateral, outward, or rightward displacement of a cable 70 toward a target trough 20T.

FIGs. 7A and 7B are photographs showing a front view and a perspective rear view, respectively, of the cable placing system 100 of FIGs. 6A – 6B, with portions of a power cable 70 being elevated toward, to, and above a target cable trough 20T along an upward, rearward, and rightwardly shifted, angled, curvilinear, or curved path (e.g., a rightwardly-directed curvilinear path, or a rightwardly curved path as defined from a front view of the cable placing system 100, where this path is formed along the intermediate path corresponding to the intermediate track 117 and the top path corresponding to the top track 130 and a plurality of frames 160 corresponding to the intermediate track 117 and the top track 130), such that the power cable 70 is deposited into the target cable trough 20T.

Embodiments in accordance with the present disclosure can exhibit alternative, additional, and/or other elements, structures, features, and/or forms in a manner that falls within the scope of the present disclosure. For example, some embodiments can employ a smaller or shortened bottom track 120 relative to other embodiments, which may not be pivotally coupled to the platform 110; or omit or exclude the bottom track 120. Notwithstanding, it can be noted that the presence of a bottom track 120 can provide distributed support to forward portions of a cable 70 that are adjacent to the cable's lowest starting location as forward portions of the cable 70 are lifted and displaced away from the lowest starting location, such that undesirable or unwanted stresses upon the cable 70 can be reduced, minimized, or avoided as the cable 70 is lifted and displaced, thereby aiding the preservation of cable integrity.

As a further example, one or more platforms 110 can be coupled to a plurality of wheels 118a, e.g., in a manner described above, as well as a set of platform guide rollers 118b, e.g., in a manner shown in FIG. 8. The platform guide rollers 118b can aid alignment and/or retention (e.g., self-alignment and/or self-retention) of the platform 110 with respect to between a set of platform guide structures (e.g., a pair of platform guide structures) that extend along the floor or ground surface. The platform guide rollers 118b can have an axis of rotation that is transverse or perpendicular to the axes of rotation of the platform's wheels 118a, in a manner readily understood by individuals having ordinary skill in the relevant art.

As yet another example, as indicated in FIG. 9, a cable hauling machine 115 can have an egress 115e that is laterally or horizontally offset with respect to its ingress 115i, such that portions of a cable 70 displaced by or through the cable hauling machine 115 are laterally displaced or routed along a particular (e.g., predetermined or selected) path (e.g., corresponding to a curve) by or within the cable hauling machine 115 itself. Such a cable hauling machine 115 can include a plurality of serially disposed cable hauling wheels and/or belts 115w that are laterally offset relative to each other (e.g., in a pairwise manner between the ingress 115i and the egress 115e), and which are coupled to and driven by a set of hauling machine motors, in a manner that individuals having ordinary skill in the art will comprehend.

The representative embodiments presented herein are to be considered in all respects only as illustrative, and not restrictive. Embodiments in accordance with the present disclosure are limited only by the following claims.

Claims

1. A system for lifting portions of a cable away from a lower surface that supports the cable, and conveying lifted portions of the cable toward a vertically elevated target destination, the system
5 comprising:

a frame structure extending upwardly relative to the lower surface and displaceable along a direction parallel to the lower surface, wherein the frame structure includes a front portion, a back portion rearwardly opposite the front portion, a left side, a right side laterally opposite the left side, a bottom portion that is closest to the lower surface, and a
10 top portion that is furthest from the lower surface;

a set of track elements carried or provided by or coupled to the frame structure, wherein the set of track elements establishes relative to portions of the frame structure a cable transportation path that is elevated relative to the lower surface such that the cable transportation path is vertically further away from the lower surface at the back portion
15 of the frame structure than at the front portion of the frame structure; and

a cable conveying machine coupled to the frame structure, wherein the cable conveying machine is configured for progressively displacing the lifted portions of the cable away from the front portion of the frame structure toward the back portion of the frame structure along the cable transportation path.

2. The system of claim 1, further comprising a set of lateral displacement guides coupled to the set of track elements, wherein each lateral displacement guide is configured for retaining particular portions of the cable at a selected lateral position relative to the left side and the right side of the frame structure as the lifted portions of the cable are displaced toward the target
25 destination.

3. The system of claim 2, wherein the set of lateral displacement guides includes at least one lateral displacement guide that is laterally repositionable at multiple locations relative to the left side and the right side of the frame structure.

5 4. The system of claim 1, 2, or 3, wherein the cable conveying machine comprises a cable hauling machine having an ingress facing toward the front portion of the frame structure at which portions of the cable are drawn into the hauling machine, and an egress facing toward the back portion of the frame structure at which portions of the cable are output from the hauling machine.

10 5. The system of claim 4, wherein the egress is vertically further away from the lower surface than the ingress.

6. The system of any one of claims 1 to 5, wherein the set of track elements comprises a plurality of cross bars that extend lengthwise parallel to each other, and which are configured for
15 supporting particular lifted portions of the cable between the front portion of the frame structure and the back portion of the frame structure.

7. The system of any one of claims 1 to 6, wherein the set of track elements comprises a plurality of rollers configured for rotating in response to displacement of particular portions of the cable
20 therealong.

8. The system of any one of claims 1 to 7, wherein the set of track elements includes a first track element disposed between the front portion and the back portion of the frame structure, and a second track element disposed beyond the back portion of the frame structure.

9. The system of claim 8, wherein the second track element is pivotally coupled to the frame structure such that the second track element is laterally displaceable relative to the left side and the right side of the frame structure.

5 10. The system of claim 8 or 9, wherein the second track element is coupled to the frame structure by way of a hinge structure such that the second track element is upwardly and downwardly displaceable relative to the frame structure.

10 11. A modular system for lifting portions of a cable away from a lower surface that supports the cable, and conveying lifted portions of the cable toward a vertically elevated target destination, the system comprising:

15 a plurality of frame structures disposed serially relative to each other with respect to the lower surface, wherein each of the plurality of frame structures extends upwardly relative to the lower surface and is displaceable along a direction parallel to the lower surface, wherein each of the plurality of frame structures includes a front portion, a back portion rearwardly opposite the front portion, a left side, a right side laterally opposite the left side, a bottom portion that is closest to the lower surface, and a top portion that is furthest from the lower surface, and wherein the plurality of frame structures comprises:

a first frame structure; and

20 a last frame structure coupled to the first frame structure and having a top portion that is further away from the lower surface than the top portion of the first frame structure;

25 a set of track elements carried or provided by or coupled to the plurality of frame structures, wherein the set of track elements establishes a cable transportation path that is elevated relative to the lower surface such that the cable transportation path is vertically further away from the lower surface at the back portion of the last frame structure than at the front portion of the first frame structure; and

at least one cable conveying machine coupled to the plurality of frame structures, wherein the at least one cable conveying machine is configured for progressively displacing the lifted portions of the cable away from the front portion of the first frame structure toward the back portion of the last frame structure along the cable transportation path.

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12. The system of claim 11, further comprising a set of lateral displacement guides coupled to the set of track elements, wherein each lateral displacement guide is configured for retaining particular portions of the cable at a selected lateral position relative to the left side and the right side of a particular frame structure within the plurality of frame structures as the lifted portions of the cable are displaced toward the target destination.

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13. The system of claim 12, wherein the plurality of lateral displacement guides includes at least one lateral displacement guide that is laterally repositionable at multiple locations relative to the left side and the right side of a particular frame structure within the plurality of frame structures.

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14. The system of claim 11, 12, or 13, wherein the at least one cable conveying machine comprises a cable hauling machine having an ingress facing toward the front portion of the first frame structure at which portions of the cable are drawn into the hauling machine, and an egress facing toward the back portion of the last frame structure at which portions of the cable are output from the cable hauling machine.

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15. The system of claim 14, wherein the egress is vertically further away from the lower surface than the ingress.

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16. The system of any one of claims 11 to 15, wherein the set of track elements comprises a plurality of cross bars that extend lengthwise parallel to each other, and which are configured for

supporting particular lifted portions of the cable between the front portion of a particular frame structure within the plurality of frame structures and the back portion of the particular frame structure within the plurality of frame structures.

5 17. The system of any one of claims 11 to 16, wherein the set of track elements comprises a plurality of rollers configured for rotating in response to displacement of particular portions of the cable therealong.

10 18. The system of any one of claims 11 to 17, wherein the set of track elements includes a first track element disposed between the front portion and the back portion of a particular frame structure within the plurality of frame structures, and a second track element disposed beyond the back portion of the last frame structure within the plurality of frame structures.

15 19. The system of claim 18, wherein the second track element is pivotally coupled to the last frame structure such that the second track element is laterally displaceable relative to the left side and the right side of the last frame structure.

20 20. The system of claim 18 or 19, wherein the second track element is coupled to the last frame structure by way of a hinge structure such that the second track element is upwardly and downwardly displaceable relative to the last frame structure.

21. A method for lifting portions of a cable away from a lower surface that supports the cable, and conveying lifted portions of the cable toward a vertically elevated target destination, the method comprising:

25 providing a frame structure extending upwardly relative to the lower surface and displaceable along a direction parallel to the lower surface, wherein the frame structure includes a

front portion, a back portion rearwardly opposite the front portion, a left side, a right side laterally opposite the left side, a bottom portion that is closest to the lower surface, and a top portion that is furthest from the lower surface;

providing a set of track elements carried or provided by or coupled to the frame structure,
5 wherein the set of track elements establishes relative to portions of the frame structure a cable transportation path that is elevated relative to the lower surface such that the cable transportation path is vertically further away from the lower surface at the back portion of the frame structure than at the front portion of the frame structure;

providing a cable conveying machine coupled to the frame structure; and

10 activating the cable conveying machine to progressively lift portions of the cable away from the lower surface and displace the lifted portions of the cable away from the front portion of the frame structure toward the back portion of the frame structure along the cable transportation path in an automated manner.

SYSTEM FOR PLACING A CABLE INTO A TROUGH

ABSTRACT

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A system for placing a cable into a horizontal trough (e.g., along an underground cable tunnel wall) includes a platform carrying a hauling machine that includes an ingress facing the front of the platform, which receives the cable; and an egress facing the rear of the platform, from which the cable is displaced outward from the hauling machine by way of a hauling mechanism. A bottom track and a top track respectively extend from the front and the back of the platform. The bottom track, the hauling machine, and the top track collectively form a cable displacement path that is inclined upwardly and rearwardly along the bottom track, through the hauling machine, and along the top track. The top track is configurable to have an end selectively elevated to a height above an open recess of the trough, and is selectively laterally (re)positionable toward the trough.

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