Sept. 25, 1962 J. M. A. HUBERT 3,055,484

OVERHEAD CONVEYER SYSTEM

Filed March 25, 1960

5 Sheets-Sheet 1

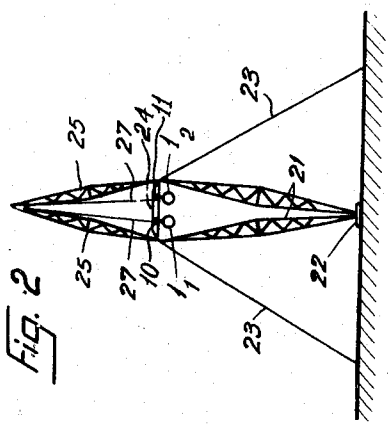


Fig. 2

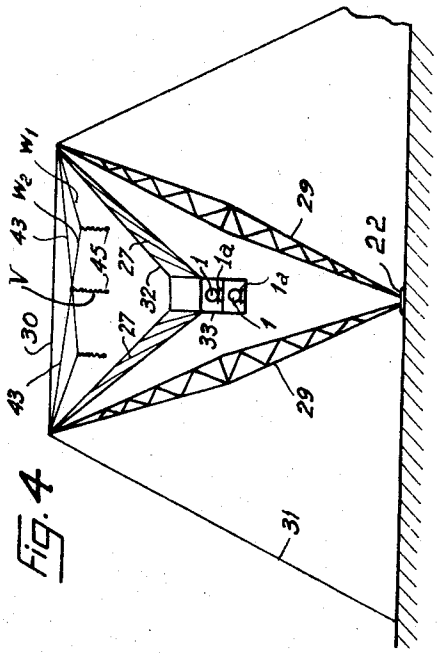


Fig. 4

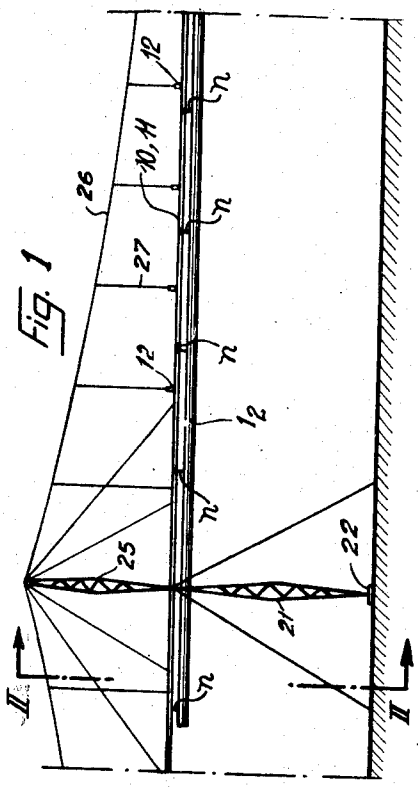


Fig. 1

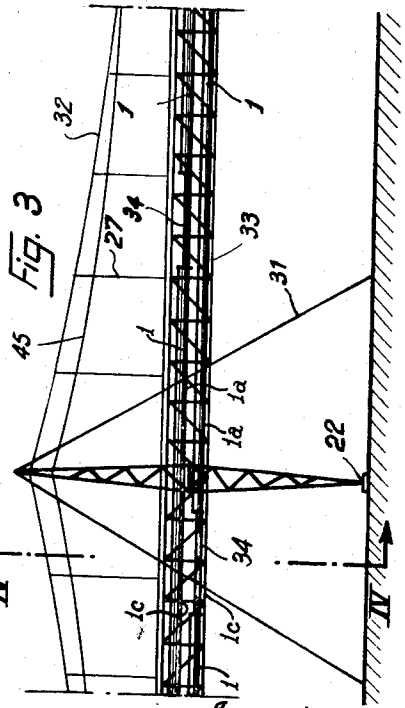


Fig. 3

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Fig. 5

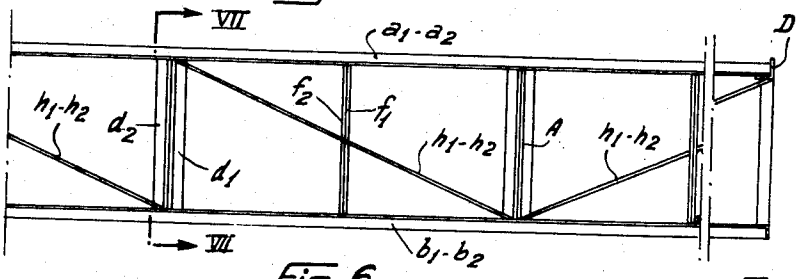


Fig. 6

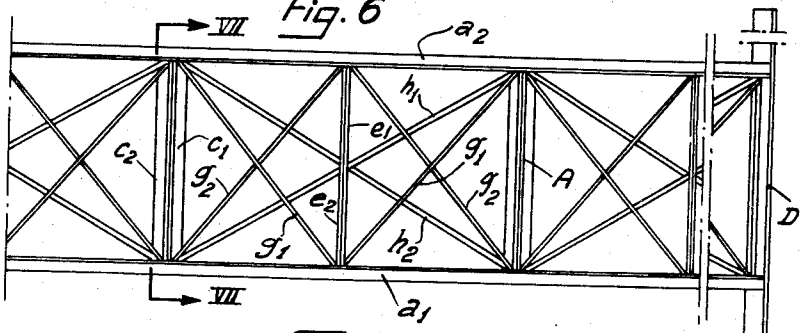


Fig. 7

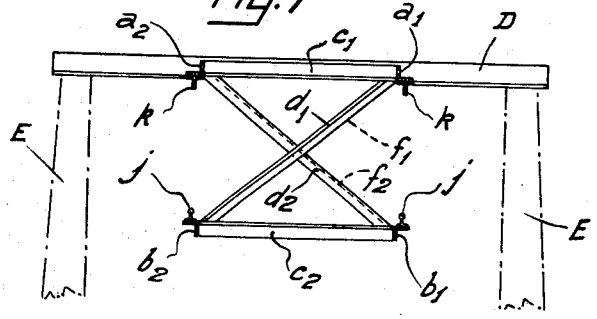
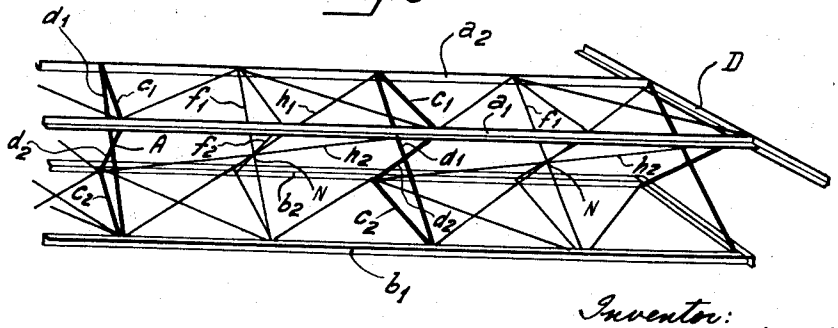


Fig. 8



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Fig. 9

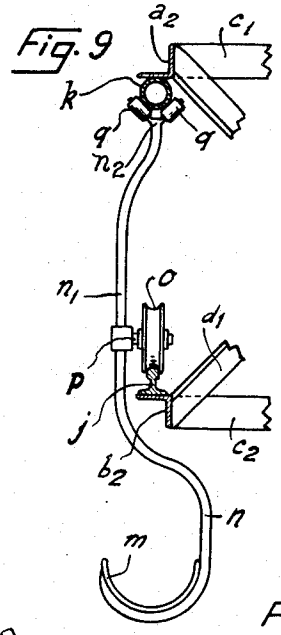


Fig. 10

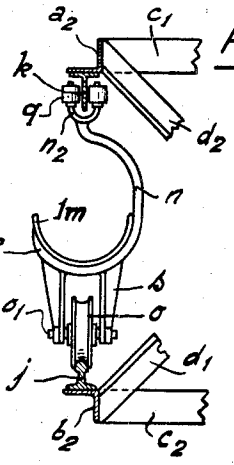
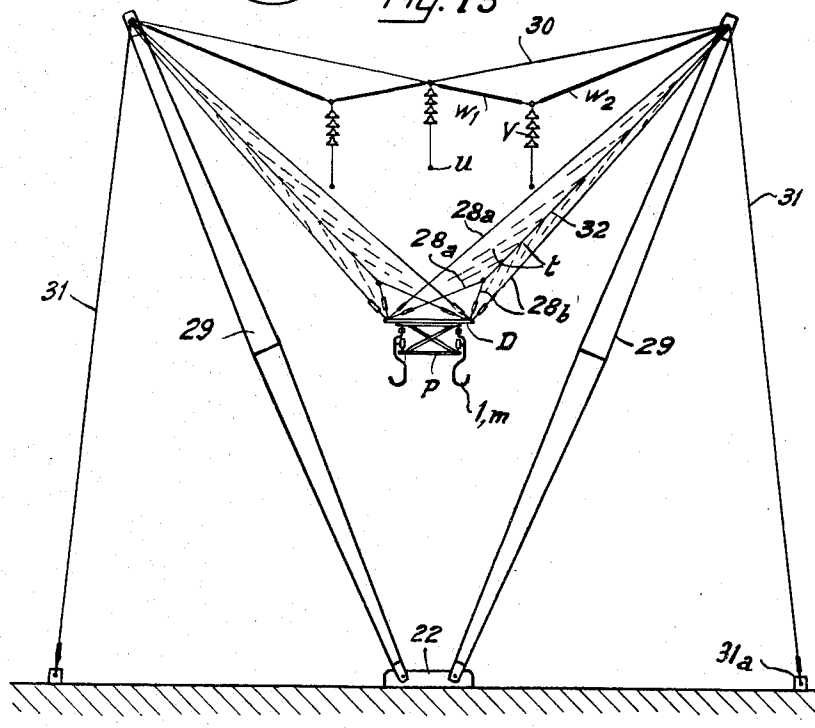


Fig. 13



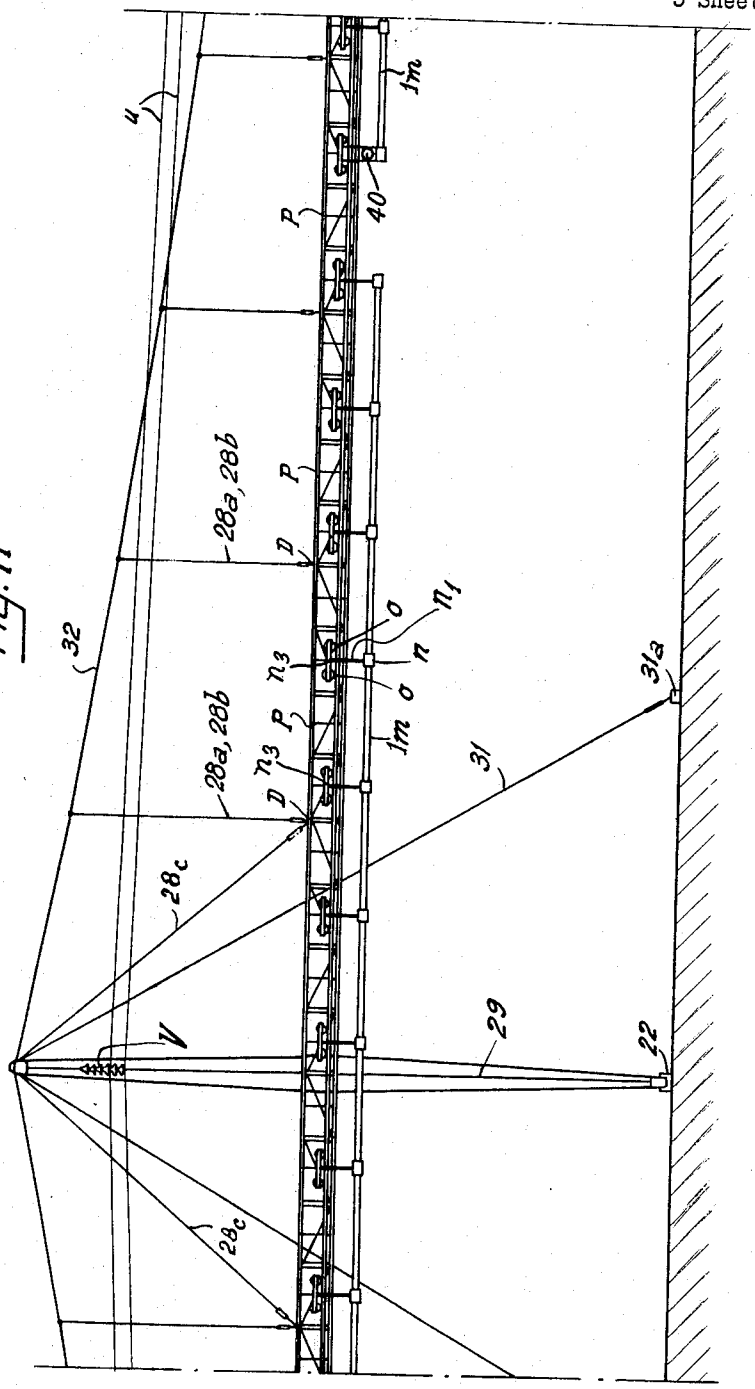
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Fig. 11



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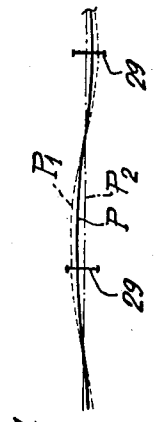


Fig. 14

Fig. 12

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United States Patent Office 3,055,484 Patented Sept. 25, 1962

3,055,484

OVERHEAD CONVEYER SYSTEM

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Filed Mar. 25, 1960, Ser. No. 17,522
Claims priority, application France May 6, 1957
10 Claims. (Cl. 198—129)

This is a continuation-in-part of my application Ser. No. 732,859 filed May 5, 1958.

The invention relates to conveyer systems of the type using one or a plurality of flexible, elongated, trough- or tube-shaped conveyer elements of predetermined length supported on trucks having rollers or wheels riding along a track which is desirably formed as a closed loop or circuit. There may be provided a single such conveyer element extending the full length of the looped track, or a plurality of conveyer elements. The conveyer element or elements may be supported from trucks of the monorail type riding a single overhead rail extending parallel to and spaced above the conveyer elements. The invention is more especially directed to the construction of supporting structure for the overhead tracks for this latter type of conveyer systems.

It is an object of this invention to provide an improved overhead track structure for a conveyer system, wherein the spacing between adjacent supporting frames serving to support the track over the ground may be considerably increased so as to provide a maximum amount of ground clearance area and facilitate the crossing of rough and uneven terrain.

Another object is to provide a relatively rigid and practically continuous track structure over which the truck wheels will ride with a minimum danger of derailing.

A further object is the provision of a track which, while being continuous, will be freely expansible with varying temperatures.

It is a further object to provide a track structure in the general form of a girder having means providing a pair of spaced parallel tracks therein for the respective travel of the conveyer elements thereover in each of two opposite directions. Yet another object is to provide a track structure in the form of a girder comprising at each side of it a carrier rail and a guide rail for the conveyer elements, whereby to minimize pendulous oscillation of the conveyer elements on the carrier rail. Further objects will appear.

According to an important aspect of the invention there is provided a track structure comprising a continuous girder made up from lattice girder sections interconnected end to end, and V-shaped supporting tower structures for said girder each comprising an upwardly diverging pair of towers, a pair of flexible connecting elements, such as wire rope or cable, interconnecting each longitudinally extending series of tower apices, and suspension means for supporting said girder from said flexible elements at spaced points therealong.

According to another important aspect there is provided a track structure in the form of a girder having an X-shaped cross section, with a pair of parallel spaced main carrier rails extending along the outer sides of the lower legs of said X-shaped girder and guide rails extending along the outer sides of the upper legs of the girder.

The above and further objects, features and aspects of the invention will appear as the disclosure proceeds with reference to the accompanying drawings wherein:

FIG. 1 is a side elevation, simplified, showing part of a catenary overhead track structure according to the invention with one supporting tower structure therefor;

FIG. 2 is a section on line II—II of FIG. 1;

FIG. 3 is a view similar to FIG. 1 illustrating a modified form of overhead track structure;

FIG. 4 is a section on line IV—IV of FIG. 3;

FIG. 5 is a side elevation, on a larger scale, showing a girder section used as a support for the track of the conveyer system;

FIG. 6 is a corresponding plan view;

FIG. 7 is a section on line VII—VII of FIGS. 5 and 6.

FIG. 8 is a simplified perspective view of a girder according to FIGS. 5, 6, and 7 for more clearly illustrating the latticework of the girder;

FIGS. 9 and 10 illustrate two alternative uses of a girder as shown in the foregoing figures for the purposes of the invention;

FIGS. 11 and 12 are partial elevation and plan views respectively illustrating a continuous girder according to the foregoing figures supported from a catenary arrangement;

FIG. 13 is an end view of the system of FIGS. 11 and 12; and

FIG. 14 is a diagrammatic view in plan illustrating the manner in which thermal expansion may be taken up in a catenary-supported track system according to the invention.

A conveyer system of the type to which this invention relates preferably employs as the carrier elements for the materials or goods being conveyed long tubes **1** (see FIGS. 1 to 4) made of a semi-rigid sheet material that is capable of flexing transversely of the length of the tube so as to conform to changes in direction of the track both horizontally and vertically, and filled with the liquid or other substance to be conveyed. Alternatively where the conveyed stock is solid, the conveyer elements may be in the form of elongated troughs of similar semi-rigid material, as shown at *m* (FIGS. 9, 10, 11), having the solid goods distributed over their length. Such tubular or trough-like elements are supported from trucks having a pair of carrier wheels or rollers riding on a track comprising a pair of narrow-gauge rails **1***c*, as shown in FIGS. 3 and 4; or, in another and preferred version, the carrier elements may be suspended as at **1***b* from single-wheel trucks riding a monorail track as shown in FIGS. 1 and 2. Embodiments of such monorail suspension means are illustrated in FIGS. 9 and 10. A plurality of tubular or trough-like conveyer elements **1** (or **1***m* as shown in FIGS. 8 and 9) are used along the full length of the closed loop track forming a chain of more or less continuous character and driven along the track in continuous rotation. The adjacent conveyer elements **1** of such a string may be interconnected by coupling links **34** (FIG. 3) and may all be driven by some common draft mechanism. Preferably however the drive is imparted to the string of elements by providing selected ones of the carrier trucks thereof with small separate electric motors **40** (FIG. 11) mounted thereon and supplied with electric power e.g. by way of slider contacts engaging a conductive rail parallel to the track.

It will be understood that details concerning the conveyer elements and their carrier means or trucks may be found in the co-pending original application and do not require further description herein since the present invention is not concerned primarily with the conveyer elements and carrier means, but rather is directed to the construction of the track structure therefor.

In the embodiment shown in FIGS. 1 and 2, there are provided two parallel spaced monorail tracks **10** and **11** providing a round trip with the conveyer elements 1_1 riding the "up" track **10** in one direction and elements 1_2 riding the "down" track in the opposite direction. The two monorail tracks are interconnected ladderwise by uniformly spaced tie members **12**. The resulting horizontal ladder-like structure is supported bodily at spaced intervals by gantry or tower structures disposed in vertical planes transverse to the tracks. Each such structure

comprises a pair of upwardly-diverging masts or uprights **21** pivoted to a base **22** fixed in the ground and maintained by stays **23**. The tops of the masts are interconnected by cross members **24**. The cross members **24** are longer than are the afore mentioned ties **12** and serve to support the monorail tracks. Surmounting the V-structure formed by uprights **21** there may be an inverted V structure comprising a pair of somewhat shorter masts **25** having their lower ends attached to the tops of the lower masts **21**, and converging upwardly with their upper ends being interconnected at an upper apex as shown. Extending through the upper apices of all the tower structures and attached thereto is a single catenary element or cable **26**. Depending from spaced points of the catenary cable **26** are double slings **27** having their lower ends attached to the ends of ties **12** and thus serving to support the whole track structure including the monorail tracks and ties in the spaces intermediate the adjacent towers.

In the alternative and preferred embodiment shown in FIGS. 3 and 4 each tower structure is of simple V shape comprising only the upwardly diverging pair of masts **29** on the base **22**, having their upper ends interconnected by the tie cable **30**. Stays **31** are provided. In this construction there are two parallel transversely spaced catenary cables **32** extending through the apices of masts **29**, and having V-shaped slings **27** depending therefrom to support the track structure. While in this embodiment there may be provided two horizontally spaced monorail tracks similar to what was shown in FIGS. 1 and 2 described above, an alternative form of track is shown comprising two double-rail tracks **1***c* extending in vertically spaced or stacked relation within a box grider **33** of lattice construction. The double rail tracks are shown supporting two-wheeled trucks **1***a* with tubular conveyer elements **1** thereon as described above.

Referring to FIGS. 5 to 8, a preferred construction of track supporting lattice girder according to this invention will now be described. In the form shown the lattice girder includes a pair of upper longitudinal members *a***1** and *a***2** and a pair of lower longitudinal members *b***1** and and *b***2** arranged in the form of a rectangle in cross section; each longitudinal member is here shown as an angle and the apices of the four angles are all directed inwardly of the rectangle. The four longitudinal members are trussed at spaced points by main transverse frames or trusses each comprising an upper cross member such as *c***1** bridging the upper members *a***1** and *a***2**, a lower across member *c***2** bridging the lower members *b***1** and *b***2**, and the two diagonal members *d***1** and *d***2**. All four members of each truss may desirably be angle irons. Interspersed with the main trusses of the type just described and equally spaced between them are similar trusses of more lightweight character and each including the upper and lower cross members *e***1** and *e***2** and diagonals *f***1** and *f***2**.

In the upper horizontal plane of the girder containing members *a***1** and *a***2** there is provided cross bracing comprising the diagonals *g***1**, in zigzag pattern, and similarly in the lower horizontal plane of the grider there is the zigzag diagonal cross-bracing comprising the diagonals *g***2**, with the zigzags being crossed as between the upper and lower horizontal planes as will be apparent from the drawings.

Further bracing is provided for the girder in the form of cross-diagonal members such as *h***1** and *h***2**, each of which extends between one end of the lower cross member *c***2** of each main truss and the remote end of the upper cross member *c***1** of an adjacent main truss. Considering the girder section spanning two adjacent supports or suspension means, and designating by A the main truss positioned at the centre of such span, there is a pair of the cross-diagonals *h***1** and *h***2** extending from the opposite ends of the lower cross member *c***2** of truss A to the remote ends of the upper member *c***1** of each of the two main trusses positioned to either side from the said central main truss A, another pair of cross diagonals *h***1** and *h***2** extending from the ends of the lower cross member *c***2** of each of these last-mentioned main trusses to the opposed ends of the upper cross member *c***1** of the next main trusses positioned outwardly from the said last-mentioned main trusses, and so on outwards to each end of the girder span under consideration. It will be clear that the resulting latticework as shown in FIG. 5 constitutes in side view an N-shaped girder of the type known as a Pratt girder. Such a latticework is known to possess the advantage that the cross diagonal braces *h***1**, *h***2** are always stressed in tension under bending loads applied to the girder, so that they can advantageously be provided in the form of round rods or flat strip members.

It will further easily be understood especially from consideration of FIGS. 8 and 7 that viewed in end view the girder has an X-shaped cross sectional configuration, in which continuous free spaces are provided along each side of the girder between the two crossed diagonal planes containing the diagonals *d***1**, *d***2**, *f***1**, *f***2**, and cross diagonals *h***1**, *h***2**. These continuous side spaces provide clearance for the passage of the trucks supporting the conveyer elements.

Mounted on the outwardly projecting flanges of the lower longitudinal members *b***1** and *b***2** are the rails *j* for the rollers or wheels of the trucks. Secured to the under faces of the outwardly projecting flanges of the upper longitudinal members *a***1** and *a***2** are guides or rails *k* which may either be flat strips as shown in FIGS. 7 and 10 or round rods or tubes as in FIG. 9 or of other suitable cross sectional shape, serving as upper guides for the rolling assemblies. According to a modified construction, the rails *j* and guides *k* may actually constitute the longitudinal members of the girder with the angle members such as *a***1**, *a***2** and *b***1**, *b***1** being omitted to provide a more lightweight structure. Since the upper members of the girder are stressed in compression the guide rails *k* may be provided in tubular form as shown in FIG. 9 to increase resistance to compression loads.

At each end of the free span of the girder the upper cross member *c***1** of the related main frame is provided in the form of a heavier and longer member such as D serving to couple the adjacent sections of the girder into a continuous girder.

A girder constructed as just described may be supported either from catenary supports as previously described with reference to FIGS. 1 to 4, or on simple bearer posts E (FIG. 7) on which the ends of the end cross members D bear. Where catenary suspension is used, as will be described in greater detail with reference to FIGS. 11 to 13, the side projecting lengths of the end cross members D may be made unequal, with the shorter end being on that side supporting the empty conveyer elements 1_2 and the longer ends on the side carrying the loaded conveyer elements. Thus the centre of gravity in a transverse plane of the loaded girder can be displaced so that it will be restored substantially into the vertical midplane of the girder in the loaded condition of the conveyer system.

In the construction shown in FIG. 9 the conveyer elements shown as trough elements (though tubular elements might be used just as well); are suspended from trucks in the form of hooks *n* so bent that the centre of gravity of the loaded conveyer element **1***m* is positioned vertically below the rail *j*. Secured as by a collar to the vertical rising part *n***1** of each hook suspension member is a journal *p* on which is journalled a flanged roller or wheel *o* engaging the rail *j*. The rising part *n***1** is bent inwards into alignment with the upper rail or guide *k* and is bifurcated at its end *n***2** with the branches of the fork having a pair of rollers *g* journalled thereon engaging the opposite sides of the guide rail *k*. With such an arrangement there is provided a large stabilizing leverage for imparting lateral stability to the trucks and

minimizing swinging movements of the loaded containers under the effect of side winds, centrifugal force when rounding bends and the like, while at the same time retaining low reaction forces against the guide rails *k*.

As shown in FIG. 11 longitudinal stability may be improved by coupling the trucks in pairs to provide bogie trucks. In such case the pairs of rollers *o* may be coupled by means of coupling members *n*3 and the midpoints of such members may be pivoted to the journals *p* (FIG. 9) of the suspension means.

In the modified construction shown in FIG. 10 the conveyer elements 1*m* rather than being suspended below the rails *j* are supported on arcuate cradling members *r* having depending legs *s* across the lower ends of which are journalled the axles *o*1 of wheels *o* riding the rails *j*. The upper part of the arrangement may be broadly unchanged with respect to FIG. 9, with the rising arms *n* extending from the cradles and terminated at their upper ends in bifurcations *n*2 carrying the rollers *q* engaging the guide *k*.

FIGURES 11 to 13 illustrate a conveyer system according to the invention including a catenary-supported continuous girder of the type described above with reference to FIGURES 5–8 with conveyer elements suspended from trucks so as to be positioned beneath the rails by suspension means generally similar to that of FIG. 9. In this system, each V-shaped supporting tower structure comprises, as previously described, a pair of diverging masts **29** having their interconnected lower ends resting on a ground base **22** by means of ball and socket members. Each of the branch towers **29** is a lattice girder forming a pair of opposed truncated pyramids. The tops of both branch towers are interconnected by a tie cable **30** maintained in a state of tension by means of the pairs of stays **31** having their upper ends attached to the tops of the towers and their lower ends anchored on tensionable members **31***a* positioned generally as shown in the plan view of FIG. 12.

The two catenary supporting cables **32** extending along the tops of the paired masts **29** serve to support the previously described track-supporting girder in the following manner. The opposite ends of each of the cross-members D of increased length as previously described are attached to the lower ends of a first pair of sling cables **28***a*, **28***b* respectively, which both have their upper ends attached to a common point of one of the catenary cables **32**, and are furtther attached to the lower ends of a second pair of sling cables **28***a*, **28***b* which have their upper ends attached to a common point of the other catenary cables **32** opposite the first point. The sling cables **28***a* and **28***b* are of greatest length at the ends of each span of catenary cable i.e. at the supporting towers **29**, and gradually decrease in length toward the midpoint of the span. The two catenary cables **32** are drawn inwards towards each other from the respective vertical planes of their upper ends, so as to hang in downwardly converging oblique planes as shown in FIG. 13. In this figure, only the longest and shortest sling cable pairs **28***a*—**28***b* of a given span are shown in full lines, while intermediate sling cables are shown dotted.

Further, stay cables (FIG. 11) are attached across the tops of the masts **29** and the respective ends of the nearest cross-members D on either side to prevent longitudinal swinging of the girder.

Conveniently, in view of the V-arrangement of the supporting towers **29** they may be made to support electric power lines for general utilities, in addition to supporting conductors for supplying power to the motors powering the trucks, if required. Thus FIG. 13 illustrates the three conductors *u* of a three-phase power supply line suspended by way of insulators *v* from the pivotal junction points of four interpivoted links *w*1, *w*2 having their outer ends attached to the tops of the masts **29**, and the midpoint of the linkage being attached to the transverse cable **30** spanning the diverging apices of the tower structure. Instead of using the rigid linkage shown the insulator strings may be suspended directly from the cable **30** if desired. From a consideration of FIGURES 11, 12, 13 it will be apparent that the sag of the conductors *u* is considerably less than that of the catenary cables **32** so that the clearance spacing between them will be amply sufficient for saftey.

Under large variations in atmospheric temperature the girder may be exposed to considerable expansion and contraction strains especially where the span between adjacent towers is great. Such thermal deformation will tend to subject the supporting towers to stresses directed along the length dimension of the girder P and this may be objectionable. Consequently, referring to FIG. 14, it is contemplated according to the invention that the suspension or sling cables such as **28***a*, **28***b*, **28***c* are initially so adjusted in relative length as to impart to the girder P a generally sinuous configuration in plan, as shown by full line (FIG. 14). The continuous girder assumes the shape of a continuous sinusoidal curve having a wavelength corresponding to the spacing between adjacent supporting towers **29**. On longitudinal expansion of the girder with increasing temperature, the initial sinusoid will change to a sinusoid **P1** of increased amplitude, while when the temperature decreases below normal the curve will approach more nearly the straight line **P2**. The sinusoidal undulations resulting from such an arrangement have a curvature radius so great as not to interfere with the movement of the trucks.

What I claim is:

1. In a conveyer system including conveyer elements in the form of transversely deformable, elongate containers of substantially uniform cross section and trucks supporting said conveyer elements at spaced points thereof, each of said trucks having a carrier wheel journalled thereon and guide means supported on the trucks above said carrier wheel in spaced relation thereto, and supporting structure for supporting said trucks to permit continuous travel of said conveyer elements simultaneously in opposite directions therealong; said supporting structure comprising elongate girder means having the general shape of an X in cross section with upper and lower horizontal cross-member means across the top and bottom of said X, a track extending longitudinally of said girder means on the upper surface of each end of said bottom cross-member means and engageable by said carrier wheels of the trucks, and guides extending longitudinally of said girder at the under surface of each end of said upper cross-member means and engageable by said guide means of the trucks, and means for supporting said girder means.

2. In a conveyer system including conveyer elements in the form of transversely deformable, elongate containers of substantially uniform cross section and trucks supporting said conveyer elements at spaced points thereof, said trucks having wheels journalled thereon, supporting structure for supporting said trucks for continuous movement of said conveyer elements over a two-way track; an elongate lattice girder having two upper and two lower longitudinal members spaced at the apices of a rectangle as viewed in transverse section, truss frames spaced along said girder and each comprising a pair of upper and lower cross members spanning said upper and lower longitudinal members respectively, and a pair of diagonal members connecting each end of one cross member with the end of the other cross member diagonally remote therefrom, and track means, constituting said two-way track, extending along the respective longitudinal members and engageable by said truck wheels; said means for supporting the guide means including spaced supporting means for said girder connected with selected ones of said main frames.

3. In a structure according to claim 2, further including cross bracing means for said girder comprising first diagonal bracing elements each connecting one end of an upper cross member of one main truss frame with the remote end of an upper cross member of an adjacent main

truss frame, second diagonal bracing elements each connecting one end of a lower cross member of one main truss frame with the remote end of a lower cross member of an adjacent main truss frame, and third diagonal bracing elements each connecting one end of an upper cross member of one main truss frame with the remote end of a lower cross member of an adjacent main truss frame, whereby said cross-braced girder will have an X-shaped contour in transverse section to provide clearance space for said trucks.

4. The structure according to claim 3, wherein said third diagonal elements are connected to ends of an upper cross member forming part of a main truss frame supported on a girder-supporting means, and to the remote ends of lower cross members forming part of adjacent main truss frames, said third diagonal elements being all inclined in a downward direction away from said girder supporting means and toward the midpoint of the span between said supporting means.

5. The structure according to claim 3, further including auxiliary truss frames intermediate said main truss frames and each including upper and lower cross members and diagonal members interconnecting one end of each cross member with the remote end of the other cross member, and means assembling the crossing point of said last mentioned diagonal members with said third diagonal bracing elements.

6. The structure according to claim 1, wherein said guide means comprises a bifurcated upper end portion of said truck, a pair of rollers journalled in horizontally spaced relation on said bifurcated end portion, and cooperating with opposite sides of said guide.

7. The structure according to claim 1, wherein said girder means comprises a plurality of girders interconnected in aligned relation, said upper cross member means include an extended cross member projecting beyond both said sides of said X at least at one end of each girder, and said girder supporting means are supportingly connected to the ends of said extended cross members.

8. A conveyer system comprising conveyer elements in the form of transversely deformable, elongate containers of substantially uniform cross section, trucks supporting said elements at spaced points thereof, each of said trucks having a carrier wheel and guide rollers positioned vertically above said carrier wheel, a plurality of interconnected generally aligned girder sections each having a pair of lower longitudinal side members defining rail means at their upper surfaces for said carrier wheels of the trucks and having a pair of upper side members defining guide means at their under surfaces for said guide rollers, said pairs of side members disposed at the apices of a rectangle; first diagonal bracing means in the horizontal planes of said upper side members, second diagonal bracing means in the horizontal planes of said lower side members and third diagonal bracing means in each of the diagonal planes containing an upper side member and the lower side member remote therefrom; at least one cross member having ends projecting beyond said side members at the end of each girder section and positioned in the horizontal plane of said upper side members; a plurality of paired masts disposed in spaced vertical planes along said girder normally thereto, the masts in each pair defining an upwardly open V surrounding said girder; base means and swivel means pivoting the lower end of each pair of masts to said base means; inextensible connecting means interconnecting the apices of each pair of masts; flexible stay means connected to each pair of masts for holding the same in erect condition; a pair of catenary cables interconnecting the corresponding apices of all said paired masts on each side of said girder, and suspension cable means connecting spaced points of each catenary cable with at least one of the projecting ends of each said cross members.

9. A structure according to claim 8, wherein trucks on one side of said girder are adapted to carry loaded conveyer elements in one direction and trucks on the other side are adapted to carry empty conveyer elements in the opposite direction, and wherein said projecting ends of the cross members on said one side of the girder are longer than the projecting ends of the cross members on the other side.

10. The structure according to claim 8, wherein said suspension cable means comprise a pair of cables connected at their one ends to a common point of a catenary cable and connected at their opposite ends to the respective ends of a common cross member.

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