July 22, 1958 M. LE ROY 2,844,232

ARTICULATED BEAM STRUCTURE

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Fig. 1.

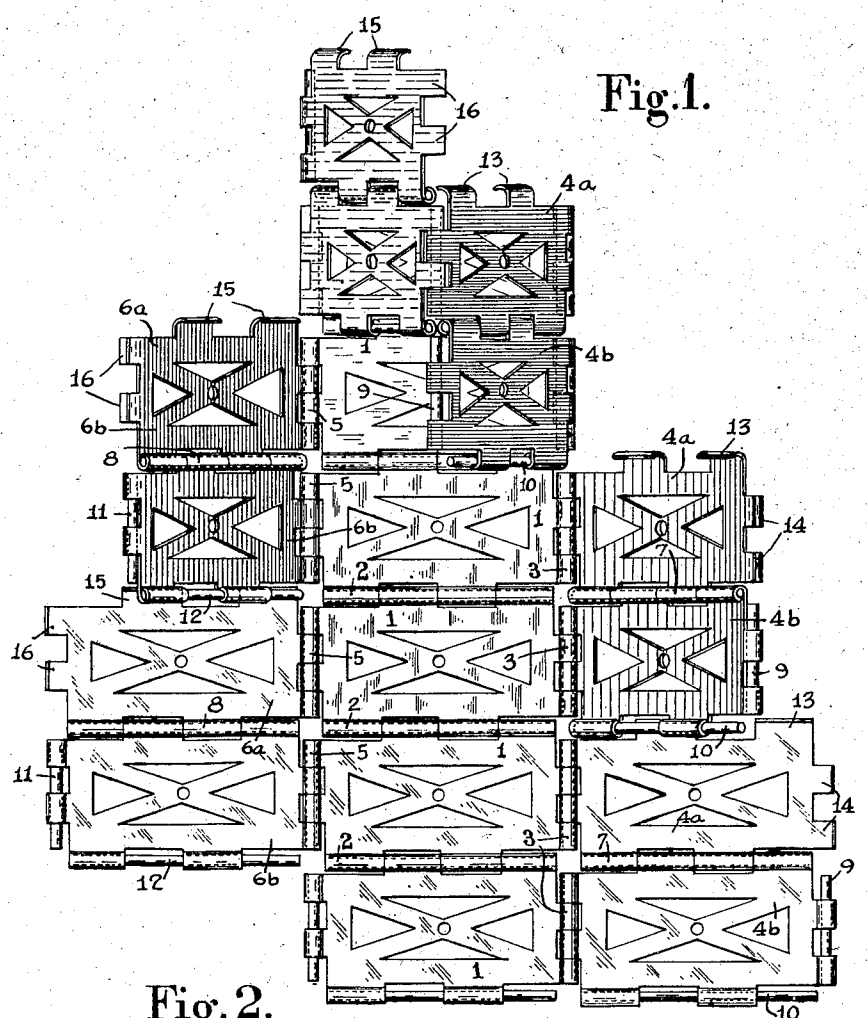
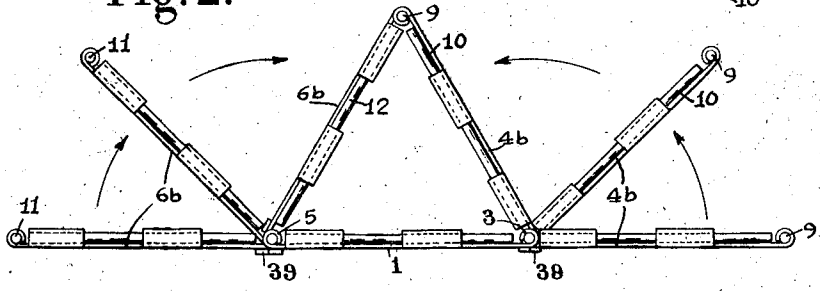


Fig. 2.



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ARTICULATED BEAM STRUCTURE

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Fig.3.

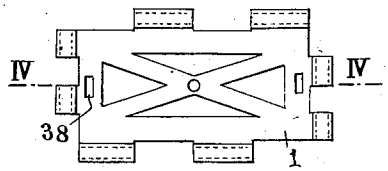

Fig.5.

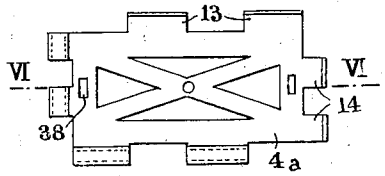

Fig.4.

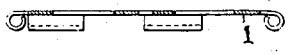

Fig.6.

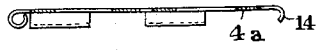

Fig.8.

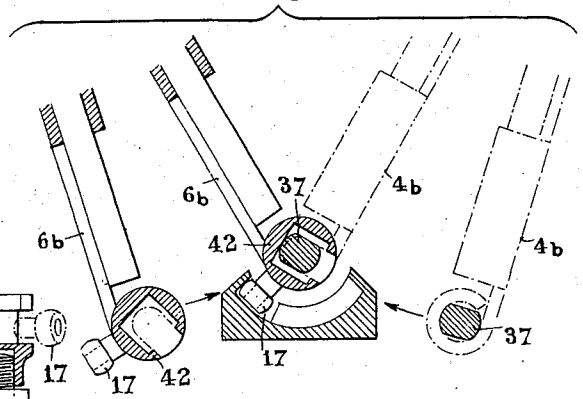

Fig.7

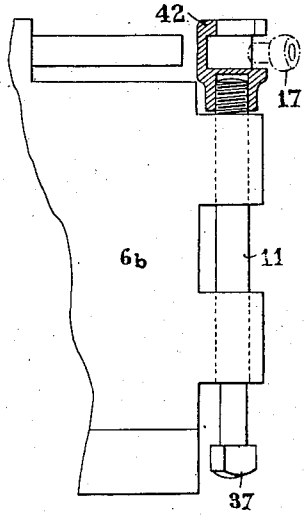

Fig.9

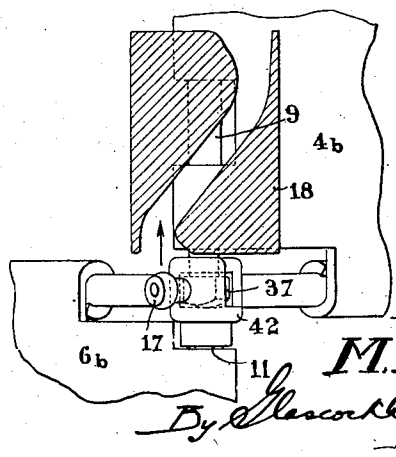

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Fig. 10.

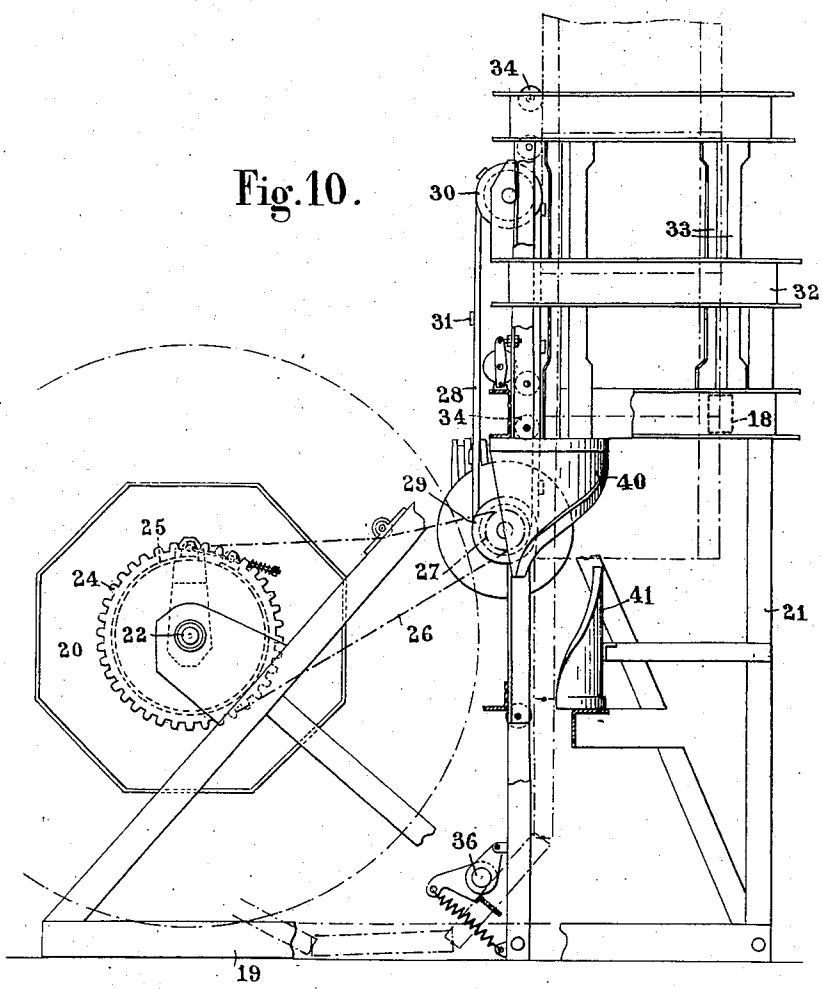

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Fig.11.

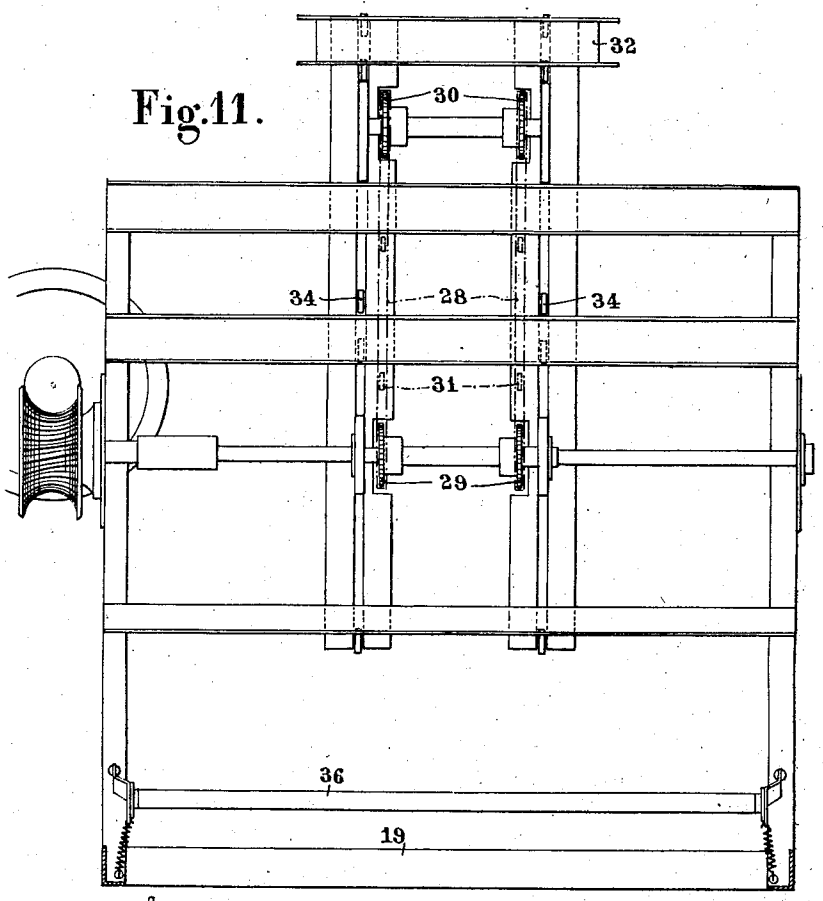

Fig.12.

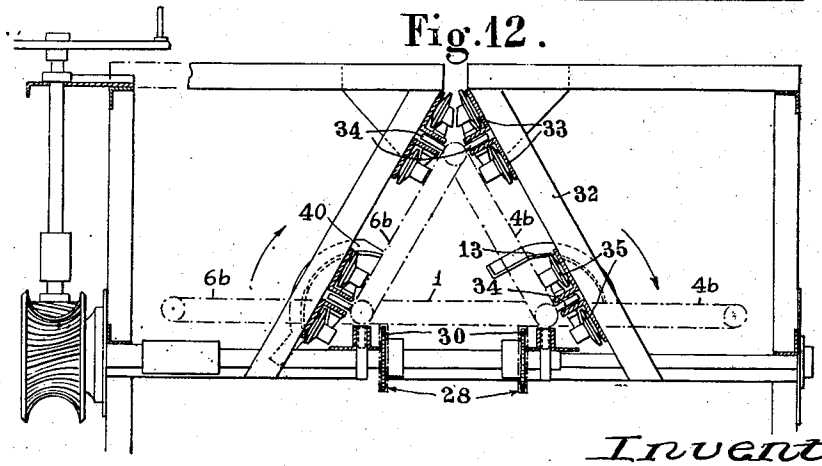

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Fig.14

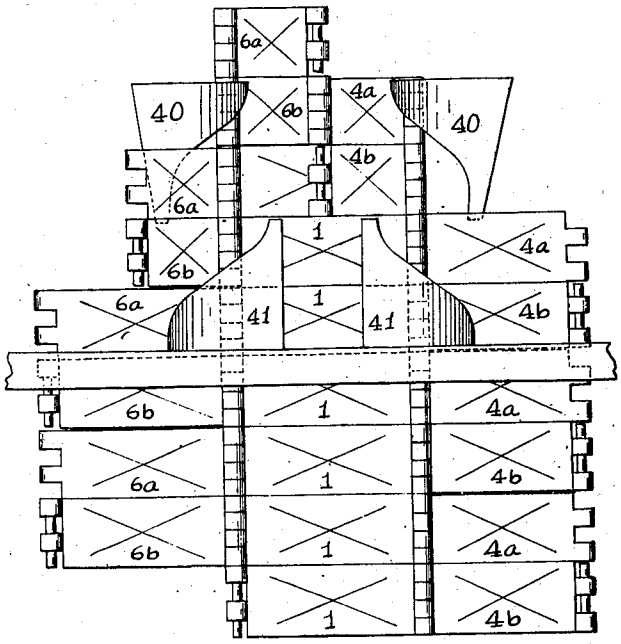
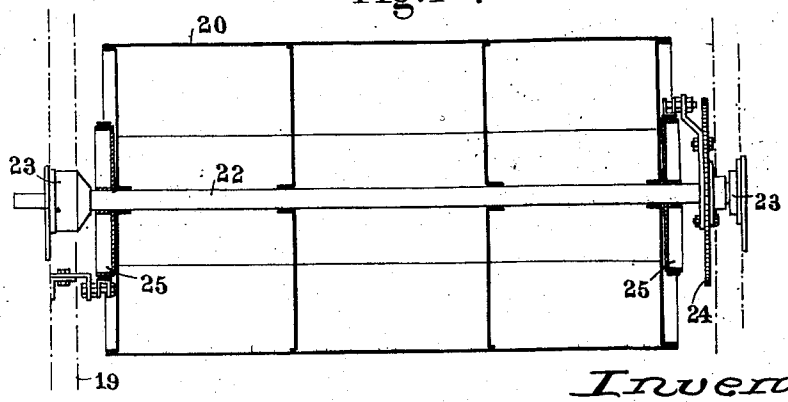


Fig.13.



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2,844,232

ARTICULATED BEAM STRUCTURE

Michel Le Roy, Paris, France

Application December 31, 1952, Serial No. 328,875

Claims priority, application France March 21, 1952

4 Claims. (Cl. 189—34)

The present invention relates to girders, and more particularly to improvements in girders consisting of rigid elements or links connected with one another and in means for rigidly erecting a girder of such type by assembling such elements and for spreading the elements to their initial form after disconnecting certain elements of the girder from one another.

The object of this invention is to provide an improved device comprising the component elements of a hinged girder and enabling either the stowing or transport of these elements wound up in the form of a unit of relatively reduced over-all dimensions, or the erection of the girder to its operative condition and the winding thereof to its inoperative condition.

In the U. S. Patents No. 2,143,953, filed on June 24, 1936, and No. 2,620,904, filed on July 31, 1946, to the same applicant, girders are described as consisting of similar elements which may be disposed in three juxtaposed rows and provided with hinge-like connecting means, the latter being permanent or non-releasable on either side of the mediate row and releasable along the outer edges of the lateral elements so as to form in the assembled condition of these elements a triangular-sectioned rigid girder adapted on the other hand to be wound for instance on a drum or barrel after disconnecting and spreading the beam in its plane.

Now according to this invention it has been found that the erection of the girder could be facilitated to a substantial extent while avoiding the risk of jamming the parts involved by providing permanent hinged connections along the four sides of the elements forming the mediate row and alternate permanent and releasable hinged connections between the elements forming the lateral rows with a one-element staggering between the opposite rows. The other hinged connections of these lateral elements are of the releasable type and the assembling is effected as the lateral elements are folded toward one another at the outlet of the reeling apparatus.

Thus, the pivoting or swinging of the lateral elements in directions at right angles to the axis of the erected girder when the latter is folded to its triangular-section condition or unfolded to a flat ribbon-like assembly is facilitated because there always is a permanent hinge-like connection of two links from one or the other lateral row to form two axial extensions of a hinge-like connection between two elements of the mediate row.

In addition, the hinged connections may be so arranged that as the elements are unfolded to form a flat assembly a prestressing thereof is produced, each of these hinged connections being provided with male and female parts forming together when assembled a head adapted to be compressed by a fixed guide member at the top of the girder.

The tiltable apparatus for winding up and paying out this girder comprises the following improvements:

The rotary barrel on which the chain of elements is stored is driven through the control of a pair of band brakes operative in opposite directions of rotation for

paying off or winding up the interconnected elements, respectively;

The invention includes cam means equal in number with the number of lateral rows of elements, disposed symmetrically with respect to the girder axis and operative on the lateral rows of elements for folding and unfolding the same;

A detachable fitting guide member is disposed on the barrel-carrying framework above the aforesaid cam members and comprises rollers adapted to exert a resilient pressure on the engaged elements;

A reducing gear drives an endless chain provided with lugs adapted to engage the elements to drive same in either direction.

Other details of the improved hinged-element girder and girder-developing apparatus according to the invention will become apparent as the following description proceeds with reference to the affixed drawings forming part of this specification. In the drawings:

Figure 1 is a diagrammatical plan view of a group of hingedly connected elements in developed or flat, partly-folded, and closed conditions respectively.

Figure 2 is an end view of the group shown in Fig. 1.

Figures 3 and 4 are respectively a front view and a section along line IV—IV of Fig. 3; showing constructional details of an element belonging to the mediate row.

Figures 5 and 6 are similar views showing constructional details of an element belonging to a lateral row.

Figures 7 to 9 are detail views showing the interlocking of two pairs of lateral elements folded back towards each other.

Figure 10 is a side-elevational view showing girder developing means, the girder elements being shown only in dotted lines to simplify the drawing.

Figures 11, 12 and 13 are an end view, a horizontal section and an axial section, respectively, of the winding drum.

Figure 14 illustrates diagrammatically the mechanism acting on the component elements of the structure when in their spread, flattened condition, for folding the lateral elements towards each other about their hinged connections.

As clearly shown in Fig. 1, the hinged-girder elements comprise a number of identical rectangular panel-like elements **1** pivotally attached to one another along their longer sides through hinged connections **2**. These elements **1** will thus constitute together a ribbon-like structure, and hinged connections are also formed along their smaller sides, as shown. Lateral elements *4a* and *4b* are attached through the lateral hinged connections **3** positioned on the right-hand side of the figure to the elements of the mediate row, and other lateral elements *6a* and *6b* are attached through the lateral hinged connections **5** positioned on the left-hand side of the figure to the elements of the mediate row. These lateral elements *4a*, *4b* and *6a*, *6b* are of rectangular configuration and have the same dimensions as the central elements. The assembly of panel-like elements, when spread or lying in a common plane as shown in the lower portion of Fig. 1, will thus constitute a unitary structure having on the one hand adjacent transverse rows made of a central or mediate element **1** positioned between two lateral elements *4a*, *4b* or *6a*, *6b*, and on the other hand three longitudinal and juxtaposed rows, namely a mediate row of elements **1** and two lateral rows made of elements *4a*, *4b* and *6a*, *6b*, respectively. As shown in Fig. 2, the pivotal movement of the lateral elements *4b*, *6b* about their hinged connections **3**, **5** in the direction of the arrows is limited by abutments **39** mounted on the back face of the medial elements **1**, so that the lateral elements cannot rotate beyond the spread position in which they lie in the plane of the mediate elements (see lower

portion of Fig. 1). Moreover, the hinged connections 3, 5 are so arranged that a certain additional force is required to complete this pivotal movement, whereby when each transverse row is in its spread position it will normally tend to remain in this position. The lateral elements 4*a*, 4*b* are grouped to form successive pairs of adjacent panels pivotally attached through hinged connections 7 with each other along their longer sides. The same applies to the elements 6*a*, 6*b* of the other longitudinal row, also connected by pairs through hinge means 8, as shown. According to this invention and considering the elements in the longitudinal direction, i. e. from top to bottom of Fig. 1, the first element 6*a* of each pair 6*a*, 6*b* is hingedly connected to the same mediate element 1 as the second element 4*a* of a pair of elements 4*a*, 4*b* of the other longitudinal row. The second element (4*b* or 6*b*) of each pair of lateral elements is formed along its outer and lower sides with knuckles engaged by pins 9, 10 in the case of elements 4*b* and 11, 12 in the case of elements 6*b*. The first element (4*a* or 6*a*) of each pair of lateral elements carries on its upper and outer side hook means 13, 14 for elements 4*a*, and 15, 16 for elements 6*a*, these hook means being adapted to engage either the pins 10 or 11, or the pins 12 or 9.

In Figs. 3, 4 and 5, 6 there is shown respectively the configuration of an element 1 and an element 4*a* of a pair of elements 4*a*, 4*b*. These figures illustrate more particularly substantially rectangular apertures 38 formed in the vicinity of the smaller sides and intended to engage other corresponding portions of the assembly shown by way of example.

In Figs. 7 to 9 there is shown how, in the position in which a pair of elements 6*a*, 6*b* folded back towards the preceding pair of elements 4*a*, 4*b* (this position being similar to that of the two pairs of elements at the top of Fig. 1), the pin 11 of element 6*b* interlocks beneath the pin 9 of element 4*b*. Each pin 9 and 11 is formed at its lower end with a bolt extension 37 and at its upper end with a screwed head 42 having internally a bolt-clasp configuration and externally a radial extension 17. When the element 6*b* of Fig. 7 is rebatted under element 4*b*, the head 42 of element 6*b* engages the bolt extension 37 of element 4*b*, as shown. When a strong pull is exerted on the assembly of pin 11 placed end to end beneath pin 9 by acting on the radial extension 17 of the head 42 of the lower element 6*b*, this head 42 will be screwed on the upper, externally screwthreaded end of pin 11. Actually, this pull is exerted on the radial extension 17, during an upward movement of the element assembly in the direction of the arrow, by a helical cam groove formed in a stationary member 18 included in those components of the device which are described hereafter.

Figs. 10 to 14 illustrate the parts of the device according to the invention which enable the above-described assembly in its wound condition to be either stowed and transported, or erected to constitute a rigid girder by unwinding and folding it, and subsequently winding it up after its utilization as a girder, respectively.

On one side of the metal framework 19 are mounted the barrel 20, cam members 40 and 41 and a guiding structure 21 forming the base of the erected girder.

Figure 14 shows how the jointed-girder elements 1, 4*a*, 4*b*, 6*a* and 6*b* spread out flat, are erected into a prismatic girder during a rising movement, by the successive engaging of alternate panels 4*a* and 6*a* against two symmetrical rails 40 involving the successive folding back of the pairs of panels alternatively 4*a*, 4*b* and 6*a*, 6*b*. During the descending movement, the spreading out of the jointed assembly is effected by engaging the panels 6*b* and 4*b* against the two symmetrical contour rails 41, similar to the rails 40 but turned in the opposite direction.

The barrel 20 having its shaft 22 journalled in bearings 23 fast with the framework 19 is rotatably driven by a toothed wheel 24 through the control of a pair of band brakes 25 operable to control rotation in opposite directions; this toothed wheel 24 is on the one hand—rotatably driven by a chain 26 engaging a driving pinion 27 to which adequate motion is imparted from any suitable mechanism, and on the other hand fast with another pinion 29 driving through an endless chain 28 another pinion 30, both pinions 29 and 30 being journalled in fixed positions on the frame structure. Driving lugs 31 adapted to engage the girder elements are provided in adequate space relationship on this chain 28.

The framework has detachably mounted thereon a metal frame structure consisting of section elements 32 interconnected by vertical posts 33 and so as to form around the closed girder a triangular structure. Rollers 34 are resiliently mounted on these posts, for example through the medium of resilient washers 35.

In these figures the chain-dotted lines show diagrammatically the girder elements along their path from the reeling barrel 20 through the stretcher device 36 to the cam members 13 and then to the rollers 34 in the position for engagement by the lugs 31 of the girder-erecting chain 28, these lugs engaging companion apertures 38 formed in the elements (see Figs. 3 and 5). The heads 17 resulting from the closing of the lateral elements and the interengagement of the end portions of the hinge pins are pressed by the cam member 18; thus, the girder is delivered in rigid form from its guiding and supporting framework.

The framework structure may be provided with rollers or like elements for transporting it from one site of erection to another.

Besides, this framework may be dismantled together with the girder of the fixed frame structure by resorting to adequate assembling means and the apparatus may be used for erecting another girder.

What I claim is:

1. An articulated beam structure comprising a first set of rectangular panels pivotally connected to one another and forming a row, successive lateral pairs of similar panels pivotally connected to the opposite lateral sides of successive pairs of panels of said first set in staggered relationship with the pairs of panels of the other set of lateral panels and with the first panel of each lateral pair opposite the second panel of the other lateral pair, the inner sides of the panels of each successive pair of lateral panels having staggered shackles cooperating with complementary staggered shackles at the lateral sides of the panels of the first set and a hinge pin extending through said shackles, spaced shackles on the outer and lower sides of the second panel of each lateral pair, a hinge pin extending through the last named shackles, spaced hook means on the upper and outer sides of the first panel of each lateral pair, the spaced upper hook means being adapted to coact with the hinge pin of the spaced shackles of the lower side of the adjacent panel of the next successive pair and said spaced outer hook means being adapted to engage the pin of the spaced shackles on the outer side of the corresponding opposite lateral pair, means for winding and unwinding said beam structure, means for folding said lateral panels against each other during the unwinding operation, and means for spreading the lateral panels during the winding operation.

2. An articulated beam as claimed in claim 1 in which each pin has a head on one end and a rotatably and axially movable socket member on the other, means for alternately moving successive pairs of panel members of the respective rows toward one another to engage the heads on the pins in one lateral row in the socket members on the pins in the other lateral row, and means for turning the socket members to move the pins axially relative to one another to apply clamping forces in the longitudinal direction of the beam.

3. An articulated beam structure according to claim 1,

which comprises stops rigidly carried by the lateral ends of each panel in the first set to limit the spreading movement of each lateral panel pivoted to said panel of the first set to an extreme position in which said lateral panel is co-planar with said panel of the first set.

4. An articulated beam structure comprising a first set of rectangular panels pivotally connected along their adjacent long sides thereby forming a row, successive lateral pairs of similar panels pivotally connected at their inner sides to the opposite lateral sides of successive pairs of panels of said first set in staggered relationship with the pairs of panels of the other set of lateral panels and with the first panel of each lateral pair opposite the second panel of the other lateral pair, spaced shackles on the outer and lower sides of the second panel of each lateral pair, a hinge pin extending through the shackles, spaced hook means on the upper and outer sides of the first panel of each lateral pair, the spaced upper hook means being adapted to coact with the hinge pin of the

spaced shackles of the lower side of the adjacent panel of the next successive pair and said spaced outer hook means being adapted to engage the hinge pin of the spaced shackles on the outer side of the corresponding opposite lateral pair, means for winding and unwinding said beam structure, means for folding said lateral panels against each other during the unwinding operation, and means for spreading the lateral panels during the winding operation.

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