Dec. 9, 1952 M. LE ROY 2,620,904

ARTICULATED BEAM

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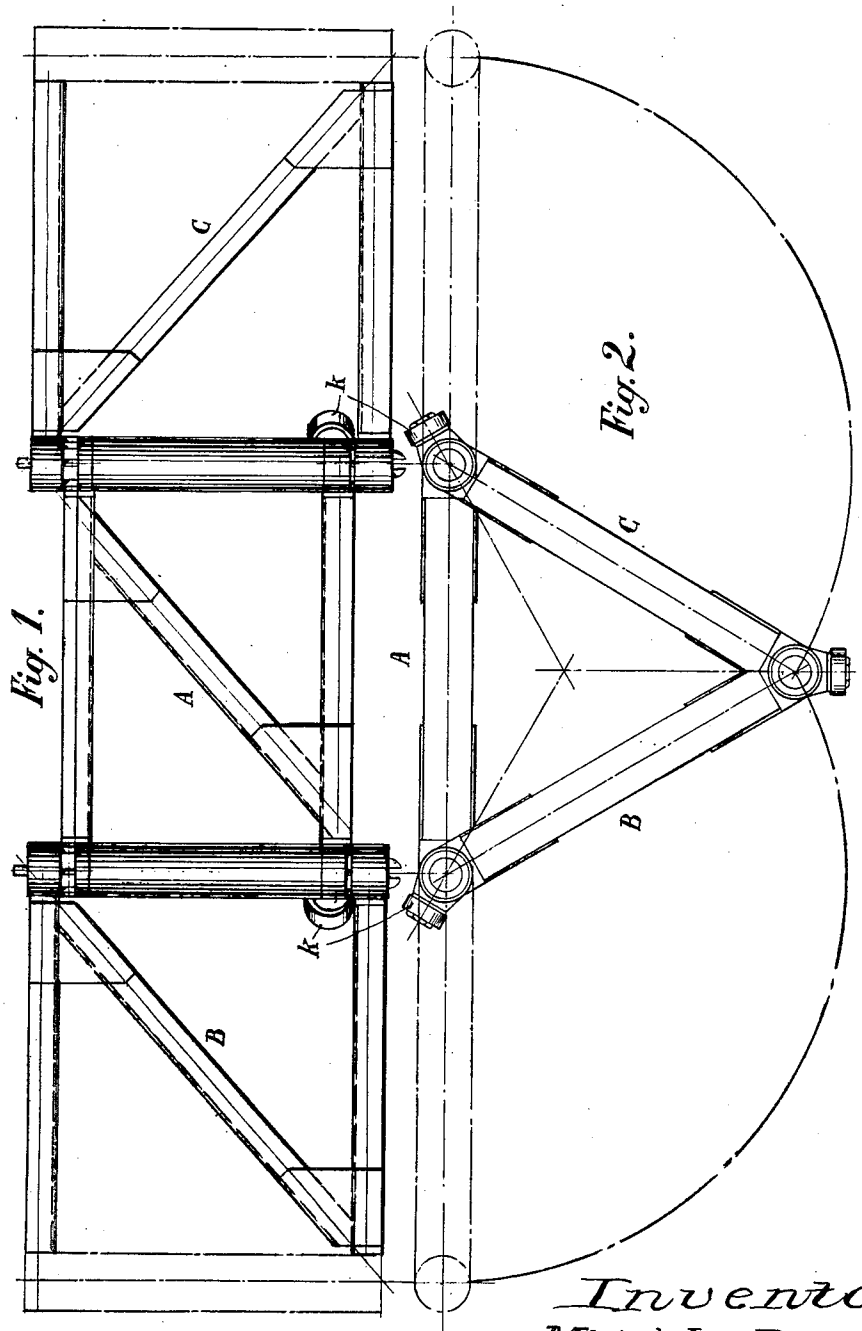

Fig. 1.

Fig. 2.

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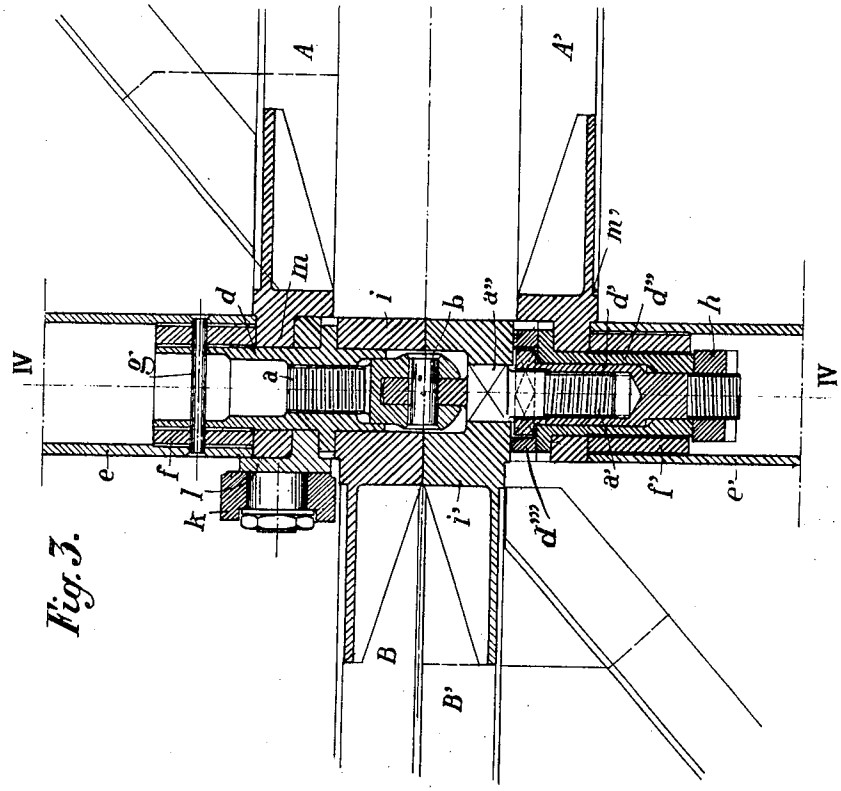

Fig. 3.

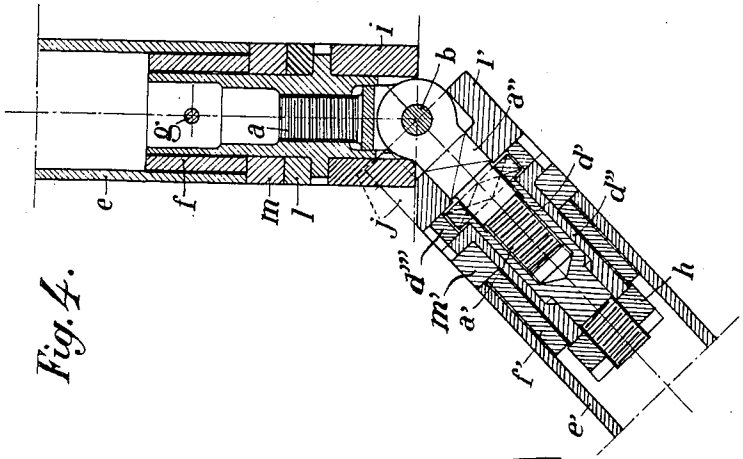

Fig. 4.

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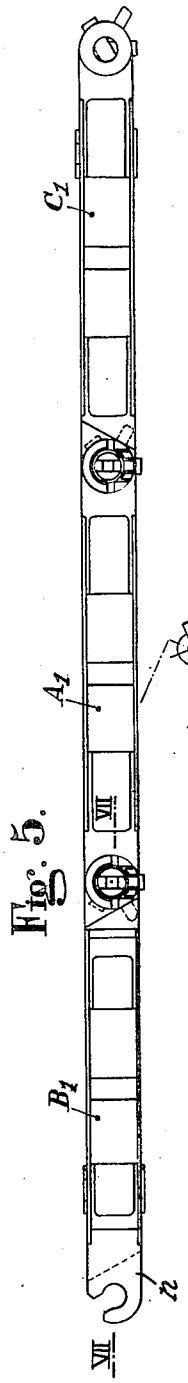

Fig. 5.

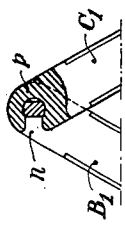

Fig. 14.

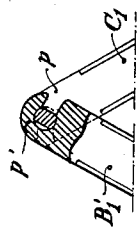

Fig. 15.

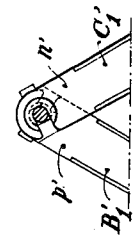

Fig. 16.

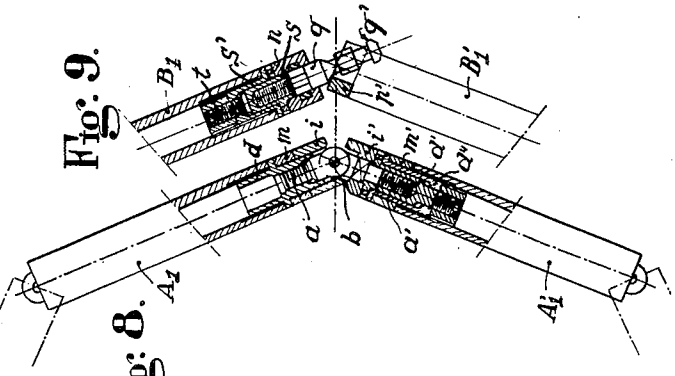

Fig. 9.

Fig. 8.

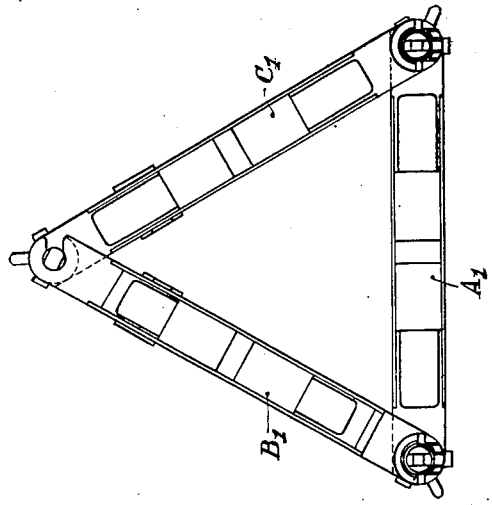

Fig. 6.

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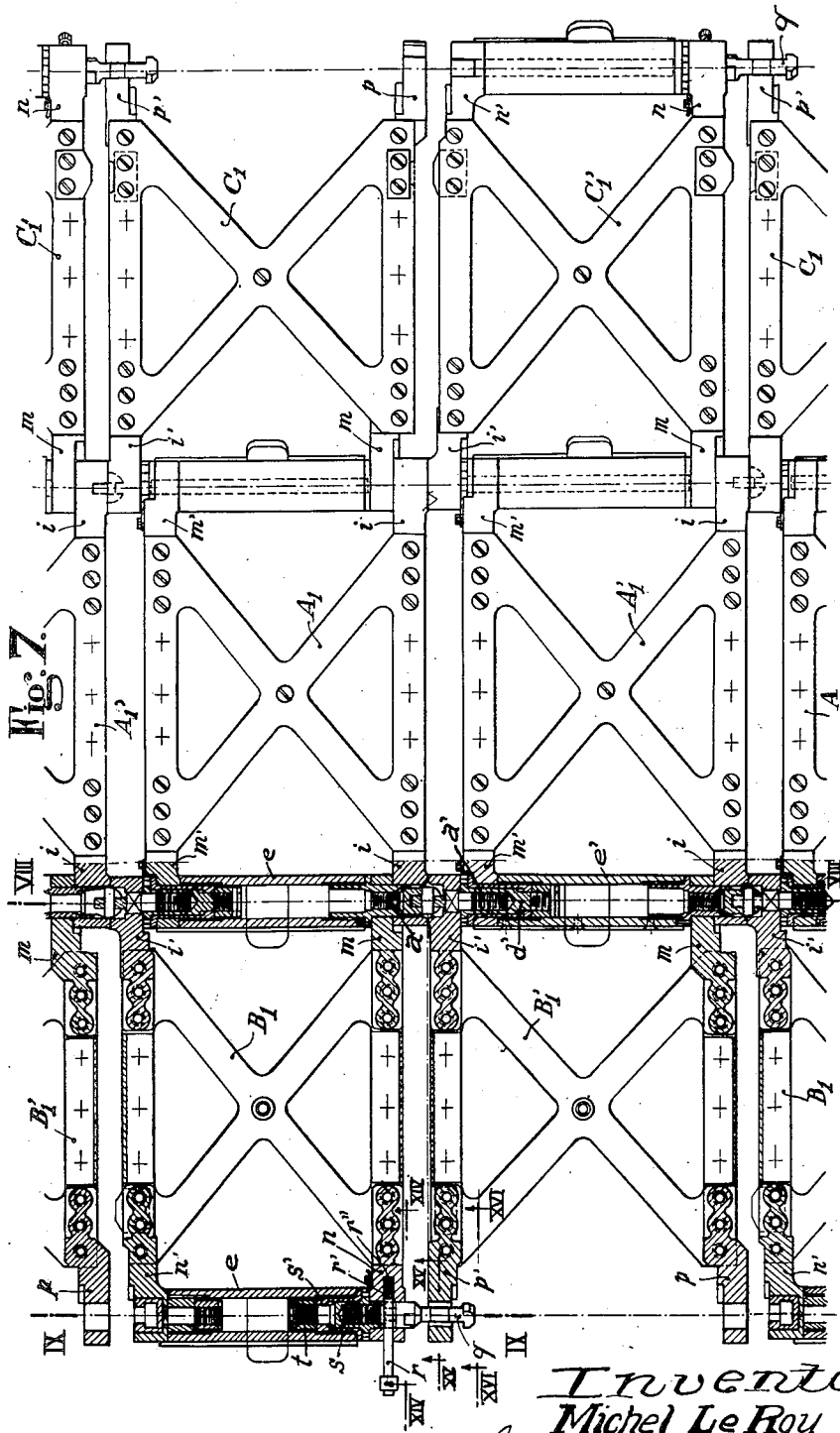

FIG. 7.

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Fig. 10.

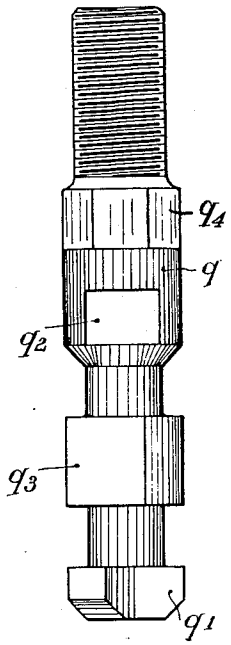


Fig. 11.

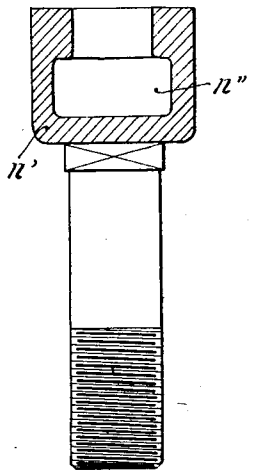


Fig. 12

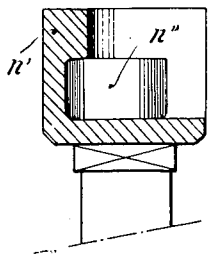
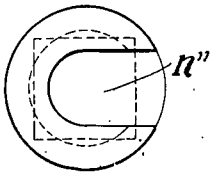


Fig. 13.



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Patented Dec. 9, 1952 2,620,904

UNITED STATES PATENT OFFICE

2,620,904

ARTICULATED BEAM

Michel Le Roy, Paris, France

Application July 31, 1946, Serial No. 687,350
In France August 8, 1945

2 Claims. (Cl. 189—37)

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The present invention relates to an articulated beam.

More particularly the invention relates to an improvement in that type of articulated beam shown and described in my prior Patent 2,143,953, issued January 17, 1939.

In general the articulated beam structure includes a plurality of panels pivotally mounted so that they can be folded to form masts or beams of triangular cross-section, the panels being connected in rows of three constituting intermediate panels and a lateral or end panel on each side of the intermediate panel, three pivotally interconnected panels constituting a unit and a plurality of said panel units being connected in series by a joint permitting flexure of one panel unit of three interconnected panels relative to the other about an axis perpendicular to the axes of rotation of the panels of each unit.

With the aforedescribed relationship the panels can be extended into a common plane with the one panel unit being capable of pivoting relative to the other panel unit and the lateral panels of each unit can be pivoted about axes extending longitudinally of the interconnected units to form a triangular mast or beam when the outer ends of the respective lateral panels are connected to one another.

In accordance with the present invention the articulated beam structure has for a primary object to provide such a pivoted relationship between the interconnected panel units that when the end panels of successive units are swung toward one another to form the triangular beam the hinge eyes of the panels, where they are pivotally interconnected, are clamped to one another to provide a rigid relationship of interconnected panels.

More particularly the present invention has for an object to provide an articulated beam including a panel assembly in which the hinge eyes of the various panels of a group of three panels are symmetrically arranged in such fashion that when two consecutive groups are connected about a two-part pintel or rod passing through the hinge eyes, the hinge eyes of four adjacent panels in two successive units are in alignment and the pintels or rods constitute pivots in threaded engagement with sockets provided, respectively, with threads of opposite pitch and carried by panels, appertaining respectively to each of the successive groups, so that when the end panels are folded toward one another to form the triangular beam, the threaded engagement between the pintels and the sockets effects axial movement of

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the sockets toward and away from one another in accordance with the direction of rotation of the panels of each group relative to one another depending on whether the panels are being assembled to form the triangular beam or developed into a plane to permit folding or winding of the system of interconnected panel units as disclosed in my above identified prior patent.

Additionally the invention has for an object to provide an articulated beam, including a rotatable pin having a threaded end mounted in a socket in one of the outer hinge eyes of the end panels of the group, the pin projecting longitudinally of that panel and being provided with locking surfaces engageable respectively with the outermost hinge eyes of the other lateral panels of successive interconnected panel units, when folded into the triangular relationship, with the rotation of the pin effecting a locking movement of the assembled outermost hinge eyes to additionally rigidify the articulated triangular beam.

Broadly speaking, the invention therefore has for an object to provide pivoting members of successive units of pivotally connected panels having surfaces of opposite pitch or slopes of different values which when rotated relatively to one another provide for longitudinal movement toward one another of the panels of the successive interconnected units to rigidify the resulting triangular mast.

Further and more specific objects will be apparent from the accompanying drawings illustrating two forms of the invention and in which—

Figure 1 is an elevational view of one panel unit constituting three panels pivotally connected and shown in an inoperative position when lying in a common plane.

Figure 2 is a plan view from above of the panel unit of Figure 1 when the same is in operative position and forming the triangular beam.

Figure 3 is a vertical cross-sectional view on an enlarged scale illustrating the arrangement for assembling four adjacent panels of successive interconnected panel units.

Figure 4 is a cross-sectional view taken through line IV—IV of Figure 3, illustrating the pivotal connection between the successive units permitting flexure of the units relative to one another when they lie in their common plane.

Figure 5 is an elevational view of a modified form of articulated beam in its open position.

Figure 6 is a corresponding elevational view of the beam illustrated in Figure 5 in its operative position forming a triangular beam.

Figure 7 is a plan view of a portion of the beam

showing interconnected panel units and the joint therebetween, with portions of this view constituting a sectional view taken on line VII—VII of Figure 5.

Figures 8 and 9 are partial cross-sectional views taken along lines VIII—VIII and IX—IX of Figure 7 and illustrating the panels in partial folded relation relative to one another.

Figure 10 is an elevational view of a detail of a locking pin carried by one of the lateral panels of each unit of panels.

Figures 11 and 12 are vertical cross-sectional views of a locking cup that cooperates with a locking pin.

Figures 13 is a plan view from above of the cup illustrated in Figures 11 and 12.

Figures 14, 15 and 16 respectively illustrate sectional views taken along lines XIV—XIV, XV—XV and XVI—XVI of Figure 7, the lateral panels illustrated as folded in succession.

As illustrated in Figures 1 and 2, each panel unit includes panels A, B and C of rectangular configuration pivotally secured together about axes extending longitudinally of each panel at the opposite sides of the intermediate panel A so that the end panels B and C can be unfolded, as shown in Figure 1, to lie in a common plane with panel A or folded toward one another, as illustrated in Figure 2, to provide the triangular prism or beam.

To provide the triangular mast of such panel units, a series of units are interconnected so that the pivoting axes of the panels of the respective units lie in alignment with one another. The pivoting axis including, as illustrated in Figure 3, two rods or pintels *a*, *a'* respectively pivotally connected about a pintel or pivot *b* extending tranversely of the longitudinal axis of rotation. The relation of the pivot *b* permitting the unit of panels A, B, C to pivot about the axis *b* relative to the next successive unit of panels including the panels A', B' shown in Figure 3 so that the two interconnected panel units assume the position illustrated in Figure 4.

As set forth hereinbefore the present invention has for an object to provide in the triangulated beam structure an improved pivot arrangement connecting the panels in such fashion as to provide perfect rigidity of the panels when assembled in the form of a triangular beam or mast.

As disclosed with particular reference to Figure 3, the axes of rotation of the panels of the group relative to one another constitutes the two-part pintel or rod *a*, *a'*. These rods are threaded with respective left and right hand pitches and are in engagement with sockets *d* and *d'* respectively, that are correspondingly threaded and secured to the two superposed panels A, A'. The socket *d* mounted in the panel A is permanently secured inside the tube *e* forming the part of panel A by a threaded engagement within a sleeve *f* which sleeve in turn is screwed within the tube *e* and the assembled arrangement of sleeve *f* and socket *d* is held fast by means of a transverse pin *g*.

The rod *a'* is in threaded engagement with the socket *d'* which is mounted within the tube *e* of panel A' in a manner to permit angular adjustment of this socket relative to the socket *d*. With this adjustment in view, the socket *d'* is frictionally fitted within another socket *d''* so that the socket *d'* may rotate with slight friction relative to the socket *d''*. The socket *d''* is in threaded engagement within a sleeve *f'* in turn threadedly engaged inside the tube *e'* of panel A'. As illustrated in Figure 3 the head of the socket *d'*, which is polygonal, is surrounded by a polygonal adjusting ring *d'''*, the hinge eye *m'* of panel A' being of reduced thickness so as to permit manipulation of the ring *d'''* and thus the socket *d'* within the socket *d''*. The lower end of the socket *d'* constitutes a threaded shank and a nut *h* is engaged over this shank to bear against the lower end of socket *d''*. Suitable means, not shown, are provided to adjustably maintain the ring *d'''* in rigid relationship with respect to the hinge eye *m'*. The internal threads of the socket *d'* have a pitch that is opposite to that of the threaded shank of this socket and also opposed to the pitch of the threads of the rod *a'* so that when the panels are assembled in the triangular form the socket *d'* does not merely rotate with the rotation of the rod *a'*. This rod *a'* is provided as shown with a square shaped enlarged portion *a''* that fits within a recess of similar shape provided in the hinge eye *i'* in the panel B' so that when panel B' is rotated the rod *a'* moves therewith.

It is thus clear that when the panels B', B are folded toward panels A', A, rotation of the rods *a*, *a'* relative to the sockets *d*, *d'* due to the opposite pitch relationship in the respective threaded engagements effects movement of the hinge eyes *m*, *m'* toward one another in clamping relationship relative to the hinge eyes *i*, *i'* so that the panels of the successive groups of panels are securely clamped in rigid relationship along the lateral edges of the intermediate panels A, A'. As shown the nut *h* bears against the lower surface of the sleeve *d''* thus effecting the axial movement of the panel A' toward panel A during pivotation of the lateral panels toward the intermediate panels. Inasmuch as the similar pivoting relationship is embodied in the connection of the panels C, C' with panels A, A' on the opposite lateral edge of the intermediate panels the final triangular beam will have perfect rigidity along the edges thereof.

The adjustable relationship of the locking ring *d'''* relative to the socket *d'* permits compensating for any clearance existing in the panels due to wear of the hinge eyes in use.

When the panels are unfolded from the triangular form the rotation of the rods *a*, *a'* in the opposite direction effects the opposite axial movement of the sockets *d*, *d'* to relax the clamping relationship.

With respect to Figure 4, illustrating the rocking of one panel unit about its transverse axis relative to the successive panel unit, suitable recesses *j* are provided in the hinge eyes *i*, *i'* of the panels B, B' and C, C' on the sides thereof toward which it is desired to provide the rocking movement of the panel units relative to one another. When the panels are pivoted to form the triangular beam as shown in Figure 2 these recesses *j* are shifted with reference to one another so that the hinge eyes *i*, *i'* lie flush against one another in a stable relationship.

As illustrated in Figures 1 to 3 a roller *k* is provided on a ring *l* inserted between the hinge eye *m* on panel A and the base of the socket *d*. Similar rollers are arranged on the three edges of the mast and serve to facilitate the erection of the mast. These roller members are an optional feature of the articulated beam.

It is further believed that within the scope of the invention that details of structure of rods *a*, *a'* and sockets *d*, *d'* and *d''* can be modified

as well as the shape and form of the panels A, B, C.

With particular reference to Figures 5 to 13, the median panels A_1 and A_1' of the successive groups are connected to the lateral or end panels B_1 or B_1' of successive groups through pivoting arrangements similar to those described in connection with Figure 3 and which pivoting arrangements are illustrated in more detail in Figure 7.

Each of the panels of Figure 7 comprises a frame including the end tube *e* and cross members with the hinge eyes *m, i, i', m'* of successive panel units being secured by means of screws or bolts to angles of the frame.

The length of the tube members *e, e'* of successive panel units is of course determined in accordance with desired length of the panel.

Figures 5 to 16 illustrate the connection of the lateral panels B_1, C_1 with panels B_1', C_1' on the third edge of the triangular beam when the lateral panels are folded toward one another.

The hinge eyes of the lateral panels as at *n, p, p', n'* are of different construction from the hinge eyes on the opposite sides of the median panels of each group and the assembly of the lateral panels with one another further includes the locking pins or rod *q* carried by the hinge eyes of one lateral panel of each successive unit of panels.

As illustrated in Figure 7 when the panels are in developed position so that they lie in a common plane, the disposition of the lateral hinge eyes *n', n, p', p* of successive panels B_1, B_1' bears such relation to the successive hinge eyes *p', p, n', n* of the lateral panels C_1, C_1' that when the panels are folded in triangulated relationship the hinge eye *p* of panel C_1 fits between the hinge eye *n* of panel B_1 and the hinge eye *p'* of panel B_1' and the hinge eye *n'* of panel C_1' fits beneath these three immediately aforementioned hinge eyes so that the four hinge eyes *n, p, p', n'* are in alignment so that manipulation of the pin *q* as described hereinafter effect rigidifying of these hinge eyes along the third edge of the triangulated beam. Of course additional pins *q* and a similar structural relationship of hinge eyes follows longitudinally throughout successive interconnected units with the exception that in the arrangement shown the pins *q* are mounted on opposite lateral panels of successive groups.

Each of these pins *q* is mounted within the hinge eye *n* of panel B_1 of one group and panel C_1' of the next adjacent group. As illustrated in Figure 10, the pin *q* is provided with a T-shaped end *q'* which fits within the cup *n''* provided in the hinge eye *n'*. This cup *n''* includes a circular recess provided with a lateral gate or notch through which the T-shaped end of the pin *q* may pass when the pin assumes a suitable angular position. This gate or notch however bears such a width in relation to the shape of the head of the pin *q* that when the pin is slightly rotated by movement of the spanner *r* as described hereinafter the T-shaped head cannot be withdrawn from the notch and thus the hinge eye *n'* remains associated with the pin *q*.

The pin *q* includes locking surfaces in the form of flats denoted at *q2*, *q3* which cooperate with the hinge eyes *p, p'* of panels C_1, B_1' respectively. These hinge eyes *p, p'* are provided with a circular opening the diameter of which corresponds to that of the pin and further include a notch communicating with said opening cut to a width corresponding to the thickness of the flats *q2*, *q3* whereupon a slight rotation of pin *q* after the

successive positioning of the hinge eyes *p, p', n'* secures the locking of the panels B_1, C_1 and B_1', C_1' to one another as illustrated in plan in Figure 6. The rotation of the pin *q* screws the same longitudinally within a threaded socket *s* locked by a nut *t*, in a sleeve *s'* in turn screwed inside the tube *e* of panel B_1 as shown in more detail in Figures 7 and 9. This axial movement of the pin relative to the socket clamps the hinge eyes *n, p, p', n'* together to form a rigid relationship similar to the clamping action effected when the rods *a, a'* are rotated.

The rotation of the spindle *q* is performed by means of a spanner illustrated in Figure 7. This spanner or wrench *r* is provided with a usual handle and includes a cylindrical head housed inside a recess in the hinge eye *n* of panel B_1. This head has an internal polygonal shape to engage a polygonal section *q4* of pin *q*. This polygonal section fits exactly inside the recess in the head of the wrench and the recess in the hinge eye is so shaped as to limit the movement of the wrench to positions permitting engagement of the pin inside the cup of the hinge eye *n'* of panel C_1', in hinge eye *p'* of panel B_1', in the hinge eye *p* of panel C_1 or in the locking position for all the hinge eyes *n, n, p', n'* of panels B_1, C_1, B_1', C_1'. The extreme positions of the wrench correspond to the engagement of the lateral walls of the recess in the hinge eye against the wrench handle corresponding respectively to the position of the panels in their open and closed locked position. When the beam erecting or unfolding operations are respectively completed, the wrench is held fast in either one of the end positions through the engagement of ball *r'*, urged by a spring *r''* mounted inside the recess in the hinge eye *n*, with cooperating recesses formed in the periphery of the head of the wrench.

With reference to Figure 7, it is clear that in the assembly of the panels into a triangular beam, panel B_1 is first elevated and then panel C_1 is raised, to be followed by panel B_1' and lastly panel C_1'. The pin *q* is rotated slightly each time in the desired direction. Simultaneously with the locking of the hinge eyes *n, p, p', n'* of the lateral panels, the hinge eyes, *m, i, i', m'* on the intermediate panels are clamped in the manner described with reference to Figures 1 to 4 whereby the assembly of the panels of the successive groups in triangular formation is rendered rigid. Any play in the hinging relationship of the panels may be compensated for by the adjustable mounting of the sockets *d'* and *s*.

For dismantling or unfolding the triangular beam it is sufficient to proceed in the reverse manner and as the panels are opened in succession into a common plane system may be reeled about a suitable drum or winch as described in my prior patent by reason of the provision of the transverse pivots *b* interconnecting the rods *a, a'* and the provision for removal of the pins *q* from the hinge eyes *n*. This folding relationship is illustrated in Figures 8 and 9.

It is clear therefore that the present invention provides an articulated beam that comprises a structural assembly of interconnected panel units and which assembly constitutes three longitudinal rows of rectangular panels with the rows being arranged side by side. Each panel is provided with a hinge eye at each of its four corners, the hinge eyes that are arranged on the opposite sides of the panels of the intermediate row of panels being in groups of four superposed hinge eyes respectively appertaining to four adjacent panels

of successive groups. The hinge eyes on the lateral panels are arranged in groups of two superposed hinge eyes when the panels are unfolded. The groups of two superposed hinge eyes are arranged symmetrically with relation to the intermediate panels so that they are adapted to be imbricated or overlapped when the lateral rows of panels are folded toward each other by pivoting them around the longitudinal edges of the intermediate rows of panels and when folded toward one another the outer hinge eyes of sucsive lateral panels in two successive groups of panels forming four superposed hinge eyes in longitudinal alignment. We thus have a triangulated structure in which four hinge eyes are provided along each corner of the triangulated structure in superimposition and alignment and in overlapping relationship. A pair of rods are mounted within each group of four superposed hinge eyes of four adjacent panels including panels of the intermediate row of panels and these rods are pivotally interconnected by a pivot having its axis parallel to the transverse sides of the intermediate hinge eyes. A pin is mounted in one of the hinge eyes of the two groups of two hinge eyes in the lateral panels and includes an outer end protruding in said one hinge eye while the other three hinge eyes of said two groups of hinge eyes of the lateral panels are provided with lateral apertures which receive the outer end of the spindle when said lateral rows of panels are folded toward one another.

One of the rods is held rotatably fast with one of the intermediate hinge eyes of the group of four superposed hinge eyes of the four adjacent panels including the median row of panels and an internally threaded socket is provided in each outermost hinge eye of the groups of four superposed hinge eyes, with the ends of the respective rods being threaded with reverse pitches and in engagement with similar threads on the respective sockets so that when the panel with respect to which one of the rods is rotatably fast is folded toward the other panels the ends of both rods will be screwed into the sockets so that the intermediate hinge eyes of each group of four superposed hinge eyes will be clamped by the outermost hinge eyes.

It is further clear that the invention comprises a T-shaped end on the pin and an internally threaded socket fast to the hinge eye carrying the pin with the pin having a screw threaded end in engagement with the socket and recesses provided in the other hinge eyes of the two groups of two superposed hinge eyes to receive the pin and a spanner controlling the rotation of movement of the pin so that when the two groups of two superposed hinge eyes are assembled together on the pin to form another group of four superposed hinge eyes, the T-shaped end will bear against a socket on one of the hinge eyes receiving the same to draw the several hinge eyes together in clamping relationship.

Having now described my invention, what I desire to secure by U. S. Letters Patent is:

1. An articulated beam comprising a structural assembly of three longitudinal rows of rectangular panels, said rows being arranged side by side, each panel having a hinge eye at each of its four corners, said hinge eyes being arranged on either sides of the intermediate row of panels in groups of four superposed hinge eyes pertaining to four adjacent panels and on either sides of a pair of lateral rows of panels in groups of two superposed hinge eyes, the hinge eyes of each first mentioned group of superposed hinge eyes being aligned longitudinally whilst the groups of two hinge eyes are arranged symmetrically to the intermediate row of panels and are adapted on the one hand to be imbricated into each other when said lateral rows of panels are folded toward each other by pivoting about the longitudinal edges of said intermediate row of panels and, on the other hand, to form in this position a group of four superposed hinge eyes in longitudinal alignment, a pair of rods mounted in each group of four superposed hinge eyes of four adjacent panels, a pivot having its axis parallel to the transverse sides of a panel adjoining one of said intermediate hinge eyes of said group of four superposed hinge eyes of four adjacent panels, both rods being rotatably mounted on said pivot, a pin mounted in one of the hinge eyes of said two groups of two hinge eyes that are symmetrical in relation to said intermediate row of panels, said pin having an outer end protruding from said one hinge eye whilst the other three hinge eyes of said two groups of two hinge eyes symmetrical in relation to said intermediate row of panels are each provided with a lateral aperture adapted to receive said outer end of said pin when said lateral rows of panels are folded toward each other by pivoting about the rods mounted in each group of four superposed hinge eyes of four adjacent panels, one of said rods being rotatably fast with one of the intermediate hinge eyes of said group of four superposed hinge eyes of four adjacent panels hingedly connected through said rods, said rods being screw-threaded with reverse pitches at each of their ends opposite to the pivot through which they are pivotally connected to each other, each outermost hinge eye of the groups of four superposed hinge eyes of four adjacent panels hingedly connected through said pair of rods, having an internally screw-threaded socket fast therewith, the threaded ends of said pair of rods being screwed in said sockets whereby on folding the panel rotatably fast with one of said rods toward the panels adjoining the outermost hinge eyes of said group of four superposed hinge eyes of said four adjacent panels hingedly connected through said rods, the ends of both rods will be screwed in said sockets, said intermediate hinge eyes will be clamped between said outermost hinge eyes and therefore said four adjacent panels hingedly connected through said rods tightened against one another.

2. An articulated beam comprising a structural assembly of three longitudinal rows of rectangular panels, said rows being arranged side by side, each panel having a hinge eye at each of its four corners, said hinge eyes being arranged on either sides of the intermediate row of panels in groups of four superposed hinge eyes pertaining to four adjacent panels and on either sides of a pair of lateral rows of panels in groups of two superposed hinge eyes, the hinge eyes of each first mentioned group of superposed hinge eyes being aligned longitudinally whilst the groups of two hinge eyes are arranged symmetrically to the intermediate row of panels and are adapted on the one hand to be imbricated into each other when said lateral rows of panels are folded toward each other by pivoting about the longitudinal edges of said intermediate row of panels and, on the other hand, to form in this position a group of four superposed hinge eyes in longitudinal alignment, a pair of rods mounted in each group of four su-

perposed hinge eyes of four adjacent panels, a pivot having its axis parallel to the transverse sides of a panel adjoining one of said intermediate hinge eyes of said group of four superposed hinge eyes of four adjacent panels, both rods being rotatably mounted on said pivot, a pin having one end mounted in one of the hinge eyes of said two groups of two hinge eyes that are symmetrical in relation to said intermediate row of panels, said pin having an outer end protruding from said one hinge eye whilst the other three hinge eyes of said two groups of two hinge eyes which are symmetrical in relation to said intermediate row of panels are each provided with a lateral aperture adapted to receive said outer end of said pin when said lateral rows of panels are folded toward each other by pivoting about the rods mounted in each group of four superposed hinge eyes of four adjacent panels, the terminal portion of the outer end of said pin having a T-shape, the other end thereof mounted in the hinge eye being screw-threaded, each of the hinge eyes provided with a pin having an internally-screw-threaded socket fast therewith, said screw-threaded end of said pin being screwed in said socket and a spanner controlling the rotational movement of said pin whereby, on rotating said pin by means of said spanner after having engaged on said pin the lateral apertures of the three hinge eyes of the two groups of two hinge eyes which are symmetrical in relation to the intermediate row of panels outside the hinge eye in which said pin is mounted, said pin will be screwed home in said socket, said T-shaped end of said pin will be brought closer to the hinge eye in which said pin is mounted and, therefore, the pair of hinge eyes interposed between the hinge eye of the panel in which said pin is mounted and the hinge eye on which said T-shaped end is caused to bear will be tightened.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
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