March 24, 1959 J. D. GOLLNOW 2,878,498

BRIDGE CONSTRUCTION

Filed June 28, 1954 3 Sheets-Sheet 1

Fig. 1.

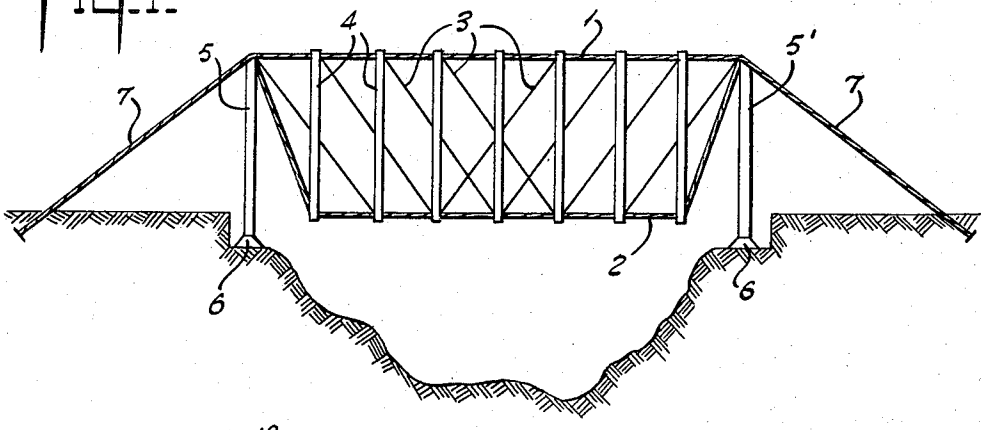


Fig. 2.

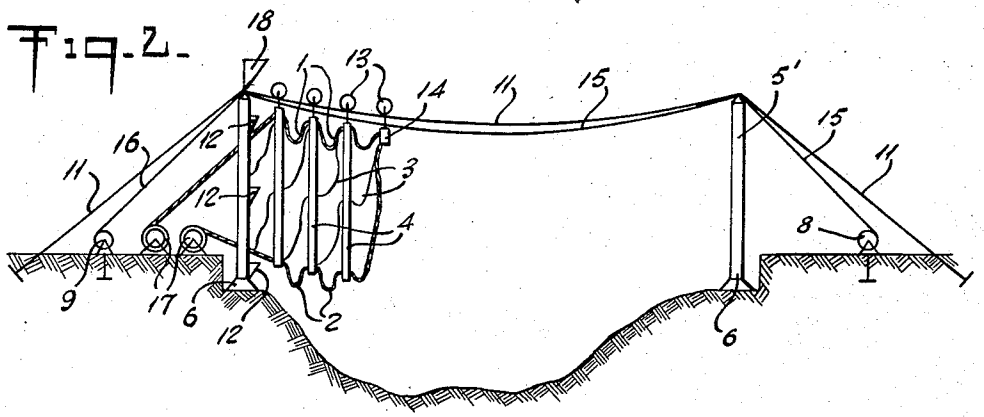
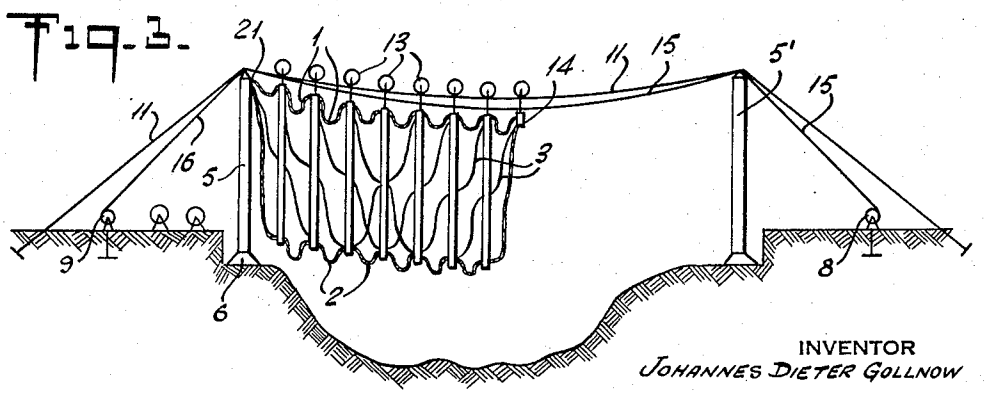


Fig. 3.



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March 24, 1959 J. D. GOLLNOW 2,878,498

BRIDGE CONSTRUCTION

Filed June 28, 1954 3 Sheets-Sheet 2

Fig. 4.

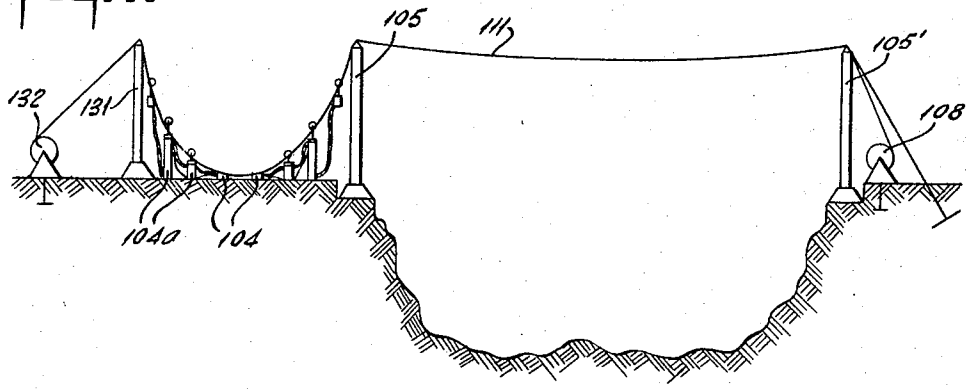


Fig. 5.

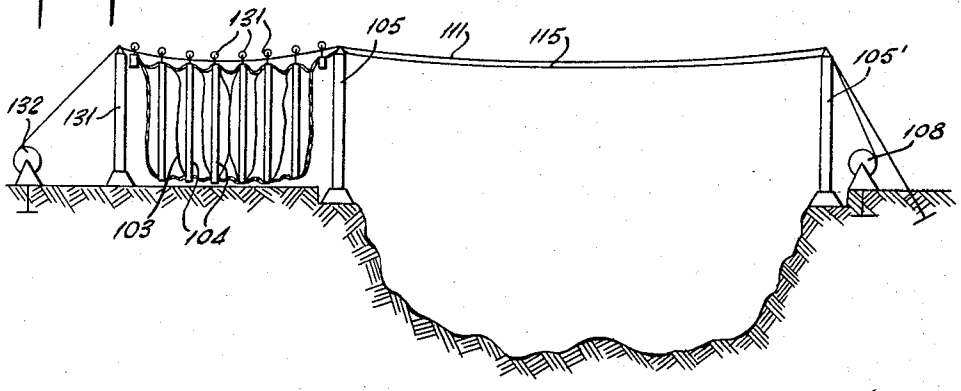
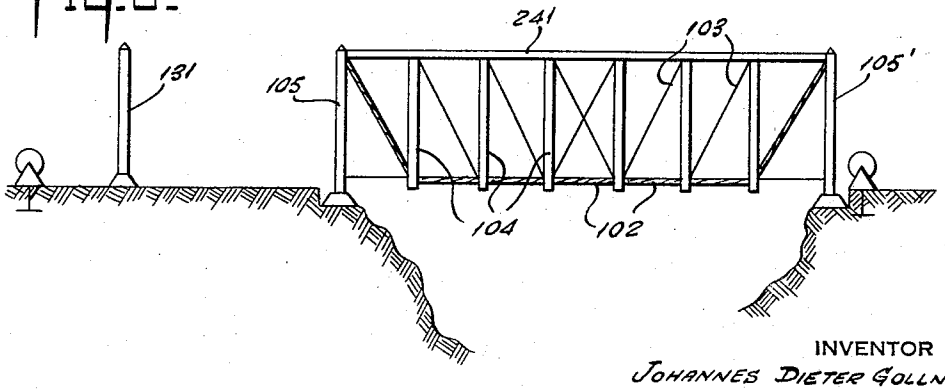


Fig. 6.



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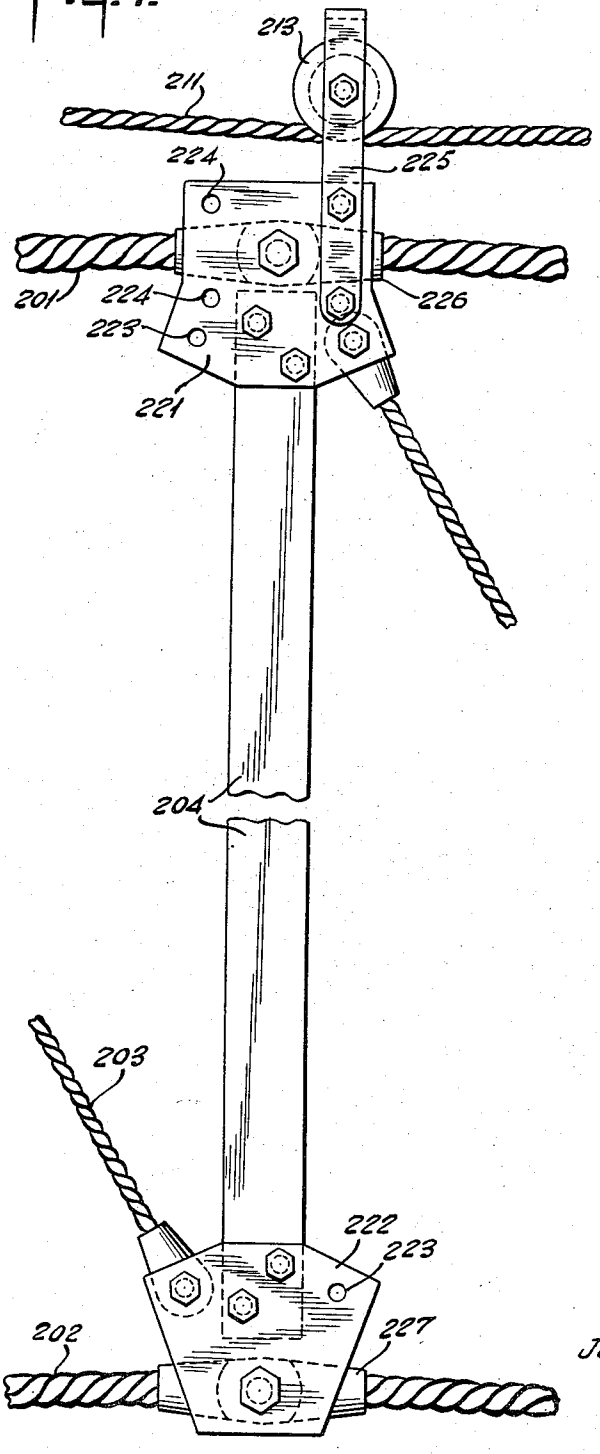
JOHANNES DIETER GOLLNOW

March 24, 1959 J. D. GOLLNOW 2,878,498

BRIDGE CONSTRUCTION

Filed June 28, 1954 3 Sheets-Sheet 3

Fig. 7.



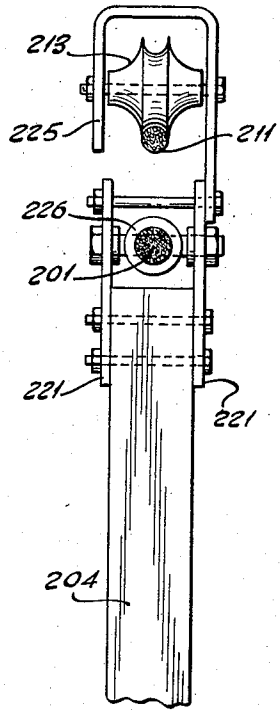


Fig. 8.

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2,878,498

BRIDGE CONSTRUCTION

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Application June 28, 1954, Serial No. 439,497

Claims priority, application Germany June 27, 1953

7 Claims. (Cl. 14—1)

The present invention relates to supporting structures generally, and more particularly to bridges and a new method of erecting the same.

It is one of the objects of the invention to design a new bridge structure, and especially one for relatively great span lengths, which can be erected very quickly and at a low cost both in labor and material.

Another object of the invention is to erect a bridge of relatively great solidity and load capacity, and without any of the usual preliminary supporting structures which under previous bridge building methods first had to be erected and later removed at a considerable expense and waste of time, and which usually could not be used again for subsequent constructions.

Consequently, it is an important object of the invention to erect a bridge with the aid of only a few accessories and materials which, moreover, after they have accomplished their purpose during this erection, may be easily dismantled or removed for subsequent use in the erection of another bridge.

Another object of the invention resides in a new method of erecting a bridge or similar supporting structure of a permanent nature by means of materials and accessories which are of light weight and easily transportable.

More specifically, it is an object and a feature of the invention to erect a bridge, and particularly one of considerable length, very easily and quicky, and by the mere use of a supporting cable for spanning the river or ravine and serving as the main support of the bridge during its erection, and only a few auxiliary anchorage means and other accessories, all of which are easily and quickly put up for the erection of the bridge and again quickly removed for building another bridge or similar structure.

For these reasons, the invention is particularly adapted not only for the erection of bridges for normal civilian traffic but also for military use where the quick erection of a reliable bridge span—possibly even under enemy fire—may be the key to victory.

Although chiefly concerned with the erection of bridges, the present invention is, however, not limited thereto. Thus, for example, the framework designed according to the invention, and the speedy and inexpensive method of erecting it may also be applied to the erection of large halls, hangars, barracks, or similar buildings, and to constitute the supporting framework and walls thereof. Such further application of the invention will also be of tremendous advantage both for the erection of industrial buildings as well as those used for aviation or military purposes.

The objects, features, and advantages of the invention are at least substantially due to the new design of a framework in the form of a trussed arch or latticed frame, and the new method of erecting the same by means of non-rigid and non-compressive girders or trusses, such as cable ropes and the like, so that these cable ropes constitute the main support of the final bridge or similar structure.

Further objects, features, and advantages of the invention will appear from the following detailed description thereof and the accompanying drawings, in which

Fig. 1 shows diagrammatically a cable frame designed and erected according to the invention, and forming one of the spans of a bridge;

Figs. 2 and 3 show two different stages in the erection of a suspension or supporting frame as illustrated in Fig. 1;

Figs. 4 and 5 show two different stages in the erection of a bridge according to a modification of the invention;

Fig. 6 illustrates another embodiment of the invention, and shows a bridge substantially completed;

Fig. 7 is an enlarged side view of a vertical supporting beam with a trolley wheel used in the erection of the new bridge; while

Fig. 8 is a front view of the trolley shown in Fig. 7.

Referring to the drawings, Fig. 1 diagrammatically illustrates an open web girder or suspension frame consisting of upper and lower chords **1** and **2**, and diagonal struts **3** secured thereto, all of them preferably consisting of steel cables of a strength depending upon the length of the bridge and its required load capacity. In the central part of the span, the diagonal struts **3** cross each other, while toward both ends they extend in the same direction so as better to take up the transverse forces. The vertical supporting beams **4** consist of rigid elements. The entire suspension frame rests upon bridge portals **5** which, in turn, are anchored in foundation blocks **6**. The upper chord **1** is held under tension by guy ropes **7**.

A complete bridge will consist of two or more suspension frames of the type described which may be braced relative to each other in any suitable manner, and between which the bridge roadway may be built, for example, on the level of the lower chords **2**. For reasons of a better illustration of the invention, the roadway has not been specifically shown in the drawings.

Fig. 2 shows a bridge according to the invention under construction and illustrates the new method of erecting it, in which the suspension frame is first being assembled in a collapsed position at one side of the bridge site and then pulled across the entire river or ravine to be spanned. For this purpose, the portals **5** are first erected on the foundation blocks **6**, and an erection cable **11** is then layed over the portals and temporarily anchored on both sides. If it is not readily possible to cross the ravine or river, a lead line may first be shot from one side to the other and then used to draw the erection cable **11** across the site. One of the portals **5** from the point of which the erection is to take place is preferably provided with working platforms or scaffolds **12** which, when no longer needed, may be removed. For assembling the suspension frame, one of the beams **4** is raised up, for example, by means of a light derrick **18** mounted on the tip of the portal **5**, and suspended on a trolley wheel **13** which is adapted to roll along the erection cable **11**. Then, the diagonal struts **3** and the upper and lower chords **1** and **2** will be secured at the respective truss joints. Since all these elements consist of wire ropes, they may remain during the assembly in a slack or collapsed condition. A traction rope **15** as well as a backstay rope **16** are then secured to the first truss joint **14** in which the lower chord **2**, one diagonal strut **3**, and the upper chord **1** intersect, and which subsequently is secured to the opposite portal **5'**. Both ropes **15** and **16** lead to winches **8** and **9** at the opposite sides or at both sides of the river or ravine to be bridged.

The upper and lower chords **1** and **2** may either consist of individual pieces which are secured to the respective truss joints by means of cable clamps, or they may extend clear across the entire bridge span, in which case they may be rolled up on drums **17** and unrolled there-

from step by step as the suspension frame is being assembled and the traction rope **15** tightened to draw the truss joint **14** further across when the necessary connections on one vertical beam **4** have been completed.

Fig. 3 illustrates the same bridge building site in a stage of construction when the individual elements of the suspension frame have been completely assembled but when all those elements which consist of wire rope are still in a slack condition, and the vertical beams **4** are still relatively close together and not drawn apart to their proper final spacing. The suspension frame is then drawn entirely across the entire bridge span by means of the traction rope **15**, and the latter is then drawn taut so that the upper and lower chords **1** and **2** will have the necessary final tension and the entire suspension frame will be lifted from the erection cable **11**. After guy ropes or braces **7** have been securely anchored and the erection cable **11** as well as the trolley wheels **13** have been dismounted, the suspension frame will have attained its final shape, as illustrated in Fig. 1.

After thus erecting the first main suspension frame of the bridge, the second frame as well as any additional supporting frames may then be erected and secured in the same manner. With the main supporting frames once being erected, it will then be a relatively easy matter to install the other essential parts of the bridge, such as portal and lateral braces and the like, as well as crossbeams, treadways or stringers, and other elements necessary for building a permanent roadway thereon. Depending upon the particular position of the site, such roadway may either be mounted on the level of the upper chords **1**, the lower chords **2**, or any intermediate level.

Figs. 4 and 5 illustrate a modification of the invention in which, aside from the portals **105** and **105'**, an auxiliary portal or upright **131** is provided at such a distance from the main portal **105** so as to leave sufficient intermediate space to assemble the individual elements of the suspension frame in a slack or collapsed position. Thus, in this embodiment of the invention, the main suspension frame will be assembled outside of the actual bridge span. A preferred method of erecting the bridge consists in first completely assembling and mounting the main suspension frame flatly on the ground in the space intermediate the auxiliary portal **131** and the main portal **105**, including the connection of the trolley wheels **113** to the beams **104**. The erection cable **111**, which is stretched across the river or ravine to be bridged and placed on the tip of the portals **105** and **105'** in the manner as previously described relative to Figs. 2 and 3, is then first temporarily secured to a suitable post or bracket laterally of the portal **105**, whereupon it is threaded on the ground through the trolley wheels which are mounted on beams **104**, and then layed over the auxiliary portal **131** and connected to the winch **132**. When the erection cable **111** is then being tightened by means of the winch **132**, the entire suspension frame, still in a slack or collapsed position, will gradually be raised from the ground, as illustrated in Fig. 4, in which some of the beams **104***a* have already been partly raised, while those toward the middle between the portals **105** and **131** are still resting on the ground. When the erection cable **111** is further tightened by means of the winch **132**, the entire suspension frame will be raised and brought into the position illustrated in Fig. 5. Thereafter, as previously described relative to Figs. 2 and 3, the traction rope **115** will be tightened by means of the winch **108** and the suspension frame drawn past the portal **105**, with the trolley wheels **113** rolling along the erection cable **111**, and entirely across the span, whereupon the traction rope will be drawn taut so that the suspension frame will become substantially self-supporting. The necessary guy ropes are then secured and tightened, and the erection and traction cables **111** and **115** as well as the trolley wheels **113** and the other accessories such as the auxiliary portal **131** and the winches **108** and **132** may then be removed.

In order to illustrate the applicability of the new method of bridge building to suspension or supporting frames of various designs, a different type of open web design or latticework has been used to construct the frame shown in Figs. 4 and 5 than that used in Figs. 1 to 3. However, as in Figs. 1 to 3, a steel cable may also be used for the upper supporting chord.

If, however, for certain reasons the upper chord should only be placed under tension during the erection of the bridge, while in the final condition such special anchorage of the upper chord should be dispensed with, a different bridge design, as illustrated in Fig. 6, may be followed. After erecting the suspension frame or frames, as described relative to Figs. 2 to 5, an upper chord or beam of rigid sections **241** will then be installed. Since the respective road gap has already been bridged by the suspension frame, such installation will be an easy matter. This may be done, for example, by advancing the individual beam sections **241** by means of suitable rollers or trolleys along the regular chord cable and securing them at the truss joints to the vertical beams **104**. The following beam sections **241** may then be rolled forwardly along those already in place and secured to the next vertical beam. After the entire horizontal beam has been completed and secured, the guy ropes, such as shown in Fig. 1, may be loosened and removed. The beam sections **241** may also be successively installed prior to the removal of the erection cable by suspending the first section on hoists or trolleys on such cable, and rolling it along the same to the proper position and then mounting it on the first vertical beam. The following sections **241** may then either be hoisted in the same manner to their proper position, or they may be moved there by sliding them along the sections already in place.

Fig. 7 shows on an enlarged scale a side view of a vertical beam together with the upper and lower truss joints and the trolley wheel, as applied in the bridge constructions shown in Figs. 1 to 6, while Fig. 8 shows a front view of the upper half thereof. The vertical beam **204** of any suitable cross sectional shape has secured to its upper end a pair of fishplates **221** and to its lower end a pair of fishplates **222**. Both pairs of plates have bores **223** in which either the bolts for securing the upper and lower chords or the diagonal struts are mounted as desired in the particular instance. The upper fishplates **221** have additional bores **224** for mounting the yokes **225** in which the trolley wheels **213** are rotatably supported. The yokes **225** are open on one side so that they may be easily placed upon the erection cable **211**. After the suspension frame has been fixed in place and properly secured, the yokes and wheels are removed. If, as shown in Fig. 6, a rigid upper chord or beam **241** is to be installed after the suspension frame as such has been secured in place, the bores **224** will then be utilized for mounting the beam sections or bolting them to each other as well as to the vertical beams **204**. In the particular embodiment of the invention as illustrated in Figs. 7 and 8, the upper chord cable **201** and the lower chord cable **202** consist of individual sections which are connected by twin cable clamps **226** and **227**, respectively. The bores provided in these clamps are used for bolting them to the fishplates **221** and **222**, respectively.

The inventive design of the suspension frames permits the application of tension and compression members of various types. The tension members may, for example, consist of ropes or cables of various types or of chains, while the compression members may be of tubular construction, of normal steel of flat or angular cross section, of wood, reinforced concrete, light metal, or other suitable materials.

The individual suspension frames may also be made of parabolic, parallel-truss, or other shape customary in bridge superstructures. If desired, and especially when

used on steep embankments, the upper chord thereof may also be rested and secured directly upon the abutments without the use of any portals. A bridge consisting of suspension or supporting frames of the type as described may, without change of its individual members, also be adapted to various load capacities or different span lengths by making the main frames of single, double, or triple walls, depending upon the particular requirements in each case, or by making the individual frames of a single floor type as shown in Fig. 6, or a double floor type, as shown in Fig. 1.

If the bridge building site is such that the terrain between the two portals is easily accessible and a light, or possibly a floating, trestle may be built or placed within the span to be bridged so that the slack or collapsed suspension frame may be assembled thereon, the auxiliary portal 131 as well as the erection cable may then be dispensed with. The traction ropes will then be secured on both sides directly to the first and last truss joints 14 and 21 of the upper chord and layed over the portals, and the suspension frame will then be pulled up directly and tightened until the two outer ends of the upper chord will rest upon the portals.

The suspension frames according to the invention and the new method of erecting a bridge may be applied with particular advantage if the bridge to be built has to span several successive ravines or other breaks in the surface of the terrain. The suspension frames will then be connected together at their upper chords, and the outwardly directed tension to solidify the individual frames need only be applied to the outer ends of the entire string of bridges.

The simplicity with which the suspension frame may be manipulated and the low weight thereof permit its application and the application of the new method not only to the erection of bridges but also to the use of such frames as supporting structures for large halls, hangars, or the like, or as scaffolds or for similar purposes.

While the foregoing description sets forth in detail what I regard as the preferred embodiments of my invention, it is to be understood that numerous changes may be made therein without departing from the spirit and scope of the invention as defined in the appended claims.

Having thus described my invention, what I claim as new is:

1. A method of erecting a frame structure for a bridge comprising a frame consisting of upper and lower flexible chords, rigid vertical beams intermediate said chords, and diagonal flexible struts connecting said flexible chords and vertical beams, comprising the steps of stretching a cable across the gap to be bridged, assembling the individual elements of said frame on the ground in a collapsed condition with the beams closely adjacent each other and interconnecting the diagonal struts with the flexible chords and arranging the assembly with the chords in a slack condition, attaching trolleys to one end of each of said beams, raising the elements of said frame in a successive order and gradually suspending said trolleys on said cable with the beams in vertical position, applying a traction on the outer end of the upper chord facing the gap and simultaneously releasing the other end thereof so as to draw the slack frame on said trolleys along said cable, securing the other end of said upper chord, applying further traction on said first outer chord end so as to spread apart the individual elements of said frame, drawing said upper chord taut and anchoring it in a fixed position, and removing said cable and trolleys from said frame.

2. A method of erecting a bridge comprising at least two frames, each consisting of upper and lower flexible chords, rigid vertical beams intermediate said chords, and diagonal flexible struts connecting said flexible chords and vertical beams, comprising the steps of stretching a cable across the gap to be bridged, assembling the individual elements of said frame on the ground in a collapsed condition with the beams closely adjacent each other and the flexible chords and diagonal struts in a slack condition, attaching trolleys to one end of each of said beams, raising the elements of said frame in a successive order and gradually suspending said trolleys on said cable with the beams in vertical position, applying a traction on the outer end of the upper chord facing the gap and simultaneously releasing the other end thereof so as to draw the slack frame on said trolleys along said cable, securing the other end of said upper chord, applying further traction on said first outer chord end so as to spread apart the individual elements of said frame, drawing said upper chord taut and anchoring it in a fixed position, removing said trolleys from said frame and cable, hoisting a rigid horizontal beam section from one end of said frame along said cable and mounting it on the first intersection of the upper chord with the first vertical beams and diagonal strut, moving a second rigid horizontal beam section along said first section and mounting it on the second intersection, and successively sliding other beam sections along those already mounted into their respective place and successively mounting the same on the following intersections until a rigid horizontal beam extends across the gap to be bridged, and finally removing said cable.

3. A method of erecting a bridge comprising at least two frames and consisting of upper and lower flexible chords, rigid vertical beams intermediate said chords, and diagonal flexible struts connecting said flexible chords and vertical beams, comprising the steps of stretching a cable across the gap to be bridged, assembling the individual elements of said frame on the ground in a collapsed condition with the beams closely adjacent each other and the flexible chords and diagonal struts in a slack condition, attaching trolleys to one end of each of said beams, raising the elements of said frame in a successive order and gradually suspending said trolleys on said cable with the beams in vertical position, applying a traction on the outer end of the upper chord facing the gap and simultaneously releasing the other end thereof so as to draw the slack frame on said trolleys along said cable, securing the other end of said upper chord, applying further traction on said first outer chord end so as to spread apart the individual elements of said frame, drawing said upper chord taut and anchoring it in a fixed position, removing said trolleys from said frame and cable, suspending a rigid horizontal beam section on said cable, hoisting it to the first intersection of the upper chord with the first vertical beam and diagonal strut, and securing it to said intersection, and successively hoisting other beam sections along said cable to the following intersections and securing them thereto until a rigid horizontal beam extends across the gap to be bridged, and finally removing said cable.

4. A method of erecting a bridge comprising at least two frames, each consisting of upper and lower flexible chords, rigid vertical beams intermediate said chords, and diagonal flexible struts connecting said flexible chords and vertical beams, comprising the steps of mounting at least one pair of portals on each side of the gap to be bridged, extending an erection cable across the gap and over the upper ends of two corresponding opposite portals, and tightening said cable, assembling the individual elements of one frame on the ground in a collapsed condition with the rigid beams closely adjacent each other and the flexible chords and diagonal struts in a slack condition, hoisting successive elements of said frame to an upright position and attaching them successively to the erection cable with the vertical beams still relatively closely adjacent each other and the upper and lower chords and diagonal struts in a slack condition, spreading the frame members apart and tautly across the gap and securing the outer ends of the upper

chord in a fixed position on the ground, removing the erection cable, erecting the second frame in the same manner as said first frame, and bracing both frames relative to each other and to the ground.

5. A method of erecting a bridge comprising at least two frames, each consisting of upper and lower flexible chords, rigid vertical beams intermediate said chords, and diagonal flexible struts connecting said flexible chords and vertical beams, comprising the steps of mounting at least one pair of portals on each side of the gap to be bridged and at least one upright of substantially the same height as said portals on one side of the gap and spaced from one of the portals on that side, extending an erection cable across the gap and over the upper ends of two corresponding opposite portals and said upright, tightening said cable intermediate said portals but leaving the cable portion substantially slack between said upright and the adjacent portal, assembling the individual elements of one frame on the ground intermediate the upright and the adjacent portal, and in a collapsed condition with the rigid beams closely adjacent each other and the flexible chords and diagonal struts in a slack condition, attaching trolleys to one end of each of said beams, attaching all of said trolleys to said cable portion, tightening said cable portion at the free outer end thereof adjacent said upright and thereby gradually raising the entire frame from the ground, rolling the frame on said trolleys past the adjacent portal and spreading the adjacent frame elements apart intermediate said portals above said gap, drawing the outer ends of the upper chord taut and securing said ends in a fixed position on the ground, removing the trolleys, the erection cable, and upright, erecting the second frame in the same manner as said first frame, and bracing both frames relative to each other and to the ground.

6. A method of erecting a bridge comprising at least two frames, each consisting of upper and lower flexible chords, rigid vertical beams intermediate said chords, and diagonal flexible struts connecting said flexible chords and vertical beams, comprising the steps of mounting at least one pair of portals on each side of the gap to be bridged and at least one upright of substantially the same height as said portals on one side of the gap and spaced from one of the portals on that side, extending an erection cable across the gap and over the upper ends of two corresponding opposite portals and said upright, tightening said cable intermediate said portals but leaving the cable portion substantially slack between said upright and the adjacent portal, assembling the individual elements of one frame on the ground intermediate the upright and the adjacent portal, and in a collapsed condition with the rigid beams closely adjacent each other and the flexible

chords and diagonal struts in a slack condition, attaching trolleys to one end of each of said beams, attaching all of said trolleys to said cable portion, tightening said cable portion at the free outer end thereof adjacent said upright and thereby gradually raising the entire frame from hte ground, rolling the frame on said trolleys past the adjacent portal and spreading the adjacent frame elements apart intermediate said portals above said gap, drawing the outer ends of the upper chord taut and securing said ends in a fixed position on the ground, removing the trolleys from the frame and cable, suspending a rigid horizontal beam section on the cable, hoisting it to the first intersection of the upper chord with the first vertical beam and diagonal strut, and securing it to said intersection, and successively hoisting other beam sections along said cable to the following intersections and securing them thereto until a rigid horizontal beam extends across the gap to be bridged, removing said erection cable, erecting the second frame in the same manner as said first frame, bracing both frames relative to each other and to the ground, and finally removing said uprights.

7. A method of erecting a bridge comprising erecting a pair of supports on opposite sides of a gap to be bridged for each side supporting frame member of the bridge, stretching a normally temporary cable across corresponding supports from one side of said gap to the other, assembling on the ground on one side of the gap a plurality of rigid bridge verticals for each set of corresponding supporting frame members, said verticals being assembled in close side by side relation, interconnecting said verticals with flexible chord members, raising said assembly and suspending same on said temporary cable adjacent one side of said gap, holding one end of said assembly on one side of said gap while drawing the opposite end of said assembly across said gap while it is supported from said temporary cable, stretching said frame apart to space said rigid elements apart and tighten said chord members and thereafter interconnecting the supporting frame member assemblies to complete the bridge structure.

References Cited in the file of this patent

UNITED STATES PATENTS

140,888	Clarke	July 15, 1873
1,868,630	De Vou	July 26, 1932
1,967,828	Leake	July 24, 1934
2,339,098	Nagin	Jan. 11, 1944
2,376,023	Bailey	May 15, 1945

FOREIGN PATENTS

283,633	Italy	Mar. 17, 1931
146,236	Austria	June 25, 1936
447,143	Italy	Apr. 4, 1949