C. E. INGLIS.

MILITARY BRIDGE AND THE LIKE.

APPLICATION FILED OCT. 9, 1915.

1,181,013.

Patented Apr. 25, 1916.

6 SHEETS—SHEET 1.

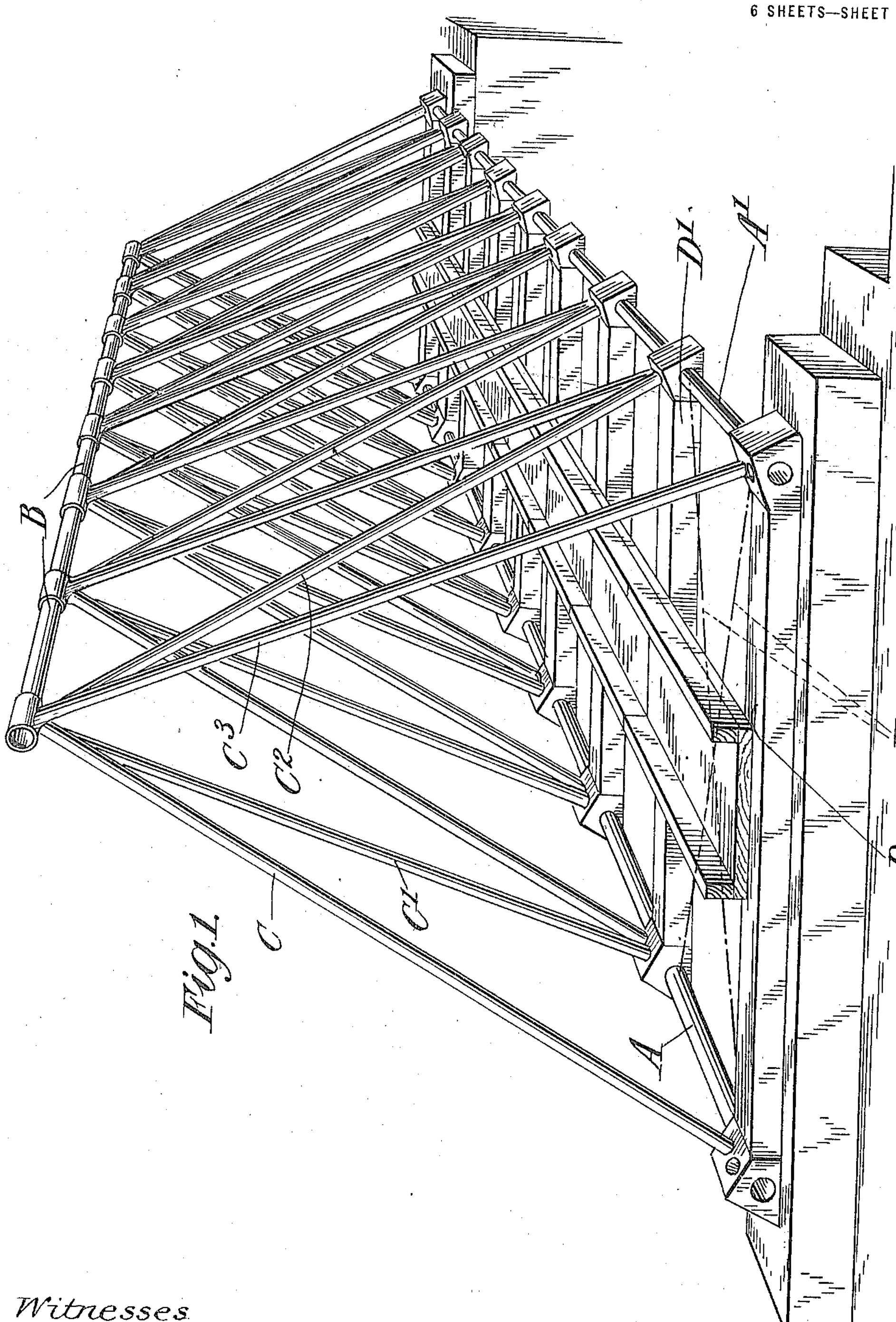


Fig. 1.

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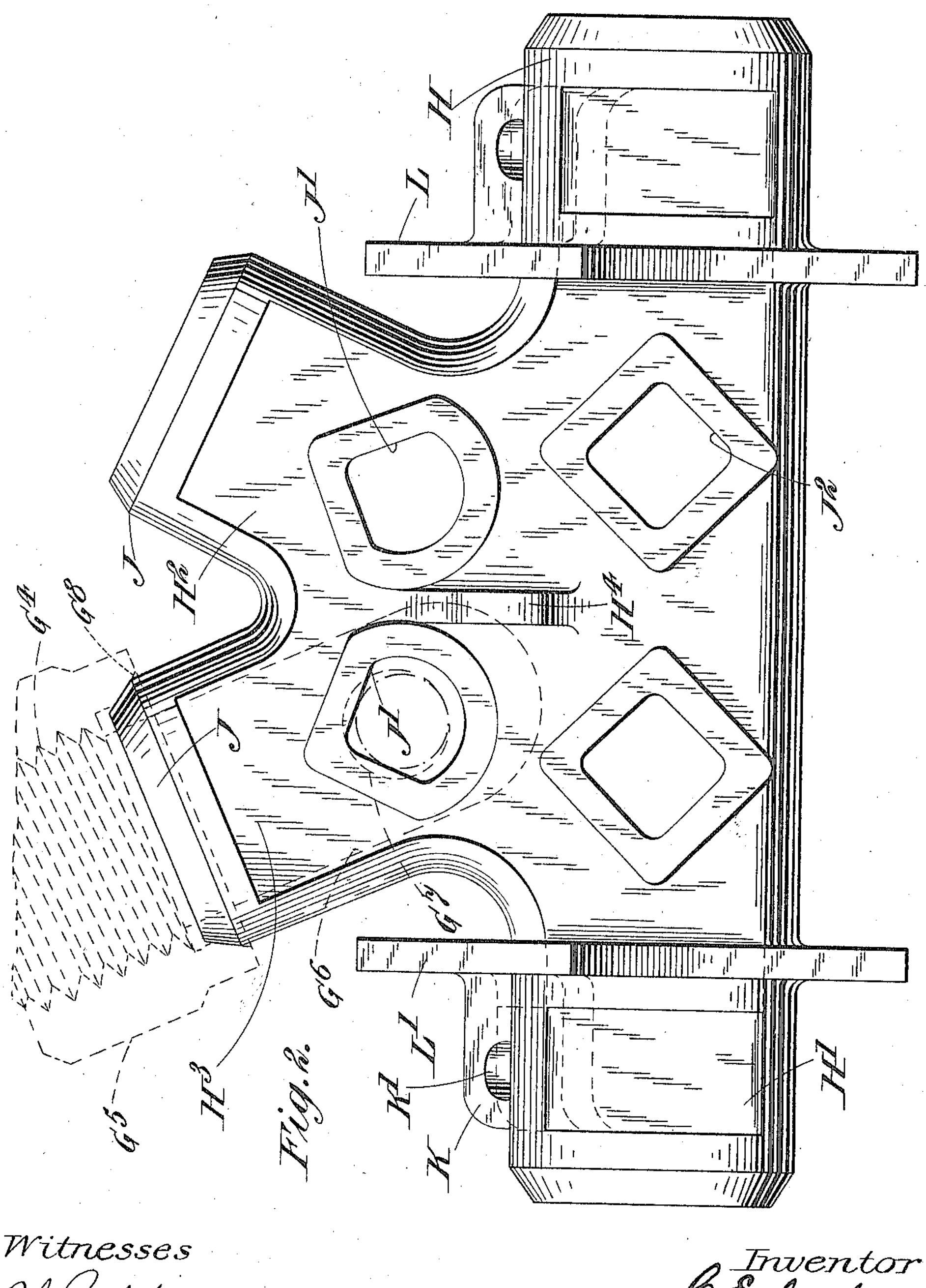

Fig. 2.

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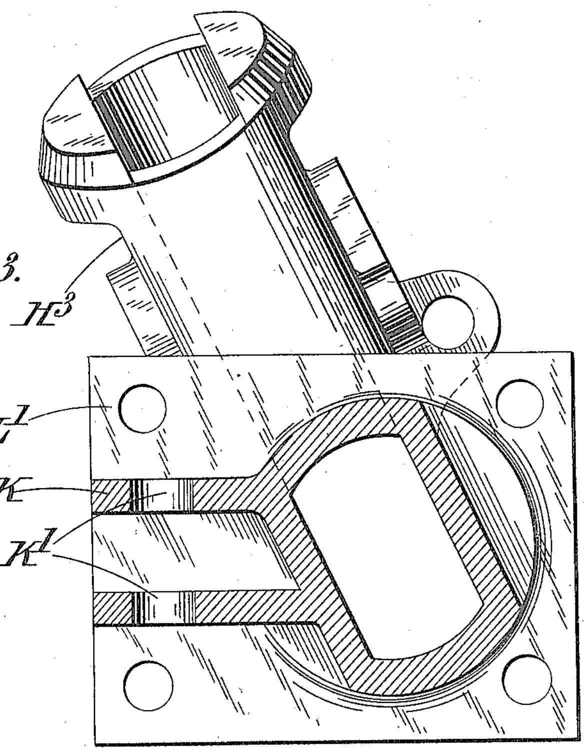
Fig. 3.

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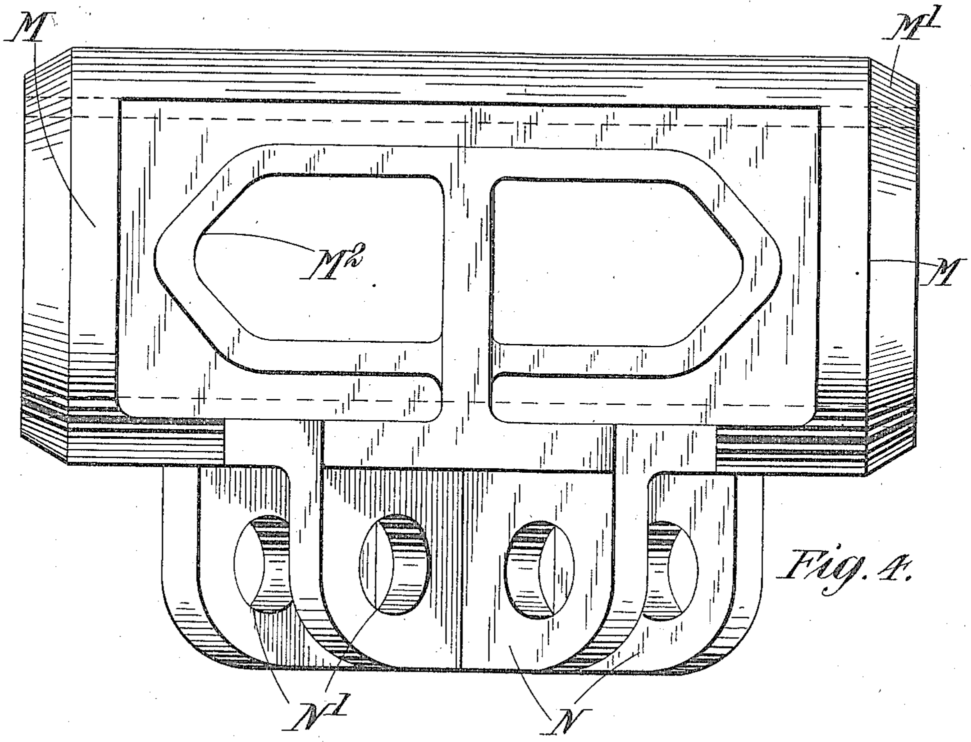
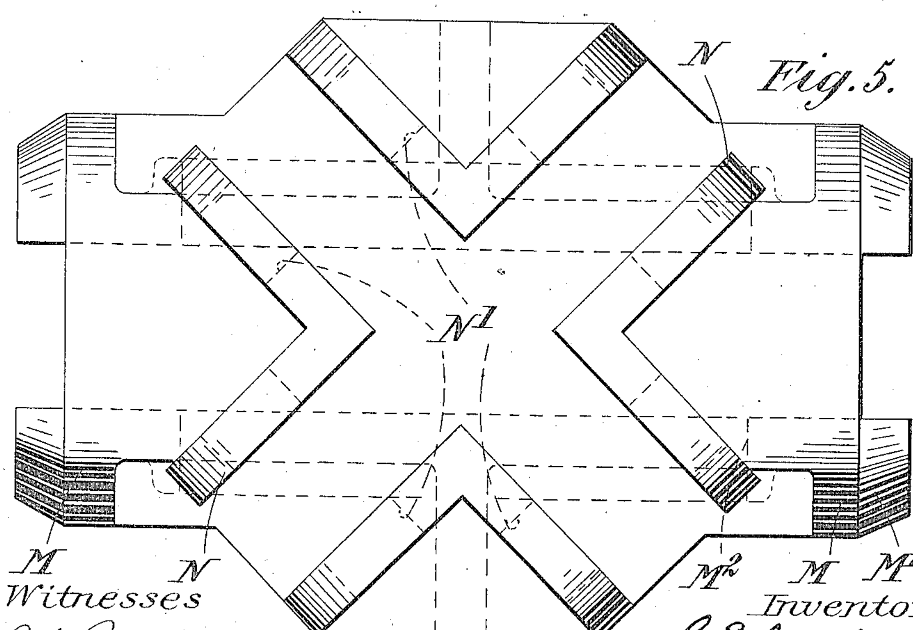



Fig. 4.

Fig. 5.




Witnesses

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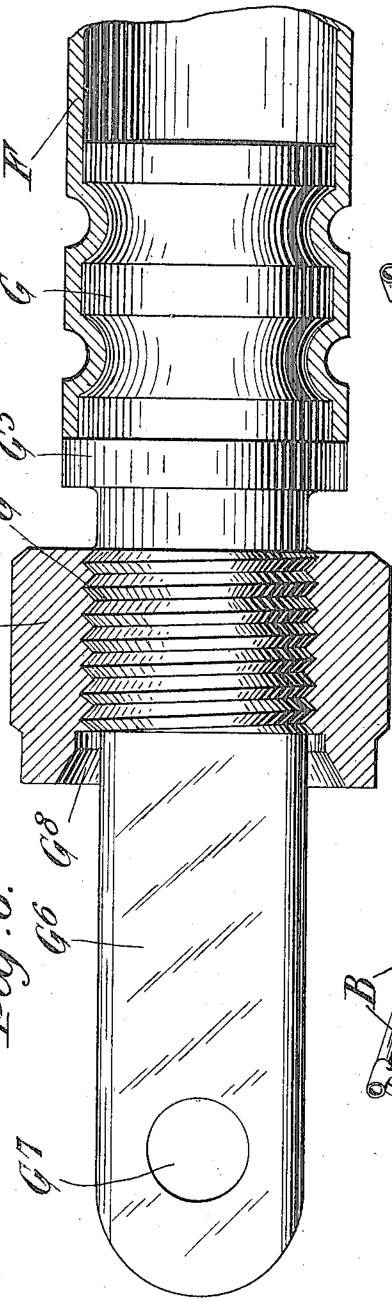


Fig. 6.

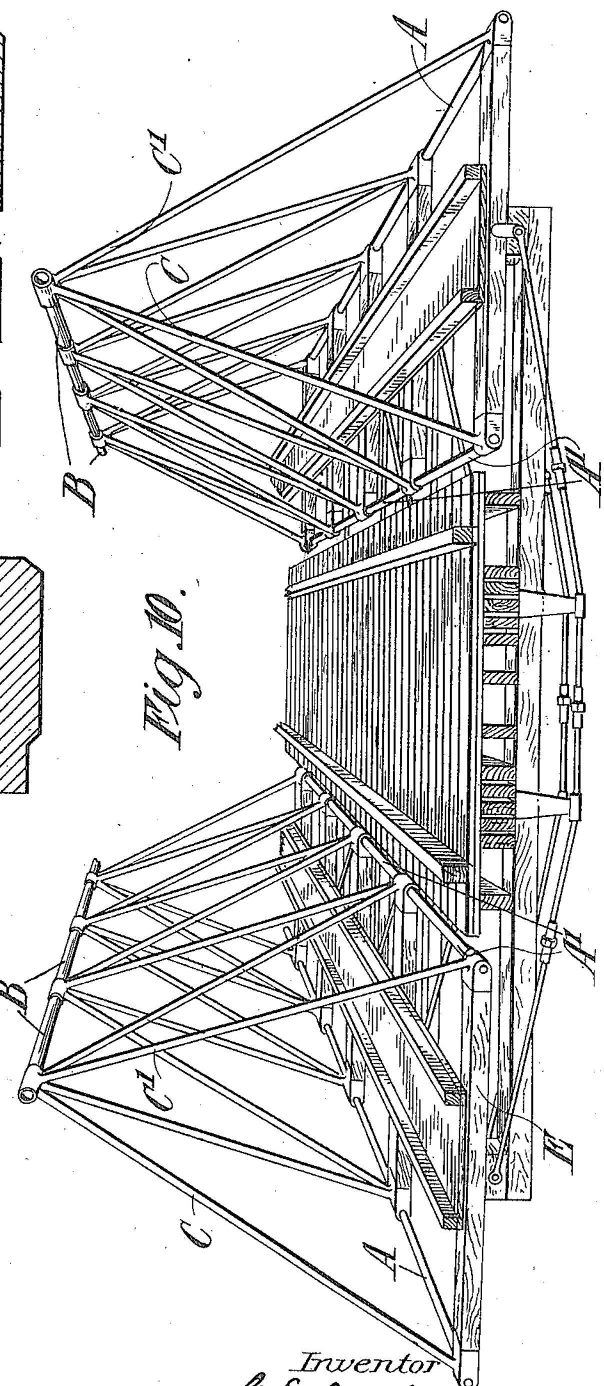


Fig. 10.

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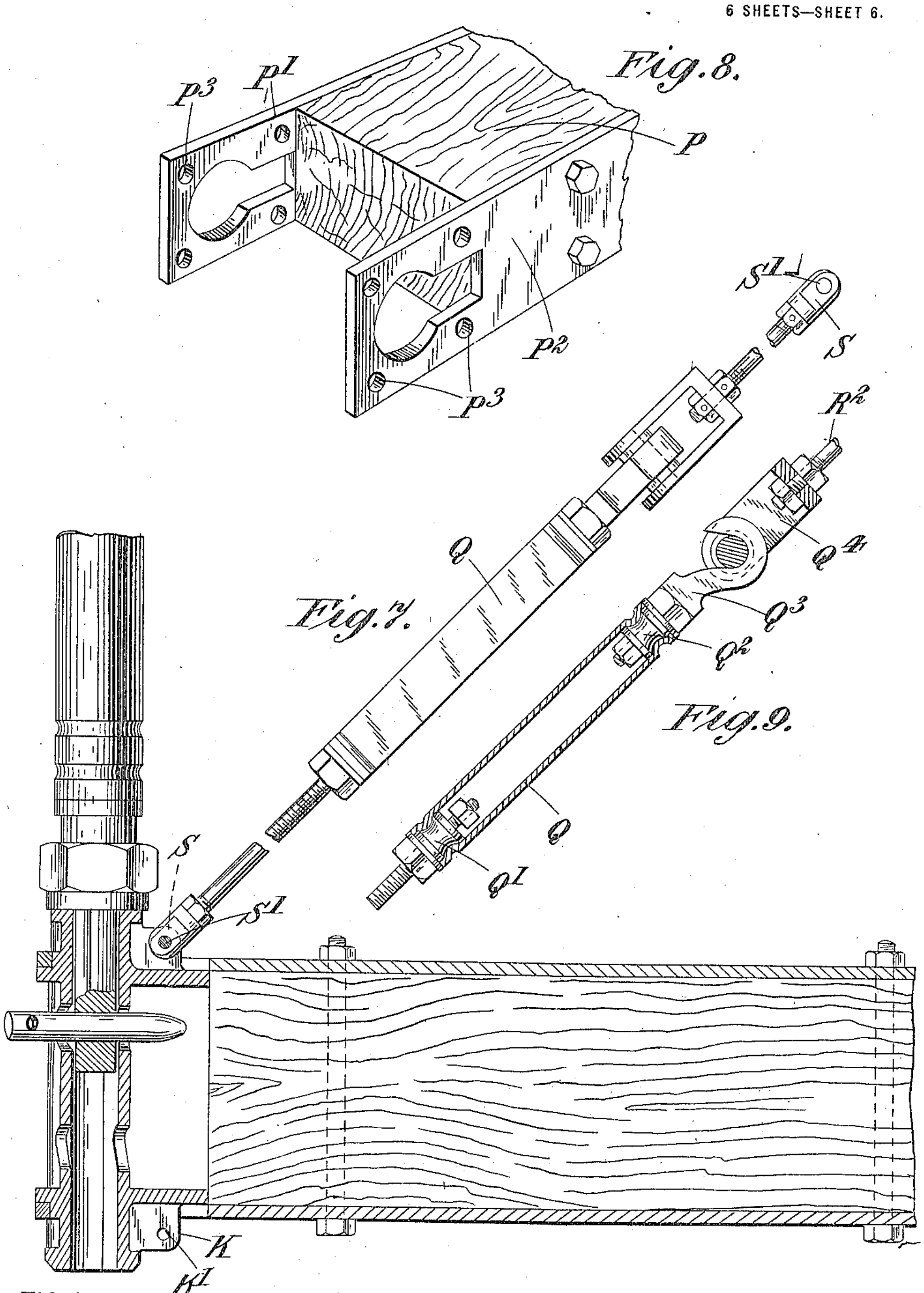
6 SHEETS—SHEET 6.

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# UNITED STATES PATENT OFFICE.

CHARLES EDWARD INGLIS, OF GRANTCHESTER, NEAR CAMBRIDGE, ENGLAND.

MILITARY BRIDGE AND THE LIKE.

1,181,013. Specification of Letters Patent. Patented Apr. 25, 1916.

Application filed October 9, 1915. Serial No. 55,085.

*To all whom it may concern:*

Be it known that I, Charles Edward Inglis, a subject of the King of England, residing at Grantchester, near Cambridge, England, have invented certain new and useful Improvements in Military Bridges and the like, of which the following is a specification.

This invention is for improvements in or relating to military bridges and the like and has for its object to provide a novel construction of bridge which is of light weight in relation to its strength and which can be readily erected or taken to pieces for erection in another position if desired, or it may be erected permanently.

A primary object of the present invention is to provide a structure which, while retaining ease of erection, shall be more rigid than such structures have hitherto commonly been.

According to the present invention, a bridge or braced structure is constructed in pyradimal sections (for example open frameworks having each a rectangular base) having their bases connected together coterminously to provide, each by two of the sides of the base a pair of longitudinal members of the structure, in combination with members connecting their apexes together in series so that the connecting members constitute a third longitudinal member of the structure. It will be appreciated that when the pyramids are arranged in series, the cross members of the base will be duplicated, that is to say, there will be two members lying against one another; one of these will be removed so that strictly, the base of each pyramid consists of three sides, the fourth side being supplied by an adjacent pyramid. The sections will however be referred to as pyramids hereinafter.

In the design of a portable bridge of the type above described the construction of the joints is of particular importance from a practical point of view and according to another feature of the invention a joint for joining a tie-rod or strut to another part is made with two engaging co-axial coned surfaces, one on the rod or strut and the other on the part to which it is to be joined; the coned surfaces are arranged with the cone axis in the line of pull or thrust and a pin-and-slot "reverse engagement" is also provided between the two parts. The term "reverse engagement" is used to indicate an engagement of such a character as will retain the parts engaged against the application of a force in the reverse direction to that which tends to press together the two coned surfaces already mentioned.

When the joint-block is to be used for connecting several members together it may be provided with two or more joints as above described all so arranged that their cone axes intersect at a point common to them all.

Other features of the invention relate to details of the construction hereinafter fully described and illustrated with reference to the accompanying drawings in which—

Figure 1 is a diagrammatic perspective view of a complete bridge. Fig. 2 is an elevation of a joint-block used to connect the sections of the bottom longitudinal members of the structure shown in Fig. 1. Fig. 3 is a side elevation partly in section of Fig. 2. Fig. 4 is a side elevation of the joint-block used for connecting the sections of the top longitudinal member shown in Fig. 1. Fig. 5 is an underside view of the joint-block shown in Fig. 4. Fig. 6 is a view partly in section showing the method of connecting a frame-member to a joint-block. This part is shown in place in chain-lines in Fig. 2. Fig. 7 is a plan partly in section showing the construction of the cross-struts and their method of connection to the joint-blocks and the sway bracing. Fig. 8 shows the construction of an end of a cross-strut. Fig. 9 shows the detailed construction of the sway bracing. Fig. 10 is a diagrammatic perspective view of a modified construction of bridge.

The invention has been illustrated and will now be described as applied to the construction of a light military foot-bridge for infantry.

The general construction of the bridge is illustrated in Fig. 1. The lower booms of the bridge are built up in sections A $A^1$ of weldless steel tube, any sufficient number of these being joined in series to provide the required length of structure. The upper boom is similarly built up of sections of weldless steel tube B. The connection between the upper and lower booms is made by tubes C, $C^1$, $C^2$, $C^3$ which are arranged as shown in the form of a rectangular pyramid of which the two tubes A, $A^1$ form opposite sides of the base. The ends of these two base-members are connected by transverse struts D, $D^1$ which will be hereinafter more fully described. The four members A, $D^1$ $A^1$, D constituting the base of the pyramidal frame or section, are braced together by diagonal ties E; it will be seen that this construction of a section of the bridge in pyramidal form gives a perfectly rigid unit. The whole structure may be considered as a series of these pyramidal units or bays arranged in line with one another and having their apexes connected by the members B which constitute the upper longitudinal or compression member of the structure. It will be seen from an examination of the figure, that this structure may also be considered as two Warren girders inclined to one another and having a common longitudinal member made up of the sections of tube B. One of these girders is constituted by the tubes $A^1$, $C^3$, $C^2$ and B, and the corresponding parts in the adjacent sections. The other girder is made up of the members A, C, $C^1$ and B and their corresponding parts.

The joint between the bottom ends of the members of a bay, and also their joint with the adjacent members of the bay are effected by means of joint-blocks, and jointing connections on the ends of the tubes. These latter are illustrated in Fig. 6.

In the end of each tubular member F there is inserted a cylindrical plug G in which two encircling grooves $G^1$, $G^2$ have been formed. The projecting part of the plug is formed with a collar $G^3$ which butts against the end of the tube and with a screw-threaded part $G^4$ upon which there is provided a nut $G^5$. Beyond the threaded portion the end of the plug is flattened as at $G^6$ to form a tongue and this is pierced from one flat face to the other by a hole $G^7$ whose axis intersects the longitudinal axis of the tubular member F. The plug is secured in place by forcing, for example rolling, the metal of the tube wall into the grooves $G^1$ $G^2$ on the plug. The weight of the plug is conveniently reduced by boring it to a convenient depth from the end which is subsequently inserted in the tube F. The nut $G^5$ has formed on the face of it toward the tongue $G^6$ a conical recess $G^8$, the purpose of which will be hereinafter described.

The joint-block is illustrated in Figs. 2 and 3 and in this particular instance it is in the form of a box-casting having four tubular sockets. Two of these H, $H^1$, are in line with one another to receive the adjacent lower boom members $A^1$, and above these are two other sockets $H^2$ $H^3$ inclined to one another V-fashion to receive the diagonal or web members $C^2$ or $C^3$, one of these diagonals belonging to one section or bay of the bridge and the other to the next adjacent bay. Only one of the sockets need be described in detail as the others are similar. The outer end of the socket $H^2$ is coned as at J to fit the coned recess $G^8$ in the nut $G^5$ above described and the interior of the socket is shaped to receive the tongue $G^6$. The socket is made somewhat larger than the tongue so that the latter can be easily inserted, being subsequently centered by the engagement of the coned surfaces. It will be appreciated that the surface J may be made cylindrical instead of conical, and that it would still automatically center itself in the coned recess $G^8$ in the nut. Some distance from the outer end of the socket, it is traversed by a sector-shaped slot or opening $J^1$ which has its V toward the open end of the socket and on the center line of the coned part J. Instead of using sector-shaped holes they may be made approximately rectangular as at $J^2$, being arranged with a diagonal on the axis of the corresponding coned portion of a socket. In any case the four holes for the four sockets are so placed as to surround a central point at which the axes of the four sockets intersect.

It is important in the manufacture of the joint-block that the V-shaped holes traversing the sockets should be exactly in line with the axis of the cone for the corresponding socket. The tube is engaged with the socket as shown in dotted lines in Fig. 2 by inserting the tongue $G^6$ into the socket until the hole $G^7$ registers with the hole $J^1$ when a pin can be inserted therethrough; this pin for ease in erection is made a loose fit both in the opening J and in the hole $G^7$, this looseness being somewhat exaggerated for clearness in Fig. 2. The nut $G^5$ is then screwed down until its coned portion $G^8$ engages with the coned portion J on the socket. This action takes up the slackness of the pin in the opening J and in the hole $G^7$ and it also serves to hold the tube end so that its direction as well as its position is rigidly fixed.

On the side of the sockets H, $H^1$ which receive the horizontal or boom members $A^1$, there is cast a double flange K which is provided with two holes $K^1$ which constitute a fastening for the diagonal or sway bracing (hereinafter described) of the four bottom members of the pyramid. These joint-blocks are further provided with flanges L, $L^1$ by which they are secured to the transverse struts or floor-carrying members of the bridge. Each of these struts carries one of the blocks at each end and the various tube-members are connected to it in erecting the bridge.

The joint-block to be used in connection with the tubes B (Fig. 1) which constitute the upper longitudinal member of the structure are illustrated in Figs. 4 and 5. This joint-block comprises two tubular sockets M which are coned on the outside at $M^1$ and provided with a V-shaped hole $M^2$ similar to the sockets already described with reference to Fig. 2. On the underside of the block are cast four pairs of flanges N which are bored through at $N^1$. The tubes $C^2$, $C^3$ are provided at their upper ends with tongues similar to those illustrated in Fig. 6, but without the screw-threaded portion and coned nut, and these tongues are received between the two flanges and secured by a pin passed through the flanges and the tongue.

Where pins are used for making joints in the various sockets, the pins are preferably secured to the casting by means of chains. In the example illustrated in Fig. 2 a small web $H^4$ is provided at the middle to which the chains for the four pins required may be secured.

The transverse struts hereinbefore referred to are illustrated in Figs. 7 and 8. They each constitute one of the base members of a pyramid and consist preferably of wooden beams reinforced by steel side plates screwed or bolted to the wooden part of the member. Fig. 8 shows the construction of the end of the strut according to which the steel plates $P^1$, $P^2$ extend beyond the wooden portion P and are provided with openings to receive the sockets H, $H^1$, Fig. 2. Further holes $P^3$ are provided in these bridging portions of the plate to permit the flanges L, $L^1$ to be secured to the strut by bolts.

Diagonal bracing is provided at the base of each pyramid as indicated at E in Fig. 1 and the braces are preferably in the form of stay rods. A strainer or turn-buckle is fitted to each of the said rods and a preferred construction is illustrated in Fig. 9. A tube Q is fitted with plugs $Q^1$, $Q^2$ at each end, these being held in place by spinning the metal wall of the tube into a groove formed in the plug. The part of the plug projecting beyond the tube end is shaped like a nut so that if the turn-buckle becomes too stiff for hand rotation, a spanner may be applied to this portion to facilitate the turning. The plug $Q^1$ is internally threaded to fit the screw-thread on the stay rod R. The rod R projects into the interior of the tube Q and is prevented from being removed therefrom by a nut $R^1$ screwed on the end and pinned to the rod. The plug $Q^2$ is bored to take a swivel-hook $Q^3$ which engages with a U-shaped link $Q^4$ on the other portion of the stay-rod $R^2$. The two ends of the stay-rod are fitted with tongues S which are shaped to fit between the flanges K and be secured in place by pins passing through the holes $K^1$ and holes $S^1$ in the tongues.

The gangway across the bridge for foot traffic may be of any suitable construction and is laid on the transverse struts along the middle of the bridge. If desired this track may consist of trussed planks to give a stiff construction, and the planks may be protected with a nosing of angle-iron where they engage with the transverse struts.

This structure is so designed with respect to its members and joints that it can be turned upside down if desired and provided with a broad gangway so that a bridge suitable for wheeled traffic is thus obtained. With this object in view all the joints and tubes are designed to be able to resist compression as well as tension stresses.

In Fig. 10 there is illustrated diagrammatically a bridge constructed in accordance with the present invention but intended for heavier traffic than that already described. Two structures similar to those already described are placed side by side a suitable distance apart and a roadway is provided between them to take wheeled or other traffic. The roadway may be supported by ties from each of the transverse struts D, $D^1$ of the two bridges. Further details of the construction of the bridge need not be given as they are similar to that already described or are such as are well within common knowledge.

It will be understood that the description given above is mainly by way of example of the application of this invention and that various details may be modified without departing from the spirit of the invention as set forth in the appended claims.

What I claim as my invention and desire to secure by Letters Patent is:—

1. In a braced structure the combination of a plurality of pyramidal sections, means connecting the base of each pyramid coterminously with the base of the next, and means connecting the apex of each pyramid to the apex of the next; substantially as described.

2. In a braced structure the combination of a plurality of open frames of pyramidal shape, means connecting two parallel members of the base of each frame each coterminously with one of two similar parallel members of the base of an adjacent frame, and means connecting the apex of each frame to the apex of an adjacent frame; substantially as described.

3. In a braced structure the combination of a plurality of open frames each comprising two parallel tubular base-members, a timber strut-member connecting them transversely at one end and four tubular members all connected together at one end and each connected at its other end to the end of a tubular base-member thereby constituting a pyramid, means connecting the two tubular base-members of each pyramidal frame coterminously with the two tubular base-members of an adjacent frame, and means connecting the apex with each pyramidal frame with the apex of an adjacent frame, substantially as described.

4. In a braced structure the combination of a plurality of open frames of pyramidal shape, joint-boxes connecting the base-members of the frame together and to the base-members of an adjacent frame, mutually engaging coned surfaces on the box and on each of the members to which it is connected, said surfaces being co-axial with the direction of the stress in the member, a pin-and-slot connection between the box and each member arranged with the longitudinal axis of the pin intersecting the cone axis, and holding the box and the member together against forces tending to separate the coned surfaces, and means connecting the apex of each pyramidal frame to the apex of an adjacent frame; substantially as described.

5. In a braced structure the combination of a plurality of open frames of pyramidal shape, joint-boxes connecting the base-members of the frame together and to the base-members of an adjacent frame, mutually engaging coned surfaces on the boxes and on each of the members to which it is connected, said surfaces being co-axial with the direction of the stress in the member, a loose pin-and-slot connection between the boxes and each frame member arranged with the longitudinal axis of the pin intersecting the cone axis, holding the box and member together against forces tending to separate the coned surfaces, and means connecting engagement of the said coned surfaces takes up the looseness of the pin-and-slot connection and means connecting the apex of each pyramidal frame to the apex of the next; substantially as described.

6. In a demountable portable bridge the combination of a plurality of pyramidal sections, means connecting the base of each pyramid co-terminously with the base of the next, means connecting the apex of each pyramid to the apex of the next, and flooring supported from said pyramidal sections; substantially as described.

7. In a braced structure the combination of two sets of pyramidal sections disposed side by side, each set having the bases of its sections connected co-terminously in series and the apexes also connected in series, and flooring supported by said two sets of pyramidal sections; substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

CHARLES EDWARD INGLIS.

Witnesses:
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Harry L. Liedge.

**Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."**