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(56) Related Art
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ABSTRACT

A modular system for the construction of a lattice panel for a bridge. comprises first and second chord members (20, 28) and a plurality of web members (1). Each web member comprises three legs forming a triangle. One leg (2) extends perpendicularly between the chord members. The second and third legs (3, 4) are joined to each other and to the ends of the first leg. The ends of the first leg (1) are provided with means for connecting the web member to the chords (20, 28). Interlocking means (13, 19) are provided at the joint between the second and third legs, and mid way along the first leg, so that adjacent web members can be connected together.

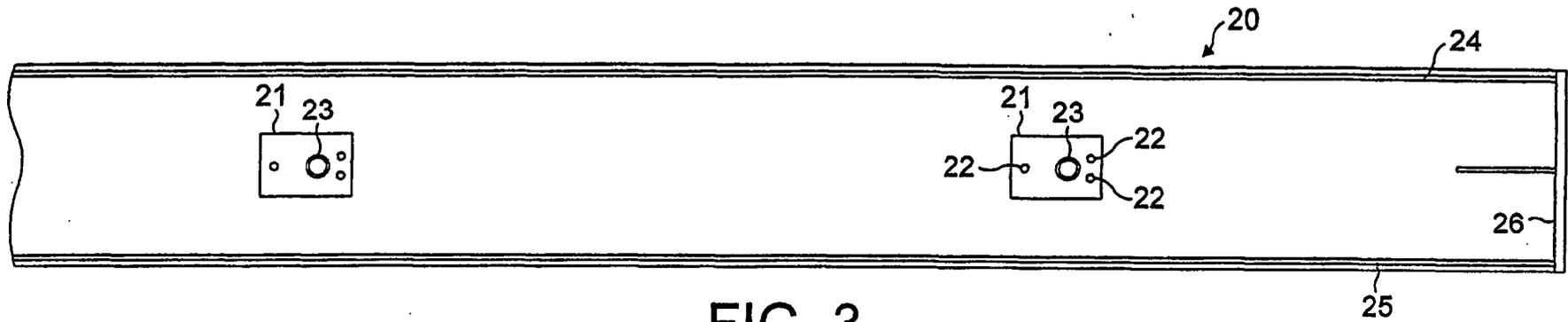


FIG. 3

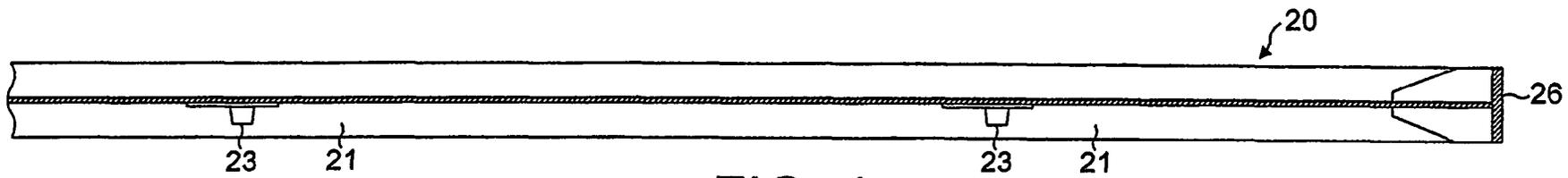


FIG. 4

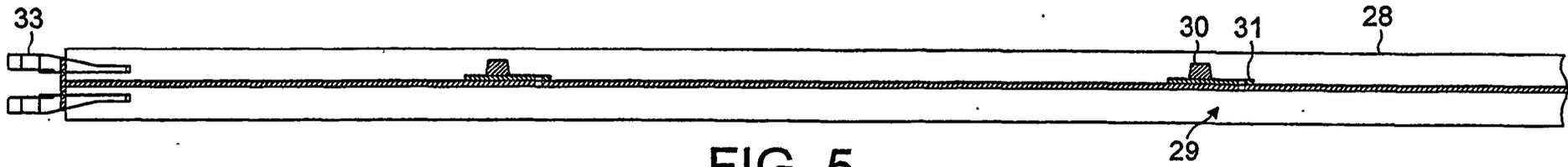


FIG. 5

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COMPLETE SPECIFICATION
STANDARD PATENT

Invention Title:

Lattice panel structures

The following statement is a full description of this invention including the best method of performing it known to us:-

Lattice Panel Structures

This invention relates to lattice panel structures, such as bridges of the "Bailey" type. The invention is particularly concerned with a modular lattice panel system.

In a typical "Bailey" bridge construction there is provided a main girder at each side of the bridge, transoms extending between the girders and a deck supported on the transoms. The girders are formed from prefabricated lattice panels of steel which are joined together longitudinally. Two or more sets of the lattice panels may be secured together in the vertical direction so as to provide the required depth of girder, and to this end the panels are generally of a rectangular configuration. A common type of lattice panel consists of upper and lower longitudinally extending chords which are joined together by a lattice of web members. These will generally include vertically extending web members and angled web members which may for example extend at an angle of about 45° to the chords. Various panel configurations are disclosed in GB-A-2 251 018, for example.

To join the panels together in end to end relationship to provide the required length of girder, pin and aperture joints are usually employed to ensure speed and simplicity of assembly on site. One end of each chord will be formed with a female portion and one with a male portion. These are mated when the panels are to be joined together and then a transverse pin is inserted through apertures in the portions.

Bridges of the above type are often used as temporary structures, for example to replace bridges destroyed by floods, earthquakes or acts of war. They are supplied as prefabricated components which are assembled on site. In one common method of construction, the bridge girders are assembled on one side of the gap to be bridged, such as a river or ravine, and pushed out and over to the other side.

In a conventional system, the lattice panels are provided as completely prefabricated units with the web members welded to the chords. Typically, a standard length prefabricated panel will be available, and the designer of a bridge will use the appropriate number of these, to be joined end to end, for the bridge.

A significant advantage of using prefabricated panels is that bridges can be constructed quickly with the minimum of on - site fabrication. However, there are design constraints due to the limited number of panel configurations available. It is also necessary to restrict the length of the prefabricated panels used as the basic units, so that there is sufficient flexibility to achieve a desired length by joining a number together.

However, the joins between adjacent panels can be expensive, particularly if they are of the pin joint variety requiring forgings. The more panel units are required to span a given length, the more joins are required. a further problem is that prefabricated panels are bulky to transport.

5 An object of the present invention is to provide a modular system for constructing lattice panels which provides greater flexibility but which does not increase to an undesirable level the time spent on site to construct a bridge.

It is known to provide a bridge constructed from a modular system and comprising a horizontally extending structural member formed by a plurality of lattice
10 panels joined end to end, each lattice panel comprising an elongate upper chord member, an elongate lower chord member and a plurality of web members attached to the chord members and holding them apart in a vertical direction.

Any discussion of documents, acts, materials, devices, articles or the like which has been included in the present specification is solely for the purpose of providing a
15 context for the present invention. It is not to be taken as an admission that any or all of these matters form part of the prior art base or were common general knowledge in the field relevant to the present invention as it existed before the priority date of each claim of this application.

Throughout this specification the word "comprise", or variations such as
20 "comprises" or "comprising", will be understood to imply the inclusion of a stated element, integer or step, or group of elements, integers or steps, but not the exclusion of any other element, integer or step, or group of elements, integers or steps.

Viewed from one aspect, the present invention provides a bridge constructed from a modular system and comprising a horizontally extending structural member
25 formed by a plurality of lattice panels joined end to end, each lattice panel comprising an elongate upper chord member, an elongate lower chord member and a plurality of web members attached to the chord members and holding them apart in a vertical direction, which is characterised in that each web member comprises three legs forming a triangle, a first leg extending perpendicularly between the chord members, and
30 second and third legs being joined to each other and to adjacent the ends of the first leg and in that there are provided the following means which interlock each web member to the chord members and to like web members:

first interlocking means adjacent the upper end of the first leg which interlocks with corresponding second interlocking means provided at intervals along the upper
35 chord member;

third interlocking means adjacent the lower end of the first leg which interlocks with corresponding fourth interlocking means provided at intervals along the lower chord member;

fifth interlocking means adjacent the join between the second and third legs;

5 and

sixth interlocking means intermediate the ends of the first leg;

wherein the fifth interlocking means of one web member is interlocked with the sixth interlocking means of an adjacent like web member.

Viewed from another aspect, the present invention provides a modular system
10 for the construction of a lattice panel for a structure, comprising an elongate first chord member, an elongate second chord member and a plurality of web members for attachment to the chord members so as to hold them apart transversely, which is characterised in that each web member comprises three legs forming a triangle, a first leg extending perpendicularly between the chord members, and second and third legs
15 being joined to each other and to adjacent the ends of the first leg, and in that there are provided the following means which are for interlocking each web member to the chord members and to like web members:

first interlocking means adjacent one end of the first leg which is for interlocking with corresponding second interlocking means provided at intervals along
20 the first chord member;

third interlocking means adjacent the other end of the first leg for interlocking with corresponding fourth interlocking means provided at intervals along the second chord member;

fifth interlocking means adjacent the join between the second and third legs;

25 and

sixth interlocking means intermediate the ends of the first leg; wherein the fifth interlocking means of one web member is adapted to be interlocked with the sixth interlocking means of an adjacent like web member; wherein:

the second and third legs are joined together by a junction unit which receives
30 the ends of both legs, the junction unit comprising a plate parallel to the longitudinal direction of the first leg carrying the fifth interlocking means and apertures, and the sixth interlocking means is provided on a plate parallel to the longitudinal direction of the first leg provided with apertures aligned with the apertures in the plate, the apertures being adapted to receive fasteners for securing the web member to an
35 adjacent like web member; and wherein:

one of the fifth and six interlocking means comprises a spigot projecting in the longitudinal direction of the lattice panel and the other of the fifth and sixth interlocking means comprises a recess for receiving the spigot.

Viewed from another aspect, the present invention provides a modular system
5 for the construction of a lattice panel for a structure, comprising an elongate first chord member, an elongate second chord member and a plurality of web members for attachment to the chord members so as to hold them apart transversely, which is characterised in that each web member comprises three legs forming a triangle, a first leg extending perpendicularly between the chord members, and second and third legs
10 being joined to each other and to adjacent the ends of the first leg, and in that there are provided the following means which are for interlocking each web member to the chord members and to like web members:

first interlocking means adjacent one end of the first leg which is for interlocking with corresponding second interlocking means provided at intervals along
15 the first chord member;

third interlocking means adjacent the other end of the first leg for interlocking with corresponding fourth interlocking means provided at intervals along the second chord member;

fifth interlocking means adjacent the join between the second and third legs;
20 and

sixth interlocking means intermediate the ends of the first leg;
wherein the fifth interlocking means of one web member is adapted to be interlocked with the sixth interlocking means of an adjacent like web member; wherein:

the first leg is provided at each end with a junction unit, a first junction unit
25 being attached to the third leg and having the first interlocking means which is for interlocking to the first chord member and a second junction unit being attached to the second leg and having the third interlocking means which is for interlocking to the second chord member; and wherein

each first chord member is a continuous member provided with a plurality of the
30 second interlocking means at intervals along its length so as to be adapted for attachment to a plurality of the web members, and each second chord member is a continuous member provided with a plurality of the fourth interlocking means at intervals along its length so as to be adapted for attachment to a plurality of the web members.

35 Viewed from another aspect, the invention provides a lattice panel constructed from either of the modular systems set out above, comprising the first and second chord

members and a plurality of the web members connected to the chord members and to each other. Viewed from another aspect the invention provides a structural member comprising a plurality of such lattice panels joined end to end, with the first chords of adjacent panels connected together, the second chords of adjacent panels connected
5 together, and a web member of one panel being connected to a web member of an adjacent panel by means of the fifth interlocking means of the web member of one panel being interlocked with the sixth interlocking means of the web member of the other panel. Viewed from another aspect, the invention provides a structure comprising such a structural member.

10 Viewed from another aspect, the invention provides a prefabricated web member for use as the web member in either modular system as described above comprising three legs forming a triangle, wherein:

a first leg comprises an elongate member having at each end respective first and second mounting plates perpendicular to the axis of the first leg, one mounting plate
15 being provided with the first interlocking means for connection to a first chord member and with at least one aperture to receive a fastener to secure the mounting plate to the first chord member, and the other mounting plate being provided with the third interlocking means for connection to a second chord member and with at least one aperture to receive a fastener to secure the mounting plate to the second chord member;

20 the second and third legs extend at an acute angle from adjacent the ends of the first leg to a junction where there is provided a third mounting plate whose plane is parallel to the longitudinal direction of the first leg, the third mounting plate being provided with the fifth interlocking means for connection to another web member and with at least one aperture to receive a fastener to secure the mounting plate to the other
25 member; and

the first leg is provided with a fourth mounting plate intermediate its ends whose plane is parallel to the longitudinal direction of the first leg, the plate being provided with the sixth interlocking means for connection to the fifth interlocking means of another web member, and also being provided with at least one aperture to
30 receive a fastener to secure the plate to the other web member.

As regards web members which comprise three legs forming a triangle, US Patent 3,835,612 discloses a scaffolding system, comprising bracing frames and vertical uprights, the vertical uprights having coupling means enabling the uprights to be fitted one above another, and lateral engaging means for the engagement of the
35 bracing frames. The bracing frames include complementary engaging means adapted to cooperate with the lateral engaging means of adjacent vertical uprights. Each bracing

frame comprises at least one connecting cross member having an end comprising securing means adapted to be secured directly to an adjacent bracing frame. At least some of the bracing frames comprise two skew connecting cross-members which cooperate with a horizontal cross-member to form a triangle lying between immediately adjacent vertical uprights, the securing means being located at the corner of a triangle
5 where said skew connecting cross-members meet.

In use of the present invention, a lattice panel can be constructed with upper and lower chord members and a lattice of web members providing vertical legs extending between and connected to the chord members, and inclined legs which are joined to the vertical legs of adjacent web members. Such an arrangement provides a strong lattice
10 panel.

It is a simple matter to provide lattice panels of desired lengths, by selecting chord members of appropriate lengths and a corresponding number of web members. To cover a certain distance it may be possible to use a single panel constructed from the modular components with long chord members, rather than two or more standard lattice
15 panels joined end to end. From a manufacturing point of view, it is preferable to fabricate and store the modular components capable of forming lattice panels of various lengths, rather than complete lattice panels of various lengths. Furthermore, the conventional joints between lattice panels, typically involving forged components, are
20 expensive. The ability to construct longer panels, simply and from prefabricated components, reduces the total number of panels required for a particular job and thus the number of expensive joints. The end user will also have fewer inter-panel joints to assemble if longer panels can be used.

The fabrication of the lattice panels may be carried out at a manufacturing site
25 once an order is received, for shipment to a place of use. Alternatively, the modules may be shipped to the end user for assembly into panels on-site. This may be preferable from a shipping point of view. It may also be possible for the chord members to be manufactured locally if their design is simple enough, this being discussed below, so that only the web members have to be shipped.

30 It is known for the upper chords of lattice panels to be joined by simple compression joints, for example using abutting flanges and threaded fasteners. These chords can be made on site relatively easily. The lower chord joints are in tension and conventionally they have been in the form of pin joints which provide the required tensile strength whilst being relatively quick and simple to assemble. The pin joints are
35 expensive, forged items, and it is less feasible to manufacture the lower chords on site. In accordance with the present invention, however, it is practical to use longer chords

and fewer chord joints. For example, a panel in accordance with the invention may be between three and four times the length of a conventional panel. It is thus feasible to use alternative chord joints for the lower chords, which are cheaper and easier to manufacture even though it may take longer to join two chords. Thus, in one proposed
5 arrangement the lower chord joints are provided by splice plates and several threaded fasteners. An advantage of such a simple joint is that the chords only need to be provided with apertures for the fasteners and it is a more practical proposition for the chords to be made on site.

There may be a number of different chords that can be used. For example, a
10 stronger chord could be provided if required. This could be only at suitable positions, such as at the centre of a bridge span. This avoids the need to take a standard lattice panel and add a reinforcing chord to it. It is also possible to introduce camber by using chords of different lengths at the top and bottom of a panel. A longer upper chord will introduce positive camber, resisting the tendency of a bridge to sag in the middle.

15 The interlocking means should be such that the modules can be assembled in the required orientation and also provide for the transfer of forces. In a preferred embodiment, where two interlocking means interlock, there is provided a male spigot on one member and a matching female recess, for example in the form of an aperture, on the other member. For any interlock there may be one, two, three, four or more such
20 spigots and matching recesses. There may also be fasteners such as threaded bolts secured by nuts to clamp the components together, although the primary purpose of such threaded fasteners will generally not be to transfer forces. In one preferred form, the first and third interlocking means, at opposite ends of the first leg of the web member, comprise spigots. This means that the chords only need to have apertures to
25 constitute the corresponding second and fourth interlocking means. This again helps in simplifying the design of the chords, reducing manufacturing costs and also making it feasible for them to be manufactured on site. However, if desired, reinforcing components could be attached to the chords to receive the spigots.

The fifth and sixth interlocking means, which are provided to join the web
30 members together, preferably also comprise spigots and recesses. For ease of manufacture, at least one of the interlocking means may be provided on a cast member.

In general, the philosophy behind the preferred implementation of the invention is to keep the chords and their joints as simple as possible, and to concentrate the more complex and / or expensive structures on the web members. The design of the modular
35 web member may lend itself to robotic construction, something which has not been

considered feasible with the construction of entire lattice panels from individual components.

A web member may be in the form of an isosceles triangle, with the second and third legs of equal length. In such an arrangement, the sixth interlocking means will be
5 arranged on the mid point of the first leg and the fifth interlocking means, where the second and third legs meet, will be aligned with this. In one preferred arrangement, the angle that each of the second and third legs makes with the first legs is about 45° , so that the width of a web member is about one half of its height, i.e. the extent of the first leg which extends perpendicularly between the chord members. By using a web
10 member with a longer first leg, it is possible to construct a deeper lattice panel. Preferably, when this is done the angles between the first leg and the second and third legs are preferably reduced to retain the same width for the web member so that it will remain compatible with the same chords, decks and other components used with other web members. In general, the angle between the first leg and the second / third legs is
15 preferably in the range of 35° to 45° . In preferred embodiments, this range can provided panels in the range of about 15 feet (about 4.5 m) to about 23 feet (about 7 m) high. Conventional Bailey bridge panels are frequently stacked on each other to increase height, and apart from anything else this doubles the number of chord joints that have to be made.

20 It will be appreciated that in a practical arrangement the triangle may not be perfect and that the legs might not consist solely of members which meet immediately adjacent their ends, for example. Thus, in one preferred arrangement the second and third legs may be joined together by a junction unit which receives the ends of both legs and is provided with the fifth interlocking means. Similarly, the first leg may
25 comprise a member which is joined at each end to a junction unit. These are respectively attached to the second and third legs, and have the first and third interlocking means for connection to the chord members.

A typical chord member for use in accordance with the present invention be of H section. Such a section will effectively define a pair of channels. One end of a first
30 leg of a web member (in practice, a junction unit) will be received within one channel section of an upper chord, and the other end of the first leg will be received within one channel section of a lower chord.

The web member first legs may each comprise a pair of spaced, parallel elements. These will help to resist outwards deflection of the chords, and in particular
35 the upper chord when a panel is used in a bridge. The spaced elements are preferably tube members, as indeed are the legs of the web members generally. The use of such

web members, resistant to deflection, means that there will normally need to be only one line of panels along a side of a bridge, with only a single upper chord and a single lower chord. Frequently in traditional Bailey bridge structures it is necessary to have twin lines of panels. This therefore doubles the number of chord joints and this is
5 another reason why in preferred embodiments of the present invention it is feasible to use chord joints which, individually, take longer to assemble. The preferred web members, being more resistant to deflection, may also make it unnecessary to use additional lateral struts which are frequently used in conventional Bailey bridge structures.

10 The chord members may be provided with any suitable means for interconnecting them to the chord members of adjacent panels. This include male and female pin joint portions, for receiving either vertical or horizontal pins; apertured plates for receiving bolts or other suitable fasteners as disclosed in GB-A-2 251 018 for example; or any other suitable means. However, as noted earlier, a preferred joint for
15 the upper chords is a compression joint using flanges and fasteners, and a preferred joint for the lower chords is a tension joint using splice plates and fasteners. This also has the advantage that such a joint may more resistant to fatigue, as it does not require the use of welding to attach forged pin joint components to the chords.

When a lattice panel is constructed using the chord members and web members
20 as described above, at one end there may be the second and third legs of a web member projecting beyond the ends of the chords; and at the other end there will then be a first leg of another web member positioned inwardly of the ends of the chords. Joining two lattice panels together will involve joining the upper and lower chords together, and also joining the projecting web member to the web member of the adjacent panel.

25 For use in a bridge or similar structure, preferably the first leg of a web member is provided with means for attachment to a transom which will support a deck. The connection between the leg and the transom may be by means of a spigot and recess, for example a trapezoidal cross section recess on the first leg and a matching spigot on the transom. In practice, it may only be necessary to attach a transom to alternate web
30 members. The web members which are not to be attached to transoms may not be provided with the necessary attachment means, and they may even have lighter first legs as they will be required to withstand less stress than the first legs of the other web members. Where s transom is attached, the upright first legs form the uprights of a stress transmitting "U". At the ends of a structure, there could be stronger web members
35 with sturdier upright legs and if desired also sturdier diagonal legs, to account for increased shear forces. These end web members could be provided with means for

attachment to transoms. Other web members could be provided for various purposes as required. For example, a special web member adapter could be provided so that a bridge can be launched using a conventional launcher nose used with current Bailey type bridges.

5

Some embodiments of the invention will now be described by way of example and with reference to the accompanying drawings in which :

Figure 1 is a perspective view of a web member for use in a system in accordance with the invention;

10 Figure 2 is a side view of part of the web member in the region A marked on Figure 1;

Figure 3 is an underneath plan view of part of an upper chord used in the system;

Figure 4 is a section through the part of the upper chord;

15 Figure 5 is a section through part of a lower chord;

Figure 6 is a side view of a lattice panel using the web members and chords;

Figure 7 is a perspective view of part of a bridge constructed using a number of the lattice panels;

Figure 8 is a perspective view of a modified web member;

20 Figure 9 is a plan view of an upper chord for use with the web member of Figure 8;

Figure 10 is an end view of the chord of Figure 9;

Figure 11 is a plan view of a lower chord for use with the web member of Figure 8;

25 Figure 12 is an side view of the chord of Figure 11;

Figure 13 is perspective view of an end post for use in a system with the components of Figures 8 to 12; and

Figure 14 is a perspective view of part of a bridge using the components of Figures 8 to 13.

30 In figure 1 a steel web member 1 is of generally triangular shape, having an elongate upright leg 2 and two legs 3 and 4 of equal length, inclined at about 45° to the upright leg. The upright leg 2 comprises a pair of spaced, parallel, square section tubes 5 and 6. At the upper end of the leg 2 is a junction unit 7 which is welded between the tubes 5 and 6. This includes a pair of spaced vertical plates 8 between which is welded
35 the end of leg 4, and a horizontal plate 9. The plane of horizontal plate 9 is therefore perpendicular to the elongate axis of upright leg 2. The plate 9 has three apertures 10

for receiving fasteners, and a large central aperture 11 for receiving a locating lug to interlock the web member to an upper chord. At the lower end of the upright leg 2 is a corresponding junction unit 12, which receives the end of leg 3 and is adapted to be connected to a lower chord. This has a plate and apertures corresponding to those in the
5 upper unit 7.

The other ends of legs 3 and 4 are received by a third junction unit 13. this comprises a pair of spaced vertical plates 14, between which the ends of the legs are welded, and a vertical plate 15. The vertical plate 15 comprises a pair of apertures 16 for receiving fasteners, and three large, vertically spaced apertures 17 for receiving
10 locating lugs on a like web member. The junction unit 13 is positioned vertically mid way relative to the upright leg 2.

Mid way up the upright leg 2 is provided a mounting plate 18, welded to the tubes 5 and 6. With reference to Figure 2, this is provided with three vertically spaced lugs 19 which are adapted to mate with the apertures 17 on a plate 15 of a like member.
15 Apertures 220 are provided, to be aligned with apertures 16 on the plate 15 of a like member, so that the two plates 18 and 15 can be secured together, e.g. by means of threaded fasteners and nuts, and thus two web members joined together.

Figure 3 is an underneath view of part of a steel upper chord 20 of H section, and Figure 4 is a section through part of the chord. Spaced along the upper chord 20 at
20 equal intervals are location means in the form of plates 21. Each plate 21 has three apertures 22 for receiving threaded fasteners, and a downwardly projecting lug 23. The lug 23 is configured to locate inside the aperture 11 in plate 9, on the end of leg 2 of a web member. The apertures 22 will then be aligned with the apertures 10 in the plate so that the web member can be attached to the upper chord by means of nuts and bolts.

25 The junction unit 7 on the web member fits in the space between the flanges 24 and 25 of the lower part of the "H" section of the upper chord 20. At each end of the upper chord there is provided a transverse plate 26 which is apertured at 27 (Figure 7) so that two chords of adjacent panels can be joined together by abutting the plates 26 and securing them by means of bolts passing through the apertures.

30 Figure 5 shows a lower chord 28 in section, this also being a steel H section member. This has plates 29 spaced at equal intervals along its length, defining lugs 30 and apertures 31. These are adapted to cooperate with corresponding apertures in the lower junction unit 12 of the leg 2 of a web member, in the same way that the upper unit 7 is secured to the upper chord 20. In this manner a web member 1 can be secured
35 between the upper and lower chords, with the upright leg 2 extending perpendicularly between them.

It will be appreciated that in the above arrangement, the web members are secured to the transverse portions of the "H" section upper and lower chords. This means that the width of the chords can be varied, for example so as to increase or decrease their strength, without affecting the connections with the web members. With
5 a conventional structure, the web forming members are frequently connected to the vertical flanges forming the legs of the H section chords. Thus, in such conventional arrangements, varying the widths of the chords would vary the spacing between the flanges to which the web forming members need to be attached. It will also be appreciated that with the new arrangement described above, it is possible to use a single
10 chord with web members of different widths, provided they fit in the space between the vertical flanges.

It is possible to mix the widths of the chords used in a particular bridge, for example to increase strength where there is high loading. It should be noted that the compression type of joint used on the upper chords facilitates this. Apertures can be
15 aligned in the transverse end plates 26 of the upper chords, even if the overall widths are different.

The lower chord has pin joint portions at its end for joining to adjacent lower chords, in this arrangement comprising a pair of male portions 32 at one end (Figures 6 and 7) and a pair of female portions 33 at the other end. The portions can be joined
20 together by vertical pins 34 (Figure 7).

Figure 6 is a side view of a lattice panel 35 comprising upper chord 20, lower chord 28 and four web members 1. Each of these is joined to the chords as described above, so that the upright legs 2 extend substantially perpendicularly between the chords. The web members 1 are also joined to each other. The lugs 19 on the upright
25 leg 2 of one web member are engaged in the apertures 17 of the junction unit 13 of an adjacent panel, and the web members are joined together by nuts and bolts through the mating apertures 16 and 20.

To construct a bridge member, a number of panels 35 are joined end to end. The plates 26 of adjacent upper chords, and the pint joint portions 32 and 33 of adjacent
30 lower chords are joined as described above. In addition, the junction unit 13 of the protruding web member of one panel mates with the lugs 19 of the adjacent panel, and the two web members are joined together as described above.

As shown in Figure 7, a number of panels 35 are joined together end to end to form a left hand side member of a bridge, and a number are also joined together end to
35 end to form a right hand side member. Transverse supports 36 are attached to the panels, by means of junction blocks 37 which are provided on each upright web

member leg 2, welded between the tubes 5 and 6. The transverse supports are secured by threaded fasteners. Decking 38 is laid over the transverse supports 36. The junction blocks 37 have trapezoidal recesses which receive spigots on the transverse supports. As a threaded fastener is tightened, it urges a spigot into the tapered trapezoidal recess thus tightening the engagement between the spigot and recess. This reduces play in the connection between the transverse supports 36 and the web members and reduces misalignment. Misalignment can reduce the stability of the upper chord in particular.

As described above, four web members 1 are used for each panel 35. However, longer or shorter chords can be used, and more or fewer web members, so as to produce panels of different lengths.

Figures 8 to 14 illustrate a modified system. Many components are the same and their description is not repeated. Figure 8 shows a modified web member 40 with legs 41, 42 and 43. At either end of leg 41 are interlocking means 44 and 45 for use with upper and lower chords respectively. Each interlocking means is provided with four spigots 46 and three apertures 47 for receiving fasteners. Figure 9 shows an upper chord 48 for use with the modified web member 40. Along its length are interlocking means each comprising four apertures to receive spigots 46 and three apertures to match apertures 47 and receive threaded fasteners. As shown in Figure 10, the end of the chord member is provided with a plate 51 having apertures 52, so that it can be attached to a like chord to form a compression joint.

Figure 11 shows a bottom chord 53 which like chord 48 has interlocking means along its length comprising apertures 54 to receive spigots of interlocking means 45 of the web member 40 and apertures 55 to receive threaded fasteners. At its end it is provided with twelve apertures 56 and twelve side apertures 57 (Figure 12) so that it can be attached to a like chord by a splice plate and fasteners passing through the apertures.

Figure 13 shows an end post 58 for use in a system with web member 40 and chords 48 and 53. It has the same interlocking means 59, 60 at its ends. It also has additional connectors 61 which can be used to attach a launch "nose" of a conventional type for when a bridge is being pushed out over a river or the like.

Figure 14 shows part of a bridge 62 using the components of Figures 8 to 13. It shows web members 40, upper chords 48 joined at 63, lower chords 53 joined at 64, end posts 58, transoms 65 extending between the web members and between the end posts, and part of a deck 66 laid on the transoms.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

1. A bridge constructed from a modular system and comprising a horizontally extending structural member formed by a plurality of lattice panels joined end to end, each lattice panel comprising an elongate upper chord member, an elongate lower chord member and a plurality of web members attached to the chord members and holding them apart in a vertical direction, characterised in that each web member comprises three legs forming a triangle, a first leg extending perpendicularly between the chord members, and second and third legs being joined to each other and to adjacent the ends of the first leg, and in that there are provided the following means which interlock each web member to the chord members and to like web members:

first interlocking means adjacent the upper end of the first leg which interlocks with corresponding second interlocking means provided at intervals along the upper chord member;

third interlocking means adjacent the lower end of the first leg which interlocks with corresponding fourth interlocking means provided at intervals along the lower chord member;

fifth interlocking means adjacent the join between the second and third legs; and

sixth interlocking means intermediate the ends of the first leg;

wherein the fifth interlocking means of one web member is interlocked with the sixth interlocking means of an adjacent like web member.

2. A bridge as claimed in claim 1, wherein the web member is in the form of an isosceles triangle, with the second and third legs of equal length.

3. A bridge as claimed in claim 2, wherein each of the second and third legs is inclined to the first leg at an angle of between about 35° to 45°.

4. A bridge as claimed in claim 1, 2 or 3 wherein the second and third legs are joined together by a junction unit which receives the ends of both legs and is provided with the fifth interlocking means.

5. A bridge as claimed in any preceding claim, wherein the first leg is provided at each end with a junction unit, one junction unit being attached to the third leg and having the first interlocking means which is interlocked to the upper chord member, and one junction unit being attached to the second leg and having the third interlocking means which is interlocked to the lower chord member.

6. A bridge as claimed in any preceding claim wherein one of the first and second interlocking means comprises a spigot and the other comprises a recess adapted to receive the spigot.

7. A bridge as claimed in claim 6, wherein said one of the first and second interlocking means comprises a plurality of spigots.

8. A bridge as claimed in claim 6 or 7, wherein the said one of the first and second interlocking means is the first interlocking means.

9. A bridge as claimed in claim 6, 7 or 8 wherein the web member and the upper chord member further comprise aligned apertures which receive fasteners securing the web member to the upper chord member.

10. A bridge as claimed in any preceding claim wherein one of the third and fourth interlocking means comprises a spigot and the other comprises a recess adapted to receive the spigot.

11. A bridge as claimed in claim 10, wherein said one of the third and fourth interlocking means comprises a plurality of spigots.

12. A bridge as claimed in claim 10 or 11, wherein the said one of the third and fourth interlocking means is the third interlocking means.

13. A bridge as claimed in claim 10, 11 or 12, wherein the web member and the lower chord member further comprise aligned apertures which receive fasteners securing the web member to the lower chord member.

14. A bridge as claimed in any preceding claim wherein one of the fifth and sixth interlocking means comprises a spigot and the other comprises a recess adapted to receive the spigot.

15. A bridge as claimed in claim 14, wherein the fifth interlocking means comprises the aperture and the sixth interlocking means comprises the spigot.

16. A bridge as claimed in claim 14 or 15, wherein there are further provided aligned apertures adjacent the fifth and sixth interlocking means which receive fasteners securing one web member to an adjacent web member.

17. A bridge as claimed in claim 14, 15 or 16, wherein one of the fifth and sixth interlocking means comprises a plurality of vertically spaced spigots and the other comprises a corresponding plurality of apertures adapted to receive the spigots.
18. A bridge as claimed in any preceding claim, wherein the first leg of the web member comprises a pair of parallel, spaced elements.
19. A bridge as claimed in claim 18, wherein the sixth interlocking means is provided on a plate connected to the spaced elements.
20. A bridge as claimed in claim 18 or 19, wherein the spaced elements are tubular.
21. A modular system for the construction of a lattice panel for a structure, comprising an elongate first chord member, an elongate second chord member and a plurality of web members for attachment to the chord members so as to hold them apart transversely, characterised in that each web member comprises three legs forming a triangle, a first leg extending perpendicularly between the chord members, and second and third legs being joined to each other and to adjacent the ends of the first leg, and in that there are provided the following means which are for interlocking each web member to the chord members and to like web members:
- first interlocking means adjacent one end of the first leg which is for interlocking with corresponding second interlocking means provided at intervals along the first chord member;
 - third interlocking means adjacent the other end of the first leg for interlocking with corresponding fourth interlocking means provided at intervals along the second chord member;
 - fifth interlocking means adjacent the join between the second and third legs;
 - and
 - sixth interlocking means intermediate the ends of the first leg;
- wherein the fifth interlocking means of one web member is adapted to be interlocked with the sixth interlocking means of an adjacent like web member; wherein:
- the second and third legs are joined together by a junction unit which receives the ends of both legs, the junction unit comprising a plate parallel to the longitudinal direction of the first leg carrying the fifth interlocking means and apertures, and the sixth interlocking means is provided on a plate parallel to the longitudinal direction of the first leg provided with apertures aligned with the apertures in the plate, the

apertures and being adapted to receive fasteners for securing the web member to an adjacent like web member; and wherein:

one of the fifth and six interlocking means comprises a spigot projecting in the longitudinal direction of the lattice panel and the other of the fifth and sixth interlocking means comprises a recess for receiving the spigot.

22. A modular system as claimed in claim 21, wherein the first leg is provided at each end with a junction unit, a first junction unit being attached to the third leg and having the first interlocking means which is for interlocking to the first chord member, and a second junction unit being attached to the second leg and having the third interlocking means which is for interlocking to the second chord member.

23. A modular system as claimed in claim 22 wherein the first junction unit comprises a plate perpendicular to the axis of the first leg carrying the first interlocking means and apertures for alignment with apertures in the first chord member, the apertures being for receiving fasteners to secure the web member to the first chord member; and wherein the second junction unit comprises a plate perpendicular to the axis of the first leg carrying the third interlocking means and apertures for alignment with apertures in the second chord member, the apertures being for receiving fasteners to secure the web member to the second chord member.

24. A modular system for the construction of a lattice panel for a structure, comprising an elongate first chord member, an elongate second chord member and a plurality of web members for attachment to the chord members so as to hold them apart transversely, characterised in that each web member comprises three legs forming a triangle, a first leg extending perpendicularly between the chord members, and second and third legs being joined to each other and to adjacent the ends of the first leg, and in that there are provided the following means which are for interlocking each web member to the chord members and to like web members:

first interlocking means adjacent one end of the first leg which is for interlocking with corresponding second interlocking means provided at intervals along the first chord member;

third interlocking means adjacent the other end of the first leg for interlocking with corresponding fourth interlocking means provided at intervals along the second chord member;

fifth interlocking means adjacent the join between the second and third legs;
and

sixth interlocking means intermediate the ends of the first leg;

wherein the fifth interlocking means of one web member is adapted to be interlocked with the sixth interlocking means of an adjacent like web member; wherein:

the first leg is provided at each end with a junction unit, a first junction unit being attached to the third leg and having the first interlocking means which is for interlocking to the first chord member, and a second junction unit being attached to the second leg and having the third interlocking means which is for interlocking to the second chord member; and wherein

each first chord member is a continuous member provided with a plurality of the second interlocking means at intervals along its length so as to be adapted for attachment to a plurality of the web members, and each second chord member is a continuous member provided with a plurality of the fourth interlocking means at intervals along its length so as to be adapted for attachment to a plurality of the web members.

25. A modular system as claimed in claim 24 wherein the first junction unit comprises a plate perpendicular to the axis of the first leg carrying the first interlocking means and apertures for alignment with apertures in the first chord member, the apertures being for receiving fasteners to secure the web member to the first chord member; and wherein the second junction unit comprises a plate perpendicular to the axis of the first leg carrying the third interlocking means and apertures for alignment with apertures in the second chord member, the apertures being for receiving fasteners to secure the web member to the second chord member.

26. A lattice panel constructed from a modular system as claimed in any of claims 21 to 25, comprising the first and second chord members and a plurality of the web members connected to the chord members and to each other.

27. A structural member comprising a plurality of lattice panels as claimed in claim 26 joined end to end, with the first chords of adjacent panels connected together, the second chords of adjacent panels connected together, and a web member of one panel being connected to a web member of an adjacent panel by means of the fifth interlocking means of the web member of one panel being interlocked with the sixth interlocking means of the web member of the other panel.

28. A structure comprising a structural member as claimed in claim 27.

29. A prefabricated web member for use as the web member in a modular system as claimed in any of claims 21 to 25, comprising three legs forming a triangle, wherein:

a first leg comprises an elongate member having at each end respective first and second mounting plates perpendicular to the axis of the first leg, one mounting plate being provided with the first interlocking means for connection to a first chord member and with at least one aperture to receive a fastener to secure the mounting plate to the first chord member, and the other mounting plate being provided with the third interlocking means for connection to a second chord member and with at least one aperture to receive a fastener to secure the mounting plate to the second chord member;

the second and third legs extend at an acute angle from adjacent the ends of the first leg to a junction where there is provided a third mounting plate whose plane is parallel to the longitudinal direction of the first leg, the third mounting plate being provided with the fifth interlocking means for connection to another web member and with at least one aperture to receive a fastener to secure the mounting plate to the other member; and

the first leg is provided with a fourth mounting plate intermediate its ends whose plane is parallel to the longitudinal direction of the first leg, the plate being provided with the sixth interlocking means for connection to the fifth interlocking means of another web member, and also being provided with at least one aperture to receive a fastener to secure the plate to the other web member.

30. A web member as claimed in claim 29, wherein one of the fifth and six interlocking means comprises a spigot projecting outwardly from its respective mounting plate and the other of the fifth and sixth interlocking means comprises a recess in its respective mounting plate for receiving the spigot.

31. A web member as claimed in claim 30, wherein the one of the fifth and six interlocking means comprising a spigot comprises a plurality of spigots.

32. A web member as claimed in claim 31, wherein the plurality of spigots are spaced in the longitudinal direction of the first leg.

33. A web member as claimed in claim 30, 31 or 32, wherein the sixth interlocking means comprises a spigot projecting from the plate and the fifth interlocking means comprises a recess in the plate receiving the spigot.

34. A web member as claimed in any of claims 29 to 33, wherein each of the first and third interlocking means comprises an aperture for receiving a spigot.

35. A web member as claimed in any of claims 29 to 33, wherein each of the first and third interlocking means comprises a spigot projecting in the longitudinal direction of the first leg.

36. A web member as claimed in claim 35, wherein each of the first and third interlocking means comprises a plurality of the spigots projecting in the longitudinal direction of the first leg

37. A web member as claimed in any of claims 29 to 36, wherein the first leg of the web member comprises a pair of parallel, spaced elements.

38. A web member as claimed in claim 37, wherein the spaced elements are tubular.

39. A web member as claimed in claim 37 or 38, wherein the fourth mounting plate on which the sixth interlocking means is provided is connected between the spaced elements of the first leg of the web member.

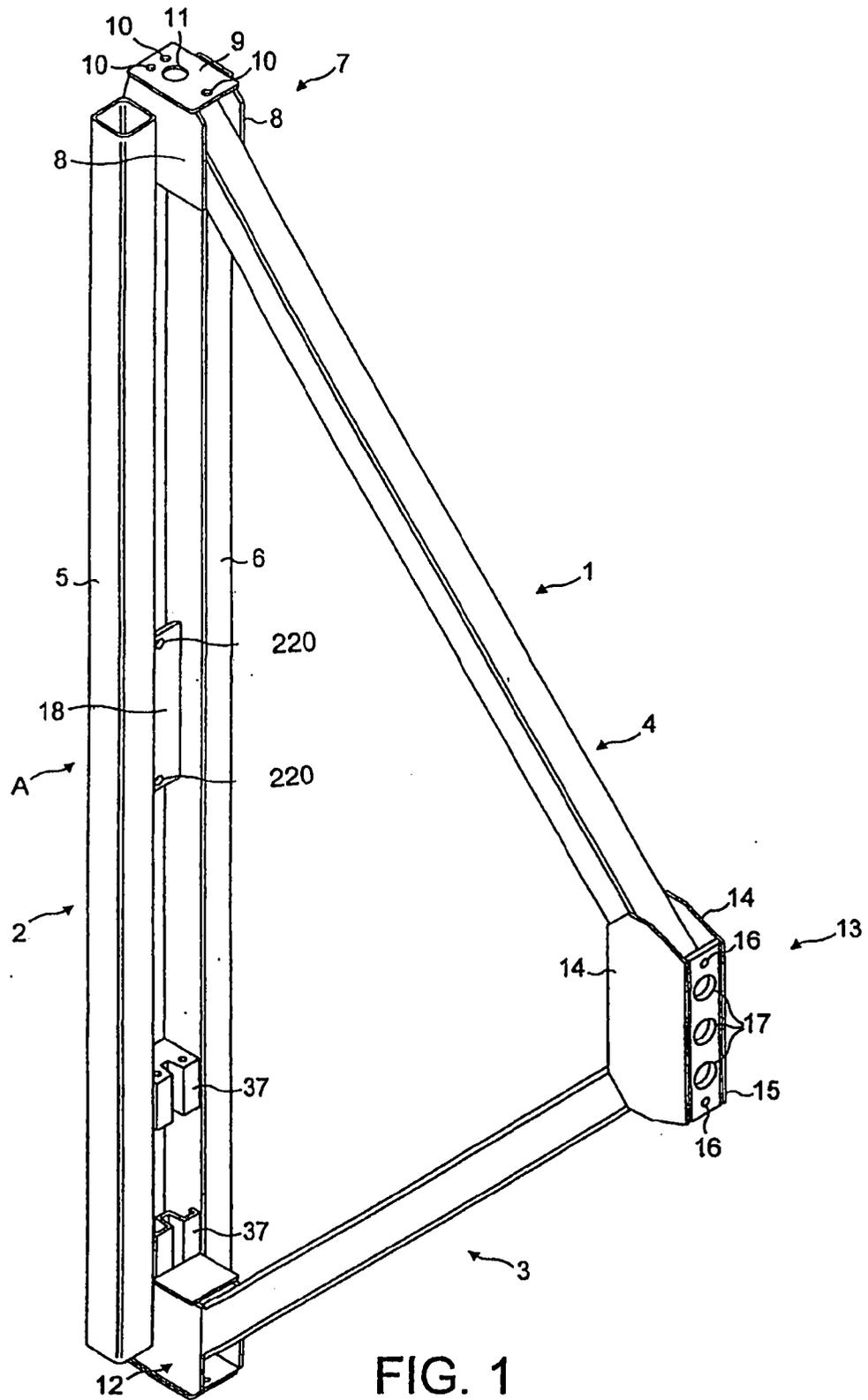


FIG. 1

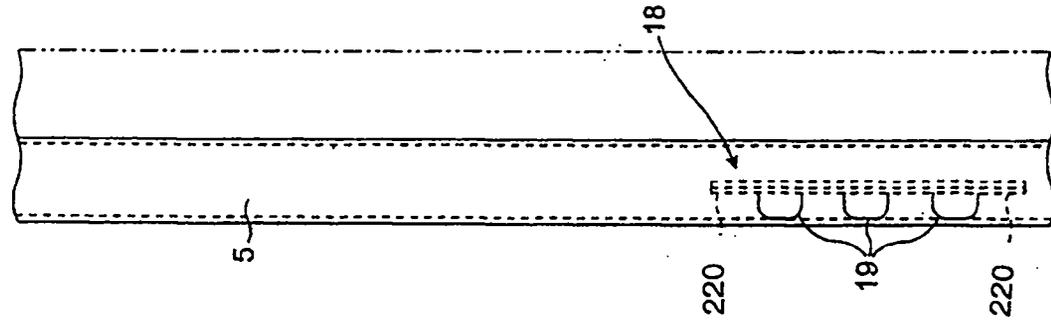


FIG. 2

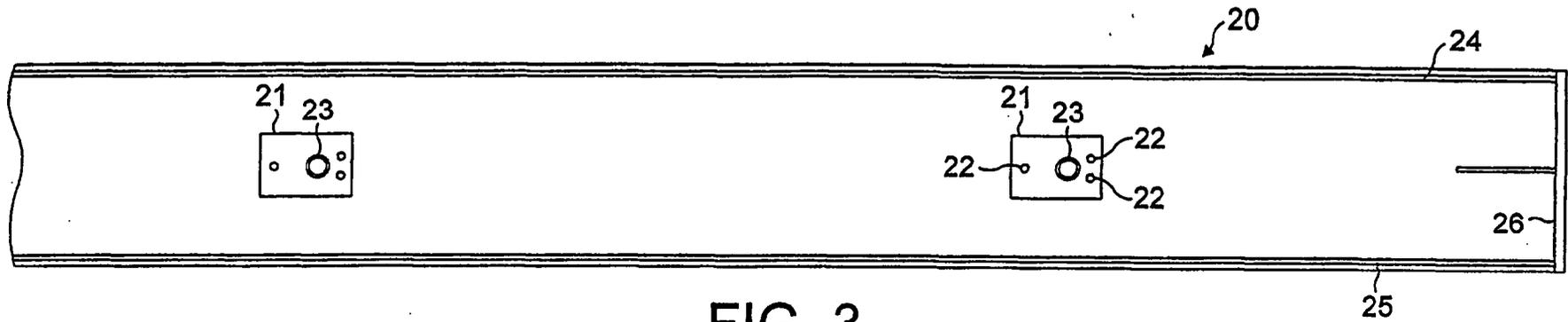


FIG. 3

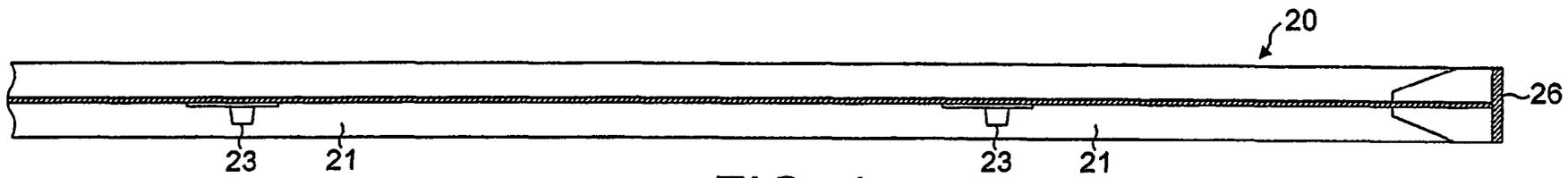


FIG. 4

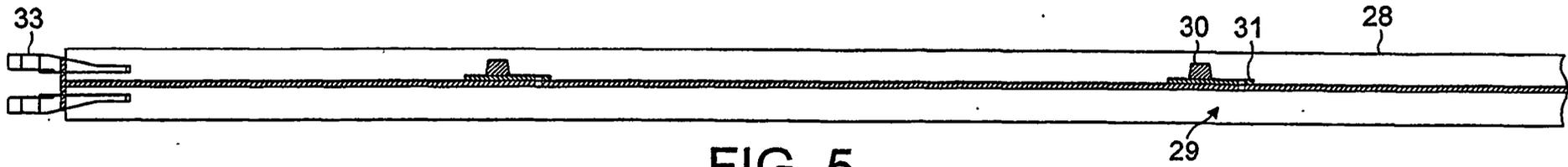


FIG. 5

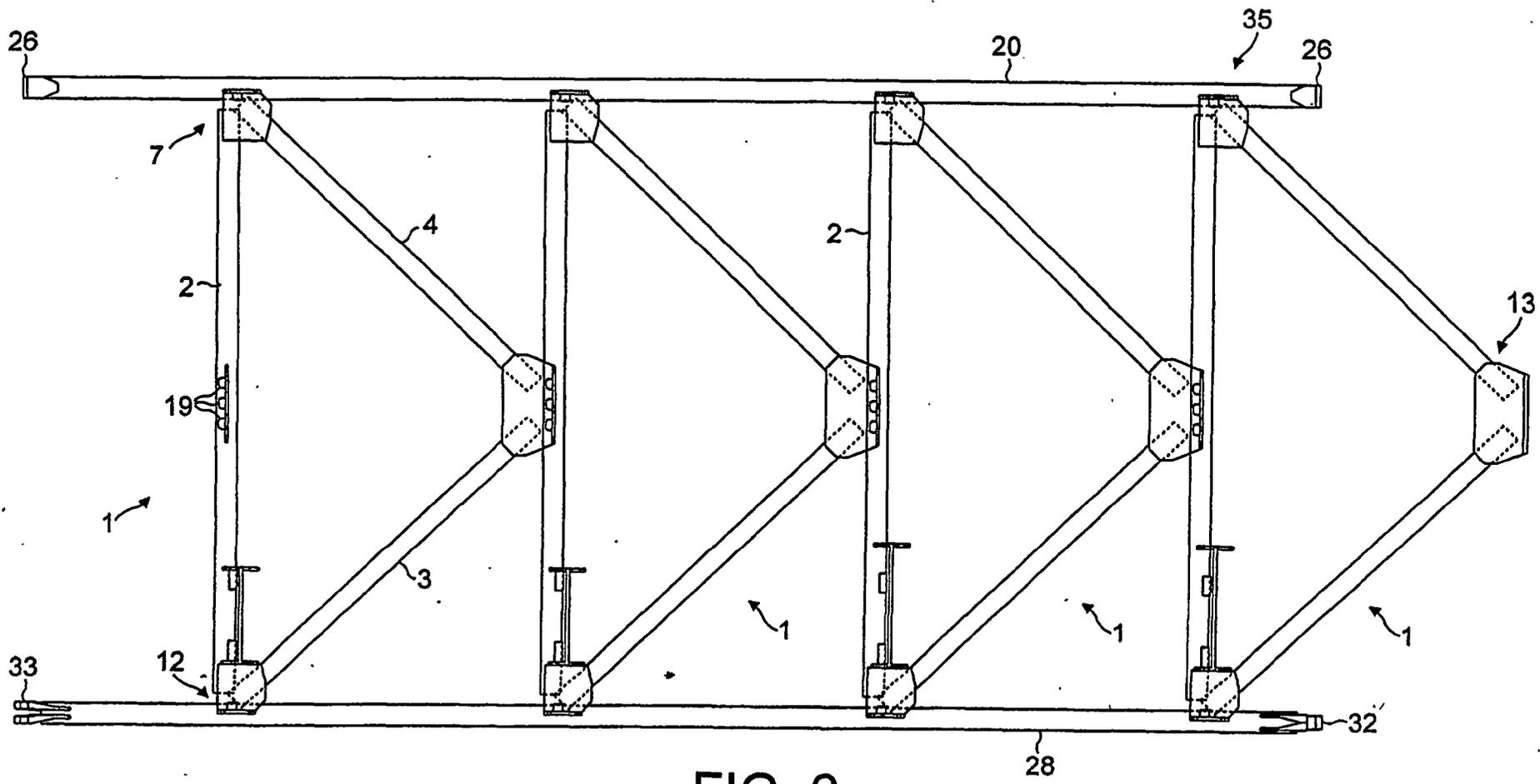


FIG. 6

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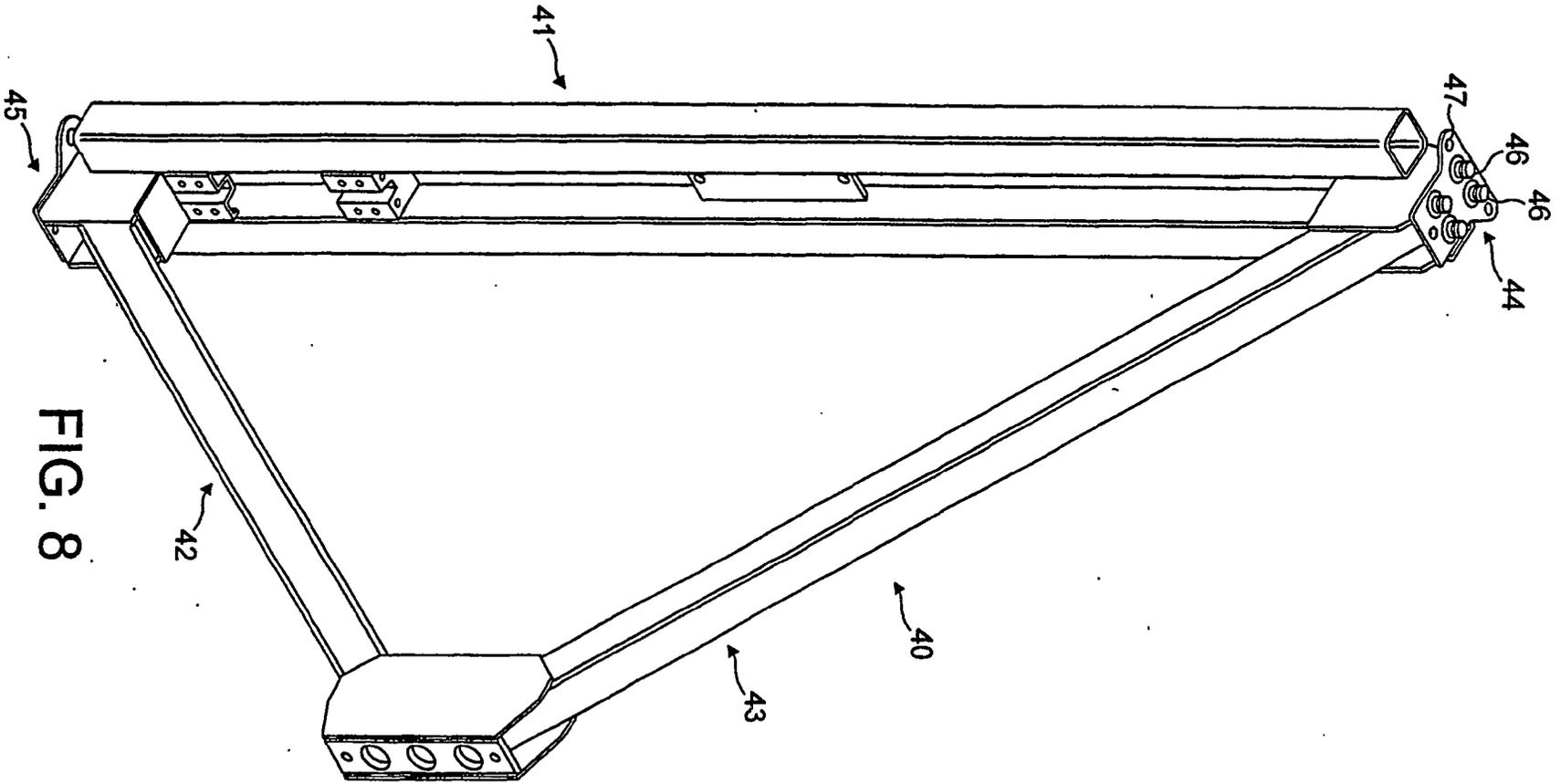


FIG. 8

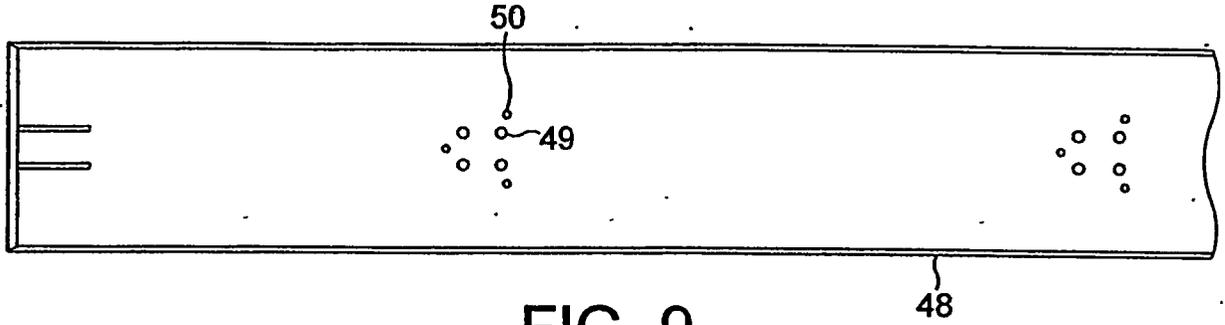


FIG. 9

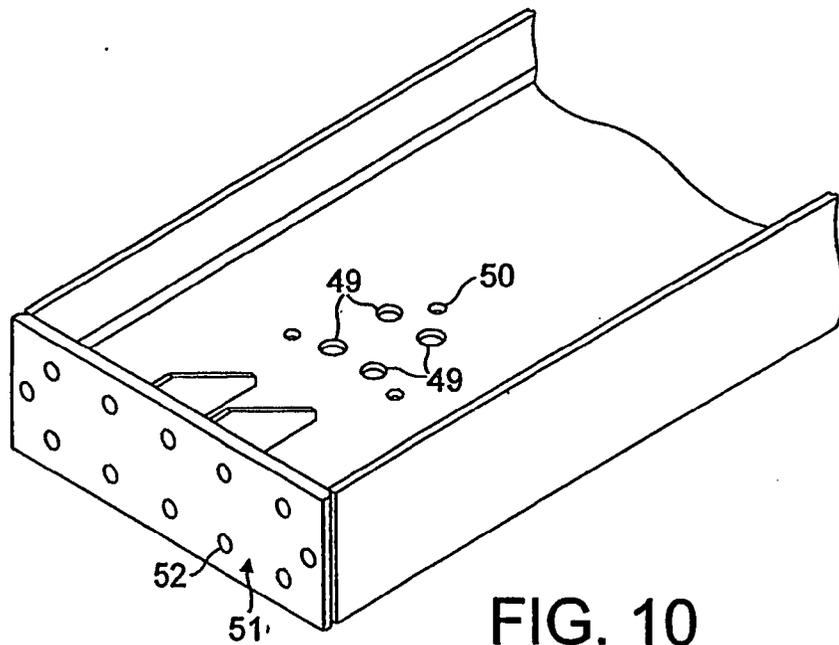


FIG. 10

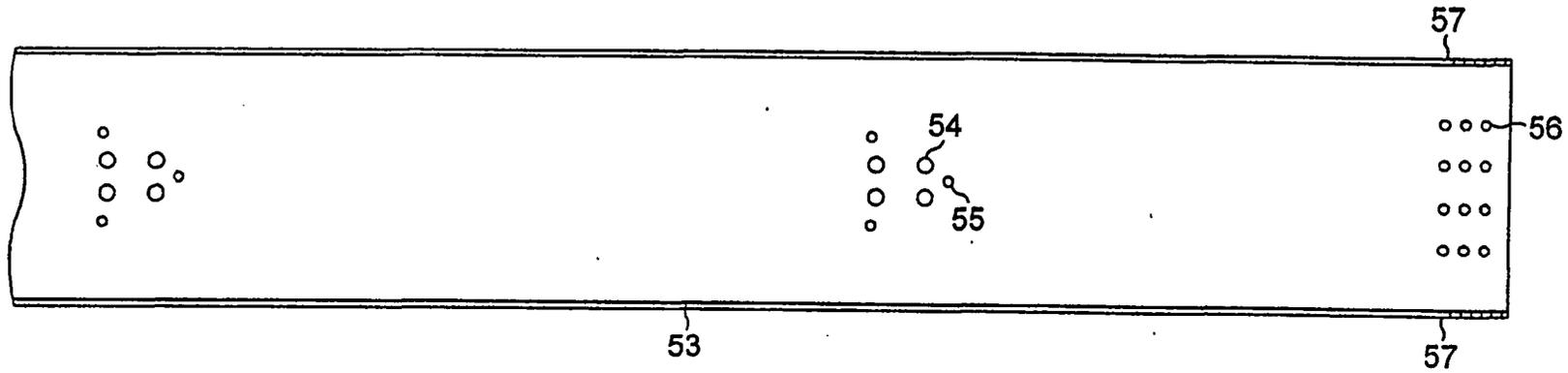


FIG. 11

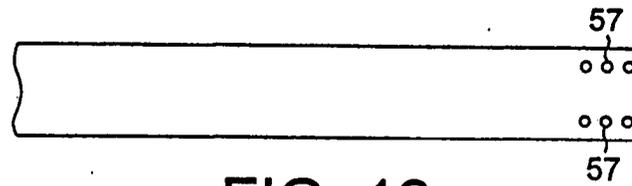


FIG. 12

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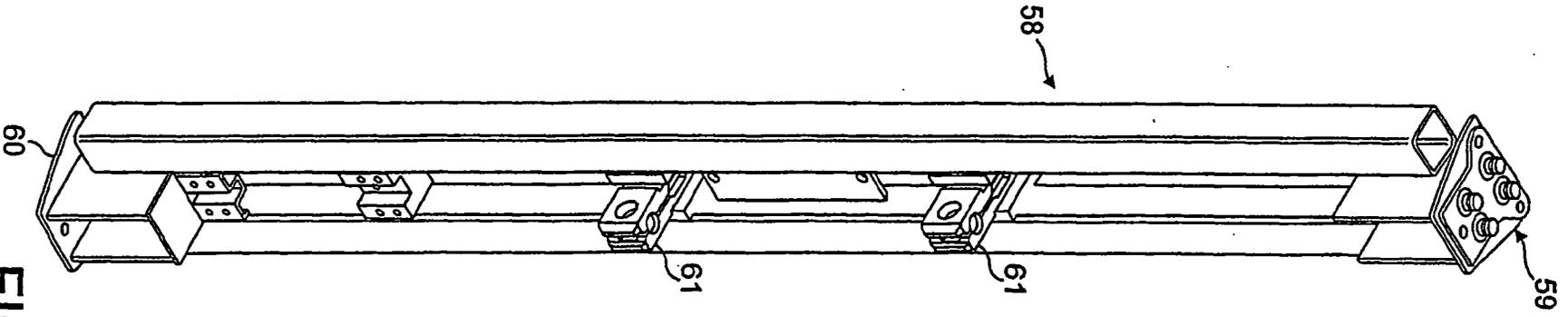


FIG. 13

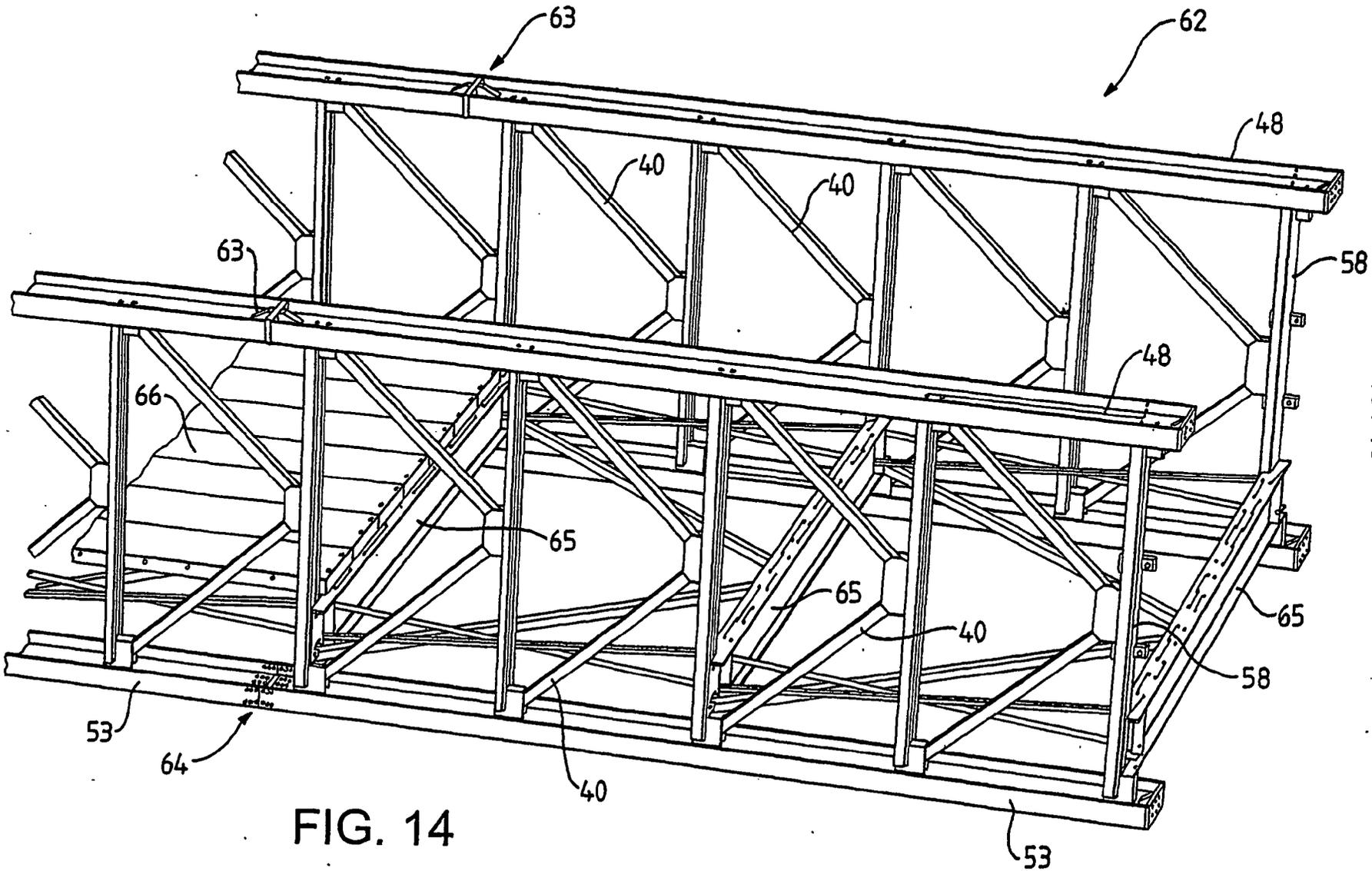


FIG. 14

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