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(54) **Truss connecting means**

(57) The present invention relates to a truss connecting means which includes main tubes and hinged links. The main tubes are connected to each other by the hinged links. The hinged link includes first hinged parts,

second hinged parts, steel pins and a circular tube. Both ends of the circular tube are connected respectively to the second hinged part, while the second hinged part is connected to the first hinged part with the steel pin as the shaft.

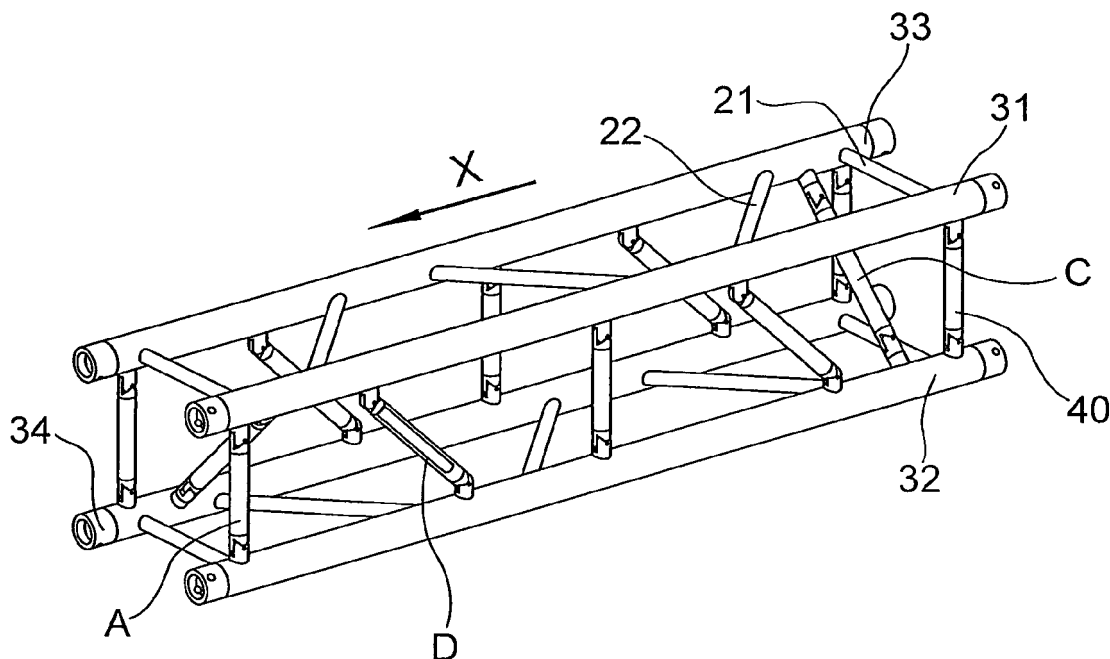


Fig. 19

Description

FIELD OF THE INVENTION

[0001] The present invention relates to the application of metal frames such as stage lighting stands, display racks for exhibition and building structures, etc., in particular, to a truss connecting means respectively carrier, bearer, bearing or supporter connecting means, by which trusses can be folded and/or extended.

BACKGROUND OF THE INVENTION

[0002] A known straight truss and a curved truss are shown in Figure 1 and Figure 2. The aluminium alloy truss is formed by welding four large main tubes and many small additional tubes, with light weight and high strength. Welded at both ends of the main tubes are tapered sockets with tapered pin holes on it; special taper pins and steel pins are used to insure the high strength connection between the trusses as well as the truss and the square joint.

[0003] The shown truss can not be folded due to the fixed connection between the main tube 100 and the additional tube 200. In addition, the distribution and the surface processing of the truss will cost much more than the foldable truss of the present invention, which takes up less volume after being disassembled, and thus saves energy in production. Moreover, after the surface processing is conducted, it will be difficult for the trusses shown in Figure 1 and Figure 2 to be connected together. Even if large trusses are managed to be assembled, it still requires complicated technology and consumes a lot of materials.

[0004] The curved truss, for example, has even larger packing volume, which prohibits its widespread use. However, by adopting the foldable curved truss of the present invention, the packing volume will be significantly reduced, which reduces the cost in production, distribution and other procedures.

SUMMARY OF THE INVENTION

[0005] The object of the present invention is to provide a truss connecting means, by which a truss can be folded and extended.

[0006] To achieve the above object, the present invention provides a truss connecting means which includes main tubes and hinged links, the main tubes are connected by the hinged links, the hinged link includes first hinged parts, second hinged parts, steel pins and a circular tube, both ends of the circular tube are connected respectively to the second hinged part, while the second hinged part is hinged to the first hinged part by the steel pin.

[0007] According to the present invention, a groove can be provided on one end of the first hinged part while a tongue can be provided on one end of the second hinged part, alternatively, a tongue is provided on one

end of the first hinged part and a groove is provided on one end of the second hinged part alternatively, the hinged portions of the first hinged part and the second hinged part are the same, i.e. both are grooves or tongues.

[0008] The truss connecting means can also comprise a rotatable base. At least one end of the first part can be provided with a circular stem having a circular hole, and the circular stem is engaged into the rotatable base by means of a steel pin passing through the circular hole.

[0009] The truss connecting means can also comprise a rotatable base, the outer surface of which is provided with a groove. At least one end of the first part can be provided with a circular stem having a circular hole and the circular stem is engaged into the groove of the rotatable base by means of a steel pin passing through the circular hole.

[0010] The truss connecting means can also comprise an expansion link, at least one end of the expansion link is engaged into the circular tube, a steel pin passes through the circular hole of the circular tube. The other end of the expansion link can be provided with the second hinged part, which is connected with the other end of the circular tube.

[0011] The truss connecting means can also include an expansion link and a rotatable base. In this case at least one end of the first hinged part is provided with a circular stem having a circular hole. The circular stem is engaged into the rotatable base by the steel pin passing through the circular hole. The one end of the expansion link can be engaged into the circular tube; a steel pin passes through the circular hole of the circular tube. The other end of the expansion link is provided with the second hinged part, which is connected with the other end of the circular tube.

[0012] The truss connecting means can also include an expansion link and a rotatable base, and the outer surface of the rotatable base can be provided with a groove. The at least one end of the first hinged part can be provided with a circular stem having a circular hole on it, and the circular stem can be engaged into the groove of the rotatable base by the steel pin passing through the circular hole of the circular tube. One end of the expansion tube can be engaged into the circular tube, and a steel pin passes through the circular hole of the circular tube; the other end of the expansion link can be provided with the second hinged part, which is connected with the other end of the circular tube.

[0013] The hinged links of the present invention can be straight hinged links or tilted hinged links, or diagonal hinged links.

[0014] According to the present invention, when folding longitudinally along the axis direction of the main tube, the straight hinged links and the extendable tilted hinged links can be arranged alternately, and the tilting direction of the tilted links is in accordance with the folding direction. When folding the truss laterally along the direction that is perpendicular to the axis of the main tube, the

forward tilted links and the reverse tilted links can be arranged alternately, and the extendable tilted hinged links are in the same direction.

[0015] According to the present invention, when a plurality of trusses are connected with each other, trusses in the forward folding direction and trusses in the reverse folding direction can be alternately connected.

[0016] According to the present invention, the corresponding main tubes of the two folding planes can be parallel to each other.

[0017] The present invention has the advantages that it provides an easy and fast way to fold a truss and to optimize the forces exerted on the truss; the folded volume has been reduced, which saves a lot fees in transportation and storage. Although there are some other ways to get the similar folding effect, the folding manner of the present invention can achieve a greater volume reducing ratio, and is more convenient to use. The exterior of the folded truss is much similar to known fixed truss, of which the aesthetic appearance also promotes its use.

[0018] In addition, the taper pin connecting structure and the square joint of the foldable truss are the same with that of the known fixed truss. Therefore, the foldable truss and the fixed truss can be combined together, which ensures the compatible connecting of the fixed truss, the foldable truss and the square joint, which gains economic benefit while saves the investment.

[0019] Meanwhile, the truss according to the present invention can be made in a larger size without increasing the volume too much the volume reducing ratio is very large. Therefore, the load carrying capacity of the truss is enhanced with a safer truss structure.

[0020] The volume reducing ratio of the present invention will be increasing for large truss or its components; accordingly, the benefit it brings will be more significant.

[0021] The folding structure as described in the present invention can be widely used in the fields of e.g. stage lighting stands, display and exhibition and trade shows, and can gain better economic benefits. In the area of building structure, as the volumes of the trusses are too large to transport, the folding manner of the present invention is adopted to significantly reduce the volume of the truss, and hence to strengthen the structure of the products and reduce workload in the field.

BRIEF DESCRIPTION OF THE DRAWINGS OF THE INVENTION

[0022]

Figure 1 is a structural drawing of a known straight truss;

Figure 2 is a structural drawing of a known curved truss;

Figure 3 is a structural drawing of a first fixed

Figure 4

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Figure 5

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Figure 6

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Figure 7

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Figure 8

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Figure 9

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Figure 10

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Figure 11

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Figure 12

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Figure 13

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Figure 14

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Figure 15

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Figure 16

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Figure 17

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Figure 18

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Figure 19

hinged link A of the present invention;

is an exploded view of the first fixed hinged link A of Figure 3;

is a structural drawing of a rotatable hinged link B of the present invention;

is an exploded view of the rotatable hinged link B of Figure 5;

is a structural drawing of a rotation-limited hinged link C according the present invention;

is an exploded view of the rotation-limited hinged link C of Figure 7;

is a structural drawing of an extendable-retractable fixed hinged link D according to the present invention;

is an exploded view of the extendable-retractable fixed hinged link D of Figure 9;

is a structural drawing of the extendable-retractable rotatable hinged link E according the present invention;

is an exploded view of the extendable-retractable rotatable hinged link E of Figure 11;

is a structural drawing of the extendable-retractable rotation-limited hinged link F of the present invention;

is an exploded view of the extendable-retractable rotation-limited hinged link F of Figure 13;

is a structural drawing of the second fixed hinged link G according to the present invention;

is an exploded view of the second fixed hinged link G of Figure 15;

is a structural drawing of the third fixed hinged link H according to the present invention;

is an exploded view of the third fixed hinged link H of Figure 17;

is a structural drawing of the square truss according to the present inven-

	tion being folded longitudinally;			to the present invention being folded longitudinally (along the X direction);
Figure 20	is a view of the square truss of Figure 19 being folded longitudinally;		Figure 34	is a plan view showing the connecting manner of the curved truss according to the present invention when folded longitudinally (along the X direction);
Figure 21	is the first schematic drawing of the diagonal links of the square truss of Figure 20 being folded longitudinally;	5		
Figure 22	is the second schematic drawing of the diagonal links of the square truss being folded longitudinally;	10	Figure 35	is a structural drawing of the curved truss of the present invention being folded laterally;
Figure 23	is a schematic drawing of the diagonal links of the rectangular truss being folded longitudinally;	15	Figure 36	is a plan schematic drawing of the curved truss according to the present invention being folded laterally;
Figure 24	is a structural drawing of the square truss (double rows of additional tubes) being folded longitudinally;	20	Figure 37	is a plan schematic drawing of the special-shaped truss according to the present invention being folded laterally;
Figure 25	is a plan schematic drawing of the hook links of the square truss being folded longitudinally;		Figures 38-40	are schematic drawings illustrating the longitudinally folding process of the two-tube truss with taper pin;
Figure 26	is a structural drawing of the square truss of the present invention being folded laterally (along the Y direction);	25	Figure 41	is a schematic drawing of the connecting of the telescopic truss according to the present invention;
Figure 27	is a plan schematic drawing of another arrangement mode of the links of the square truss being folded laterally (along the Y direction);	30	Figure 42	is a structural drawing showing an embodiment of the telescopic truss according to the present invention;
Figure 28	is a structural drawing illustrating an embodiment of the curved truss according to the present invention being folded longitudinally (along the X direction);	35	Figure 43	is a schematic drawing of the connecting of the hinged truss according to the present invention;
Figure 29	is a plan view of the curved truss according to the present invention being folded longitudinally (along the X direction);	40	Figure 44	is a structural drawing showing an embodiment of the hinged truss according to the present invention;
Figure 30	is a folding view of the curved truss being folded longitudinally;	45	Figures 45-47	are schematic drawings illustrating the longitudinally folding of the four-tube covered truss;
Figure 31	is a structural drawing of another embodiment of the curved truss being folded longitudinally (along the X direction);	50	Figures 48-50	are schematic drawings illustrating the laterally folding of the four-tube covered truss;
Figure 32	is a folding view of the curved truss of Figure 31 being folded longitudinally;	55	Figures 51-56	are schematic drawings illustrating the longitudinally folding of the covered truss connected by two types of single taper pins;
Figure 33	is a plan view showing the connecting manner of the square truss according		Figures 57-59	are schematic drawings illustrating the longitudinally folding of the covered truss connected by double taper pins;

Figures 60-63 are schematic drawings illustrating the functional structure of the truss according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0023] In order to illustrate the structural features of the present invention and its efficiency, preferable embodiments will be described with reference to the corresponding drawings:

[0024] The four faces of a square truss are subject to different forces in use, especially when the truss is used as a beam which requires high strength. Usually the forces exerted on two of its four faces are larger than that on the other two faces. Meanwhile, it is more likely to use a number of trusses that are connected together by square joints instead of using a single truss in practice. Therefore, it is advantageous to arrange a movable hinged link of the present invention onto the two faces that are bearing smaller force, so as to reduce the volume of the truss; moreover, the strength of whole truss structure will be maintained for the combination of a plurality of trusses and the square joints.

[0025] The truss connecting means of the present invention mainly includes the following components: the first fixed hinged link A, the rotatable hinged link B, the rotation-limited hinged link C, the extendable-retractable fixed hinged link D, the extendable-retractable rotatable hinged link E, the extendable-retractable rotation-limited hinged link F and the second fixed hinged link G, etc.

[0026] Figure 3 is a structural drawing of the first fixed hinged link A of the present invention.

[0027] Figure 4 is an exploded view of the first fixed hinged link A of Figure 3. The first fixed hinged link A includes a first hinged part 1, a second hinged part 2, a steel pin and a first circular tube 4.

[0028] The two ends of the first circular tube 4 are respectively fixed connected to the second hinged part 2; the tongue of the second hinged part 2 is adaptively connected with the groove of the first hinged part 1, while the steel pin 3 passes through the groove of the first hinged part 1 and the tongue of the second hinged part 2 as a fixed shaft about which the first hinged part 1 and the second hinged part 2 are rotatable connected. The first fixed hinged link as shown in Figure 3 can swing in a plane, and its hinge structure can be vertical or tilted.

[0029] Figure 5 is a structural drawing of the rotatable hinged link B of the present invention.

[0030] Figure 6 is an exploded view of the rotatable hinged link B of Figure 5. The rotatable hinged link B includes the second hinged part 2, the steel pin 3, the first circular tube 4, the third hinged part 5 and the first rotatable base 6.

[0031] The two ends of the first circular tube 4 are respectively fixed connected to the second hinged part 2; the tongue of the second hinged part 2 is adaptive connected with the groove of the third hinged part 5, while the steel pin 3 passes through the groove of the third

hinged part 5 and the tongue of the second hinged part 2 as a fixed shaft about which the third hinged part 5 and the second hinged part 2 are rotatable connected. The other end of the third hinged part 5 is provided with a circular stem having a circular hole in it. The circular stem of the third hinged part 5 is received in the first rotatable base 6 and fixed into the bottom of the first rotatable base 6 by the steel pin 3 passing through the circular hole of the circular stem of the third hinged part 5. When the hinge swings, it can rotate around 360 degree.

[0032] Figure 7 is a structural drawing of the rotation-limited hinged link C of the present invention.

[0033] Figure 8 is an exploded view of the rotation-limited hinged link C of Figure 7. The rotation-limited hinged link C includes the second hinged part 2, the steel pin 3, the first circular tube 4, the third hinged part 5 and the second rotatable base 7.

[0034] The two ends of the first circular tube 4 are respectively fixed connected to the second hinged part 2; the tongue of the second hinged part 2 is adaptive connected with the groove of the third hinged part 5, while the steel pin 3 passes through the groove of the third hinged part 5 and the tongue of the second hinged part 2 as a fixed shaft about which the third hinged part 5 and the second hinged part 2 are rotatable connected. The other end of the third hinged part 5 is provided with a circular stem having a circular hole in it; the circular stem of the third hinged part 5 is received into the second rotatable base 7, and the steel pin 3 passes through the circular hole of the circular stem of the third hinged part 5 and the groove of the second rotatable base 7. The width of the groove determines the rotation angle of the steel pin 3, that is, the groove underneath the second rotatable base 7 is used to limit the rotation angle of the hinge; the bottom of the second rotatable base 7 is connected with the main tube. When the hinge swings, the third hinged part 5 rotates within a limited angle relative to the second rotatable base 7.

[0035] Figure 9 is a structural drawing of the extendable-retractable fixed hinged link D of the present invention; Figure 10 is an exploded view of the extendable-retractable fixed hinged link D of Figure 9. The extendable-retractable fixed hinged link D includes the first hinged part 1, the second hinged part 2, the steel pin 3, the expansion link 9 and the second circular tube 10.

[0036] One end of the second circular tube 10 is fixed to the second hinged part 2; the tongue of the second hinged part 2 is adaptive connected with the groove of the first hinged part 1, while the steel pin 3 passes through the groove of the first hinged part 1 and the tongue of the second hinged part 2 as a fixed shaft about which the first hinged part 1 and the second hinged part 2 are rotatably connected.

[0037] One end of the expansion link 9 is provided with the fourth hinged part 8; the tongue of the fourth hinged part 8 is adaptively connected with the groove of the first hinged part 1, while the steel pin 3 passes through the groove of the first hinged part 1 and the tongue of the

fourth hinged part 8 as a fixed shaft about which the first hinged part 1 and the fourth hinged part 8 are rotatable connected. The other end of the fourth hinged part 8 is a circular stem having a circular hole in it. The expansion link 9 can slidably extend and retract inside the second circular tube 10; therefore, when the expansion link 9 is in touch with the bottom of the second circular tube 10, they are fixed by the steel pin 3 passing through the circular hole in the circular stem of the fourth hinged part 8 and the circular hole in the second circular tube 10.

[0038] Therefore, when the hinge swings, the expansion link 9 can extend and retract by sliding inside the second circular tube 10.

[0039] Figure 11 is a structural drawing of the extendable-retractable rotatable hinged link E of the present invention; Figure 12 is an exploded view of the extendable-retractable rotatable hinged link E of Figure 11. The extendable-retractable rotatable hinged link E includes the second hinged part 2, the steel pin 3, the third hinged part 5, the first rotatable base 6, the fourth hinged part 8, the expansion link 9 and the second circular tube 10.

[0040] One end of the second circular tube 10 is fixed connected to the second hinged part 2; the tongue of the second hinged part 2 is adaptive connected with the groove of the third hinged part 5, while the steel pin 3 passes through the groove of the third hinged part 5 and the tongue of the second hinged part 2 as a fixed shaft about which the third hinged part 5 and the second hinged part 2 are rotatable connected. The other end of the third hinged part 5 is provided with a circular stem having a circular hole in it. The circular stem of the third hinged part 5 is engaged in the first rotatable base 6 and fixed into the bottom of the first rotatable base 6 by the steel pin 3 passing through the circular hole of the circular stem of the third hinged part 5.

[0041] One end of the expansion link 9 is provided with the fourth hinged part 8; the tongue of the fourth hinged part 8 is adaptive connected with the groove of the third hinged part 5, while the steel pin 3 passes through the groove of the third hinged part 5 and the tongue of the fourth hinged part 8 as a fixed shaft about which the third hinged part 5 and the fourth hinged part 8 are rotatable connected. The other end of the third hinged part 5 is provided with a circular stem having a circular hole in it. The circular stem of the third hinged part 5 is engaged in the first rotatable base 6 and fixed into the bottom of the first rotatable base 6 by the steel pin 3 passing through the circular hole of the circular stem of the third hinged part 5.

[0042] The other end of the fourth hinged part 8 is a circular stem having a circular hole in it. The expansion link 9 can slidably extend and retract inside the second circular tube 10; therefore, when the expansion link 9 is in touch with the bottom of the second circular tube 10, they are fixed by the steel pin 3 passing through the circular hole in the circular stem of the fourth hinged part 8 and the circular hole in the second circular tube 10.

[0043] Therefore, when the hinge swings, the expansion link 9 can extend and retract by sliding inside the

second circular tube 10. Meanwhile, the third hinged part 5 can also rotate relative to the first rotatable base 6.

[0044] Figure 13 is a structural drawing of the extendable-retractable rotation-limited hinged link F of the present invention; Figure 14 is an exploded view of the extendable-retractable rotation-limited hinged link F of Figure 13. The extendable-retractable rotation-limited hinged link F includes the second hinged part 2, the steel pin 3, the third hinged part 5, the second rotatable base 7, the fourth hinged part 8, the expansion link 9 and the second circular tube 10.

[0045] One end of the second circular tube 10 is fixed connected to the second hinged part 2; the tongue of the second hinged part 2 is adaptive connected with the groove of the third hinged part 5, while the steel pin 3 passes through the groove of the third hinged part 5 and the tongue of the second hinged part 2 as a fixed shaft about which the third hinged part 5 and the second hinged part 2 are rotatable connected.

[0046] The other end of the third hinged part 5 is provided with a circular stem having a circular hole in it; said circular stem of the third hinged part 5 is engaged into the second rotatable base 7 and fixed into the groove of the second rotatable base 7 by the steel pin 3 passing through the circular hole of the circular stem of the third hinged part 5. The width of the groove determines the rotation angle of the steel pin 3, that is, the groove underneath the second rotatable base 7 is used to limit the rotation angle of the hinge; the bottom of the second rotatable base 7 is connected with the main tube. When the hinge swings, the third hinged part 5 rotates within a limited angle relative to the second rotatable base 7.

[0047] One end of the expansion link 9 is provided with the fourth hinged part 8; the tongue of the fourth hinged part 8 is adaptive connected with the groove of the third hinged part 5, while the steel pin 3 passes through the groove of the third hinged part 5 and the tongue of the fourth hinged part 8 as a fixed shaft about which the third hinged part 5 and the fourth hinged part 8 are rotatable connected. The other end of the third hinged part 5 is provided with a circular stem having a circular hole in it. The circular stem of the third hinged part 5 is engaged in the second rotatable base 7 and fixed into the groove of the second rotatable base 7 by the steel pin 3 passing through the circular hole of the circular stem of the third hinged part 5. The width of the groove determines the rotation angle of the steel pin 3, that is, the groove underneath the second rotatable base 7 is used to limit the rotation angle of the hinge, and the bottom of the second rotatable base 7 is connected with the main tube. When the third hinged part 5 swings, it rotates in a limited angle relative to and the second rotatable base 7.

[0048] The other end of the fourth hinged part 8 is provided with a circular stem having a circular hole in it. The expansion link 9 can slidably extend and retract inside the second circular tube 10; therefore, when the expansion link 9 is in touch with the bottom of the second circular

tube 10, they are fixed by the steel pin 3 passing through the circular hole in the circular stem of the fourth hinged part 8 and the circular hole in the second circular tube 10.

[0049] Therefore, when the hinge swings, the expansion link 9 can extend and retract by sliding inside the second circular tube 10. Meanwhile, the third hinged part 5 can also rotate within limited angle relative to the second rotatable base 7.

[0050] In addition, Figure 15 is a structural drawing of the second fixed hinged link G of the present invention; Figure 16 is an exploded view of the second fixed hinged link G of Figure 15. The difference between Figure 15, Figure 16 and Figure 3, Figure 4 is that, the first hinged part 1 is a groove while the second hinged part 2 is a tongue; the fifth hinged part 11 is a tongue while the sixth hinged part 12 is a groove. The other hinged links can also be provided with this arrangement.

[0051] Figure 17 is a structural drawing of the third fixed hinged link H of the present invention.

[0052] Figure 18 is an exploded view of the third fixed hinged link H of Figure 17. The difference between Figure 17, Figure 18 and Figure 15, Figure 16 is that, the fifth hinged part 11 is a single tongue while the sixth hinged part 12 is a single groove; the hinge part of the seventh hinged part 13 is double-tongue with double-groove, which is the same as the hinge part of the eighth hinged part 14. The other hinged links can also be provided with this arrangement. The hinge parts of the seventh hinged part 13 and the eighth hinged part 14 can in the form of three-tongue and three-groove, etc., and the present invention is not intended to be restricted to the two forms.

[0053] The arrangement of the hinged links of the present invention is not restricted to the manners as described above. However, the preferred embodiment of the present invention is that in Figure 17, which is more practical than the two modes as shown in Figure 3 and Figure 15. In the following mode, the first hinged part 1 in Figure 3 is used as the groove and the second hinged part 2 of Figure 3 is used as the tongue. In order to be concise, the modes in Figure 15 and Figure 17 will not be described (i.e. the fifth hinged part 11 as the tongue and the sixth hinged part as the groove; the hinges of the seventh hinged part and the eighth hinged part are the same double-tongue or double-groove). In addition, the first hinged part 1 and the fifth hinged part 11 can be tilted, which looks more similar to the welded tilted link of the fixed single pieces of the truss. By adopting the tilted fixed hinge, the truss can be folded in the same way while force applied onto the truss is optimized.

[0054] The truss connecting means usually applies to the straight truss and the curved truss. The truss connecting means of the present invention may perform better with the straight truss. However, as to the curved truss used in certain application, its performance may be influenced, for it is the folded face that bears the forces. Nevertheless, the strength can be enhanced by increasing the diameter of the foldable additional tubes or the wall thickness of the foldable additional tubes. Specific

square straight truss and curved truss will be described in the following.

[0055] Figure 19 is a structural drawing of the square truss of the present invention being folded longitudinally.

There are four main tubes 31, 32, 33 and 34 (there can be more than four main tubes or less than four main tubes depending on actual need, and the present invention is not restricted to that) as well as a number of additional tubes in Figure 19. The additional tube is formed by said first fixed hinged link A, the extendable-retractable fixed hinged link D and the rotation-limited hinged link C; however, the additional tube can be formed by other components, which is not intended to be restricted. In order to be concise and easy to understand, the extendable-retractable fixed hinged link D of Figure 19 is illustrated by a sectional view, while the rest three extendable-retractable fixed hinged links are not shown in a sectional view. The rest of the figures of the present invention also adopt the combination of sectional view.

[0056] As shown in Figure 19, when the truss is folded along the X direction, the upper single piece, which is formed by welding the first main tube 31, the third main tube 33, the first additional tube 21 (straight additional tube) and the second additional tube 22 (tilted additional tube), moves along the X direction, while the third additional tube 40 swings along the X direction about the shaft of the hinge of the first fixed hinged link A. All the straight links formed by the first main tube 31 and the second main tube 32 moves in the way along the X direction. At the same time, while the extendable-retractable fixed hinged link D swings about its shaft, the extendable telescopic unit formed by the expansion link 9 and the second circular 10 will be elongated accordingly, and all the tilted links between the first main tube 31 and the second main tube 32 are extending as they swing. All the straight hinged links and the tilted hinged links between the third main tube 33 and the fourth main tube 34 move in the same way.

[0057] During the process, the rotation-limited hinged link C rotates as it swings about its shaft along the X direction, until the hinged part of the first main tube 31 is in touch with the second main tube 32.

[0058] In this way, the fixed welded single piece formed by the first main tube 31, the third main tube 33, the first additional tube 21 and the second additional tube 22 will move along the X direction until the hinged part of the first main tube 31 is in touch with the second main tube 32, and the hinged part of the third main tube 33 is in touch with the fourth main tube 34; thus the folding process of the truss is completed. The folded truss is shown in Figure 20.

[0059] Figure 21 is the first schematic drawing of the diagonal rotation-limited hinged links of the square truss when being folded longitudinally; Figure 22 is the second schematic drawing of the diagonal rotation-limited hinged links of the square truss when being folded longitudinally. Figure 23 is one of the schematic drawings of the diagonal rotation-limited hinged links of the rectangular truss

when being folded longitudinally; its folding manner is the same as that of the square truss.

[0060] It should be noted that the geometric position of the axis of the rotation-limited hinged link C and the axis of the first fixed hinged link A should follow the relationships described in Figure 21 and 22, in order not to change the length of the rotation-limited hinged link C. Obviously, the length of the rotation-limited hinged link C will be changed during the folding process if it fails to meet the requirement of the geometric position; such an extendable-retractable link mechanism will not only increase the production cost, but also lower the stability of the whole truss structure. Using the rotation-limited hinged link C as the diagonal link of the truss can prevent said link C from randomly rotating to some angle that may cause itself being locked, which further impedes the folding process.

[0061] The diagonal rotation-limited hinged links C of the truss as shown in Figure 21 can be parallel or crossed, the latter of which is more commonly used, as adopted in Figure 22 and 23. When a number of trusses are to be connected, the neighbouring two diagonal links are crossed in order to enhance the stability of the whole truss structure and to optimize the force distribution. As shown in Figure 19, all the first fixed hinged links A and all the extendable-retractable fixed hinged links D between the first main tube 31 and the second main tube 32 are within the same plane. Moreover, in order to be folded as shown in Figure 20, the first fixed hinged link A and the extendable-retractable fixed hinged link D have to be separated from each other in a certain distance.

[0062] When the truss is in the opened configuration, i.e. operable configuration as shown in Figure 19, the telescopic tube is the shortest and is enabled to bear stress. The length of the diagonal rotation-limited hinged link C of the square truss will not be changed during the folding process; also, more diagonal links can be added to maintain the overall rigidity of the truss, so as to enhance its load carrying capacity.

[0063] Figure 19 is a structural drawing of the square truss (single-row of additional tubes) of (delete) when being folded longitudinally, and Figure 24 shows another structure of the square truss (double rows of additional tubes) when being folded longitudinally. In Figure 19, the space between the first fixed hinged link A and the extendable-retractable fixed hinged link D is relatively large, which lowers its load carrying capacity. The truss shown in Figure 24 can overcome this drawback, wherein the first fixed hinged link A and the extendable-retractable fixed hinged link D are in two parallel plans with certain distance from each other; therefore, the first fixed hinged link A and the extendable-retractable fixed hinged link D can be alternatively arranged closely.

[0064] The tilted links in Figure 19 can be arranged in a staggered arrangement; the reverse tilted link is detachable. When the truss needs to be folded, the shafts of screws at both ends of the reverse tilted link are detached, so as to fold the truss in the same manner as

that in the Figure 19.

[0065] The reverse tilted link can be in the form of hook link 50 as in the truss shown in Figure 25, which is easy and fast to be fixed and detached. Although the hook link 50 is easy to be fixed and detached, it may influence the overall appearance of the truss, and may not as simple and practical as the truss shown in Figure 19.

[0066] Because some trusses are heavy, they can be equipped with casters in order to be more convenient to use.

[0067] Figure 26 is a structural drawing of the square truss of the present invention when being folded laterally. When the straight truss is folded along the Y direction, the first fixed hinged link A swings about its axis, and the rotatable hinged link B swings in a circle around the axis, while the hinged part of the rotatable hinged link B rotates relative to the rotation base of the hinge. At the same time, the diagonal extendable-retractable fixed hinged link D swings about its axis with its expansion link being extended until the truss is folded. The straight link between the two tilted links can be removed, as shown in Figure 27; that is, there are several ways for combining the straight links and the tilted links. It should be noted that the axis of the first fixed hinged link A and the axis of the extendable-retractable fixed hinged link D are in the same plane in Figure 26.

[0068] There are several ways to enhance the load carrying capacity of the truss. On one hand, more straight links and tilted links can be closely arranged in different manners, of which the most commonly used is that similar to the arrangement of the straight links and tilted links in the fixed welded single piece; meanwhile, the strength of the truss is enhanced by increasing the thickness of the wall of the first fixed hinged link A and the extendable-retractable fixed hinged link D or by increasing the diameter of the tubes. On the other hand, the rigidity of the truss and its load carrying capacity can be enhanced by adding more diagonal links along the length of the truss and fixing extendable-retractable fixed hinged link D by pins and screws.

[0069] The lateral folding of the rectangle truss is in the same way as that of the square truss. The volume of the laterally folded square truss is 30~70% of its original volume; the volume of the longitudinally folded square truss is 30~70% of its original volume. Thus it can be seen that the volume of the laterally folded square truss is a bit larger than that of the longitudinally folded square truss, especially for trusses of large size. The volume of the longitudinally folded square truss is 20%~50% smaller than that of the laterally folded square truss; therefore, the longitudinally folding manner is advantageous.

[0070] The volume of the laterally folded truss is not reduced as much as that of the longitudinally folded truss; however, the arrangement of the straight links and the tilted links is not limited by the geometrical condition of the folded truss, which is benefit to load carrying or other special application. The longitudinally folding manner as shown in Figure 19 will significantly reduce the volume

of the truss, which is more suitable to the circumstances in which small volume is required and the strength of the truss is not very high.

[0071] Figure 28 is a structural drawing illustrating an embodiment of the curved truss of the present invention when being folded longitudinally (i.e. the diagonal link is in the middle symmetric plane of the curved truss). All the straight links of the first fixed hinged links A are perpendicular to the folding direction X, so as to enable all the first fixed hinged links A to swing along the X direction. The extendable-retractable rotatable hinged link E swings about its axis along the folding direction X as shown in Figure 29. Meanwhile, in the folding process, the telescopic tube of the extendable-retractable rotatable hinged link E extends, and its hinged part rotates. The geometrical position of the axis of the rotation-limited hinged link C in the middle symmetric plane is shown in Figure 21. The rotation-limited hinged link C rotates (in the same manner with the rotation-limited hinged link C in Figure 19) during the folding process, and the folded truss is shown in Figure 30.

[0072] As shown in Figure 31, the extendable-retractable rotation-limited hinged links F (i.e. the diagonal links are located at both ends of the curved truss) can also be adopted in a curved truss, with the crossing direction as shown in Figure 31, and the folded truss as shown in Figure 32. When being folded along the X direction, the staggered extendable-retractable rotation-limited hinged links F will be extended; if the opposite arrangement is adopted, screws and pins are needed to fix the length of the diagonal links.

[0073] The connecting of the square trusses is shown as Figure 33. When being connected, the diagonal links of the neighbouring ends of respective truss should be staggered to form a fixed structure of the whole truss with forces closed, so as to perform good load carrying capacity, as shown in Figure 34.

[0074] Only the diagonal links in the middle symmetric plane of the curved structure of the curved truss will remain the length without being changed. Hence, the structure of the curved truss can be simplified in case the truss possesses high rigidity.

[0075] In addition, there is another structure of the laterally folded truss as shown in Figure 35. The diagonal links of this embodiment can be connected in various directions, e.g. parallel to the folding direction or parallel to the direction of normal plane of the curved main tubes. The diagonal links is extended when being folded along the folding direction as shown in Figure 36. The axis of the hinge of the first fixed hinged link A is perpendicular to the Y direction, with the folding manner the same as that of the above.

[0076] In addition, for the four-tube special-shaped truss, the same folding manner as that of the present invention along the X direction as shown in Figure 37 can be realized if only the corresponding main tube of the two fixed welded single pieces meet the geometrical condition, i.e. being parallel to each other, and the two fixed

welded single pieces are of the same size, with their hinges arranged along the folding direction of X as shown. In deed, whether the shape and size of the main tube of folding truss is eligible for folding, by using these hinged links as described, main tubes can be connected by the extendable-retractable rotatable hinged links, so as to achieve the corresponding aim of folding. When the truss is opened from the folded configuration, steel pins can be used to fix the slidable expansion links of these extendable-retractable rotatable hinged links, and further fix the corresponding links of the truss, so as to form the whole truss structure by connecting a plurality of trusses.

[0077] Yet there is another type of truss link structure, which is formed by retractable straight links (i.e. straight hinged links) and fix-length tilted links (i.e. tilted hinged links), of which the folding manner is the same with that of the fix-length straight links and extendable tilted links. However, in practice, the retractable straight links have certain drawbacks and its load carrying capacity is low. Therefore, in the operable configuration, the length of the retractable straight links can be fixed by using screws and pins. However, since there are a number of straight links, this structure is not as practical as the folding manner of Figure 19.

[0078] In practice, springs can be used inside the hinges and the expansion links, so as to make the opening and folding process of the truss quicker and more convenient, which makes the truss to be easier to use.

[0079] The square (including rectangle) straight trusses and the curved trusses can be connected with each other, for example, Figure 33 and 34 are plan views showing the connecting manner of the square truss and the curved truss of the present invention when folded longitudinally. As to the connecting of the laterally fold trusses, the diagonal links are staggered with each other at the neighbouring connecting areas, so as to form a fixed structure by connecting multiple trusses, which possesses a certain capacity of load carrying.

[0080] In conclusion, here are the key points of the present invention: firstly, the folding manner of this type of structure and the certain geometrical position and size adapted to this manner; secondly, the alternatively arranged manner following the tilting direction of the extendable-retractable tilted link or the diagonal links, by which two or more straight or curved trusses are connected to form a fixed structure from single movable truss, thus the load carrying capacity of the whole structure is enhanced (including a single truss or multiple trusses, straight or curved foldable and movable trusses, which are connected to the square joints and can also form a fixed structure of the trusses with certain capacity to carry load); thirdly, the compatibility of the foldable trusses with similar look, the fixed trusses and the square joints to be connect together.

[0081] The above described is the folding manner of the four-tube truss with a taper pin. The folded two-tube truss with taper pin is shown in Figure 38, 39 and 40, of which the folding manner is the same with the above

described.

[0082] According to the connecting manner, the trusses can be divided into different types including trusses with taper pin, trusses with telescopic tube, hinged trusses and covered trusses. The folding manner is the same with that of the two-tube and four-tube trusses with taper pin as above described. The telescopic truss is shown in Figure 41 and 42, while the hinged truss is shown in Figure 43 and 44.

[0083] Figure 41 is a schematic drawing of the connecting of the telescopic truss of the present invention.

[0084] Figure 42 is a structural drawing showing an embodiment of the telescopic truss of the present invention.

[0085] Figure 43 is a schematic drawing of the connecting of the hinged truss of the present invention.

[0086] Figure 44 is a structural drawing showing an embodiment of the hinged truss of the present invention. The folding manner is the same with the above described.

[0087] The followings drawings illustrate the longitudinally and laterally folding of the square trusses of the present invention, which shows how the square trusses are folded.

[0088] Figure 45-47 are schematic drawings illustrating the longitudinally folding process of the covered truss.

[0089] Figure 48-50 are schematic drawings illustrating the laterally folding process of the covered truss.

[0090] Figure 51-56 are schematic drawings illustrating the longitudinally folding process of the covered truss connected by two types of single taper pins.

[0091] Figure 57-59 are schematic drawings illustrating the longitudinally folding process of the covered truss connected by double taper pins. The folding manners are similar to the above described. The movable link on the cover of the covered folded trusses that are longitudinally or laterally folded is equivalent to the first fixed hinged link as above mentioned. For the covered trusses with single taper pin and double taper pin, the linkage taper pins of the four main tubes are moved to the middle of the section of the truss, which has the following advantages. Firstly, the main tubes can be provided with grooves or tongue edge, which allows the truss to be more decorative, for example, to insert into the truss a decorating board or to fit into it the decorating pictures (as shown in Figure 60 to 63). Secondly, when used in some light loaded exhibition, the efforts to connect the trusses can be reduced, which enables the use of the truss to be easier with higher efficiency. According to the function, the trusses can be divided into the following types: trusses with decorating board inserted into the groove of the main tubes; trusses that using Velcro to attach and remove the decorating board; trusses that using silicon stripes to fix the canvas; trusses provided with guide rail for track lights, etc. As shown in Figure 60 to 63, the taper pins or screws that connecting the trusses are separated from the strip groove or the main tubes with tongue edge, but their folding manners are the same with the above described.

[0092] In summary, all the embodiments described are the preferable embodiments of the present invention and this invention is not restricted to the embodiments shown. Any modification or variation with regard to the shapes, structures, features without departing substantially from the spirit of the invention shall be included herein within the scope of the claims of the present invention.

Claims

1. Truss connecting means, comprising main tubes (31, 32, 33, 34), **characterized in that** said truss connecting means further comprises hinged links (A, B, C, D, E, F, G, H) connected between and connecting the main tubes (31, 32, 33, 34), said hinged links (A, B, C, D, E, F, G, H) comprises first hinged parts, second hinged parts, steel pins (3) and a circular tube (4), wherein both ends of the circular tube (4) are respectively connected to the second hinged parts, said second hinged parts are hinged to said first hinged parts (1) by the steel pin.
2. The truss connecting means of claim 1, **characterized in that** a groove is provided on one end of the first hinged part while a tongue is provided on one end of the second hinged parts, or, a tongue is provided on one end of the first hinged parts and a groove is provided on one end of the second hinged parts, or, the first hinged parts and the second hinged parts have the same hinged portions which are both grooves or tongues.
3. The truss connecting means of claim 1 or 2, **characterized in that** it further comprises at least one rotatable base (6), wherein at least one end of the first hinged parts is provided with a circular stem (5) with a hole therein, and the circular stem (5) is engaged into the rotatable base (6) by means of the steel pin (3) passing through the circular hole.
4. The truss connecting means of claim 2, **characterized in that** it further comprises at least one rotatable base (7) having a groove on its outer surface, wherein at least one end of the first hinged parts is provided with a circular stem (5) having a circular hole therein, and the circular stem (5) is engaged into the rotatable base (7) by means of the steel pin (3) passing through the circular hole and the groove.
5. The truss connecting means of claim 2, **characterized in that** it further comprises at least one expansion link (D, E, F), wherein the one end of said expansion link (D, E, F) is received in the circular tube (10), and the steel pin (3) passes through the circular hole of the circular tube, the other end of the expansion link (D, E, F) is provided with a second hinged part, which is connected to the other end of the cir-

cular tube (10).

folding planes are parallel to each other.

6. The truss connecting means of claim 2, **characterized in that** it further includes at least one expansion link (D, E, F) and at least one rotatable base (6),
 wherein at least one end of the first hinged part is provided with a circular stem (5) having a circular hole in it, and the circular stem (5) is engaged into the rotatable base (6) by means of the steel pin (3) passing through the circular hole, one end of said expansion link (D, E, F) is engaged into the circular tube (10), and the steel pin (3) passes through the circular hole of the circular tube (10), the other end of the expansion link (D, E, F) is provided with a second hinged part, which is connected to the other end of the circular tube (10).

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7. The truss connecting means of claim 2, **characterized in that** it further includes at least one expansion link (D, E, F) and a rotatable base (7) having a groove on its outer surface, wherein at least one end of the first hinged part is provided with a circular stem (5) having a circular hole therein, and the circular stem (5) is engaged into said groove of said rotatable base (7) by means of the steel pin (3) passing through the circular hole, one end of said expansion link (D, E, F) is received in the circular tube (10), and the steel pin (3) passes through the circular hole of the circular tube (10), the other end of the expansion link (D, E, F) is provided with a second hinged part, which is connected to the other end of the circular tube (10).

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8. The truss connecting means of claim 2, **characterized in that** said hinged links (A, B, C, D, E, F, G, H) are straight hinged links or tilted hinged links or diagonal hinged links.

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9. The truss connecting means of claim 8, **characterized in that** the straight hinged links and extendable tilted hinged links are arranged alternately and the tilting direction of the tilted links is in accordance with the folding direction (X, Y) when being folded longitudinally along the axis direction of the main tube (31, 32, 33, 34), when folding laterally along the direction that is perpendicular to the axis of the main tube (31, 32, 33, 34), the forward tilted links and the reverse tilted links are arranged alternately, and the extendable diagonal hinged links are in the same direction.

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10. The truss connecting means of any one of claims 1-9, **characterized in that** trusses in the forward folding direction and trusses in the reverse folding direction are alternately connected when a plurality of trusses are connected with each other.

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11. The truss connecting means of claim 10, **characterized in that** the main tubes (31, 32, 33, 34) of two

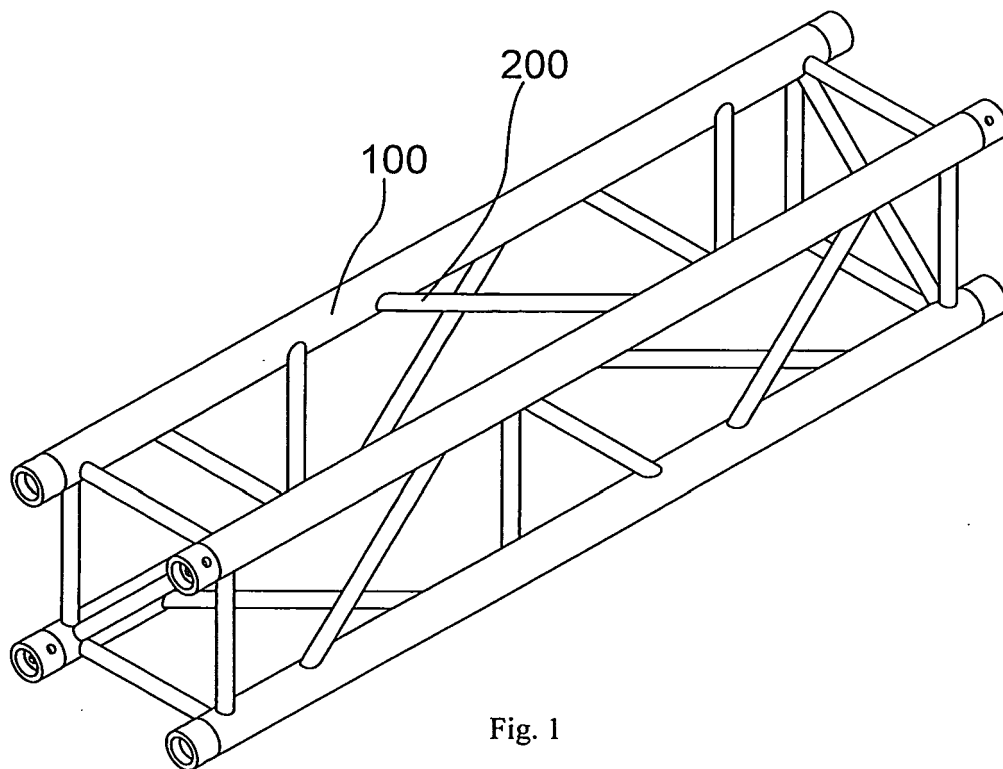


Fig. 1

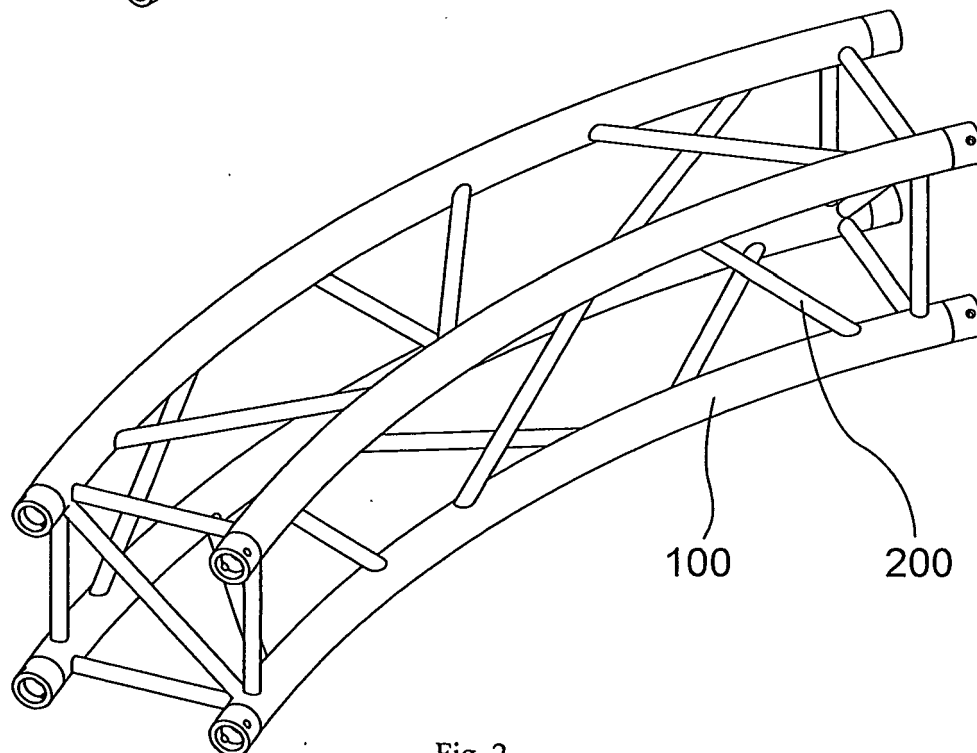


Fig. 2

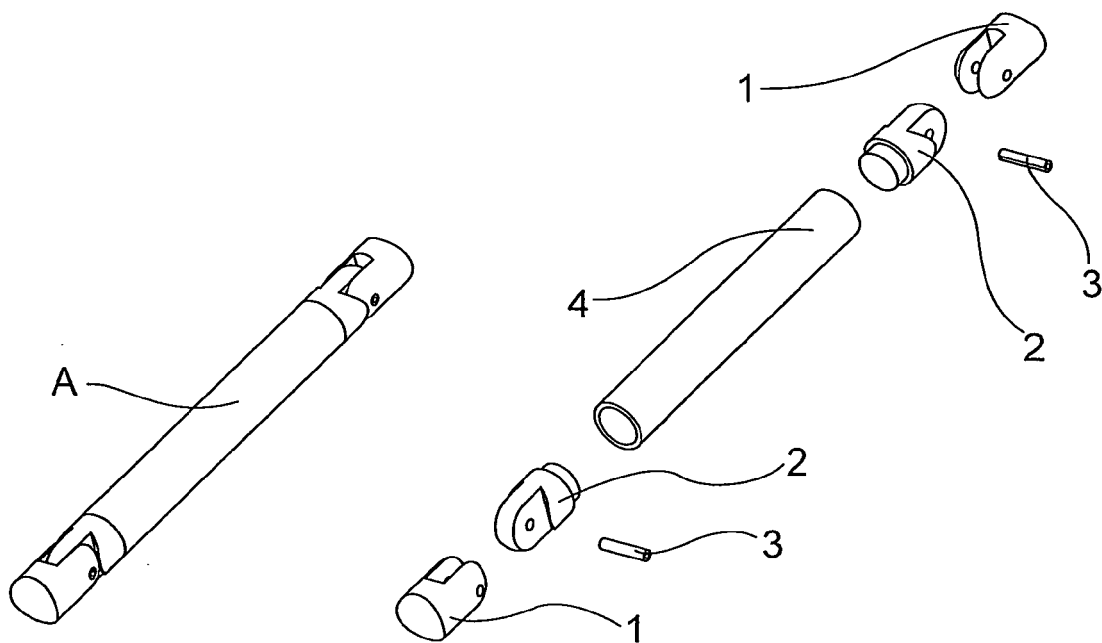


Fig. 3

Fig. 4

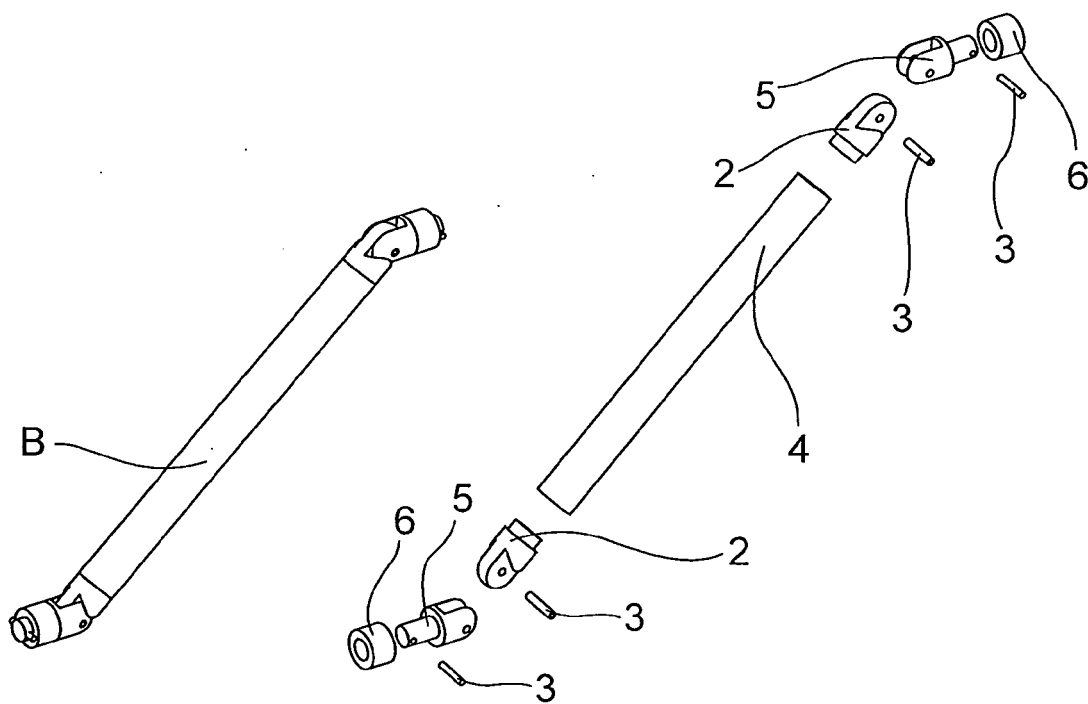


Fig. 5

Fig. 6

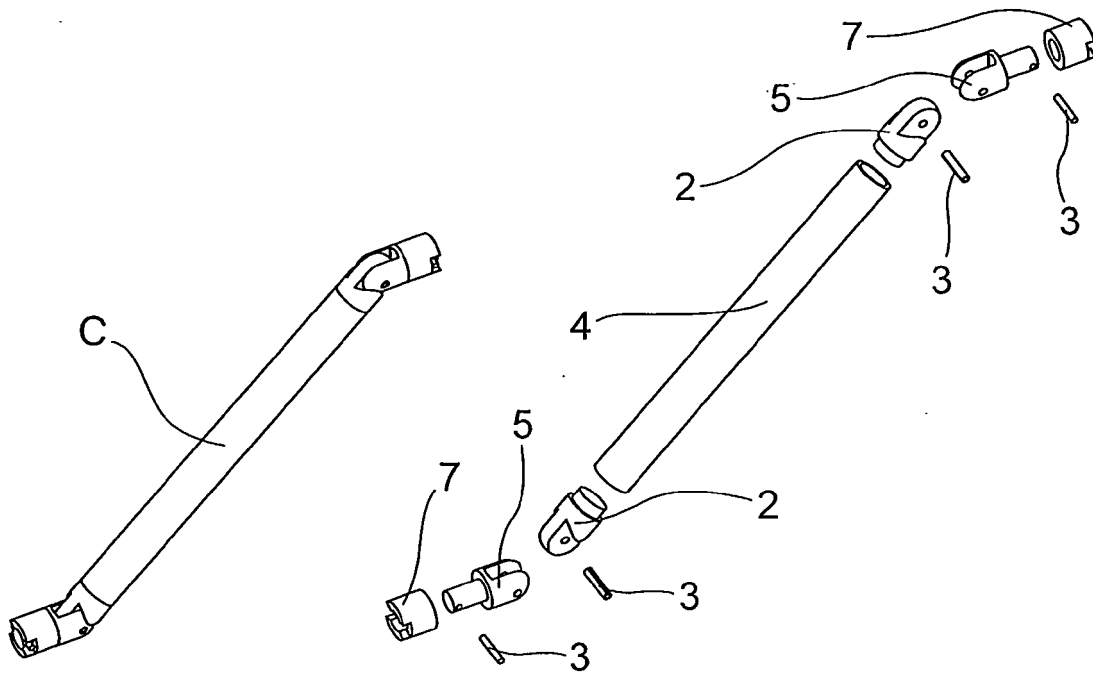


Fig. 7

Fig. 8

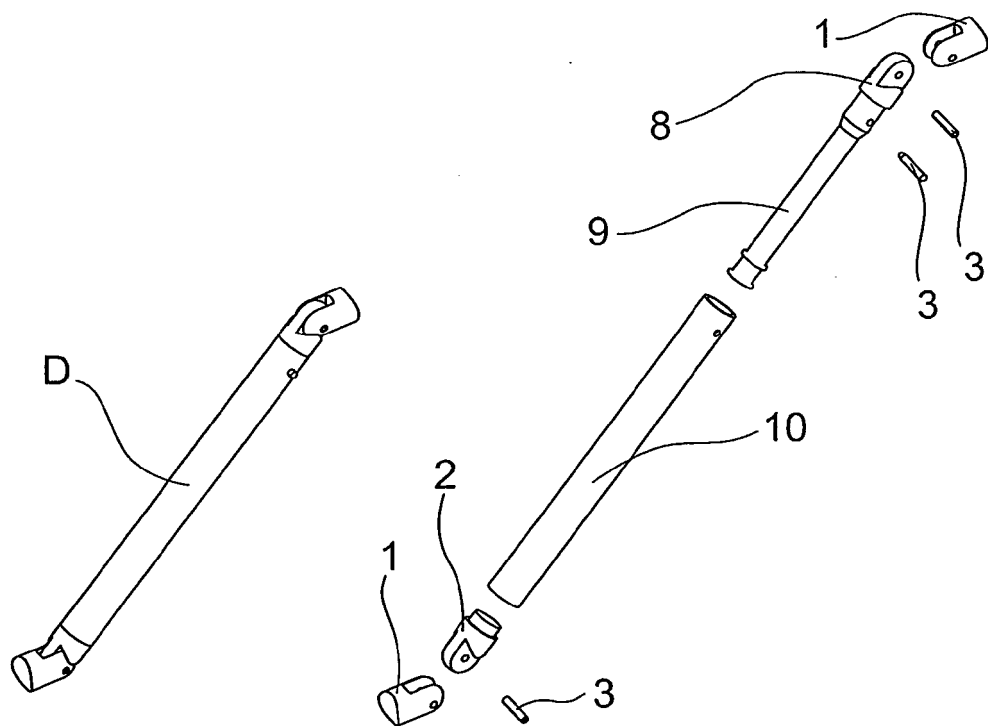


Fig. 9

Fig. 10

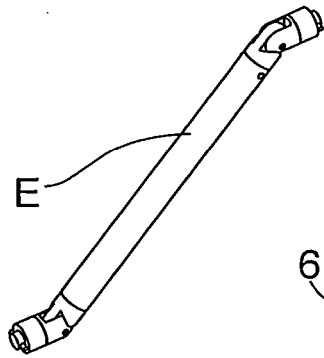


Fig. 11

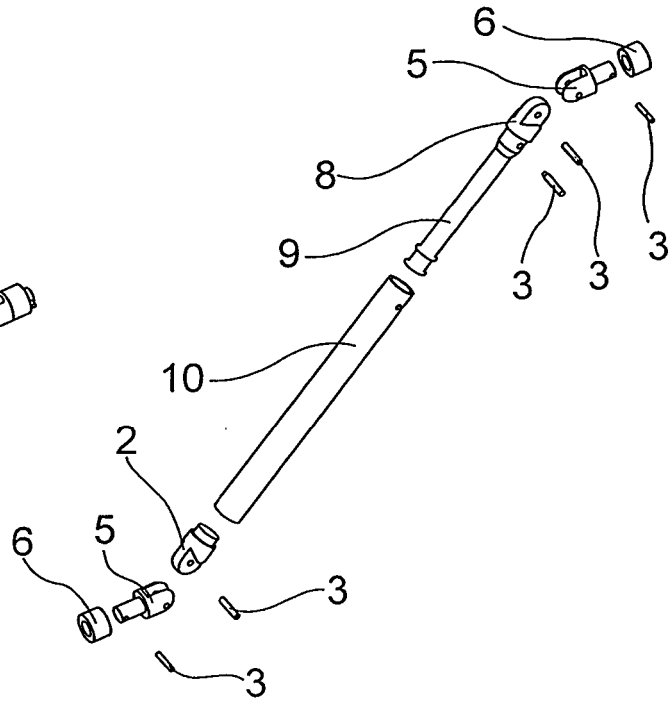


Fig. 12

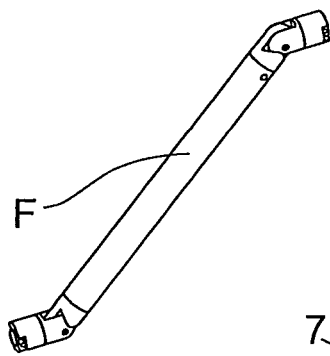


Fig. 13

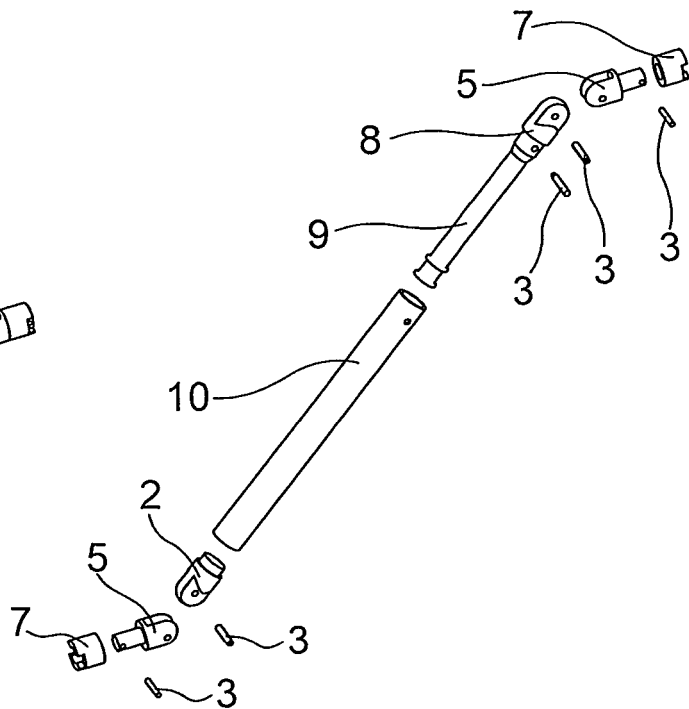


Fig. 14

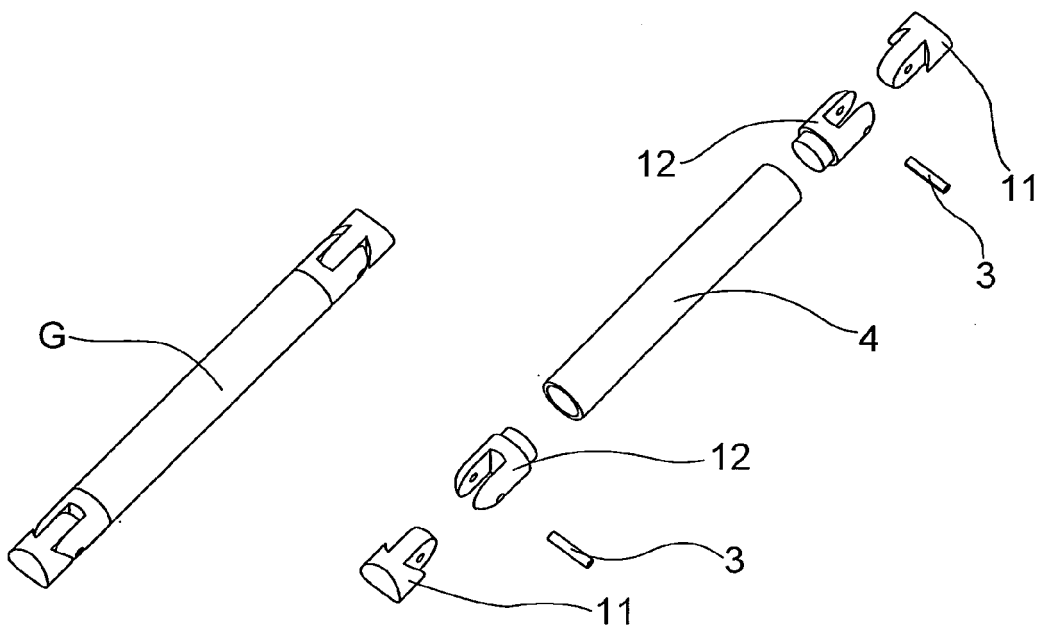


Fig. 15

Fig. 16

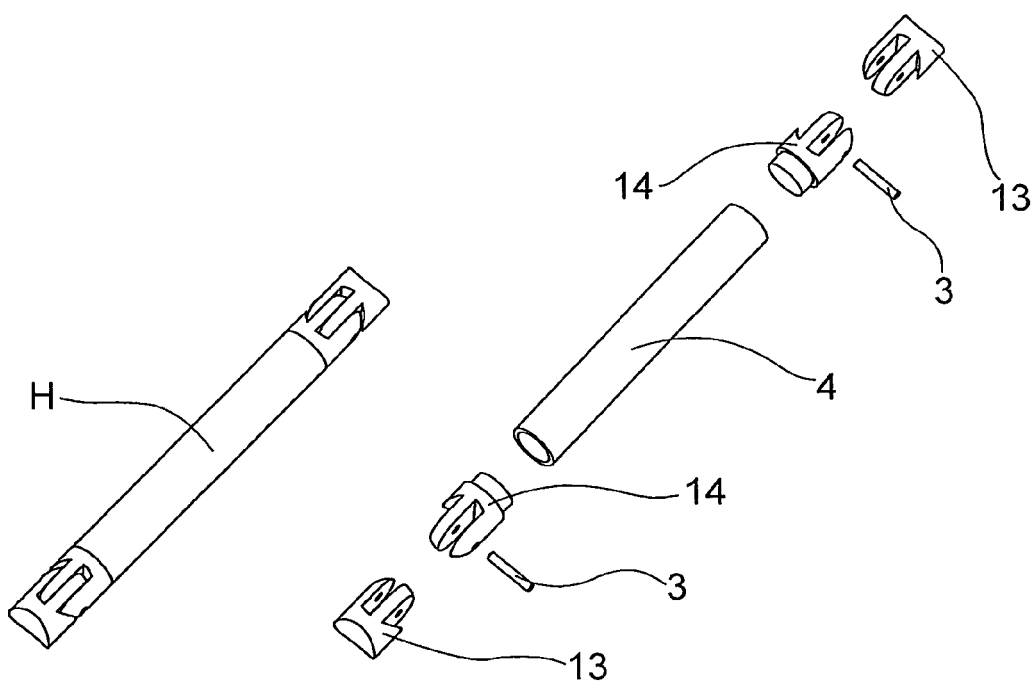


Fig. 17

Fig. 18

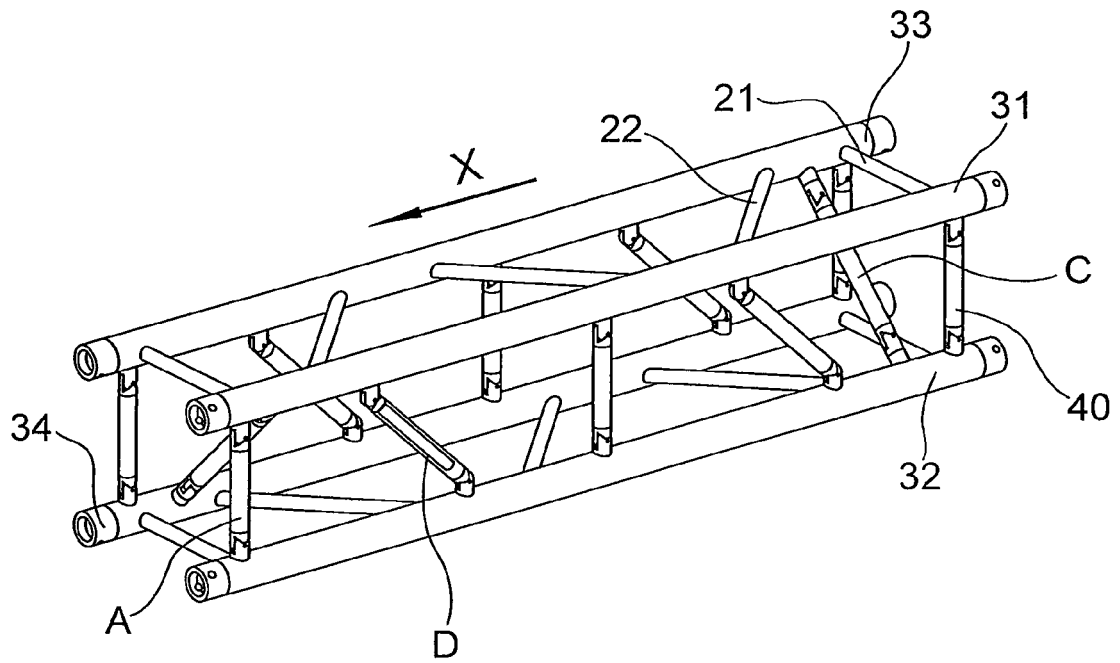


Fig. 19

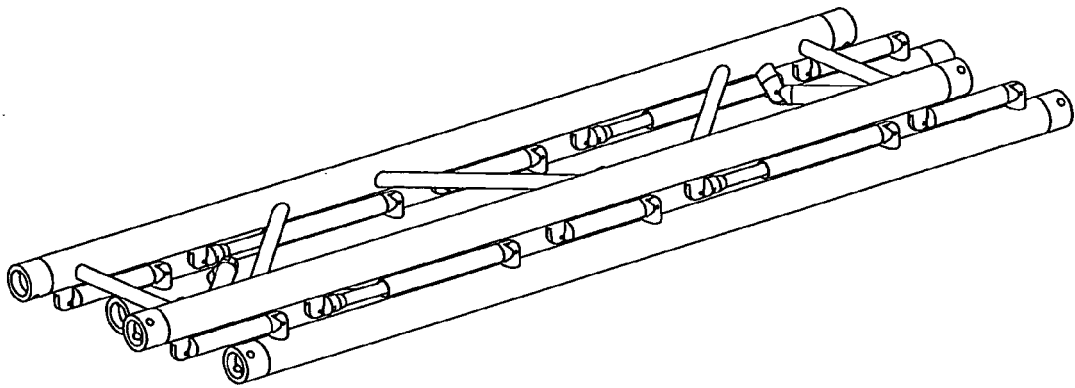


Fig. 20

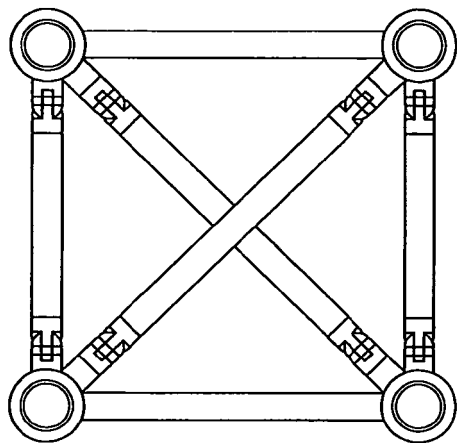


Fig. 21

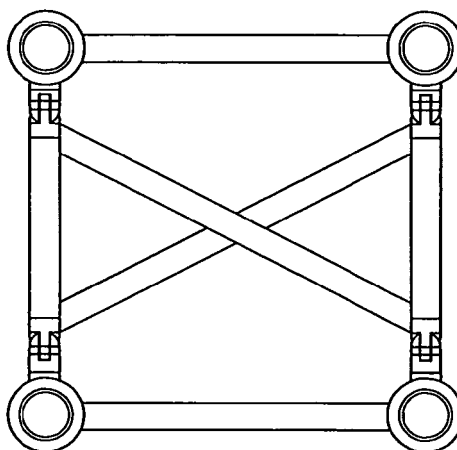


Fig. 22

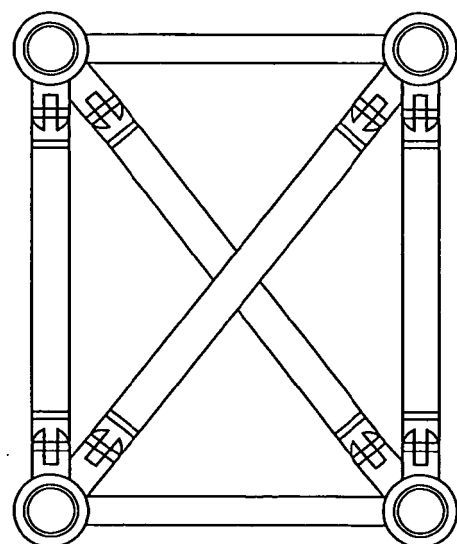


Fig. 23

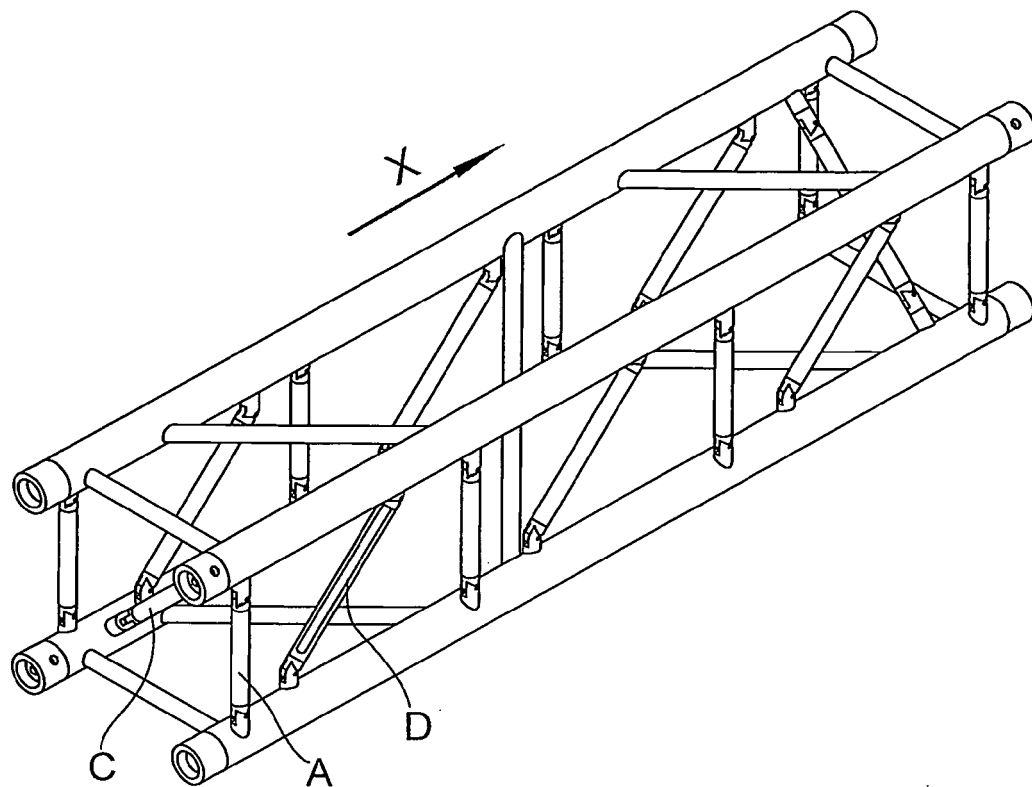


Fig. 24

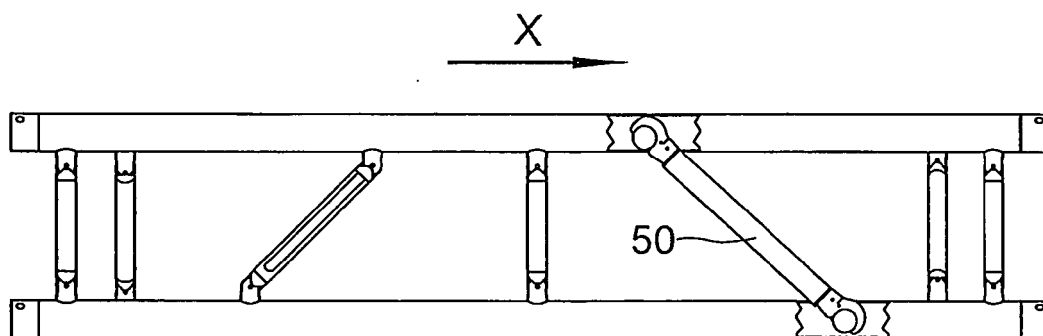


Fig. 25

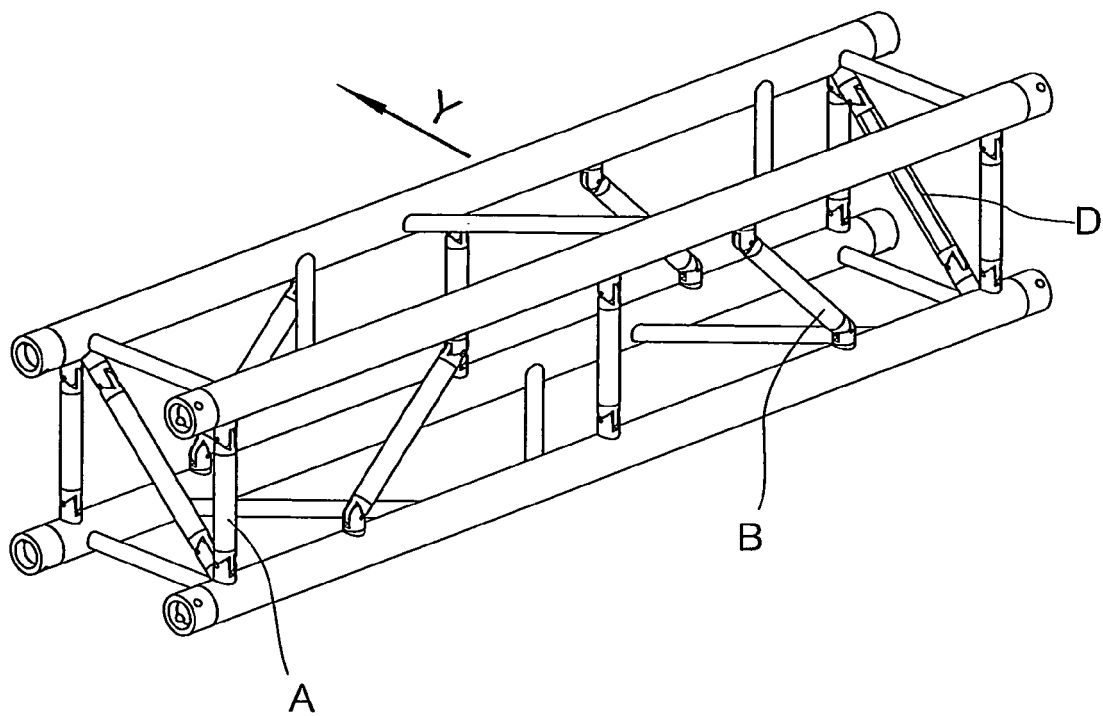


Fig. 26

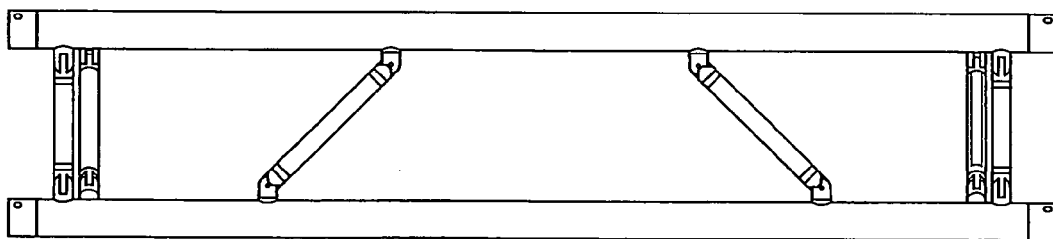
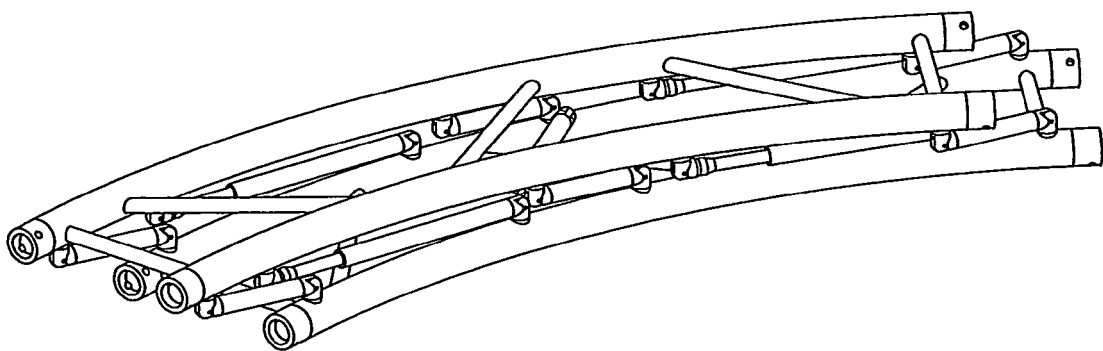
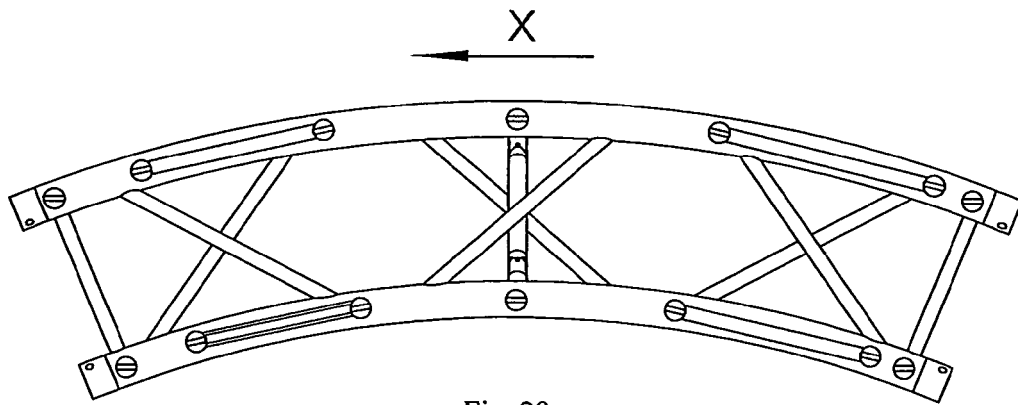
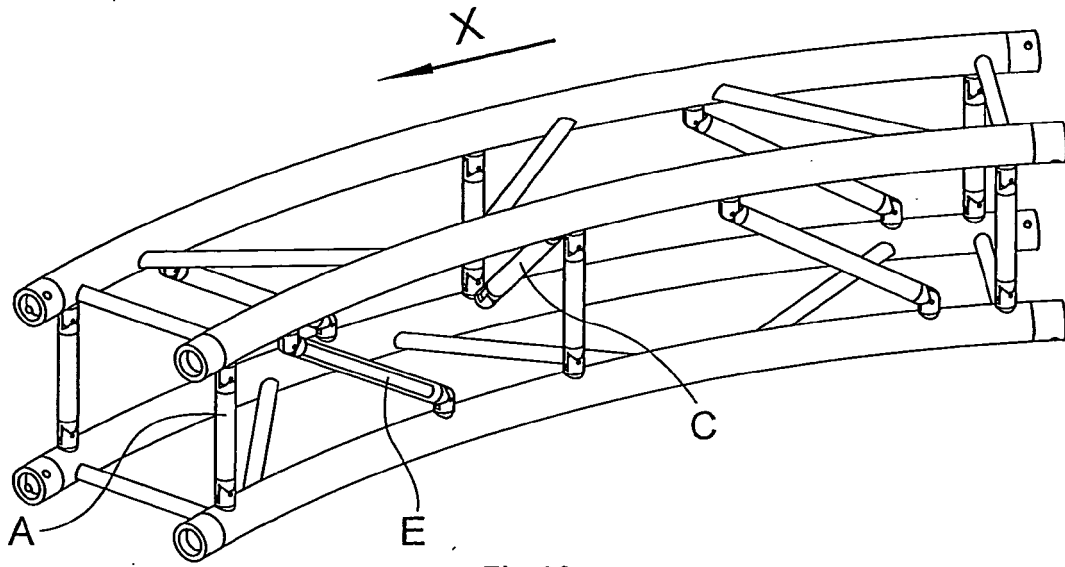


Fig. 27



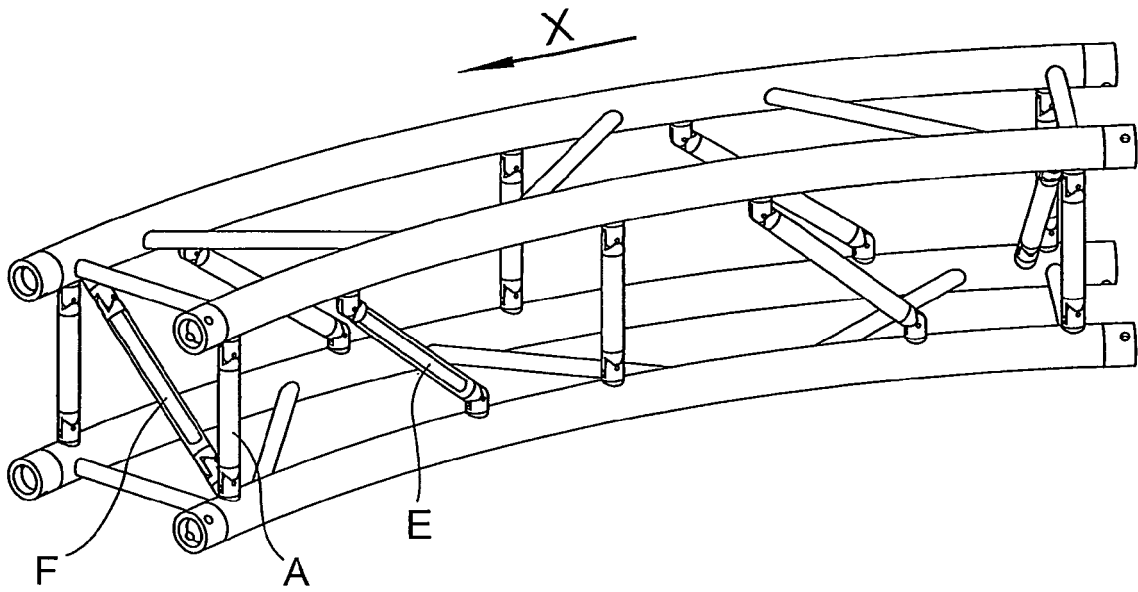


Fig. 31

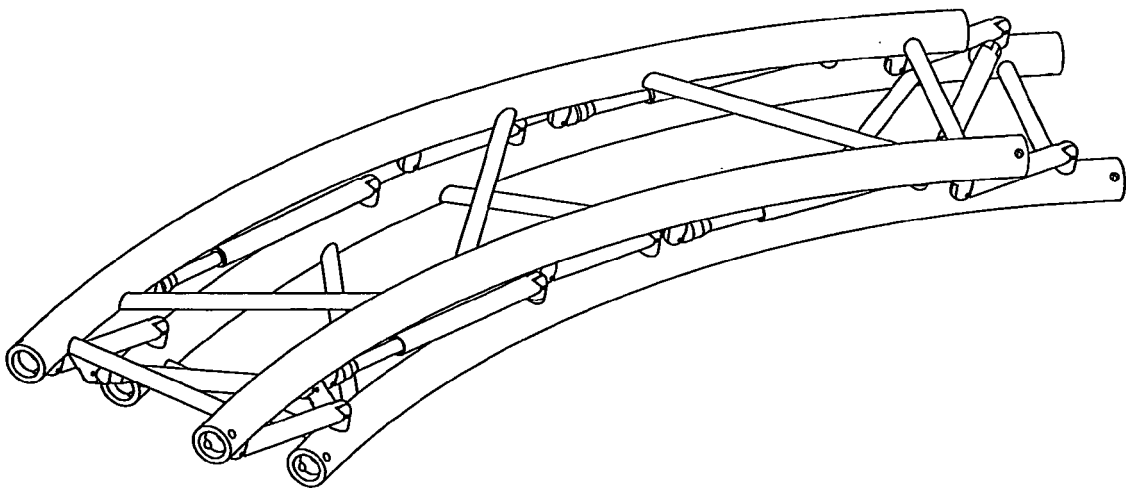


Fig. 32

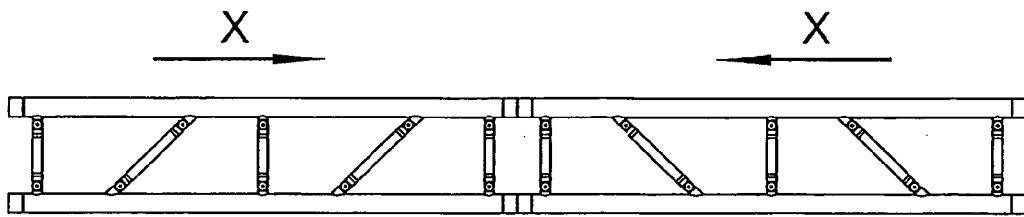


Fig. 33

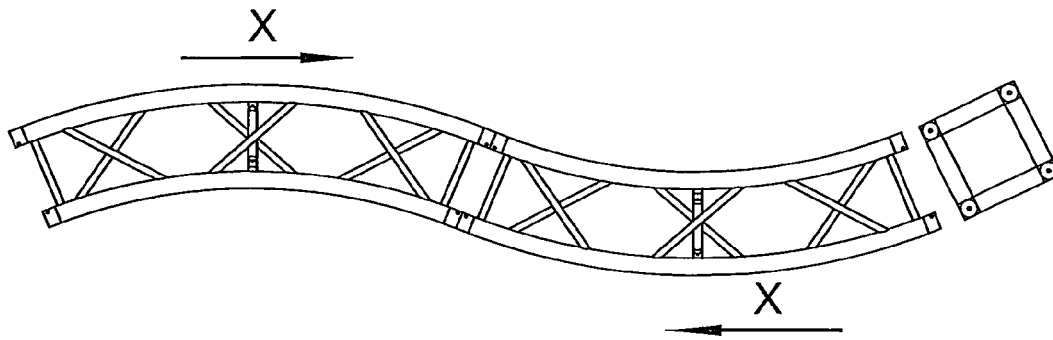


Fig. 34

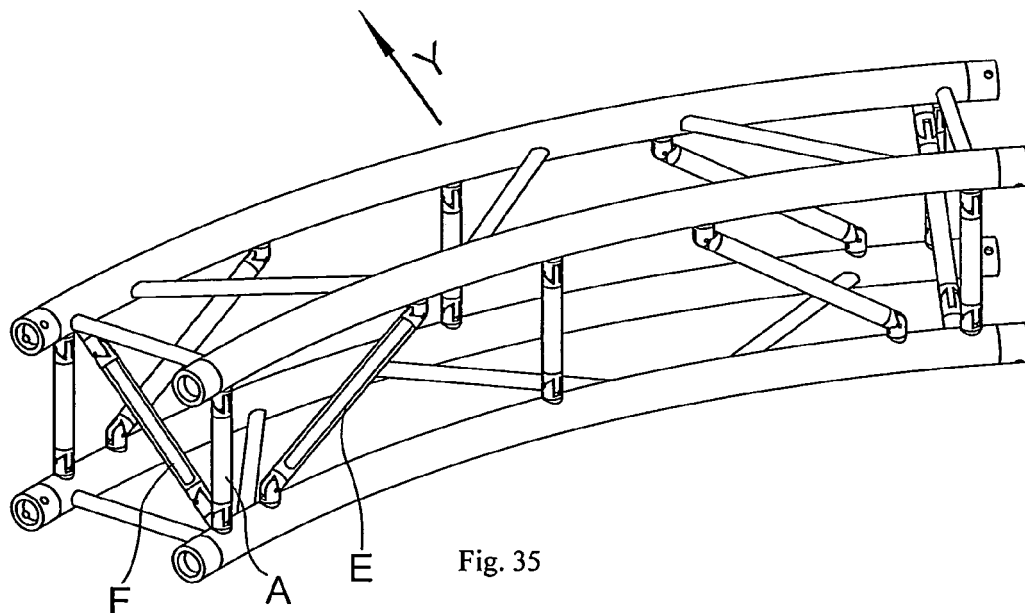


Fig. 35

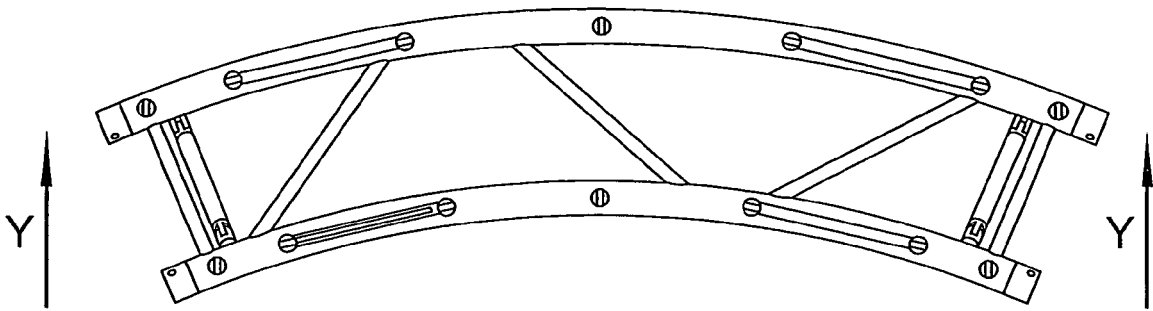


Fig. 36

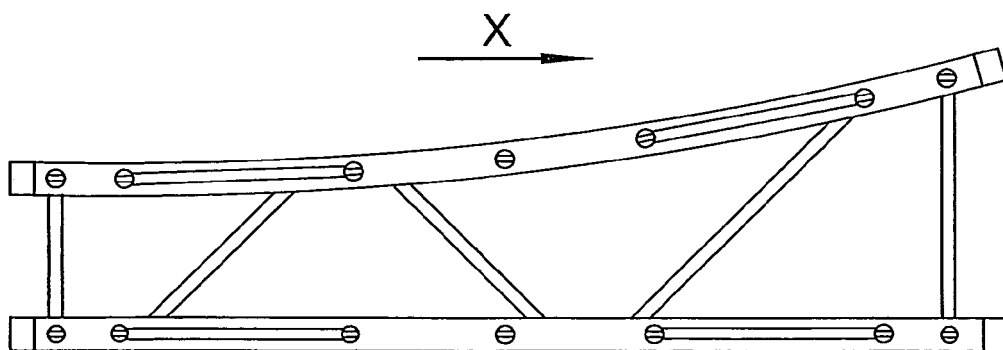


Fig. 37

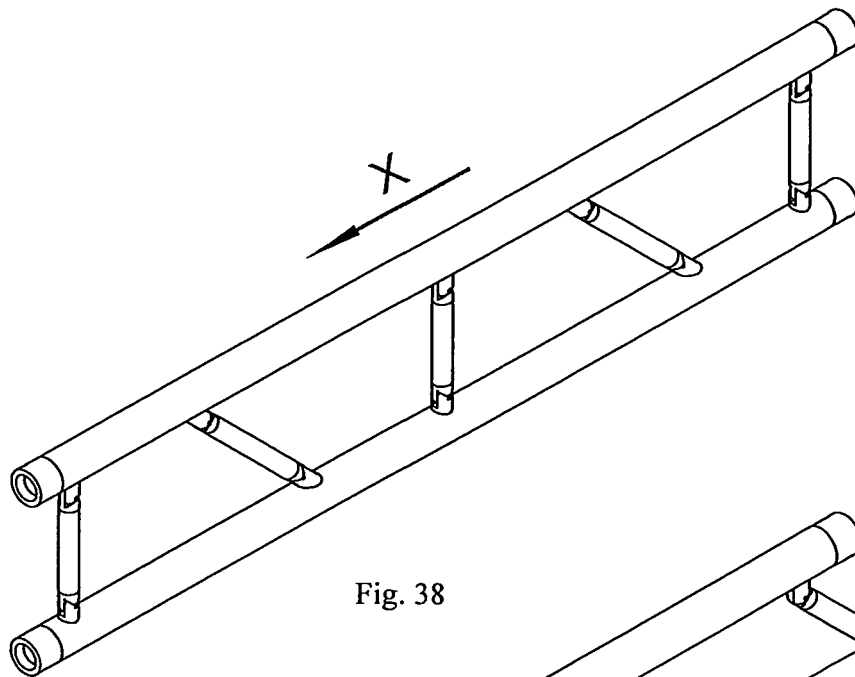


Fig. 38

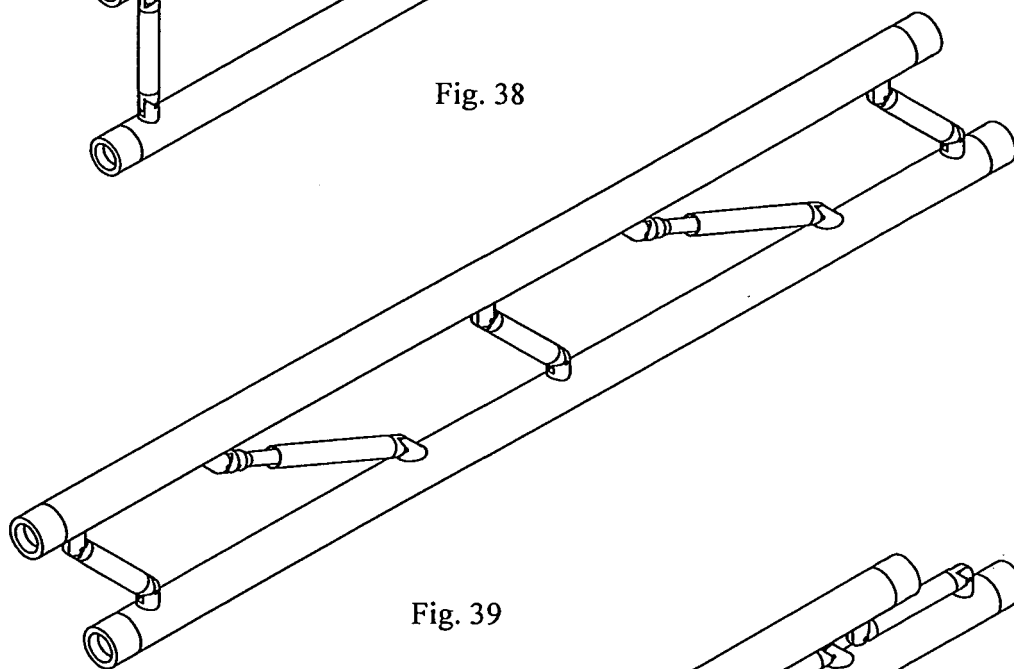


Fig. 39

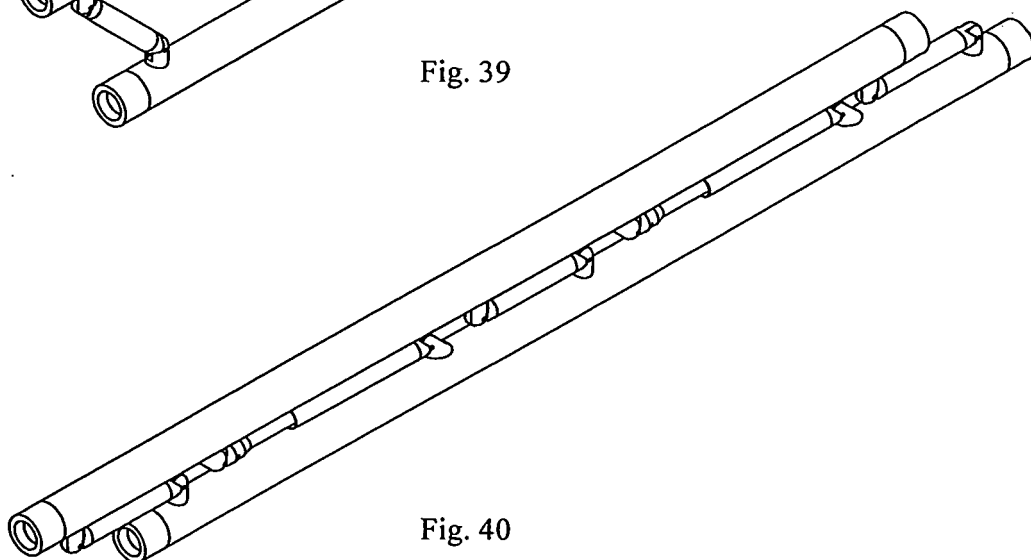


Fig. 40

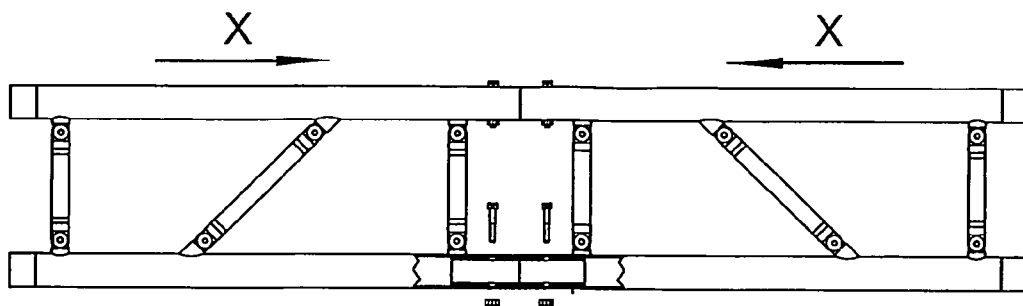


Fig. 41

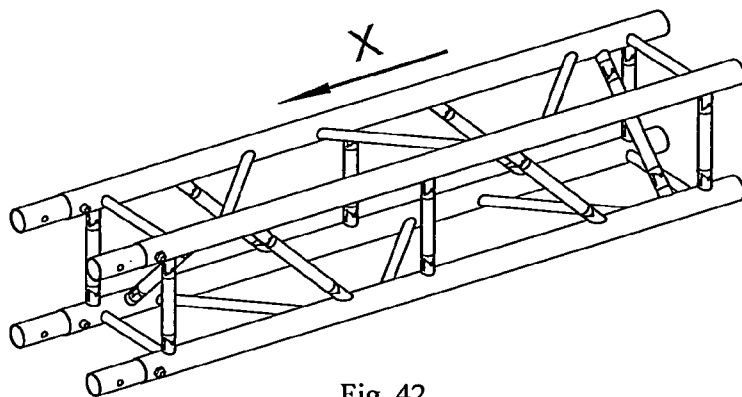


Fig. 42

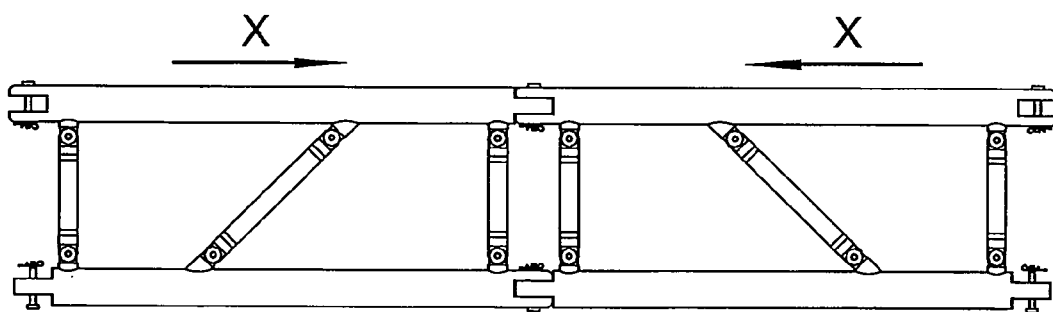


Fig. 43

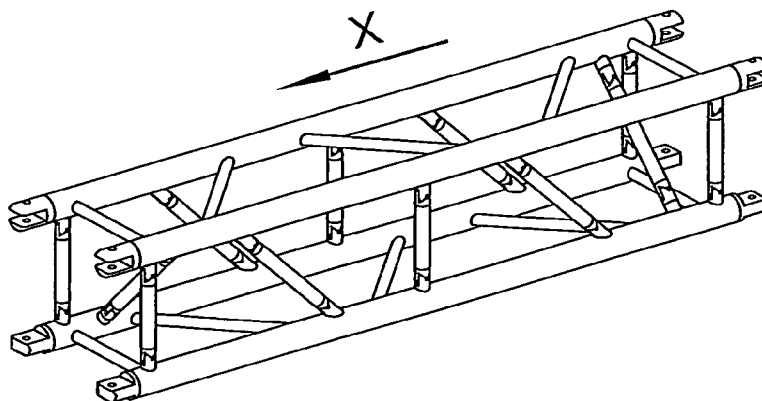


Fig. 44

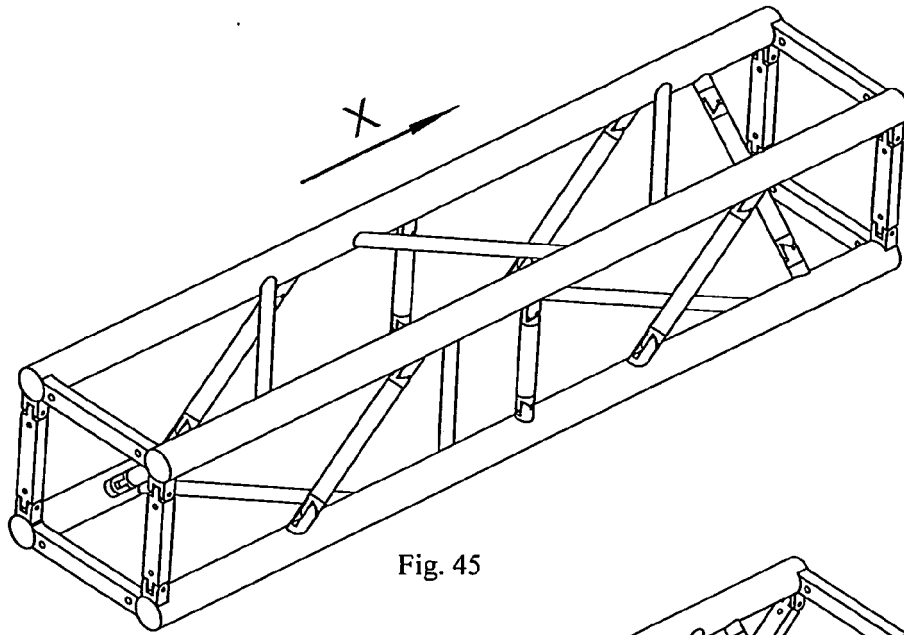


Fig. 45

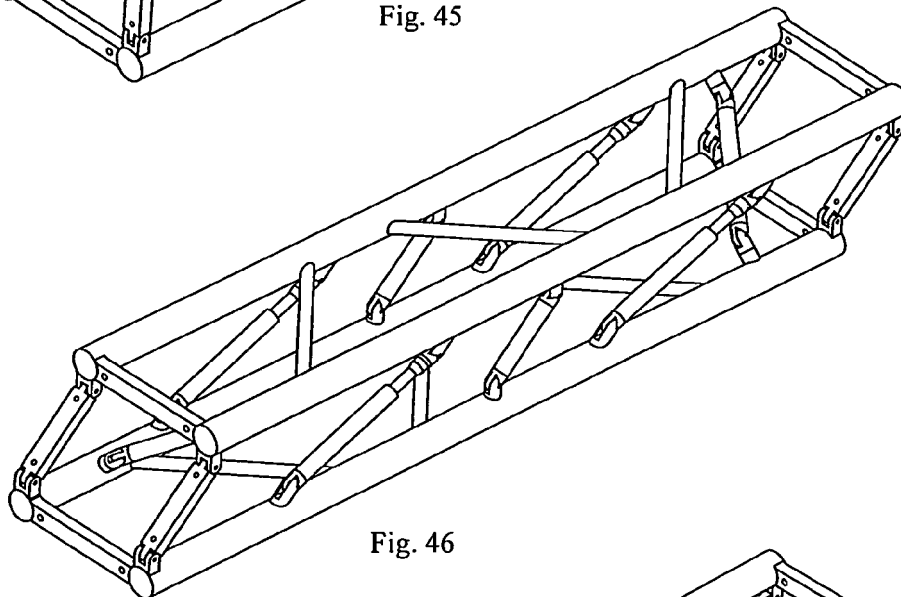


Fig. 46

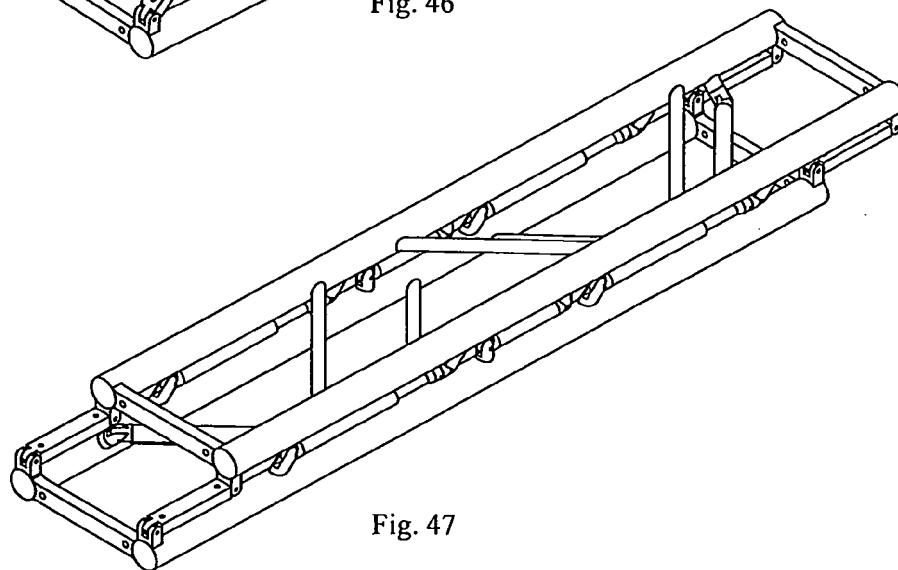


Fig. 47

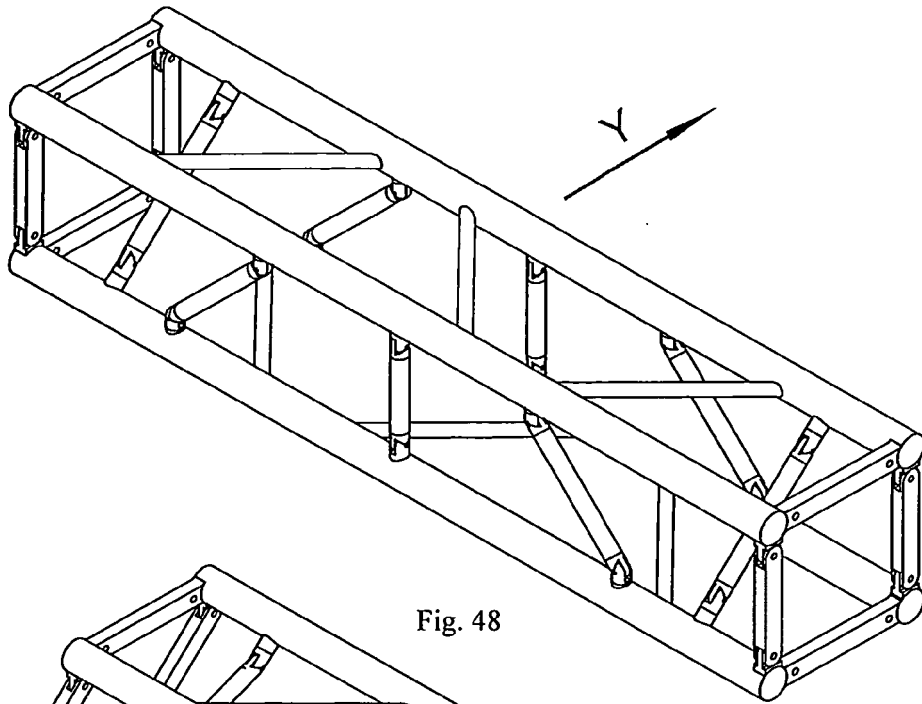


Fig. 48

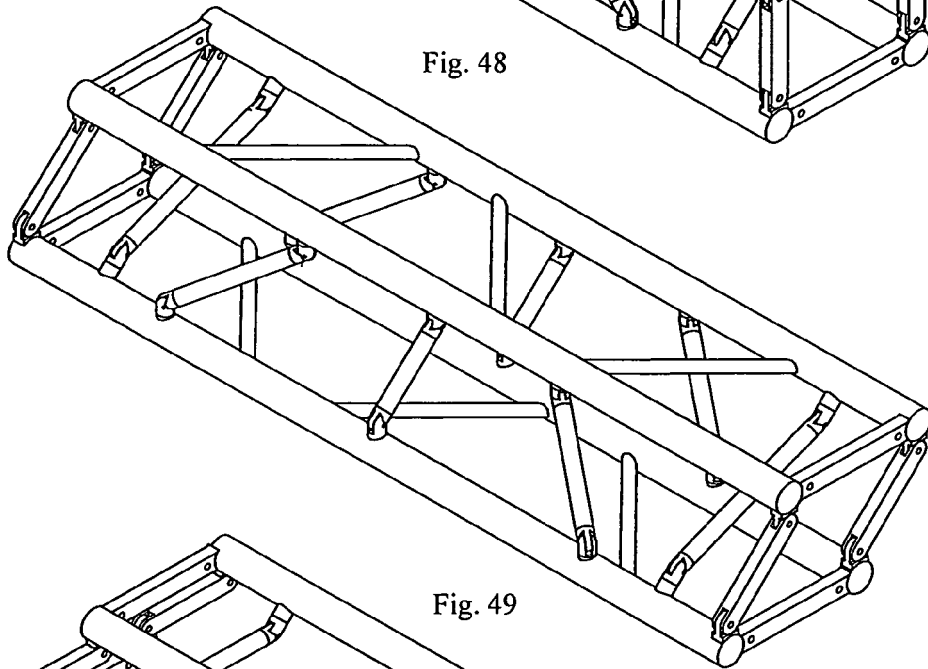


Fig. 49

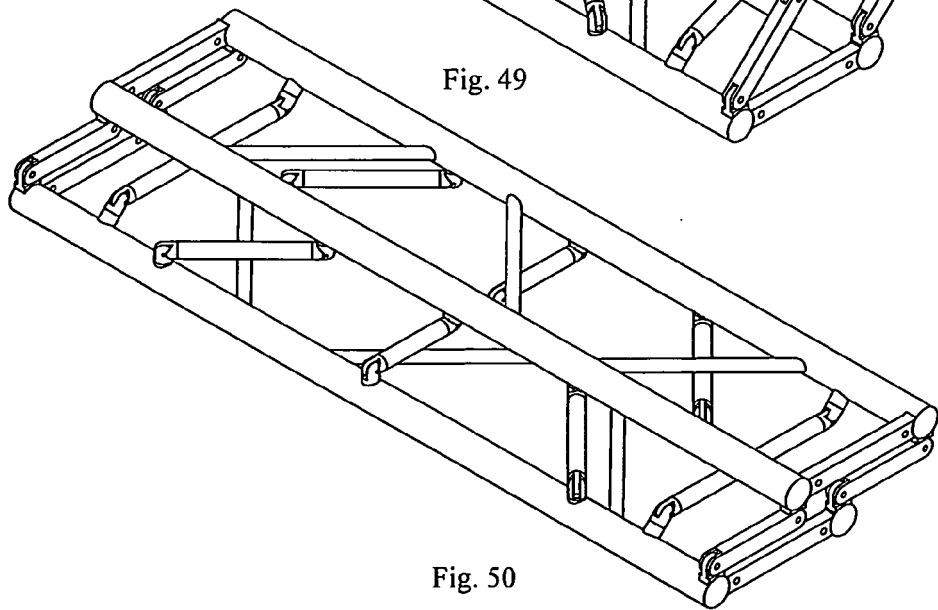


Fig. 50

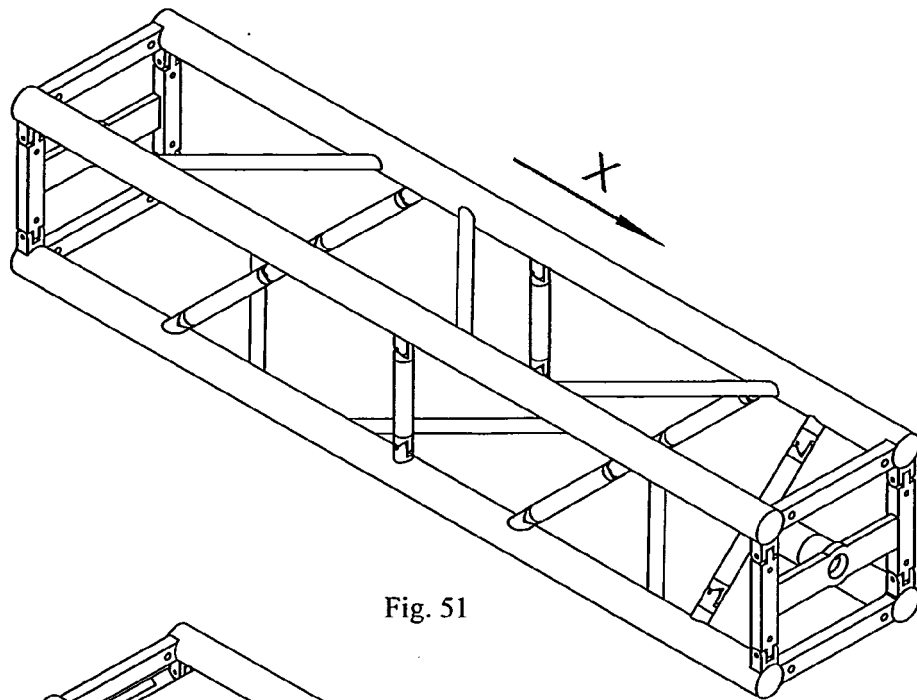


Fig. 51

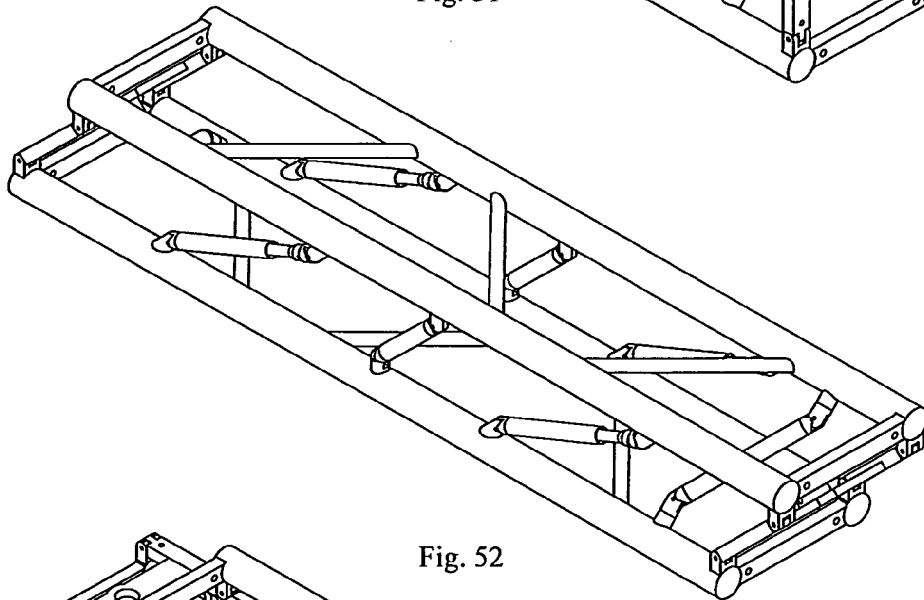


Fig. 52

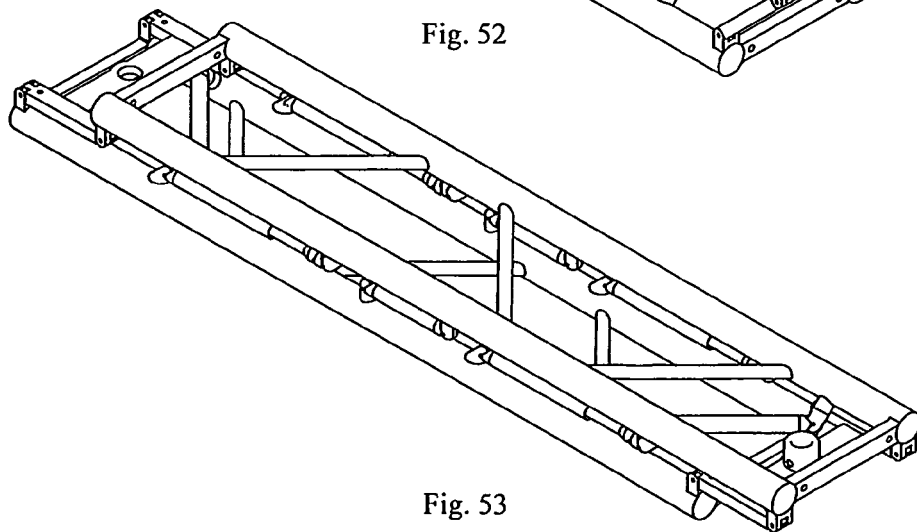


Fig. 53

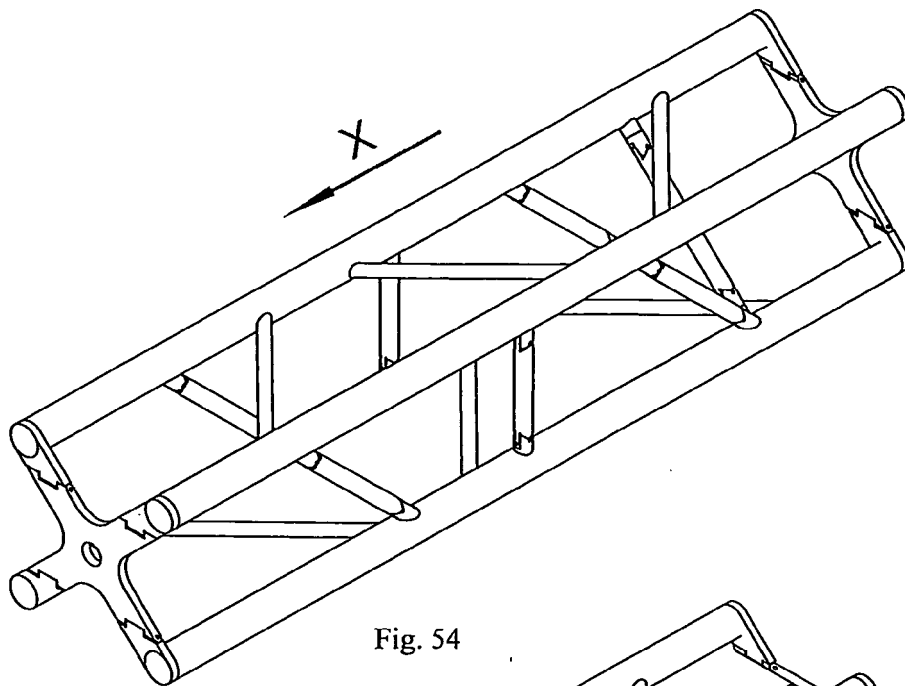


Fig. 54

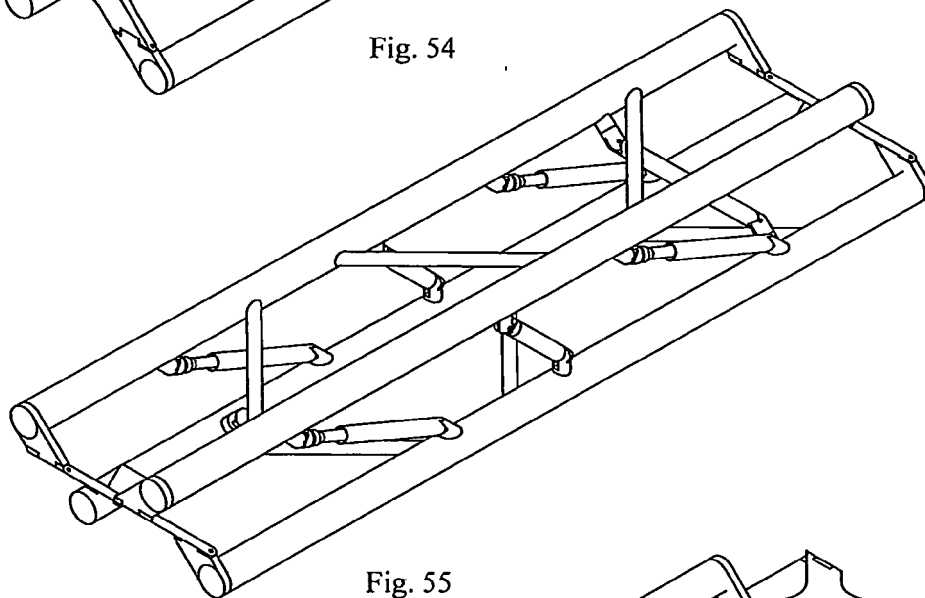


Fig. 55

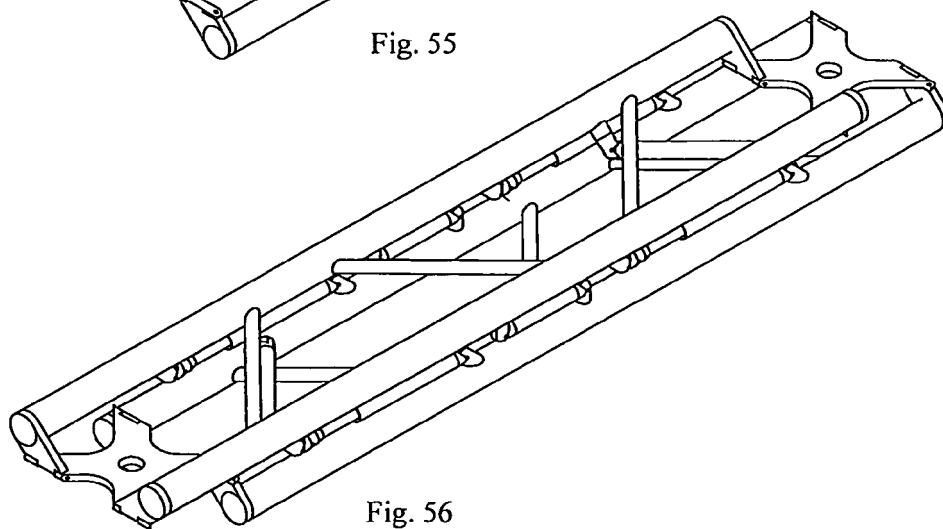


Fig. 56

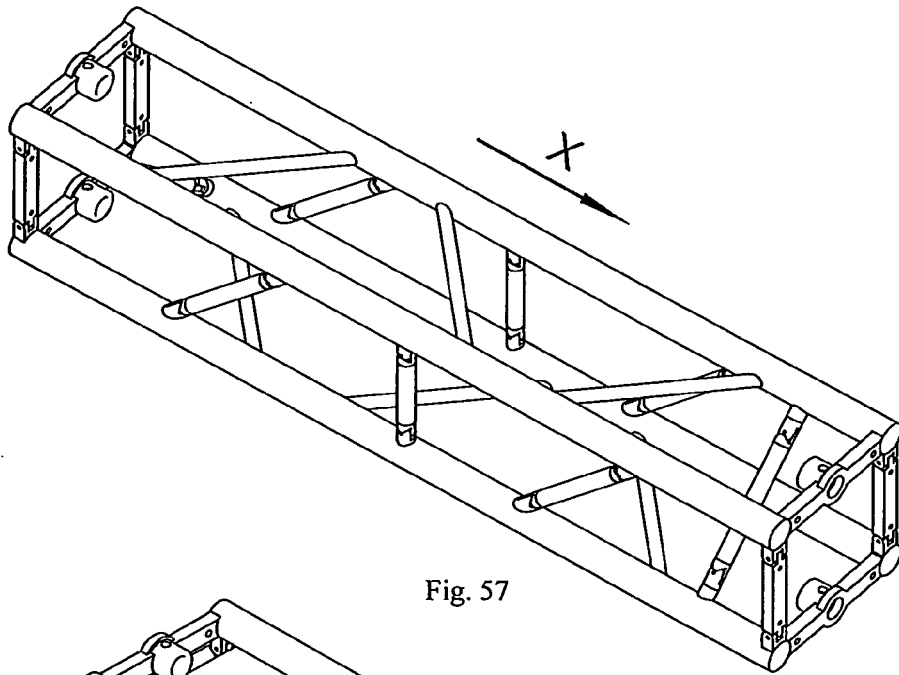


Fig. 57

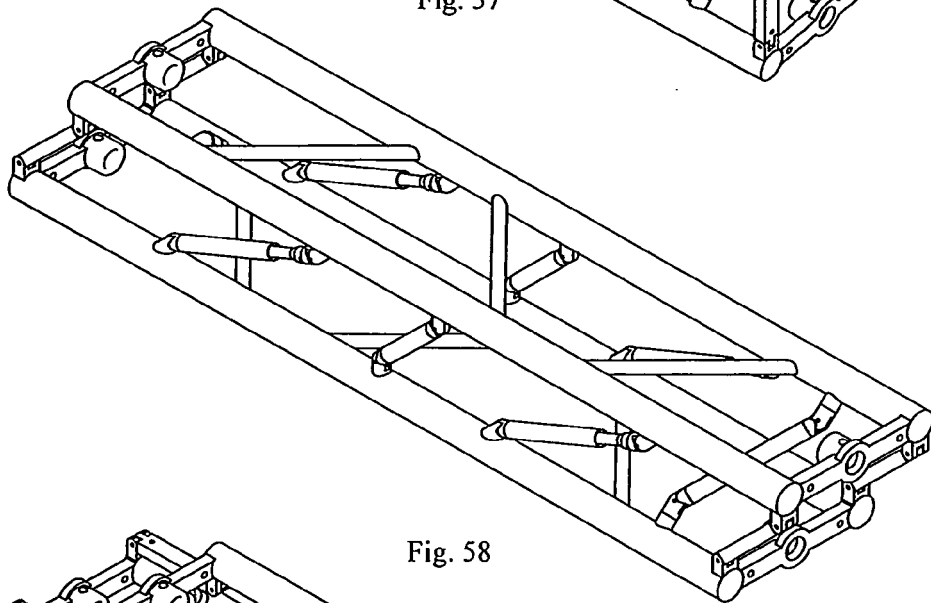


Fig. 58

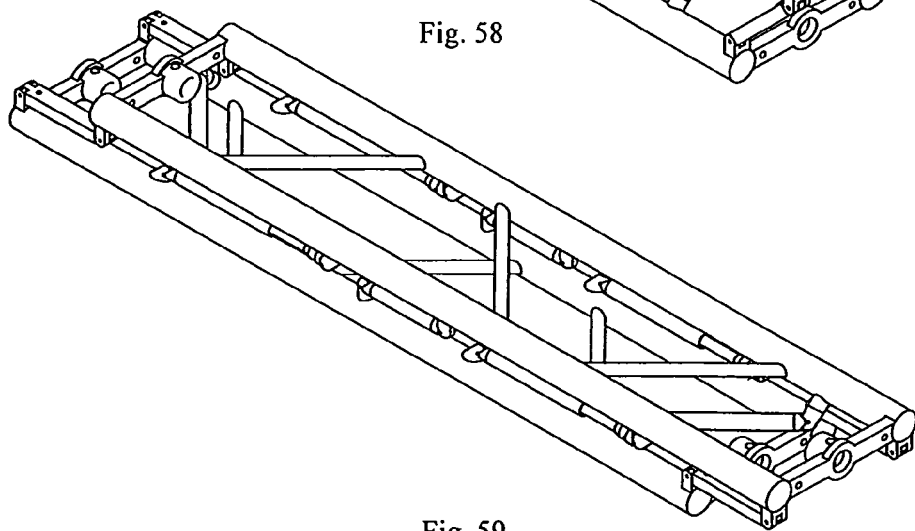


Fig. 59

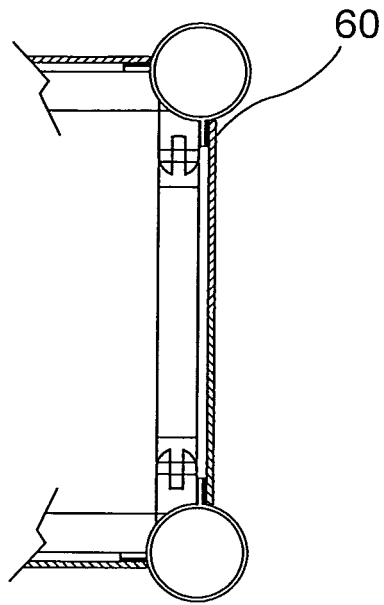


Fig. 60

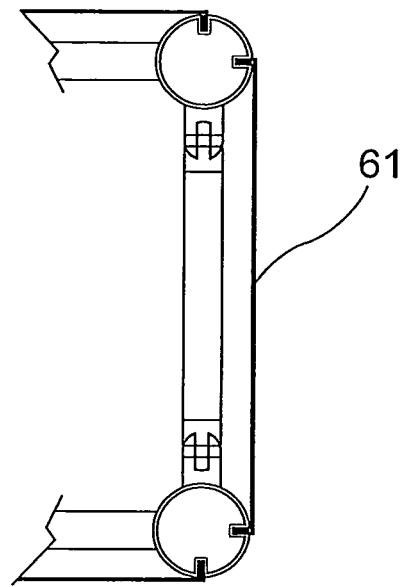


Fig. 61

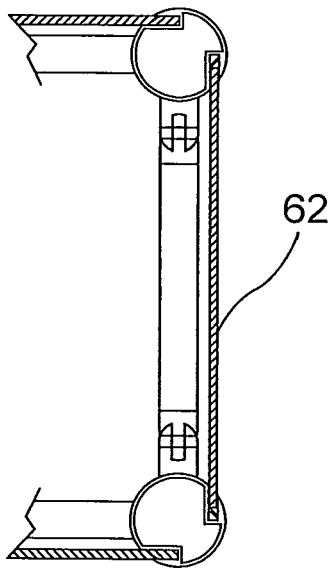


Fig. 62

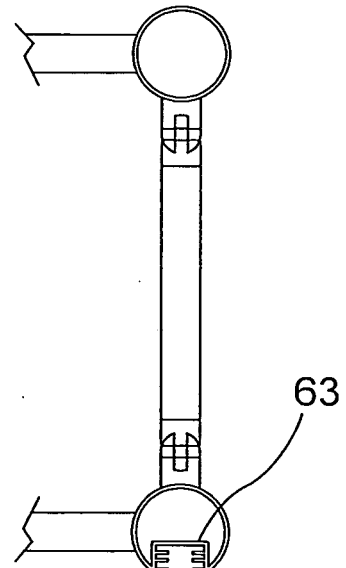


Fig. 63