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Abstract

A chair for receiving an insert and retaining the insert during casting of a concrete panel, the chair comprising one or more support portions for supporting the chair relative to a surface on which said panel is to be cast; and said chair being adapted to retain the said insert against axial movement of the insert relative to the chair in both axial directions. An insert for use with the chair, and a kit comprising the chair and the insert are also provided.

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Invention Title:

CHAIR

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

Chair

Field of the Invention

The present invention relates to chairs for locating or supporting construction elements, especially but not exclusively in the production of tilt-up or pre-cast concrete panels.

Background

Tilt-up and pre-cast concrete panels are often provided with construction elements provided therein to reinforce the panel and/or to allow engagement or attachment of the panel by fittings or machinery.

Concrete panels are often provided with construction elements in the form of threaded inserts, frequently called ferrules, cast therein. Threaded inserts are typically elongate with a threaded bore open at one or both ends, and are often anchored in a panel by a cross bar which passes through a radial through-aperture in the threaded insert and which is substantially in the plane of the panel. The cross bar may be a reinforcing bar of the concrete panel, and the term reinforcing bar, used herein, is intended to include cross bars which anchor inserts. A threaded insert should have its open end at or adjacent a surface of the panel, and thus requires careful positioning during casting of a panel.

Concrete panels are often provided with construction elements in the form of lifting anchors cast therein. A typical lifting anchor is adapted to be engaged by suitable machinery in order to allow the panel to be moved, and includes an engagement portion which is typically adapted to be located at or adjacent a surface of a cast panel. Prior to casting a concrete panel, a lifting anchor is generally provided with a "void former" surrounding the engagement portion, in order to exclude concrete from the area immediately surrounding the engagement portion. The cast panel is thus provided with

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a void surrounding a recessed engagement portion of each lifting anchor. Lifting anchors, and associated void formers, require accurate positioning during casting of a panel, to allow stress to be distributed through the panel and to allow adequate access to the engagement portions. Lifting anchors are often positioned at least partially by location relative to, and coupling to, a reinforcing bar.

To facilitate positioning of construction elements in the form of threaded inserts, plastic chairs with threaded-insert positioning portions have been provided. Wire supports with lifting-anchor positioning portions have been provided. The plastic chairs or wire supports are often tied to reinforcing bars using wire ties in an attempt to secure positioning of, respectively, the threaded inserts or lifting anchors relative to the reinforcing bars.

Reinforcing bars used to assist in positioning threaded inserts or lifting anchors are typically tied to a metal mesh structure which reinforces the panel. Chairs have been provided for supporting reinforcing bars and/or mesh. Chairs have been provided which support both a reinforcing bar and a threaded insert. Wire supports have been provided which support a lifting anchor, and to which a reinforcing bar can be tied, prior to casting.

One chair for supporting a threaded insert includes a reinforcing bar support portion upon which a reinforcing bar, which passes through an aperture in the threaded insert, is supported. In using such chairs, the position of the insert in the direction of the depth of the panel is determined by the height at which the reinforcing bar is supported (from the "bottom" of the panel, as cast). Chairs have been formed with cylindrical legs of various heights so that the correct height chair can be selected to properly position construction elements of different lengths or in panels of different thicknesses.

Summary of the Invention

A chair for receiving an insert of the type comprising an elongate body with a central axis extending in the direction of elongation of the body and a foot portion which extends further from the central axis of the insert, in a radial direction, than does the axially extending elongate portion, the chair being for retaining said insert during casting of a concrete panel, and the chair being adapted to retain the said insert against axial movement of the insert relative to the chair in the first axial direction of the insert and in the second, substantially opposite, axial direction of the insert, the chair comprising:

one or more support portions for supporting the chair relative to a surface on which said panel is to be cast and wherein the chair comprises:

at least one first insert-restraining portion for contacting the foot portion of the insert and restraining movement of the insert in the first axial direction of the insert;

at least one second insert-restraining portion for contacting the foot portion of the insert and restraining movement of the insert in the second axial direction of the insert;

wherein at least one first insert-restraining portion comprises a first insert-restraining element which is moveable relative to at least some of the rest of the chair in order to allow at least part of the foot of the said insert to move past said first insert restraining element in the second axial direction of the insert, to thereby connect the insert to the chair.

The chair may be adapted to receive an insert which comprises a threaded insert.

The chair may be adapted to receive an insert which comprises a lifting anchor.

The lifting anchor may be a foot anchor.

Preferably, the chair comprises an insert

receiving portion for receiving an insert.

Preferably, the chair is adapted to retain the said insert against axial movement of the insert relative to the chair, without use of additional elements, and in particular, even when no reinforcing bar is engaged with the insert.

Preferably, there are provided at least two first insert-restraining portions.

Preferably, the or each first insert-restraining portion is formed as part of at least one first insert-restraining element.

Preferably, there are provided at least two first insert-restraining elements.

Preferably, there are provided at least two second insert-restraining portions.

Preferably, the or each second insert-restraining portion is formed as part of at least one second insert-restraining element.

Preferably, there are provided at least two second insert-restraining elements.

Preferably said at least one first insert-restraining element is biased toward the restraining position.

Preferably, said at least one first insert-restraining element is adapted to be forced from the restraining position to the non-restraining position by movement of at least part of an insert in the second axial direction.

Preferably, said at least one first insert-restraining element is adapted not to be forced from the restraining position to the non-restraining position by movement of at least part of an insert in the first axial direction.

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Preferably, said at least one first insert-restraining element comprises a first engagement portion adapted to be engaged by an insert when the insert is moved in the second axial direction, so that the first insert-restraining element is forced substantially out of the path of the insert.

Preferably, said at least one first insert-restraining element comprises a second engagement portion adapted to be engaged by an insert when the insert is forced in the first axial direction, so that the first insert-restraining element remains in the path of the insert in order to restrain movement of the insert in the first axial direction.

Preferably the at least one first insert-restraining element is adapted to be moved angularly about a rotation axis that remains substantially stationary relative to at least part of the rest of the chair.

Preferably the rotation axis is in a plane substantially perpendicular to the main axis of the chair.

Preferably, when the insert is forced in the first axial direction, the force applied by the insert to the second engagement portion is applied to a region of the second engagement portion which is closer to the main axis of the chair than is the rotation axis. In a preferred embodiment application of a force in the first direction thus tends to force the first insert-restraining elements towards the main axis of the chair, avoiding splaying of the first insert-restraining elements.

Preferably the at least one first insert-restraining element includes a portion for engaging a peripheral part of the insert. In a preferred embodiment this prevents the first insert-restraining elements being moved substantially towards the axis of the chair.

Preferably the chair comprises one or more elements, distinct from the at least one first insert-restraining element, for restricting radial movement of the insert.

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Preferably the second insert-restraining elements are adapted to restrict radial movement of the insert.

Alternatively or additionally one or more parts of the chair adjacent the one or more second insert-restraining elements may be adapted to restrict radial movement of the insert.

Preferably, the chair comprises between three and six first insert-restraining elements.

Preferably, the chair comprises between three and six second insert-restraining elements.

Preferably, the insert receiving portion is provided at a generally central part of the chair.

Preferably, the insert receiving portion comprises at least two first insert-restraining elements.

Preferably, the insert receiving portion comprises at least two second insert-restraining elements.

Preferably, at least two first insert-restraining elements are angularly spaced about an insert receiving portion.

Preferably, at least three first insert-restraining elements are substantially equally angularly spaced about the insert receiving portion.

Preferably, at least two second insert-restraining elements are angularly spaced about the insert receiving portion.

Preferably, at least three second insert-restraining elements are substantially equally angularly spaced about the insert receiving portion.

The words "equally angularly spaced" in this context are not intended to be construed as a limitation that the insert receiving portion is circular, since insert receiving portions of other cross sections may be used. However, in at least one preferred embodiment the insert receiving portion is generally circular in cross section.

Preferably, the chair comprises at least one first foot portion adapted to support the chair, relative

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to the substrate, at a first higher height, and at least one second foot portion, adapted to support the chair, relative to the substrate, at a second lower height.

Preferably, there is provided means for a user to select whether the or each first foot portion or the or each second foot portion is operational.

Preferably, when each first foot portion is in its operative position each respective second foot portion is non-operational.

Preferably, each first foot portion projects further from the remainder of the chair than each second foot portion.

Preferably, each second foot portion can be made operative by removal of each first foot portion.

The chair is preferably formed so that each first foot portion may be detached from the remainder of the chair.

Preferably, each first foot portion is adapted to be broken off of the remainder of the chair.

In some embodiments the chair further comprises at least one third foot portion for engaging the surface, adapted to support the chair at a third height.

In some embodiments, each of the first and second foot portions can be moved from an operative position to a non-operative position by detachment of said foot portions from the remainder of the chair.

In some such embodiments the or each third foot portion can engage the surface when the first and second foot portions are in non-operative positions, thereby enabling the chair to be configured to space apart the insert support portion from the surface at a third height.

In some embodiments, the chair has a plurality of leg members and has a first foot portion and a second foot portion projecting from each leg member.

In some embodiments, the chair has a plurality of leg members and has a first foot portion, a second foot portion, and a third foot portion projecting from each leg

member.

Preferably, the chair comprises at least two leg members which act as support portions.

Preferably, the chair comprises four leg members which act as support portions.

Preferably, each leg member is associated with at least one foot portion for engaging the substrate on which a concrete panel is to be cast and, in use, spaces apart said at least one foot portion from the insert receiving portion.

Preferably, each leg portion is provided with at least one first foot portion adapted to support the leg portion at a first higher height, and at least one second foot portion, adapted to support the leg portion at a second lower height.

Preferably, each foot portion has a contact portion for contact with the surface which has a surface area which is small compared to the total cross sectional area of each leg member.

Preferably, each foot portion has a contact portion which is not more than approximately 25 square millimetres.

Preferably, each foot portion is tapered from a wider connection portion, connected to a leg member, to a narrower contact portion for contact with the surface.

Preferably, the or each first foot portion is longer than the each second foot portion.

Preferably, at least one first foot portion comprises a first foot connection portion, connected to a leg member, and a first foot contact portion for contact with the surface, the first foot connection portion and the first foot contact portion being spaced apart by a first distance.

Preferably, at least one second foot portion comprises a second foot connection portion, connected to a leg member, and a second foot contact portion for contact with the surface, the second foot connection portion and

the second foot contact portion being spaced apart by a second distance.

Preferably the first distance is greater than the second distance.

Preferably, the chair is formed from a plastic.

Preferably, the chair is injection moulded.

Preferably, the chair is suitable for injection moulding by a two-part mould.

A preferred embodiment of a chair in accordance with the first aspect of the present invention further comprises at least one bar-engaging portion adapted to engage a reinforcing bar associated with the insert and, in use, retain the reinforcing bar in a predetermined orientation, in a plane substantially perpendicular to the axis of the chair.

Preferably, the chair comprises at least two bar-engaging portions.

Preferably, the or each bar-engaging portion is configured to provide a recess into which the bar may snugly fit.

Preferably, the chair is configured so that, in use, it is adapted to exert a force upon said insert, which forces the insert to exert a force upon the bar which helps to retain the bar in the or each recess.

Preferably the or each bar engaging portion provides a guide surface for guiding the bar towards the predetermined orientation.

Preferably the or each guide surface is adjacent the, or a respective, recess.

Preferably the or each guide surface is adapted to guide the bar back to the recess, in the event that the bar becomes inadvertently separated from the recess.

Preferably the or each bar engaging portion provides a bar abutment surface for preventing angular movement of the bar past the predetermined orientation in one rotational direction.

Preferably the or each abutment surface is

adjacent the, or a respective, recess.

In a preferred embodiment engagement and retention of a reinforcing bar by the bar-engaging portions reduces or eliminates the need to manually tie the reinforcing bar to the chair, thus making placement of assemblies consisting of a chair, an insert and a reinforcing bar considerably more quick and convenient to assemble and position.

In an embodiment of a chair in accordance with the present invention the insert receiving portion comprises a construction element support portion for supporting a construction element in the form of an insert and the chair further comprises:

a retainer for retaining in position a void former associated with the construction element; and at least one support for connecting the retainer and the support portion.

Preferably, the at least one support for connecting the retainer and the support portion is substantially rigid.

Preferably, the chair comprises at least two substantially rigid supports for connecting the retainer and the support portion.

Preferably, the chair further comprises at least two leg portions, adapted to space the construction element support portion from a surface upon which a concrete panel is to be cast.

Preferably the leg portions are generally tubular.

Preferably, the construction element support portion is formed from a plastic.

Preferably, the retainer is formed from a plastic.

The retainer is preferably adapted to fit around a void former.

The retainer is preferably adapted to fit around a void former which comprises two or more parts, and to

retain two or more parts in a desired position relative to said construction element.

Preferably, the at least one support is formed from a plastic.

Preferably, at least one support is formed as a single piece with the retainer.

Preferably, at least one support is formed as a single piece with the retainer, by a plastics moulding process, most preferably injection moulding.

Preferably, at least one support is generally tubular.

Preferably, at least one of a support and a leg portion is formed with a generally axially extending cavity therein.

At least one support may be connected to at least one leg portion by a connection member which fits within a cavity provided in at least one of the support and the leg portion.

The connection member is preferably formed separately from the support and the leg portion.

The connection member may be formed as an integral part of the support.

The connection member may be formed as an integral part of the leg portion.

According to a second aspect of the present invention there is provided a kit comprising:
a construction element comprising an insert; and
a chair for receiving the insert and retaining the insert during casting of a concrete panel,

wherein portions of the chair and of the insert can interact so that said insert is retained against axial movement of the insert relative to the chair in the first axial direction of the insert and in the second, substantially opposite, axial direction of the insert.

The insert may comprise a threaded insert.

The insert may comprise a lifting anchor.

The lifting anchor may be a foot anchor.

Preferably the chair is in accordance with the first aspect of the present invention.

According to a third aspect of the present invention there is provided an insert for use with the chair in accordance with the first aspect of the present invention and/or forming part of the kit in accordance with the second aspect of the present invention.

The insert may comprise a threaded insert.

The insert may comprise a lifting anchor.

The insert may comprise a foot anchor.

Preferably, the insert comprises an axially extending elongate portion in which is provided an axially extending female threaded bore.

Preferably, the insert comprises a foot portion which extends further from the axis of the insert, in a radial direction, than does the axially extending elongate portion.

According to a fourth aspect of the present invention there is provided a threaded insert for use with the chair in accordance with the first aspect of the present invention and/or forming part of the kit in accordance with the second aspect of the present invention, the threaded insert comprising an axially extending elongate portion and a foot portion which extends further from the axis of the threaded insert, in a radial direction, than does the axially extending elongate portion.

Preferably, the insert is formed of metal.

Preferably, the axially extending elongate portion is provided with a generally radially extending through bore, for receiving a reinforcing bar therethrough.

Preferably, the foot portion comprises a foot bottom surface facing generally in a first axial direction.

Preferably, the foot bottom surface is adapted to engage a restraining portion of a chair for restraining

axial movement of the insert relative to the chair in the first axial direction.

Preferably, the foot portion comprises a foot upper surface facing at least partially in a second axial direction.

Preferably, the foot upper surface is adapted to engage a restraining portion of a chair for restraining axial movement of the insert relative to the chair in the second axial direction.

Features disclosed above as being preferable in relation to the fourth aspect of the invention may also be beneficial in embodiments of the third aspect.

Brief description of the drawings

Embodiments of the invention will now be described by way of example only with reference to the accompanying drawings, in which:

Fig. 1 is a perspective view of a chair related to a preferred embodiment of a chair in accordance with the present invention;

Fig. 2 is a plan view of the chair of Fig. 1;

Fig. 3 is a side view of the embodiment of Figs. 1 and 2;

Figs. 4 and 5 are respectively side views on IV-IV and V-V in Fig. 2;

Figs. 6 and 7 are respectively cross-sections on VI-VI and VII-VII of Fig. 2;

Figs. 8 and 9 are side views corresponding generally to Figs. 4 and 5 respectively, but showing the position of an insert and reinforcing-bar supported in, respectively, a higher position and a lower position;

Fig. 10 is a perspective view of an embodiment of a chair in accordance with the present invention;

Fig. 11 is a perspective view of the chair of Fig. 10 from a different angle;

Fig. 12 is a plan view of the chair of Fig. 1;

Figs 13 and 14 are respectively side views on

XIII and XIV in Fig. 12;

Figs 15 and 16 are respectively cross-sections on XV-XV and XVI-XVI of Fig. 12;

Fig. 17 is a cross sectional view corresponding to that of Fig. 16, but showing schematically the position of an insert supported in the chair;

Fig. 18 is an enlarged cross sectional view corresponding to part of that of Figs 16 and 17, and showing schematically the movement of an element of the chair;

Fig. 19(a) is a side view of an insert for use with the chair of Figs 1 to 9;

Fig. 19(b) is a plan view of the insert of Fig. 19(a);

Fig. 19(c) is a cross section on C-C of Fig. 19(b);

Fig. 20(a) is a schematic partial cross sectional view of a reinforcing bar, associated with an insert, being retained by the chair of Figs 10 to 18; and

Fig. 20(b) is a schematic showing how the reinforcing bar of Fig. 20 (a) is retained by opposed elements of the chair of Figs 10 to 18;

Fig. 21 is an exploded perspective view of a further embodiment of a chair in accordance with the present invention, an insert and part of a void former;

Figs 22 to 24 are a perspective views corresponding to Fig. 21, but from different angles;

Figs 25 and 26 are a perspective views showing the elements of Figs 21 to 24 in a less exploded view;

Figs 27 to 30 are perspective views showing separate elements of Figs 21 to 26;

Figs. 31, 32 and 33 are respectively a side elevation, a plan view and a perspective view of an embodiment of a fixing element which is appropriate for use with the chair of Figs 1 to 10 and variations of which are appropriate for use with the chairs of Figs 10 to 18 and/or 21 to 28 in accordance with an aspect of the

present invention; and

Fig. 34 is a partial cross-sectional view of an embodiment of a chair, fixed relative to a surface by the fixing element of Figs. 31 to 33.

Detailed Description of Embodiments

With reference to Figs. 1 to 9, an embodiment of a chair, for supporting a reinforcing-bar and a threaded insert, is generally designated 1. The chair of Figs 1 to 9 is related to the chair of the present invention and description of this chair is included to assist in understanding some features of the embodiments of chairs in accordance with the present invention is for particular use in supporting a reinforcing-bar relative to a generally horizontal surface upon which a tilt-up concrete panel is to be cast. The casting of tilt-up concrete panels is known per se and will not be described herein. The chair 1 comprises an insert receiving portion in the form of a central generally cylindrical portion 10 which defines a cavity or recess therein into which a threaded insert, to be cast into a concrete panel, may be provided. The cavity or recess which is defined is designated 5 in the drawings and in this embodiment is open at both ends. Extending radially outwardly from the cylindrical portion are first, second, third and fourth web portions 11, 12, 13, 14 for connecting the cylindrical portion to respective first to fourth legs 21, 22, 23, 24. Each leg 21, 22, 23, 24 is generally cylindrical in form and extends downwardly substantially perpendicular to the respective web portion. At the lower end of each leg 21, 22, 23, 24 is provided a respective first foot 31, 32, 33, 34 and a respective second foot 41, 42, 43, 44. Each of the first feet projects downwardly a greater distance than each of the second feet so that, in use, the chair may be supported on a surface on the four first feet 31, 32, 33, 34. However, in order to vary the distance between the rest of the chair and the surface, the user has an option

of removing each of the first feet 31, 32, 33, 34, for example with pliers, so that the chair can stand upon the second feet 41, 42, 43, 44. Thus, the provision of two different sets of feet allows the user to select the height at which the chair supports a reinforcing-bar and insert relative to the surface on which it stands.

Each of the legs includes a generally cylindrical bore therethrough 25, 26, 27, 28, respectively.

Extending between the cylindrical portion 10 and each of the legs 21, 22, 23, 24 along an upper extreme of each of the web portions 11, 12, 13, 14 are provided respective horizontal brace members 15, 16, 17, 18. The brace members 15, 16, 17, 18 are of approximately the same width as the diameter of the legs and extend perpendicularly outward from the web portions 11, 12, 13, 14 to form reinforcing flanges which help to reinforce the web members. The horizontal brace members help prevent undesirable flexing of the web portions.

Extending upwardly from the cylindrical portion and substantially continuous therewith there are provided supporting members to support an insert which, in this embodiment, are in the form of first to fourth upwardly extending projections 51, 52, 53, 54. Each projection includes a respective first to fourth buttress portion 55, 56, 57, 58 which is somewhat triangular in shape and which extends from the top of the respective projection 51, 52, 53, 54 to the respective horizontal brace members 15, 16, 17, 18 almost as far as the respective first to fourth legs 21, 22, 23, 24. At the base of one of the buttress portions 58 is an identification tab 59 which bears information, for example, relating to the dimensions of the chair.

Each upwardly extending projection further includes a respective first to fourth part cylindrical portion 61, 62, 63, 64 which is substantially continuous with the inner surface of the cylindrical portion 10 and which extends a short distance on either side of the

respective buttress portion. The part cylindrical portions 61, 62, 63, 64, therefore, effectively provide reinforcing flanges to help prevent undesirable lateral movement of the projections 51, 52, 53, 54. The upwardly extending projections 51, 52, 53, 54 further comprise first to fourth vertically extending guide rails 65, 66, 67, 68 for guiding and frictionally retaining a threaded insert for casting into a concrete panel. It will be appreciated that in this embodiment the guide rails 65, 66, 67, 68 run continuously from the upwardly extending projections 51, 52, 53, 54 to the cylindrical portion 10.

It will be appreciated that, in use, there is a space between the upwardly extending projections 51, 52, 53, 54 for receiving a threaded insert and this space is continuous with the recess or cavity 5 into which the insert may extend. Between any two adjacent upwardly extending projections, there is provided a space through which a reinforcing-bar may pass. It will be appreciated that a reinforcing-bar which runs diametrically with respect to the cylindrical portion 10 will pass between two of the four upwardly extending projections through part of the insert receiving space and then between the other two of the four projections. In this way a reinforcing-bar, and a threaded insert which it anchors, can be received and located by the chair. Between the first and second extending projections 51, 52 there is effectively provided a slot which, in this embodiment, extends downward to the level of the horizontal brace members 15, 16, 17, 18, the top edges of the web portions 11, 12, 13, 14, the top of the cylindrical portion 10 and the tops of the legs 21, 22, 23, 24. A substantially identical slot is provided between the third and fourth upwardly extending projections 53, 54. Thus, a reinforcing-bar which extends through the slot between the first and second upwardly extending projections 51, 52 and through the slot between the third and fourth upwardly extending projections 53, 54 will be supported effectively

on the upper edges of the cylindrical portion 10 at a first, lower, height. These upper edges of the wall defining the cylindrical portion 10 are designated 71 and 72 in the drawings and are examples of lower reinforcing-bar support portions.

Between the second and third upwardly extending projections 52, 53 there is provided a less deep slot which is terminated at its bottom end by an arcuate wall portion 76 which may be regarded as an extension of the wall of the cylindrical portion 10. In the preferred embodiment, the slot between the second and third projections 52, 53 is approximately two thirds of the depth of the slot between the first and second upwardly extending projections 51, 52. That is to say the wall portion 76 extends upwardly from the cylindrical portion 10 approximately a third of the height of the upwardly extending projections 51, 52, 53, 54. The upper edge 73 of the wall portion 76 provides a surface which can support a reinforcing rod. A similar wall portion 77 is provided between the first and fourth upwardly extending projections 51, 54 and provides an upper edge 74 for supporting a reinforcing-bar. Thus, the wall edges 73 and 74 may be regarded as examples of higher reinforcing-bar support portions for supporting a reinforcing-bar at a height higher than the height at which a bar would be supported by the wall edges 71, 72.

It will, of course, be appreciated that there are many ways of providing support portions to support a reinforcing-bar and the preferred embodiment illustrates one example. Variations are possible. For example reinforcing-bar support portions could be formed by recesses cut in a sturdy cylindrical or square tubular portion, or supports non-continuous with a cylindrical portion could be provided to extend between upwardly projecting portions.

Figs. 8 and 9 show a chair of the general type described above with a reinforcing-bar 80 and threaded

insert 81 supported at a higher height in Fig. 8 and at a lower height in Fig. 9.

It will be appreciated that the provision of higher and lower reinforcing-bar support portions on the chair and also the provision of two distinct sizes of foot allow a single manufactured chair, such as the embodiment of Figs. 1 to 9, to support a reinforcing-bar at any one of four heights. This provides a substantial benefit over earlier designs of chair which had a fixed height, and which would therefore require four separate chairs to give a user a choice of four heights.

With reference to Figs. 10 to 18, an embodiment of a chair in accordance with the present invention, for supporting a threaded insert, is generally designated 101. The chair is particularly suitable for use in supporting a threaded insert relative to a generally horizontal surface upon which a "precast" concrete panel is to be cast. The casting of precast concrete panels (which are panels which are cast at a manufacturing site, prior to transportation to a construction site where they are to be used) is known per se and will not be described herein. (It will be appreciated that the same chair could be used, to some extent, to support a suitably shaped lifting anchor.)

The chair 101 comprises an insert receiving portion in the form of a central generally cylindrical portion 110, with a somewhat octagonal radial cross section, which defines a space into which a threaded insert, to be cast into a concrete panel, can be provided and retained. In this embodiment the space, which is designated 105 in the drawings, is axially short and is open at both ends. In this embodiment the axis of the generally cylindrical portion 110 may be regarded as the axis of the chair 101, and also the axis of an insert to be retained by the chair 101.

The cylindrical portion 110 comprises first to fourth wall portions which, because they may be regarded as parts of the central cylindrical portion 110 of the

chair will be referred to as first, second, third and fourth central wall portions 106, 107, 108, 109, respectively. The cylindrical portion 110 further comprises first, second, third and fourth insert-support portions 135, 136, 137, 138, respectively.

The first to fourth central wall portions 106, 107, 108, 109, which each form part of the periphery of the cylindrical portion 110, are spaced apart from each other and distributed equally about the cylindrical portion 110, alternating with the insert-support portions 135, 136, 137, 138. That is, as best seen in Figs 10 to 12, each central wall portion is located between two insert-support portions, and each insert-support portion is located between two central wall portions.

The first and third central wall portions 106, 108 are provided with respective reinforcing bar retainers 150, 160 on the upper edges thereof. The reinforcing bar retainers 150, 160 are substantially diametrically opposed across a diameter of the cylindrical portion 110, and are adapted to support and retain a reinforcing bar, associated with an insert retained in the chair 101 in a predetermined angular orientation relative to the chair. Referring to Fig. 18 the first reinforcing bar retainer 150 will be described, and it will be appreciated that the second reinforcing bar retainer 160 corresponds. The first reinforcing bar retainer 150 may be regarded as an upwardly projecting part of the central wall portion 106. The first reinforcing bar retainer 150 comprises a recess portion 153 adapted to receive and retain a reinforcing bar. To one side of the recess portion 153 is a stop portion 151 with an abutment edge 152 for preventing rotational movement of a reinforcing bar (in a plane perpendicular to the axis of the chair) past the recess portion 153. To the other side of the recess portion 153 is a guide portion 154 which helps guide a reinforcing bar into the recess portion 153. As illustrated in Fig.18 (and even though not shown in some of the other drawings) the

guide portion is inclined so that a reinforcing bar will be guided into the recess portion 153, and so that it will be difficult for the bar to inadvertently rotate so as to leave the recess portion 153 traverse the guide portion 154 and disengage from the reinforcing bar retainer 150.

Extending radially outwardly from the cylindrical portion 110 are first to eighth generally radial wall portions 111, 112, 113, 114, 115, 116, 117, 118, which connect the generally cylindrical portion first to fourth legs 121, 122, 123, 124.

The first generally radial wall portion 111 connects the fourth central wall portion 109 to the first leg 121. The second and third generally radial wall portions 112, 113 respectively, are attached to opposite ends of the first central wall portion 106, and connect the first central wall portion 106 to the first and second legs, 121, 122 respectively. The fourth and fifth generally radial wall portions 114, 115 respectively, are attached to opposite ends of the second central wall portion 107, and connect the second central wall portion 107 to the second and third legs, 122, 123, respectively. The sixth and seventh generally radial wall portions 116, 117 respectively, are attached to opposite ends of the third central wall portion 108, and connect the third central wall portion 108 to the third and fourth legs, 123, 124, respectively. The eighth generally radial wall portion 118 connects the fourth central wall portion 109 to the fourth leg 124.

Each leg 121, 122, 123, 124 is generally cylindrical in form and extends downwardly substantially perpendicular to generally radial wall portions to which it is attached. At the lower end of each leg 121, 122, 123, 124 is provided a respective first foot 131, 132, 133, 134 and a respective second foot 141, 142, 143, 144. Each of the first feet projects downwardly a greater distance than each of the second feet so that, in use, the chair may be supported on a surface on the four first feet

131, 132, 133, 134. However, in order to vary the distance between the rest of the chair and the surface, the user has an option of removing each of the first feet 131, 132, 133, 134, for example with pliers, so that the chair can stand upon the second feet 141, 142, 143, 144. Thus, the provision of two different sets of feet allows the user to select the height at which the chair supports an insert relative to the surface on which it stands.

Each of the legs 121, 122, 123, 124 includes a generally cylindrical bore 125, 126, 127, 128, respectively, therethrough.

The generally radial wall portions, 111 to 118, are substantially continuous with the radially outermost surfaces of the respective legs, 121 to 124, and with the central wall portions, 106 to 109, to which they attach. The chair 101 therefore has a substantially continuous outer surface, which is nominally described as consisting of the aforementioned elements to aid description, and the continuous nature of which is, perhaps best illustrated in Fig. 13. The substantially continuous outer surface defines a shape which is generally cruciform in radial cross section, with a leg at the end of each extremity, as best seen in Fig. 12 (although it will be appreciated that numbers of legs other than four, and consequently different shapes could be used).

The central wall portions 106, 107, 108, 109, each form part of the periphery of the chair 101, as well as helping to define the cylindrical portion 110, and are substantially rigid, or immovable, relative to most of the rest of the chair 101. Attached to an upper part of each central wall portion 106, 107, 108, 109, is a respective insert-stopping member 145, 146, 147, 148, which projects a small distance generally towards the axis of the chair 101, and which, in use, supports an insert against upwards axial movement by preventing at least part of an insert from moving axially (upwardly) out of the space 105. Each insert-stopping member 145, 146, 147, 148 has a

respective, inclined insert engaging surface 145a, 146a, 147a, 148a, respectively, for engaging an inclined upper surface of a foot portion of an insert.

The insert-support portions 135, 136, 137, 138 are each provided, at an upper part thereof with a generally upward facing insert support surface 135a, 136a, 137a, 138a, respectively, which, in use, supports an insert against downwards axial movement. The generally upward facing insert support surfaces 135a, 136a, 137a, 138a, are examples of first insert-restraining portions which retain the insert against axial movement, relative to the chair, in a first (downwards) axial direction, and the inclined insert engaging surfaces 145a, 146a, 147a, 148a of the insert-stopping members 145, 146, 147, 148 are examples of second insert-restraining portions which retain the insert against axial movement, relative to the chair, in a second (upwards) axial direction.

Each insert-support portion 135, 136, 137, 138 is provided with a step 135b, 136b, 137b, 138b, respectively, which is adjacent the respective support surface 135a, 136a, 137a, 138a, and which provides a generally inwardly facing surface for engaging an outer circumferential edge of an insert. Each insert-support portion 135, 136, 137, 138 is flexibly connected, at a lower part thereof, to the rest of the chair. In this embodiment the connection is provided by two connection elements 140 which are small in cross sectional size and which provide a somewhat flexible and resilient connection, so that the insert support portion can effectively pivot a small angular distance about a generally horizontal axis defined by a line between the two connection elements 140. Thus the upper part of each support portion may be displaced slightly, radially outwardly by a suitable force, and will return to its equilibrium position when the force is no longer applied.

Each insert-support portion 135, 136, 137, 138 is provided with an inclined surface, for engaging at least

part of an insert as that part of the insert is moved axially and upwardly past the insert support. The inclined surfaces are inclined slightly towards the centre of the chair, in the upwards direction, and provide forcing portions 135c, 136c, 137c, 138c by which each insert-support portion 135, 136, 137, 138 can be forced radially outwardly by an insert.

In use, therefore, when a suitably dimensioned part of an insert is moved upwardly, engaging the forcing portions 135c, 136c, 137c, 138c of the insert support portions 135, 136, 137, 138, the insert forces the upper parts of the support portions 135, 136, 137, 138 radially outwardly. When (at least that part of) the insert has passed the forcing potions 135c, 136c, 137c, 138c, the upper parts of the insert-support portions 135, 136, 137, 138, return to their equilibrium positions. If an appropriately dimensioned insert is used, as illustrated schematically in Fig. 17, the insert will then be able to sit upon, and be supported by, the support surfaces 135a, 136a, 137a, 138a. The insert-support portions 135, 136, 137, 138 may therefore be regarded as having a pawl-like action.

It will be appreciated that the connections between the insert-support portions 135, 136, 137, 138 and the rest of the chair are radially further from the axis than the support surfaces 135a, 136a, 137a, 138a. Thus even a strong downwards force on the insert will tend to push the insert-support portions 135, 136, 137, 138 together, rather than splaying them, so they will not be caused to move out of the path of the insert, and the insert will be retained. Furthermore the steps 135b, 136b, 137b, 138b, will prevent the insert-support portions 135, 136, 137, 138 from moving inwardly past the periphery of the insert. Thus undesirable pivoting of the insert-support portions 135, 136, 137, 138 when the insert is in place is prevented. Furthermore, the structure of the insert-stopping members 145, 146, 147, 148 and their

inclined insert engaging surfaces 145a, 146a, 147a, 148a, restrain radial movement of the insert, so that the insert is radially restrained and cannot apply large radial forces to the insert-support portions 135, 136, 137, 138.

It will be appreciated that the insert can be connected to the chair merely by pushing the insert into the chair. The insert will be restrained from axial movement, relative to the chair, in the downward direction by the support surfaces 135a, 136a, 137a, 138a. The insert-stopping members 145, 146, 147, 148 will restrain the insert from moving relative to the chair in the upwards direction, and that the insert is also constrained in the radial direction. This enables an insert to be coupled to the chair securely, quickly and easily, so that the chair can then easily be located, without the possibility of separation of the chair and insert.

With reference to Figs 19(a), 19(b) and 19(c), an embodiment of an insert 170 suitable for use with the chair 101 will now be described. The insert 170 comprises an elongate portion 171, of substantially uniform (and in this embodiment generally hexagonal) cross section, and a wider foot portion 172 at a first end of the elongate portion. An axial female threaded bore 173 is provided in the elongate portion 171, and is open at the second end thereof. A radial through bore 174 is provided in the elongate portion 171, between the blind end of the axial female threaded bore 173 and the foot portion 172. The foot portion 172 provides a generally flat underside 176 (which, as seen in Fig. 17, may contact and be supported by the insert support portions 135, 136, 137, 138) and an inclined upper surface portion 175 (which, in use, may engage and be restrained by the inclined insert engaging surfaces 145a, 146a, 147a, 148a of the insert-stopping members 145, 146, 147, 148).

It will be appreciated that insert 170 and chair 101 are dimensioned to compliment each other, so that the functions described and illustrated can be effectively

performed. With reference to Fig. 20(a), one example of this is that the axial distance between the foot portion 172 and the radial through bore 174 compliments the axial distance between the insert-stopping members 145, 146, 147, 148 (and insert support portions 135, 136, 137, 138) and the recess portions 153, so that when an insert is retained in the chair 101 and a reinforcing bar 180 is passed through the radial through bore 174, then a force must be applied to the reinforcing bar 180 in order to "lift" it onto the reinforcing bar supports 150, 160. Consequently, by virtue of the slight intrinsic resilience in the system (especially due to the use of a suitable plastic to form the chair 101) the reinforcing bar 180 will continue to be gently forced into the recess portion 153 of reinforcing bar support 150 (and corresponding recess portion 163 of reinforcing bar support 160). Fig 20(b) shows the reinforcing bar 180 retained in recess portions 153, 163 of a closer reinforcing bar support 150 and a further away reinforcing bar support 160, and it will be appreciated that other elements are omitted from this drawing for clarity, even though the drawing is intended to illustrate the position with an insert in place. The reinforcing bar 180 is shown cross hatched to illustrate that it is aligned in the direction into and out of the page. It will be appreciated that the reinforcing bar will not inadvertently rotate, relative to the chair, about the axis of the insert (not shown). Furthermore it will be appreciated that the reinforcing bar 180 can not be rotated, relative to the chair, about the axis of the insert (not shown) in one direction (corresponding to the closer end of the bar moving to the right) but that with some effort the reinforcing bar 180 can be rotated, relative to the chair, about the axis of the insert (not shown) in the other direction (corresponding to the closer end of the bar moving to the left).

The described embodiment therefore provides a

chair 101 that allows a threaded insert to be easily and securely coupled thereto without the need to use additional fixing elements or to tie the insert to the chair. Suitably shaped lifting anchors could similarly be coupled to the chair 101. The described embodiment also allows a reinforcing bar associated with the insert to be manually rotated, about the axis of the insert to a position where it is easily and effectively locked in place against inadvertent movement relative to the chair and insert. This provides a quick and convenient (and hence economical) arrangement for use in a process in which hundreds of chairs inserts and reinforcing bars must be manually positioned. Some lifting anchors include through apertures for receiving reinforcing bars. A foot anchor (eg. of the type shown in Figs. 21 to 26) could be provided with such an aperture if desired, although provision of such an aperture would be likely to adversely affect its load bearing capacity.

It will, of course, be appreciated that there are many ways of providing a chair which accepts an insert and supports it against axial movement relative to the chair, and the illustrated embodiment provides just one, currently preferred example. In alternative embodiments restraining means other than pawl-like structures could be used, or different configurations of pawl-like structure could be included in a chair. In one alternative a groove could be provided in the insert and one or more inwardly biased locking members could be provided to engage in the groove. In another alternative, pawl-like structures could be included in the threaded insert, rather than the chair. While these options are intended to fall within the broadest scope of at least some aspects of the present invention, the embodiment of Figs. 10 to 20(b) has a number of desirable features including: the chair can be manufactured as a one-piece product; economical manufacture from a plastic, by injection moulding; simple, economical moulding, because the structure involves no

"hidden" surfaces that would require use of a mould with more than two parts; robust structure, since the pawl-like parts (the insert support portions) are supported by the insert when load is applied; inclusion of height options.

With reference to Figs. 21 to 30, an embodiment of a chair, for supporting an insert, is generally designated 201. The chair is particularly suitable for use in supporting an insert in the form of a lifting anchor, and in its illustrated form the chair 201 is for supporting a foot anchor 270, and an associated void former, of which half 280, is illustrated. The foot anchor 270 has a foot 271 (somewhat similar to the foot portion 172 of the insert 170) and a head 272 adapted to be engaged by a lifting clutch.

The chair 201 has many similarities to the chair 101 described above, so only the differences will be described in detail.

The chair 201 does not include the reinforcing bar retainers 150, 160 of the chair 101 (although a variation could, if desired). The chair 201 does, however include a void former retaining structure 250. The void former retaining structure 250 comprises a retainer in the form of a generally ring-shaped member 251 which acts, in use, to retain the void former 280 in position, and first and second leg-like supports 252, 254, which, in use, connect the ring-shaped member 251 to the rest of the chair. In this embodiment each of the leg-like supports 252, 254 is generally cylindrical and includes an axial bore 253, 254. The retaining member could, of course, be formed in any shape suitable for retaining a void former (eg square), or could be composed of two or more separate and distinct elements which in combination are adapted to retain a void former. In this embodiment the retaining member includes a number of apertures 256 to facilitate tying a reinforcing bar thereto.

The rest of the chair could be substantially similar to the chair 101, with the leg-like supports 252,

254 being connected to legs (eg 21, 23) via dowel-like connection members or some other suitable connection means (eg solvent welding). However, in the illustrated embodiment there are a number of variations. The means for retaining the insert against axial movement is structured differently. Whereas in the chair 101 the pawl-like elements (insert support portions 135, 136, 137, 138) are pivoted at their respective bottoms and adapted to receive an insert introduced generally cylindrical portion 110 from below, the chair 201 includes first to fourth pawl-like elements 235, 236, 237, 238 which are pivoted at their respective tops, and adapted to receive an insert introduced into a generally cylindrical portion 210 from above, and then prevent its axial movement in the upwards direction. To prevent movement of the insert in the downwards direction the chair 201 is provided with a cruciform stop member 245, which effectively blocks passage of the insert through the bottom of the generally cylindrical portion 210 while allowing passage of concrete therethrough during casting. This configuration allows a foot (eg 271) of an insert to sit lower in the generally cylindrical portion 210 of chair 201 than it could in the generally cylindrical portion 110 of chair 101, which is sometimes desirable.

The chair 201 further differs from the chair 101 in that each of its first to fourth legs 221, 222, 223, 224 is provided with a first foot 231, a second foot, 232, and also a third foot 233. This provides a choice of three heights, selectable by retaining each of the first feet, removing each of the first feet to make the second feet operative, or removing the first and second feet to make the third feet operative.

The chair 201 further comprises first and second cylindrical spacers 256, 258 which allow the desired spacing between the generally cylindrical (insert retaining) portion 210 and the ring-shaped member 251.

The chair 201 thus provides a stable rigid

structure for supporting a foot anchor and associated void former in a desired position.

Referring now to Figs. 31 to 33, an embodiment of a fixing element for fixing a chair relative to a surface on which the chair is to be supported, is generally designated 300. The fixing element 300 is suitable for use with the chair 1 of Figs. 1 to 9, but it will be appreciated that variations, suitable for use with other chairs, could be provided. This fixing element comprises a stem portion which in this embodiment is in the form of an elongate cylindrical member 310 which has a bevelled first end 311 for facilitating insertion into a hole. The cylindrical member 310 has a flared second end 312 which terminates in an abutment portion in the form of a flange 320. Provided upon the flange 320 for insertion into a cavity of a chair (for example the chair of Figs. 1 to 9) is provided a connection portion in the form of a moulded engaging element 313. The moulded engaging element has a plurality of engaging portions 315, 316, 317, 318 for engaging and frictionally retaining an internal cylindrical part of a chair and a plurality of recessed portions 321, 322, 323, 324 for accommodating the insert-engaging rails of a chair. The abutment portion, flange 320 limits the insertion of the fixing element into the recess of the chair. It will be appreciated that the illustrated embodiment of a fixing element is specifically designed so that the connection portion fits into the recess of the chair and frictionally engages the chair so as to retain it relative to the fixing element. The structure of the illustrated embodiment is convenient since it is desirable to provide the stem portion substantially coaxially with the desired position of an insert and in this embodiment the elongate cylindrical member 310 is coaxial with the moulded engaging element 313 which in turn, in use, would be coaxial with the central recess of a chair and thus coaxial with the threaded insert. However, it will be appreciated that

many variations are possible. For example a fixing element could provide connection portions for attachment to the legs, web portions, or any other suitable part or parts of a chair and the connection could be frictional, by snap-fitting, or by any other suitable means. Furthermore, a fixing element and chair could be formed integrally rather than as separate elements. In a preferred embodiment, however, the fixing element and chair are provided as separate elements. The fixing element and chair may be conveniently manufactured from a robust and durable plastic by injection moulding.

Referring now to Fig. 34 which is a schematic partial cross-section showing the chair of Figs. 1 to 9 in use in conjunction with the fixing element of Figs. 31 to 33, the chair 1 rests upon a surface 330 and is fixed relative thereto by the fixing element 300.

In use, an operator merely drills a hole 340 in the surface 330 in the position corresponding to the desired location of, for example, a threaded insert. A fixing element 300 is connected to a chair 1 and the elongate cylindrical member 310 is pushed into the hole 340 until the previously chosen first feet 31, 34 or second feet 41, 44 abut the surface. As shown in Fig. 34, the first feet 31, 34 abut the surface 330, but it will be appreciated that if it were desired to set the seat at a slightly lower height, the first feet would be removed prior to use and the second feet 41, 44 would abut the surface 330. A reinforcing-bar and threaded insert (not shown) could then be fitted to the chair 1 at the desired height (that is with the reinforcing-bar engaging either the higher or lower reinforcing-bar support portions) of the chair 1. It will be appreciated that because the chair is connected to the surface by a single frictional connection the chair can be rotated about its axis to accommodate a reinforcing-bar in a desired orientation and (by allowing either of the higher or lower reinforcing bar support portions to be brought into position) at a desired

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height. Predetermining the position of inserts by drilling holes coaxial with the desired insert position is particularly convenient, especially if a number of inserts with exact spacing are required.

Alternative methods of fixing a stem portion to a surface could be used. For example, an adequately strong adhesive might be suitable. If the chair is aligned correctly initially, then realignment to allow a reinforcing bar to be received by the desired parts of the chair should not be necessary. It is important that the connection between the fixing element and the surface, and the connection between the fixing element and the chair should be secure enough to prevent inadvertent movement of the chair during casting of the concrete panel. However, the connection between the fixing element and the surface should be suitable for allowing the concrete panel, in which the fixing element and chair are cast, to be removed from the surface without undue difficulty and without damaging the panel or surface. Frictional connection of a plastic stem in a hole in the surface is suitable, and is currently preferred.

It will be appreciated that features of some of the above described chairs may be introduced into other embodiments. For example the chairs 1 or 101 could be provided with three sets of feet, as illustrated and described with reference to the chair 201. Such variations should be regarded as disclosed herein.

Modifications and improvements may be incorporated without departing from the scope of the present invention.

It is to be understood that, if any prior art publication is referred to herein, such reference does not constitute an admission that the publication forms a part of the common general knowledge in the art, in Australia or in any other country.

In the claims which follow and in the preceding description of the invention, except where the context

requires otherwise due to express language or necessary implication, the word "comprise" or variations such as "comprises" or "comprising" is used in an inclusive sense, i.e. to specify the presence of the stated features but not to preclude the presence or addition of further features in various embodiments of the invention.

CLAIMS

A chair for receiving an insert of the type comprising an elongate body with a central axis extending in the direction of elongation of the body and a foot portion which extends further from the central axis of the insert, in a radial direction, than does the axially extending elongate portion, the chair being for retaining said insert during casting of a concrete panel, and the chair being adapted to retain the said insert against axial movement of the insert relative to the chair in the first axial direction of the insert and in the second, substantially opposite, axial direction of the insert, the chair comprising:

one or more support portions for supporting the chair relative to a surface on which said panel is to be cast and wherein the chair comprises:

at least one first insert-restraining portion for contacting the foot portion of the insert and restraining movement of the insert in the first axial direction of the insert;

at least one second insert-restraining portion for contacting the foot portion of the insert and restraining movement of the insert in the second axial direction of the insert;

wherein at least one first insert-restraining portion comprises a first insert-restraining element which is moveable relative to at least some of the rest of the chair in order to allow at least part of the foot of the said insert to move past said first insert restraining element in the second axial direction of the insert, to thereby connect the insert to the chair.

2. A chair as claimed in claim 1 wherein the insert-restraining element is moveable between a restraining position in which it restrains axial movement of said inset, and a non-restraining position in which it does not substantially restrain axial moveable of said inset, and is biased towards the restraining position.

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3. A chair as claimed in claim 2 wherein the insert-restraining element is adapted to be forced from the restraining position to the non-restraining position by movement of at least part of said insert in the second axial direction of the insert.

4. A chair as claimed in any preceding claim, further comprising at least one bar-engaging portion which is adapted to engage a reinforcing bar associated with, and extending through, a generally radially extending through bore of the insert and which is adapted, in use, to retain the reinforcing bar in a predetermined orientation in a plane substantially perpendicular to the axis of the chair.

5. A kit comprising a chair as claimed in any preceding claim and a threaded insert for use with the chair wherein the threaded insert comprises an axially extending elongate portion and a foot portion which extends further from the axis of the threaded insert, in a radial direction, than does the axially extending elongate portion.

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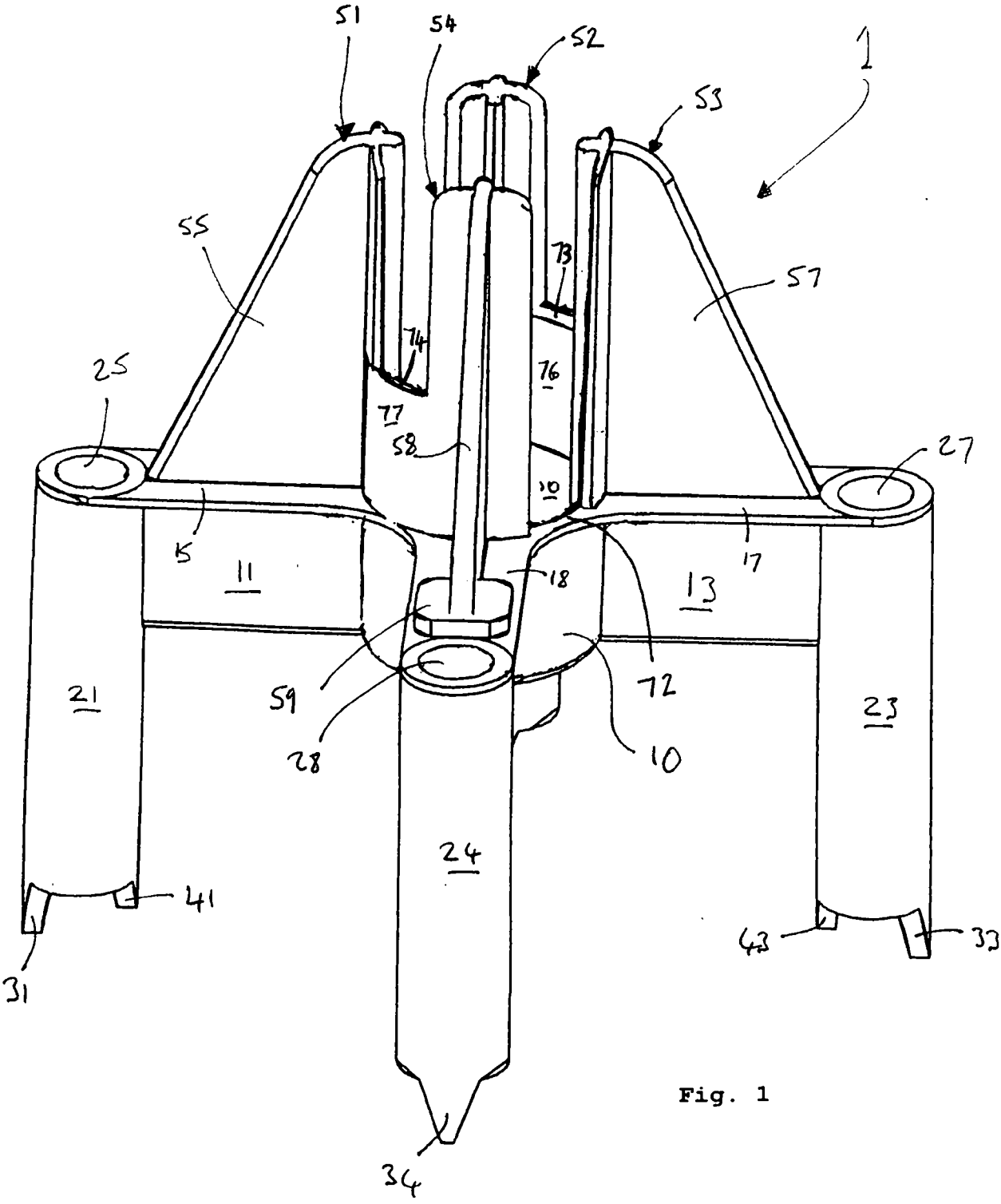

Fig. 1

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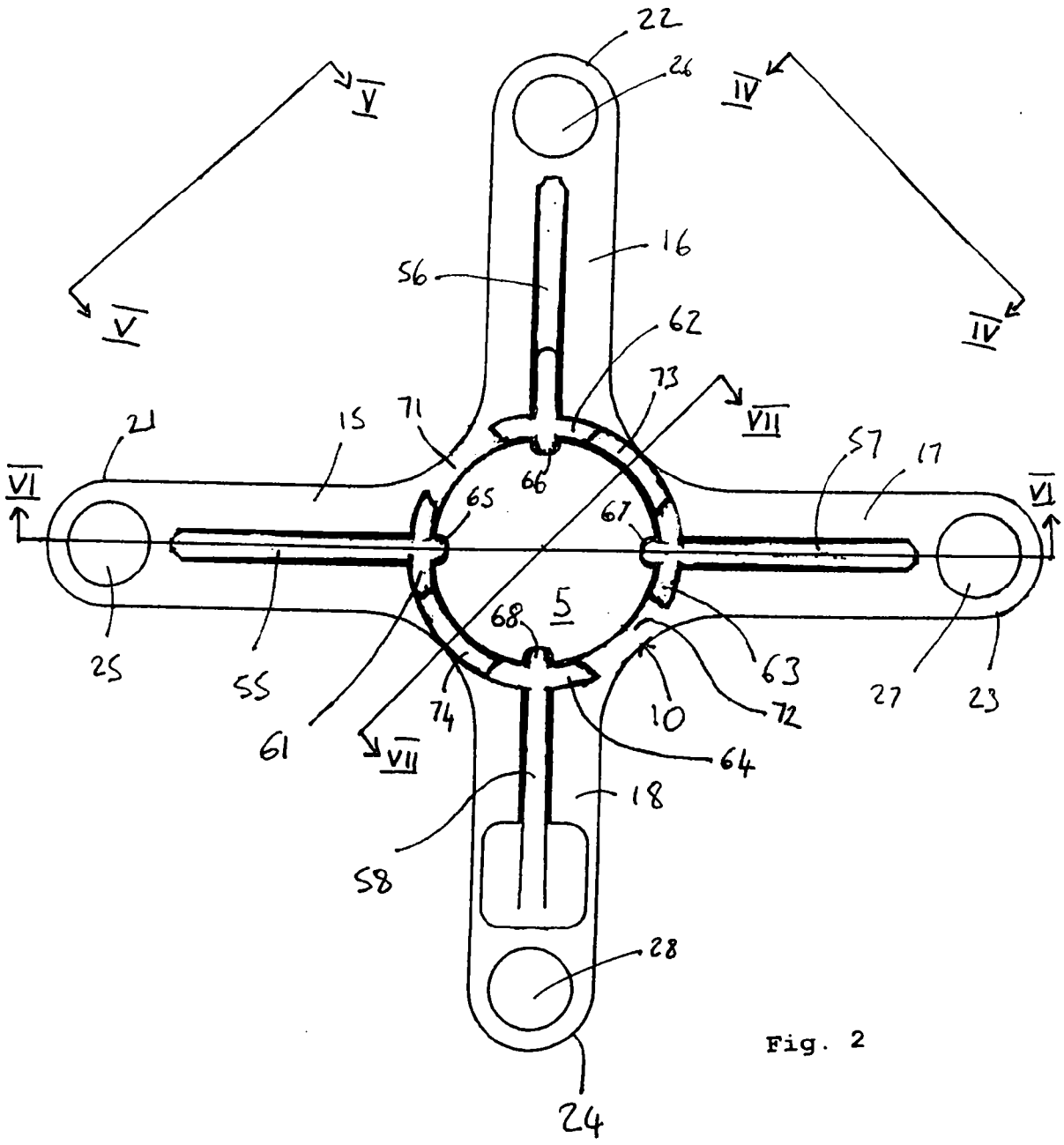

Fig. 2

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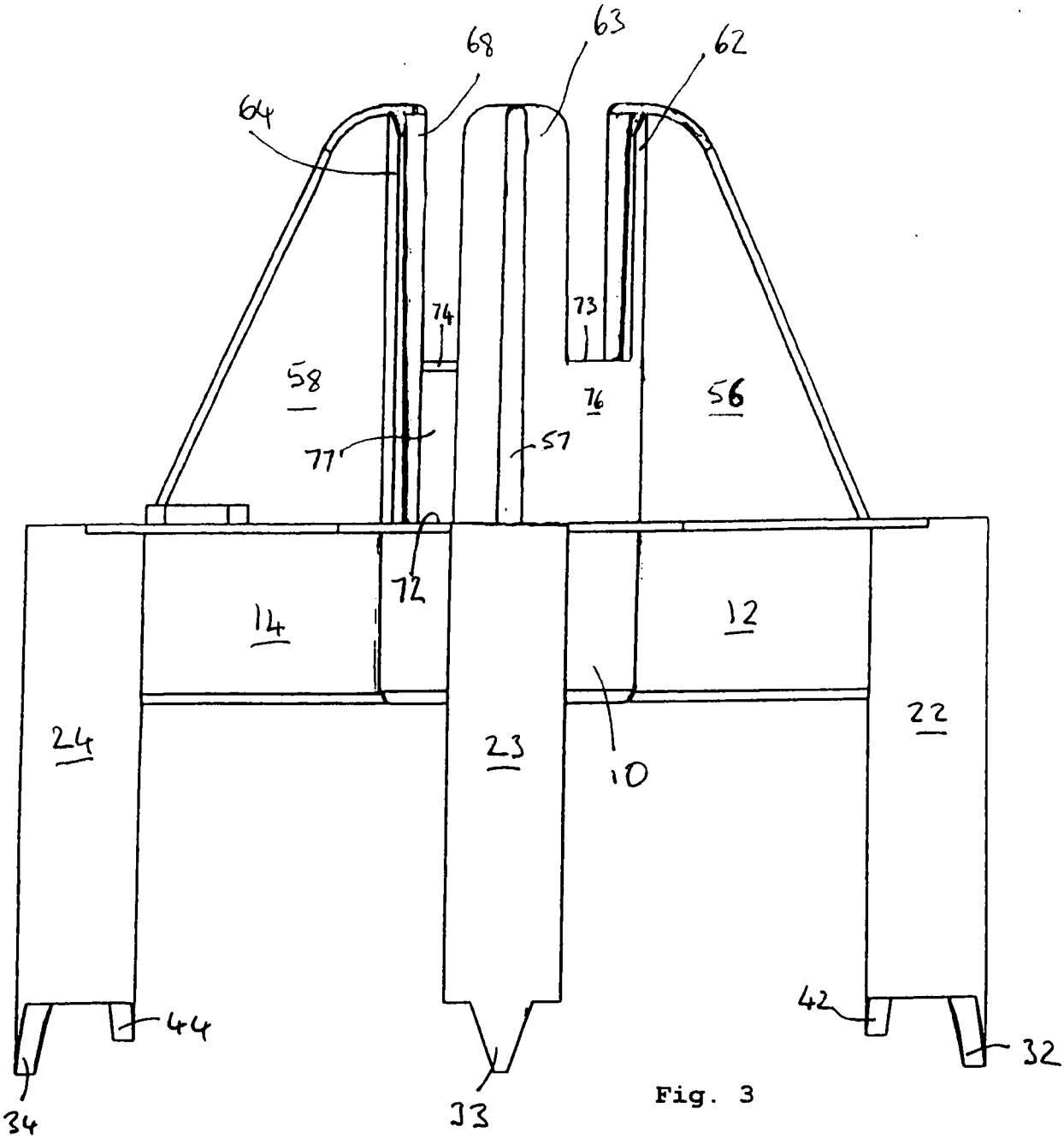

Fig. 3

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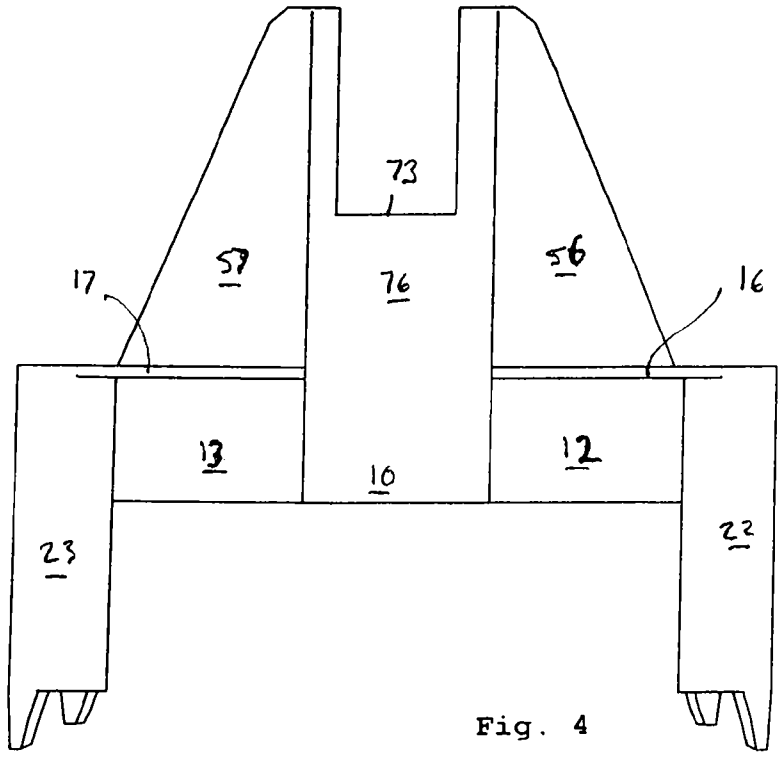

Fig. 4

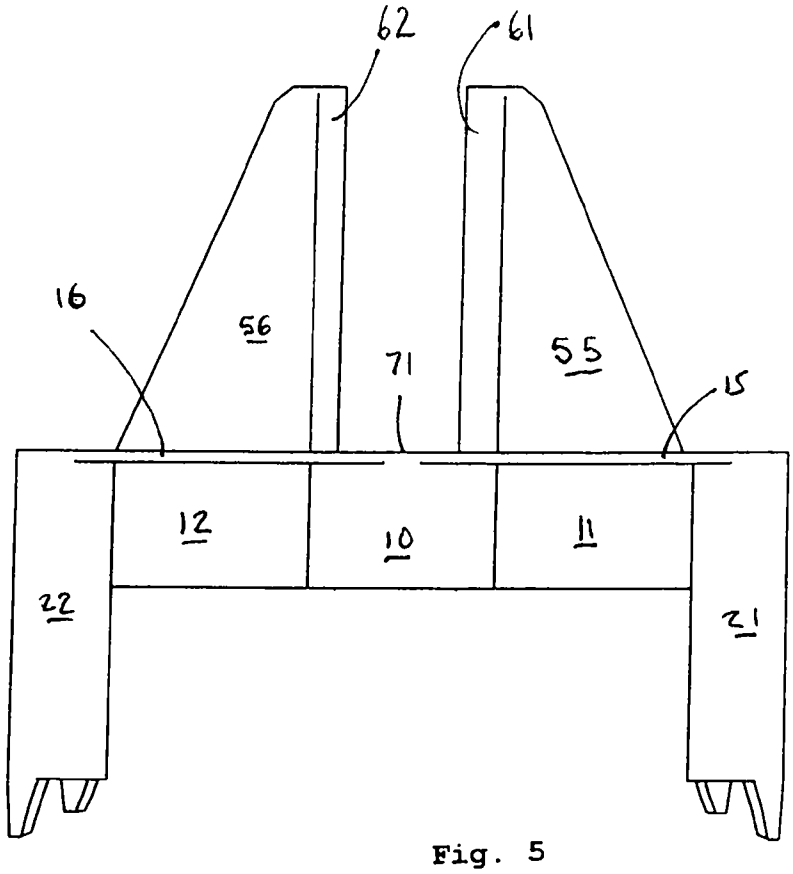

Fig. 5

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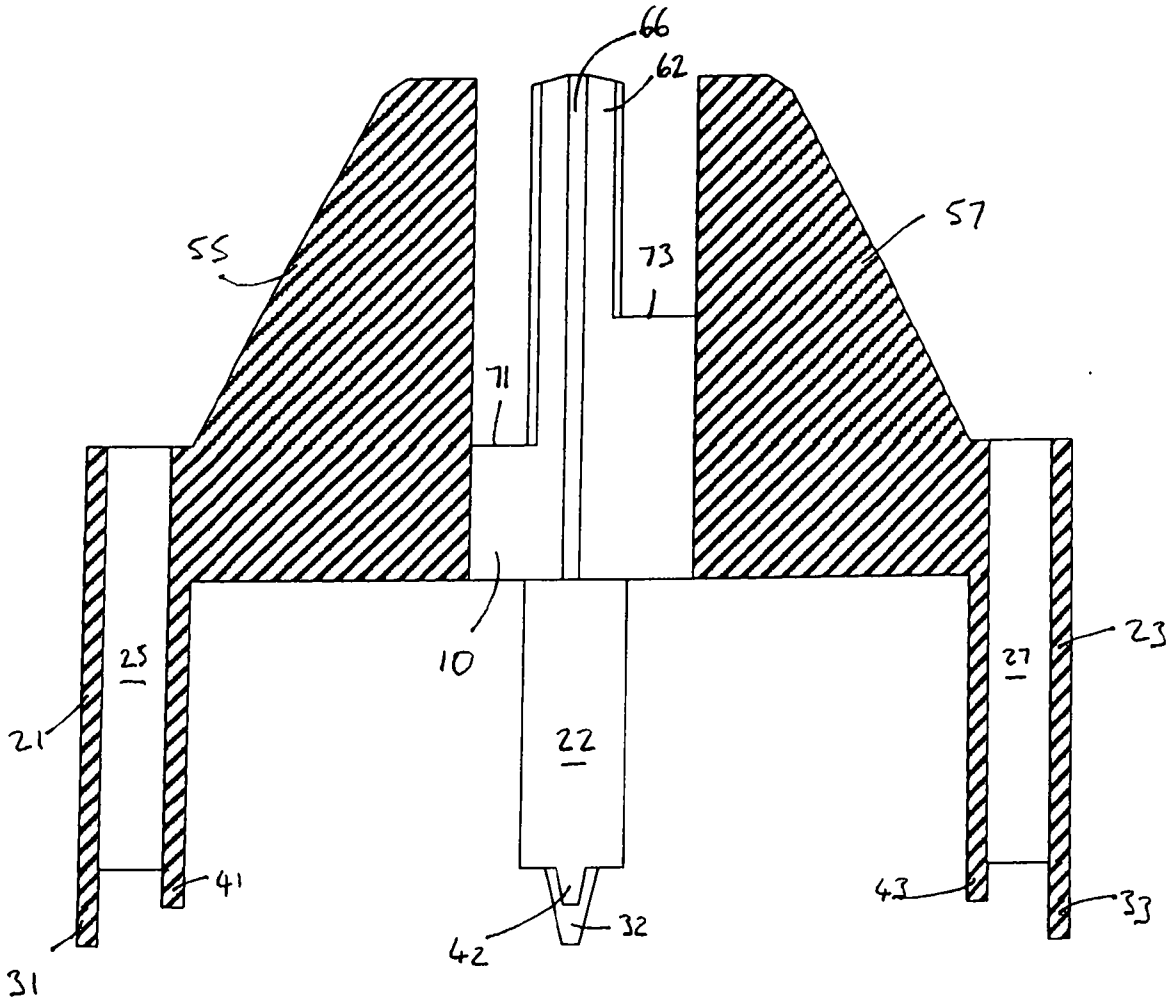

Fig. 6

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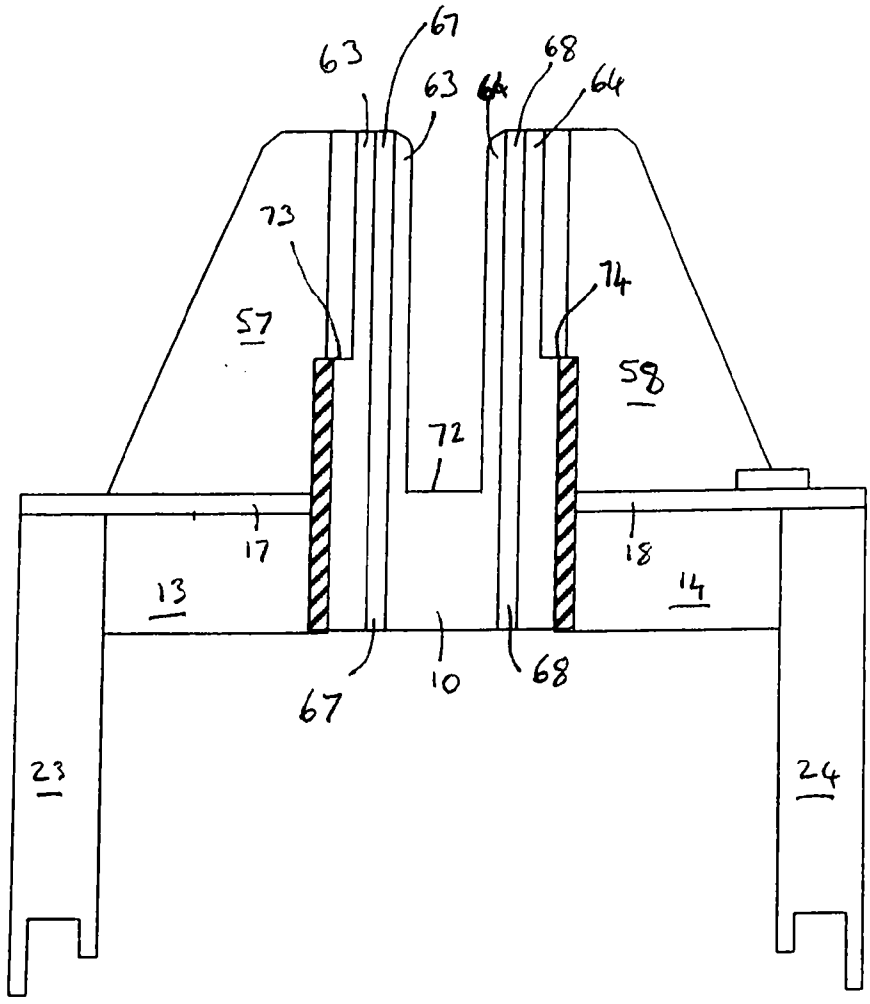

Fig. 7

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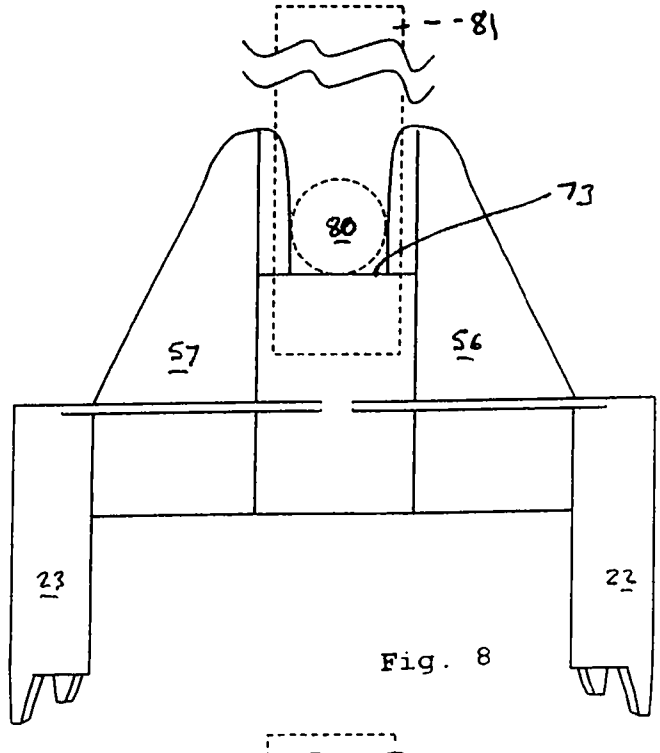

Fig. 8

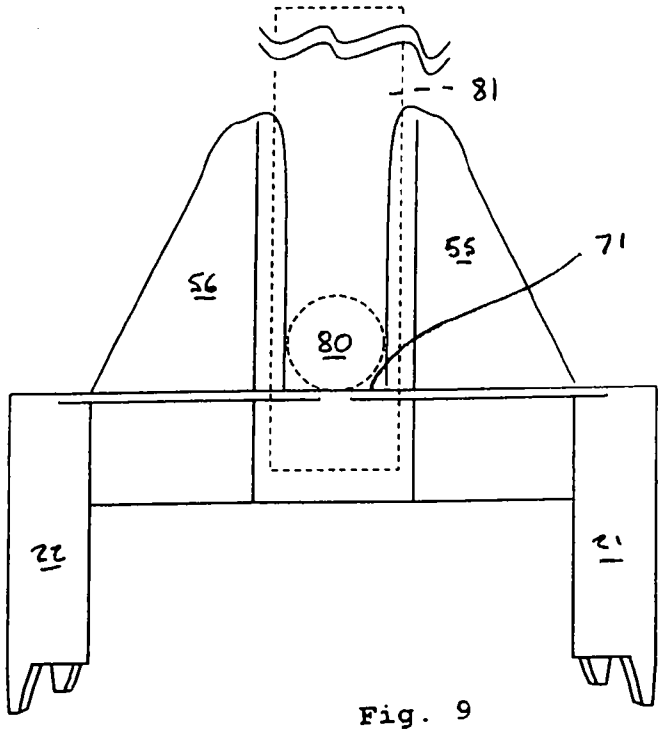

Fig. 9

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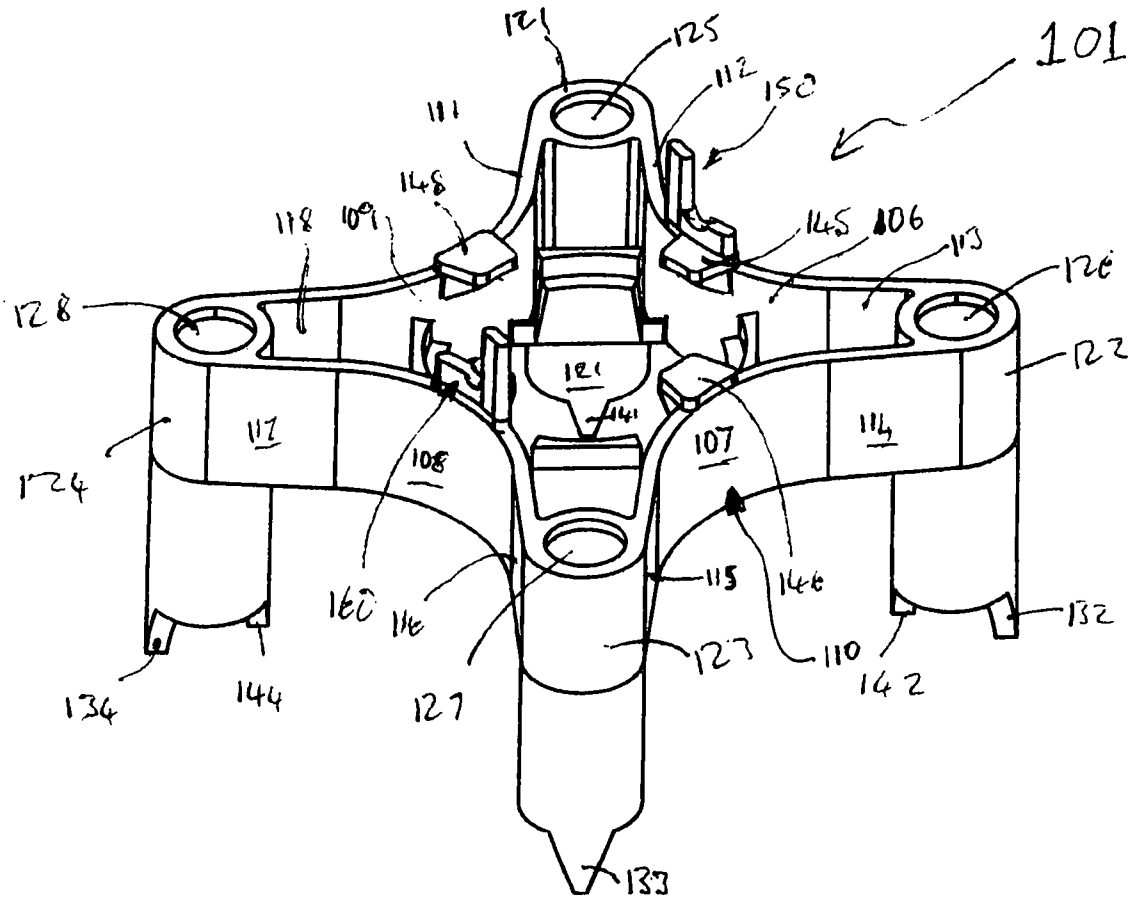

Fig. 10

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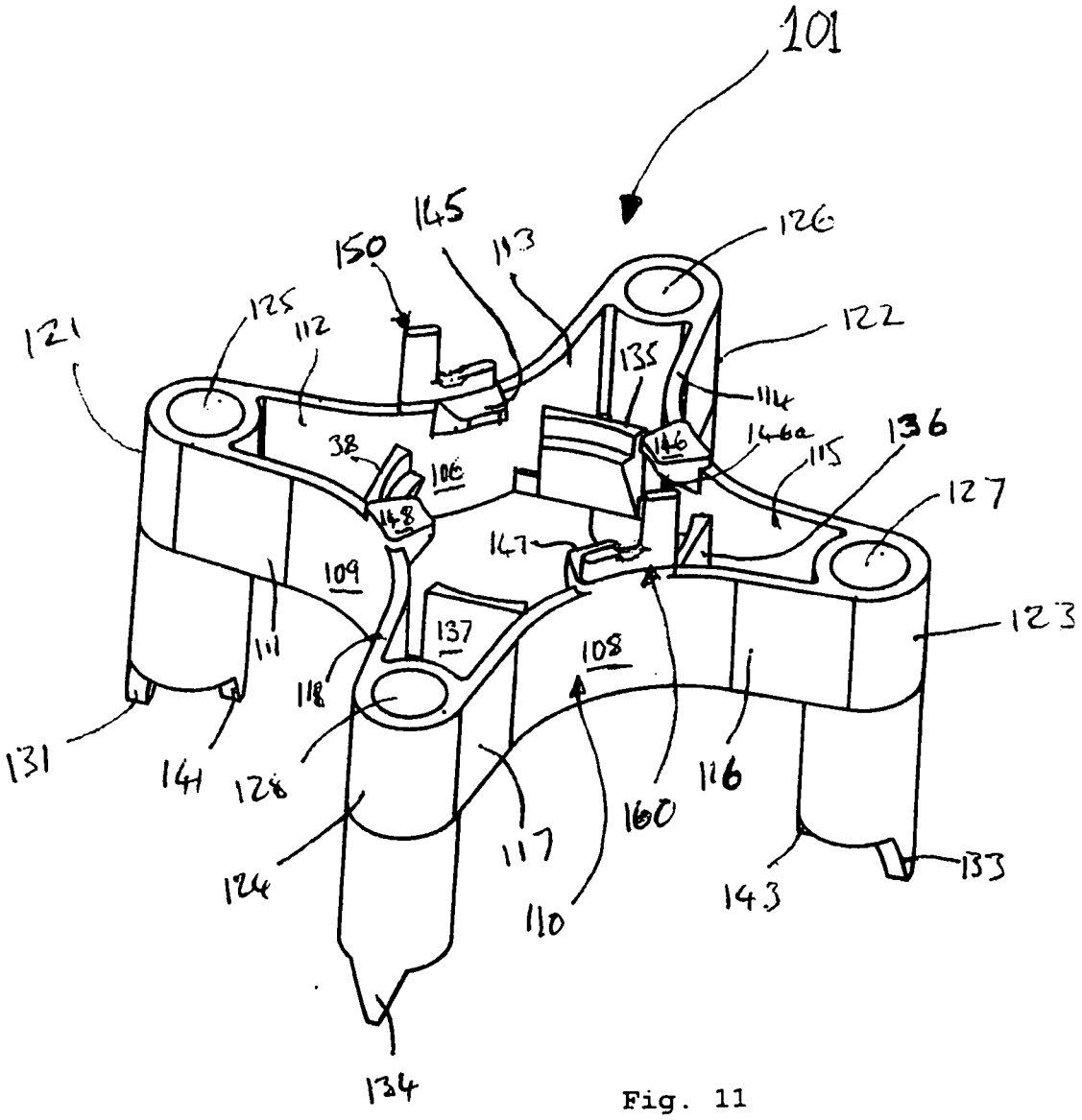

Fig. 11

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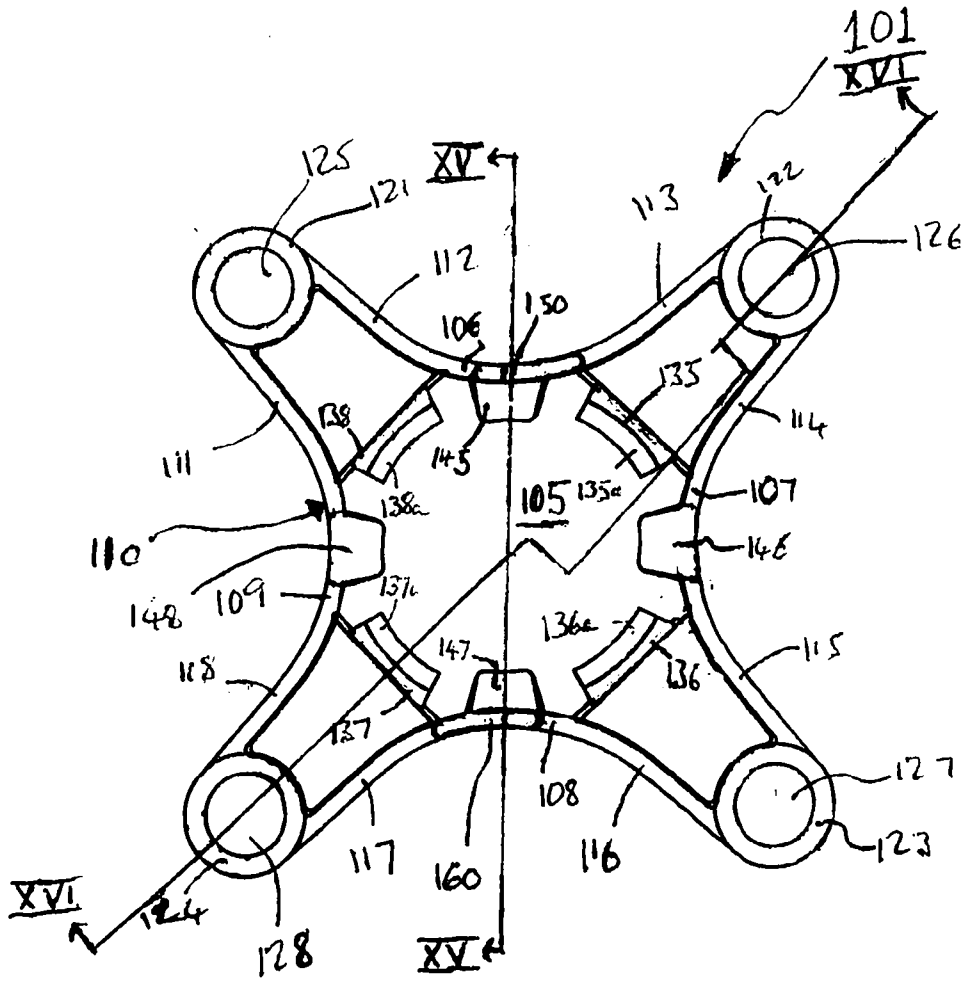


Fig. 12

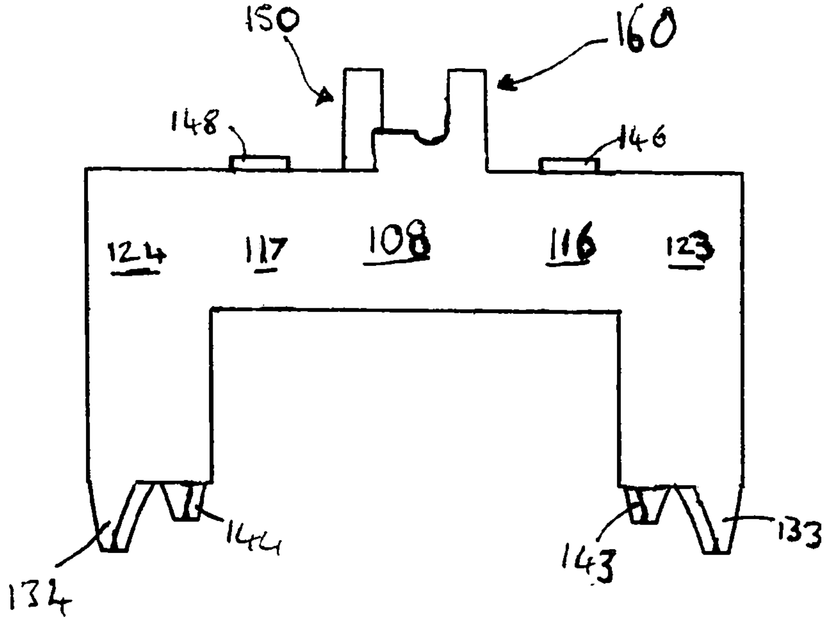


Fig. 13

Fig. 14

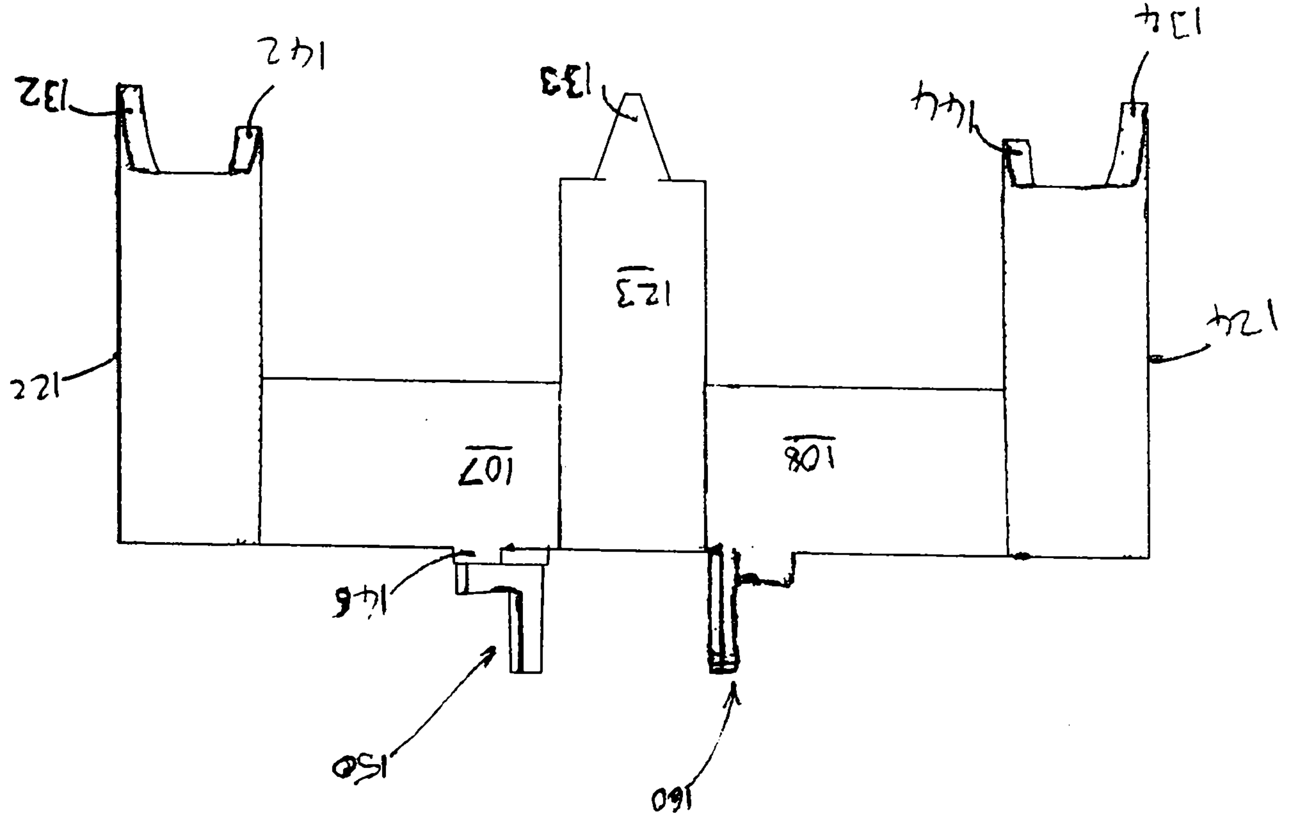
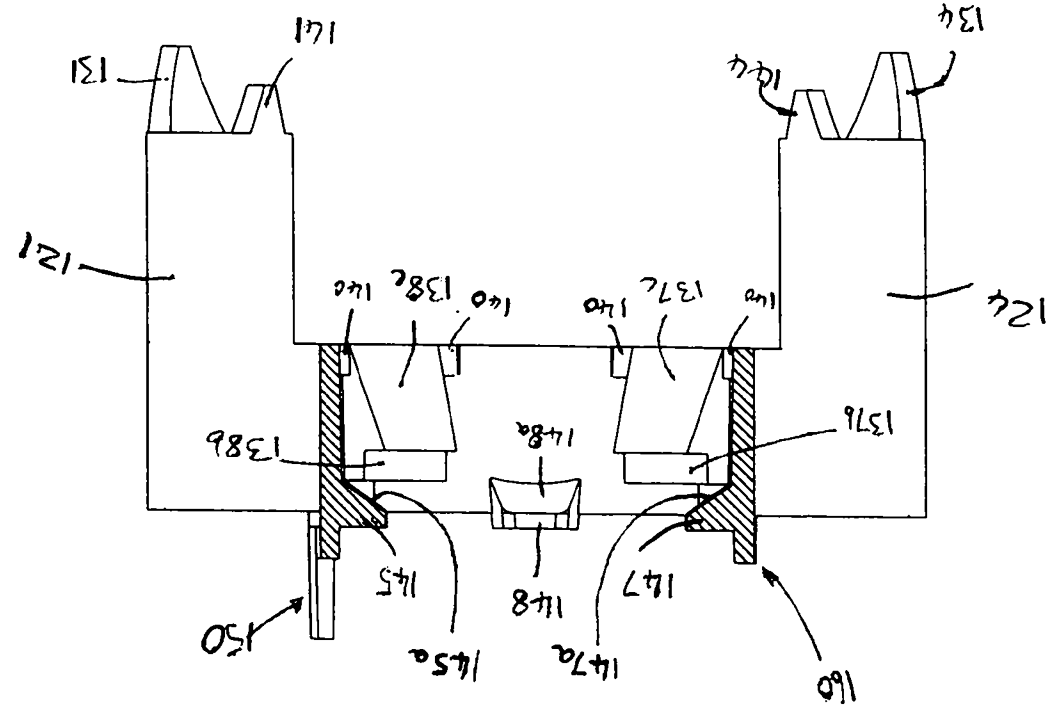


Fig. 15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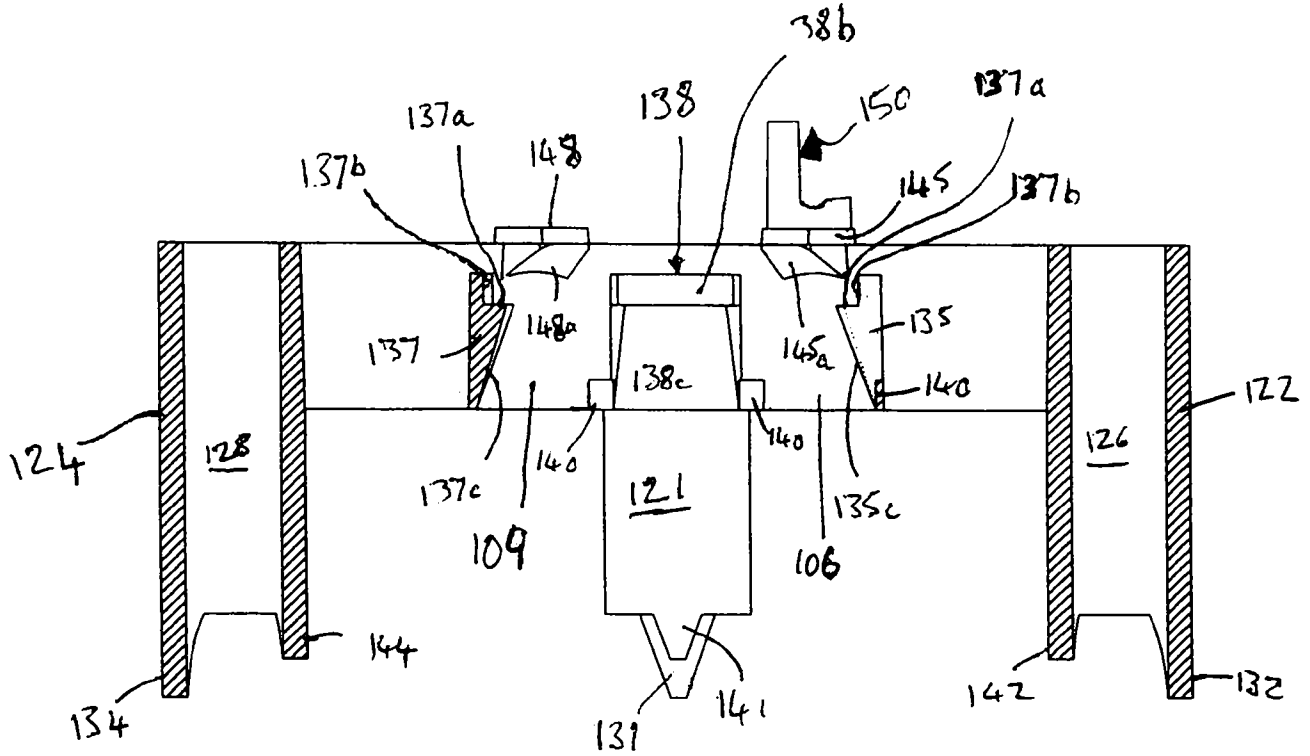
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131
141
142
132

Fig. 16

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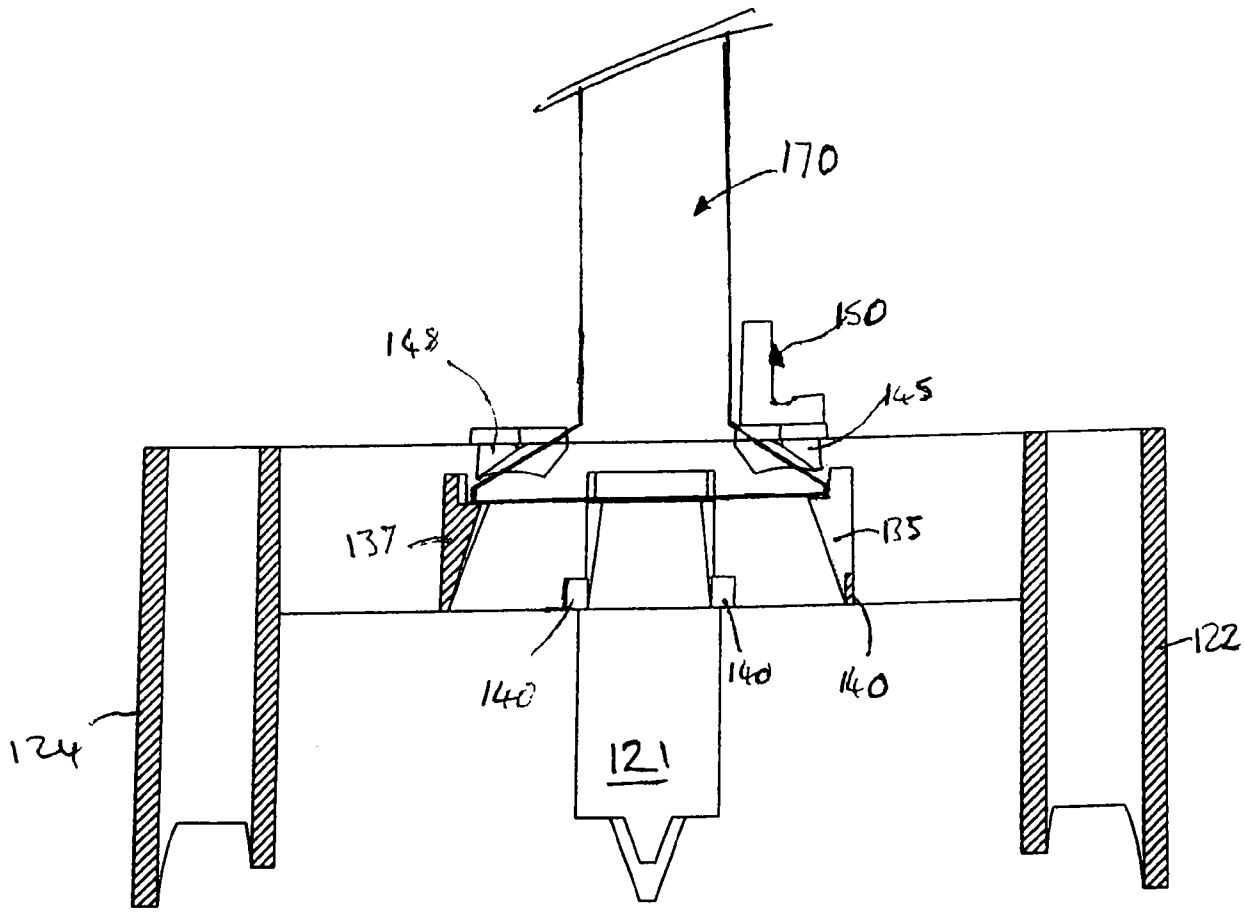

Fig. 17

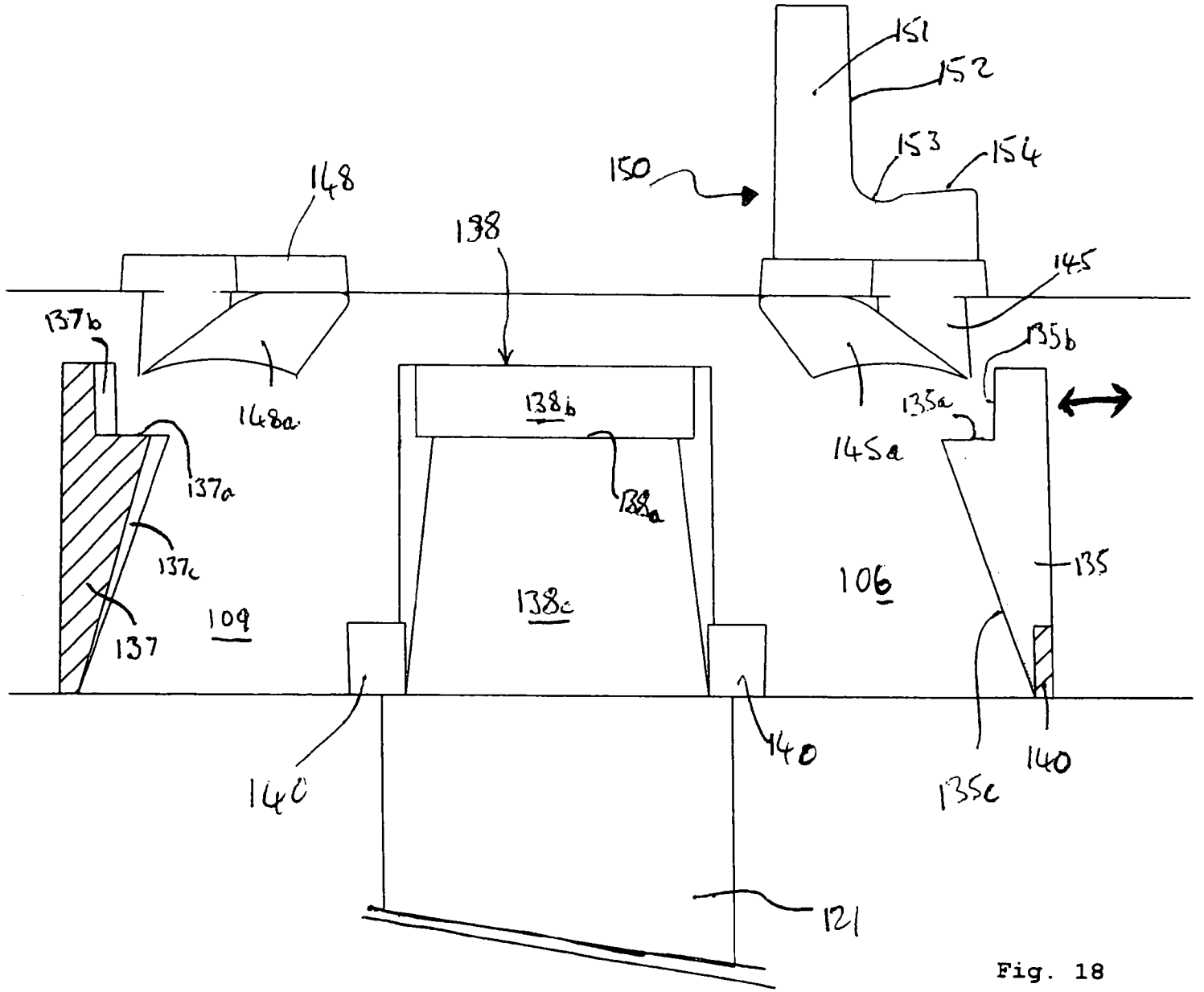

Fig. 18

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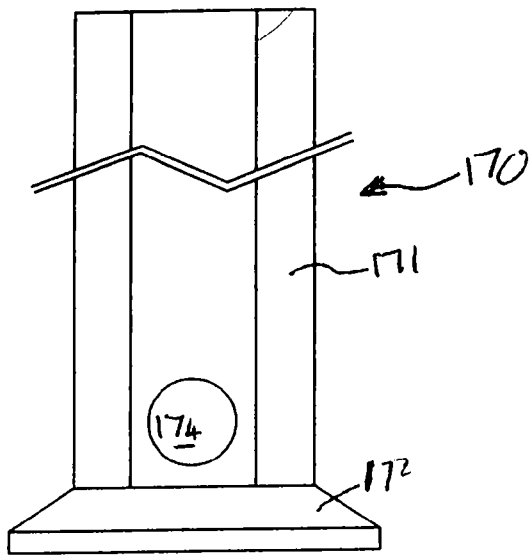

Fig. 19(a)

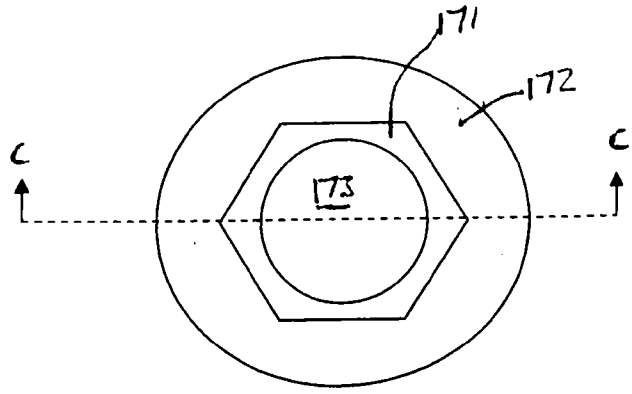

Fig. 19(b)

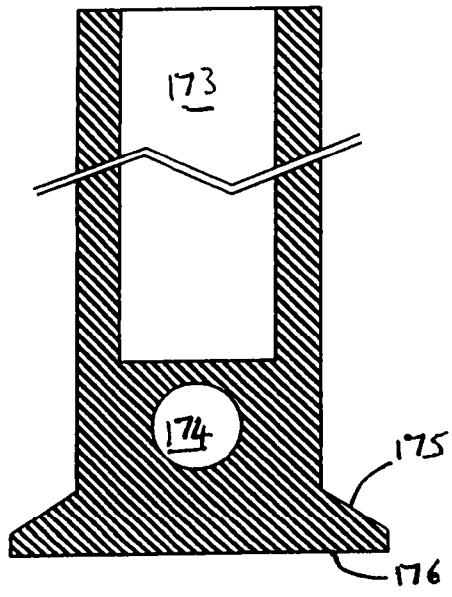

Fig. 19(c)

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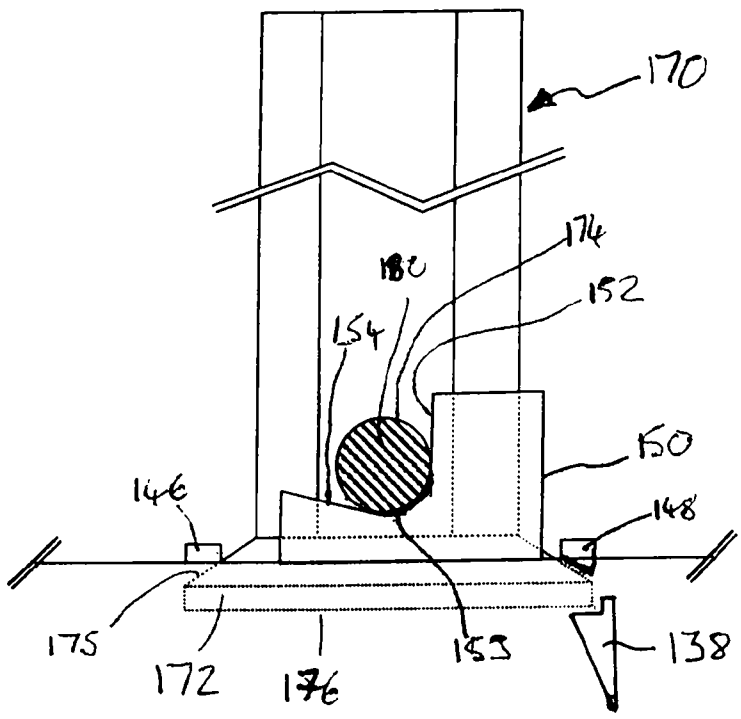

Fig. 20(a)

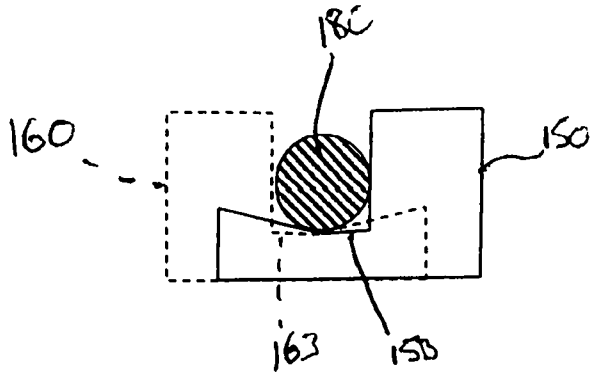

Fig. 20(b)

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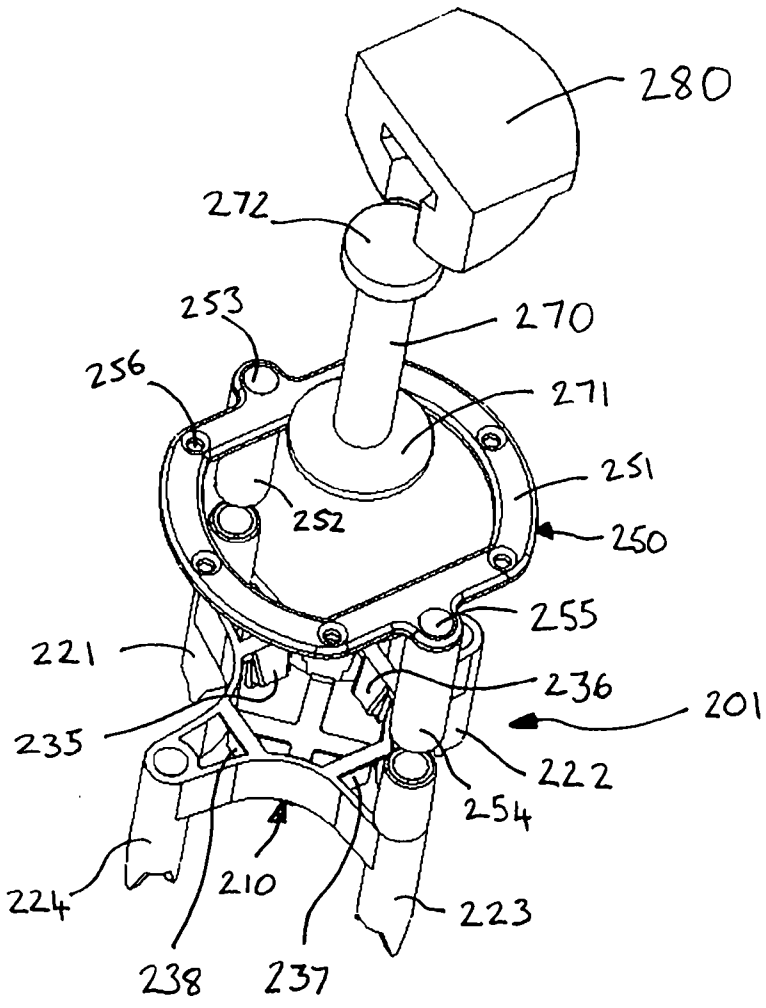

Fig. 21

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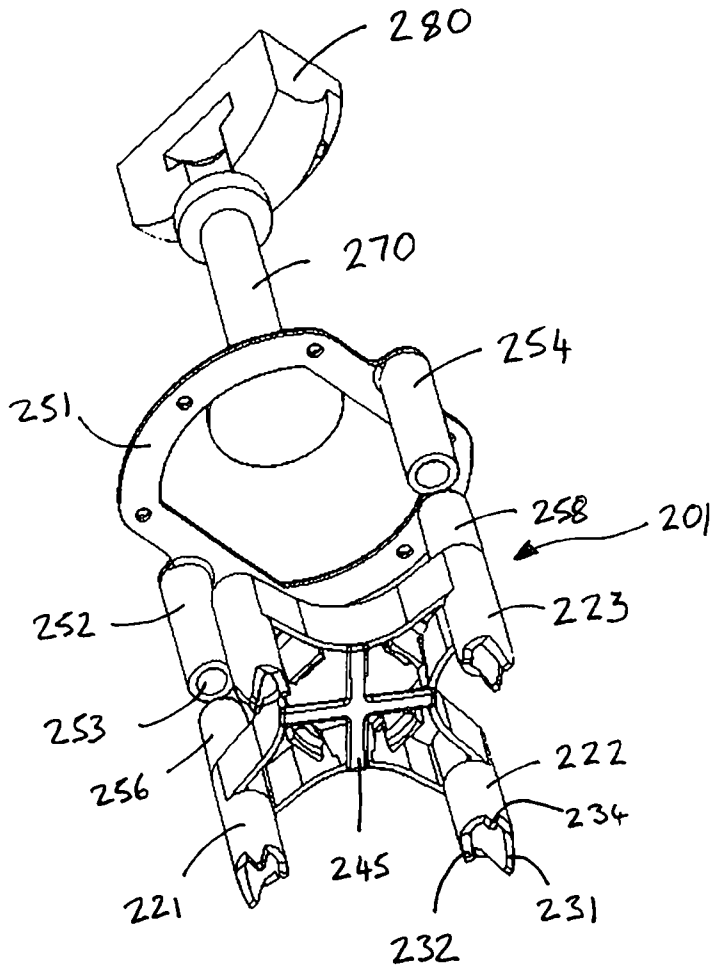

Fig. 22

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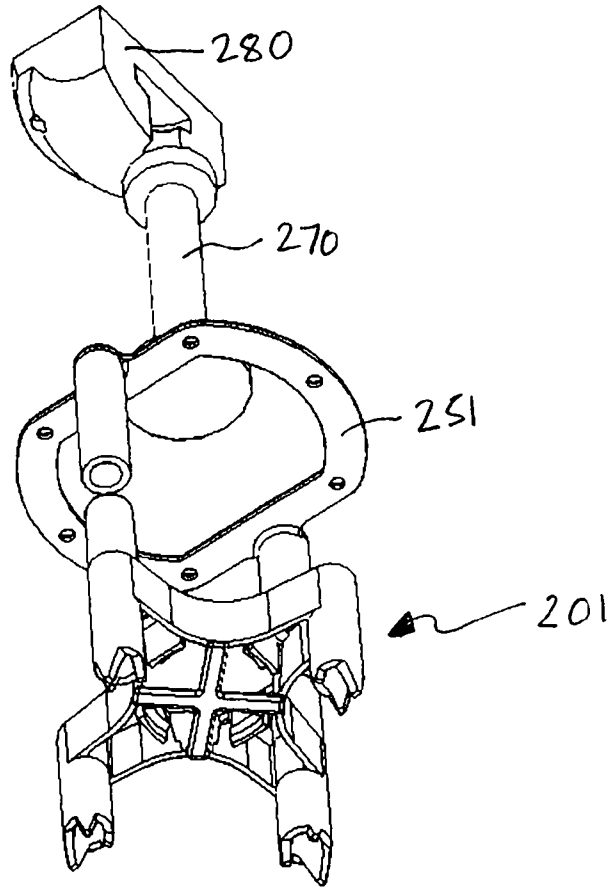

Fig. 23

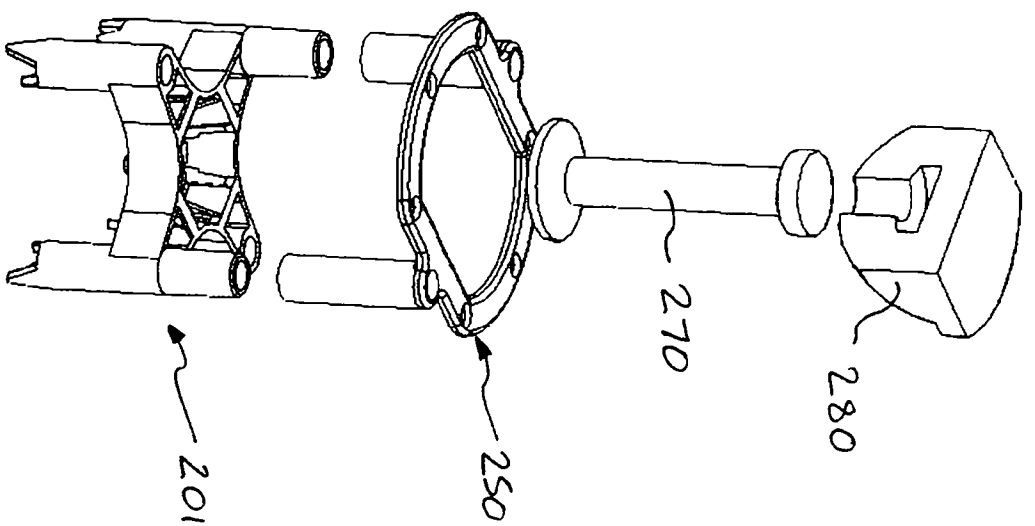

Fig. 24

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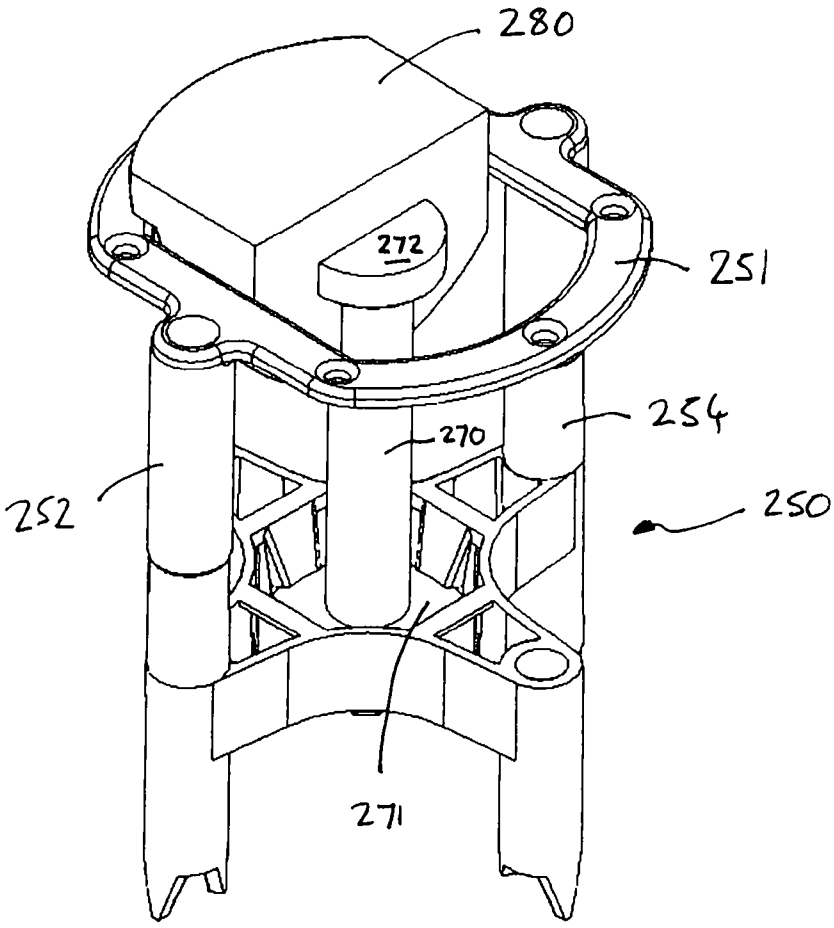

Fig. 25

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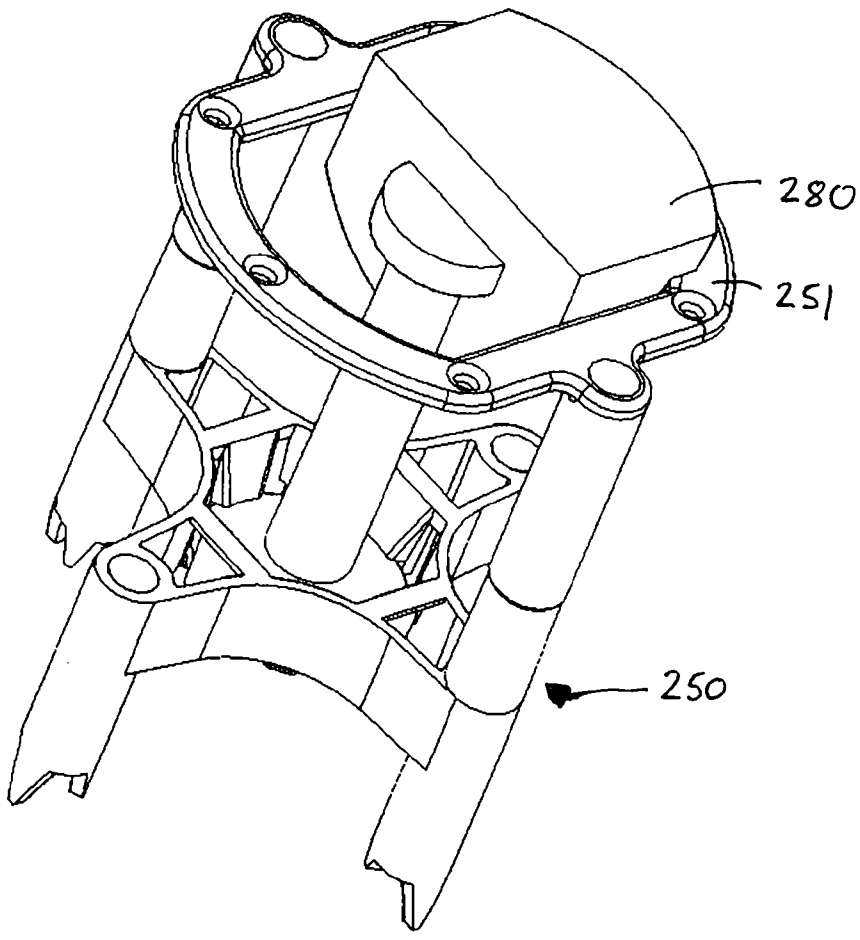

Fig. 26

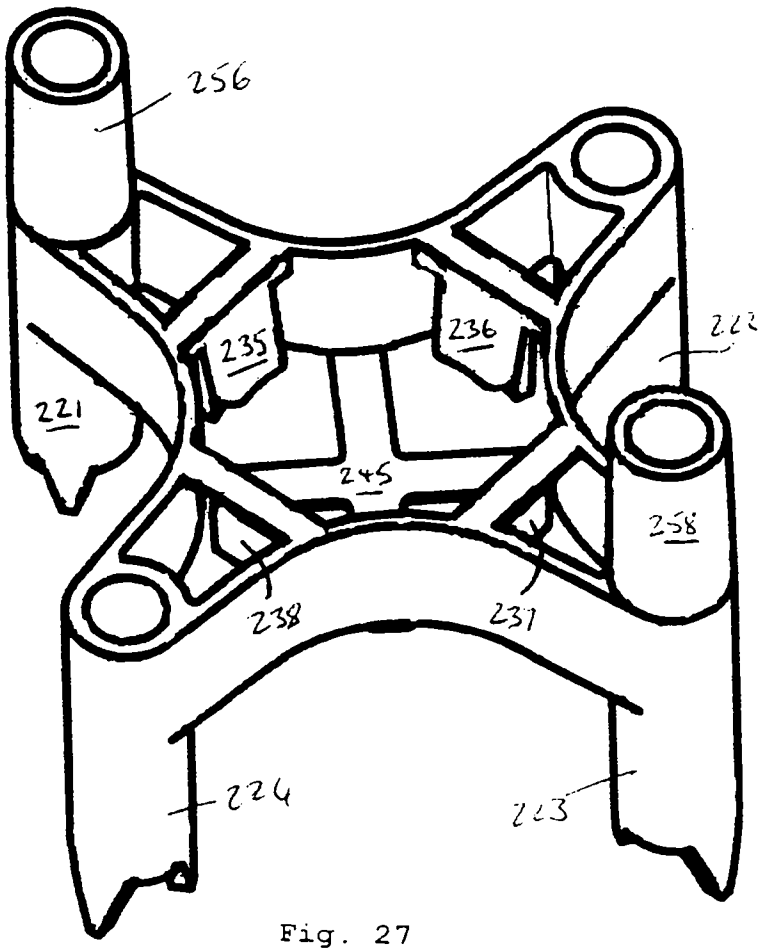

Fig. 27

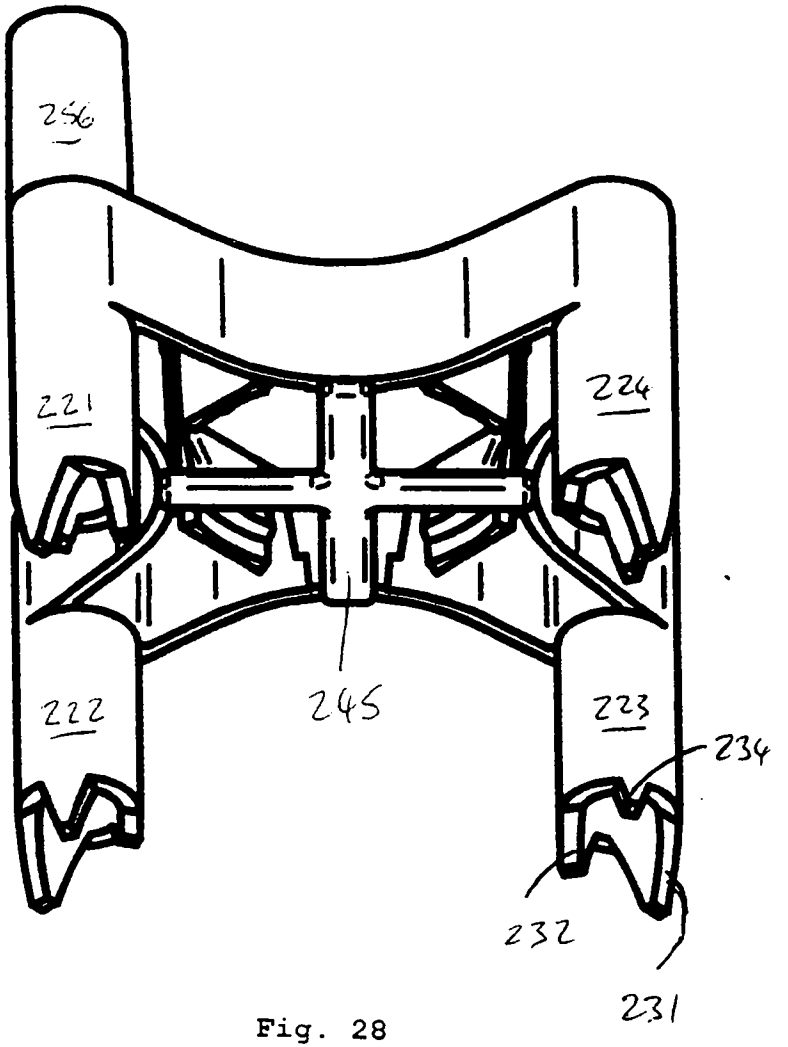

Fig. 28

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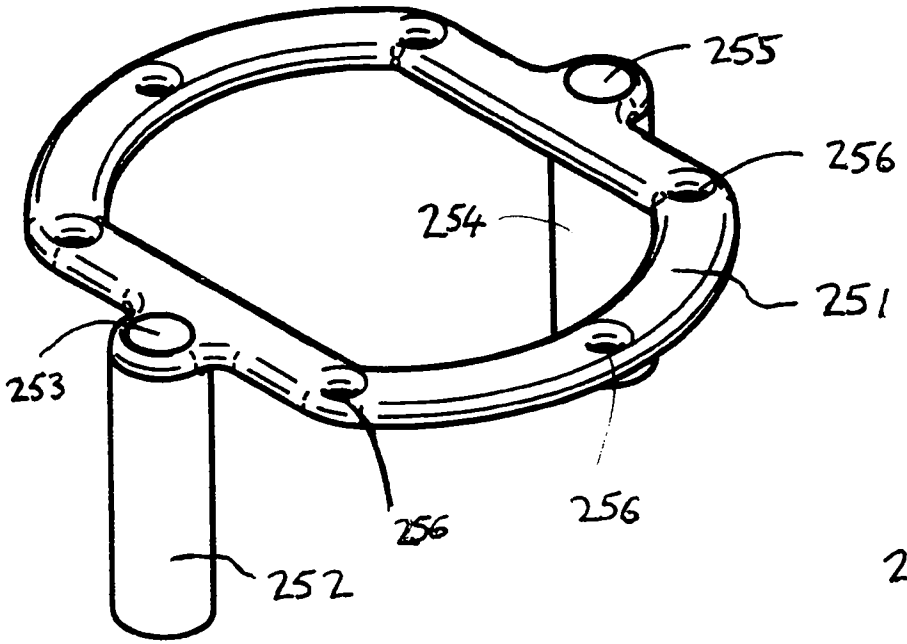

Fig. 29

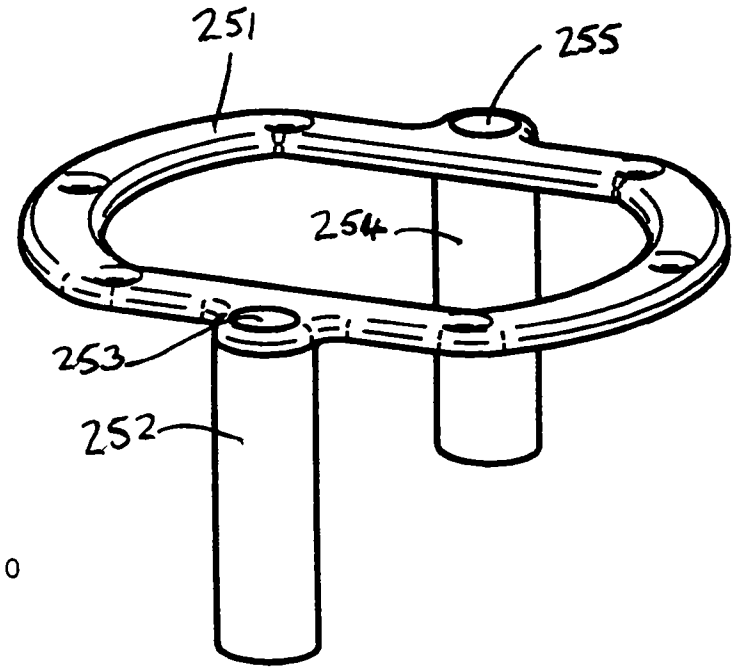

Fig. 30

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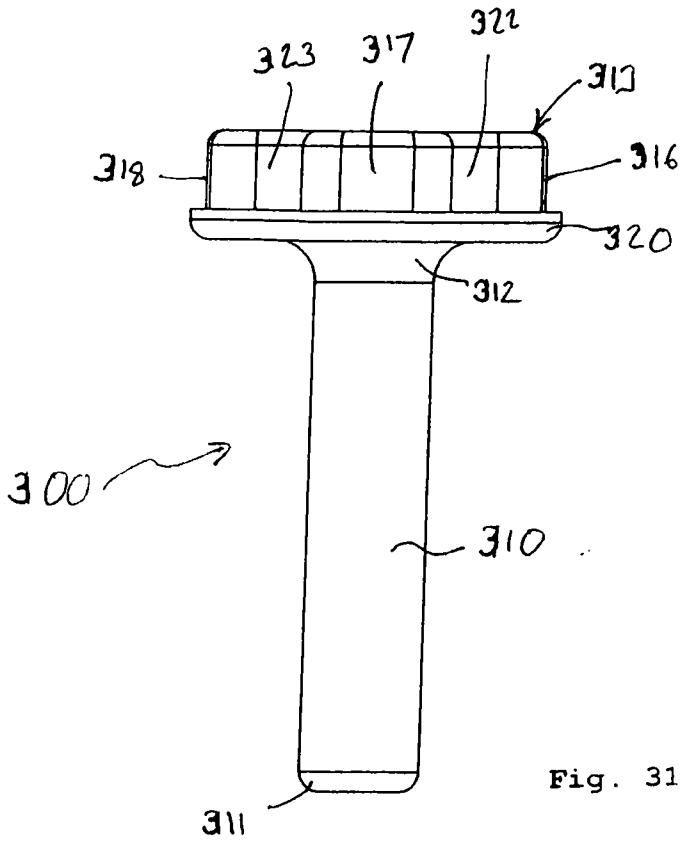

Fig. 31

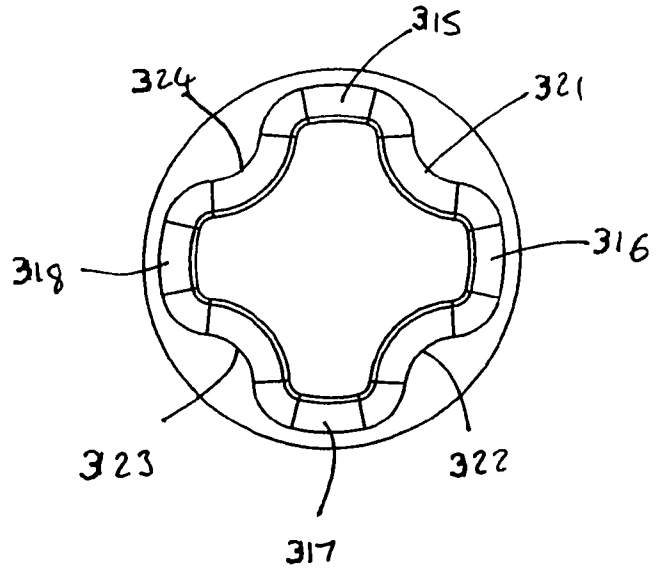

Fig. 32

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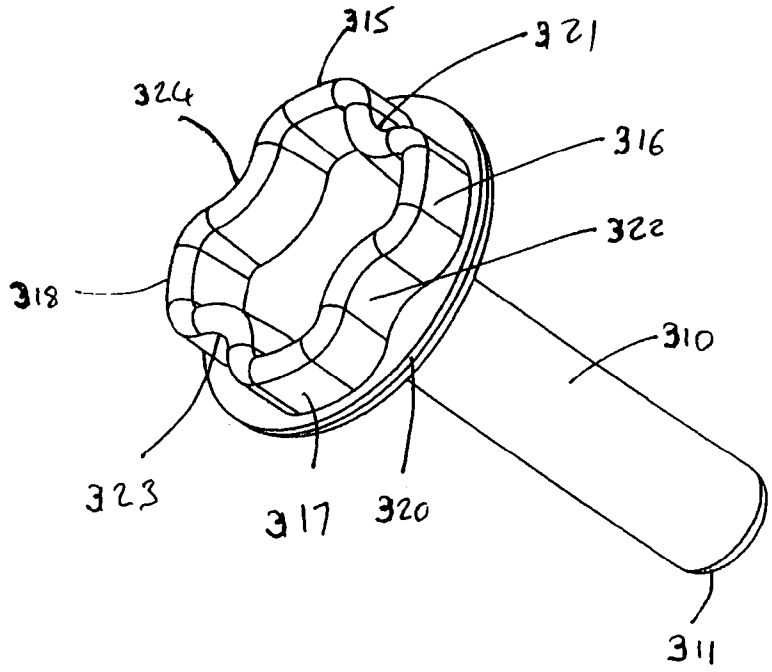

Fig. 33

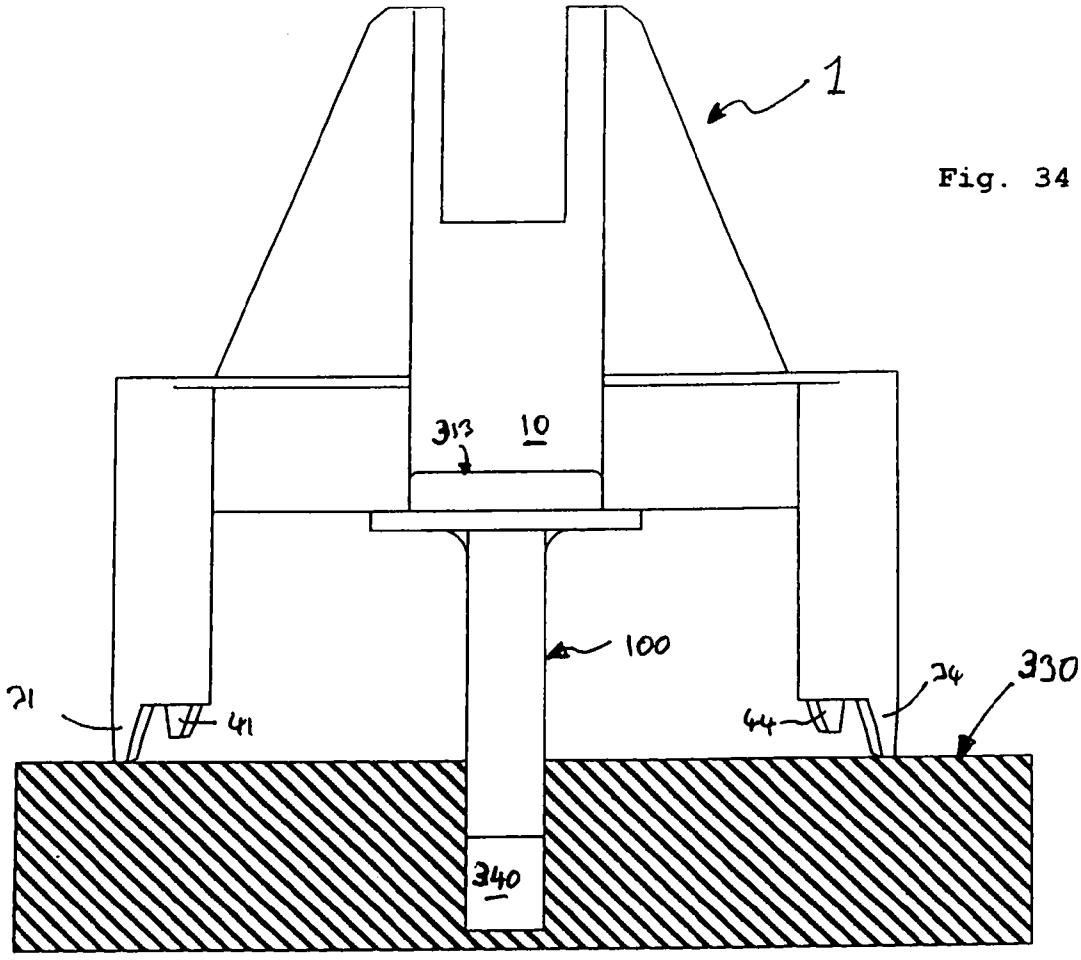

Fig. 34