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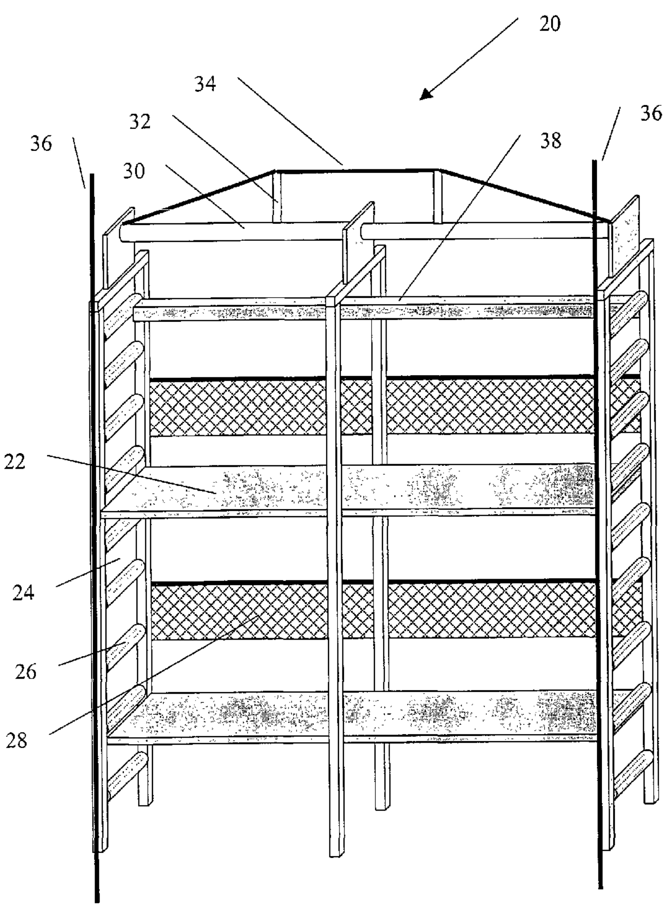

(57) Abstract: A scaffolding system is provided. The scaffolding system comprises a suspension cable, at least one restraint wire comprising a portion for securing to a structure and a scaffolding unit for suspension from a structure by means of the suspension cable. The scaffolding unit comprises at least one restraint guide for the restraint wire, and the at least one restraint wire is for controlling the position of the scaffolding unit in a direction perpendicular to a direction of suspension. The scaffolding system provides for an increase in flexibility of use and a reduction in installation and operating costs, whilst meeting safety requirements.

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SCAFFOLDING SYSTEM

The invention relates to scaffolding systems of a kind used in building construction and building maintenance. More particularly, it relates to a suspended scaffolding system, which provides for a simplification in scaffolding system structure, and an improvement in the flexibility of use and reliability of scaffolding systems, whilst affording a reduction in operating costs.

Access platforms have long been used on buildings as a platform from which to perform inspection and maintenance tasks. For example, the painting of the exterior of a building or the washing of the windows of a building might require an access platform. Alternatively, an inspection or survey of the entire exterior of a building might be required. Access platforms for such inspection and maintenance activities are conventionally of a type that comprises a cradle suspended from the top of a building by means of cables. The cables are attached to the cradle and dispensed from booms positioned on the top of the building. In such a conventional system, the vertical position of the cradle is determined by means of a winch provided on the cradle or on the booms.

More recently, there has been a requirement for such suspended systems to be permanently installed on newly constructed buildings. A permanently installed conventional access system is shown in Figure 1. The conventional system comprises a cradle 10 which is suspended from a suspension system 11 provided on the top of a building 1, by means of cables 16. The suspension system 11 of Figure 1 comprises booms 12 which are secured to the top of the building 1, which booms guide the cables 16 and determine the separation between the cradle 10 and the exterior face of the building. The cradle is moved up and down the vertical direction by means of a winch provided on the cradle 10 or the suspension system 11 to give access to the full height of the building 1. In such a conventional system, the cradle 10 is often subject to forces which cause the cradle to move in an undesirable fashion. For example, the cradle can be moved by exposure to strong winds, which movement can be prejudicial to the safety of the operators or the integrity of the building.

Cradles in conventional access systems are often of a considerable weight. Moreover, the cradles are usually designed to carry significant loads. Thus, the permanently installed suspension systems of conventional access systems are designed to withstand large forces. Accordingly, conventional suspension systems need to be very firmly fixed to the top of the building. In addition, a counter-balance weight 14 is required to balance the weight of the cradle, as is shown in Figure 1.

The conventional system shown in Figure 1 only provides access to part of one of the vertical exterior faces of the building 1. However, access to the entire vertical exterior surface of a building is frequently required. In a conventional system of the type shown in Figure 1, a railing is provided around the perimeter of the top of the building. A trolley moves on the railing to move the cradle in the horizontal direction from one position to another on the exterior surface of the building. As discussed above with reference to the suspension system, the railing needs to be very firmly secured to the top of the building to withstand the large forces applied by the weight of the cradle.

The conventional access system shown in Figure 1 is beset by a significant problem, in that a permanently installed system requires frequent safety inspections. Conventional access systems are often used for a small number of weeks over an entire year. Thus, the operational costs can be unduly burdensome, especially when it is considered that access systems which are installed on newly constructed buildings can be required to be kept operational for periods of more than twenty years.

A further problem resides in the inspection and maintenance of buildings which were completed before the introduction of requirements to install access systems at the time of construction. As discussed above, access systems are of a substantial weight and require firm attachment to a building for safe operation. Measures taken to ensure the safe operation of conventional access systems which are installed at the time of construction of a building can often involve considerable labour and material. The installation of conventional access systems after the completion of the construction of a building can often be considerably more complex and costly.

Moreover, irrespective of whether installation takes place before or after completion of construction of a building, the installation and operation of a conventional access system on a building is complex and costly and provides an access system that is inflexible in use.

Thus, there is a requirement for an access system which is simple to install and flexible to operate, and which affords a reduction in the access system inspection regime without compromising on safety.

In a first aspect the present invention relates to a scaffolding system comprising:

a suspension cable;

at least one restraint wire comprising a portion for securing to a structure;

a scaffolding unit for suspension from a structure by means of the suspension cable, said scaffolding unit comprising at least one restraint guide for said restraint wire; and

said at least one restraint wire is for controlling the position of said scaffolding unit in a direction perpendicular to a direction of suspension.

In a second aspect the present invention relates to a scaffolding system comprising:

a first anchor point for disposal towards or at the bottom of a first elevation of a building;

a scaffolding unit for suspension from or adjacent a second elevation of a building opposite said first elevation; and

a first cable for disposal on a building and for coupling to said suspended scaffolding unit, said cable comprising a first portion at or towards one end of the cable for securing to said first anchor point.

In a third aspect the present invention relates to a scaffolding system comprising:

at least one anchor point for permanent disposal towards or on the top of a building;

at least one suspension system for removeably coupling with said at least one anchor point; and a scaffolding unit for temporary suspension adjacent a building from said at least one suspension system.

In a fourth aspect the present invention relates to a scaffolding system for temporary disposal on a building comprising:

at least one cable;

at least one member for removeable disposal on a building and for supporting of said at least one cable;

a scaffolding unit for suspension from or adjacent a building;

at least one suspension element provided on said scaffolding unit for attachment to a portion of said at least one cable.

In another aspect the present invention relates to a scaffold system which provides for a reduction in scaffold system design time, assembly and complexity, whilst having good structural integrity.

Scaffold systems have long been used on buildings and other structures as a platform from which to perform construction and maintenance tasks. For example, in the construction of a building, roof components are often required to be installed over an atrium within the building or over a forecourt at a peripheral part of the building. Alternatively, the maintenance of an atrium or forecourt in a building, in particular the upper parts of the atrium or forecourt, or the washing of the transparent roof of an atrium or forecourt might require a scaffold. Scaffold systems for such construction and maintenance activities are conventionally of a type that is built-up from ground level to provide a work platform at the required location and level within the atrium or forecourt.

The basic structure of a conventional scaffold system is shown in Figure 18. Figure 18 is a sectional representation of an atrium formed within building 10 by means of an enclosed or partially enclosed space formed by the side portions 12 of the building. A roof 16 is positioned over the atrium, which roof can often be substantially of some transparent material such as glass. The roof 16 of the building 10 of Figure 18 is under construction or is undergoing maintenance. Access to the roof 16 of the building 10 is gained from a temporary scaffold unit 20 which is positioned proximate the roof to permit work to be carried out. In such a conventional scaffold system, support for the scaffold unit 20 is provided by several vertical support columns or members, which are supported on the ground or the floor 14 of the atrium. The vertical support columns are represented by the left-hand and right-hand vertical supports 22 in Figure 18.

A conventional scaffold system, such as that shown in Figure 18, presents the problem that the vertical columns 22 obstruct access at or around ground level. Furthermore, the roofs of many atriums or forecourts can be a considerable distance above ground level requiring long and/or many components to construct the vertical columns. Thus, much material and assembly time is required to provide support for what may be a comparatively small scaffold unit. Safety considerations may require the provision of side-wall brackets 26 for securing the vertical columns 22 to the side portions 12 of the building to improve the lateral stability of the scaffold system, as is shown in Figure 18. Such a measure further complicates the scaffold system design process and increases the time required for scaffold system assembly and installation. In addition, the lack of appropriate points on the building side portions for affixing the brackets 26 or the need to avoid damage to the internal fabric of the building may make the providing of such brackets difficult. Cross braces 28, as shown in Figure 18, might also be required for the stability of the scaffold system. Inclusion of cross braces 28 in a scaffold system complicates the design, assembly and installation processes yet further. Another disadvantage of conventional scaffold systems is the requirement to store and transport large quantities of components.

A further quite separate problem can arise when an atrium or forecourt is large in the horizontal direction, i.e. in width or length. A wide or long atrium or forecourt requires a scaffold unit 20 with a large span. Moreover, it is generally desirable to provide a scaffold unit with a large area for most maintenance and construction tasks. Therefore, the need to move a smaller scaffold unit from one position to the next is reduced and maintenance and construction tasks can be carried out with greater efficiency. However, a scaffold unit with a large surface area or a scaffold unit with a large span, which is supported towards its outer periphery, can lack rigidity, i.e. the scaffold unit can flex and distort. The lack of rigidity and strength of such an outer periphery supported scaffold unit is a particular problem when the scaffold unit is required to support a heavy load. Rigidity and strength is provided in a conventional scaffold system by means of additional vertical columns between the scaffold unit and ground, as is represented by the central column 24 in Figure 18.

However, the conventional solution to lack of rigidity and strength in scaffold units has the significant disadvantage of impeding access at ground level in the building, complicating the scaffold system design and assembly time and increasing the component requirements.

Another disadvantage of the conventional scaffold system is that features within the atrium or forecourt, e.g. escalators, can make installation of support columns for a scaffold system difficult or even impossible.

A further disadvantage of the conventional scaffold system is the difficulty in moving the scaffold system from one position within the atrium or forecourt to another without disassembling at least part of the scaffold system.

Thus, there is a requirement for a scaffold system which is comprised of a minimum number and/or size of components and which does not restrict access within an atrium or forecourt of a building or structure. Furthermore, there is a requirement for a scaffold system which involves minimal design and assembly time, whilst providing a scaffold system with good structural integrity and stability.

In a fifth aspect, the present invention relates to a scaffold system comprising a scaffold unit and at least two attachments:

said at least two attachments for disposal on at least two vertical portions of a structure; and

said scaffold unit can be mechanically linked to said at least two attachments such that said scaffold unit is spaced from a ground plane of said structure.

In a sixth aspect, the present invention relates to a method of use of a scaffold system comprising a scaffold unit and at least two attachments, the method comprising:

disposing said at least two attachments on at least two vertical portions of a structure; and

mechanically linking said scaffold unit to said at least two attachments such that said scaffold unit is spaced from a ground plane of said structure.

In another aspect the present invention relates to a scaffolding system, which provides for a reduction in the time taken for building and maintenance tasks. In addition, the invention allows for a significant reduction in the size and/or the number of scaffolding system components.

Scaffolding systems have long been used on buildings as a platform from which to perform construction and maintenance tasks. For example, in the construction of a building of rectangular configuration, wall panels are required to be installed on the four exterior walls of the building. In such a construction activity the wall panels are installed at different levels and locations on the building from a work platform provided by a scaffolding system. Alternatively, the painting of the exterior of a building or the washing of the windows of a completed building might require scaffolding. Scaffolding systems for such construction and maintenance activities are conventionally of a type that is built-up from ground level to provide work platforms at the required locations and levels on the exterior of the building. A conventional scaffolding system which has been built up from ground level is shown in Figure 27. The scaffolding system 10 is usually supported on or near the ground and assembled to extend up to the top of a building 1, which is under construction or maintenance.

Figure 28 provides a detailed representation of the scaffolding unit 10 shown in Figure 27. The scaffolding unit 10 comprises one or more work platforms 2 each of which are fixed to two or more vertical poles 4. The poles 4 function primarily as vertical supports for the work platforms 2. The strength of the scaffolding unit 10 can be increased by the inclusion of horizontal poles 6, which are connected to the platforms 2 and the vertical poles 4 by means of clamps 8. The horizontal poles 6 can be used to secure the scaffolding unit to the building. When the scaffolding unit 10 is installed on the side of a building as is shown in Figure 27, supports are often provided at several points on the scaffolding unit to secure the scaffolding unit to the exterior of the building. The supports can take the form of brackets, which are mechanically or chemically attached to the exterior of the building, or clamps, which are secured to appropriate features on the exterior of the building.

Many conventional scaffolding systems are beset by the problem that they extend a considerable height above ground level. Such conventional scaffolding systems are constructed of a large number and/or size of components. Thus, there is a correspondingly large storage and transportation requirement for the operator. Furthermore, the scaffolding system design, assembly and installation time is complicated and lengthy.

A further problem with conventional scaffolding systems relates to the time taken for completion of work on a building. A conventional scaffolding system of the type shown in Figure 27 permits work to be carried out on one part of a building at a time. Such a conventional scaffolding system is often not readily moveable from one part of the building to another. Thus, as the construction or maintenance work moves from one part of the building to another, the work stops and the scaffolding system is disassembled, moved and then reassembled before work recommences. Much time can be expended on the disassembly and re-assembly of the scaffolding system each time it is moved, during which time no work is being carried out on the building. Thus, the length of time required for disassembly and re-assembly of the scaffolding system can be a significant proportion of the total time required for construction or maintenance work on a building.

Therefore, there is a requirement for a scaffolding system which affords a reduction in the number and/or size of components and which is more readily transported and stored, whilst not compromising on the capabilities of the scaffolding system.

Furthermore, there is a requirement for a scaffolding system which can be moved from one location on a building to another with minimal interruption of the work being carried out on the building.

In a seventh aspect, the present invention relates to a method of use of a scaffolding system comprising a multi-stage scaffolding unit, at least one support element and at least one suspension element, said multi-stage scaffolding unit comprising a plurality of stages corresponding to a plurality of levels of a building, the method comprising:

providing for the scaffolding unit to be supportable adjacent or on the building by said at least one support element, and

providing for the scaffolding unit to be suspensible adjacent or from the building by said at least one suspension element, and

selecting between said supporting of the scaffolding and said suspension of the scaffolding.

In an eighth aspect, the present invention relates to a scaffolding system comprising:

a multi-stage scaffolding unit comprising a plurality of stages corresponding to a plurality of levels of a building;

at least one support element for supporting the scaffolding system adjacent to or on a building, and

at least one suspension element for suspending the scaffolding system adjacent to or from a building.

In another aspect the present invention relates to relates to a modular scaffolding system which provides for a reduction in scaffolding system design time and assembly and which is adaptable and readily transportable, whilst having good structural integrity.

Scaffolding systems have long been used on buildings and other structures as a platform from which to perform construction and maintenance tasks. For example, in the construction of a building of rectangular configuration, wall panels are required to be installed on the four exterior walls of the building. In such a construction activity the wall panels are installed at different levels and locations on the building from a work platform provided by a scaffolding system. Alternatively, the painting of the exterior of a building or the washing of the windows of a completed building might require scaffolding. Scaffolding systems for such construction and maintenance activities are conventionally of a type that is built-up from ground level to provide work platforms at the required locations and levels on the exterior of the building.

Typically, such conventional scaffolding systems permit work to be carried out on one portion of a building at a time and are often not readily moveable from one part of the building to another. Thus, as the construction or maintenance activity moves from one part of the building to another, the scaffolding system must be disassembled before being moved and reassembled before work can recommence. Much time can be expended on the disassembly and reassembly of the scaffolding system each time it needs to be moved, with a consequential increase in cost and an increase in the risk of worker injury.

More recently, some of the above-noted problems have been alleviated by means of scaffolding systems of a suspension type. The basic structure and operation of a suspension type scaffolding system is shown in Figure 35. The building 10 of Figure 35 is under construction or is undergoing maintenance. A single scaffolding unit 16 is suspended from the top of the building 10 to enable the work to be carried out. The scaffolding unit 16 is suspended from the top of the building 10 by means of cables 14. The cables 14 are attached to the scaffolding unit 16 and are dispensed from winches 12 via booms 18, which winches and booms are positioned on the roof of building 10. The length of the cables 14 is controlled by means of the winches 12, whereby the vertical position of the scaffolding unit 16 can be determined. The distance between the building exterior and the scaffolding unit 16 is determined by the length of the booms 18 extending beyond the top edge of the building 10. Instead of the fixed boom 18 and winch 12 arrangement shown in Figure 35, a mobile roof vehicle can be provided to permit the scaffolding unit to be moved along the side of the building and around corners, without disassembly of the scaffolding unit 16. An advantage of the suspension-type scaffolding system compared with the conventional ground based type is a reduction in assembly and disassembly time. Moreover, by suspending the scaffolding system from the roof of the building there is no restriction of access to the building around ground level.

Figure 36 provides a detailed representation of the scaffolding unit 16 shown in Figure 35. The scaffolding unit 16 comprises one or more work platforms 22 each of which are fixed to two or more ladder sections 24. Ladder sections 24 function primarily as vertical supports for the work platforms 22. The provision of rungs 26 on the ladder sections 24 facilitates the vertical movement of persons from one work platform 22 to another. As shown in Figure 36, the depth of the work platforms 22 is greater than the width of the ladder sections 24. This feature permits persons to move with greater ease from one end of a work platform 22 to the other, especially when there is a ladder section provided in the middle of the work platform for additional support as is shown in Figure 35. The strength of the scaffold unit 16 can be increased by the inclusion of support sections 28. A suspension beam 30 is attached to the scaffolding unit to provide a means of attachment for the suspension cables. The suspension beam 30 can be provided at the top of the scaffolding unit 16, as shown in Figure 35. Alternatively, the suspension beam can be provided at a lower part of the scaffolding unit, and to improve stability the suspension cables can be attached to or fed-through the upper portions of the scaffolding unit. Of course, it will be appreciated by the skilled person that the scaffolding unit shown in Figure 36 is merely illustrative and that modifications and variations can be made to the individual components and the overall structure of the scaffolding unit without changing its basic function.

However, the conventional suspension type scaffolding system shown in Figure 35 only addresses the problems associated with ground based scaffolding systems to a limited extent. Furthermore, the conventional suspension type scaffolding system creates a further significant problem. There is often a requirement in building construction or maintenance to carry out work on two or more different parts of the building. For example, work may be required at two locations on the exterior of the building that are some distance apart in the horizontal and/or vertical direction. Such a circumstance would require the scaffolding unit of the type shown in Figure 36 to be large in the horizontal and/or vertical direction. Alternatively, the exterior of the building might not be planar, in that it comprises one or more portions that extend some distance outwards from the exterior surface of the building. Such a circumstance might make it difficult to position the scaffolding unit of Figure 35 close to the building or it might make the design of the scaffolding unit complex. The result in both circumstances is an unwieldy scaffolding unit, which involves a lengthy design and assembly time. Furthermore, the inevitable increase in weight necessitates the use of a more powerful winch motor to move the scaffolding unit up and down the building.

On the other hand, two or more smaller scaffolding units could be independently suspended from the roof of the building. The advantages of this latter approach are a greater flexibility of use, a reduction in the size and/or number of scaffolding unit components and no requirement for high power winch motors. However, a significant disadvantage of this approach is instability in each of the smaller scaffolding units, for example as may be the case in high winds or during adjustment of the vertical position of a smaller scaffolding unit. Furthermore, movement of persons from one smaller scaffolding unit to an adjacent smaller scaffolding unit is more difficult and dangerous.

Thus, there is a requirement for a scaffolding system which is adaptable, which is comprised of the minimum number and/or size of components and which is readily transportable, whilst having good structural integrity and stability. Furthermore, there is a requirement for a scaffolding system which can accommodate different building shapes and provide a working platform for different tasks without incurring an increase in system design time, system assembly time and operational costs.

According to a ninth aspect, the present invention relates to a scaffolding system comprising at least a first scaffolding module and a second scaffolding module each capable of being suspended from a structure;

each of said scaffolding modules comprising means to mechanically link the first scaffolding module to the second scaffolding module;

said mechanical link means permits movement of the first scaffolding module in relation to the second scaffolding module in a first direction; and said mechanical link means restricts movement of the first scaffolding module in relation to the second module in a second direction perpendicular to said first direction.

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

Fig. 1 is a representation of a conventional access system;

Fig. 2 is a representation of a scaffolding system according to the present invention;

Fig. 3 is a representation of a view of the scaffolding unit shown in Fig. 2;

Fig. 4 is a representation of another view of the scaffolding unit shown in Fig. 2;

Figs. 5a, 5b and 5c are examples of building attachments according to the present invention;

Fig. 6 is a representation of a view of another embodiment of the scaffolding unit shown in Fig. 2;

Fig. 7 is a representation of a first method of use of a scaffolding system according to the present invention;

Fig. 8 is a representation of a second method of use of a scaffolding system according to the present invention;

Figs. 9a to 9e is a representation of a third method of use of a scaffolding system according to the present invention;

Figs. 10a to 10d is a representation of a fourth method of use of a scaffolding system according to the present invention;

Figs 11a and 11b are a representation according to another embodiment of the present invention;

Fig. 12 is a representation of ground anchor points for use with the scaffolding system of Figs. 11a and 11b;

Fig. 13 is a representation of a roof anchor point for use with the scaffolding system of Figs. 11a and 11b;

Fig. 14 is a detailed representation of a roof anchor point;

Fig. 15 is a detailed representation of another example of roof anchor points;

Fig. 16 is a representation of a roof cable support for use with the scaffolding system of Figs. 11a and 11b;

Fig 17 is a top view of a roof cable support arrangement for use with the scaffolding system of Figs. 11a and 11b;

Fig. 18 is a representation of a conventional supported scaffold system;

Fig. 19 is a representation of a first embodiment of the scaffold system of the present invention;

Fig. 20 is a representation of a second embodiment of the scaffold system of the present invention;

Fig. 21 is a representation of an alternative embodiment of a scaffold unit;

Fig. 22 is a detailed cutaway view of a scaffold unit;

Fig. 23 is a view of a scaffold unit;

Fig. 24 is detailed end section of a scaffold unit;

Fig. 25 is a representation of an alternative means of use of the present invention.

Fig. 26 is a top view of an alternative means of supporting the scaffold unit according to the present invention;

Fig. 27 is a representation of a conventional scaffolding system;

Fig. 28 is a representation of the scaffolding unit shown in Fig. 27;

Figs. 29a and 29b are a representation of a scaffolding system according to the present invention;

Fig. 30a is a representation of the scaffolding unit shown in Figs. 29a and 29b;

Fig. 30b provides examples of supports for the scaffolding unit shown in Fig. 30a;

Fig. 31a is a representation of an alternative embodiment of a scaffolding unit according to the present invention;

Fig. 31b provides examples of mechanical linkages for the scaffolding unit shown in Fig. 31a;

Fig. 32 is a representation of a first method of use according to the present invention;

Fig. 33 is a representation of a second method of use according to the present invention;

Fig. 34 is a representation of a third method of use according to the present invention;

Fig. 35 is a representation of a conventional suspended scaffolding system;

Fig. 36 is a representation of the scaffolding unit shown in Fig. 35;

Fig. 37 is an illustration of the present invention comprising two suspended scaffolding modules;

Fig. 38a is a representation of a top view of the mechanical linkage between two scaffolding modules;

Fig. 38b is a representation of a cutaway side view of the mechanical linkage between two scaffolding modules;

Fig. 39a is a detailed illustration of a mechanical linkage;

Fig. 39b is a detailed illustration of an alternative mechanical linkage;

Fig. 40a is an illustration of a first means of linking scaffolding modules around a corner of a building;

Fig. 40b is an illustration of a second means of linking scaffolding modules around a corner of a building;

Fig. 40c is an illustration of a third means of linking scaffolding modules around a corner of a building;

Fig. 41 is a representation of a second embodiment of the present invention;

Fig. 42 is a representation of another arrangement of the present invention.

Figure 2 shows a scaffolding unit 20 suspended from the roof of a building 1 by means of cables 16 dispensed from a suspension system 11. The suspension system 11 comprises a boom 12 and members for supporting the boom on the roof of building 1. A counter-balance weight or securing point 14 is provided in the suspension system 11 to balance the weight of the scaffolding unit 20, as discussed above. According to the present invention, the suspension system 11 and scaffolding unit 20 are temporarily disposed on the roof of the building 1. This means of disposal is in contrast to the aforementioned conventional access system wherein the cradle 10 of Figure 1 is permanently installed on the roof of the building 1. As discussed above, a building access system needs to be secured to the roof of the building to provide for safe operation. Accordingly, the temporary access system of the present invention is secured to the roof of the building 1 of Figure 2 by means of anchor points which are permanently installed on the roof of the building. Such anchor points can be installed on the roof or towards the upper part of a building either during or after construction. However, it is preferred that the anchor points are installed during construction of a building. It is preferred that the anchor points are of a simple and low cost nature, in that they are structurally uncomplicated and comprised of standard materials and components. The anchor points provide a means of temporarily securing a suspension system and suspending a scaffolding unit or access platform in a safe manner. Examples of anchor points are described below in more detail with reference to Figures 5a to 5c. Thus, the according to the present invention anchor points are permanently installed on or towards the roof of a building. The anchor points provide a safe means of attachment of a suspension system and the suspension of a scaffolding unit to enable work to be carried out on the vertical exterior faces of the building.Once work on the building is complete the suspension system and scaffolding unit can be removed from the building leaving only the anchor points remaining on the building. The suspension system and scaffolding unit can then be relocated to another building, which is provided with similar such anchor points, for work to be carried out on that other building. In contrast, the conventional access system of Figure 1 comprises a permanently installed suspension system 11 and cradle 10. Providing such a conventional access system on a building involves considerable expenditure on the part of the building contractor or building owner. Furthermore, a conventional access system usually comprises moving parts or is of a complexity which requires frequent maintenance. Moreover, safety requirements are such that frequent safety inspections are required. On the other hand, the access system according to the present invention confers the significant benefits of reducing installation and operating costs.

Figure 3 is a detailed representation of the scaffolding unit 20 shown in Figure 2. The scaffolding unit 20 comprises one or more work platforms 22 each of which are fixed to two or more ladder sections 24. Ladder sections 24 function primarily as vertical supports for the work platforms 22. The provision of rungs 26 on the ladder sections 24 facilitates the vertical movement of persons from one work platform 22 to another. The strength of the scaffolding unit 20 can be increased by the inclusion of support sections 28. A suspension beam 30 is attached to the scaffolding unit to provide a means of attachment for the suspension cables. The suspension beam 30 can be provided at the top of the scaffolding unit 20, as shown in Figure 3. Alternatively, the suspension beam can be provided at a lower part of the scaffolding unit, and to improve stability the suspension cables can be attached to or fed-through the upper portions of the scaffolding unit.

It is preferred that the suspension beam 30 of a scaffolding unit 20 includes a truss to strengthen the suspension beam 30. Usually the truss is a bowstring truss of a kind shown in Figure 3. The bowstring truss of Figure 3 comprises a cable 34, which is supported on spacers 32 provided on the suspension beam 30 and is attached to either end of the suspension beam 30. Usually, the cable 34 of the bowstring truss is under tension.

It is preferred that the scaffolding unit 20 comprises a material handling bar 38, as shown in Figure 3. The material handling bar 38 provides a handling system for the likes of glass panes and construction panels. Usually, the material handling bar 38 is provided towards the upper portions of the scaffolding unit, although the material handling bar 38 can be installed at any position on the scaffolding unit 20.

Of course, it will be appreciated by the skilled person that the scaffolding unit shown in Figure 3 is merely illustrative and that modifications and variations can be made to the individual components and the overall structure of the scaffolding unit without changing its basic function.

According to the present invention, a scaffolding unit 20 is provided with at least one restraint wire 36. The restraint wire 36 is connected at its upper end to the suspension system of the scaffolding system. The restraint wire is suspended in a direction substantially between the suspension system and the ground and is mechanically coupled to the scaffolding unit 20. The function of the restraint wire is to restrict movement of the scaffolding unit 20 in directions perpendicular to the direction of suspension of the unit 20, which direction of suspension is usually the direction of movement of the scaffolding unit 20 in relation to a building under maintenance or inspection. As shown in Figure 3, two restraint wires 36 are provide at either end of a side of the scaffolding unit 20, which side faces away from the building 1 under maintenance or inspection. The two restraint wires 36 can be provided at any position along the side of the scaffolding unit 20 which faces away from the building 1. Any number of restraint wires 36 can be provided along the side of the scaffolding unit 20 which faces away from the building 1. In a preferred embodiment, two restraint wires 36 are provided along the side of the scaffolding unit 20, at or towards either end of the side. Restraint wires positioned along a side of a scaffolding unit facing away from a building are referred to as rear restraint wires. Rear restraint wires restrict movement of a scaffolding unit 20 in a direction which is perpendicular to the direction of suspension of the scaffolding unit and in line with a direction of disposition of the scaffolding unit 20 in relation to a building 1.

Figure 4 is a side view of the scaffolding unit 20 shown in Figure 3. The scaffolding unit 20 is shown in relation to a building 1, which is under maintenance or inspection. The end view of the scaffolding unit of Figure 4 shows a vertical ladder section 24 provided with rungs 26. One of the two rear restraint wires 36 of Figure 3 is shown in Figure 4. In addition, Figure 4 shows an additional restraint wire 42, which is referred to as a side restraint wire. The side restraint wire 42 is attached at an upper end to the suspension system on the roof of a building and is suspended in a direction substantially between the suspension system and the ground. The side restraint wire 42 is mechanically coupled to the scaffolding unit 20. In a preferred embodiment, a side restraint wire 42 is provided at either side of the scaffolding unit 20. More than one side restraint wire 42 can be provided at either side of the scaffolding unit 20 if required. The side restraint wire 42 restricts movement of a scaffolding unit 20 in a direction which is perpendicular to the direction of suspension of the scaffolding unit and perpendicular to a direction of disposition of the scaffolding unit 20 in relation to a building 1.

A side restraint wire 42 can be mechanically coupled to the scaffolding unit 20 by means of a loop arrangement, which is provided on the side of the scaffolding unit, and through which the side restraint wire is fed. Alternatively, the side restraint wire can be mechanically coupled by means of a wire guide arrangement 44, which is provided on the side of the scaffolding unit as is shown in Figure 4. Such a wire guide arrangement takes the form of a member in which a channel is formed, which channel acts to accommodate the side restraint wire 42. Alternatively, the side restraint wire 42 can be mechanically coupled by means of one or more pulley arrangements 40, as shown in Figure 4. As stated above, the rear restraint wires 36 are mechanically coupled to the scaffolding unit 20. Any one of the means of mechanical coupling described above with reference to the side restraint wires 42 can be used with the rear restraint wires 36. It is preferred that a pulley arrangement 40 is used with the rear restraint wires, as shown in Figure 4.

The rear and side restraint wires 36, 42 of the present invention are, as is discussed above, secured at an upper end to a suspension system and mechanically coupled to a scaffolding unit. The rear and side restraint wires extend towards another end below the scaffolding unit where the restraint wires are attached to a weight, which weight is disposed on the ground or suspended below the scaffolding unit. Alternatively, the restraint wires are attached to the ground or some portion of a building at or towards the ground.

As discussed above with reference to Figure 2, according to the present invention the provision of anchor points, which are permanently installed on a building, permits removal of the suspension system and scaffolding unit. Figures 5a to 5c provide examples of permanently installed anchor points. In Figure 5a, an anchor point 50 is provided on a portion of a roof of a building 1. The anchor point of Figure 5a comprises a portion 54 which is embedded within the material of the roof of the building. A second portion 52 of the anchor point 50 extends above the level of the roof of the building. The second portion 52 includes a means for securing a suspension system, which means might comprise a hoop for accommodating a boom of a suspension system, as shown in Figure 5a. Figure 5b shows a different embodiment of the arrangement of Figure 5a. In Figure 5b, the first portion 54 of anchor point 50 is embedded in an up-stand 5 provided as part of the structure of the roof of building 1. In both Figure 5a and Figure 5b, the second portion 52 of the anchor point 50 comprises an extended portion to raise the means for securing the suspension system above the level of the roof. Figure 5c shows another arrangement of an anchor point in more detail than the anchor points shown in Figures 5a and 5b. The anchor points 50 of Figure 5c comprises a member 54 secured to building 1 by means of securing elements 56. The securing elements can be rivets, bolts or the like and are embedded in the building 1 at the time of construction of the building or at a later time. Embedding of the securing elements 56 after the building has been constructed can be achieved by, for example, drilling of the material of the building followed by the cementing or gluing in place of the securing elements 56. The anchor point 50 of Figure 5c comprises a bracket 58 which is attached to the member 54. Alternatively, the bracket 58 can form part of the temporarily installed suspension system. As shown in Figure 5c, a boom 12 of a suspension system is secured to the bracket 58 of the anchor point 50 by means of a bolt 60.

Figure 6 is a side view of an alternative embodiment of the scaffolding unit 20 shown in Figure 4. In Figure 4, the scaffolding unit 20 is adjacent a building 1. Similarly to that as described above with reference to Figure 4, the scaffolding unit 20 of Figure 6 comprises a rear restraint wire 36, a side restraint wire 42 and restraint wire guides 40, 44. As shown in Figure 6, the scaffolding unit 20 comprises a work platform 64, the position of which can be fixed anywhere between the upper and lower portions of the scaffolding unit 20. In addition, it is preferred that the scaffolding unit comprises means for preventing the scaffolding unit 20 from coming into contact with a building. As shown in Figure 6, such means can take the form of a roller 66, which is attached to the building side of the scaffolding unit 20.

Typically, a scaffolding unit of the kind shown in Figure 4 has a Safe Working Load (SWL) of 1000 kg. The SWL can be increased to 2000kg by means of a truss 68 provided on a work platform to strengthen the work platform, as shown in Figure 6. It is preferred that the truss is of a bowstring type, as discussed above with reference to Figure 3.

Figure 7 provides an illustration of a first method of use of a scaffolding system according to the present invention. Two scaffolding units 20 are shown as being suspended from the building 1 of Figure 7. The scaffolding unit and suspension system provided on either side of the building 1 of Figure 7 are not connected to each other. Thus, this arrangement is referred to as a non-continuous arrangement. The suspension system 11, which suspends each scaffolding unit 20, comprises a boom 12, a suspension cable 16 and a main support. The main support of the suspension system takes the form of a permanent anchor point as described above, in particular with reference to Figure 5. As discussed above, the weight of the scaffolding unit 20 needs to be compensated for, for safe operation of the scaffolding system. The weight compensator, which is represented by component 70 in Figure 7, takes the form of a cast-in connection to a roof slab, an up-stand or a temporary arrangement, which temporary arrangement might comprise weights. The weight compensator 70 can be either wholly or partially installed on a building. For example, a compensator might comprise an embedded element, as discussed with reference to the anchor points of Figures 5a, 5b and 5c, which can be temporarily connected to a cable attached to the end of a boom of a suspension system. Alternatively, the cable and embedded element might be provided permanently on the roof of the building. The permanent components of a compensator can be installed either during construction of a building or after completion of a building. A permanently installed compensator according to the present invention is structurally simple and is comprised of a few low cost parts. It is preferred that the scaffolding system shown in Figure 7 includes rear and/or side restraint wires 36, which restraint wires are described above with reference to Figures 3 and 4. The rear and side restraint wires 36 restrict the movement of the scaffolding unit 20 in directions perpendicular to the direction of suspension of the scaffolding unit. Alternatively, in the scaffolding system of Figure 7 the suspension system can be entirely temporary, i.e. no permanently installed anchor points or compensators are provided on or towards the roof of building 1. In this arrangement, stability of the main support can be achieved by means of use of a floor-slab, and the weight compensation achieved by means of weight boxes.

Figure 8 provides an illustration of a second method of use of a scaffolding system according to the present invention. Two scaffolding units 20 are shown as being suspended from the building 1 of Figure 8. The suspension system 11, which suspends each scaffolding unit 20, comprises a boom 12, a suspension cable 16 and a main support. The main support of the suspension system can take the form of a permanent anchor point as described above, in particular with reference to Figure 5. Alternatively, the main support can be entirely temporary, e.g. a steel or scaffolding structure or a wheeled assembly. The scaffolding system of Figure 8 comprises a connection member 72 which connects suspension systems 11 provided on opposing side of a building 1. Thus, the arrangement shown in Figure 8 is referred to as a continuous arrangement. The connection member can be a cable or a solid member. It is preferred that the scaffolding system comprises a truss arrangement to strengthen the connection between suspension systems on opposing sides of a building. As shown in Figure 8, a typical truss arrangement is a bowstring truss 74 comprising a cable supported by spacers provided on the suspension systems 11 and the connection member 72. In addition, it is preferred that each scaffolding unit 20 is provided with rear and/or side restraint wires 36. The restraint wires 36 are connected at an upper end to a suspension system 11 and are coupled to a scaffolding unit. The restraint wires are connected at a lower end either to a weight suspended below the scaffolding unit or to the ground or some portion of a building.

The method of use shown in Figure 8 provides the means to counter-balance the weight of the two scaffolding units 20. When the two scaffolding units 20 are in a similar lie and are bearing similar loads the two scaffolding units are self-balancing, i.e. one scaffolding unit acts as a balance to the other scaffolding unit. When the scaffolding units are in a different lie or are bearing dissimilar loads the restraint wire of each scaffolding unit provides a balancing force for the opposing scaffolding unit, which balancing force is coupled via the suspension systems 11 and connection member 72.

Figures 9a to 9e are a representation of a third method of use of a scaffolding system according to the present invention. Figures 9a to 9e are a top view of a building 1 showing a suspension system for a scaffolding system in different positions and arrangements on the roof of the building 1. The suspension systems shown in Figures 9a to 9e are of the continuous kind shown in Figure 8, i.e. the suspension systems on opposing sides of a building are connected, for example by means of a connection member. Figure 9a shows a first phase of work on a building 1, wherein two suspension systems 80 are provide on opposing upper and lower sides of the building 1. In addition, a further two suspension systems 82 are provide at the right side of the building 1, from which a scaffolding unit 20 is suspended. The suspension systems 80 and 82 are of a kind as described above. As indicated in Figure 9a, for safe operation the arrangement is secured to the building at four positions 84. Once work on the right hand exterior face of the building 1 is complete, the suspension systems 82 for gaining access to the right hand exterior face of the building 1 are removed and two scaffolding units 20 are suspended from the opposing suspension systems 80, as shown in Figure 9b. No change in the suspension system securing positions is required. Thereafter, the suspension systems 80 are moved to positions on the building 1 as shown in Figures 9c and 9d to enable work to begin on the third and fourth phases of work. Finally, two additional suspension systems 82 are included in the arrangement to gain access to the left hand exterior face of the building for the fifth phase of work, as shown in Figure 9e. As is clearly demonstrated by the method of use shown in Figures 9a to 9e, a scaffolding system according to the present invention affords a considerable increase in flexibility of access to the exterior of a building. Furthermore, such an arrangement requires a minimum number of points of attachment and changes in points of attachment to the building. In contrast, a conventional access system of the kind shown in Figure 1 would require the installation of an access rail around the perimeter of the roof of the building. Thus, a significant increase in system complexity and cost would be incurred.

Figures 10a to 10d are a representation of a fourth method of use of a scaffolding system according to the present invention. Figures 10a to 10d are a top view of a building 1 showing a suspension system for a scaffolding system in different positions and arrangements on the roof of the building 1. The suspension systems shown in Figures 10a to 10d are of the non-continuous kind shown in Figure 7, i.e. the suspension systems on opposing sides of a building are not connected. Figure 10a shows a first phase of work on a building 1, wherein two suspension systems 90 are provide on opposing upper and lower sides of the building 1. In addition, a further two suspension systems 92 are provide at the right side of the building 1, from which a scaffolding unit 20 is suspended. The suspension systems 90 and 92 are of a kind as described above. As indicated in Figure 10a, for safe operation the arrangement is secured to the building at four positions 94. Once work on the right hand exterior face of the building 1 is complete, the suspension systems 92 for gaining access to the right hand exterior face of the building 1 are removed and two scaffolding units 20 are suspended from the opposing suspension systems 90, as shown in Figure 10b. No change in the suspension system securing positions is required. Thereafter, the suspension systems 90 are moved to positions on the building 1 to enable work to begin on the third and fourth phases of work. The arrangement for the third phase of work is shown in Figure 10c. Finally, two additional suspension systems 92 are included in the arrangement to gain access to the left hand exterior face of the building for the fifth phase of work, as shown in Figure 10d. As is clearly demonstrated by the method of use shown in Figures 10a to 10d, a scaffolding system according to the present invention affords a considerable increase in flexibility of access to the exterior of a building. Furthermore, such an arrangement requires a minimum number of points of attachment and changes in points of attachment to the building. In contrast, as stated above a conventional access system of the kind shown in Figure 1 would require the installation of an access rail around the perimeter of the roof of the building.

In the scaffolding units described herein, which are of the type comprising rear restraint wires, it is preferred that the position of the wires can be changed either manually or automatically. The movement of the position of the rear restraint wires is accomplished by moving the restraint guides provided on the scaffolding unit.

Another embodiment of the present invention is illustrated in Figures 11a and 11b. Figure 11a shows a top view of a building 1 and an arrangement for suspending two scaffolding units on opposing vertical exterior faces or elevations of the building. A first scaffolding unit is suspended by means of a first cable 100 and a second scaffolding unit is suspended by means of a second cable 102. As shown in Figure 11b, the first cable 100 and the second cable 102 are disposed over the vertical exterior surfaces and roof of the building 1. One end of the first cable 100 is attached to the ground on a first elevation of the building and the first scaffolding unit is suspended adjacent the second elevation by means of the first cable 100, which second elevation opposes the first elevation. The scaffolding unit moves in the vertical direction on the elevation of the building by means of a climber motor provided on the scaffolding unit. The climber motor grips the cable and causes the scaffolding to move relative to the cable. It is preferred that the end of the first cable 100 which is adjacent the second elevation of the building, i.e. the elevation at which the first scaffolding unit is suspended, is attached to the ground. Either end of the first cable 100 can be attached at or towards the bottom of the building instead being attached to the ground. One end of the second cable 102 is attached to the ground on the second elevation of the building and the second scaffolding unit is suspended adjacent the first elevation by means of the second cable 102. It is preferred that the end of the second cable 102 which is adjacent the first elevation of the building, i.e. the elevation at which the second scaffolding unit is suspended, is attached to the ground. In addition, it is preferred that the portion of the first cable which is adjacent the first elevation of the building is coupled to the second scaffolding unit to act as a restraining wire for the second scaffolding unit. Furthermore, it is preferred that the portion of the second cable which is adjacent the second elevation of the building is coupled to the first scaffolding unit to act as a restraining wire for the first scaffolding unit. The cables are coupled to their respective scaffolding units by restraint guides of a type discussed above. Thus, two scaffolding units are suspended and restrained on opposing elevations of a building by means of a two cable arrangement. Each of the two cables acts as a suspension cable for one scaffolding unit and as a restraining wire for the other scaffolding unit. In a preferred embodiment the arrangement comprises four cables, with two of the four cable functioning as suspension cables and each of the two cables attached to either end of a scaffolding unit. The preferred four wire arrangement provides for maximum stability of the scaffolding units and maximum safety of the operators. Typically, the cables 100 and 102 have a cross-section of 16 mm.

As shown in Figure 11a, a length of cable 104 can be provided on a cable 102. The length of cable 104 is referred to as a spur. The spur 104 is provided on the main cable at around roof height and is secured to the roof or an upper portion of the building. It is preferred that a spur 104 is provided on each of the cables in a scaffolding system. The presence of a spur 104 on the cables provides for a back-up means of suspension in the event that the main cable 100, 102 fails.

Figure 12 is a representation of the anchor points that are used to secure the cables 100 and 102 of Figures 11a and 11b to the ground. Figure 12 shows the ground 110, e.g.

the pavement, at the bottom of a building 1. Two anchor points 112 and 114 are shown in Figure 12 at ground level 110. An anchor point can extend above the level of the ground 110, as illustrated by the left-hand anchor point 112 of Figure 12. Alternatively, an anchor point can be embedded in the ground 110, as illustrated by the right-hand anchor point 114 of Figure 12. It is preferred that an embedded anchor point 114 is provided with a cover. The anchor points can either be embedded in the ground or bolted to the ground. It is preferred that the cables 100 and 102 are attached to the anchor points by means of a bolt and hole arrangement. Alternatively, the cables 100 and 102 can be attached to the anchor points by means of cement or some other high strength adhesive. It is preferred that four anchor points are provided for every 10 meter distance along the side of a building.

For safe and reliable operation of the scaffolding system illustrated in Figures 11a and 11b it is preferred that the cables 100 and 102 are supported on the roof of the building. A representation of an appropriate means of roof support is shown in Figure 13. The building 1 of Figure 13 comprises a concrete or steel parapet 120, which extends around the outer periphery of the roof of the building. An attachment member 122 is disposed on the roof of the building 1 behind the parapet 120, to provide a means of attachment for the roof cable supports. The attachment member 122 can be of any appropriate shape or material. However, it is preferred that the attachment member is a steel tube. The attachment member 122 can be cast into the roof of the building. Alternatively, the attachment member can be welded to the parapet 120, if the parapet is made of steel.

Where a steel column head is accessible on a roof an alternative means of attaching an attachment member can be used. Figure 14 is a representation of a steel column 126, which is accessible at roof level. An attachment member 124 is welded to the top of the steel column 126 to provide an attachment point for the roof cable supports. Alternatively, concrete column heads might be accessible on the roof of a building. An attachment member can be cast into the top of the concrete column head to provide an attachment point for the roof cable supports. Usually, concrete and steel columns are provided in a building at a separation of 4.5 to 9 meters.

An alternative to the arrangements shown in Figures 13 and 14 exists where a steel or concrete ring beam is present on a building. Figure 15 shows a steel or concrete ring beam 126. The attachment members 124 are provided on the steel or cement ring beam by an appropriate means, e.g. by casting in or by welding.

The roof cable support attachment members 122, 124 are permanently installed on a building during the construction of the building. Alternatively, the members 122, 124 can be installed after completion of the building, and can, if it is required, be removed after the work is complete.

Figure 16 is an illustration of a typical roof cable support arrangement. As shown in Figure 16, an extension element 128 is secured to the attachment member 124. Where the attachment member is a hollow cylinder and the extension element is a cylinder of an appropriate diameter the extension member can be slidably engaged with the attachment member. The function of the extension element 128 is to raise the roof cable support above the level of the roof of the building. The roof cable support is provided on the extension element. The roof cable support comprises two sets of pulleys. As is shown in Figure 16, a first set of pulleys 130 is provided at the top of the roof cable support. A second set of pulleys 132 is provided at a position extending beyond the outer periphery of the building. As can be seen from Figure 16, the two sets of pulleys 130 and 132 support and guide the cables of the scaffolding system. Referring to Figure 16, a first cable 100 is attached to a first scaffolding unit at one end. The first cable 100 extends up the first elevation of the building, runs over the inner-most pulley of the second set of pulleys 132 and runs in between the pulleys of the first set of pulleys 130. The first cable 100 then extends across the roof of the building to a second roof cable support arrangement, which is similar to that shown in Figure 16. At the second roof cable support arrangement the first cable 100 passes over the upper-most pulley of the first set of pulleys 130 and over the outer-most pulley of the second set of pulleys 132. The first cable 100 extends down the second elevation of the building and is attached to the ground. The second cable 102 is coupled to the first scaffolding unit to perform a restraining function as described above. The second cable 102 extends from the first scaffolding unit up the first elevation of the building, over the outer-most pulley of the second set of pulleys 132 and passes over the upper-most pulley of the first set of pulleys 130, as shown in Figure 16. The second cable then extends across the roof of the building to the second roof cable support arrangement where the second cable follows the path taken by the first cable 100 in the first roof cable support arrangement shown in Figure 16. The second cable 102 extends down the second elevation of the building and is attached to a second scaffolding unit. The pulleys of the first set of pulleys 130 and the second set of pulleys 132 can be positioned so that the first cable 100 and the second cable 102 are in line with each other in the vertical direction. Alternatively, the pulleys of the first and second set of pulleys 130 and 132 can be positioned so that the first and second cables 100 and 102 are separated in the horizontal direction.

A preferred embodiment of the roof cable support arrangement is shown in plan view in Figure 17. A scaffolding unit 20 is represented as being suspended from a building 1. The scaffolding unit 20 is suspended from cables provided over the roof of the building as described above, which cables are not shown in Figure 17. As shown in Figure 17, the arrangement comprises two extension elements 128 and two roof cable support arrangements of a type described above with reference to Figure 16. Each of the two roof cable support arrangements comprises two brackets 134 and 136, on which are provided pulleys for supporting and guiding the cables of the scaffolding system. Alternatively, each of the two roof cable support arrangements can comprises one bracket where appropriate. It is preferred that the brackets 134 and 136 have a gallows type structure, i.e. each bracket comprises a brace member, which brace member is attached at one end to the distal end of the bracket and attached at its other end to the extension element 128. The pulleys of the arrangement of Figure 17 comprise pulleys with a horizontal axis of rotation, of the kind shown in Figure 16. The horizontal axis pulleys are represented in Figure 17 by the dark rectangles disposed towards the distal end of the brackets 134 and 136. It is preferred that the arrangement comprises pulleys with a vertical axis of rotation 138 provided on the upper portion of the brackets 134 and 136, as shown in Figure 17. The vertical axis pulleys 138 can be used as an aid in guiding the cables 100 and 102 of the scaffolding system. Alternatively, the vertical axis pulleys 138 can be used to guide a cable 140 which extends along the line of the exterior face of the building, as shown in Figure 17. The cable 140 functions as a restraint wire. It is preferred that the cable 140 is attached at one end to the ground below the scaffolding unit, extends up the exterior face of the building, runs through the roof cable support arrangements of Figure 17, extends down the exterior face of the building, and is secured at its other end to the ground.

Figure 19 shows a building 10 with vertical side portions 12 enclosing an atrium within the building which is covered by a roof 16, as is described above with reference to Figure 18. According to the present invention, as shown in Figure 19, a scaffold unit 30 is positioned proximate the roof 16 by means of attachments 32 disposed at or towards the top of the vertical side portions 12 of the building. As is evident from Figure 19, despite being some considerable height above the ground plane 14, the scaffold unit 30 is supported such that there is no requirement for support columns extending from the ground 14. Thus, there is no restriction of access at or around ground level, or indeed at any level, in the atrium. Furthermore, the number of components and/or the size of the components required for the scaffold system of Figure 19 is much less than for conventional scaffold systems. Therefore, the design, assembly and installation time and cost is significantly reduced. Moreover, the reduction in number of components and/or the size of components affords a corresponding reduction in the operator's storage and transportation requirements.

The scaffold unit 30 of Figure 19 is supported by attachments 32, which are shown positioned on top of the vertical side portions 12 of the building 10. The attachments 32 can be mechanically bonded, e.g. riveted, or chemically bonded, e.g. glued or cemented, to the top of vertical side portions 12. The attachments 32 can be installed temporarily or permanently. The scaffold unit 30 is positioned on top of the attachments 32, and may be secured to the attachments if required. At least two attachments 32 are provided for support of the scaffold unit 30, one on each of the two vertical side portions 12, as shown in Figure 19. More than two attachments 32 can be provided if required. Instead of providing the attachments 32 on top of the vertical side portions 12, as shown in Figure 19, the attachments can be provided on the atrium side face of the vertical side portions. Where work is required at some level below the roof 16 but above ground level 14 the attachments can be provided at the appropriate level on the atrium side face of the vertical side portions 12. Indeed, the attachments can be provided at any level on the side portions above ground level. A scaffold can be positioned over or underneath an atrium or forecourt roof or partition, which roof or partition is located below the top of the building, by providing the attachments at lower positions on the side portions of the building.

The attachments 32 can compromise some means of moving the installed scaffold unit. For example, the attachments 32 might comprise a rail that runs at least along part of the length of the side portion 12, and the scaffold unit 30 might comprise components, e.g. rollers, to permit the scaffold unit to move along the rails. Referring to Figure 19, such an arrangement would permit the scaffold unit 30 to move in a direction perpendicular to the plane of the representation. Thus, a scaffold unit of a particular surface area would be able to support work over a considerably greater area of the roof without requiring disassembly and re-assembly of the scaffold system.

A second embodiment of the present invention is shown in Figure 20. Figure 20 is a partial side view of a building, without the floor and lower side portions of the building shown in Figure 19. The scaffold unit 30 of Figure 20 is supported by attachments 34, which are of a suspension type. The attachments 34 can be attached to the side portions 12 at the various points and by the various means described above with reference to the first embodiment. The suspension type attachments 34 of the embodiment shown in Figure 20 comprise attachment elements, which are secured to the side portions 12 and which can extend into the atrium. Cables, or some other appropriate means of suspension, are used to connect the scaffold unit 30 to the attachment elements. The cables, or other means of suspension, can be of fixed length or of variable length. Where the cables are of variable length, the vertical position of the scaffold unit 30 can be changed in relation to the roof 16 and the ground. The length of the cables and vertical position of the scaffold unit can be controlled manually or by a motor driven apparatus, such as a winch.

Figure 21 shows an alternative embodiment of the scaffold unit 30 of Figure 19. The scaffold unit 40 is comprised of at least two tiered platforms as shown in Figure 21. It is preferred that the height of each platform within the tiered arrangement is chosen to provide an appropriate working distance between the platform surface and the roof 16. Such an arrangement is particularly useful where the roof 16 is not flat, e.g. where it is domed as is shown in Figure 21 or where it has any other non-planar profile. The scaffold system 32 and 40 of Figure 21 comprising the tiered platforms can be suspended or supported, as described above with reference to the first and second embodiments. In addition, the scaffold system 32 and 40 of Figure 21 can be configured or structurally altered as discussed above with reference to the first embodiment.

Atriums and forecourts in buildings are frequently large in area. In addition, as indicated above it is preferable to carry out building construction and maintenance tasks from a scaffold unit with as large a work surface area as possible. A scaffold unit with a large work surface area permits tasks to be carried on a correspondingly large roof area without the need to move or disassemble and re-assemble the scaffold unit or system. Furthermore, atriums and forecourts often have a wide span, i.e. the separation between the side portions 12 of a building 10 is large, requiring scaffold units to be long. Scaffold units are often required to support heavy loads, which loads may include material and machinery in addition to personnel. However, a compromise exists between the length or the work surface area of a scaffold unit and the weight of the load that can be supported by the scaffold unit. Figure 22 is a cutaway section of a preferred embodiment of a scaffold unit 30, which includes means of increasing the load bearing capability of a scaffold unit of a particular length or work surface area. The scaffold unit 30 of Figure 22 comprises a boom 54 with a support 56 at either end. Each of the supports 56 can be positioned on top of the side portions 12 of a building 10, as shown in Figure 19. The scaffold unit 30 can comprise additional booms 54 as shown in Figure 23, which booms are substantially parallel to the boom 54 of Figure 22. A platform support structure is provided on the boom 54, which platform support structure might comprise at least two beams 52 positioned in a direction perpendicular to the boom 54. The platform support structure is represented by the solid three-dimensional box 60 in Figure 23. One or more additional beams 52, which additional beams are positioned in a direction parallel to the boom 54 as illustrated in Figure 22, can be provided to increase the rigidity of the platform support structure. As shown in Figure 23, a platform 62 is positioned on top of the platform support structure 60. In addition, smaller platforms 64 can be positioned directly on the booms 54 between the platform support structure 60 and the ends of the booms 54. The platforms 62 and 64 can be replaced by or be in addition to any other work platform, for example a cage, a solid box or some more complex scaffold arrangement. If the scaffold unit is required to provide a span between two widely spaced side portions, or if a scaffold unit is required to support a heavy load, the overall structure of the scaffold unit might be insufficiently rigid to provide a safe work platform. The rigidity and strength of the scaffold unit can be significantly increased by inclusion of a truss system. Figure 22 is a representation of a preferred embodiment of a scaffold unit 30 including a bowstring truss system 58, which bowstring truss system causes only a minimal increase in the complexity and size of the scaffold unit. As shown in Figure 22, the truss system 58 is combined with one boom 54. The truss system can be used with some or all of the booms within a scaffold unit. Furthermore, the truss system can be combined with some other component of the scaffold system, for example one or more of the beams 52 of the platform support structure 60. It is preferred that the truss system 58 comprises a length of cable or wire which is attached at or towards both ends of the boom 54. One or more spacers 66 are positioned between the cable and the boom 54. The spacers can be of any hard material, e.g. a metal such as aluminium, and can be attached to the underside of the boom 54 as shown in Figure 22. The cable of the truss system 58 can be moveably coupled to the lower ends of the spacers, for example by means of a loop provided in the end of each spacer 66. The cable of the truss system is tightened by means of an appropriate mechanism, for example a threaded coupling, which shortens the length of the cable thus creating a tension in the cable. The cable, which is under tension, exerts an upward force on the spacers 66 of the truss system 58, thereby exerting an upward force on the platform support structure 60 and the platform 62. Thus, the required rigidity and additional load bearing capability can be provided. The tensioning of the cable of the truss system can be carried out on the ground, before the installation of the scaffold system, or when the scaffold unit is in-situ. The cable of the truss system can be tensioned to the extent that a camber is imparted to the platform 62 of the scaffold unit. The position, number and length of the spacers 66 of the truss system 58 can be selected to provide the required force along the length of the scaffold unit 30 and to provide the necessary load distribution along the length of the scaffold unit. It should be noted that alternative configurations of the truss system can be adopted. For example, the cable of the truss system can be replaced with non-flexible metal elements. Such alternative configurations of the truss system are capable of being put under tension and of transmitting that tension as an upward force to the scaffold unit.

A truss system, as described above, can be applied to the conventional scaffold system shown in Figure 18. By incorporating a truss system into the scaffold unit 20 of Figure 18 the requirement for the additional vertical support column 24 is removed. Thus, the truss system confers the benefit of reducing the size and/or number of components required for the scaffold system and minimises the restriction of access at and around ground level in the building.

It is preferred in the scaffold unit shown in Figure 23 that the booms 54 are at a separation of between 6 metres and 12 metres. The separation depends on the required payload. Furthermore, it is preferred that the scaffold systems described herein are made of a lightweight material, such as aluminium.

Figure 24 is a detailed representation of a side view of a scaffold unit 30. In Figure 24, a platform support structure 60 is provided on booms 54, and a platform 62 is shown as being lowered onto the platform support structure 62. Means of securing or fixing the platform 62 to the platform support structure is shown in Figure 24. For example, such means can include a projection 70 on the upper surface of the platform support structure 60 and a corresponding recess on the platform 62 to thereby prevent the platform moving in relation to the platform support structure. Alternatively, the platform can be fixed to the platform support structure with an interlocking arrangement.

Figure 25 is a representation of an alternative means of use of the present invention. The scaffold unit 30 and the attachments 34 are as described herein. The two side portions 12 extend down below ground level 14, rather than extending above ground level as shown in Figure 19. The building arrangement of Figure 25 is representative of an underground car park or some other such subterranean structure.

Figure 26 is a representation of a top view of an alternative means of supporting a scaffold unit according to the present invention. The side portions 12 of the building are perpendicular to each other, as might be the case for a forecourt at the outer periphery of a building. Of course, the side portions 12 can be at an acute or obtuse angle in relation to each other. The scaffold unit comprises two sets of booms 54 which are perpendicular to each other. Each set of booms 54 is secured to the side portions 12 as described herein with reference to the first and second embodiments. Should additional rigidity be required of the scaffold unit of Figure 26, a truss system of the kind described herein with reference to the arrangement of Figure 22 can be incorporated to provide the required rigidity and load distribution.

Figures 29a and 29b are a representation of a scaffolding system according to the present invention. As shown in Figure 29a, the scaffolding system comprises a scaffolding unit 20 which is suspended from the top of a building 1 by means of cables. The cables are attached to the scaffolding unit 20 and are dispensed from winches 22 via booms 24, which winches and booms are positioned on the roof of building 1. The length of the cables is controlled by means of the winches 22, whereby the vertical position of the scaffolding unit 20 can be determined. The distance between the building exterior and the scaffolding unit 20 is determined by the length of the booms 24 extending beyond the top edge of the building 1. Instead of the fixed boom 24 and winch 22 arrangement shown in Figure 29a, a mobile roof vehicle can be provided to permit the scaffolding unit to be moved along the side of the building and around corners, without disassembly of the scaffolding unit 20.

Figure 29b is a representation of the scaffolding unit 20 of Figure 29a operating as a supported or free-standing unit. In Figure 29b, the scaffolding unit 20 is disengaged from the suspension system, comprising cables, booms and winches, and the scaffolding unit 20 either stands on the ground or is supported at or near the bottom of the exterior face of the building 1.

A more detailed representation of the scaffolding unit of Figures 29a and 29b is shown in Figure 30a. The scaffolding unit 20 comprises one or more work platforms 12 each of which are fixed to two or more ladder sections 14. Ladder sections 14 function primarily as vertical supports for the work platforms 12. The provision of rungs 16 on the ladder sections 14 facilitates the vertical movement of persons from one work platform 12 to another. As shown in Figure 30a, the depth of the work platforms 12 is greater than the width of the ladder sections 14. This feature permits persons to move with greater ease from one end of a work platform 12 to the other, especially when there is a ladder section provided in the middle of the work platform for additional support as is shown in Figures 29a and 29b. The strength of the scaffolding unit 16 can be increased by the inclusion of support sections 18.

Of course, it will be appreciated by the skilled person that the scaffolding unit shown in Figure 30a is merely illustrative and that modifications and variations can be made to the individual components and the overall structure of the scaffolding unit without changing its basic function.

The scaffolding unit of Figure 30a comprises two types of component to permit the scaffolding unit to function in both the suspended mode of operation shown in Figure 29a and the supported mode of operation shown in Figure 29b. As shown in Figure 30a, a suspension beam 32 is provided on the scaffolding unit 20 to provide a means of attachment for the suspension cables. The suspension beam 32 can be provided at the top of the scaffolding unit 20, as shown in Figure 30a. Alternatively, the suspension beam 32 can be provided at a lower part of the scaffolding unit, and to improve stability the suspension cables can be attached to or fed-through the upper portions of the scaffolding unit. In addition to the suspension component, the scaffolding unit 20 of Figure 30a is provided with support components, which support components permit the scaffolding unit 20 to operate in the supported mode. The scaffolding unit 20 of Figure 30a is represented as comprising plates 34, which plates are disposed at the lower end portion of the ladder sections 14. The plates 34 support the scaffolding unit on the ground and provide lateral stability. The plates 34, as shown in Figure 30a, are only representative of the several and diverse means of supporting a scaffolding unit. For example, the scaffolding unit can be supported on the ground on the ends of the ladder sections 14 instead of on plates 34. Alternatively, instead of or in addition to the plates 34, one or more support elements can be provided on the building exterior side of the scaffolding unit. The support elements can be used to secure the scaffolding unit to the exterior face of a building, to provide lateral stability and to provide vertical support where the scaffolding system does not sit on the ground. Figure 30b provides two illustrative representations of such support elements 36. The left-hand support element 36 is in the form of a loop for securing to some appropriate anchor point, e.g. a hook or other loop, on a building. The right-hand support element 36 comprises a bar, which is attached to the scaffolding unit, and a plate, or bracket, which is secured to the building by mechanical or chemical bonding.

Figure 31a shows an alternative embodiment of a scaffolding system according to the present invention. The scaffolding unit 20 of Figure 31a is substantially similar in structure to the scaffolding system shown in Figure 30a. The scaffolding unit 20 of Figure 31a is operable in a suspended mode and a supported mode.

In the suspended mode of operation, suspension cables are secured to the suspension bar 32. Alternative means of suspension are as described above with reference to the scaffolding unit of Figure 30a.

In the supported mode of operation, the scaffolding unit 20 of Figure 31a is supported by means of the two support elements 38, which are positioned at either end of the scaffolding unit. The scaffolding unit 20 can be removeably secured to the support elements 38, for example by means of clamps or locking pins, and then detached from the support elements 38 when it is desired to raise the scaffolding unit. Alternatively, the scaffolding unit can be mechanically linked to the support elements 38 to permit the scaffolding unit 20 to move in a vertical direction in relation to the support elements 38.

Figure 31b is a representation of a top view of two preferred means of mechanically linking a scaffolding unit 20 to a support element 38, which means permit vertical movement of the scaffolding unit 20 in relation to the support elements 38. The left-hand drawing and right-hand drawing of Figure 31b both comprise a receptacle 40 and a member 42. As shown in Figure 31a the receptacle 40 is provided on the support elements 38 and the member 42 is provided along the vertical length of a ladder section 14 of the scaffolding unit 20. Alternatively, the receptacle 40 can be provided on the scaffolding unit 20 and the member 42 can be provided on the support elements. As shown in Figure 31b the member 42 is moveably engaged with the receptacle 40, thereby permitting movement of the scaffolding unit 20 in relation to the support element 38 in the vertical direction. As shown in Figure 31a, more than one member 42 can be provided along the vertical length of a ladder section 14 of one of the scaffolding modules. Of course, two or more mechanical linkages can be provided at a particular level on a ladder section 14.

As shown in the left hand drawing of Figure 31b, the member 42 is comprised of a shaft which is attached at one end to a ladder section on the scaffolding unit and to an engaging element 44 at its other end. The dimension of the engaging element 44 in a direction perpendicular to the direction of movement of the scaffolding unit is greater than that of the shaft of the member 42. Furthermore, receptacle 40, which is provided on the support elements 38, comprises two restriction elements 46 which extend along the length of the receptacle 40. The restriction elements 46 are of a size and position to provide an aperture in the outward face of receptacle 40 which is less than the width of engaging element 44. Thus, separation of adjacent scaffolding modules in a direction along the length of the shaft of member 42 is prevented. The relative dimensions of the engaging portion 44, the receptacle 40, the shaft of member 42 and the restriction elements 46 can be selected to provide a compromise between freedom of movement, e.g. for the relief of stress and strain, and restriction of movement of the scaffolding unit 20 in relation to the support element 38 in directions perpendicular to the permitted direction of movement. Engaging element 44 can be designed to have whatever shape provides for desired characteristics of the mechanical linkage, for example mechanical strength or low friction.

In the right-hand drawing of Figure 31b the engaging portion is provided with one or two wheels 48, which wheels are rotatably attached to the member 42. The provision of wheels 48 on member 42 affords low friction movement of the scaffolding unit. The arrangement shown in the right-hand drawing of Figure 31b includes a flexible joint 52 between two portions of the shaft of member 42. The inclusion of joint 52 in the member 42 allows for movement of the scaffolding unit relative to the support elements in a direction perpendicular to the permitted, i.e. vertical, direction of movement. A second joint might be required at the point of attachment of the member to the ladder section. Joint

52 can comprise a hinge arrangement or a ball and socket arrangement, for example. Furthermore, joint 52 can comprise means to restrict rotation of one portion 50 of the shaft of member 42 relative to the other portion of the member on which the engaging portion is provided. Alternatively, means can be provided on joint 52 to lock the two portions of the shaft of member 42 at a fixed angle.

The structure of the mechanical linkage between the scaffolding unit and the support elements 38 is not limited to the examples shown in Figure 31b and can be modified or have a different structure without changing its essential function. For example, the member 42 can take the form of an element that extends continuously along the vertical length of a ladder section and be shaped to slidably engage with the receptacle.

The support elements 38 shown in Figure 31a can be secured to the ground or secured to the exterior surface of the building. In addition, the support elements 38 can be constructed of a framework of scaffolding components, such as booms, or be comprised of solid components as shown in Figure 31a. It is preferred that the support elements are constructed and secured to the building in such a way that the support elements can be moved from one location to the next with the minimum of labour and time. Of course, it will be appreciated by the skilled person that the support elements 38 shown in Figures 31a are merely illustrative and that modifications and variations can be made to the support elements and their disposition in relation to the scaffolding unit without changing their basic function.

The scaffolding unit 20 can be raised from the support elements 38 manually or with the suspension system shown in Figure 29a. Alternatively, the scaffolding unit 20 and support elements 38 can be configured to permit the scaffolding unit to be disengaged from the support elements and moved away from the building in a horizontal direction in relation to the support elements.

Brakes can be included in the scaffolding system to fix the position of the scaffolding unit relative to the support elements. The braking system could take the form of a hole and locking pin arrangement or the form of a more sophisticated arrangement for applying a variable braking force, for example a lever based system.

In a different embodiment of a scaffolding system according to the present invention, the support elements 38 of Figure 31a are substituted by a second and a third scaffolding unit. The second and third scaffolding units are positioned on either side of the scaffolding unit 20 to provide support for the scaffolding unit. The scaffolding unit 20 can be removeably or moveably linked to the second and third scaffolding units by the means described above.

The scaffolding system according to the present invention confers the significant benefit of reducing the height of the scaffolding unit required at a location on a building. The benefit is illustrated in Figures 3a and 3b. Figures 3a and 3b show a scaffolding unit 20 which is substantially half the height of the vertical face of the building 1 on which work is being carried out. In Figure 29a the scaffolding unit 20 is suspended from a suspension system which comprises winches 22 and booms 24. In Figure 29b the scaffolding unit is disengaged from the suspension system and is supported on or near the ground, by means of the support elements described above with reference to the scaffolding units shown in Figures 30a and 31a. The scaffolding system of Figures 3a and 3b is substantially smaller than the conventional scaffolding system shown in Figure 27. Nevertheless, the scaffolding system shown in Figures 29a and 29b permits work to be carried out on the same exterior surface area of the building. A further reduction in the height of the scaffolding system 20 of Figures 29a and 29b provides a corresponding reduction in the number and/or size of scaffolding unit components for the comparatively minor disadvantage of having to alter the vertical position of the scaffolding unit 20 in the suspended mode of operation. For example, the height of the scaffolding unit 20 can be reduced to one third or one quarter of the height of the building 1. However, it is preferred that the scaffolding unit comprises a multiplicity of stages, with each stage corresponding to a level on a building. For example, each of the multiplicity of stages of the scaffolding unit can comprise a platform 12, as shown in Figure 30a, for gaining access to a level on a building. A level on a building might be a floor of a building or a location on the exterior of a building at which there is a feature requiring maintenance, e.g. a drainage component or a structural component.

A further benefit of the scaffolding system according to the present invention is illustrated in Figures 32 to 34. The further benefit is an increase in flexibility and a significant reduction in the time taken for the completion of construction and maintenance tasks on a building without an increase in scaffolding system components.

Figure 32 shows work being carried out on building 1 with two scaffolding units 20 and one suspension system 22, 24. A first scaffolding system is operated in suspended mode and a second scaffolding system is operated in supported mode. Thus, work can be carried out at two locations on the building 1 at the same time. When work is complete on the two locations, the first scaffolding unit is lowered by the suspension system towards the ground and the first scaffolding system then operates in the supported mode. The suspension system, comprising winches 22 and booms 24, is moved in the direction shown in Figure 32 to a position where the second scaffolding unit can be attached to the suspension system and operated in the suspended mode. This method of use of the scaffolding system is particularly beneficial where the suspension system can be moved easily and quickly from one position to the next. Thus, work can be carried out at more than one location on a building with a degree of flexibility not afforded by conventional scaffolding systems.

Figures 33 and 34 show another method of use of a scaffolding system according to the present invention. Figures 33 and 34 show work being carried on a building 1 with one scaffolding unit 20 and one suspension system 22, 24. Work on the building commences with the scaffolding unit 20 operating in the suspended mode as shown in Figure 33. When work at the first location on the building is complete, the scaffolding unit is lowered towards the ground to position A. The scaffolding unit is disengaged from the suspension system and work is carried out at position A. Once work at position A is complete, the scaffolding unit is moved to position B where the scaffolding unit continues to operate in the supported mode. Whilst work is being carried out on the building at positions A and B the suspension system is moved along the top of the building in the direction indicated in Figure 33. After work at position B is complete, the suspension system raises the scaffolding unit to position C. This method of use is particularly applicable where the time required for the movement of the suspension system is considerably greater than that required for movement of a scaffolding unit which is being operated in supported mode. Figure 34 shows an alternative method of use of the scaffolding system which is similar to that illustrated in Figure 33, with the exception that work commences with the scaffolding unit operating in supported mode. This alternative method of use is particularly applicable where the time required for the movement of the scaffolding unit when it is in supported mode is considerably greater that that required for movement of the suspension system.

Figure 37 shows two scaffolding modules 16 which are independently suspended from the roof of a building 10 by means of cables 14 dispensed from winches 12 via booms 18.

The operation of the winches 12 and the booms 18 and the structure and composition of the individual scaffolding modules is as described above. According to the present invention, two or more scaffolding modules 16 are mechanically linked to allow each module to move in the vertical direction independently of any other scaffolding module. Referring to Figure 37, two scaffolding modules 16 are represented as being mechanically linked at or around their adjacent sides such that the left and right-hand modules are capable of moving in the vertical direction in relation to each other. A chain of three or more mechanically linked scaffolding modules could be formed across the exterior face of the building along a left to right direction of the building shown in Figure 37. The mechanical linkage between adjacent scaffolding modules (not shown in Figure 37) restricts the movement of the adjacent modules in directions perpendicular to the vertical direction, i.e. along the direction of disposition of the two scaffolding units and along a direction perpendicular to a plane formed by the front exterior face of the building 10. The freedom of movement that the mechanical linkage affords in the vertical direction provides for improved flexibility of access to the exterior face of the building without an undue increase in the size of the scaffolding system. The restriction of movement of the scaffolding modules in relation to each other in directions perpendicular to the vertical direction provides for increased rigidity in the scaffolding system as a whole. The restrictions of movement in the perpendicular directions are particularly useful when the vertical position of a scaffolding module is being adjusted or when a module is subjected to undue force, which undue force may for example be caused by high winds or accidental impact.

In a preferred embodiment, each scaffolding module is constructed of aluminium or some other light material. Of course, less malleable and ductile materials can be used in the structure of a scaffolding module. Furthermore, with reference to Figure 36, it is preferred that work platforms 22 are 60' in length, 4' in depth and that they provide 2' of total clearance at the ladder sections 24 and 4' at all other positions. In addition, beams can be provided as handrails. It is preferred that each work platform 22 of a scaffolding module provides a Safe Working Load (SWL) of 1000 kg. Moreover, it is preferred that there is an overlap between adjacent scaffolding modules in the vertical direction of at least 25% of the length of the vertical dimension of a scaffolding module.

The mechanical linkage between adjacent modules permits movement in the vertical direction of one module in relation to the other module and restricts movement in at least one of the directions perpendicular to the vertical direction. Figures 38a and 38b are a representation of a preferred means of mechanically linking one scaffolding module to another. Figure 38a is a top view of the ladder sections 24 of two adjacent and mechanically linked scaffolding modules. Figure 38b is a cut-away side view of the ladder sections 24 of two adjacent and mechanically linked scaffolding modules. As shown in Figure 38a, the mechanical linkage comprises a receptacle 40, which is provided along the vertical length of both sides of a ladder section 24 of one of the scaffolding modules. In addition, the mechanical linkage comprises a member 42 provided on both sides of a ladder section 24 of the other scaffolding module. As shown in Figure 38a the member 42 is moveably engaged with the receptacle 40, thereby permitting movement of one scaffolding module in relation to the other scaffolding module in the vertical direction. As shown in Figure 38b, more than one member 42 can be provided along the vertical length of a ladder section 24 of one of the scaffolding modules. Of course, one rather than two mechanical linkages can be provided at a particular level on a ladder section 24, i.e. one of the two mechanical linkages shown in Figure 38a can be omitted. Where more than two scaffolding modules are to be mechanically linked, mechanical linkages are provided on the ladder sections at both, i.e. left and right-hand, sides of each scaffolding module.

The structure of the mechanical linkage between adjacent scaffolding modules is not limited to that shown in Figures 38a and 38b and can be modified or have a different structure

without changing its essential function. For example, the member can take the form of an element that extends continuously along the vertical length of a ladder section and be shaped to slidably engage with the receptacle. Figures 39a and 39b illustrate modifications to the mechanical linkage shown in Figures 38a and 38b. As shown in Figure 39a, the member 42 is comprised of a shaft which is attached at one end to a ladder section on a first scaffolding module and to an engaging element 44 at its other end. The dimension of the engaging element 44 in a direction perpendicular to the direction of movement of the adjacent scaffolding modules is greater than that of the shaft of the member 42. Furthermore, receptacle 40, which is provided on a ladder section of the second scaffolding module, comprises two restriction elements 46 which extend along the length of the receptacle 40. As shown in Figure 39a, the restriction elements 46 are of a size and position to provide an aperture in the outward face of receptacle 40 which is less than the width of engaging element 44. Thus, separation of adjacent scaffolding modules in a direction along the length of the shaft of member 42 is prevented. The relative dimensions of the engaging portion 44, the receptacle 40, the shaft of member 42 and the restriction elements 46 can be selected to provide a compromise between freedom of movement, e.g. for the relief of stress and strain, and restriction of movement of the adjacent scaffolding modules in directions perpendicular to the permitted direction of movement of one scaffolding module relative to the other scaffolding module.

Engaging element 44 can be designed to have whatever shape provides for desired characteristics of the mechanical linkage, for example mechanical strength or low friction. A preferred embodiment of the engaging portion is shown in Figure 39b. In Figure 39b the engaging portion is provided with one or two wheels 48, which wheels are rotatably attached to the member 42. The provision of wheels 48 on member 42 affords low friction movement of adjacent scaffolding modules. The arrangement of Figure 39b includes a flexible joint 52 between two portions of the shaft of member 42. The inclusion of joint 52 in the member 42 allows for movement of one scaffolding module relative to another module in a direction perpendicular to the direction of movement. A second joint might be required at the point of attachment of the member to the ladder section. Joint 52 can comprise a hinge arrangement or a ball and socket arrangement, for example. Furthermore, joint 52 can comprise means to restrict rotation of one portion 50 of the shaft of member 42 relative to the other portion of the member on which the engaging portion is provided. Alternatively, means can be provided on joint 52 to lock the two portions of the shaft of member 42 at a fixed angle.

Brakes can be included in the modular scaffolding system to fix the position of one scaffolding module relative to another. The braking system could take the form of a hole and locking pin arrangement or the form of a more sophisticated arrangement for applying a variable braking force, for example a lever based system.

End stops can be provided at or towards the end of the ladder sections, for example on the receptacles, to prevent two mechanically linked scaffolding modules from disengaging from each other.

Figures 40a, 40b and 40c are representations of different means of linking scaffolding modules around a corner of a building. Figure 40a is a view of a top corner of a building with a scaffolding module 16 suspended down the exterior of each of two perpendicular vertical faces of the building. As shown in Figure 40a, one of the scaffolding modules is provided with two receptacles 40 and the other module with members 42, which members 42 are shown in the engaged position with the receptacles 40. As is shown in Figure 38a, the two mechanical linkages at a particular vertical location on a ladder section are of substantially the same length, where two scaffolding modules on the same face of a building are to be mechanically linked. Where a mechanical linkage is to be formed around a corner between two scaffolding modules, the mechanical linkage can take the form of that shown in Figure 40a. As shown in Figure 40a, the two receptacles 40 have different lengths to extend by different amounts beyond the corner of the building. In addition, the length of the members 42 are set to correspond to the different positions of the receptacles 40 and apertures are provided in the receptacles to face the members 42. An alternative means of linking modules around a corner is shown in Figure 40b. In Figure 40b, the member 42 is angled to provide a connection around the corner of the building. In the arrangement of Figure 40b, the flexible joint 52 of Figure 39b can be employed. Another linking arrangement is shown in Figure 40c, wherein the member 42 is angled to permit one scaffolding module 16 to be suspended at a corner of the building, and the other module 16 to be suspended down one side of the building.

A second embodiment of the present invention is represented in Figure 41. Figure 41 is a view from the top of a building of two suspended scaffolding modules 16. According to this embodiment, the two scaffolding modules 16 are mechanically linked by means of member 42 and receptacle 60 to permit movement of one module in relation to the other in a direction away from the vertical exterior face of the building. The mechanical linkage of Figure 41 restricts movement of one scaffolding module in relation to the other module in directions perpendicular to the permitted direction of movement of one module in relation to the other. The member 42 and receptacle 60 have the same basic structure and function as the mechanical linkage of the first embodiment, with the exception that the receptacle 60 is perpendicular to the receptacle 40 of the first embodiment. Thus, the aperture in the receptacle 60 of Figure 41 runs in a direction towards and away from the vertical exterior face of the building. The arrangement shown in Figure 41 provides for flexibility, especially where the surface of a building is non-planar. The mechanical linkages of the first and second embodiments can be combined in the same modular scaffolding system. As shown in Figure 41, all the arrangements described herein can comprise spacer elements 62 which are attached to a scaffolding module. The spacer elements 62 aid in stabilising the scaffolding system, help protect the building from impact from the scaffolding, and are useful for setting the distance between the work platforms and the building exterior.

A further arrangement of the scaffolding system of the present invention is shown in Figure 42. Two adjacent scaffolding modules 16 are disposed vertically along a face of a building 10. The upper scaffolding module 16 is suspended from the top of the building by means of the previously described winch and boom arrangement (not shown in Figure 42) or by some other means. The lower scaffolding module 16 is suspended either from the upper module or from the top of the building. The scaffolding modules 16 have a structure as described above. The upper and lower scaffolding modules are mechanically linked by at least one mechanical linkage to permit movement of one module relative to the other in a horizontal direction along the face of the building. The members 42 of the mechanical linkages are shown in Figure 42. The mechanical linkages have a structure based on that described above. The mechanical linkages restrict movement of one scaffolding module relative to the other in directions perpendicular to the permitted direction of movement of one module in relation to the other. The arrangement of Figure 42 can be incorporated in scaffolding systems in conjunction with one or both of the first and second embodiments described herein.

The aforegoing description has been given by way of example only and it will be appreciated by a person skilled in the art that modifications can be made without departing from the scope of the present invention.

CLAIMS

1. A scaffolding system comprising:

a suspension cable;

at least one restraint wire comprising a portion for securing to a structure;

a scaffolding unit for suspension from a structure by means of the suspension cable, said scaffolding unit comprising at least one restraint guide for said restraint wire; and

said at least one restraint wire is for controlling the position of said scaffolding unit in a direction perpendicular to a direction of suspension.

2. A scaffolding system as claimed in claim 1, wherein said portion of said at least one restraint wire is for securing towards or at the top of the structure above said scaffolding unit.

3. A scaffolding system as claimed in claim 1 or claim 2, wherein a second portion of said at least one restraint wire is for securing below said scaffolding unit.

4. A scaffolding system as claimed in claim 3, wherein said second portion of said at least one restraint wire is for securing towards or at the bottom of a structure.

5. A scaffolding system as claimed in claim 3, wherein said second portion of said at least one restraint wire is for securing to a weight.

6. A scaffolding system as claimed in any one of claims 1 to 5, wherein:

said at least one restraint guide is provided on a side of said scaffolding unit, which side is for disposal substantially in line with and facing away from a surface of a structure, and

said at least one restraint wire is a rear restraint wire for control of the separation between said scaffolding unit and the surface of a structure.

7. A scaffolding system as claimed in any one of claims 1 to 5, wherein:

said at least one restraint guide is provided on a side of said scaffolding unit, which side is for disposal substantially perpendicular to a surface of a structure, and

said at least one restraint wire is a side restraint wire for control of the position of the scaffolding unit substantially in the plane of the surface of the structure.

8. A scaffolding system as claimed in any one of claims 1 to 5, wherein:

said at least one restraint guide comprises a restraint guide provided on each of a first and a second side of said scaffolding unit and two restraint guides provided on a third side of said scaffolding unit;

the first and second sides of said scaffolding unit are opposing sides for disposal substantially perpendicular to a surface of a structure;

the third side of said scaffolding unit is for disposal substantially in line with and facing away from a surface of a structure; and

said at least one restraint wire comprises two side restraint wires and two rear restraint wires for control of the position of the scaffolding unit in directions perpendicular to a direction of suspension.

9. A scaffolding system as claimed in any one of claims 1 to 8, wherein said at least one restraint guide comprises at least one roller or wheel.

10. A scaffolding system as claimed in any one of claims 1 to 9, wherein the position of said at least one restraint guide on the scaffolding unit is moveable manually or automatically.

11. A scaffolding system comprising :

a first anchor point for disposal towards or at the bottom of a first elevation of a building;

a scaffolding unit for suspension from or adjacent a second elevation of a building opposite said first elevation; and a first cable for disposal on a building and for coupling to said suspended scaffolding unit, said cable comprising a first portion at or towards one end of the cable for securing to said first anchor point.

12. A scaffolding system as claimed in claim 11, further comprising a second anchor point for disposal towards or at the bottom of a second elevation of a building, and wherein the cable comprises a second portion at or towards another end of the cable for securing to said second anchor point.

13. A scaffolding system as claimed in claim 11 or claim 12, further comprising:

a second anchor point for disposal towards or at the bottom of a second elevation of a building opposite the first elevation,

a second scaffolding unit for suspension from or adjacent said first elevation;

a second cable for disposal on a building and for coupling to said second suspended scaffolding unit, said second cable comprising a first portion at or towards one end of the cable for securing to said second anchor point.

14. A scaffolding system as claimed in claim 13, wherein:

the first cable comprises a second portion at or towards another end of the cable for securing to the second anchor point; and

the second cable comprises a second portion at or towards another end of the cable for securing to the first anchor point.

15. A scaffolding system as claimed in claim 13 or claim 14, wherein:

the first cable is for coupling to the second scaffolding unit to thereby control the position of the second scaffolding unit in a direction perpendicular to its direction of suspension; and

the second cable is for coupling to the first scaffolding unit to thereby control the position of the first scaffolding unit in a direction perpendicular to its direction of suspension.

16. A scaffolding system as claimed in any one of claims 11 to 15, further comprising a

spur from the cable for attachment at or towards the roof of a building, said spur being between the first portion of the cable and a portion of the cable for coupling to a suspended scaffolding unit.

17. A scaffolding system as claimed in claim 16 when dependant on claim 15, wherein:

spurs are provided on the first cable for attachment at or towards the top of the first elevation and at or towards the top of the second elevation of a building; and

spurs are provided on the second cable for attachment at or towards the top of the first elevation and at or towards the top of the second elevation of a building.

18. A scaffolding system as claimed in any one of claims 11 to 17, further comprising a roof anchor point for disposal at or towards the roof of a building and a support member for coupling with said roof anchor point.

19. A scaffolding system as claimed in claim 18, wherein said roof anchor point is cast, welded or affixed by concrete to the building.

20. A scaffolding system as claimed in claim 18 or claim 19, wherein said support member comprises rollers to guide the first and/or second cable.

21. A scaffolding system as claimed in any one of claims 11 to 20, wherein said anchor point is for permanent disposal on or adjacent a building and said scaffolding unit is for temporary suspension from or adjacent a building.

22. A scaffolding system comprising:

at least one anchor point for permanent disposal towards or on the top of a building;

at least one suspension system for removeably coupling with said at least one anchor point; and

a scaffolding unit for temporary suspension adjacent a building from said at least one suspension system.

23. A scaffolding system as claimed in claim 22, wherein said scaffolding unit is a

multi-stage scaffolding unit comprising a plurality of stages corresponding to a plurality of levels of a building.

24. A scaffolding system as claimed in claim 22 or claim 23, wherein said at least one anchor point is for welding or embedment towards or on the top of a building.

25. A scaffolding system as claimed in any one of claims 22 to 24, wherein said at least one anchor point is for disposal in a floor slab or an up-stand provided on the building.

26. A scaffolding system as claimed in any one of claims 22 to 25, wherein said suspension system comprises a balancing element, which balancing element is for applying a force to balance a force applied by the weight of said scaffolding unit.

27. A scaffolding system as claimed in claim 26, wherein said balancing element comprises a connection member for mechanically linking to a second suspension system.

28. A scaffolding system as claimed in claim 27, wherein said connection member comprises a truss for strengthening said connection member.

29. A scaffolding system as claimed in claim 26, wherein said balancing element comprises a member for securing to a building or the ground.

30. A scaffolding system as claimed in claim 26, wherein said balancing element comprises a weight for disposal on or towards the roof of a building or on the ground.

31. A scaffolding system as claimed in any one of claims 22 to 30, wherein said suspension system comprises a suspension member for suspending said scaffolding unit adjacent a vertical face of a building.

32. A scaffolding system for temporary disposal on a building comprising:

at least one cable;

at least one member for removeable disposal on a building and for supporting of said at least one cable;

a scaffolding unit for suspension from or adjacent a building;

at least one suspension element provided on said scaffolding unit for attachment to a portion of said at least one cable.

33. A scaffolding system as claimed in claim 32, further comprising a balancing element, said balancing element for applying a force to balance a force applied by the weight of said scaffolding unit.

34. A scaffolding system as claimed in claim 33, wherein said balancing element comprises a connection member for linking to a second scaffolding system.

35. A scaffolding system as claimed in claim 34, wherein said connection member comprises a truss for strengthening said connection member.

36. A scaffolding system as claimed in claim 33, wherein said balancing element is provided at a second portion on said at least one cable and is for securing to a building or the ground.

37. A scaffolding system as claimed in claim 33, wherein said balancing element comprises a weight for disposal on or towards the roof of a building or on the ground.

38. A scaffolding system as claimed in any one of claims 32 to 37, wherein said at least one member comprises a suspension member for suspending said scaffolding unit by means of said at least one cable adjacent a vertical face of a building.

39. A scaffolding system as claimed in any one of the preceding claims, wherein the scaffolding unit comprises a suspension element for securing to a suspension cable, said suspension element comprising a truss for strengthening the suspension element.

40. A scaffolding system as claimed in any one of the preceding claims, wherein the scaffolding unit comprises a material handling bar.

41. A scaffolding system as claimed in any one of the preceding claims, wherein the scaffolding unit comprises a work platform, and said work platform comprises a truss for strengthening the work platform.

42. A scaffold system comprising a scaffold unit and at least two attachments:

said at least two attachments for disposal on at least two vertical portions of a structure; and

said scaffold unit can be mechanically linked to said at least two attachments such that said scaffold unit is spaced from a ground plane of said structure.

43. A method of use of a scaffold system comprising a scaffold unit and at least two attachments, the method comprising:

disposing said at least two attachments on at least two vertical portions of a structure; and

mechanically linking said scaffold unit to said at least two attachments such that said scaffold unit is spaced from a ground plane of said structure.

44. A method of use of a scaffolding system comprising a multi-stage scaffolding unit, at least one support element and at least one suspension element, said multi-stage scaffolding unit comprising a plurality of stages corresponding to a plurality of levels of a building, the method comprising:

providing for the scaffolding unit to be supportable adjacent or on the building by said at least one support element, and

providing for the scaffolding unit to be suspensible adjacent or from the building by said at least one suspension element, and

selecting between said supporting of the scaffolding and said suspension of the scaffolding.

45. A scaffolding system comprising:

a multi-stage scaffolding unit comprising a plurality of stages corresponding to a plurality of levels of a building;

at least one support element for supporting the scaffolding system adjacent to or on a building, and

at least one suspension element for suspending the scaffolding system adjacent to or from a building.

46. A scaffolding system comprising at least a first scaffolding module and a second scaffolding module each capable of being suspended from a structure;

each of said scaffolding modules comprising means to mechanically link the first scaffolding module to the second scaffolding module;

said mechanical link means permits movement of the first scaffolding module in relation to the second scaffolding module in a first direction; and

said mechanical link means restricts movement of the first scaffolding module in relation to the second module in a second direction perpendicular to said first direction.

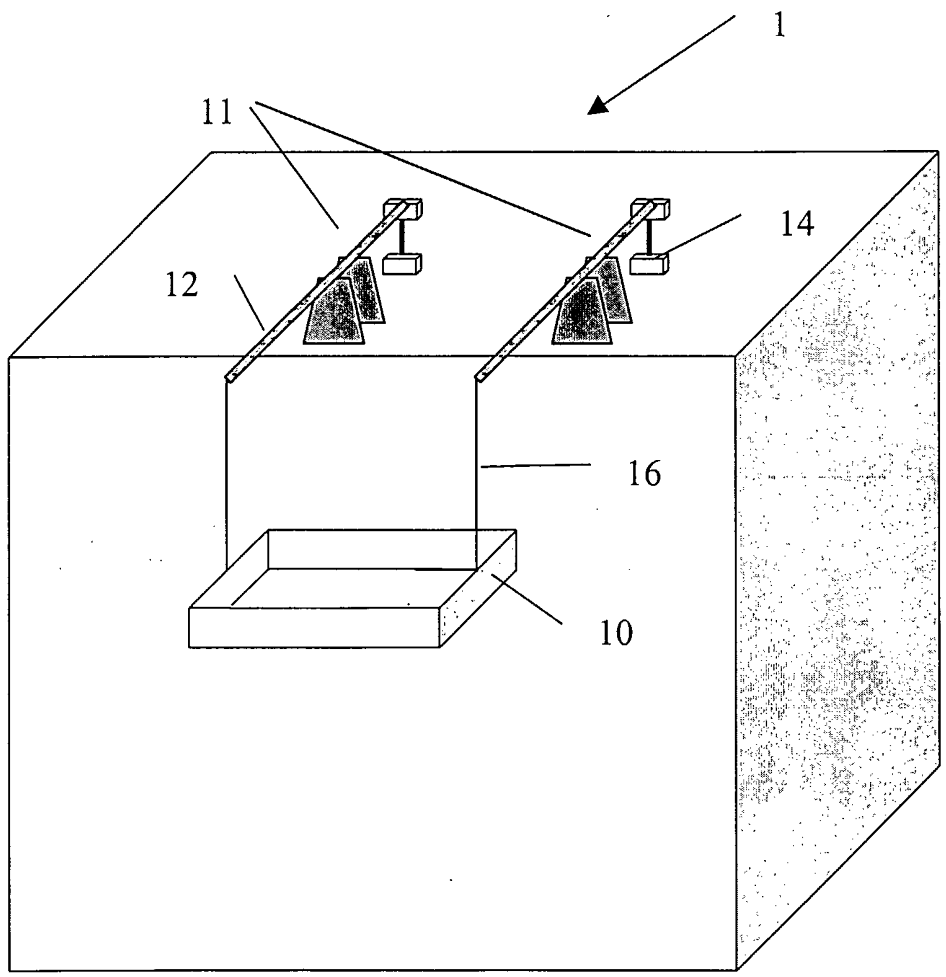

Fig. 1

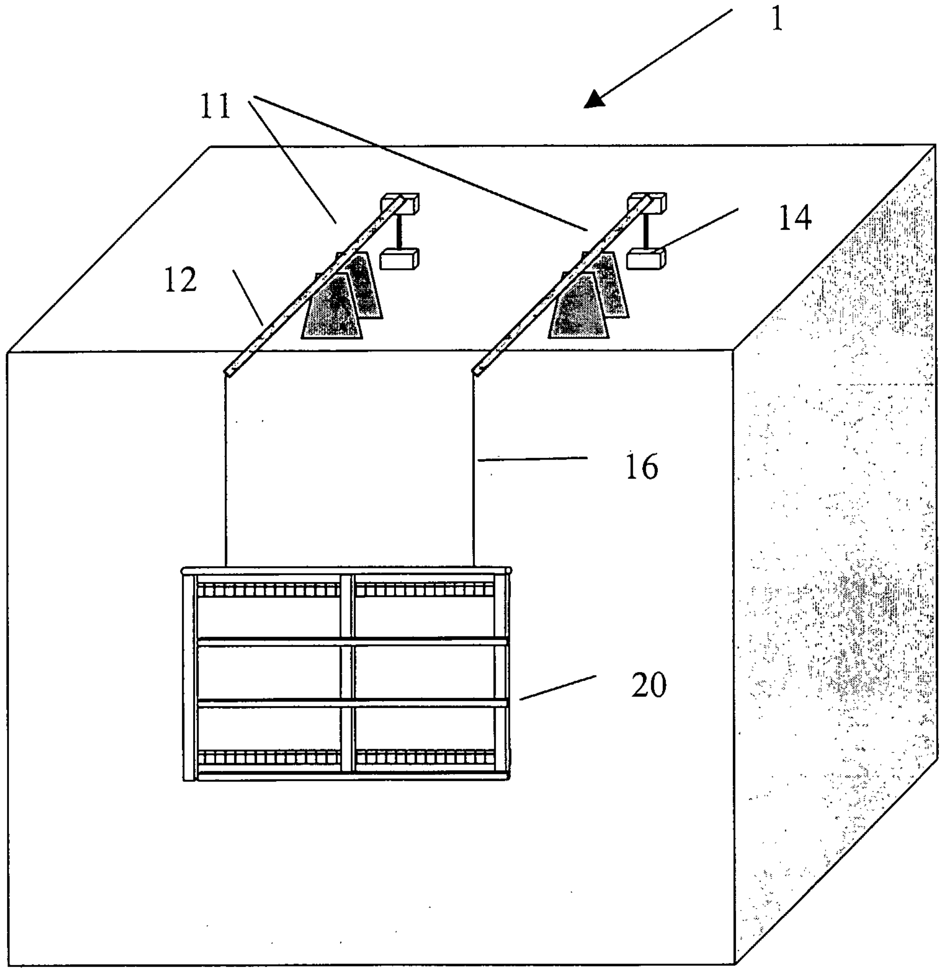

Fig. 2

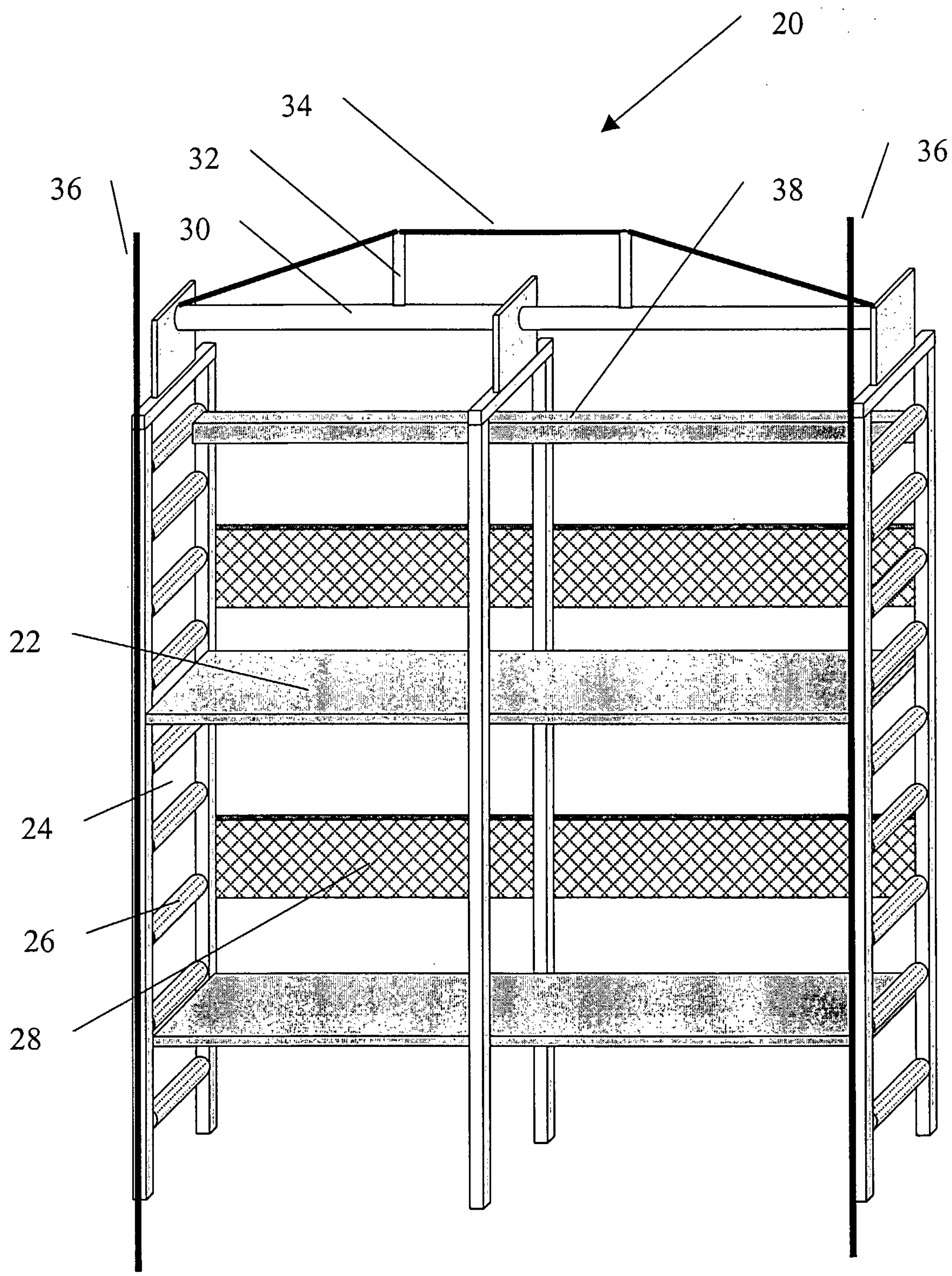

Fig. 3

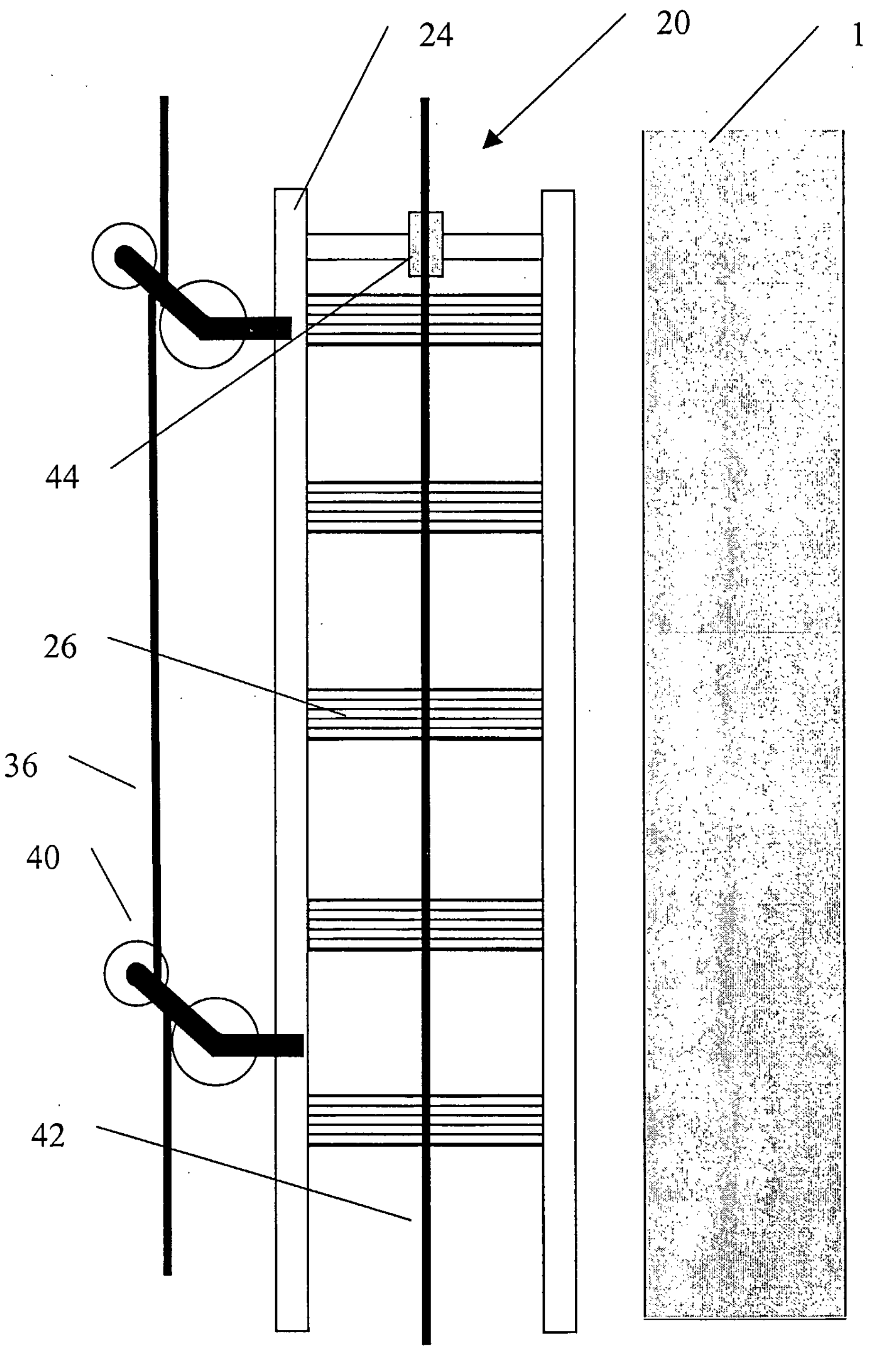

Fig. 4

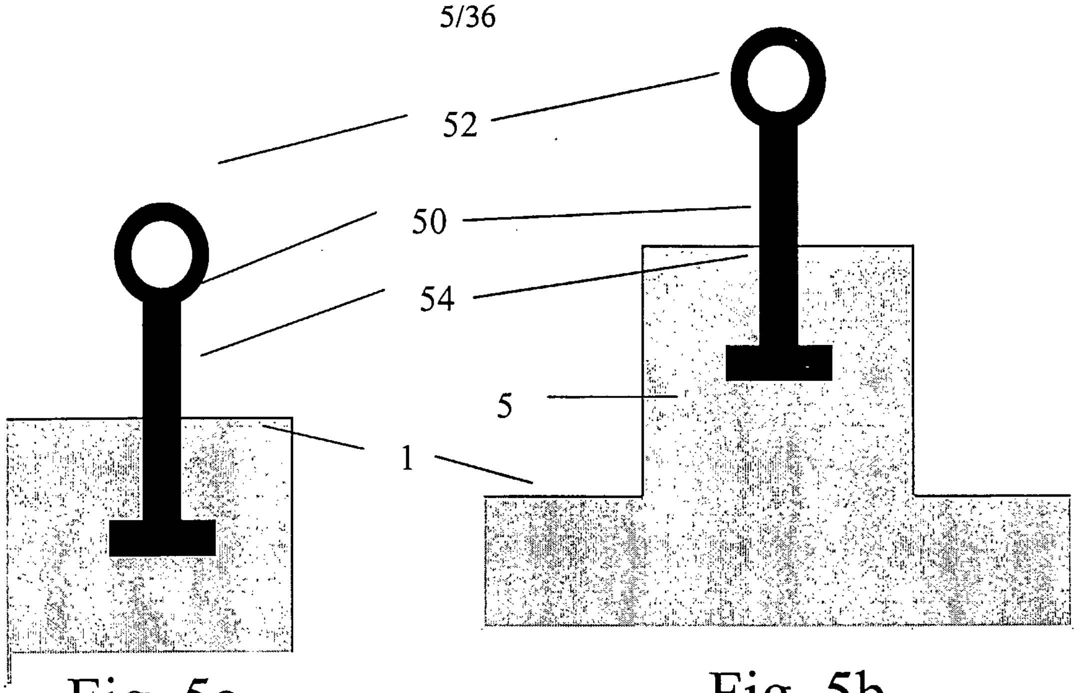

Fig. 5a

Fig. 5b

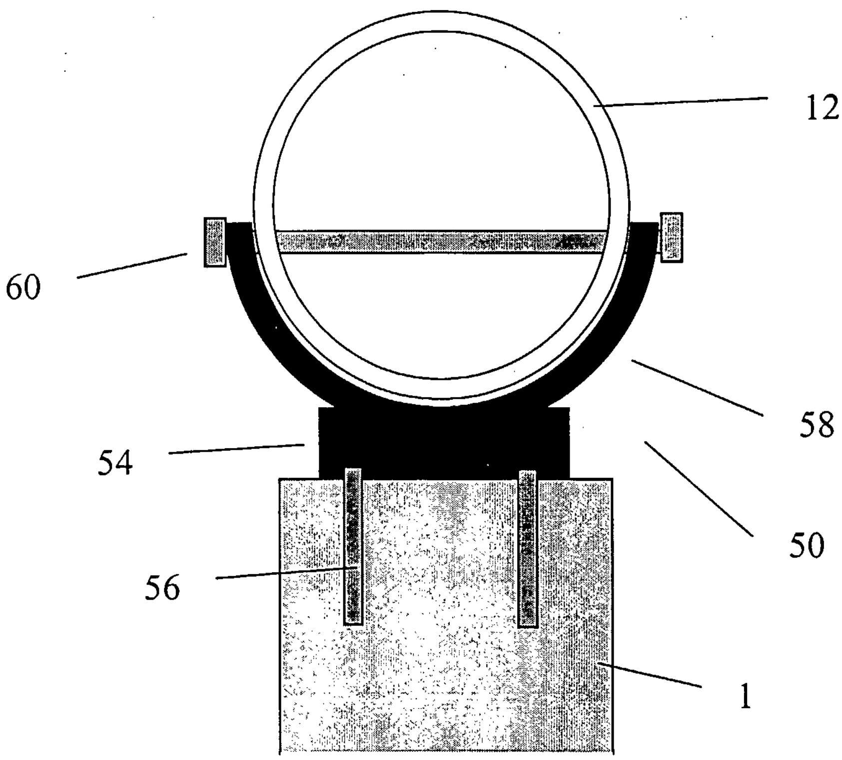

Fig. 5c

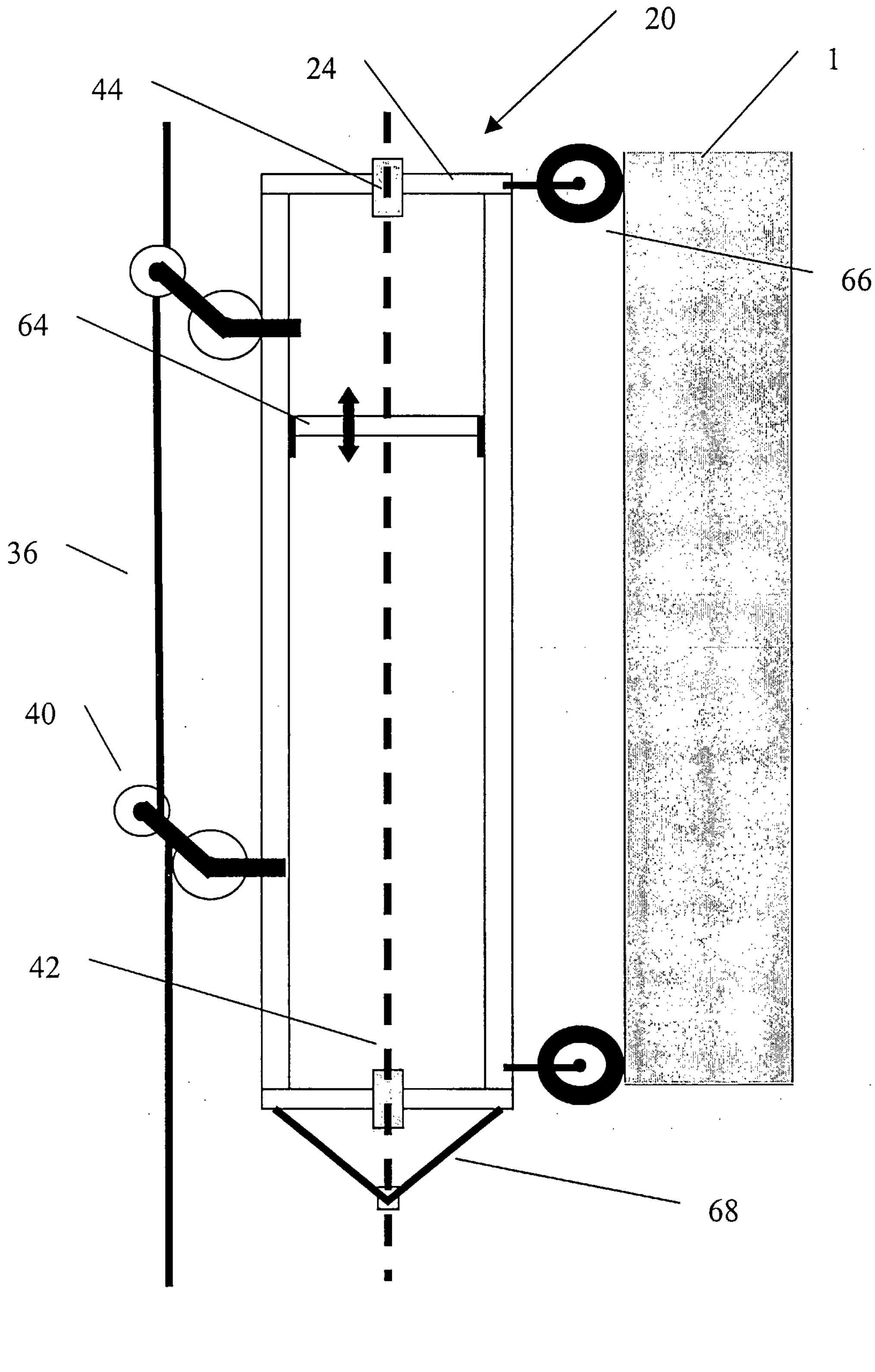

Fig. 6

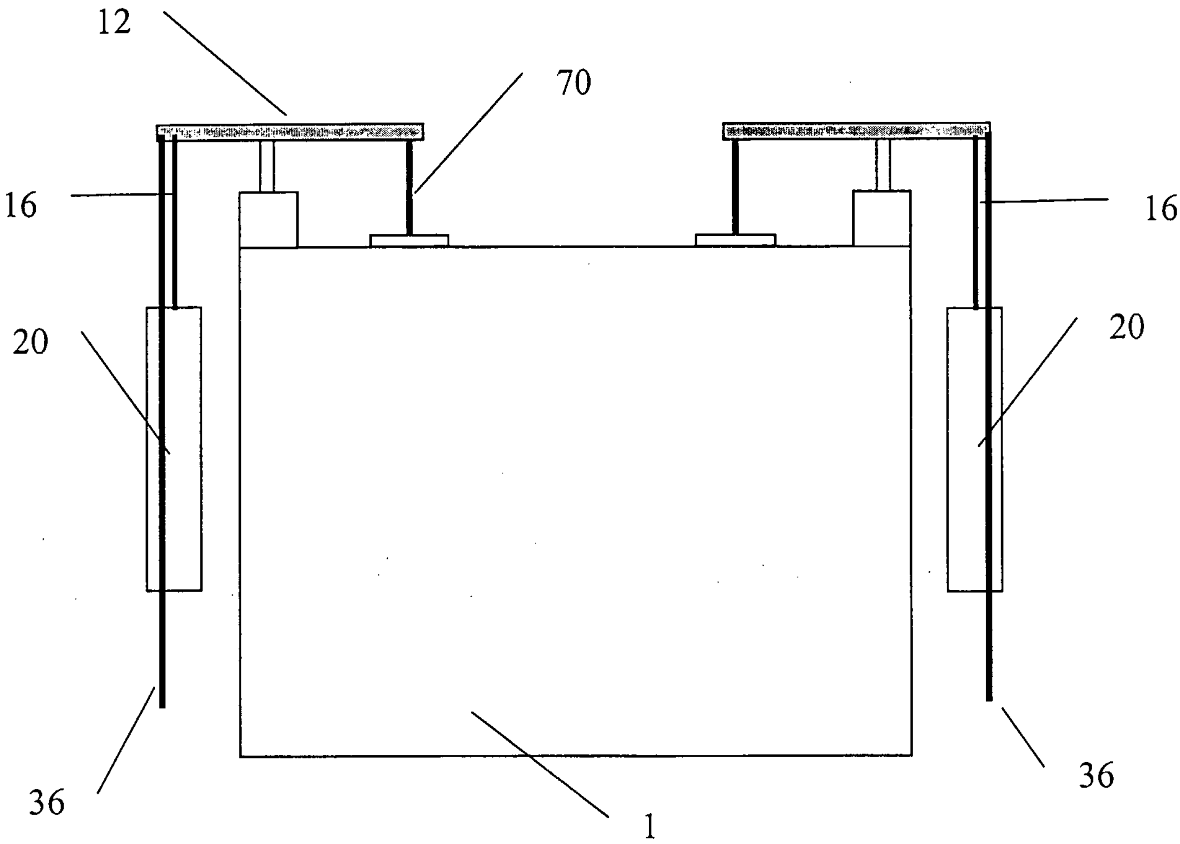

Fig. 7

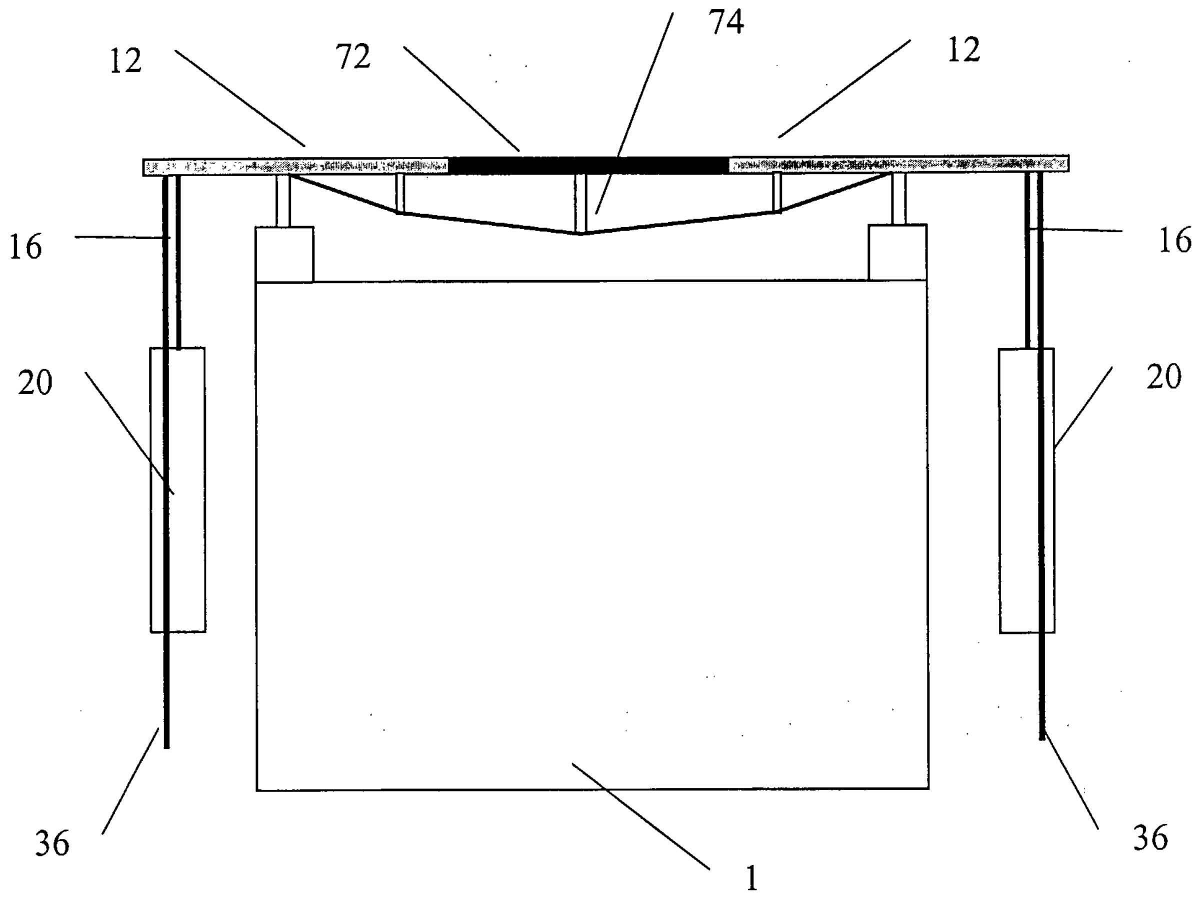

Fig. 8

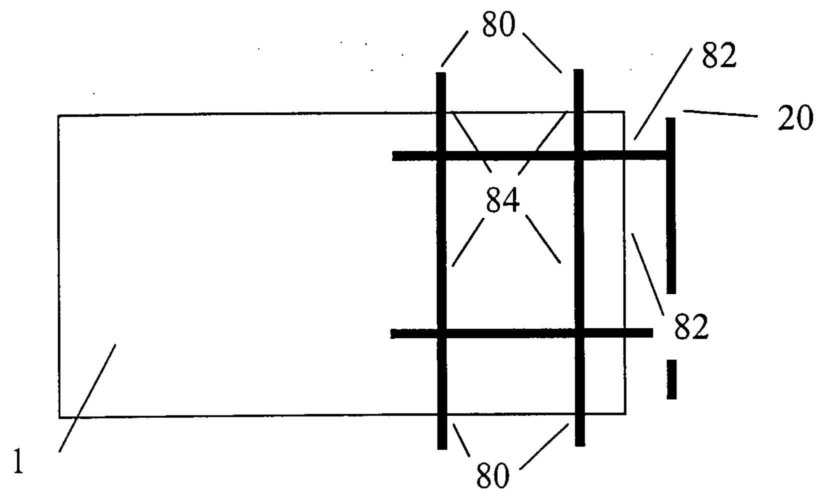

Fig. 9a

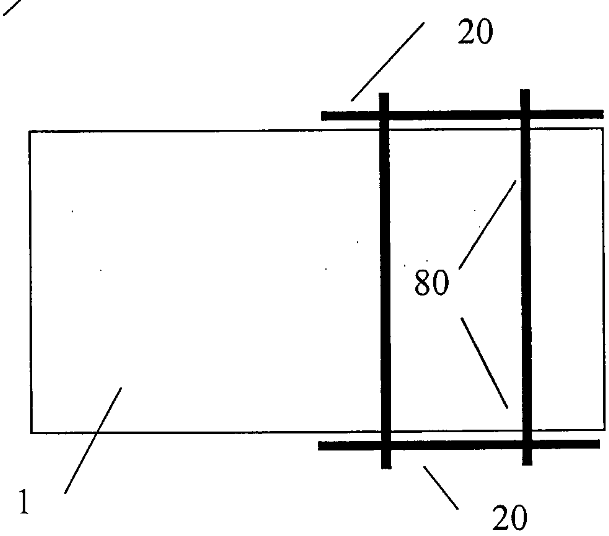

Fig. 9b

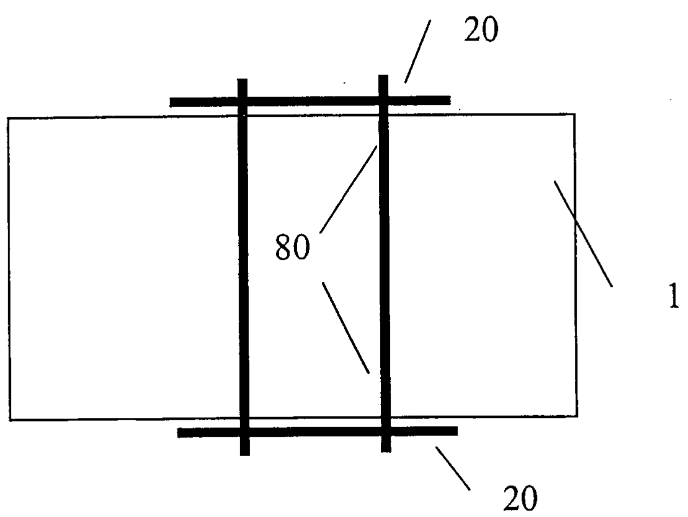

Fig. 9c

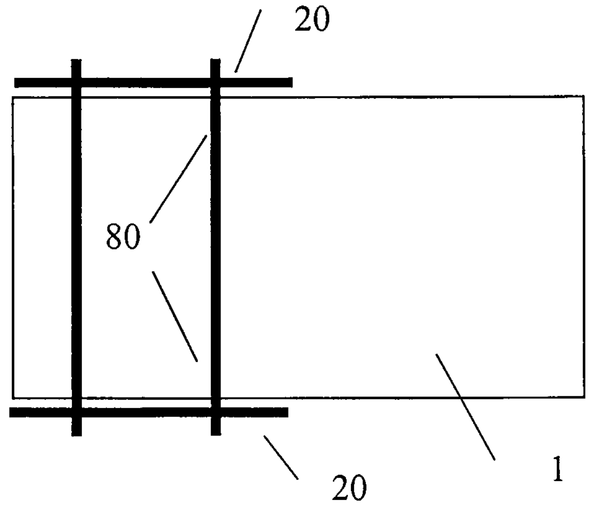

Fig. 9d

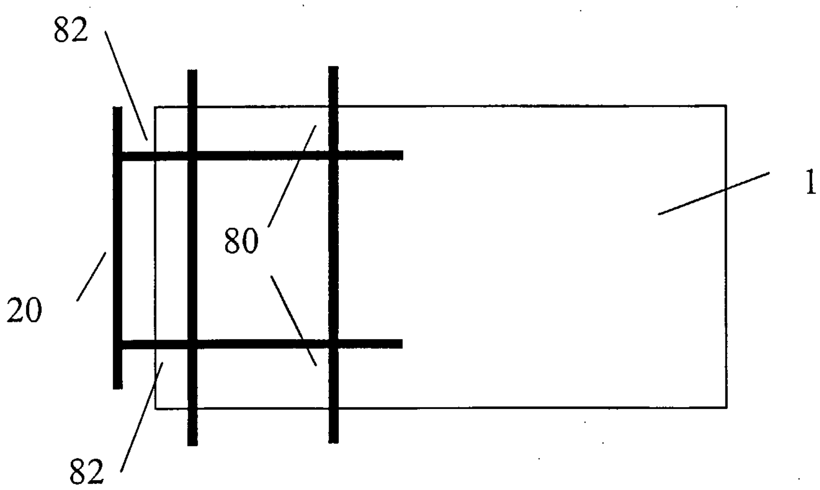

Fig. 9e

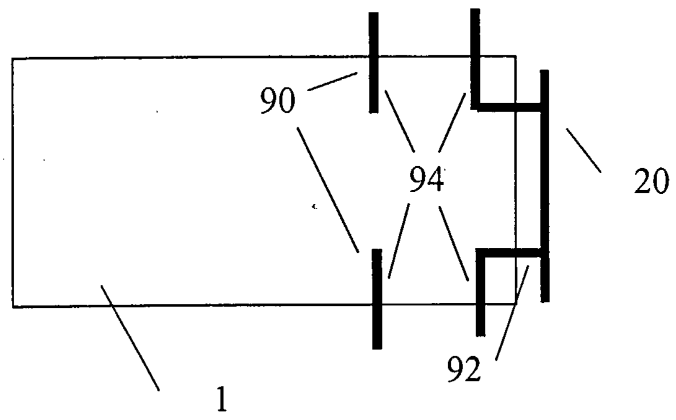

Fig. 10a

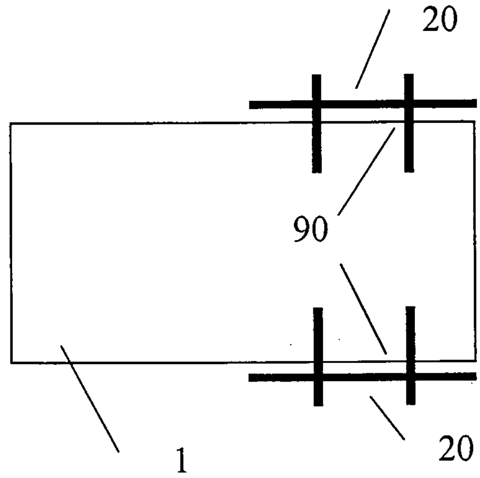

Fig. 10b

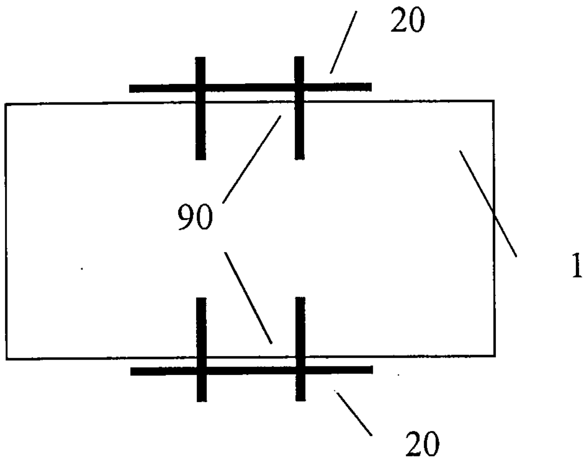

Fig. 10c

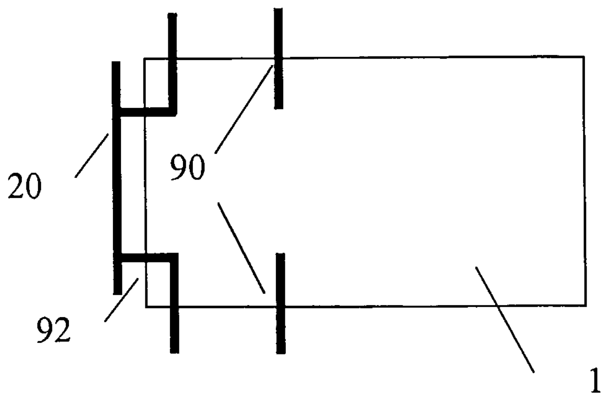

Fig. 10d

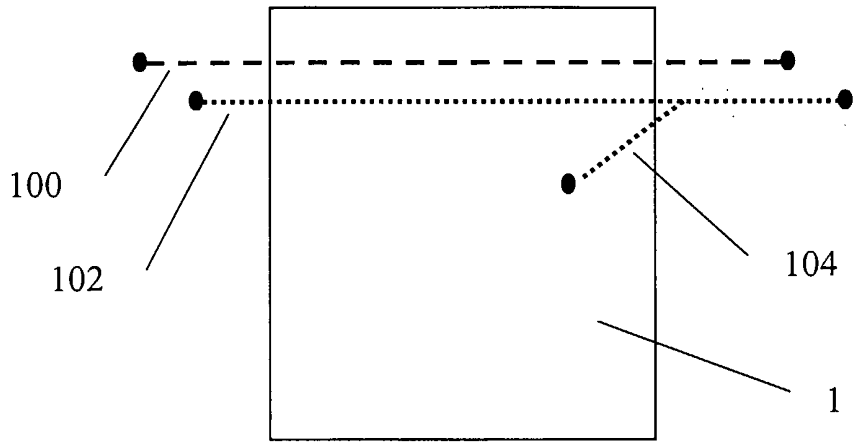

Fig. 11a

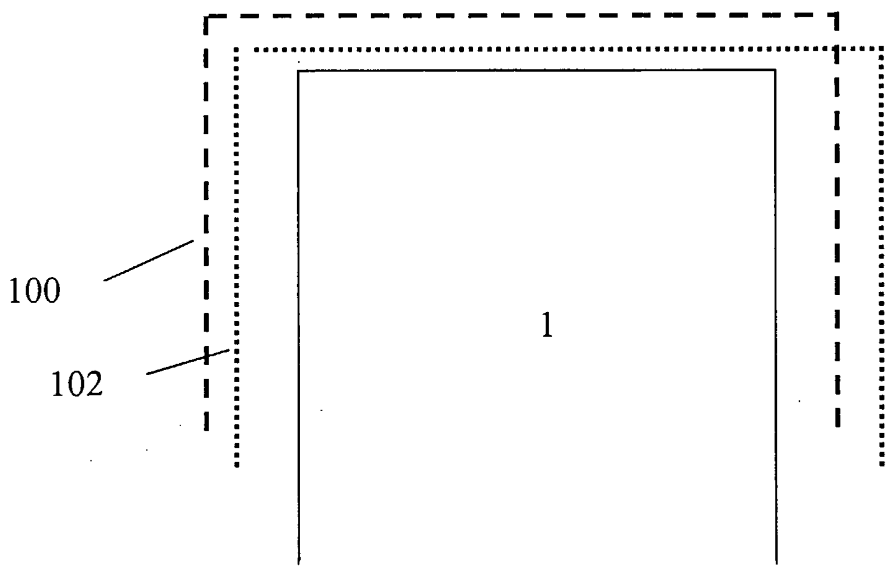

Fig. 11b

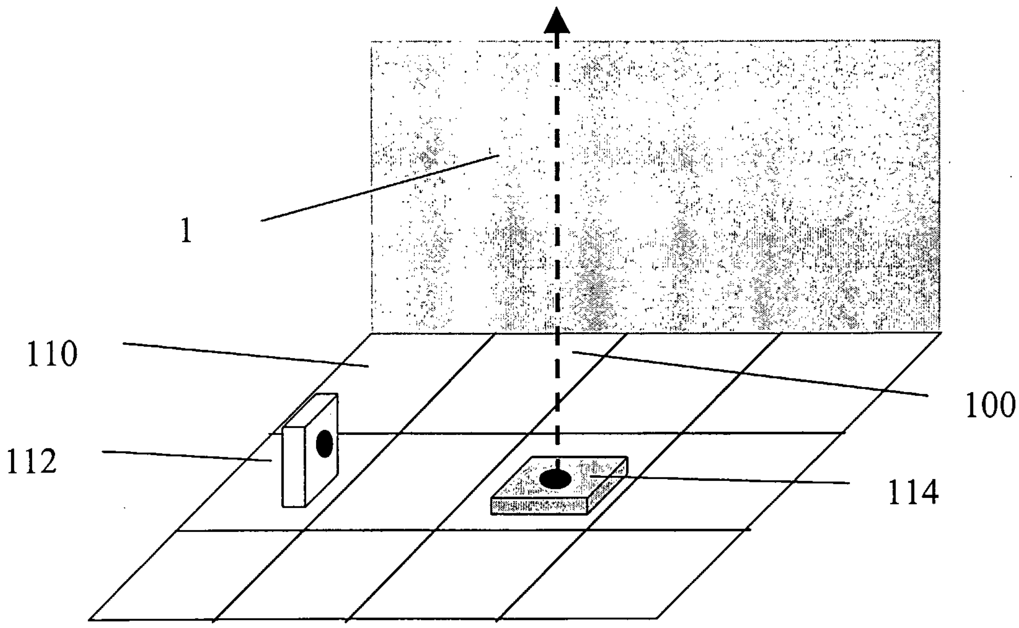

Fig. 12

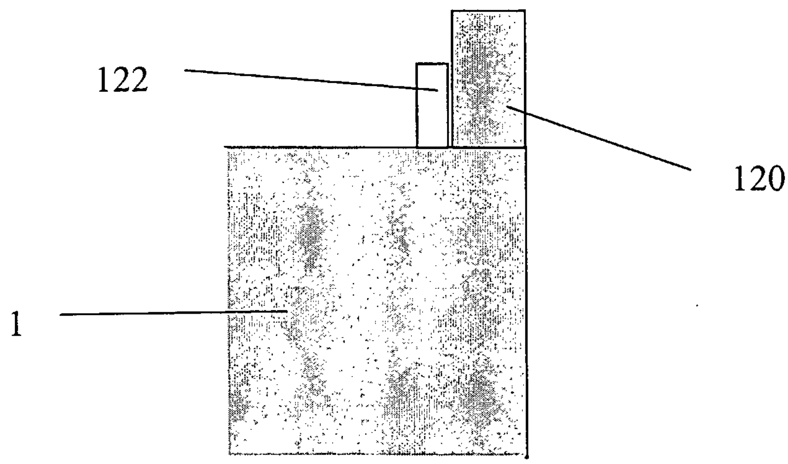

Fig. 13

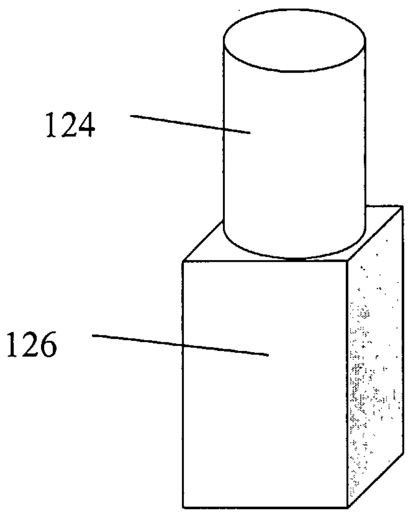

Fig. 14

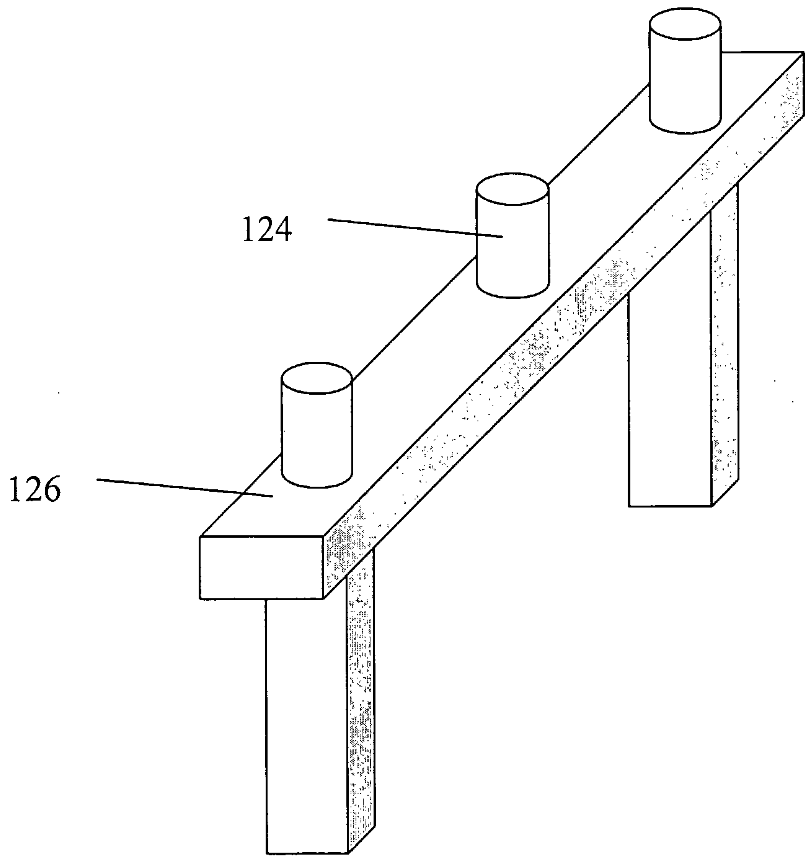

Fig. 15

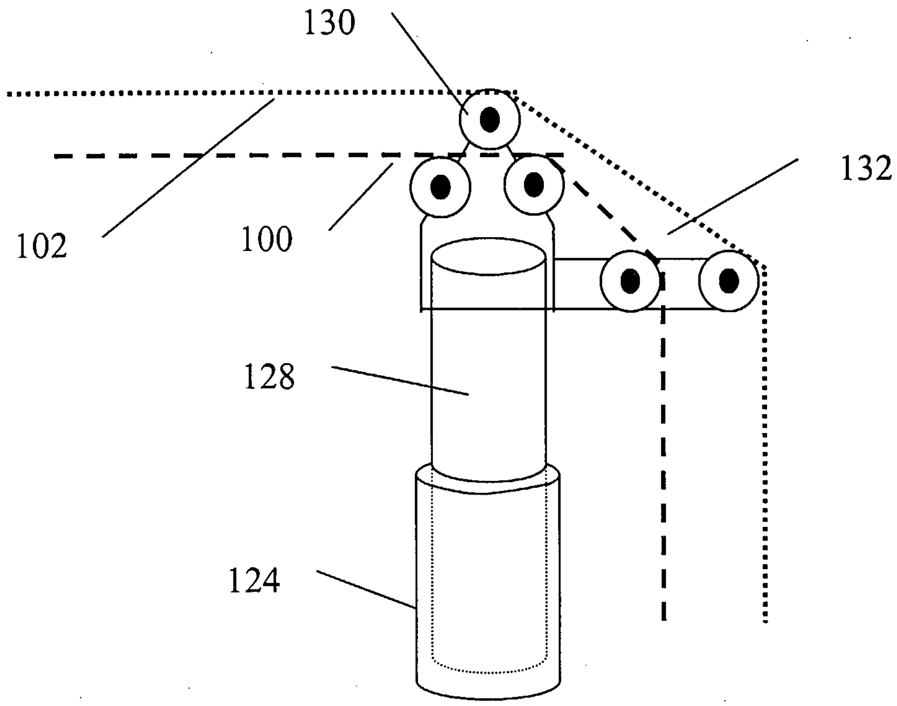

Fig. 16

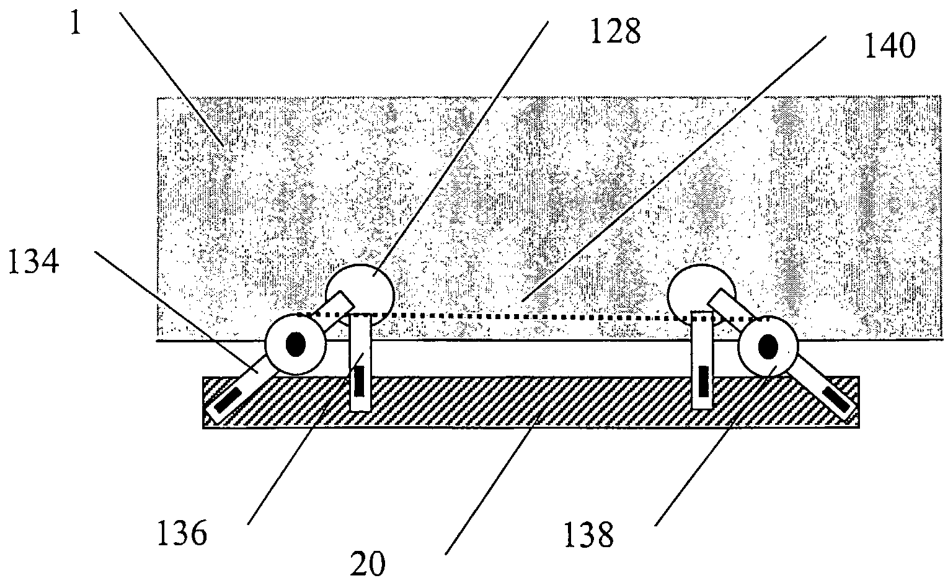

Fig. 17

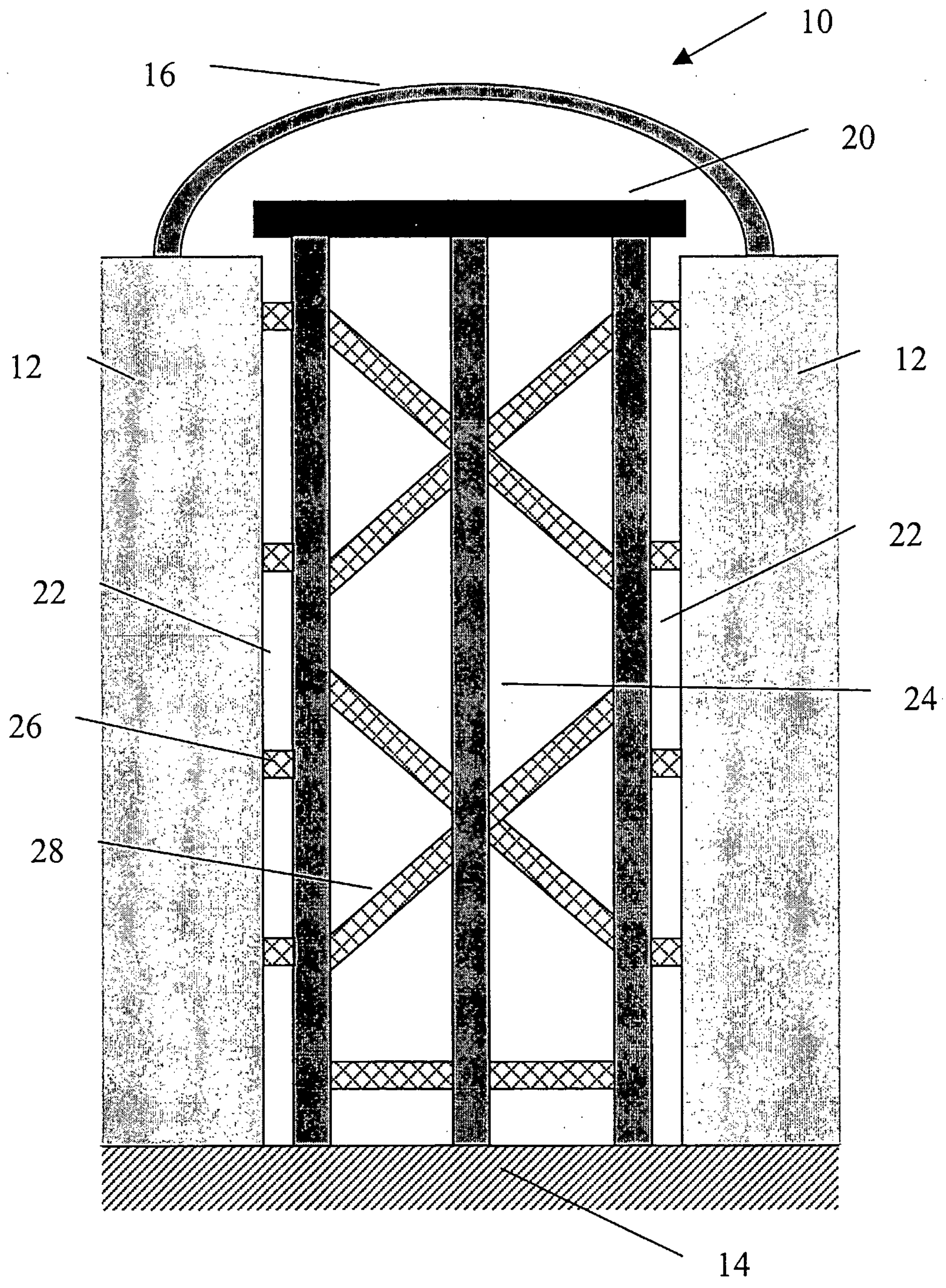

Fig. 18

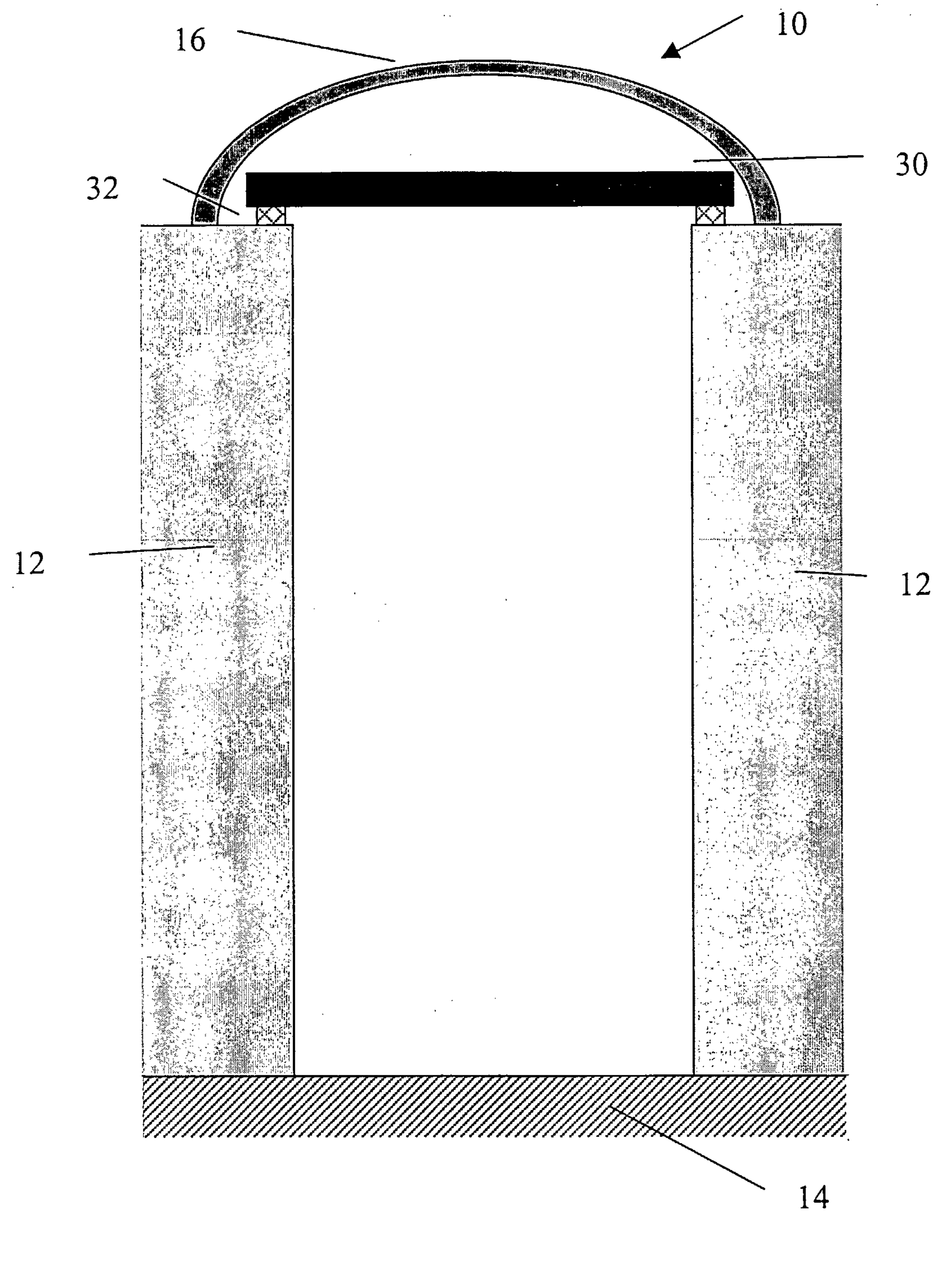

Fig. 19

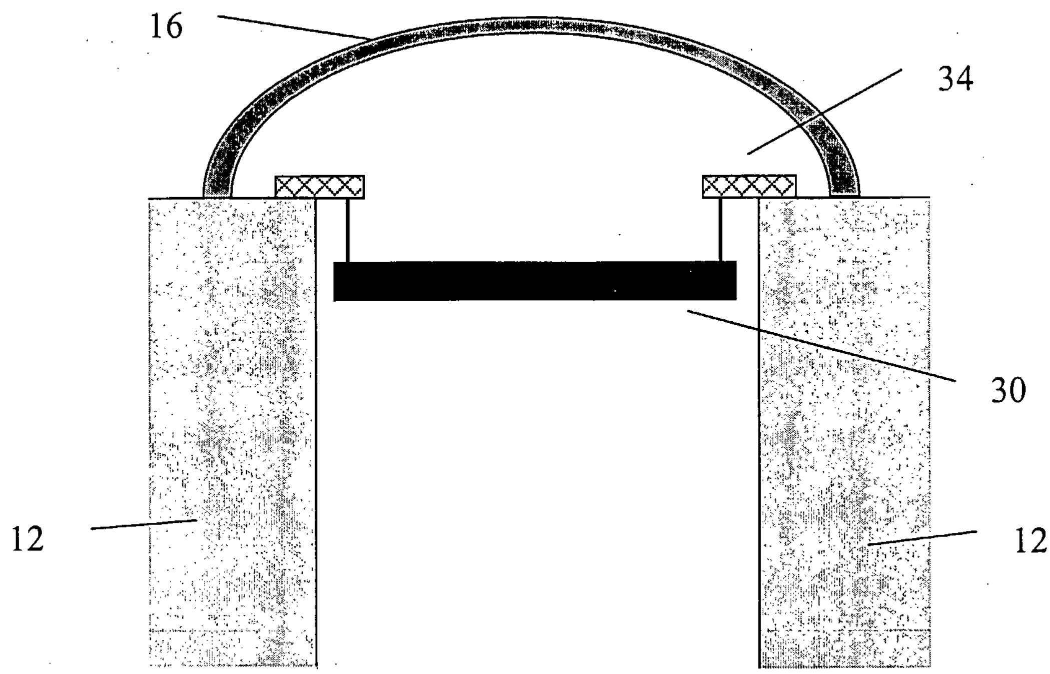

Fig. 20

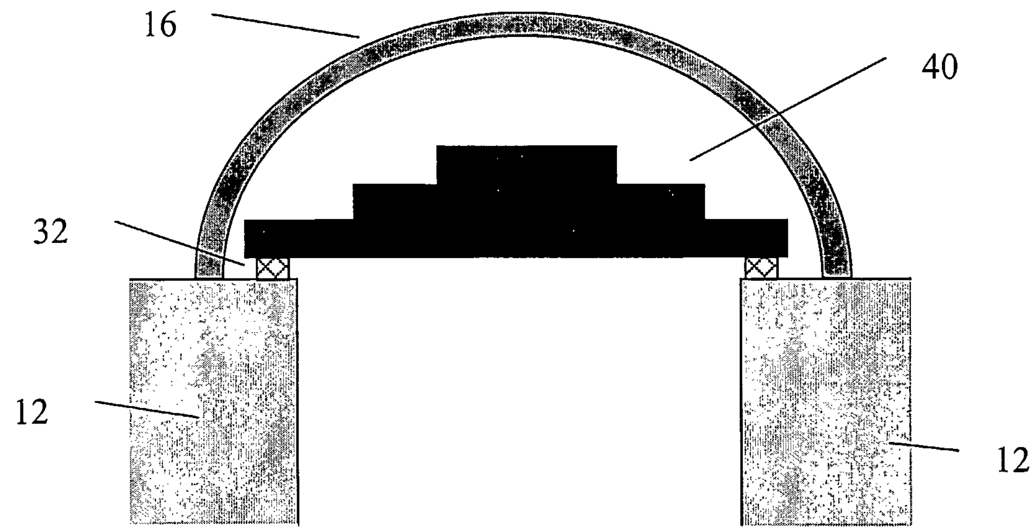

Fig. 21

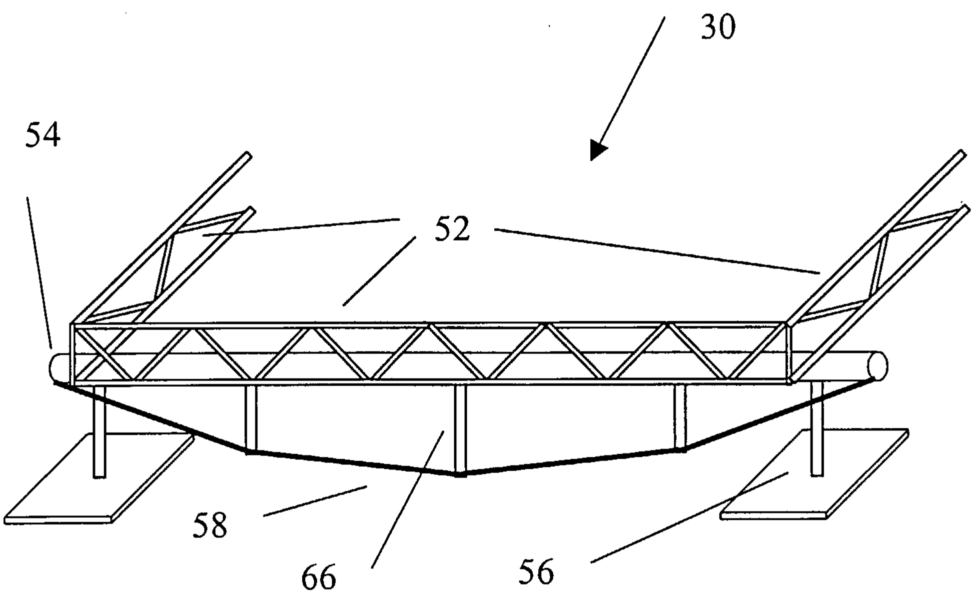

Fig. 22

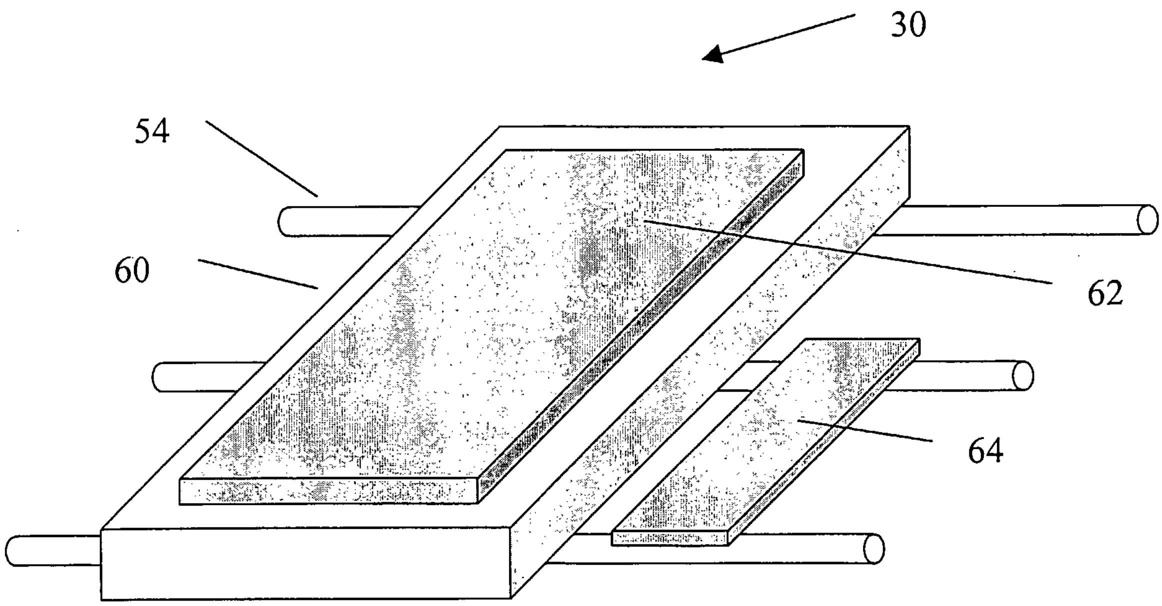

Fig. 23

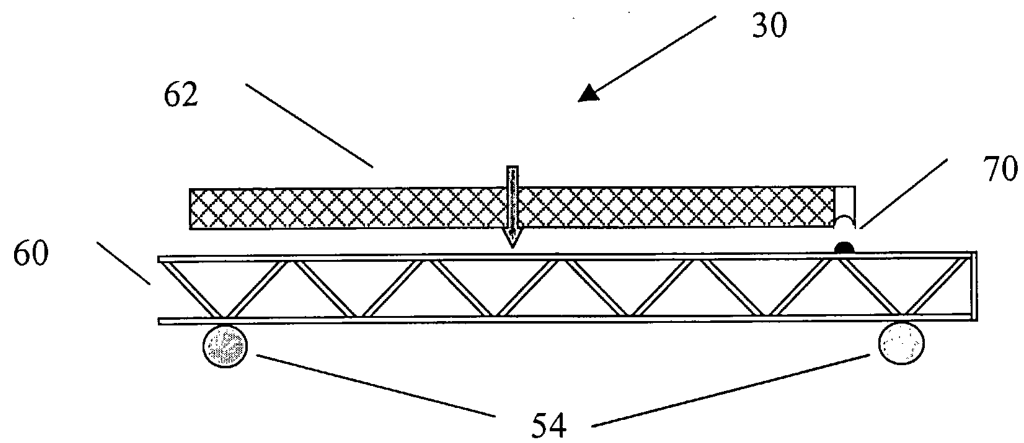

Fig. 24

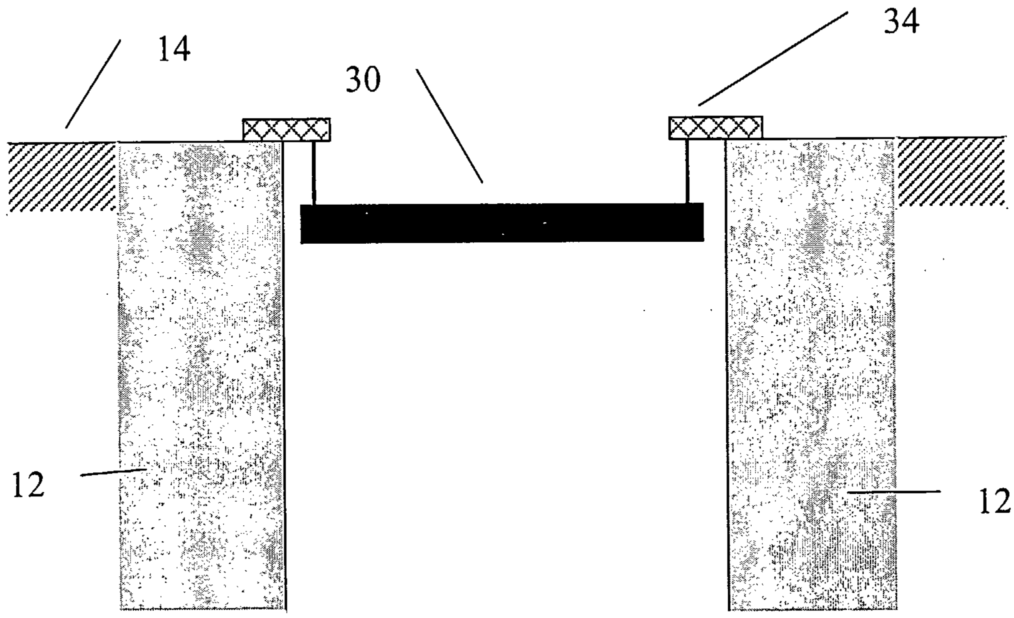

Fig. 25

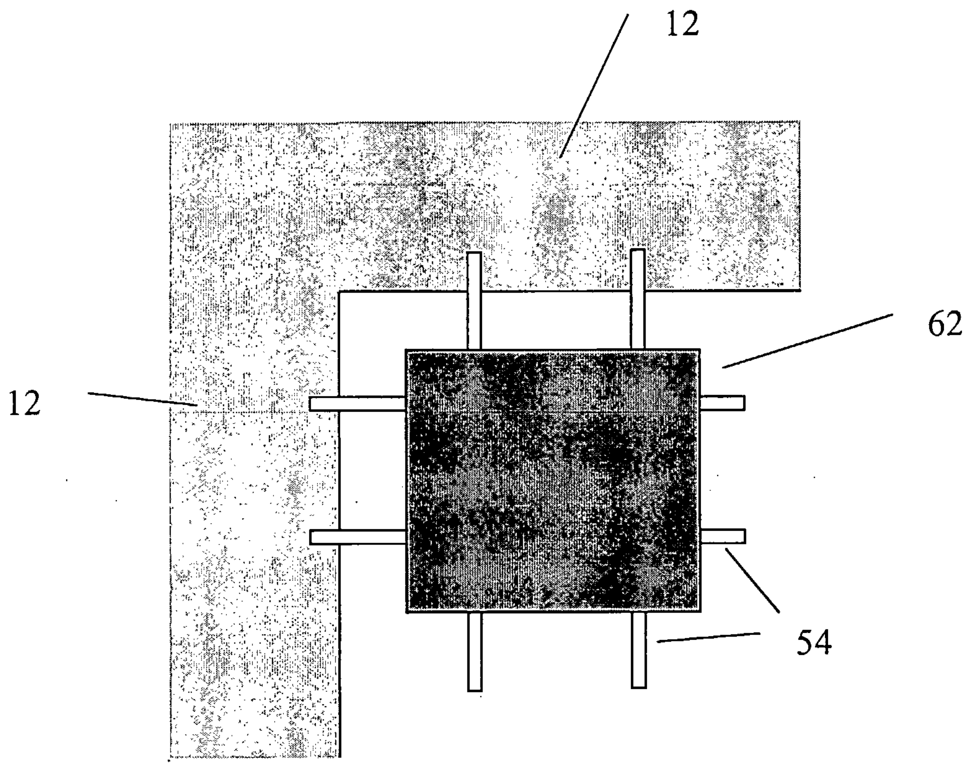

Fig. 26

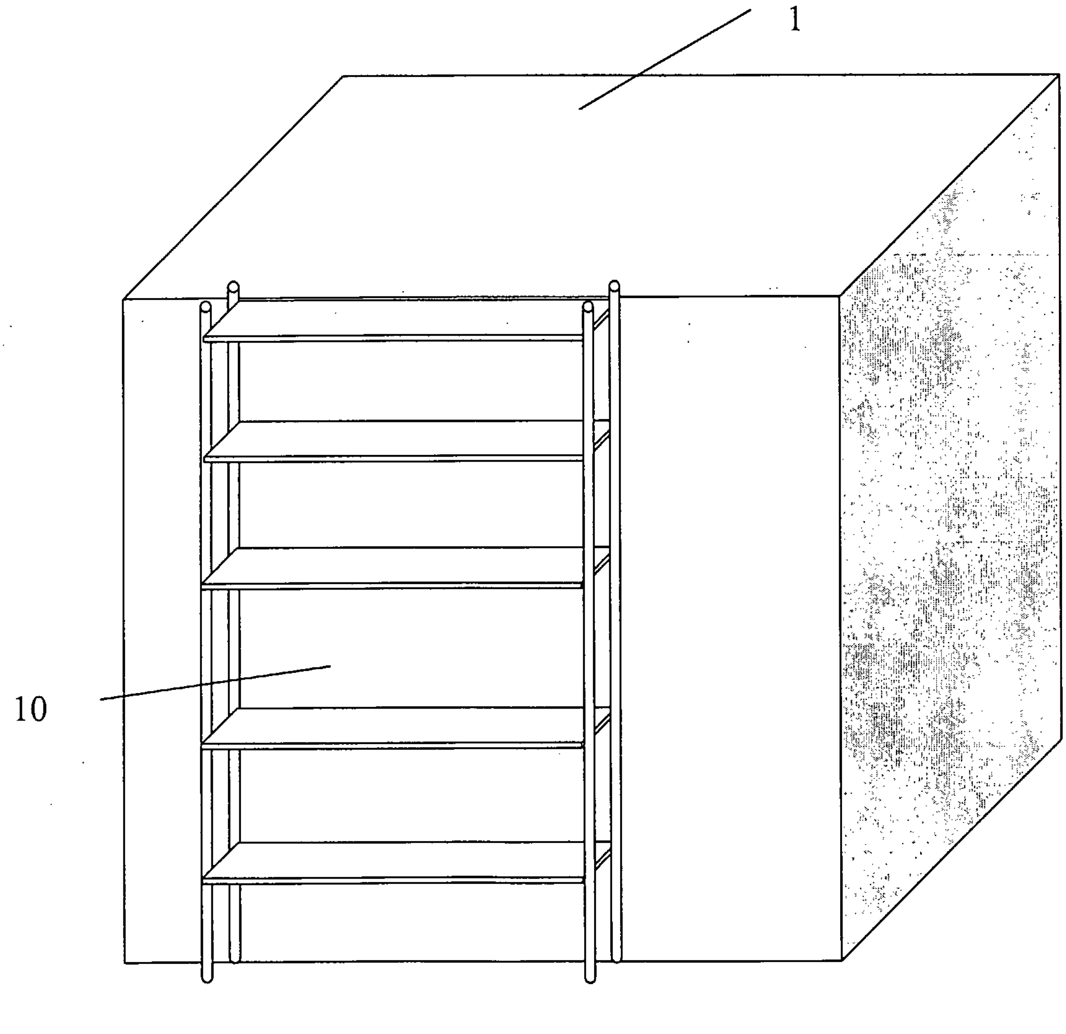

Fig. 27

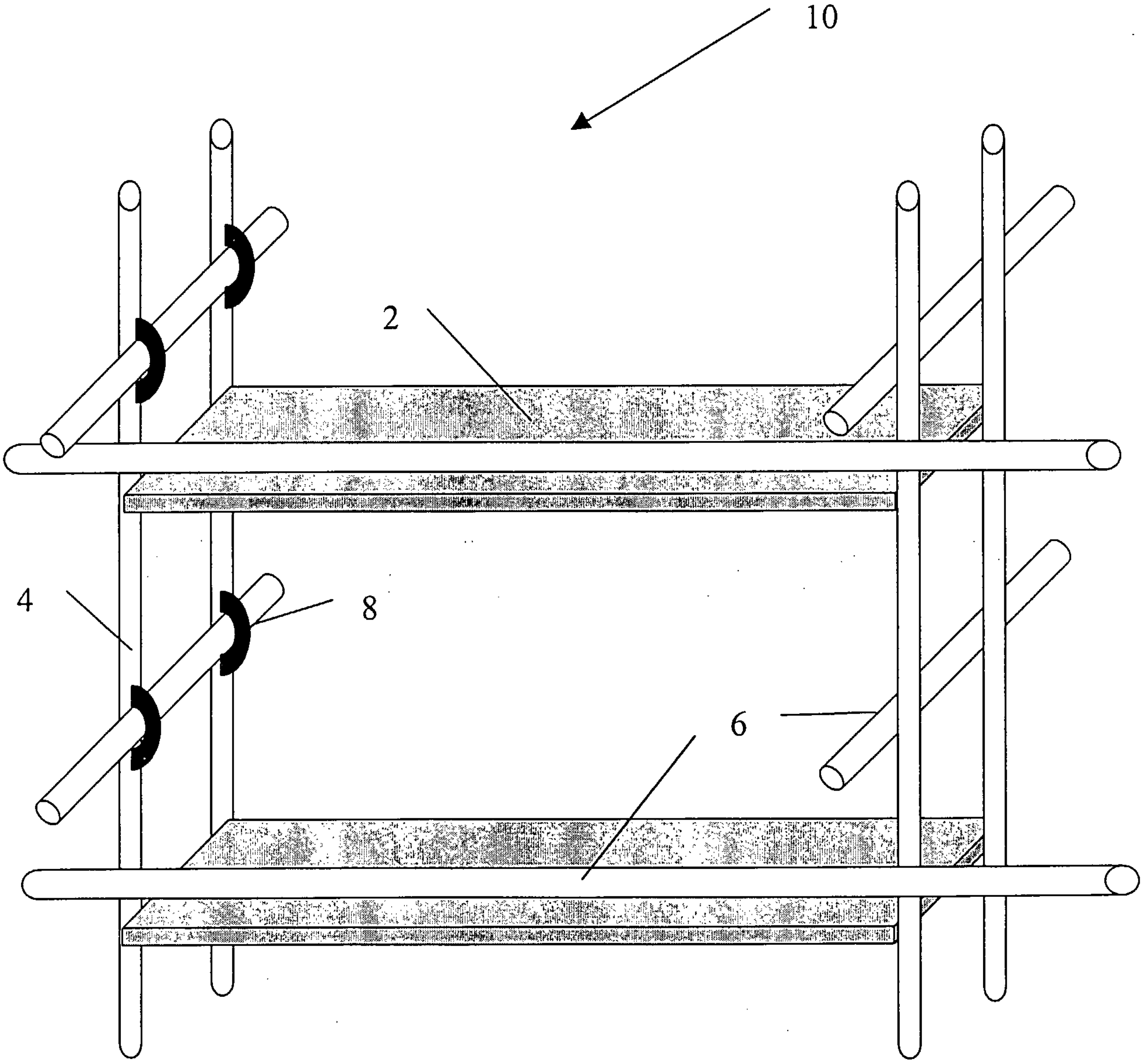

Fig. 28

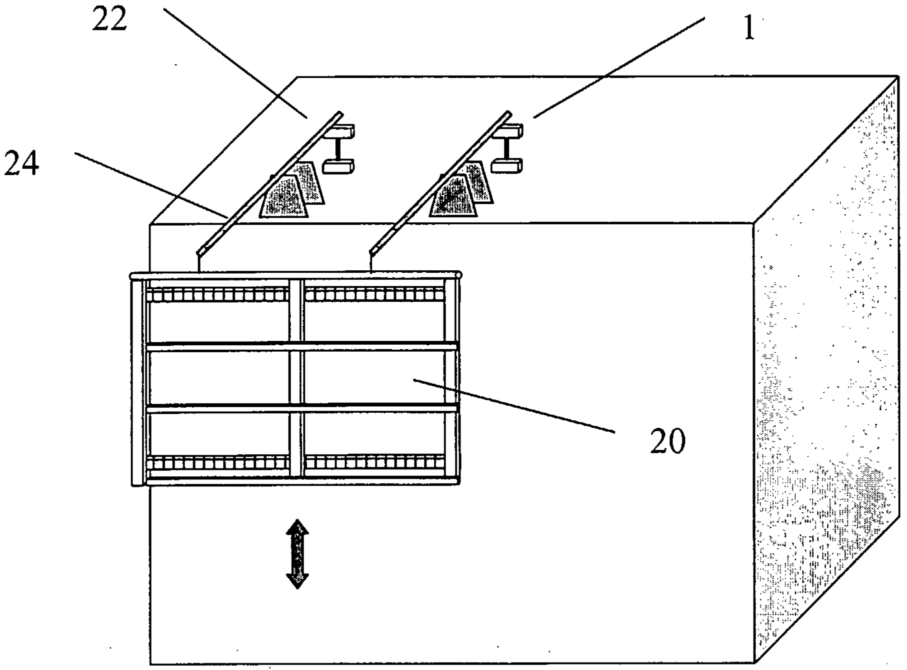

Fig. 29a

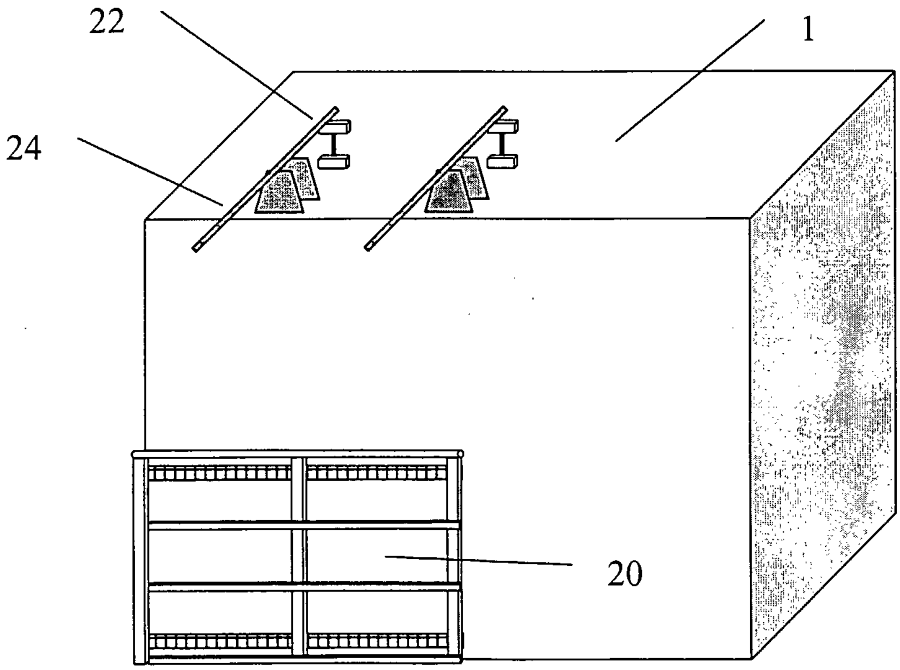

Fig. 29b

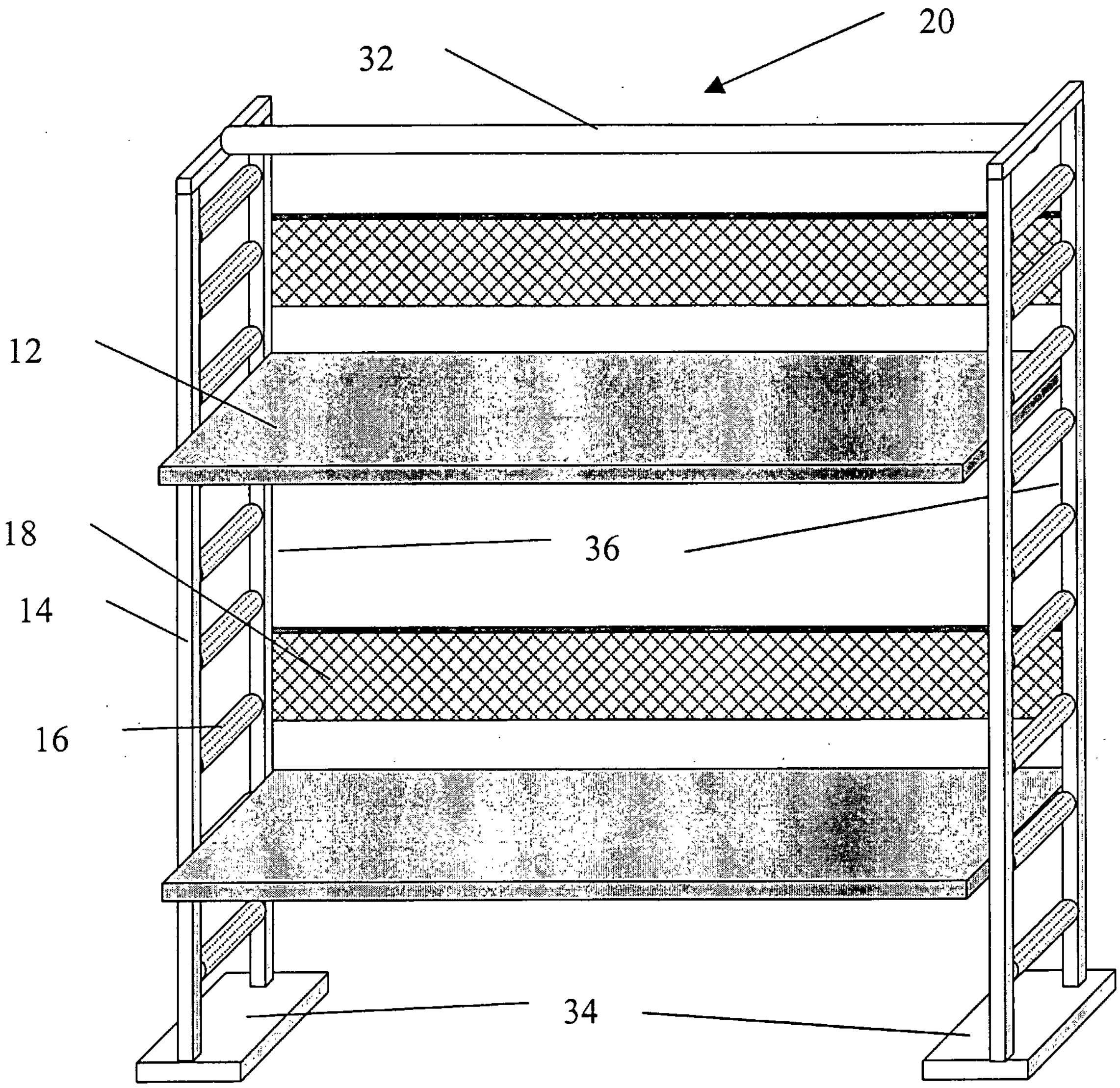

Fig. 30a

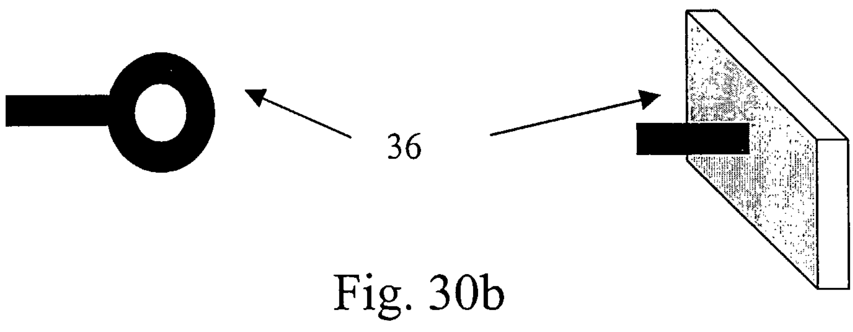

Fig. 30b

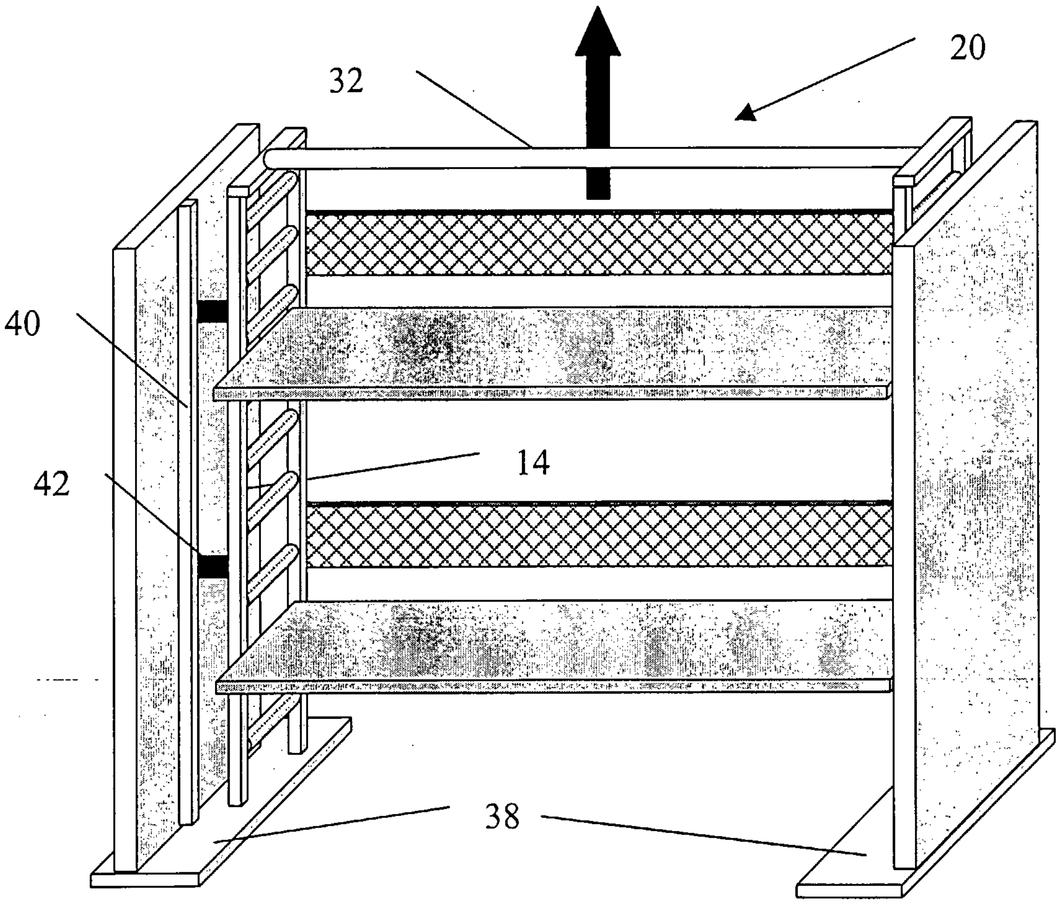

Fig. 31a

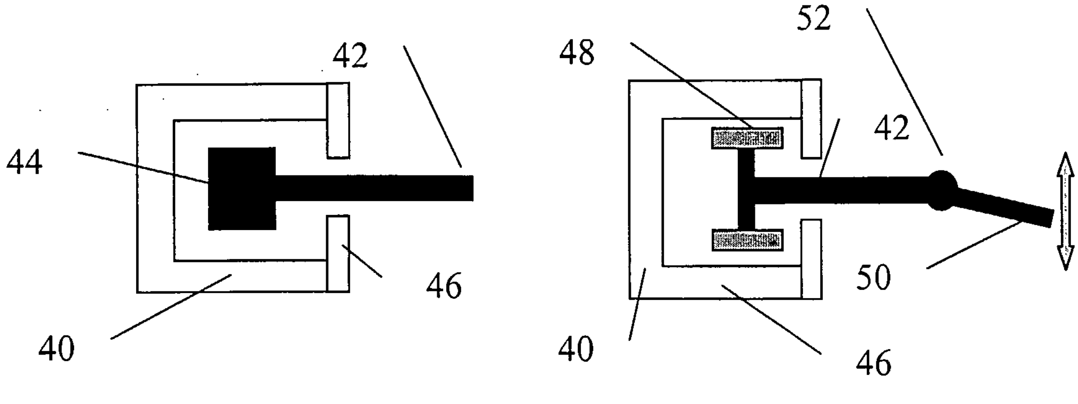

Fig. 31b

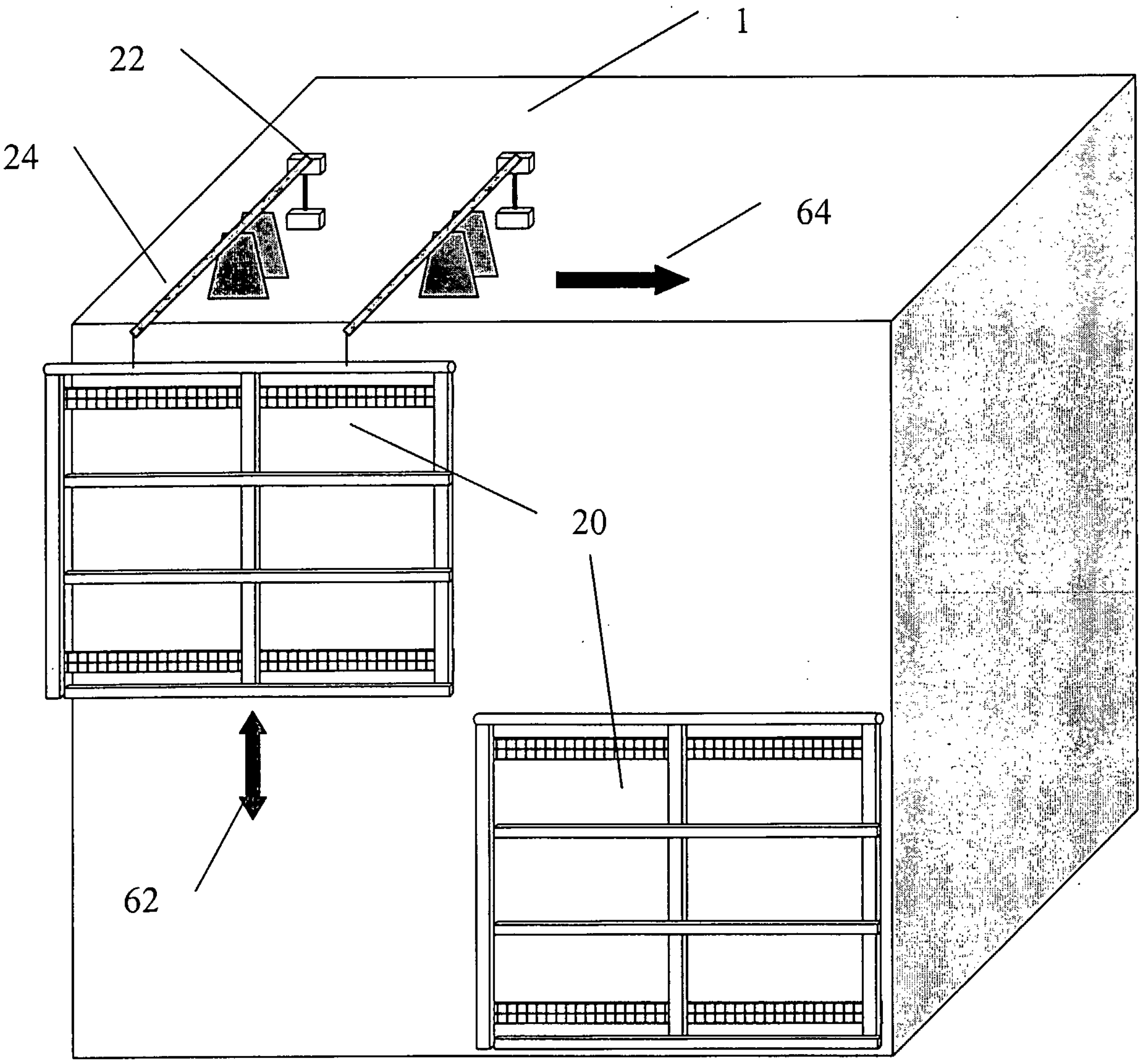

Fig. 32

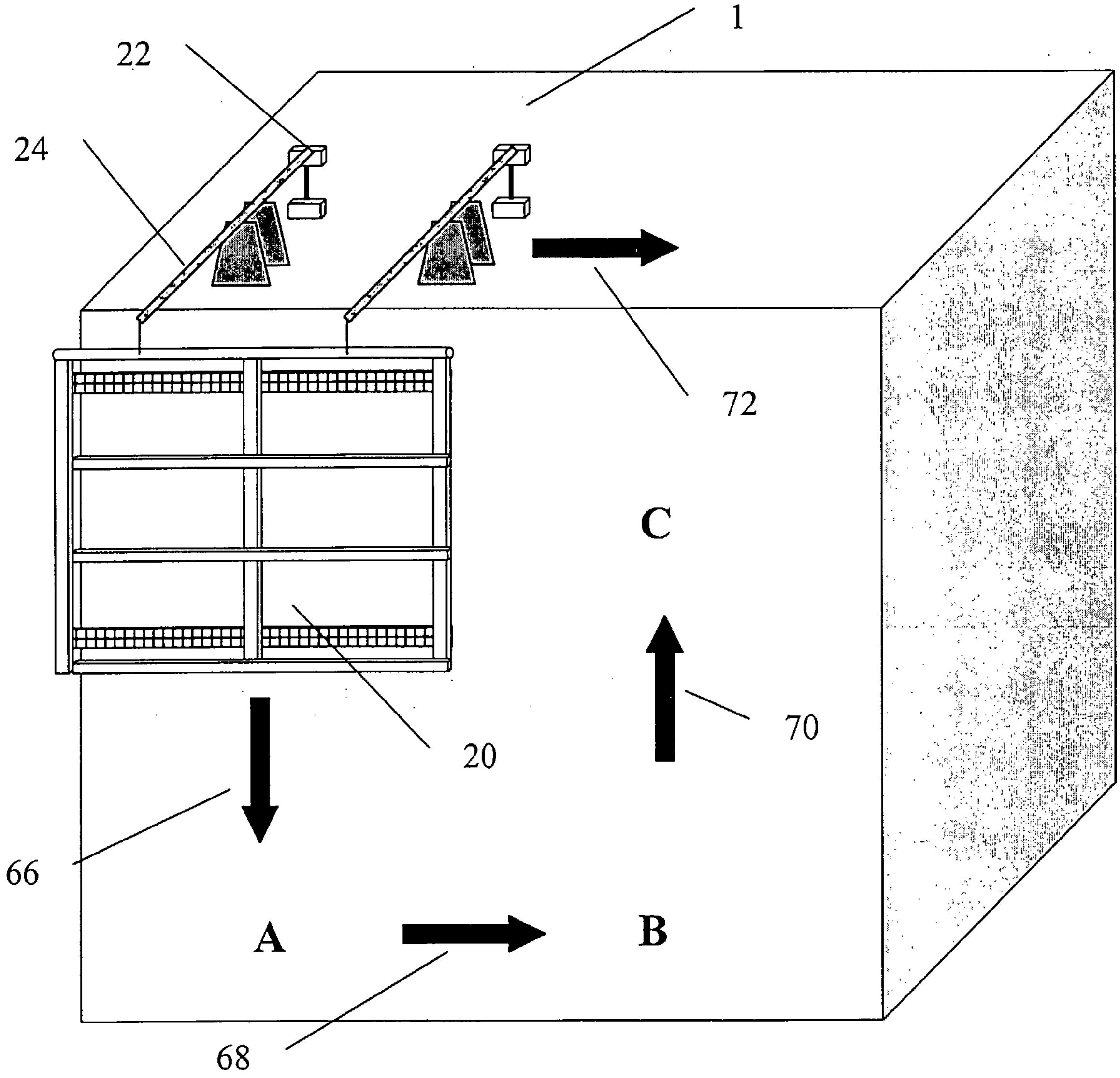

Fig. 33

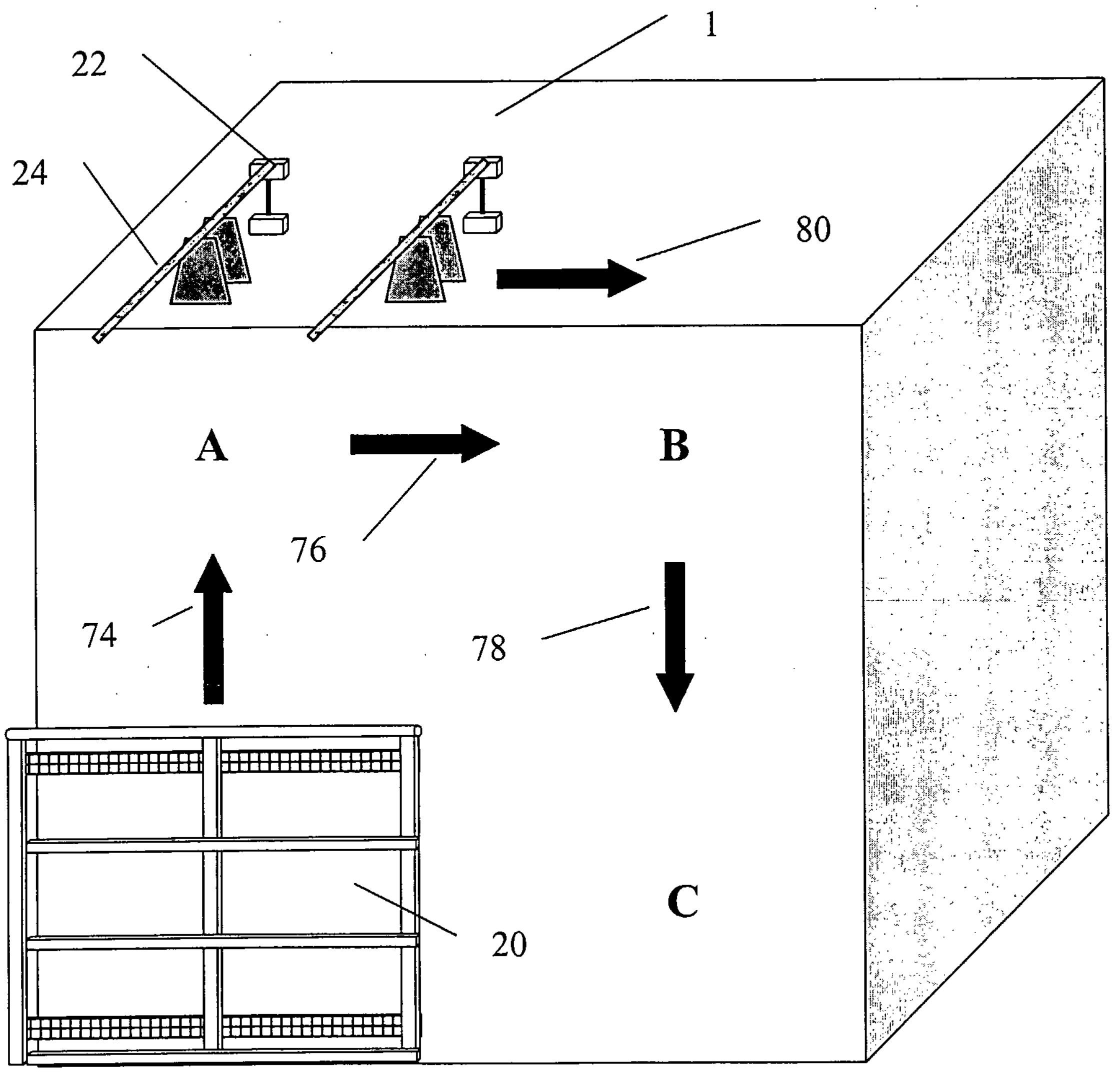

Fig. 34

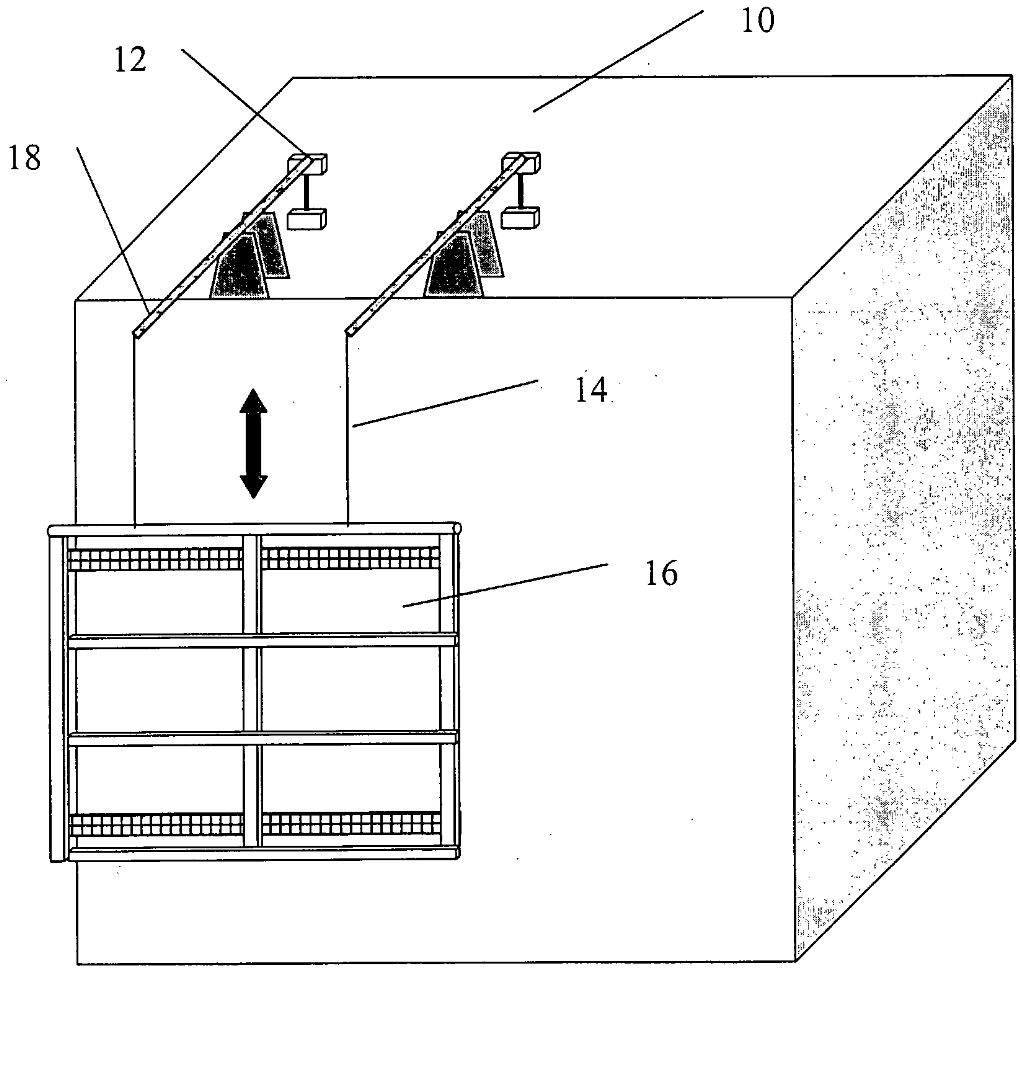

Fig. 35

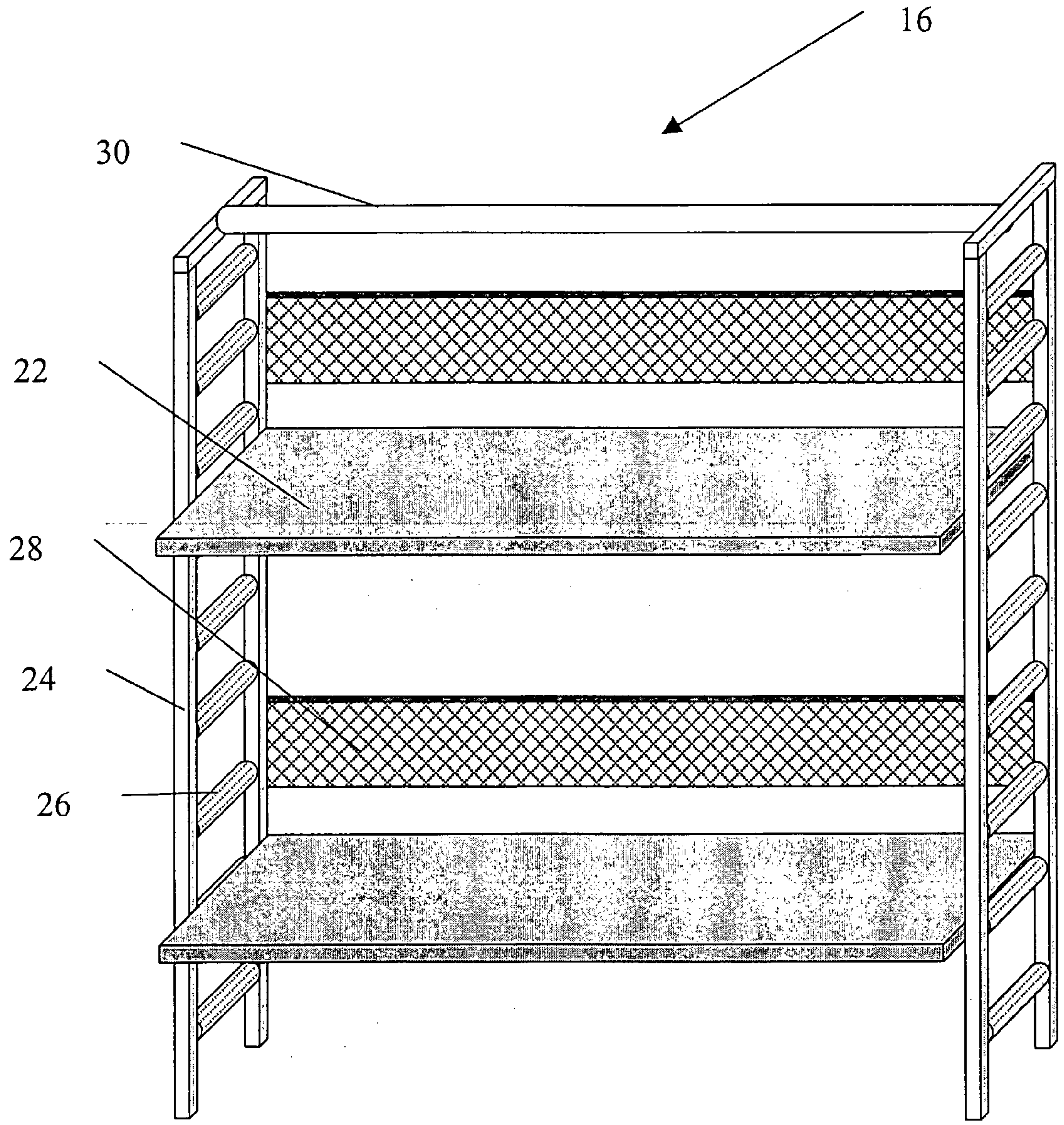

Fig. 36

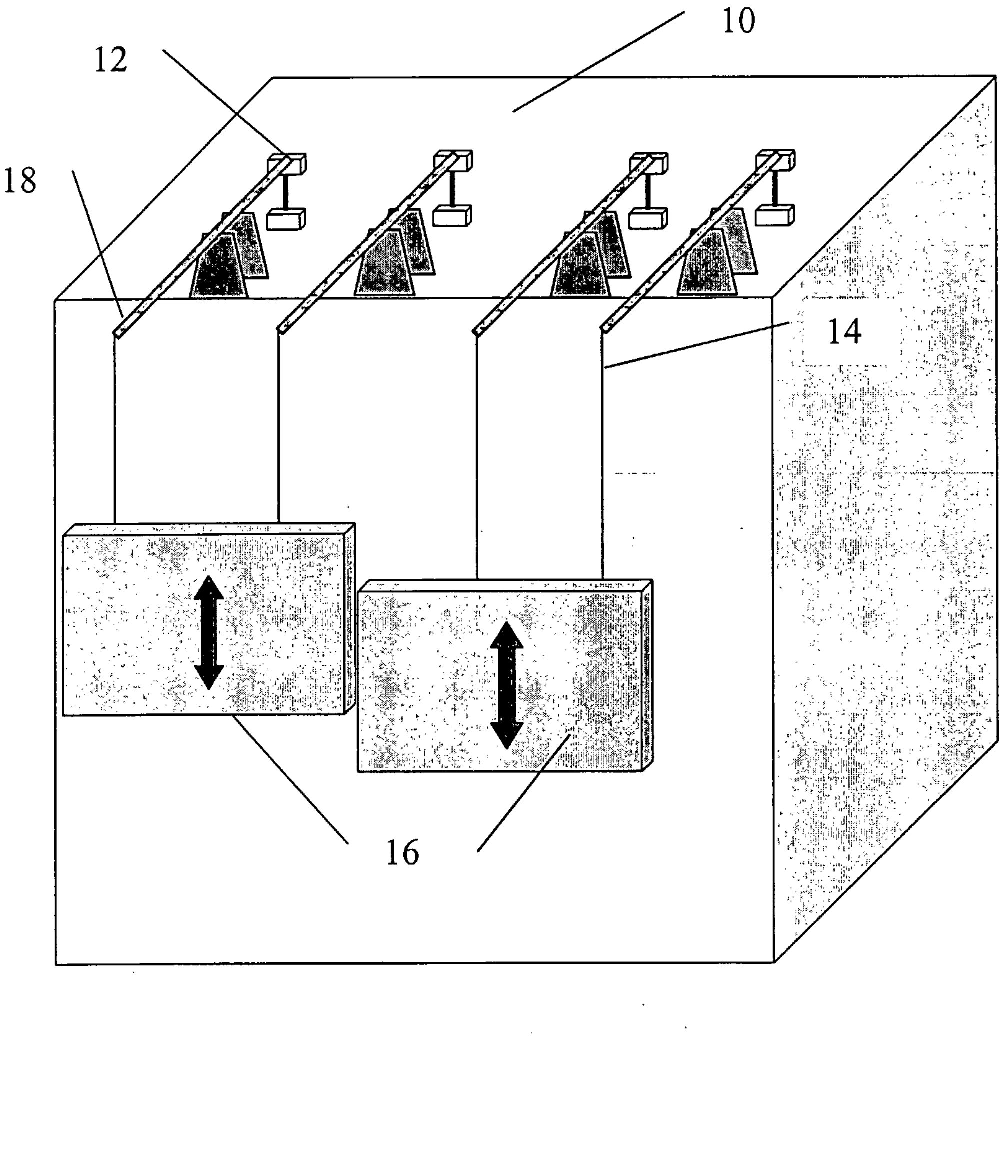

Fig. 37

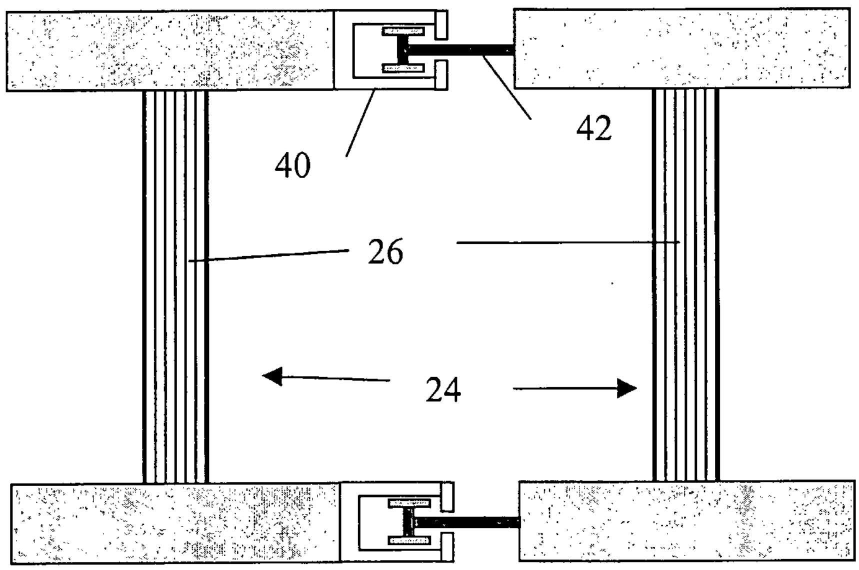

Fig. 38a

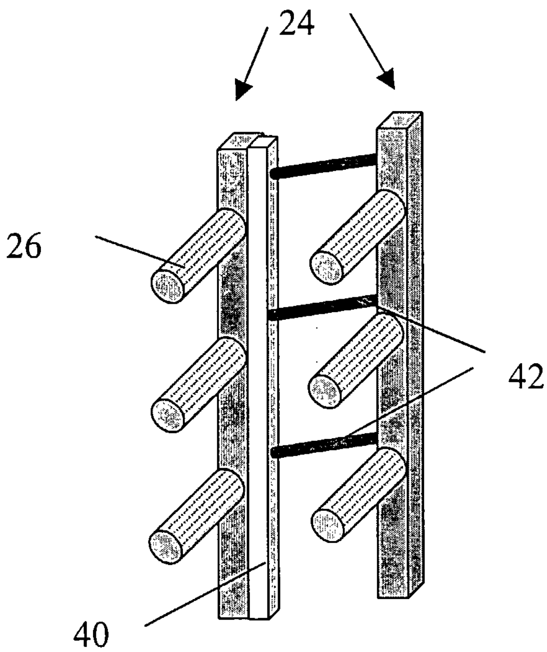

Fig. 38b

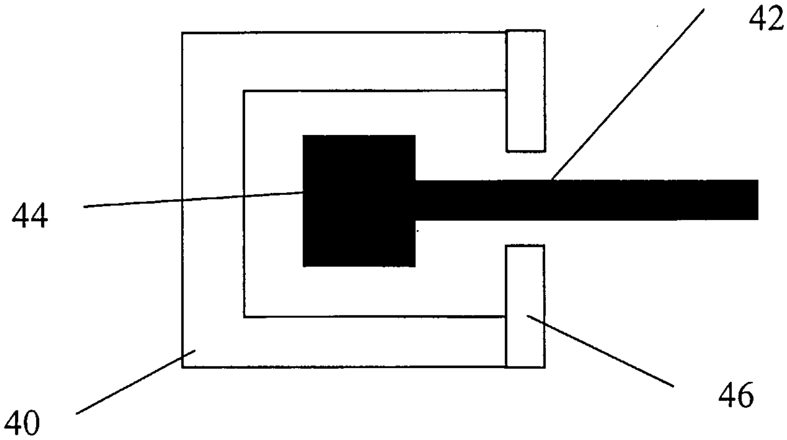

Fig. 39a

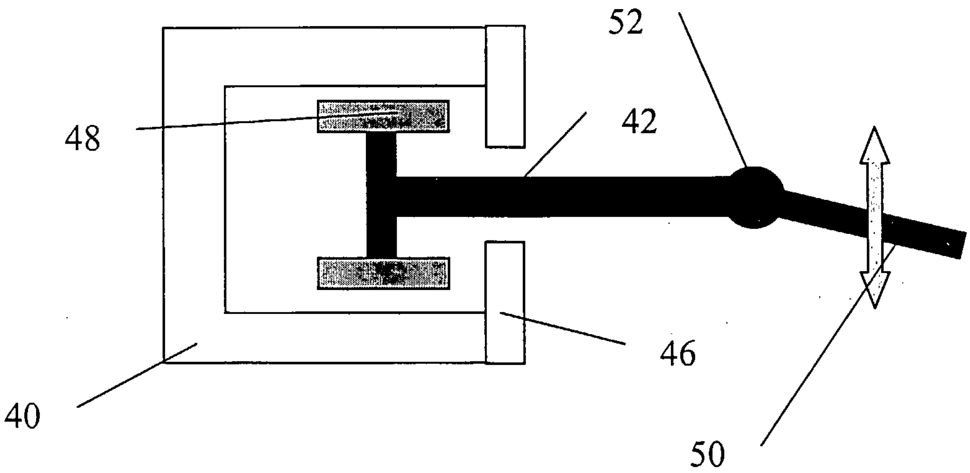

Fig. 39b

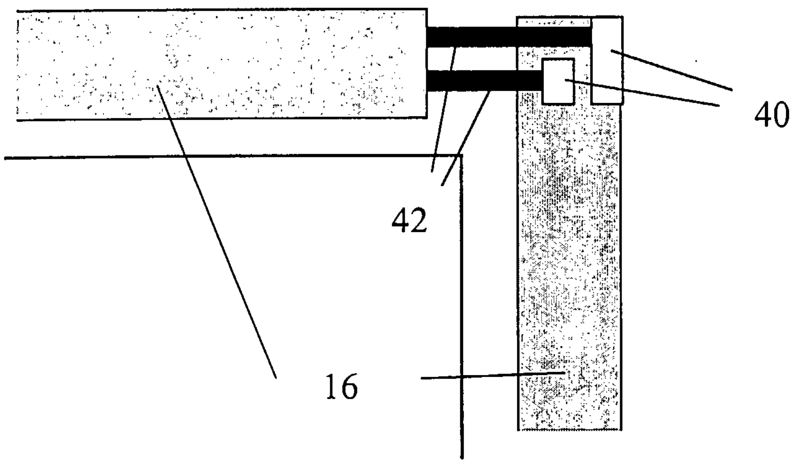

Fig. 40a

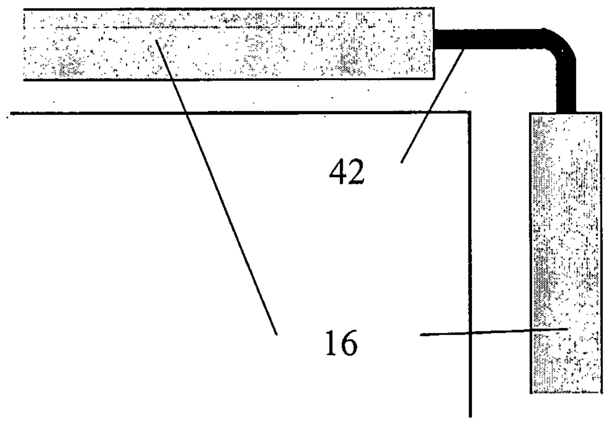

Fig. 40b

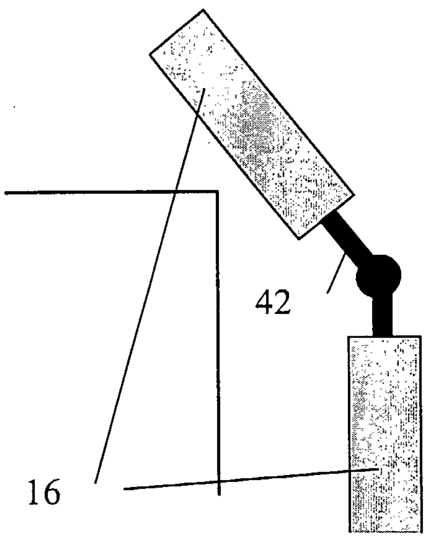

Fig. 40c

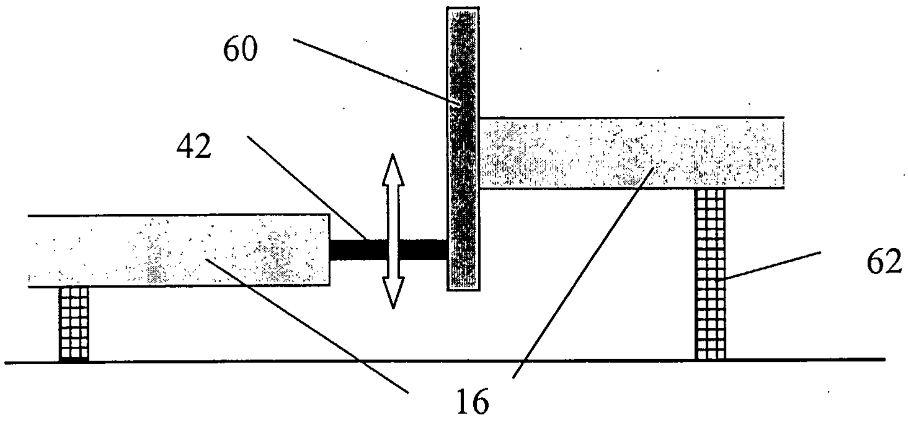

Fig. 41

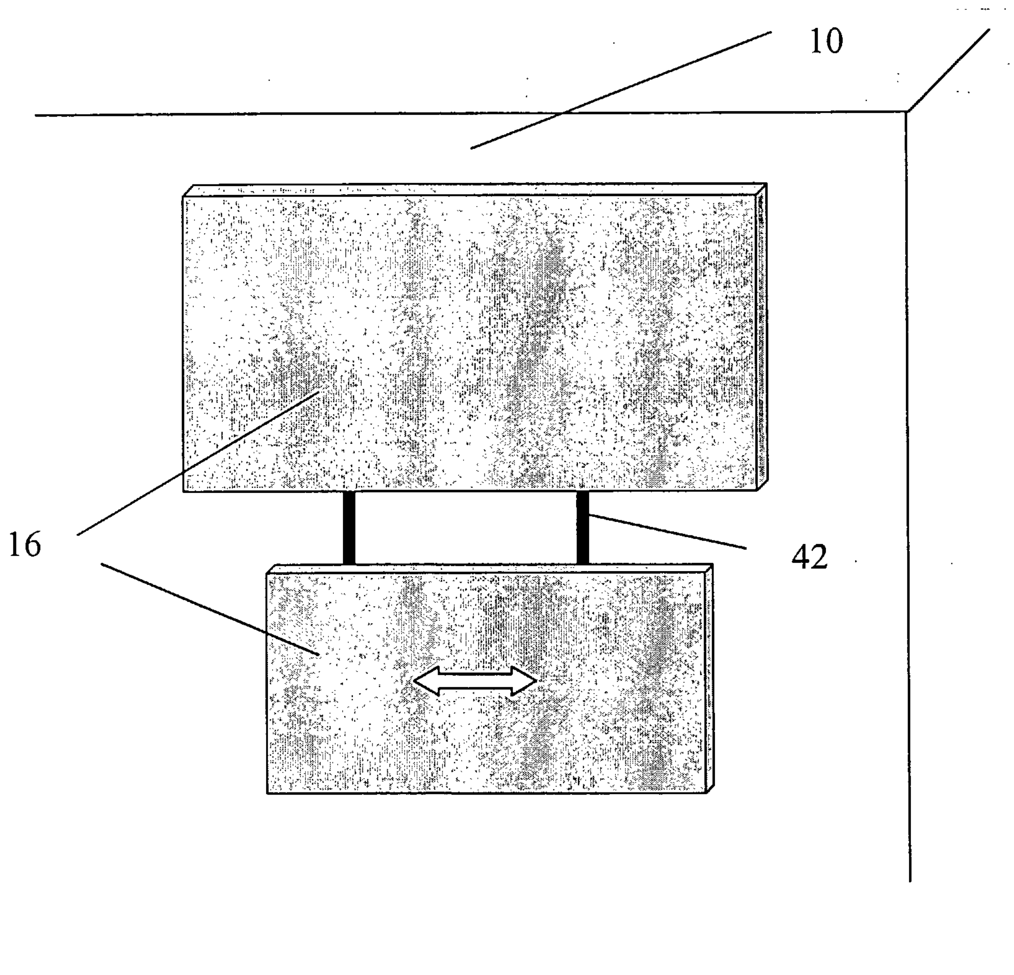

Fig. 42