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- (72) Inventor; and
(71) Applicant : SKARBÖVIG, Nils Mittet [ZA/ZA]; 1
Prosesfontein Road, Vredenburg, 7380 Western Cape
Province (ZA).
- (74) Agent: VON SEIDELS INTELLECTUAL PROPERTY
ATTORNEYS; P O Box 440, Century City, 7446 Cape
Town (ZA).
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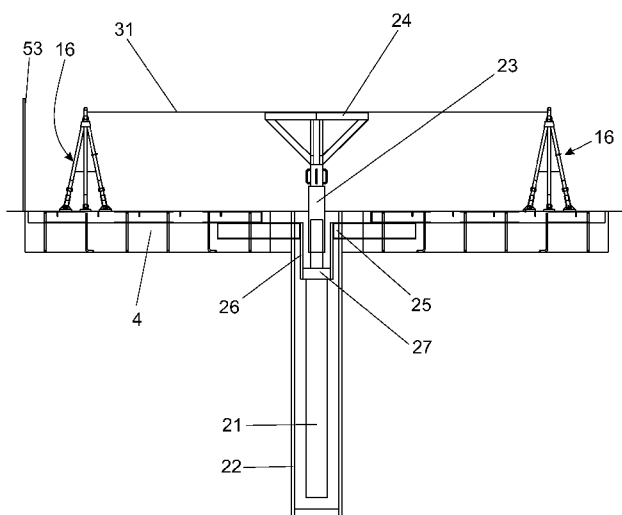


Figure 2

(57) Abstract: Textile strength testing equipment is provided comprising a generally horizontal immovable floor having formations typically in the form of rails that operatively anchor one or more feet of each of multiple columns spaced apart with the horizontal positions of individual columns being adjustable. The upper ends of the columns are provided with attachment means for attaching a textile test specimen thereto. A centrally positioned generally vertical pneumatic or hydraulic ram is provided for moving a textile engaging structure generally vertically upwards beyond the level of upper ends of the multiple columns. The height of the columns is from about 1 to about 2 metres and the size of the floor is up to about 7.5 m by about 7.5 m or more. Preferably the floor has inwardly lipped channel sectioned rails embedded in a concrete floor with the rails radiating from a central position in which the ram is located towards the centres of each side of a square floor and towards the four corners thereof. The pneumatic or hydraulic ram is accommodated in a generally vertical well that may be a suitable prefabricated vertical concrete pipe buried in a suitable excavation at the centre of the floor.



TEXTILE STRENGTH TESTING EQUIPMENT

5 FIELD OF THE INVENTION

This invention relates to textile strength testing equipment that is capable of testing the mechanical strengths and weaknesses of textiles that require certain physical strengths in order to perform their function.

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The invention is especially, but by no means exclusively, concerned with textiles in the form of nets or meshes that are commonly used to retain fallen rock and soil such as, for example, in underground mining operations, and to retain rock and soil in many other situations such as in terracing and road building operations. There are numerous other situations in which subdivided materials need to be retained by a textile that may even assume the form of a geotextile that serves to retain particulate solids whilst allowing liquids to drain away.

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20 BACKGROUND TO THE INVENTION

There appears to be no international standards on mine safety nets and there are certainly no standards in South Africa, a country rich in natural resources and replete with numerous mines, especially in the gold, platinum and coal mining fields. Specifications for other net types such as cargo nets or fishing nets, tend to be industry specific and are not applicable to the design of nets required for other purposes such as mine safety nets.

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Test facilities that have been made available in South Africa have therefore adopted a rather haphazard approach that has generally been targeted at establishing a single property of a particular net.

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In one test facility two linked steel/concrete blocks of 450 kg total mass having a size of 1 m × 0.5 m in overall impact area are repeatedly dropped from various incrementally increasing heights onto a test net that is suspended in an artificial trial stope below a crane. This facility provides discrete kinetic energy absorption values for the respective drop heights. The overall size of the net samples is limited to 1.5 m by about 2 m and is most commonly 1.5 m by 1.5 m. The size limitation follows the artificial stope dimensions and the positioning of permanently installed support props therein. A few tests were reportedly conducted on larger nets of about 2 m by 2 m, but the suspension and positioning of those nets was unsatisfactory.

In another test known as the “fall-of-ground” test the dead-loading of a 1.8 m long 2000 kg concrete block cluster onto a 2 m long net has been tested. This facility has serious limitations in terms of test results; the lack of installed instrumentation; loading mass geometry; and restricted test sample size. The test is of the kinetic energy type and even though the results can be recalculated to dead-loads, this calculation involves the impulse time of the load on the net, a measurement that is difficult to obtain without sensitive stress-strain instrumentation. Additionally, the calculation is complicated by secondary dynamic loading effects such as bouncing, damping and shock waves; inevitably, assumptions have to be made of what the precise load was at any one moment. Furthermore, the final failure behaviour of the net cannot be assessed accurately due to the incremental way of loading to destruction.

Yet another facility has a steel frame in which net test specimens can be suspended and a 2000 kg load dropped onto the net from an overhead chainblock/release device. The net size used is 2 m by 1.5 m. The load block consists of a 1 m by 1.5 m area of a steel cradle carrying a load of steel rails that are strapped into position. There is no installed instrumentation although measurements of the sag of the net after a drop from a variable height are taken using a laser level device from the side of the facility.

A test procedure at the South African Bureau of Standards involves dead-loading suspended nets with a number of gravel-filled 220 litre (44 gallon) oil drums until failure. There is no installed instrumentation and these tests are, at best, rudimentary and produce no useful data for mine safety net testing.

- 5 The dead-loading tests conducted at the SABS were carried out on square nets of 4 m side length, but could be done on other sizes, provided that the nets can accommodate the load of 220 litre (44 gallon) drums.

At the South African facility of the CSIR, a plunger in the form of half a 220
10 litre (44 gallon) oil drum is pulled horizontally through a 1 m by 1.5 m test net stretched vertically in a steel frame. In another test at the CSIR, a 1 m square test net or steel mesh sample is clamped rigidly into a heavy steel frame and is loaded to failure with a plunger. The CSIR tests are instrumented and produce load-deformation data. However, because of the
15 extremely restricted sample size and test procedures, none of these tests provides relevant results in terms of mine safety net development and/or routine testing. Given the currently installed testing equipment at the CSIR, the maximum net size which could be accommodated in a custom designed test frame would be 1.5 m by 1.5 m.

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As a general rule the sizes of test net samples is small and such small-scale tests do not allow the direct measurement of the catenary of the stretched textile in the different directions. It is clear from the aforesaid that the current situation with regard to mine safety net testing is unsatisfactory.

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Whilst nets aimed at providing mine safety have in particular prompted the development of textile strength testing equipment, exactly the same principles apply to numerous other types of textile as will be apparent from the foregoing.

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There is accordingly a need for textile strength testing equipment that is able, at least in particular circumstances, to test textiles for their multi-directional strength (radial modulus test) for the purpose of tailoring the design thereof and optionally in order to be able to optimise the weave in textile structures.

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There is also a need for textile strength testing equipment that can be designed to test near full-scale and full-scale specimens.

There is still further a need for textile strength testing equipment that would enable different loading specifications and net sizes as well as alternative net suspension designs and spacing to be evaluated and accommodated.

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SUMMARY OF THE INVENTION

15 In accordance with this invention there is provided textile strength testing equipment comprising a generally horizontal immovable floor having formations that operatively receive one or more feet of multiple columns spaced apart about a surface of the floor with the columns being anchored in the vertical direction relative to the floor and wherein the horizontal positions
20 of individual columns are adjustable, and wherein the upper ends of the columns are provided with attachment means for attaching a textile test specimen thereto, and a centrally positioned generally vertical pneumatic or hydraulic ram for moving a textile engaging structure generally vertically upwards beyond the level of upper ends of the multiple columns.

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Further features of the invention provide for the height of the columns to be from about 1 to about 2.5 m and preferably about 1.2 to 1.5 m; for each column to have three or four legs diverging from its upper end towards the floor and wherein at least one of the legs has a foot that is anchored vertically
30 relative to the floor; for the floor to be generally square in shape and of a size of at least 4,5 m by 4, 5 m and preferably about 7.5 m by 7.5 m, or somewhat larger; for the floor to have formations permanently attached thereto for

anchoring a foot associated with a column; for the formations to be inwardly lipped channel sectioned rails embedded in a concrete floor and preferably having anchors permanently secured to them and that are also cast into the concrete floor; for the inwardly directed lips of the channel sectioned rails to be interrupted, generally at extremities thereof, for allowing the introduction or removal of retaining members associated with feet of the columns that are anchored to the floor; and for the inwardly lipped channel sectioned rails to radiate from a central position in which the ram is located in a generally radial direction and typically towards the centres of each side of a square floor and towards the four corners of such square floor thereby providing eight of such inwardly lipped channel sectioned rails.

Additional features of the invention provide for the columns to each have four legs with two opposite legs in each case being anchored to the floor with the other two resting on the floor; for the upper end of at least selected and preferably all of the columns to be provided with a load cell or other force sensor positioned between the upper end of the column and the attachment means for attaching a textile test specimen thereto; and for additional flexibility to be provided regarding the positioning of columns on the floor to conform to the peripheral shape of a textile test specimen that is not in conformity with the positioning of the embedded inwardly lipped channel sectioned rails by means of loose auxiliary inwardly lipped channel sectioned rails that are bolted on to the floor by bolting them to embedded inwardly lipped channel sectioned rails in which instance auxiliary columns may be provided having shorter legs for cooperation with the auxiliary inwardly lipped channel sectioned rails.

Still further features of the invention provide for the pneumatic or hydraulic ram to be accommodated in a generally vertical well conveniently defined by a suitable prefabricated vertical concrete pipe buried in a suitable excavation at the centre of the floor; for the pneumatic or hydraulic ram to be supported in a part-spherical cradle or gimbal to enable it to accommodate slight lateral

movements of the textile engaging structure during use; for an upper end region of the piston rod of the pneumatic or hydraulic ram to be in the form of a removable extension thereto; for the textile engaging structure to be removable from the pneumatic or hydraulic ram or extension; and for a cover
5 to be provided for the upper end of the well to cover the hydraulic ram during periods of non-use with the extension and textile engaging structure removed therefrom.

The equipment may include a suitable crane for discharging weights onto the
10 upper surface of a textile test specimen suspended between the upper ends of the columns in order to replicate the type of tests that have been conducted in the past and in which the objects of suitable shape and size may be arrested from freefall by the textile test specimen. In such an instance a laser device may be used to record sag or downward deformation
15 of the textile test specimen.

Of course, each of the columns is preferably provided with a load cell or other force sensor interposed between it and attachment means operatively attached to a textile test specimen and each of the outputs from the load cells
20 or other force sensors may be fed to a computer facility. Likewise, all recordable movements and pressures associated with the pneumatic or hydraulic ram are recorded as data and also sent through to the computer facility.

25 In order that the above and other features of the invention may be more fully understood, an expanded description of one proposed embodiment of the invention follows with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:-

- 5 Figure 1 is a plan view of one embodiment of facility providing equipment according to the invention with the columns removed for clarity of illustration;
- 10 Figure 2 is a schematic sectional elevation thereof showing two columns in position;
- Figure 3 is a schematic elevation showing a single column attached to an inwardly lipped channel shaped rail with the rail shown in longitudinal section;
- 15 Figure 4 is the same as Figure 3 but with the rail shown in cross section;
- Figure 5 is a schematic plan view of the column illustrated in Figures 3 and 4;
- 20 Figure 6 is a schematic plan view of a column showing an installed load cell for determining force on the upper end of a column;
- 25 Figure 7 is the same as Figure 3 but illustrating an auxiliary column anchored by way of an auxiliary inwardly lipped channel shaped rail that is anchored to embedded rails;
- 30 Figure 8 is the same as Figure 4 but showing the auxiliary column that is illustrated in Figure 7;

Figure 9 is the same as Figure 2 but with the extension to the piston rod of the ram and its associated textile engaging structure removed and illustrating a crane in position for dropping a dead weight for the conduct of tests of a nature similar to the prior art;

Figure 10 illustrates a column during its installation procedure;

Figure 11 is a sectional view illustrating one form of construction of an inwardly lipped channel shaped rail; and,

Figure 12 is a fragmentary view thereof.

DETAILED DESCRIPTION WITH REFERENCE TO THE DRAWINGS

In the embodiment of the invention illustrated in the drawing, textile strength testing equipment according to the invention is installed in a dedicated building (1) having an operations room (2) in which computer equipment is installed and from which operation of the textile strength testing equipment is visible through protective windows (3).

In this embodiment of the invention the textile strength testing equipment comprises a generally horizontal immovable floor (4) of square shape in plan view and having dimensions appropriate to the range of testing that is to be carried out using the equipment. In the instance that the textile concerned includes mine safety nets, it is considered that a floor area of about 7.5 meters square should prove to be appropriate. The floor is made of solid cast concrete having a depth, in the presently proposed embodiment, of 0.5 meter. The concrete floor may be protected against damage from falling drop masses with suitable rubber matting and/or temporary padding.

The floor has cast into it an array of inwardly lipped channel sectioned rails (5) embedded in the concrete floor together with suitable anchors (6) permanently secured to them and also cast into the concrete mass. As shown in Figure 11, a suitably robust channel sectioned rail is conveniently
5 formed by interconnecting the lower flanges (7) of two rolled channel shaped sections (8) orientated on edge with a suitable connecting strip (9) welded to the lower flanges. Also, in order to ensure that the uppermost flanges (10) are secure against bending upwardly, a series of longitudinally spaced gusset plates (11) are welded to the inside of the upper flange and the inside
10 of the web of the rolled channel on each side of the rail. The uppermost flanges are cut away at an operatively outer end of the rail, as indicated by numeral (12) in Figure 12, in order to allow for the introduction and removal of plate-like retaining members (15) associated with feet of the columns (16) that are anchored to the floor by way of the rails, in use.

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The embedded rails are arranged to extend in radial directions from a central position in which a vertical hydraulic ram (21) is located with four rails extending towards the centres of each side of the square floor and four rails extending towards the corners of such square floor, thereby providing a total
20 of eight of such radial, inwardly lipped channel sectioned embedded rails.

The hydraulic ram is accommodated in a 4.5 metre deep well at the centre of the floor, the well being defined by a length of an appropriate diameter of pre-cast concrete pipe (22). The hydraulic ram itself is located below the floor
25 surface level and the piston rod thereof has a removable extension (23) and a textile engaging structure (24) projecting above floor level in the operative position. These items can be removed and stored elsewhere when not required for use as will be more apparent from what follows.

30 The hydraulic ram (21) is supported by the inner ends of four I-beams (25) having a major portion of their lengths embedded in the concrete with free ends thereof extending into the well from four equally angularly spaced

positions. Support is achieved by way of four downwardly extending arms (26) that carry a part-spherical cradle (27) to enable it to accommodate slight lateral movements of the textile engaging structure during use, such as may occur in the event of failure of a test specimen of textile. A cover (28) is provided for the upper end of the well to cover the hydraulic ram during periods of non-use, as shown in Figure 9.

It will be understood that, in use, the hydraulic ram is able to serve to move the textile engaging structure (24) generally vertically upwards beyond the level of upper ends of the multiple columns.

Reverting now to the columns (16), each column is, in this embodiment of the invention, about 1.2 metres high and has four generally symmetrical legs (17) diverging from the operatively upper end (18) of the column with the plate-like retaining members (15) at the lower ends of the legs. The legs are held fixed in their diverging relationship by means of braces (19) intermediate their ends. The plate-like retaining members are of generally square shape corresponding approximately with the inner dimension of the rails so that the inwardly directed lips of the rails can be clamped firmly between inner and outer plate-like retaining members. The clamping facility enables the separation of the plate-like retaining members to take place to an adequate extent to enable the inner retaining members to move past the gusset plates (11) inside the channel shaped rails. As a general rule, it is anticipated that two diametrically opposite legs will be secured to the same rail with the other two legs being supported on the floor surface, one on each side of the relevant rail. Thus, multiple columns may be spaced apart about the surface of the floor with the columns being anchored in the vertical direction relative to the floor whilst the horizontal positions of individual columns are adjustable in the radial direction.

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In use, any number of columns can be used but it is envisaged that, with a full size test sample (31) of square shape, one column will be employed in

association with each of the eight embedded rails. However, in the instance that different peripheral shapes and sizes of specimen textile need to be tested, and in the event that the eight possible embedded rails do not provide sufficient flexibility for positioning of the necessary columns, adjustable auxiliary inwardly lipped channel sectioned rails (41) (see Figures 1, 7 and 8) that may be bolted on to the floor by bolting them to appropriate embedded rails. Auxiliary columns (45) are then provided for use with the auxiliary rails, such auxiliary columns having two diametrically opposite shorter legs (46) for cooperation with the auxiliary inwardly lipped channel sectioned rails that are therefore raised off the floor.

In all instances the upper ends of the columns are provided with attachment means for attaching a textile test specimen thereto and, as a general rule, the attachments will include a load cell (48) positioned between the upper end of the column and the attachment means (49) for attaching a textile test specimen to the column, as shown in Figure 6.

As illustrated in Figure 9, the equipment may include a suitable crane (51) for discharging weights (52) onto the upper surface of a textile test specimen suspended between the upper ends of the columns in order to replicate the type of tests that have been conducted to date. A suitable release mechanism (not shown) of conventional type may be provided to enable weights of suitable shape and size to be discharged from predetermined heights so that they become arrested from the freefall condition by the textile test specimen. The weights may be dropped onto a stretched textile from the overhead crane to obtain dynamic load data. In such an instance a laser device (53) may be used to record sag or downward deformation of the textile test specimen and the outputs may be fed to the computer facility in the control room.

Each of the load cells is connected to the computers in the control room so that each of the outputs from the load cells may be monitored continuously

during any test. Likewise, all recordable movements and pressures associated with the hydraulic ram are recorded as data and also sent through to the computer facility.

- 5 In one proposed implementation of the invention a 300 kN hydraulic ram is provided for pushing upwards against the suspended (and stretched or stretchable) textile test specimen with the piston having a maximum travel of 2.5 metres which is achievable in a minimum period of 5 seconds. Using turn-buckles, the textile test specimens can, as may be required, be pre-
10 loaded (stretched) to predetermined stress levels in different directions.

To counter the upward 300 kN force of the ram, the embedded rails are anchored to the concrete floor that will weigh in excess of 50 tonnes. It is planned to use concrete of 25 MPa strength. The steel reinforcement of the
15 floor will, as much as possible, dissipate upward point loads into the concrete.

The textile engaging structure at the top of the ram for contacting the textile is interchangeable with others to provide for different
20 geometries, sizes and shapes, according to test requirements. The textile engaging structure may also be fitted with multiple displacement sensors, measuring the distance from the ground. The hydraulic oil pressure and ambient temperature may also be measured. All data will, of course, be logged, captured and processed in the computer.

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The removable extension to the piston rod of the ram may also be varied in length, for example to bring the textile engaging structure to a desired height.

Using the equipment described above a contiguous load-deformation curve
30 may be produced in respect of every loading event or localised failure event and a textile can be analysed in detail during and after each test, including the entire final failure region. The nature of the strength testing equipment

enables the precise loads to be known for any part of the curve and the kinetic energy absorption values to be calculated for the entire curve or for any portion thereof.

- 5 The facility will also allow any of the current and previous South African drop test methods to be reproduced for comparison and calibration of earlier tests.

Numerous variations may be made to the embodiment of the invention described above without departing from the scope hereof.

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The invention therefore provides textile testing equipment which will provide technologically and scientifically relevant data for the development and supply of state-of-the-art textiles, especially mine safety nets and that may, as required, be custom-designed.

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CLAIMS:

1. Textile strength testing equipment comprising a generally horizontal immovable floor having formations that operatively receive one or more feet of multiple columns spaced apart about a surface of the floor with the columns being anchored in the vertical direction relative to the floor and wherein the horizontal positions of individual columns are adjustable, and wherein the upper ends of the columns are provided with attachment means for attaching a textile test specimen thereto, and a centrally positioned generally vertical pneumatic or hydraulic ram for moving a textile engaging structure generally vertically upwards beyond the level of upper ends of the multiple columns.
2. Textile strength testing equipment as claimed in claim 1 in which the columns have a height of from about 1 to about 2.5 metres.
3. Textile strength testing equipment as claimed in claim 2 in which the columns have a height of from about 1.2 to about 1.5 metres.
4. Textile strength testing equipment as claimed in any one of the preceding claims in which the floor is generally square in shape and has a size of at least 4,5 m by 4,5 m.
5. Textile strength testing equipment as claimed in claim 4 in which the floor has a size of at least about 7.5 m by about 7.5 m.
6. Textile strength testing equipment as claimed in any one of the preceding claims in which each column has three or four legs diverging from an upper end towards the floor and wherein at least one of the legs has a foot that is anchored vertically relative to the floor.

7. Textile strength testing equipment as claimed in any one of the preceding claims in which the floor has formations permanently attached thereto for anchoring a foot associated with a column.
- 5 8. Textile strength testing equipment as claimed in claim 7 in which the formations are inwardly lipped channel sectioned rails embedded in a concrete floor and having anchors permanently secured to them and that are also cast into the concrete floor.
- 10 9. Textile strength testing equipment as claimed in either one of claims 7 or 8 in which the formations are rails radiating from a central position in which the ram is located in a generally radial direction.
- 15 10. Textile strength testing equipment as claimed in claim 9 in which the rails radiate towards the centres of each side of a square floor and towards the four corners of such square floor.
- 20 11. Textile strength testing equipment as claimed in any one of the preceding claims in which the upper end of at least selected columns is provided with a load cell or other force sensor positioned between the upper end of the column and the attachment means for attaching a textile test specimen thereto.
- 25 12. Textile strength testing equipment as claimed in either one of claims 9 or 10 in which additional flexibility is provided regarding the positioning of columns on the floor to conform to the peripheral shape of a textile test specimen that is not in conformity with the positioning of the permanent rails by means of loose auxiliary rails that are bolted on to the floor by bolting them to the permanent rails in which instance
30 auxiliary columns may be provided having shorter legs for cooperation with the auxiliary rails.

13. Textile strength testing equipment as claimed in any one of the preceding claims in which the pneumatic or hydraulic ram is accommodated in a generally vertical well.
- 5 14. Textile strength testing equipment as claimed in claim 13 in which the well is defined by a suitable prefabricated vertical concrete pipe buried in a suitable excavation at the centre of the floor.
- 10 15. Textile strength testing equipment as claimed in either one of claims 13 or 14 in which the pneumatic or hydraulic ram is supported in a part-spherical cradle or gimbal to enable it to accommodate slight lateral movements of the textile engaging structure during use.

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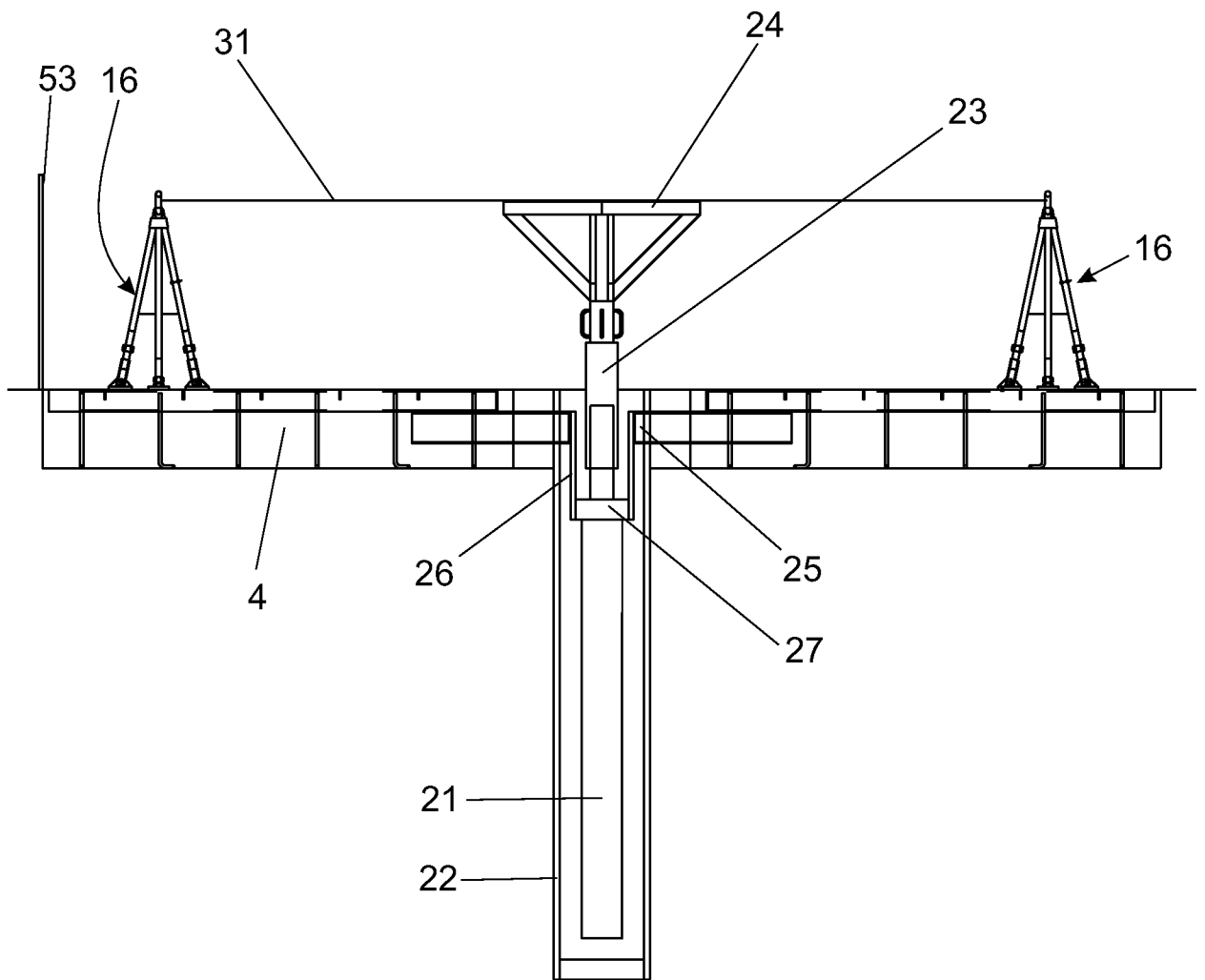


Figure 2

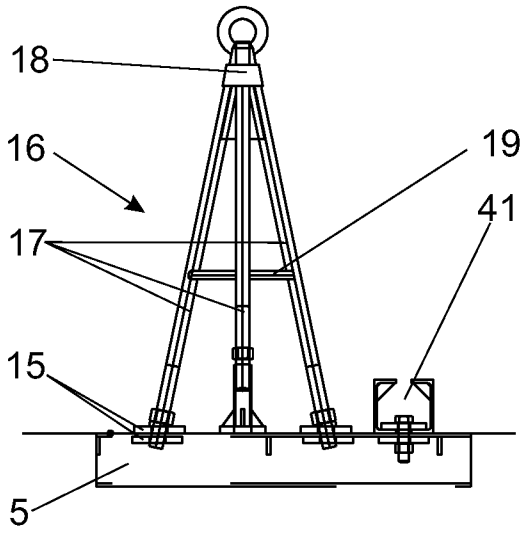


Figure 3

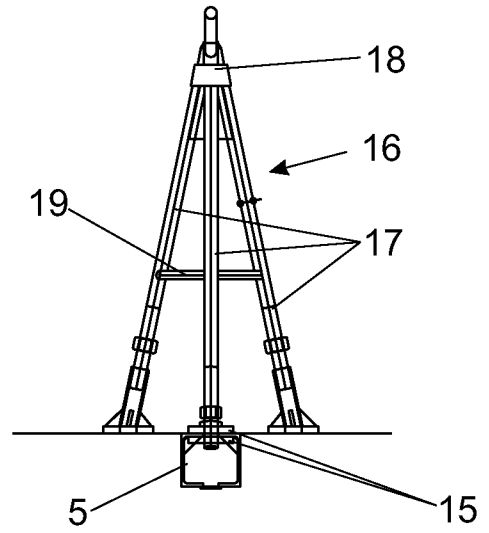


Figure 4

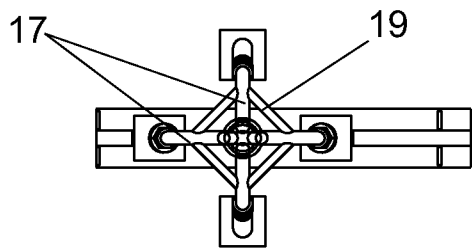


Figure 5

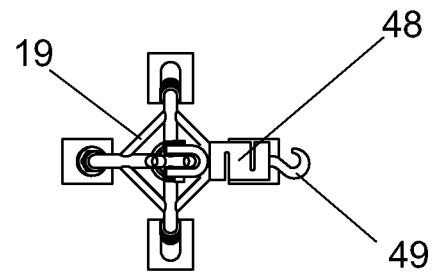


Figure 6

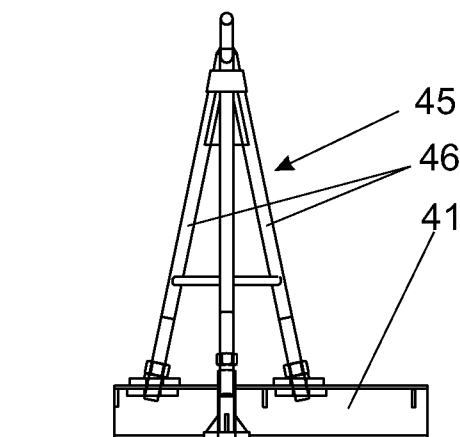


Figure 7

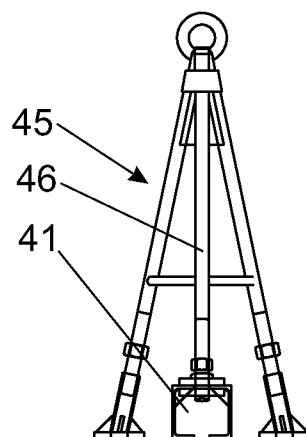


Figure 8

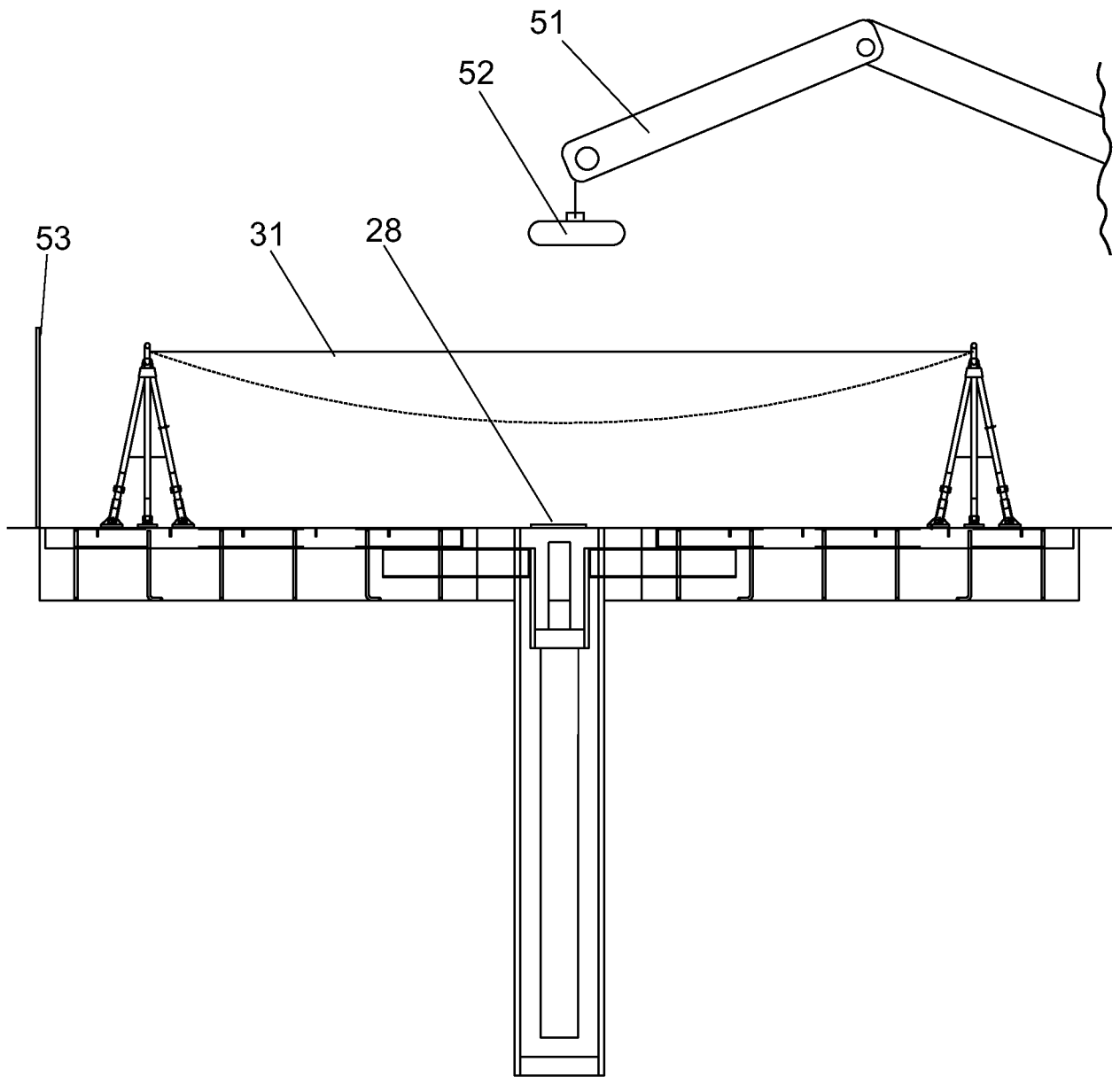


Figure 9

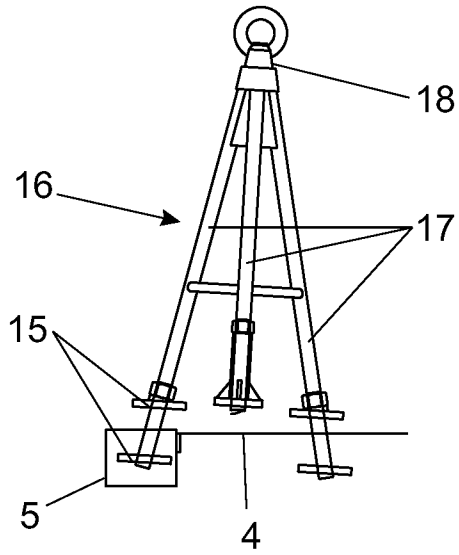


Figure 10

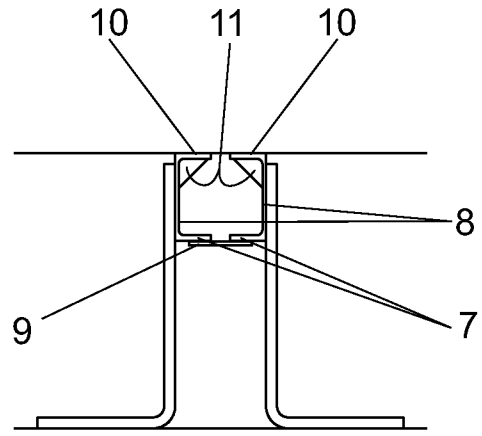


Figure 11

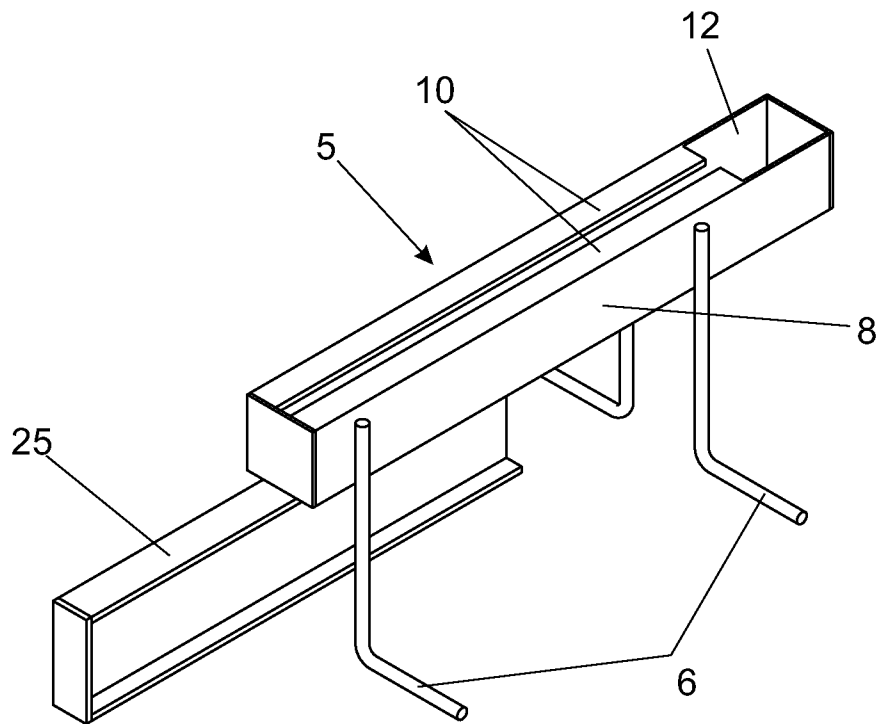


Figure 12