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(54) **SKIP AND CROSSHEAD**

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E21D 9/12 (2006.01)

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CPC E21D 7/02; E21D 1/03; E21D 9/12
See application file for complete search history.

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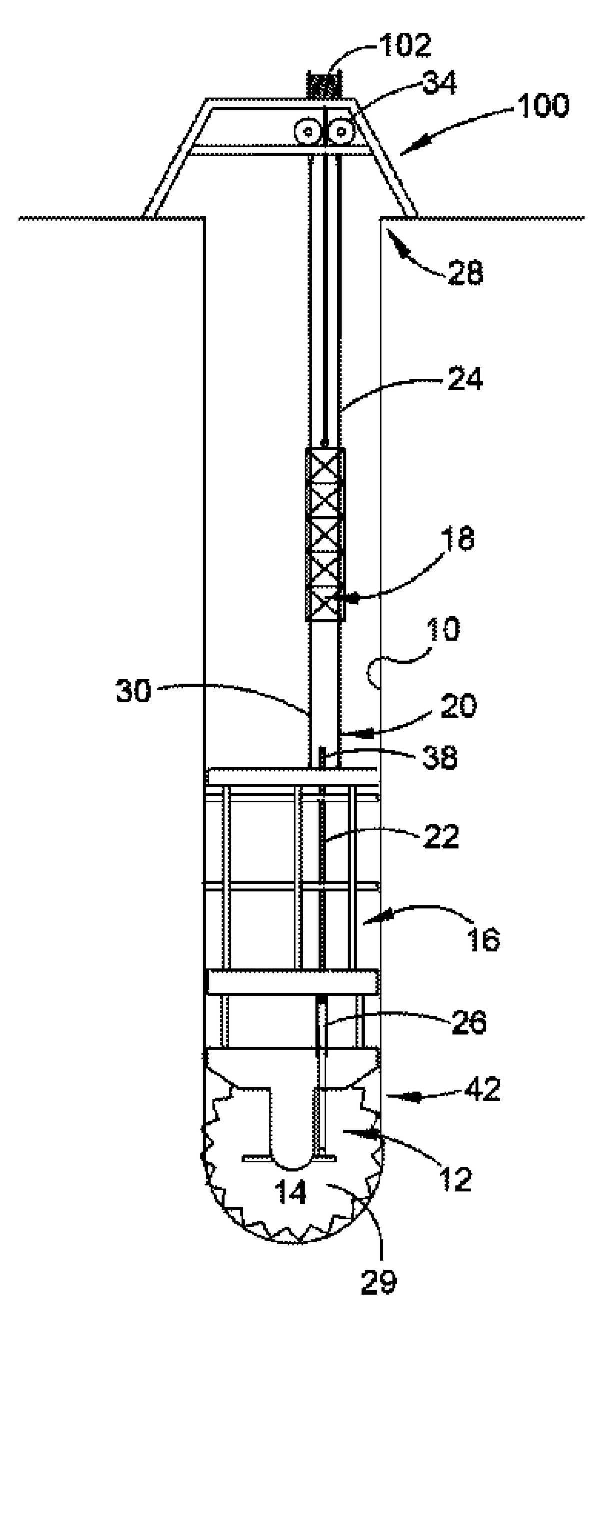
(57) **ABSTRACT**

A conveyance system for moving a conveyance along a mine shaft during shaft construction, comprising: a first guide section; a second guide section located along the mineshaft in series with the first guide section, the conveyance being movable along the first guide section; and a head section for receiving the conveyance, the head section cooperating with the first guide section to enable the conveyance to travel from the second guide section along the first guide section when received by the head section.

24 Claims, 5 Drawing Sheets



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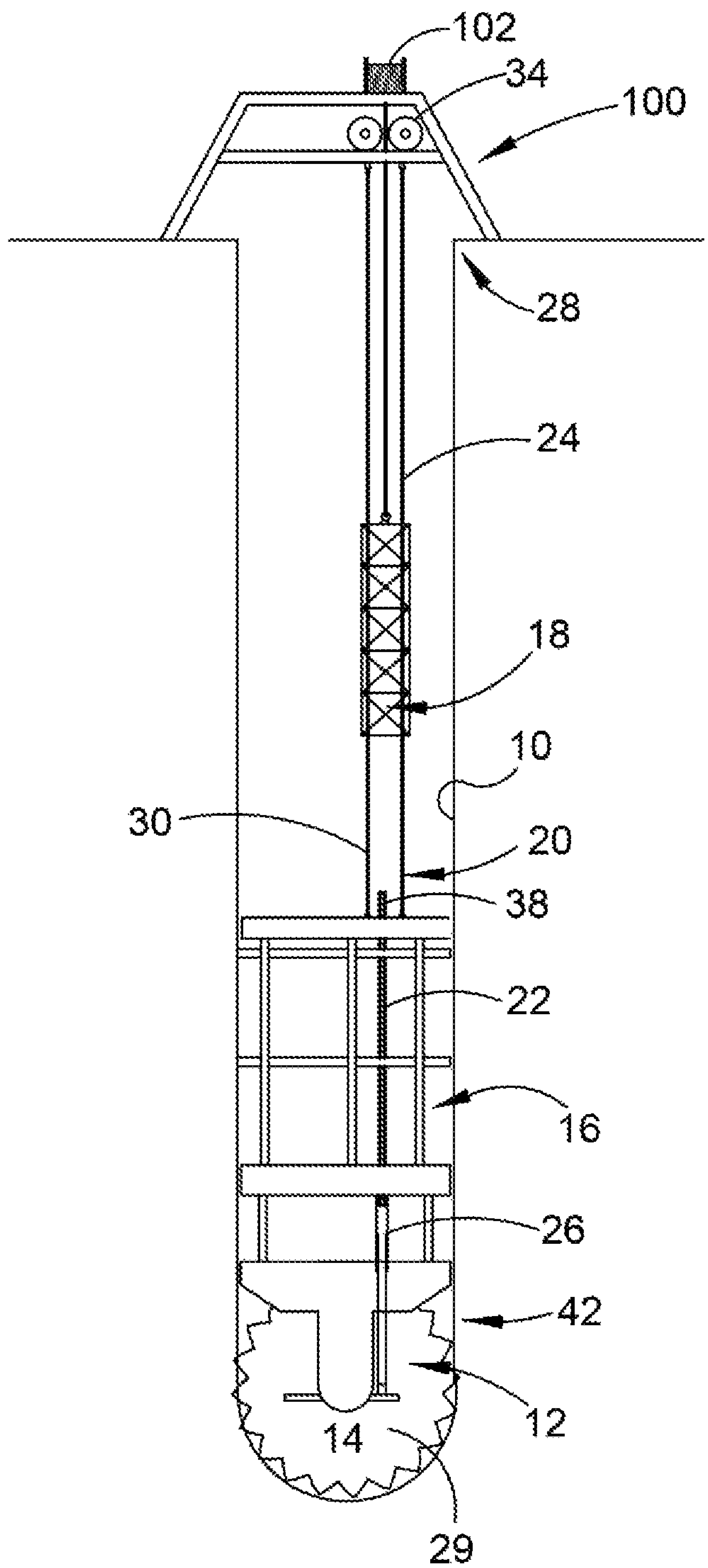

FIGURE 1

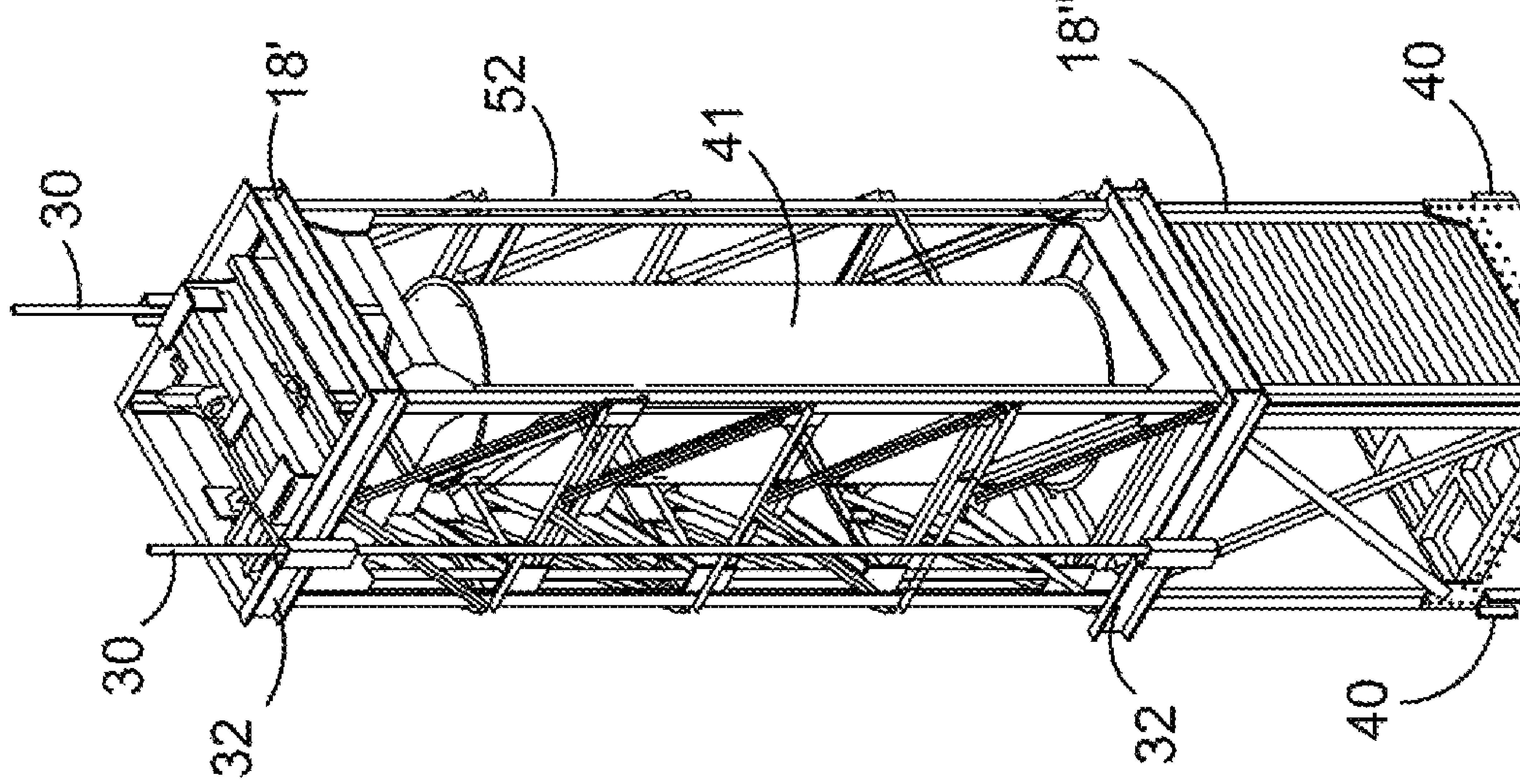

FIGURE 2

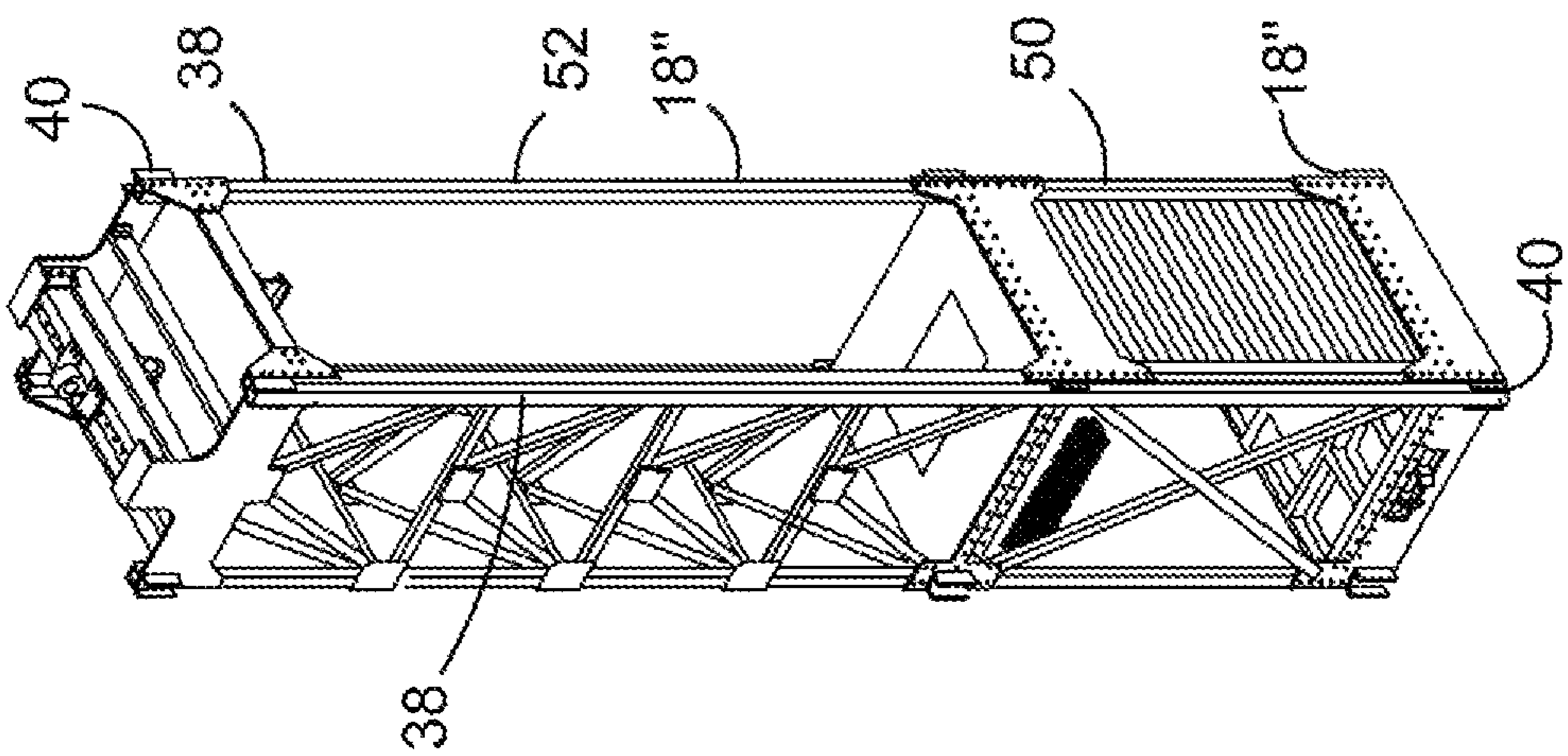

FIGURE 3

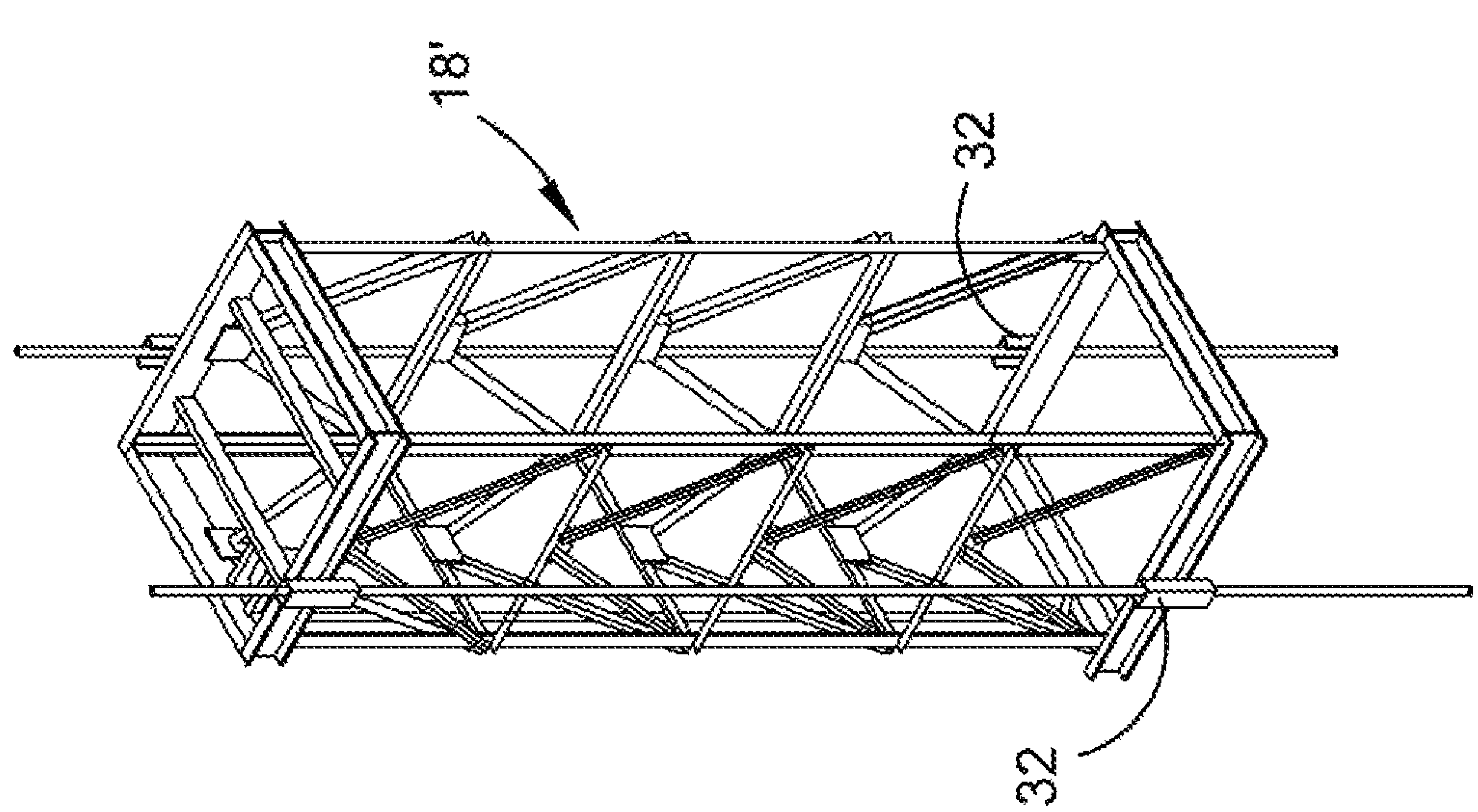

FIGURE 4

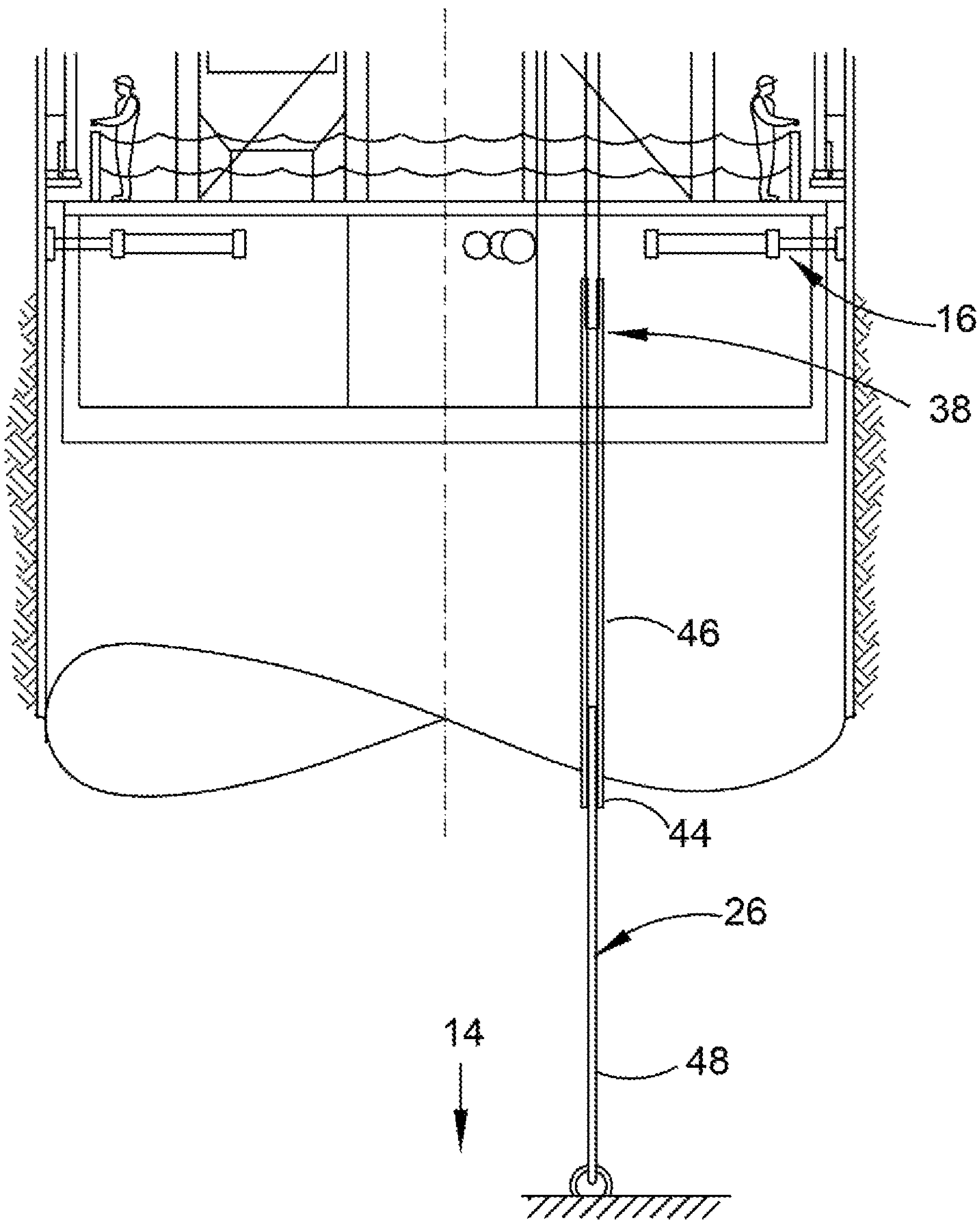

FIGURE 5

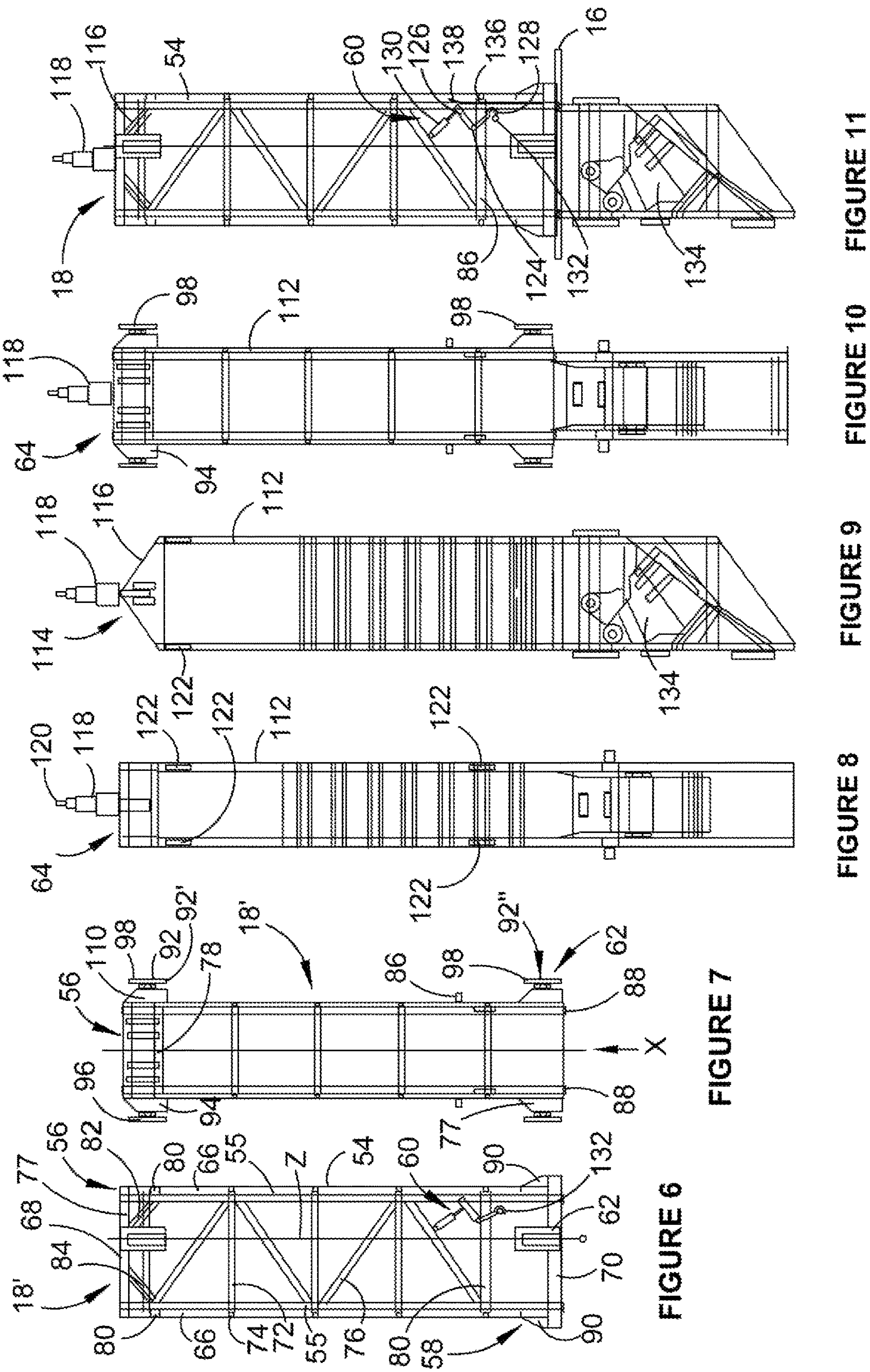

FIGURE 6

FIGURE 7

FIGURE 8

FIGURE 9

FIGURE 10

FIGURE 11

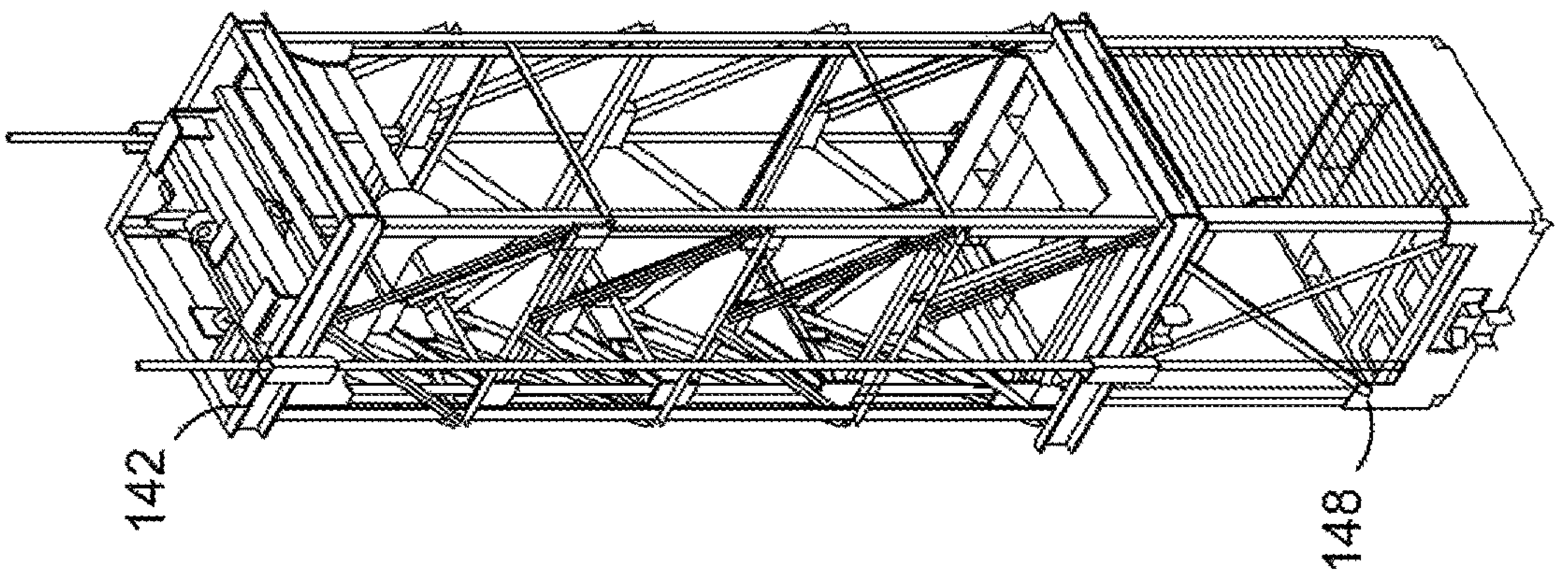

FIGURE 14

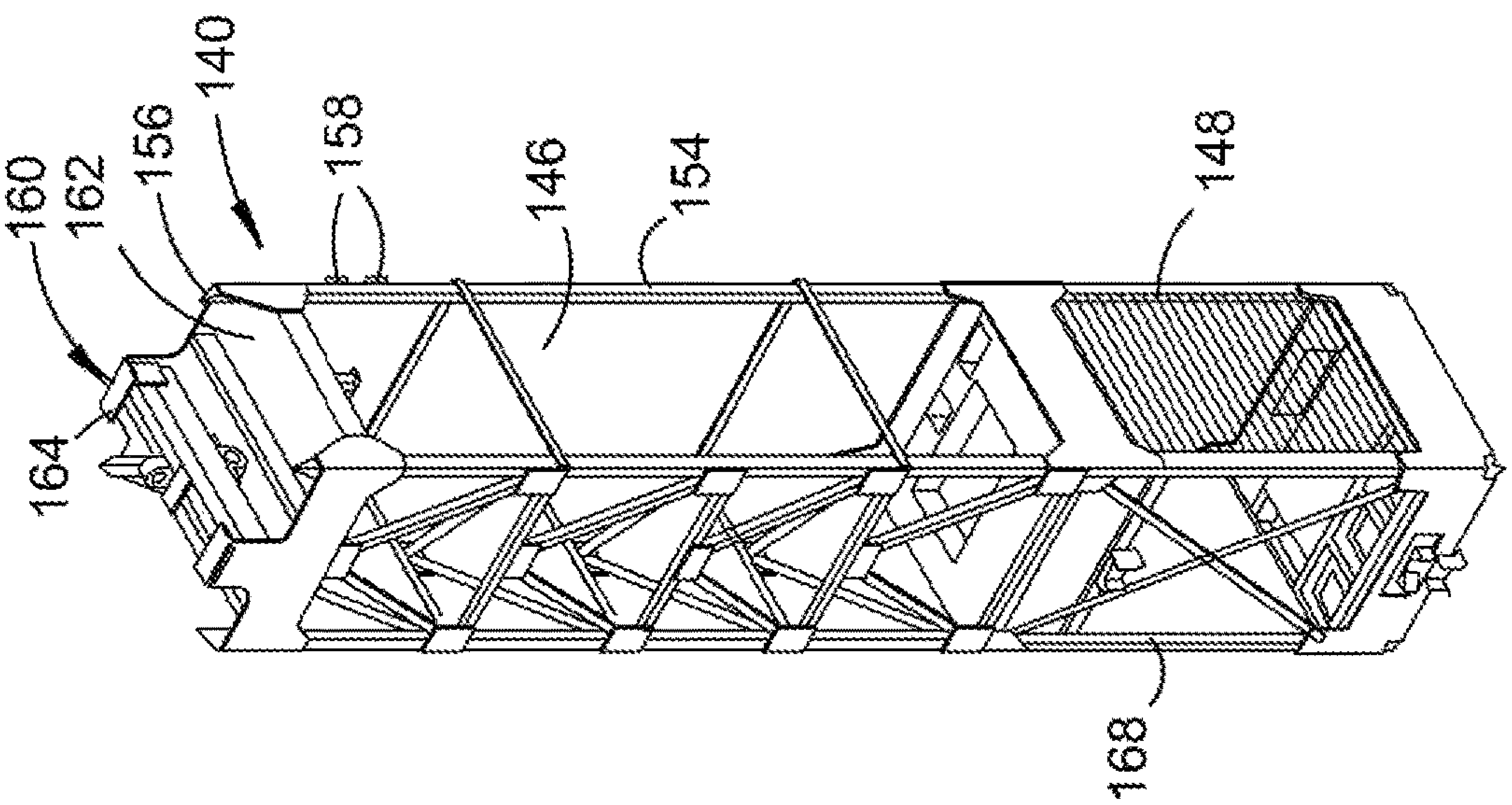

FIGURE 13

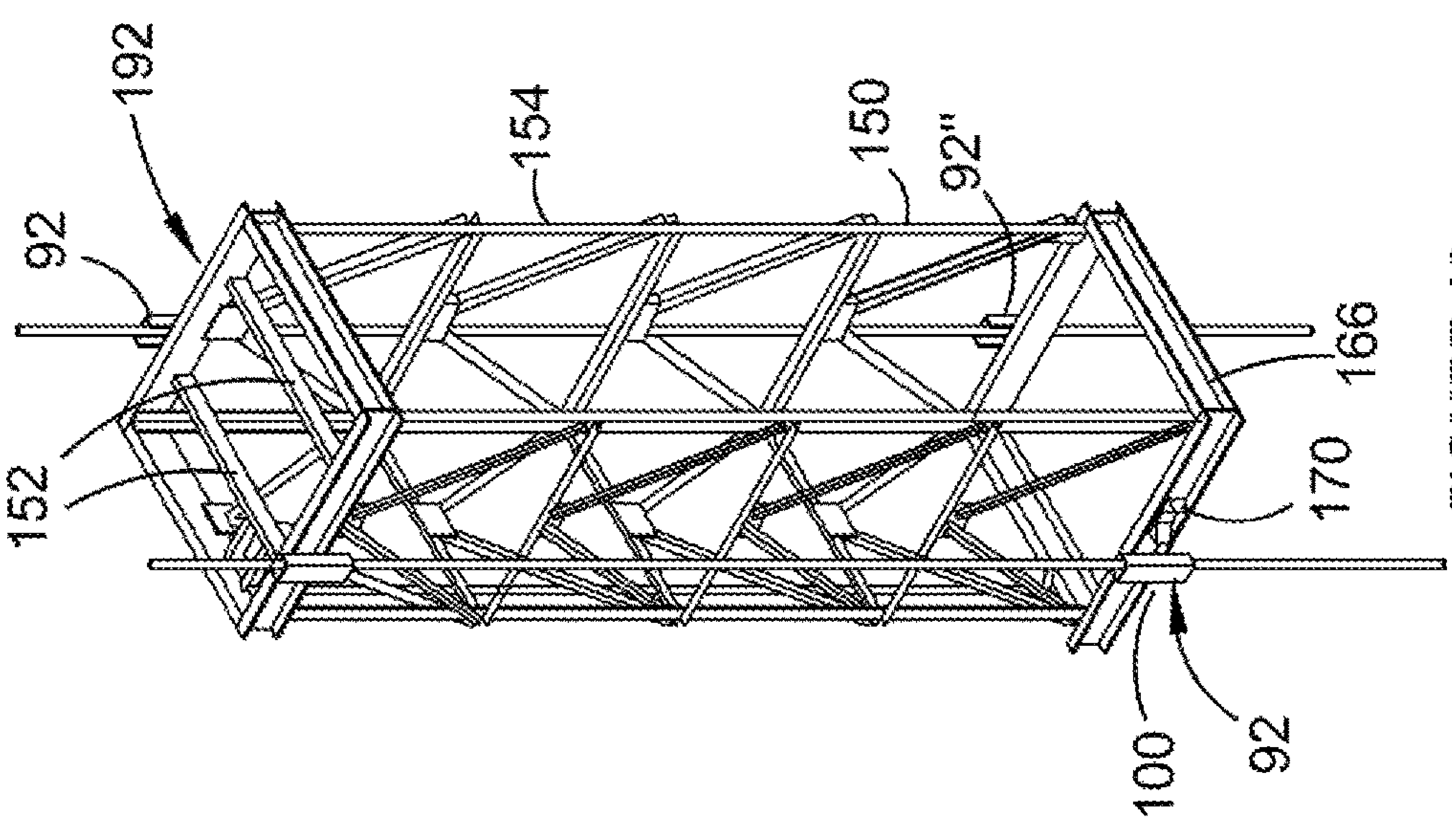

FIGURE 12

SKIP AND CROSSHEAD

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application is a U.S. National Phase filing of International Application No. PCT/AU2014/000848, filed on Aug. 25, 2014, designating the United States of America and claiming priority to Australian Patent Application No. 2013903212 filed Aug. 23, 2013, and the present application claims priority to and the benefit of both the above-identified applications, which are incorporated by reference herein in their entireties.

FIELD OF THE INVENTION

This invention relates to guiding movement of a conveyance up and down a mine shaft. It has particular but not exclusive application to guiding conveyances that convey materials and personnel up/down a mine shaft from top of shaft to an excavation region during formation of the mine shaft, and it may also have application to other purposes such as the delivery of personnel and materials up/down a mineshaft between successive lateral branches of the mineshaft at different underground depths.

This invention also relates to mine shaft conveyance systems for raising and/or lowering a conveyance in a mine shaft.

BACKGROUND OF THE INVENTION

Traditional shaft sinking operations are carried out by drilling and blasting to excavate materials from a mine shaft. The excavated material is removed by a mucking system, by which the excavated material is picked up and deposited in kibbles (large cylindrical buckets) that are hoisted to the surface on cables extending downwardly from headgear incorporating a hoist at the top of mine shaft.

Shaft sinking and mine constructions methods using blasting and mucking processes are slow and discontinuous. In this context, 'discontinuous' refers to shaft construction taking place slowly, with each stage in the drill, blast and mucking cycle all being done in series with minimal processes being completed in parallel. For example, the time between mucking stages is lengthy since after completion of one mucking stage, mucking equipment is removed from the shaft bottom, drilling equipment is lowered to the shaft bottom to drill boreholes, charges are then set in the bore holes, all equipment is removed from the bottom of the mine shaft, charges are initiated, and then the next mucking stage commences.

More recently there have been proposals to increase the speed at which sinking can progress by using mechanical excavation technology similar to that used in the horizontal civil tunnelling industry. International patent publication number WO 2011/000037A1 discloses such a proposal for sinking a mine shaft in which rock excavated by a boring machine is transferred into large capacity conveyances in the form of skips which are raised and lowered by a hoisting system installed at the top of mine shaft. On completion of shaft sinking operations the hoisting system and skips may subsequently be operated to convey material excavated during production mining stage of the mine life.

In the equipment disclosed in WO 2011/000037A1, the entire content of which is incorporated herein by reference, each loaded skip or other conveyance must travel down the mine shaft and through a work stage or "Galloway". The requirements of the system that controls and/or guides movement of the respective conveyance change as the conveyance moves through different sections (e.g. moving through the Galloway versus moving from top of mine shaft to the Galloway) of a mine shaft. The present invention provides a system to meet one or more of the changes in system requirements.

The term "skip" refers inter alia to a conveyance used to bring mined material to the top of a mine shaft. Skips are manufactured in various sizes and designs for both vertical and incline shafts, and generally include bottom door dump type conveyances.

Skips are distinct from "buckets" insofar as:

a) skips are self-dumping;

b) the properties of skips make them suitable for use in production shafts and have never previous to this invention been used in construction/sinking of a shaft;

c) skips are, during normal operation, attached at all times to the hoist rope; and

d) skips do not have to be able to free stand on the bottom of a mine shaft (i.e. can be extremely long and slender).

A "bucket" and "kibble" are typically cylindrical shaped conveyances, use to transport blasted rock from the shaft bottom, during shaft construction (sinking) operations.

When compared with skips, buckets:

a) require manual dumping

b) must be unloaded in a tip over fashion

c) are attached to the hoist rope via detachable hook to suspension chains (or bales) at the top of the bucket (minimum of 3 to maintain stability)

d) must be used in conjunction with a crosshead to provide guidance in the shaft barrel (above work stage)

e) are unguided (both in terms of rotation and swing) below shaft guide system or within work stage, and also below work stage

f) are regularly disconnected from the hoist rope (generally to load at shaft bottom) during the loading operation

g) must be round and have a height to diameter ratio that is stable and will stand unsupported on shaft bottom

h) must have a smooth outer surface so as to allow the bucket to work with bump guides to prevent swaying, and accordingly cannot have guide couplings attached to their outer surface.

Unless context specifies otherwise, the term "guide" as used herein refers to a member along which a conveyance travels down a mine shaft, and that resists or prevents both rotation of the conveyance and lateral movements of the conveyance relative to the mine shaft. Such a "guide" provides no motive or drive force to cause movement of the conveyance.

SUMMARY OF THE INVENTION

The present invention provides a conveyance system for moving a conveyance along a mine shaft during shaft construction, comprising:

a first guide section;

a second guide section located along the mine shaft in series with the first guide section, the conveyance being movable along the first guide section; and

a head section for receiving the conveyance, the head section cooperating with the first guide section to enable the conveyance to travel from the second guide section along the first guide section when received by the head section.

The head section may include a containing section in which the conveyance is at least partially received during travel of the conveyance along the first guide section.

The head section may include a chairing member that chairs against the conveyance during travel of the conveyance along the first guide section.

The chairing member may come into abutment with the conveyance.

The head section may be configured to depend from the conveyance during movement of the conveyance and head section along the first guide section.

The head section may be configured to permit passage of a hoist rope attached to the conveyance by which the conveyance is lifted and/or lowered along the mineshaft.

The head section may be arranged so that the hoist rope can extend through the head section to the conveyance.

The conveyance system may be arranged such that the head section chairs against a work stage as the conveyance travels from the first guide section along the second guide section.

The conveyance system may be arranged such that the head section does not travel along the second guide section.

The mine shaft may be substantially vertical.

The first guide section may be a variable length guide section and the section guide section may be a fixed length guide section.

The first guide section and second guide section may restrict rotational movement and swing movement of the conveyance.

The first guide section and second guide section may substantially prevent rotational movement and swing movement of the conveyance.

The conveyance system may concurrently guide multiple conveyances.

The first and second guide sections may guide each of the multiple conveyances.

Personnel and/or materials may be transported in a different one or ones of the conveyances to one or more conveyances that transport mined material.

The present invention further provides a guide system for guiding a conveyance during shaft construction, while lifting and/or lowering of the conveyance in a mine shaft, the system comprising:

an intermediate fixed length guide section; and

a variable length upper guide section extending from the intermediate section to accommodate changes in distance between the intermediate section and an upper region of the mineshaft,

wherein the guide system restricts rotational movement and swing movement of the conveyance.

The guides may be configured to allow the conveyance to transition from one guide section to the other

The guide system may further include a variable length lower guide section extending from the intermediate section to accommodate changes in distance between the intermediate section and a lower region of a mineshaft.

The lower guide section may be extendable without a corresponding extension and/or retraction of the upper guide section.

The lower guide section may retract as the upper guide section extends. The upper guide section may in fact be extendable with downward movements of the intermediate section. The lower guide section may extend between the intermediate section and a shaft forming apparatus and extend with movements of the shaft forming apparatus away from the intermediate section, and retract with movement of the intermediate section towards the shaft forming apparatus.

In some embodiments, the upper guide section extends from top of shaft down to a work stage where the upper guide section meets the intermediate section. The intermediate section is fixed to the work stage and extends through the work stage to the variable length guide system. The lower guide section may extend from the work stage to a shaft forming apparatus, extending as the shaft is formed and retracting as the work stage (and therewith the intermediate section) advances down the mine shaft towards the shaft forming apparatus.

The upper guide section and intermediate section may meet at a transition region, and the conveyance may comprise a head section and a base section, the transition region being adapted to halt downward travel of the head section whilst permitting the base section to continue downward travel along the intermediate section.

The invention may be designed for use in a substantially vertical mineshaft.

The invention also extends to a mine shaft conveyance system comprising a guide system as set out above, and a hoist system for lifting and/or lowering the conveyance along the guide system.

Embodiments of the present system may achieve higher mine shaft sinking speeds along with safer operation of conveyances along the length of the mine shaft.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the invention may be more fully explained one particular embodiment will be described in detail with reference to the accompanying drawings in which:

FIG. **1** is a side schematic view of a mine shaft-boring machine employing a guide system according to an embodiment of the present invention;

FIG. **2** is a side perspective view of a conveyance, including head and base sections, in engagement with the upper guide section (stage ropes) of the guide system;

FIG. **3** is a side perspective view of a base section of the conveyance of FIG. **2** engaged with an intermediate or workstage section (fixed guides) of the guide system;

FIG. **4** is a side perspective view of a head section of the conveyance of FIG. **2** engaged with the upper guide section (stage ropes) of the guide system;

FIG. **5** is a side schematic view of a lower guide section (telescopic guides);

FIGS. **6** and **7** show side views of a crosshead or 'bridle';

FIGS. **8** and **9** show side views of a skip;

FIGS. **10** and **11** show side views of a crosshead or bridle, with a skip received therein; and

FIG. **12** is a side perspective view of a crosshead or bridle;

FIG. **13** is a side perspective view of an auxiliary cage or conveyance including a personnel carrier; and

FIG. **14** is a side perspective view of the crosshead of FIG. **12** when received over the conveyance of FIG. **13**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Traditional Shaft Sinking

Traditionally, shaft sinking processes have used blasting and mucking methods to deepen a mine shaft. Material at the bottom of a mine shaft is drilled, explosive charges are set, the bottom of the mine shaft is blasted, and blasted rock is loaded into a conveyance for transport to top of shaft.

Finally, people and material are moved from the top of shaft down the shaft to the shaft bottom and to working locations such as the work stage.

Buckets—Kibbles

In traditional shaft sinking, kibbles (large buckets) have been used for transporting people and rock. This type of conveyance has been used for 100's of years.

There are many reasons why kibbles have been traditionally used during shaft sinking. In order to enable ready loading of a conveyance (e.g. a kibble) at the bottom of a mineshaft, the conveyance should be:

- 'open topped' to enable material to be dropped into it by a loader;
- 'freely moveable' to enable the conveyance to be located at a desirable position on the bottom of the mineshaft. The bottom of the mineshaft is typically highly irregular due to it constituting blasted rock. So a freely moveable conveyance can be stably positioned at an appropriate location for filling by the loader;
- 'cylindrical' so that the open top of the conveyance is accessible in a similar manner regardless of where the conveyance is located relative to the loader during loading of the conveyance; and
- 'connected at its top to a hoist rope'—the only logical way to lift a freely moving, cylindrical conveyance.

Clearly, buckets and kibbles (large buckets) provide these characteristics and are thus the main form of conveyance used in mine shaft sinking/construction processes.

Drawbacks of Buckets and Kibbles

Buckets and kibbles are freely suspended and unable to have attached, to an outer surface thereof, mechanisms for allowing the bucket or kibble to be coupled to a guide. One reason for this is as provided above in point (h) of the Background of the Invention. Once the cross head reaches the Galloway (workstage) the bucket hangs freely, is only constrained horizontally within the workstage but is able to rotate. Once the bucket is below the workstage it is not possible to constrain horizontal swing or rotation. As a result of the above, hoist speeds of the conveyance are reduced within the workstage and below the workstage.

In addition the lack of full guidance of the conveyance, and the general inability to fully guide the conveyance, causes health and safety risks when transporting people. This is because absolute alignment of the conveyance with, for example, a high tolerance, engineered landing pad is not possible. This creates pinch points and large hazardous gaps that must be spanned when loading and unloading people.

Also, significant time is required to align the bucket or kibble with discharge ramps and the like, and to safely tip the bucket or kibble over to discharge mined material.

Buckets and kibbles thus slow down the process of mine shaft sinking and are the root cause for some health and safety risks associated with moving people and material within the shaft.

As part of an initiative to double the speed of shaft construction and to improve the health and safety of shaft sinking miners, a new shaft sinking system has been developed. This system replaces drilling and blasting of the rock with disc cutters to fracture the rock. This system also employs a material handling system that replaces buckets with skips for the transportation of rock, and a cage to transport people and materials.

A mechanical excavation system using the disc cutters to fracture the rock is embodied by mine shaft-boring, or shaft-sinking, machine **12** located in a mine shaft **10** in FIG. **1**. The machine **12** comprises a shaft forming apparatus, namely cutting head **14**, for excavating the mine shaft **10**, and a work stage **16** on which personnel install concrete lining and shaft services in parallel with the excavation of the shaft. Such a mine shaft-boring machine is described in WO2011/000037 in which a rotary cutting head is mounted to a lower end of a main machine frame and is equipped with disc cutters for excavating the rock. Cuttings from the cutting head are passed upwardly to a discharge/loading station in the work stage and are transferred to skips for ascending the shaft to the top of shaft.

Challenges to Overcome in Using Skips During Construction

Based on skips used in production mining, it has been realised by the inventors that if skips could somehow be used in shaft sinking to convey and discharge material the rate of shaft sinking would be much greater than is the case with buckets. Also if a separate cage, able to move within the shaft independently from the skips, could be used to transport people and material instead of a bucket it would be safer and more efficient. Both of these opportunities needed the same challenges to be overcome including the provision of full conveyance guidance at all times across multiple guide systems, where the guide systems combine both fixed and flexible length systems.

In the embodiment shown in FIG. **1**, the cutter head **14** and workstage **16** will also descend at different times. So the height of the workstage **16** relative to the bottom of the mineshaft **10** will vary. Moreover, for safety reason the guides along which a skip would travel through the workstage are ideally fixed.

For these reasons, more than one type of guide system is necessary—in other words, a variable length guide extending from the top of the mineshaft to the workstage, and a fixed guide extending through the workstage.

In the embodiment shown in FIG. **1**, a further variable length guide system is required to span the gap between the bottom of workstage and the cutter head or shaft bottom.

The drawback with such systems is that skips do not readily transition between different types of guide.

While skips may be used during the production phase of a mine where a single type of guide can be used, skips have traditionally not been workable during the construction phase of a mine. One reason for this is that skips require full guidance at all times. Skips therefore do not lend themselves to applications where multiple guide systems are present.

The inventors realise that these drawbacks are significant contributing factors to the long held understanding that skips are inappropriate for use during the construction phase.

The Present System

To guide movement of a conveyance, presently embodied by skip **18**, the mine shaft **10** is equipped with a mine shaft conveyance system **100** comprising a guide system **20** as discussed below and a hoist system **102** for lifting and/or lowering the skip **18** along the guide system **20**.

The hoist system **102** is attached to the top of the skip **18** in a known manner and applies the force necessary to controllably lift and lower the skip **18** in the mine shaft **10**.

The guide system **20** guides movement of the skip **18** to ensure, for example, that it does not freely rotate during ascent/descent of the mineshaft **10**. The skips **18** travels or runs along the guide system **20** for guided travel (i.e. lifting and/or lowering) of the skip **18** in the mineshaft **10**.

As shown in FIG. **1**, the guide system **20** extends along the length of the mine shaft **10** down to the cutter head **14**.

The guide system **20** can be divided into 3 sections:

1. a first or "upper" guide section **24**
2. a second, "lower" or "workstage" guide section **22**, and
3. a third or "excavation region" guide section **26**.

The guide sections **24**, **22**, **26** extend in series from an upper region **28** of the mine shaft **10** to an excavation region **29** in which material is excavated from the mine shaft **10** to deepen the mine shaft **10**.

To speed up the construction phase of a mine it is desirable not to have to provide and extend (i.e. during lengthening of the mineshaft) separate systems for the conveyance of mined material and the conveyance of personnel and/or equipment. It is therefore useful if personnel and materials are transported to the work stage using the same system as that used for the conveyance of mined material.

Upper Guide Section **24**

The upper guide section **24** extends from the workstage guide section **22** to accommodate changes in distance between the workstage guide section **22** and an upper region **28** of the mine shaft **10**. Thus the skip **18** can travel along the upper guide section **24** as shown in FIG. **1**, between the top of shaft (e.g. an above ground loading/discharge region) and the work stage **16**. It will be understood that for winze applications the upper region **28** will not be ground level, but will be below ground level.

As the mine shaft **10** extends the distance from the upper region **28** to the work stage **16** increases. As a result the distance from the upper region **28** to the workstage guide section **22** similarly increases.

The upper guide section **24** consequently has variable length to accommodate such changes in distance between the upper region **28** and workstage guide section **22**. It may similarly be desirable to lift the work stage **16** and so the upper guide section **24** may be retractable in addition, or as an alternative, to being extendable.

The upper guide section **24** comprises a pair of stage ropes **30** that extend up the barrel of the mine shaft **10**, as shown in FIG. **2**. It will be appreciated that any number of ropes or alternative guide means may be used as desired, and that the ropes may be fabricated from any appropriate material (typically steel). For example, the upper guide section **24** may constitute wire ropes or cables, wound steel pipe or coiled tube, steel straps, chains and so forth. Any other elongated material or structure that can be wound in and wound out may be used as the upper guide section **24**.

In a preferred embodiment, the upper guide section **24** comprises multiple pairs of stage ropes **30** enabling multiple conveyances to be guided concurrently up and down the shaft. In one such embodiment, the upper guide section **24** comprises 3 or 4 pairs of stage ropes **30**, allowing for 3 to 4 conveyances to be guided simultaneously up and down the shaft.

With further reference to FIG. **1**, the stage ropes **30** are received on sheaves or cable drums **34** that unwind and wind to extend and retract the stage ropes **30**. Thus the upper guide section **24** is extendable and retractable. The sheaves **34** are mounted in a head frame **36** extending over the open upper end of the mineshaft **10**. The ropes **30** therefore extend directly downwardly from the sheaves **34** down the mineshaft **10**.

The sheaves **34** maintain sufficient tension in the stage ropes **30** to ensure that the conveyance **18** can travel up/down the upper guide section **24** without significant rotation or lateral deflection. In other words, the stage ropes **30** assist in maintaining the orientation and position of the conveyance **18** as it ascends/descends the mineshaft **10**. In some embodiments, despite being extendable and retractable, the stage ropes **30** will in practice be under sufficient tension from suspending the workstage **16** and/or other equipment, that they will form substantially rigid members with respect to any force applied by the skip **18** to the stage ropes **30**.

The opposite ends of the stage ropes **30** are connected to the top of the work stage **16** by any appropriate cable stays or other means (e.g. eyelets, swivels). The stage ropes **30** may alternatively wind through sheaves mounted to the work stage **16**. In alternative arrangements, the first (upper) guide section **24** may extend into the work stage **16** such that the work stage **16** is suspended from a lower point, or even from the bottom of the work stage **16**. All such variations are intended to constitute part of the present disclosure.

In addition, the stage ropes **30** may be connected directly to the workstage guide section **22**. However, the present stage ropes **30** are connected to the work stage **16** and the workstage section **22** extends along a parallel, but not collinear, path as shown in FIG. **1**. This is due to different guide means, namely bushings **32** and channels **40**, being the preferred guide means for use with the different types of guides, namely the wire ropes or stage ropes **30** of the upper guide section **24** and the fixed rails **38** of the workstage guide section **22**, respectively.

Workstage Guide Section **22**

As mentioned above, the length of the upper guide section **24** is desirably flexible so as to enable it to extend along with extension of the mineshaft **10**. In contrast, the length of the work stage **16** is relatively fixed so no such flexibility (i.e. being extendable/retractable) is necessary for the workstage guide section **22**.

Additionally, as personnel and materials are unloaded from the conveyance **18** when it is in the work stage **16**, it is desirable that the conveyance **18** be oriented consistently at loading/unloading points in the work stage **16**. For this reason, the workstage guide section **22** is rigid and fixed in position relative to the work stage **16**. Thus the skip **18** and cage can be stopped in a consistent position on the workstage guide section **22**, with consistent, known orientation to enable fast and efficient loading of rock into the skip and safe egress of personnel and equipment from the cage.

As shown in FIG. **3**, the workstage guide section **22** comprises a plurality of fixed rails **38** that are rigidly attached at various intervals to the work stage **16**. The fixed rails **38** slide in channels **40** (discussed in relation to FIGS. **8** and **9**) so that the skip **18** can advance through the work stage **16**.

The channels **40** are necessarily open at one side to enable the skip **18** to slide past connections (not shown) between the fixed rails **38** and the work stage **16**.

It is desirable to ensure that the skip **18** is safely mounted to the workstage guide section **22** before it transitions off the end of the upper guide section **24**. Consequently, the fixed rails **38** extend a short distance above the connection between the stage ropes **30** (i.e. the upper guide section **24**) and the work stage **16** so that guiding of the skip **18** on the fixed rails **38** commences before the stage ropes **30** cease guiding the head section **18'** when the conveyance **18** is received therein.

A slight overlap in guidance of the skip **18** by the stage ropes **30** via the head section **18'** and guidance of the skip **18** directly by the fixed rails **38** also ensures that the orientation of the skip **18** is at all times controlled.

Excavation Region Guide Section **26**

Although the excavation region guide section **26** constitutes part of the embodiment shown in FIG. **1**, it will be appreciated that no such guide section **26** may be necessary, and that the upper guide section **24** and lower or workstage guide section **22** can be provided without also providing the excavation region guide section **26**.

Similarly, it may be desirable to provide the excavation region guide section **26** without also supplying the upper guide section **24** and workstage guide section **22**.

The excavation region guide section **26** is extendable and retractable to accommodate movements of the work stage **16** or of components (e.g. the cutting head **14**) relative to the work stage **16**. In other words, the excavation region guide section **26** of FIG. **1** also constitutes a variable length guide section.

As the cutter head **14** moves away from the workstage **16**, the excavation region guide section **26** extends. Similarly, as the workstage **16** moves towards the cutter head **14**, the excavation region guide section **26** retracts.

Enabling the workstage **16** and cutter head **14** to advance at different times can be critical to proper formation of the mine shaft **10**. Personnel in the work stage **16** line the mineshaft **10** during excavation of the mineshaft **10** by the cutting head **14**. Thus the cutting head **14** will advance though the work stage **16** remains stationary. To this end the excavation region guide section **26** has variable length and is extendable without a corresponding extension and/or retraction of the workstage guide section **22**.

In the embodiment shown in FIG. **1**, the cutting head **14** may advance 10.5 m and then cease cutting, at which time the work stage **16** advances 10.5 m down the mineshaft **10** towards the cutting head **14** and lining of the next 10.5 m section of the mineshaft **10** can commence in the work stage **16**. Thus as the cutting head **14** advances the excavation region guide section **26** extends so that the workstage **16** can remain in position until the concrete sets and/or services (e.g. ducting, wiring, etc.) are installed, and as the workstage **16** advances the excavation region guide section **26** retracts.

Conversely, the excavation region guide section **26** retracts as the upper guide section **24** extends. This is because extension of the upper guide section **24** results in lowering of the work stage **16** towards the cutting head **14**. It is noted that the upper guide section **24** extends with downward movements of the workstage **16** and workstage guide section **22**.

The excavation region guide section **26** comprises a telescopic guide assembly including a plurality of telescopic guides, such as telescopic guide **44** as shown in FIG. **5**. The telescopic guides **44** ensure there is always a guide extending the full distance between the work stage **16** and cutting head **14** so that a conveyance can be guided between them even as the distance changes. Rotation of the conveyance when travelling along the variable length lower guide section **26** is undesirable due to the limited space and critical nature of the equipment between and in the work stage **16** and cutting head **14**. Thus telescopic guide systems are preferred as they constrain rotational and lateral/horizontal movement of a conveyance moving along the guide system, even though the length of the guide system changes. In addition to telescopic guides, other flexible length guides could be used in this section such as ropes, etc.

In traditional shaft sinking operations buckets are used during mucking to bring blasted rock from out of a mine shaft. Since buckets are round there is no great issue with rotation. In contrast, the conveyances **18** shown herein may have another shape, for example they may have a square or rectangular cross-section, and so rotation is undesirable. To this end, the excavation region guide section **26** may constitute a system supplied entirely separately from the complete guide system **20** described above, and be designed for fitting to an existing shaft-boring system. Such an excavation region guide section **26** (i.e. variable length guide system) would also be for guiding a conveyance along the mine shaft **10**, and would extend from the work stage **16**, the excavation region guide section **26** being extendable or retractable to accommodate changes in distance between the work stage **16** and the lower region **42** of a mineshaft **10**.

The excavation region guide section **26** as shown in FIG. **5** extends to, or in the direction of, a shaft forming apparatus such as cutting head **14**, and would thus extend or retract with changes in distance between the work stage **16** and shaft forming apparatus.

The telescopic guide **44** of the excavation region guide section **26** comprises an upper rail **46** and a lower rail **48** that is slidably received in a lower end of the upper rail **46**. The lower end of the fixed rail **38** is received in the upper end of the upper rail **46**. As the cutting head **14** advances the lower rail **48** extends from the upper rail **46**. Conversely, as the work stage **16** advances towards the cutting head **14** the lower rail **48** retracts into the upper rail **46**.

Since the larger of any two concentrically disposed rails will present an edge against which the channel **40** of the conveyance **18** may snag during raising or lowering (depending on whether the larger diameter rail is the upper or lower rail of the two concentrically disposed rails), the channels **40** are flared on their upper and lower ends.

It will be appreciated that the telescopic guide assembly may comprise any number of concentrically disposed rails. For example, the telescopic guide **44** may comprise only a single rail (e.g. upper rail **46**) that receives the fixed rail **34** attached to the work stage **16**. As such the fixed rail **34** and upper rail **46** together would form a telescopic guide system **44**. Similarly, lower rail **48** may be sized to be received in fixed rail **34**, thus omitting upper rail **46**.

It will also be appreciated that the upper rail **46** may in fact retract up the fixed rail **38** as the work stage **16** advances, and extend from the fixed rail **38** as the cutting head advances provided that there are no connections between the fixed rail **38** and work stage **16** for a sufficient length at the lower end of the fixed rail **38**.

Thus the guide system **20** comprises a variable length upper guide section **24** extending upwardly from the work stage **16**, a fixed length workstage guide section **22** fixed to the workstage **16** intermediate the other guide sections **24**, **26**, and a variable length lower (i.e. excavation region) guide section **26** extending downwardly from the workstage **16** towards a lower region in the mineshaft **10**.

Skip

The use of skips **18** (and **64** as described below) as conveyances is particularly advantageous as skips can be filled from the top or side, discharged from the bottom, e.g. using arc gate skips and corresponding latches positioned at the location at which the skips will be discharged. Contrastingly, buckets must be upended, typically manually, and are thus generally open-topped to enable material to fall out during discharging. To that end, buckets usually have chains hanging from the sides, which make proper alignment of the bucket with, e.g. a loading/discharge point, more difficult than with skips that are fully guided at all times. Skips are thus a safer and more efficient alternative to buckets.

To enable the skip **18** to travel along the stage ropes **30**, the stage ropes **30** run in running bushings **32** provided on a head section **18'** (shown in FIGS. **2** and **3**) that receives the skip **18**. The head section **18'** guides movement of the skip **18** between the upper region **28** of the mine shaft **10** and the work stage **16**.

While the skip **18** may have any appropriate construction, in the present embodiment it is represented by the construction identified with numeral **64** as shown in FIGS. **8** and **9**. In other alternatives, the skip **18** may comprise another device such as an auxiliary cage **18"**. For illustrative purposes such an auxiliary cage **18"** is shown in FIG. **2**, received in a head section **18'**, and in FIG. **3** in isolation.

The head section **18'** (which will hereinafter be interchangeably referred to as a "crosshead" or "bridle") receives the auxiliary cage **18"** and assists with guiding the auxiliary cage **18"** along the upper guide section **24** of the guide system **20**, as shown in FIG. **2**.

The auxiliary cage **18"** is used for the transportation of personnel (in lower cage **50**), but can also be used for the transportation of goods (e.g. vent pipe **41** as shown in upper cage **52** in FIG. **2**).

To transition between the upper guide section **24** and the workstage guide section **22** the head section **18'** detaches from the auxiliary cage **18"**. To facilitate this separation the upper guide section **24** and workstage guide section **22** meet at a transition region (not shown) where the head section **18'** separates from the auxiliary cage **18"**.

The transition region may simply constitute the termination points of the stage ropes **30** and is adapted to halt downward travel of the head section **18'** whilst permitting the auxiliary cage **18"** to continue downward travel along the workstage guide section **22**.

For this reason also it is desirable that there be provided separate guide means on the head section **18'** and auxiliary cage **18"**. To that end, bushings **32** are provided on the head section **18'** to guide the head section **18'** along the upper guide section **24**, and channels **40** are provided on the auxiliary cage **18"** to guide the auxiliary cage **18"** along the workstage guide section **22** after the head section **18'** has chaired against the workstage **16**.

FIGS. **6** and **7** show side views of a head section **18'**. The head section **18'** comprises a containing section **54**, head chairing section **56**, base chairing section **58**, engagement assembly **60**, and guide members **62**.

In a most rudimentary embodiment, a conveyance guide system for moving a conveyance or skip **18** along a mineshaft, will include a workstage guide section **22**, with the skip **18** (which may comprise auxiliary cage **18"** as shown in FIGS. **2** and **3**, skip **64** as shown in FIGS. **8** and **9**, or another type of conveyance) moveable along the workstage guide section **22**, an upper guide section **24** located along the mineshaft **10** in series with the workstage guide section **22**, and a head section **18'** for receiving the conveyance **18**. The head section **18'** cooperates with the upper guide section **24** to enable the conveyance **64**, **18"** to travel from the workstage guide section **22** along the upper guide section **24** when received by the head section **18'**. The skip **18** includes a chairing member (e.g. skip chairing section **114**) that cooperates with a chairing member (e.g. head chairing section **56**) of the head section **18'**. The chairing member (e.g. skip chairing section **114**) of the skip **64** or auxiliary cage **18"** comes into abutment with the chairing member (e.g. head chairing section **56**) of the head section **18'**, to chair the conveyance **18** in the head section **18'**.

Head section **18'** is essentially a passive element of the system. It is passive insofar as movement of the head section **18'** is afforded by movement of a conveyance **18** against which the head section **18** is chaired, or by downward movement of the work stage **16** when the head section **18'** is chaired against the work stage **16**. In other words, the head section **18'** depends from the conveyance **18** during movement of the conveyance **18** and head section **18'** along the first or upper guide section **24**.

The containing section **54** is for containing or receiving a conveyance **18**, such as skip **64** as discussed below or auxiliary cage **18"** as described above. The containing section **54** guides movement of the conveyance **18** during movement between the work stage **16** and an upper level (e.g. ground level) of the mineshaft **10**.

The containing section **54** is bounded by four vertical and substantially parallel corner posts **66** the ends of which are interconnected by beams. The beams include a group of four horizontal beams **68** in the region of the head chairing section **56** and a similar group of four horizontal beams **70** in the region of the base chairing section **58**. The corner posts **66**, and beams **68**, **70** together define substantially rectangular sides, top and bottom of the containing section **54**.

It will be seen from the different widths of the head section **18'** as shown in FIGS. **6** and **7**, that the groups of horizontal beams **68**, **70** each include two shorter beams and two longer beams, such that the top and bottom of the containing section **54** are substantially rectangular. Consequently, the containing section **54** has two short sides and two long sides being the sides across which the short beams and long beams respectively extend.

The posts **66** and beams **68**, **70** may be formed from any appropriate material and are presently formed from rectangular hollow section steel that is capped at the ends to avoid internal debris hang-up.

The containing section **54** further includes brace beams **72** extending between the corner posts **66**, generally in the plane of the rectangular sides of the containing section **54**, at points intermediate the ends of the corner posts **66**. In the present embodiment the beams **72** are substantially horizontal and parallel with the beams **68**, **70**. The beams **72** are equidistantly spaced between the head chairing section **56** and the base chairing section **58**, and are connected at their ends to the vertical corner posts **66** by bolts **74**.

On the longer sides of the containing section **54** (as shown in FIG. **6**), pairs of diagonal struts **76** extend from opposite sides (above and below) of one end of one beam **72** to the opposite end of the next beam **72** vertically above and below. Only one such diagonal strut **76** extends from the topmost and bottommost beams **72**, as those beams **72** have only one neighbouring beam **72** that is respectively below and above the beam **72** in question. Together, the beams **72** and struts **76** resist the containing section **54** forming a mechanism (i.e. resists relative rotation of structural members **66**, **68**, **72** and **76** about bolts **74**), thus providing structural rigidity to the containing section **54**.

On the short sides of the containing section **54** (as shown in FIG. **7**) there are no such diagonal struts.

The number of beams **72** and struts **76** may be selected as appropriate and may, for example, include 2 or more beams **66** with a corresponding number of struts **76**.

The posts **66**, beams **68**, **70**, **72** and struts **76** are each oriented and/or shaped to discourage debris collection. For example, the brace beams **72** and diagonal struts **76** may be formed from standard angle section steel opening inwardly of the containing section **54**. Since debris will typically fall around the containing section **54** rather than through it, the angle section is unlikely to gather debris.

The posts, beams **68**, **70**, **72** and struts **76** together constitute a structural latticework or structural interconnection forming the containing section **54**. These structural members define a volume of the containing section **54** in which goods, conveyances and mined material can travel in an appropriate receptacle or skip. To provide the requisite strength, the structural members are preferably made from steel, but may alternatively be made from other materials such as aluminium for some applications.

Extending up the inside of the containing section **54** are guides **55** for guiding progress of a conveyance **18** into and out of the containing section **54** (described below). The guides **55** are of the same shape as guides of the second or workstage guide section **22**. The guides **55** of the present embodiment are formed from angle-section steel extending up the inside of the containing section **54** in the corners. The angle-section steel aligns with (i.e. becomes coextensive or collinear with) the same size and gauge angle-section steel extending downwardly into the work stage **16** and constituting part of the workstage guide section **22**. The guides **55** and workstage guide section **22** are consistently shaped and come into alignment when the head section **18'** chairs against the work stage **16**, to provide a consistent guide path for the skip **18** moving into or out of the containing section **54**. The head chairing section **56** is for chairing against the skip **18**, so that the head section **18'** and conveyance **18** travel in abutment upwardly from the work stage **16** along the upper guide section **24**. The head chairing section **56** provides a rigid structural frame from which the weight of the head section **18'** can depend during travel upwardly from the work stage **16**.

The head chairing section **56** is bounded at the sides by the corner posts **66**, at the top by beams **68** and head chairing bars **77** and, across the long sides of the containing section **54**, cross members **78**. Across the shorts sides of the containing section **54** the head chairing section **56** is bounded by cross members **80**. Cross members **80** extend across the short sides of the containing section **54** at a level slightly higher than cross members **78**, so as to be spaced a distance from the next lower beam **72** that is the same as the distance between that beam **72** and the next lower beam **72**.

The head chairing section **56** abuts or "chairs" against the conveyance **18** when the conveyance **18** is hoisted from the work stage **16** into the containing section **54**. After the conveyance **18** has chaired against the head chairing section **56**, the head section **18'** travels with the conveyance **18** as it is hoisted upwardly along the upper guide section **24** away from the work stage **16**.

The head chairing bars **77** are positioned symmetrically about a centre axis Y of the containing section **54**. This symmetrical positioning ensures that the conveyance **18** is centred in the head section **18'** during ascent up the upper guide section **24**. The head chairing bars **77** extend substantially perpendicularly between the beams **68** that extend across the long sides of the containing section **54**, substantially in parallel with the beams **68** that extend across the short side of the containing section **54**. The head chairing bars **77** support upper ends of diagonal chairing bars **82** that extend between the head chairing bars **77** and the cross members **78**. The diagonal chairing bars **82** chair against the top of the conveyance **18** as discussed below (described below in relation to FIGS. **10** and **11**).

As best seen in FIG. **7**, the diagonal chairing bars **82** are paired, with a pair of diagonal chairing bars **82** positioned towards each end of a respective head chairing bar **77**, symmetrically about the centre axis Y of the containing section **54**.

Impact liners **84** are attached to the diagonal chairing bars **82** by any appropriate means, to reduce the impact of a conveyance **18** as it chairs against the diagonal chairing bars **82**. In a preferred embodiment, the impact liners each constitute a sleeve for receiving a respective diagonal chairing bar **82** before attachment of the diagonal chairing bar **82** to the head chairing bars **77** and cross members **78**. The impact liners **84** are positioned on the undersides of the diagonal chairing bars **82**. While in the present case each diagonal chairing bar **82** is provided with an individual impact liner **84**, a single impact liner **84** may extend across the underside of more than one diagonal chairing bar **82**. For example, a single impact liner **84** may extend across the undersides of the two diagonal chairing bars **82** of a particular pair of diagonal chairing bars **82**.

The impact liners **84** may be formed from any appropriate material, such as rubber, neoprene or a soft metal. The impact liners **84** may instead not be designed to absorb much, if any, impact and may instead be formed from a long-wearing material. To accommodate the absence of a shock absorber on the diagonal chairing bars **82**, the hoisting speed of the conveyance **18** may be slowed to a "creep speed", being a speed at which chairing will not cause a significant amount of vibration through the head section **18'**.

The use of impact liners **84** is preferable as they remove the need to slow the conveyance **18** down to a "creep speed". Accordingly, the time required for the conveyance **18** to traverse the shaft is reduced, which in turn adds to the overall increase in muck removal speed and hence shaft sinking speed.

The base chairing section **58** is for chairing against the work stage **16** after the head section **18'** has descended thereupon. In practice, the head section **18'** will chair against the work stage **16** as the skip **18** travels from the upper guide section **24** along the workstage guide section **22**. Upon chairing, or slightly before chairing, of the head section **18'** on the work stage **16**, the skip **18** is released from the head section **18'** to continue down through the work stage **16** for unloading and/or loading.

The base chairing section **58** is bounded at its corners by the vertical posts **66**, at the bottom generally by beams **70**, and at the top by cross members **86**. Cross members **86** extend across the sides of the containing section **54** between corner posts **66** to which the cross members **86** are bolted. The base section **58** in effect provides a rigid structural impact frame for supporting the weight of the head section **18'** when chaired against the work stage **16**.

The base chairing section **58** includes four guide plates **90** extending from the corner posts **66** on the opposite short sides of the head section **18'**, substantially perpendicularly outwardly from the short sides. Each guide plate **90** is planar and lies in a vertical plane, the respective plate **90** tapering upwardly towards a respective corner post **66**.

The base chairing section **58** is also provided with impact buffers or stops **88** depending downwardly from the lower ends of the vertical corner posts **66**. The impact buffers or stops **88** reduce the impact or impulse load as the head section **18'** chairs against the work stage **16**.

The impact buffers or stops **88** may be mounted to the corner posts **66** (or along beams **70** if desired) by any appropriate means. Presently, the impact buffers or stops **88** comprise a small square tab of rubberised shock absorber material moulded onto a plate (not shown) from which a bolt (not shown) protrudes. The bolt extends through an aperture in the end capping of the corner post **66** or other aperture, and is secured in position by tightening a nut (not shown) onto the bolt.

Since the work stage **16** will typically be provided with rubber impact liners (described below) there may be no need to provide impact buffers or stops **88**.

During movement the head section **18'** is guided along the upper guide section **24**. To that end, the head section **18'** is provided with two pairs of guide rope bearings **92**. One guide rope bearing **92'** of each pair of guide rope bearings **92** is welded or otherwise attached to the head section **18'** at the head chairing section **56**. The other guide rope bearing **92"** of the respective pair of guide rope bearings **92** is welded or otherwise attached to the head section **18'** at the base chairing section **58**.

Each guide rope bearing **92'**, **92"** comprises a roller set **96** that runs along the stage ropes (designated by broken line Z) of the upper guide section **24**. The roller set **96** is fixed to a mount **94** for mounting the respective roller set **96** to the containing section **54**.

Each mount **94** comprises a U-shaped bent plate, with the ends of the arms of the U-shape attached (e.g. welded) to the containing section **54**, and the respective roller set **96** attached (e.g. welded) to the base of the U-shape. Other types of mount will be suitable in particular circumstances, or no mount at all in cases where the roller sets **96** are mounted directly to the containing section **54**, and all such variations are intended to fall within the scope of the present disclosure.

Each roller set **96** comprises a plurality of annular rollers (not shown) housed in a cylindrical housing **98**. The housing **98** comprises two halves hinged together so that the housing **98** can be closed around a stage rope Z when installing a head section **18'**.

A tapered (e.g. torpedoed) plate **110** is attached to the outside of the housing **96**. As the head section **18'** travels upwardly into the mineshaft conveyance system **100**, the plates **110** enter female guides (not shown) to stabilise the head section **18'**.

It will be appreciated that the guide rope bearings **92** may be substituted for another guide mechanism (e.g. replaceable bronze bushings and/or spear guide slippers) to suit a different type of upper guide section **24** (e.g. rails mounted in the lining of the mineshaft).

The head section **18'** is thus configured so that the hoist rope extends through the head section **18'** to the skip **18**. Therefore, as the skip **18** chairs in the head section **18'** on its upward path, both the head section **18'** and skip **18** are lifted up the mineshaft **10** by the hoist rope pulling on the conveyance **18**.

It will be appreciated that all of the various interconnected members (e.g. members **66**, **68**, **70**, **72**) may be connected by nuts and bolts, welding, pairs of clamping plates, and other attachment methods all of which may be used and are intended to fall within the scope of the present disclosure. Moreover, those members may be formed from any appropriate material having any appropriate cross-section.

The latch **60** is a 'Kimberley' type safety latch, though any appropriate latch may be used. The latch includes an eyelet **124** mounted to the cross members **86** on both long sides of the containing section **54**. A lever **126** is pivotally mounted in the eyelet **124** to pivot between a latched position (not shown, but where the arm of the lever **126** is horizontal) and an unlatched position as shown. The lever **126** is biased to the latched position by a spring canister **130** that extends from a diagonal strut **76** to about mid-way along the arm of the lever **126**.

The lever **126** is shaped so that in its 'at rest' position it is latched. A latched position while at rest is achieved by the lever arm **126** being at an angle (presently 90°) to the catch **128**, rather than being aligned with (i.e. at 180°) the catch **128**, so that as the lever **126** descends under its own weight the catch **128** is rotated against a pin **132** (see FIG. **6**) of the skip **18** (presently skip **64**, which is an arc gate skip, though it will be appreciated that the disclosure below can be similarly applied to other types of skip **18**, such as auxiliary cage **18"**) thereby to catch the pin **132**.

FIGS. **8** and **9** show a skip **64** for conveying mined material from a work stage **16** to a dump in the region of the top of the mine shaft hoist system **100**. Skip **64** includes a frame **112** bounding a receptacle that contains the mined material during conveyance thereof.

At the top of the frame is a skip chairing section **114**. The skip chairing section **114** forms part of the frame **112** and comprises diagonal plates **116** set at an angle the same as that of the diagonal chairing bars **82**.

From the apex of the skip **64**, namely where the diagonal plates **166** meet, a cable sheath **118** extends. The cable sheath **118** attaches to the lower end of a hoist rope **120** thereby attaching the rope **120** to the skip **64**. The hoist rope **120** is hoisted by the mine shaft hoist system **100** to raise and lower the skip **64** along the mineshaft (e.g. along the workstage guide section **22** and upper guide section **24**).

The skip **64** further includes runners **122**. The runners **122** run against guides **55** as the skip **64** moves into and out of the containing section **54**. The runners **122** comprise angle-section wear plates extending around and protruding from the corners of the frame **112**. It will be appreciated, however, that the runners **122** may comprise a series of rollers or any other mechanism suitable for cooperating with guides **55** to ensure the skip **64** is appropriately aligned with the head section **18** when entering/exiting the containing section **54**.

An "in-use" case of the head section **18'** and skip **64** is shown in FIGS. **10** and **11** which show the skip **64** contained within the containing section **54** of the head section **18'**. As shown in FIG. **11**, during ascent from the work stage **16** or descent towards the work stage **16** the diagonal chairing plates **116** of the skip **64** are chaired (i.e. in abutment) with the impact liners **84** of the head section **18'**. Since the runners **122** in the corners of the skip **64** are in abutment with the guides **55** of the containing section **54**, the skip **64** remains in alignment with the head section **18'**.

The rope sheath **118** extends between the head chairing bars **77**, so that the hoist rope **120** raises and lowers both the skip **64** and head section **18'** together. In this sense, the head section **18'** in effect hangs from the skip **64** whilst in transit.

At the top of the hoist system **100** the plates **110** of the guide rope bearings **92** are received in female guides to stabilise the head section **18'** and thereby also stabilise the skip **64**. An arc gate door **134** then opens to release mined material from the skip **64**. The arc gate door **134** then closes, readying the skip **64** for descent.

Upon commencing descent, the plates **110** of the guide rope bearings **92** slide out of the female guides and the skip **64** continues down the upper guide section **24**. During descent the head section **18'** hangs from the skip **64** by virtue of the abutment between the diagonal plates **116** of the skip **64** and diagonal chairing bars **82** of the head section **18'**. Thus the rate of descent of the head section **18'** is that of the skip **64**.

On approaching the work stage **16**, the latches **60** are moved to the unlatched position by a trigger **136** mounted to the work stage **16**. The trigger **136** is in the form of a bent plate. The plate of the trigger **136** extends vertically upwardly from the work stage **16** and has a bend so that the top section **138** of the trigger **136** is at an angle to vertical, extending away from the head section **18'**.

During descent, the head section **18'** and skip **64** are latched together, with the lever arm **126** of the latch **60** extending horizontally and protruding from the short side of the containing section **54**. As the head section **18'** approaches the work stage **16**, the lever arm **126** comes into abutment with the top section **138** of the trigger **136**. As the head section **18'** descends further, the top section **138** of the trigger **136** overcomes the bias of the spring canister **130**, and pushes the lever arm **126** into the unlatched position. Since the head section **18'** effectively 'hangs' from the skip **64**, the head section **18'** travels further down towards the work stage **16** in unison with the skip **64** even after the skip **64** has been unlatched from the head section **18'**.

Shortly before the head section **18'** chairs against the work stage **16** the rate of descent slows to 'creep speed' and the chairing plates **90** of the head section **18'** are received in female guides (not shown) on the work stage **16**. This ensures the head section **18'** is properly aligned with the work stage **16**, thus ensuring the guides **55** are aligned with the workstage guide section **22** in the work stage **16**.

The head section **18'** then comes to rest against an impact liner mounted to the work stage **16**. At this point the skip **64** slides along guides **55** out of the head section **18'** and onto the workstage guide section **22**. In so doing the cable shroud or sheath **118** and rope **120** descend between the head chairing bars **77** and down through the volume of the containing section **54**.

It will be understood that at all times when the skip **64** is within the work stage **16**, the cable extends between the head chairing bars **77** through the containing section **54**.

After the skip **64** has been filled and is ascending, the skip **64** travels from the workstage guide section **22** into the containing section **54**, along the guides **55**. The rate of ascent of the skip **64** immediately before chairing with the head section **18'** is slowed to 'creep speed' so as to ensure chairing is a controlled event. Once the diagonal chairing plates **11** of the skip **64** have chaired against the diagonal chairing bars **82** of the head chairing section **56** of the head section **18'**, with the cable sheath **118** positioned centrally between the head chairing bars **77**, the rate of ascent of the skip **64** increases.

Immediately after the head section **18'** is picked up by the skip **64**, the tip of the lever arm **126** travels upwardly against the vertical part of the trigger **136**. Once the tip of the lever arm **126** reaches the bend it begins to move along the top section **138** of the trigger **136**. At this time the spring canister **130** urges the lever arm **126** progressively back towards into latched position as the head section **18'** and skip **64** ascend.

Thus the skip **64** and head section **18'** automatically latch together to ascend from the work stage **16** towards the top of the mineshaft hoist system **100** for dumping of the contents of the skip **64**.

The head section **18'** is therefore only capable of ascent or descent in unison (i.e. when chaired) with the skip **64**. The head section **18'** is essentially a passive construction that enables the skip **64** to smoothly transition between a rigid, fixed guide system such as workstage guide section **22**, and a variable length guide system, such as stage ropes constituting part of the upper guide section **24**. In effect, the head section **18'** constitutes a travelling guide frame that is picked up by the skip **64** when the skip **64** travels along the upper guide section **24**, the head section **18'** acting as an interface between the skip **64** and the guides of the upper guide section **24**. The skilled person will appreciate that latches **60** constitute, in many cases, a safety precaution only since the position of the head section **18'** on the skip **64** is set by the interaction between guides **55** and runners **122** and the chairing of the diagonal chairing bars **82** of the head section **18'** on the diagonal plates **116** of the skip **64**.

FIGS. **12** to **14** show an alternative version of the head section **142** and a conveyance **140** for conveying both parts and personnel up and down the mineshaft.

The head section **142** comprises a frame **144** having a square horizontal cross-section. The frame **144** comprises an interconnection of horizontal and diagonal struts, and brackets together constituting a rigid structure. The frame **144** is open on one side to facilitate access to a parts conveyance section **146** on top of a personnel carrier portion **148** of the conveyance **140**.

The frame **144** again includes corner posts **150** formed from angle-section steel and bearings **92'**, **92"** as discussed above in relation to head section **18'**.

The head section **142** comprises flat head chairing bars **152** against which the conveyance **140** chairs during movement of the conveyance **140** between the work stage **16** and the top of the mineshaft hoist system **100**. The flat head chairing bars **152** and head section operate in the same manner as head section **18'**, and the features of head section **142** will be understood from the discussion above in relation to head section **18'**.

The parts conveyance section **146** of the conveyance **140** is bounded by four corner posts **154**. An upper end **156** of each corner post **154** is tapered or angled inwardly to assist with alignment of the corner posts **154** with the angle-section of the corner posts **150**. To reduce friction between the corner posts **154** of the conveyance **140** and the corner posts **150** of the head section **142**, wear plates **158** are fixed at the top and bottom of the parts conveyance section **146** in pairs. The wear plates **158** of each pair bear against opposite flanges or arms of the angle-section of the corner posts **150** of the head section **142** in use.

The wear plates may be secured together using any appropriate method and may be formed from any appropriate material.

The conveyance **140** includes a chairing block **160**. The chairing block **160** comprises a pair of chairing bars **162** attached to the top of the conveyance **140** and positioned to chair against chairing bars **152** of the head section **142**, and a cable block **164** that extends between the head chairing bars **152** of the head section **142** when the conveyance **140** is chaired in the head section **142**. The cable block **164** is flared outwardly downwardly to assist with aligning the cable block **164** centrally between the head chairing bars **152** of the head section **142**, thereby locating the chairing bars **162** of the conveyance **140** on the head chairing bars **152** of the head section **142**.

The personnel carrier portion **148** depends downwardly from the parts conveyance section **146**. The length of the parts conveyance section **146** is the same as that of the head section **142** so that the personnel carrier portion **148** is below the bottommost beam **166** of the head section **142** while the head section **142** and conveyance **140** are travelling together.

The personnel carrier portion **146** includes work stage guides, in the form of female guide brackets **168**, that travel along the first guide section **22**. In contrast to the head section **18'** and skip **64** arrangement described above, the guides (i.e. corner posts) **144** of the head section **142** do not become coextensive with the first guide section **22**. Instead, as the conveyance **140** moves into or out of the head section **142** the corner posts **154** are guided into the head section **142** by corner posts **150** of the head section **142**. When the conveyance **140** travels along the workstage guide section **22** extending in the work stage **16**, the female guide brackets **168** slide along guides, presently C-section steel with the open side of the C-section facing away from the conveyance **140**, of the workstage guide section **22**.

While no latch is shown in the present embodiment, it will be appreciated that a latch or other coupling will be used to couple conveyance **140** to the head section **142**. In fact, particularly where a conveyance carries personnel it will often be a legal requirement to have such a safety precaution installed to ensure there exists a mechanical coupling between the head section **142** and conveyance **140**.

At the top of the hoist system **100** the plates **110** of the guide rope bearings **92** are received in female guides to stabilise the head section **142** and thereby also stabilise the conveyance **140**. Personnel and materials can then be loaded into or taken out of the conveyance **140**.

Upon commencing descent, the plates **110** of the guide rope bearings **92** slide out of the female guides and the conveyance **140** continues down the upper guide section **24**. During descent the head section **142** hangs from the conveyance **140** by virtue of the abutment between the chairing bars **162** of the conveyance **140** and top chairing bars **152** of the head section **142**. Thus the rate of descent of the head section **142** is that of the conveyance **140**.

Shortly before the head section **142** chairs against the work stage **16** female chairing brackets **170** of the head section **142** are received over male stubs (not shown) on the work stage **16**. Shortly before the head section **142** chairs against the work stage **16** the female guide brackets **168** are received over the end of the male guides of the workstage guide section **22** extending upwardly a short distance from the work stage **16**. The bottom of the female guide brackets **168** is flared outwardly so as to accommodate a small degree of misalignment of the female guide brackets **168** with the guide of the workstage guide section **22**.

The lower female guide brackets **168** receive the upwardly extending male portion of the workstage guide section **22** and, as the conveyance **140** is progressively lowered, the upper female guide brackets **168** eventually receive over the upwardly extending male portion of the workstage guide section **22**.

Immediately before the conveyance **140** and head section **142** having been lowered until the head section **142** comes into contact with the work stage, female chairing brackets **170** of the head section **142** receive over the male stubs (not shown) on the work stage **16**. This ensures the head section **142** is properly aligned with the work stage **16**.

At this time, the head section **142** comes to rest against an impact liner mounted to the work stage **16**. At this point the conveyance **140** slides along guides (constituting corner posts **150**) out of the head section **142** and onto the workstage guide section **22**. In so doing the cable shroud or sheath **118** and rope **120** descend between the head chairing bars **152** and down through the volume of the head section **142**.

The chairing process may occur while the conveyance **18** progresses downwardly into the work stage **16** at substantially the same speed at which the conveyance **18** descended the first guide section **24**. Alternatively, the conveyance **18** may be slowed slightly before the head section **142** chairs against the work stage **16**. In both of these examples, impact liners may be provided to reduce the impact loading of the head section **142** against the work stage **16**. As a further alternative, the conveyance **18** may be slowed to a 'creep speed' in advance of the head section **142** chairing against the work stage **16**.

It will be understood that at all times when the conveyance **140** is within the work stage **16**, the cable extends between the head chairing bars **142** through the head section **142**.

After the conveyance **140** has been filled and/or its load has been deposited, and the conveyance **140** is ascending, the conveyance **140** travels from the workstage guide section **22** into the head section **142**, along the guides (corner posts **150**). The rate of ascent of the conveyance **140** immediately before chairing with the head section **142** is slowed to 'creep speed' so as to ensure chairing is a controlled event. Once the chairing bars **162** of the conveyance **140** have chaired against the top chairing bars **152** of the head section **142**, with the cable sheath **118** positioned centrally between the head chairing bars **152**, the rate of ascent of the conveyance **140** increases.

The head section **142** is therefore only capable of ascent or descent in unison with (i.e. when chaired upon) the conveyance **140**. The head section **142** is essentially a passive construction that enables the conveyance **140** to smoothly transition between a rigid, fixed guide system such as workstage guide section **22**, and a variable length guide system, such as stage ropes constituting part of the upper guide section **24**. In effect, the head section **142** constitutes a travelling guide frame that is picked up by the conveyance **140** when the conveyance **140** travels along the upper guide section **24**, the head section **142** acting as an interface between the conveyance **140** and the guides of the upper guide section **24**.

Lastly, multiple conveyances may concurrently operate in the shaft. The first and second guide sections of the conveyance system may guide each of the multiple conveyances. Personnel and/or materials may be transported in a different one or ones of the conveyances to one or more conveyances that transport mined material.

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

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

The invention claimed is:

1. A conveyance system for moving a skip along a mine shaft during shaft sinking, the conveyance system comprising:

a first guide section for guiding movement of the skip along the mine shaft between an upper region of the mine shaft and a work stage, the work stage being arranged for transferring cuttings passed upwardly and received from a shaft forming apparatus to the skip for ascending the mine shaft to the upper region of the mine shaft, the first guide section having a variable length;

a second guide section located along the mine shaft in series with the first guide section, wherein the second guide section has a fixed length and guides movement of the skip within the work stage and along the mine shaft by engaging with the skip as the skip moves along the second guide section; and

a head section for receiving the skip, the head section cooperating with the first guide section to enable the skip to travel from the second guide section along the first guide section when received by the head section;

wherein the conveyance system provides guidance along an entire length of the mine shaft from the shaft forming apparatus to the upper region of the mine shaft.

2. The conveyance system according to claim **1**, wherein the head section includes a containing section in which the skip is at least partially received during travel of the skip along the first guide section.

3. The conveyance system according to claim 1, wherein the head section includes a chairing member that chairs against the skip during travel of the skip along the first guide section and wherein the chairing member comes into abutment with the skip.

4. The conveyance system according to claim 1, wherein the head section is configured to depend from the skip during movement of the skip and head section along the first guide section.

5. The conveyance system according to claim 1, wherein the head section chairs against a work stage as the skip travels from the first guide section along the second guide section.

6. The conveyance system according to claim 1, wherein the mine shaft is substantially vertical.

7. The conveyance system according to claim 1, wherein the first guide section and second guide section restrict rotational movement and swing movement of the skip.

8. The conveyance system according to claim 1, wherein the head section does not travel along the second guide section.

9. The conveyance system according to claim 1, wherein the second guide section extends through the work stage.

10. A guide system for guiding a skip during shaft sinking, while lifting and/or lowering of the skip in a mine shaft, the guide system comprising:

an intermediate fixed length guide section for guiding movement of the skip within a work stage and along the mine shaft, the work stage being arranged for transferring cuttings passed upwardly and received from a shaft forming apparatus to the skip for ascending the mine shaft to an upper region of the mine shaft; and

a variable length upper guide section extending from the intermediate fixed length guide section to accommodate changes in distance between the intermediate fixed length guide section and an upper region of the mine shaft, the variable length upper guide section guiding movement of the skip between the upper region of the mine shaft and the work stage,

wherein the guide system restricts rotational movement and swing movement of the skip;

wherein the guide system provides guidance along an entire length of the mine shaft from the shaft forming apparatus to the upper region of the mine shaft.

11. The guide system according to claim 10, wherein the intermediate fixed length guide section and the variable length upper guide section are configured to allow the skip to transition from one guide section to the other.

12. The guide system according to claim 10, wherein the variable length upper guide section extends from the intermediate fixed length guide section to the upper region of the mine shaft.

13. The guide system according to claim 10, wherein the intermediate fixed length guide section is fixable to the work stage.

14. The guide system according to claim 10, further including a variable length lower guide section extending from the intermediate fixed length guide section to accommodate changes in distance between the intermediate fixed length guide section and a lower region of the mine shaft.

15. The guide system according to claim 14, wherein the variable length lower guide section extends from the intermediate fixed length guide section in the direction of a shaft forming apparatus.

16. The guide system according to claim 14, wherein the variable length lower guide section extends with movements of the shaft forming apparatus away from the intermediate fixed length guide section and retracts with movements of the intermediate fixed length guide section towards the shaft forming apparatus.

17. The guide system according to claim 14, wherein the variable length lower guide section comprises a telescopic guide assembly.

18. The guide system according to claim 14, wherein the variable length lower guide section is extendable without a corresponding extension and/or retraction of the variable length upper guide section.

19. The guide system according to claim 10, wherein the variable length upper guide section extends with downward movements of the intermediate fixed length guide section.

20. The guide system according to claim 19, wherein the variable length upper guide section extends from the intermediate fixed length guide section to an above ground loading/discharge region.

21. The guide system according to claim 10, wherein the variable length upper guide section and intermediate fixed length guide section meet at a transition region, and the skip comprises a head section and a base section, the transition region being adapted to halt downward travel of the head section whilst permitting the base section to continue downward travel along the intermediate fixed length guide section.

22. The guide system according to claim 10, being for use in a substantially vertical mineshaft.

23. The guide system according to claim 10, wherein the intermediate fixed length guide section guides movement of the skip along the mine shaft by engaging with the skip while the skip moves along the intermediate fixed length guide section.

24. The guide system according to claim 10, wherein the intermediate fixed length guide section extends through the work stage to the variable length upper guide section.

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