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(54) **Mining machine roof bolting rig**

(57) A mining machine roof bolting rig (118) in which a drill or bolt head (408) is mountable at a main frame (101) of a mining machine via a first and second rig base frame (300, 301). A link arm (403) extends between the second base frame (301) and a carrier support (404) that mounts the drill or bolt head (408) via a conventional

carrier arrangement. Pivot mountings between the first and second frames and the link arms (403) allow both forward and rearward and lateral sideways movement of the drill or bolt head (408) to achieve a plurality of different bolting or drilling positions above the mining machine (100).

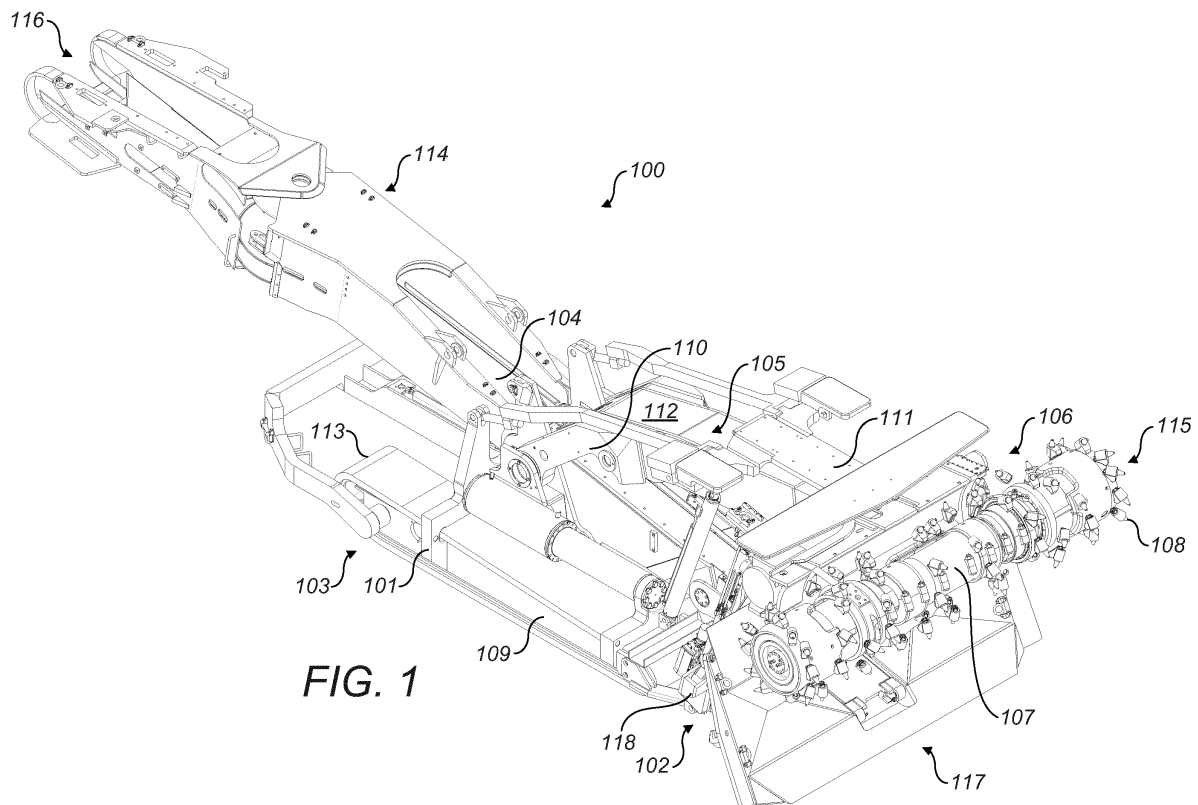


FIG. 1

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Description

Field of invention

[0001] The present invention relates to a mining machine roof bolting rig configured to secure roof straps to a roof of a mine tunnel and in particular, although not exclusively, to a bolting rig configured to provide a plurality of bolting positions relative to the mining machine via components of the rig tilting back and forth and pivoting in a sideways direction.

Background art

[0002] A variety of different methods and machines have been developed to extract minerals and other valuable materials at and below the Earth's surface. Such machines typically operate in mines at great depths.

[0003] In order to maximise excavation and mineral recovery efficiency, mining machines have been developed for specific purposes. Whilst some machines are configured exclusively to cut the mineral from a deposit or seam, other machines are configured to tunnel within the subterranean depth to effectively create the mine and provide passageways for the mineral cutters. In particular, mobile mining machines have emerged as successful apparatus to both provide direct cutting at the seam and as a means of rapid entry roadway development. Typically a mobile mining machine comprises a rotatable cutting or mining head having cutting bits provided on rotating drums to contact the mineral face. The cutting head is conventionally mounted at a moveable boom so as to be adjustable in height relative to the mine floor. As the cutting head is rotated and advanced into the seam, the extracted mineral is gathered by a gathering head and then conveyed rearwardly by the mobile machine via conveying apparatus to create discharged stock piles for subsequent extraction from the mine.

[0004] Continuous bolter miners typically comprise a pair or set of bolting rigs positioned laterally either side of the moveable boom. The rigs are operational to simultaneously bolt roof straps to the roof surface of the mine as the miner is advanced by the cutting head progressing forward through the deposit seam. Conventionally, the roof bolting rigs are tiltably mounted at the main frame of the machine to allow roof bolts to be installed at varying positions across the roof extending over the miner. An alternative configuration is to mount the bolting rigs on a sliding arrangement to allow the drill/bolt head to slide laterally between inner and outer positions across the width of the miner. However, conventional arrangements are typically complex involving a significant number of moving components that, in the dust laden environment in which the miner is operational, require regular maintenance and servicing to avoid failure. Such arrangements however remain susceptible to disruption that can impede the continuous mining and bolting operation. Furthermore, conventional drill rig mounting assemblies are

typically bulky arrangements and restrict the capability of the drill head to be positioned as close-as-possible to the main elongate centre of the miner which is desirable. These bulky mountings also prevent the drill rig from being positioned immediately behind the rotating cutting head which is again desirable to support the tunnel surface immediately behind the cutting face. Accordingly, what is required is a roof bolting rig having a mounting assembly that addresses the above problems.

Summary of the Invention

[0005] It is an objective of the present invention to provide a mining machine roof bolting rig and in particular a mounting assembly for a bolting rig that is robust in the operational environment of the miner and allows the drill head to be moved between a plurality of positions including a position very close to the longitudinal centre of the miner, to an extreme laterally outboard position and to a position immediately behind the cutting head.

[0006] The objectives are achieved by providing a roof bolting rig having a first and second component base frame such that the second frame is pivotally mounted at the first to be configured for tilting back and forth relative to the frame and a main frame of the mining machine. This configuration is specifically advantageous to allow the reliable movement of the drill head to a position immediately behind and in close proximity to the cutting head at the region of the tunnel roof. The present invention further comprises at least one link arm that is pivotally mounted to a part of the base frame such that an upper end of the link arm is capable of pivoting laterally in a sideways direction towards and away from the cutting boom of the mining machine. Accordingly, the drill head is therefore capable of being displaced to a position immediately adjacent one side of the cutting boom and to an extreme laterally outward position at one side of the mining machine furthest from the central cutting boom.

[0007] The present drill rig mounting assembly comprises at least one first pivot mounting to couple the first and second base frame components and a further set of pivot mountings associated with the link arms to allow the lateral sideways deflection of the rig. The respective pivot mountings associated with the base and the link arms are preferably aligned perpendicular to one another and spatially separated at different regions of the rig to provide a robust and reliable construction effective over a large range of motion in both the forward and backward and sideways directions. Furthermore, the use of pivot mountings within the rig mounting arrangement is significantly less complex than existing bolting rigs which is advantageous to minimise maintenance and the overall weight of the miner and associated components.

[0008] According to a first aspect of the present invention there is provided a mining machine roof bolting rig comprising: a drill or bolt head for positioning at a roof to secure a roof strap to a mine roof; a first rig base frame mountable at a main frame of a mining machine to couple

the rig to the machine; characterised by: a second rig base frame pivotally mounted at the first base frame and configured tilt back and forth relative to the first frame; a carrier support to mount the drill or bolt head; and at least one link arm pivotally mounted at a first end to the second frame and pivotally mounted at a second end to the carrier support, the link arm extending upwardly from the second frame; wherein the pivotal mounting of the link arm is substantially perpendicular or transverse to the pivotal mounting of the second frame at the first frame so that the carrier support is configured to pivot laterally in a sideways direction relative to the first frame.

[0009] Reference within the specification to a '*drill or bolt head*' refers to a device configured to create a bore and/or to embed an anchorage bolt, screw, pin or the like into a mine tunnel roof. The head may therefore be a drill unit known in the art or a hammer-like actuator to punch or thrust an elongate element into the roof via a linear motion.

[0010] In one specific implementation, the drill or bolt head is mounted at a shuttle with the shuttle mounted at an elongate carrier. The rig further comprises a drive arrangement configured to move the shuttle upward and downward at the elongate carrier relative to a head plate for positioning at the roof to support the roof strap for bolting to the roof. The shuttle, elongate carrier and drive arrangement may comprise conventional components known in the art. In particular, the elongate carrier may be a telescopic arrangement with the assembly configured to propel the drill (or bolt) head from a lower position substantially at the machine to a raised or elevated position at the head plate to perform the drilling or bolting action. Optionally, the drill rig comprises a chain drive mechanism (to mount the shuttle at the elongate carrier) and at least one linear actuator, optionally being a power operated linear actuator, to drive the telescopic extension of the carrier to both raise and lower the drill or bolt head (and the head plate) in the substantially vertical direction between the mining machine and the miner roof.

[0011] Optionally, the rig further comprises a linear actuator extending between the second frame and the link arm to drive the pivotal movement of the carrier support in the sideways direction. Such an arrangement is advantageous, due to its simple construction to provide reliable operation in the rough dusty environment of a mine. Optionally, a first end of the actuator is attached to an inboard side of the second frame and a second end of the actuator is attached towards an upper end of the link arm. Accordingly, the actuator is configured to provide a direct pushing force to the link arm to maximise power draw efficiency of the actuator. Preferably, the rig further comprises a linear actuator extending between the first frame and the second frame to drive the tilting movement of the second frame back and forth relative to the first frame. Again, the use of a linear actuator for this function provides a robust construction that requires minimum maintenance. Preferably, the linear actuators that drive the i) forward and rearward and ii) lateral side-to-side

movement of the second frame and link arm, respectively, comprise power operated cylinders such as hydraulic or pneumatic cylinders conventional to the art. The rig and/or mining machine may further comprise actuator drive components to impart the linear extension and retraction of the cylinders.

[0012] Optionally, the second frame projects upwardly from one end of the first frame. In particular, the second frame may be attached pivotally at the first frame via one end of the second frame. This configuration is beneficial to provide that the drill head component is mounted at the optimum position relative to the rotating cutting head whilst minimising the size and weight of the rig component parts. In particular, a second and uppermost end of the second frame may be configured to pivot from a position substantially vertically above a forwardmost end of the first frame to a position forwardmost of said end of the first frame. Utilising a pivot mounting is advantageous over conventional sliding arrangements that are subject to particulate and dust ingress that in turn accelerates component wear. The pivoting components are effectively shielded from the dusty environment and a reliable and robust coupling is provided accordingly. Attachment of the base frames at their respective ends also increases the range of movement in the forward and rearward direction.

[0013] Preferably, a pivot axis by which the second frame is mounted at the first frame is orientated substantially perpendicular or transverse to a pivot axis by which the link arm is mounted at the second frame such that the carrier support is configured to move in a sideways direction substantially perpendicular or transverse to the forward and backward tilting movement of the second frame. In such a configuration, the movement of components in both the longitudinal and lateral directions does not interfere with one another and accordingly the maximum available reach of the rig in these directions (during bolting operations at the roof) is optimised. Preferably, a pivot axis between the first and the second frame and a pivot axis between the link arm and the second frame are substantially perpendicular. Preferably, the rig comprises two pivot mountings coupling the second frame to the first frame and optionally a single pivot pin extending through the pivot mountings. Utilizing a single pivot pin extending between two pivot mountings provides a robust coupling and eliminates twisting and bending deformations during use. Optionally, the pivot mountings are positioned at respective ends of the first frame and the second frame. As indicated, this configuration is advantageous to maximise the longitudinal and lateral movement to achieve roof bolting as close as possible to the cutting face and the central longitudinal axis of the miner.

[0014] Preferably, the rig comprises two link arms independently pivotally mounted between the second frame and the carrier support. The dual link arm arrangement is effective to stabilise the carrier support to provide control of the lateral sideways movement and the additional working component of the vertically extendable rig

including the carrier support, linear actuators, shuttle, drill motor and shuttle drive components. Optionally, the link arms may be arranged parallel or non-parallel to one another and extend upwardly from the second frame. The orientation of the link arms relative to one another may be optimised to ensure components of the rig move in non-touching contact with one another and components of the mining machine without compromising the maximum reach in the longitudinal and lateral directions. Preferably, the at least one link arm is pivotally mounted at the second frame at a position laterally outboard of the position of attachment of the second frame to the first frame. This arrangement is effective to maximise the extension of the rig laterally outward away from the central cutting boom to provide roof bolting over an extended lateral distance at and beyond the lengthwise sides of the mining machine. Accordingly, an upper second end of the at least one link arm is configured to move laterally side-to-side between an inboard side of the first and second frame and an outboard side of the first and second frame and towards and away from a cutting boom of the mining machine that supports the cutting head.

[0015] Preferably, the carrier is mounted directly to the carrier support. Optionally, the carrier is mounted indirectly at the carrier support and/or may be stabilised at the carrier support via at least one attachment (or mounting) flange. Optionally, the attachment flange is adjustably mounted between the carrier and the carrier support to allow variation of the position of the carrier at the carrier support and in particular adjustment of the height of the carrier relative to the first and/or second frame. The adjustable attachment flange is advantageous to allow manual manipulation of the relative height position of the rig at the mining machine to suit a desired tunnel roof height within the mine. For example, the present rig arrangement allows a manual setting of the maximum available reach of the bolting head towards the cutting face and laterally over the centre and to the side of the mining machine as desired.

[0016] According to a second aspect of the present invention there is provided a mining machine or a continuous mining machine comprising at least one roof bolting rig as claimed herein.

[0017] Optionally, the mining machine is a continuous bolter miner. Optionally, the mining machine may comprise at least two roof bolting rigs mounted at a forward end of a main frame of the mining machine, the rigs positioned laterally to each side of a cutting boom projecting forwardly at the mining machine and mounting a cutting head. That is, the mining machine may comprise a plurality of roof bolting rigs mounted laterally at each side of the central cutting boom. Optionally, each of the plurality of rigs may be mounted at a common first frame such that the mining machine comprises a plurality of second frames each pivotally mounted at the common first frame. Such an arrangement may reduce the effective number of working components of the rig and/or mining machine to reduce maintenance and provide a sim-

ple, reliable and robust construction.

[0018] Preferably, the rigs are positioned immediately behind the cutting head. Preferably, at least one rig is positioned immediately adjacent one side of the central cutting boom. The relative positioning of the rig with respect to the cutting head and cutting boom is advantageous to allow roof bolting substantially at the longitudinal centre of the machine and at or immediately behind the cutting face so as to stabilise the roof and avoid undesirable collapse during and post cutting.

Brief description of drawings

[0019] A specific implementation of the present invention will now be described, by way of example only, and with reference to the accompanying drawings in which:

Figure 1 is an external perspective view of a continuous bolter miner having a drill or bolt rig mounted laterally to one side of a central cutting boom to support the cutting head according to a specific implementation of the present invention;

Figure 2 is an external side elevation of the bolter miner of figure 1;

Figure 3 is a plan view of the bolter miner of figure 2;

Figure 4 is an external rear perspective view of the bolting rig assembly of figures 1 to 3;

Figure 5 is a plan view of the bolting rig assembly of figure 4;

Figure 6 is a further rear perspective view of the bolting rig assembly of figure 5;

Figure 7 is a view from the front of the miner with the cutting head and cutting boom removed for illustrative purposes with the rig configured to be positioned at an extreme inboard position for bolting at a central position of the miner;

Figure 8 is a further front perspective view of the rig of figure 7 configured in an extreme outboard position for bolting at a laterally outward position remote from the central cutting boom.

Detailed description of preferred embodiment of the invention

[0020] Referring to figure 1, the mining machine 100 comprises a main frame 101 that provides support for an undercarriage or chassis 109 that supports a pair of endless driven tracks 113 for propelling the machine 100 over the ground and along a tunnel to advance forwardly through a material deposit seam. Main frame 101 comprises a generally forward end 102 and a generally rear-

ward end 103. A conveyor 104 extends substantially from forward end 102 to rearward end 103 and is adapted to carry material dislodged from the cutting face for subsequent discharge and stock piling at a remote location optionally using additional conveying and mining apparatus. A movable cutting boom 105 is pivotally mounted at one end 112 via a pivoting bracket 110 to main frame 101 and comprises a second end 106 mounting a cutting head 115 that in turn mounts a plurality of rotatable drums 107. Cutting bits 108 project radially from each drum 107 and are specifically adapted to cut into and dislodge the mineral material to be mined from the seam. Boom 105 and in particular end 106 is capable of being raised or lowered relative to main frame 101 and endless tracks 113 to enable machine 100 to cut the seam face over a varying height range above the ground of the mine tunnel. Boom 105 is operated by hydraulic rams 201 (referring to figure 2) and other associated components as will be appreciated by those skilled in the art.

[0021] A canopy 111 comprises a vertically uppermost region having a generally planar configuration and is adapted for being raised vertically upward from frame 101 in a manner similar to cutting boom 105 so as to contact the mine roof to provide structural support as necessary during the cutting and roof bolting operations. Additionally, a tail section 114 projects rearwardly from the rearward end 103 of frame 101 to carry rearwardly conveyor 104 to a discharge end 116 representing a rearward most part of the continuous machine 100. Machine 100 further comprises a gathering head 117 mounted at forward end 102 via a head mounting bracket 200 (referring to figure 2). Head 117 is configured to collect material removed from the deposit seam by the cutting action of head 115. The cut material is then transported rearwardly of machine 100 via conveyor 104.

[0022] As illustrated in figures 3 to 8, machine 100 further comprises a roof bolting rig indicated generally by reference 118 and mounted at the forward end 102 of frame 101 laterally to one side of cutting boom 105. Rig 118 is positioned immediately behind a boom arm 304 that extends laterally to one side of the central boom 105 and immediately behind cutting head 115. Rig 118 comprises a first base frame 300 rigidly attached to frame 101 and projecting forwardly from frame 101. A second frame 301 extends upwardly from one end of frame 300 to mount the remaining components of the rig, as described in further detail below, including in particular a head plate 302 configured for positioning in contact with the roof of the mine to support a roof strap for bolting to the roof by the rig 118. As illustrated in figure 3, rig 118 is positioned laterally to one side 303 of cutting boom 105.

[0023] Referring to figure 4, first frame 300 is rigidly attached to the forwardmost end of the main frame 101 via anchorage mounts 402. As illustrated in figure 7, second frame 301 is pivotally attached at a first end 705 to a second end of first frame 300 via a pivot mounting arrangement. In particular, the pivotal coupling of first frame 300 to second frame 301 is achieved via a single pivot

pin 704 extending through a first pivot mounting 707 and a second pivot mounting 703. In particular, first pivot mounting 707 is positioned at an inboard side of first and second frames 300, 301 whilst second pivot mounting 703 is positioned at an outboard side of the first and second frames 300, 301 relative to the central cutting boom 105.

[0024] At a fully retracted position illustrated in figures 3 to 8, a plane of second frame 301 is aligned perpendicular to a plane of first frame 300. A manual adjustable spindle 411 is attached at respective ends to first frame 300 and second frame 301 such that by linear extension, frame 301 is configured to pivot forwardly via pin 704.

[0025] Second frame provides a mounting region for a pair of link arms 403 that extend upwardly from a second end 706 of frame 301. Each link arm 403, a lowermost region, comprises a bore (not shown) to receive a pivot pin 413 such that each arm 403 is capable of lateral sideways pivoting movement about each respective pin 413 relative to frame 301. A first link arm 403 comprises a substantially straight configuration and is positioned laterally closest to side 303 of boom 105. An outboard link arm 403 comprises a generally dog-leg configuration having a main length 700 and a relatively shorter angled second length 701 that extends in the outboard direction from main length 700 away from boom 105.

[0026] A hydraulic linear actuator 410 comprises a first end 417 mounted at an inboard side 416 of frame 301 and a second end 418 mounted towards the upper end of the inboard link arm 403 via a mounting flange 500. Link arms 403 are coupled at their uppermost regions by pivotal attachment to a carrier support 404 via respective pivot pins 702 extending through respective pivot mountings 412 at support 404 and respective bores (not shown) extending through the upper ends of each link arm 403. Mountings 412 are positioned at an uppermost region 419 of support 404.

[0027] The bolting rig 118 further comprises an elongate carrier 405 being a telescopic carrier arrangement known in the art in which a shuttle 406 is slidably mounted at a plurality of runners (at carrier 405) to allow shuttle 406 to move in the upright direction from first frame 300. Carrier 405 typically comprises a chain drive mechanism and a plurality of linear actuators 600, 601, with at least one actuator coupled to head plate 302 such that when powered, head 302 is capable of being displaced in the upward direction to contact the mine roof followed by the upward movement of shuttle 406 along carrier 405 towards head 302. Shuttle 406 comprises a drill head 408 and a suitable drive motor 407. Drill head 408 comprises a drill or bolt bit 501 for boring into the mine roof to enable anchorage of a screw or bolt element to secure the roof strap at the roof. The carrier 405 and shuttle assembly 406 (including plate head 302) is mounted at carrier support 404 via an intermediate mounting flange 414. A brace 415 provided at support 404 allows adjustable mounting of flange 414 to provide positional adjustment in the upright direction (from first frame 300) of carrier

405 at support 404.

[0028] Accordingly, the drill or bolt head 408 is coupled to main frame 101 via mounting flange 414, carrier support 404, link arms 403 and the first and second rig base frames 300, 301 respectively. Via actuation of manual adjustable spindle 411, the entire carrier assembly including carrier 405, drill head 408 and head plate 302 is moved in a forward direction towards boom arm 304 such that when carrier 405 and head 302 are extended vertically upward, the drill head 408 is capable of reaching forward over and above boom arm 304 at a position of the mine roof immediately behind the cutting face creating by cutting head 115. Advantageously, the pivotal mounting of second frame 301 at first frame 300 provides a reliable moving mechanism in the harsh working environment immediately behind the cutting face.

[0029] The present rig 118 is further configured to deflect drill or bolt head 408 laterally in a sideways direction relative to central boom 105 via pivoting movement of link arms 403 relative to second frame 301. That is, by actuation of hydraulic cylinder 410, the link arms 403 are displaced from the inboard position of figure 7 to the outboard position of figure 8. This motion provides a lateral sideways displacement of carrier support 404 and in turn carrier 405 in a direction perpendicular to the longitudinal axis of machine 100 (and boom 105). Accordingly, head plate 302 and drill or bolt head 408 is capable of contacting the mine roof at a position immediately above central boom 105 when actuator 410 is retracted to the position of figure 7 and to an extreme outboard position laterally to one side of tracks 113 when actuator 410 is extended as illustrated in figure 8. Again, this pivoting action of link arms 403 is provided by relatively unsophisticated pivot pin and mounting assemblies that are advantageous when employed in the harsh dust laden environment of the miner 100. As illustrated in figures 7 and 8, link arms 403 extend either an inclined angle upwardly to the right or to the left (when viewed from the front of machine 100) at the extreme ends of lateral movement (corresponding to a full retraction and full extension of cylinder 410) such that an angle by which the borehole is formed in the mine roof is less than 10° from vertical. In one aspect, mounting flange 414 may be rigidly mounted between support 404 and carrier 405 or may be pivotally mounted and adjustable between support 404 and carrier 405 to provide dynamic variation of the angle by which drill head bit 501 may be embedded into the mine roof.

Claims

1. A mining machine roof bolting rig (118) comprising:

a drill or bolt head (408) for positioning at a roof to secure a roof strap to a mine roof;
a first rig base frame (300) mountable at a main frame (101) of a mining machine (100) to couple the rig (118) to the machine (100);

characterised by:

a second rig base frame (301) pivotally mounted at the first base frame (300) and configured to tilt back and forth relative to the first frame (300);
a carrier support (404) to mount the drill or bolt head (408); and
at least one link arm (403) pivotally mounted at a first end to the second frame (301) and pivotally mounted at a second end to the carrier support (404), the link arm (403) extending upwardly from the second frame (301);
wherein the pivotal mounting of the link arm (403) is substantially perpendicular or transverse to the pivotal mounting of the second frame (301) at the first frame (300) so that the carrier support (404) is configured to pivot laterally in a sideways direction relative to the first frame (300).

2. The rig as claimed in claim 1 further comprising a linear actuator (410) extending between the second frame (301) and the link arm (403) to drive the pivotal movement of the carrier support (404) in the sideways direction.
3. The rig as claimed in claim 2 wherein a first end (417) of the actuator (410) is attached to an inboard side of the second frame (301) and a second end (418) of the actuator (410) is attached towards an upper end of the link arm (403).
4. The rig as claimed in any preceding claim further comprising a manual adjustable spindle (411) extending between the first frame (300) and the second frame (301) to drive the tilting movement of the second frame (301) back and forth relative to the first frame (300).
5. The rig as claimed in claims 2 and 4 wherein the linear actuator (410) and the manual adjustable spindle (411) each one comprise a power operated cylinder.
6. The rig as claimed in any preceding claim wherein the second frame (301) projects upwardly from one end of the first frame (300).
7. The rig as claimed in any preceding claim wherein a pivot axis by which the second frame (301) is mounted at the first frame (300) is orientated substantially perpendicular or transverse to a pivot axis by which the link arm (403) is mounted at the second frame (301) such that the carrier support (404) is configured to move in a sideways direction substantially perpendicular or transverse to the forward and

backward tilting movement of the second frame (301).

8. The rig as claimed in any preceding claim comprising two pivot mountings (707, 703) coupling the second frame (301) to the first frame (300). 5
9. The rig as claimed in any preceding claim comprising two link arms (403) independently pivotally mounted between the second frame (301) and the carrier support (404). 10
10. The rig as claimed in any preceding claim wherein the drill or bolt head (408) is mounted at a shuttle (406) and the shuttle (406) is mounted at an elongate carrier (405); and 15
the rig (118) further comprises a drive arrangement configured to move the shuttle upward and downward at the elongate carrier (405) relative to a head plate (302) for positioning at the roof to support the roof strap for bolting to the roof. 20
11. The rig as claimed in claim 10 wherein the elongate carrier (405) is mounted at the carrier support (404) via a mounting flange (414). 25
12. A mining machine or a continuous mining machine (100) comprising at least one roof bolting rig (118) as claimed in any preceding claim. 30
13. The mining machine as claimed in claim 12 comprising at least two roof bolting rigs (118) mounted at a forward end (102) of a main frame (101) of the mining machine (100), the rigs (118) positioned laterally to each side of a cutting boom (105) projecting forwardly at the mining machine (100) and mounting a cutting head (115). 35
14. The mining machine as claimed in claim 13 wherein the rigs (118) are positioned immediately behind the cutting head (115). 40

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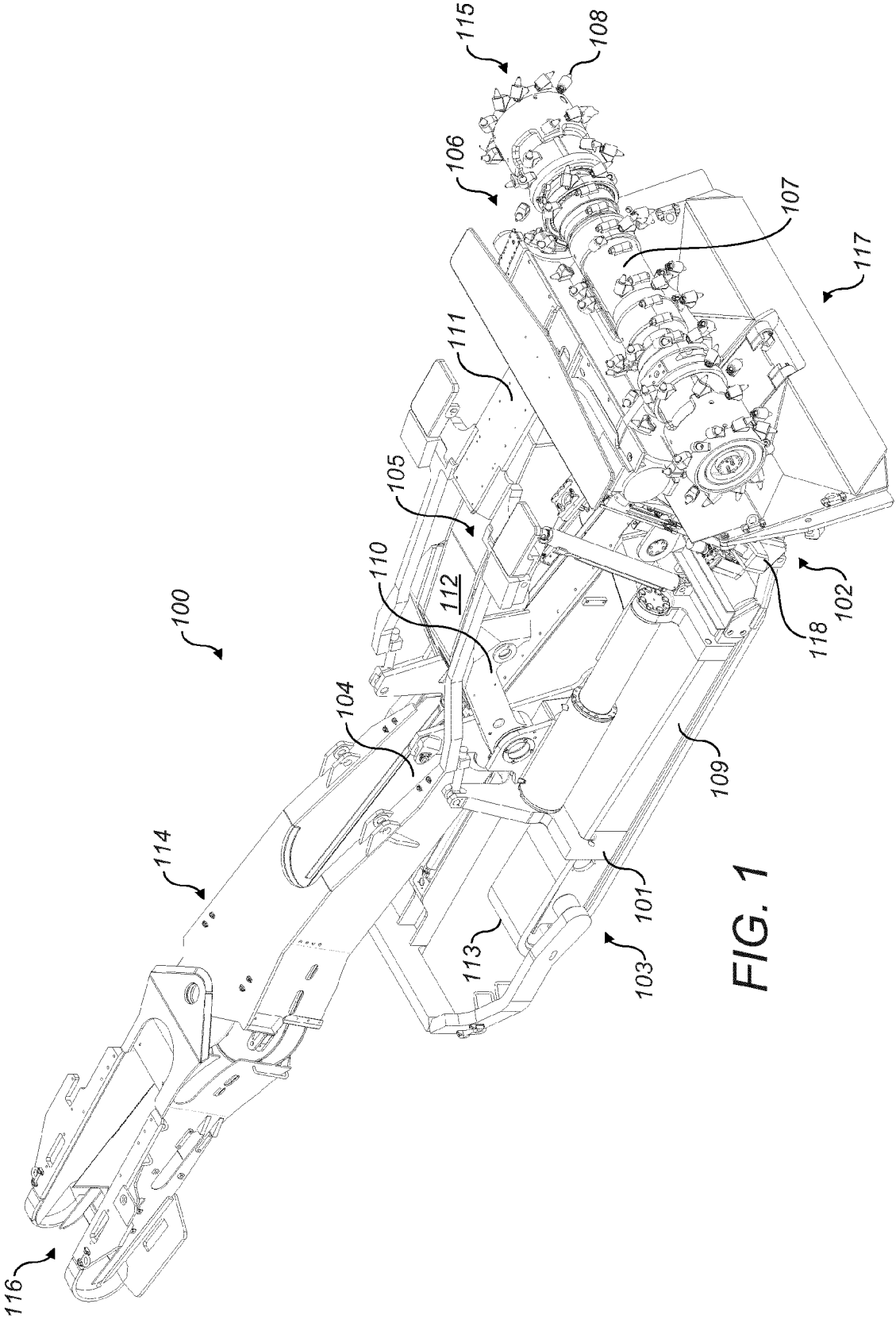


FIG. 1

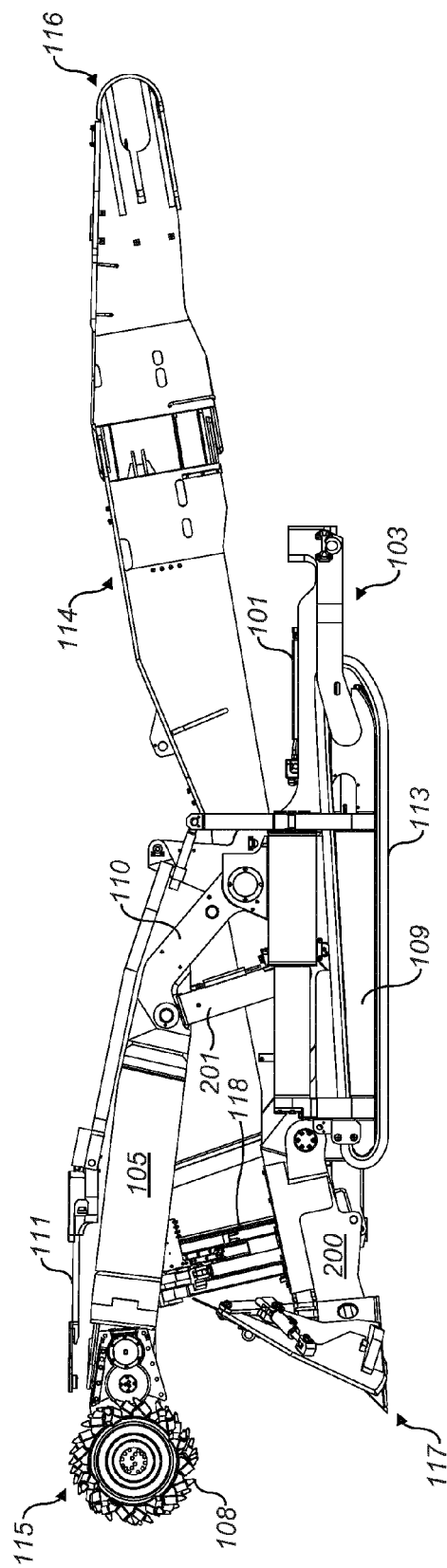
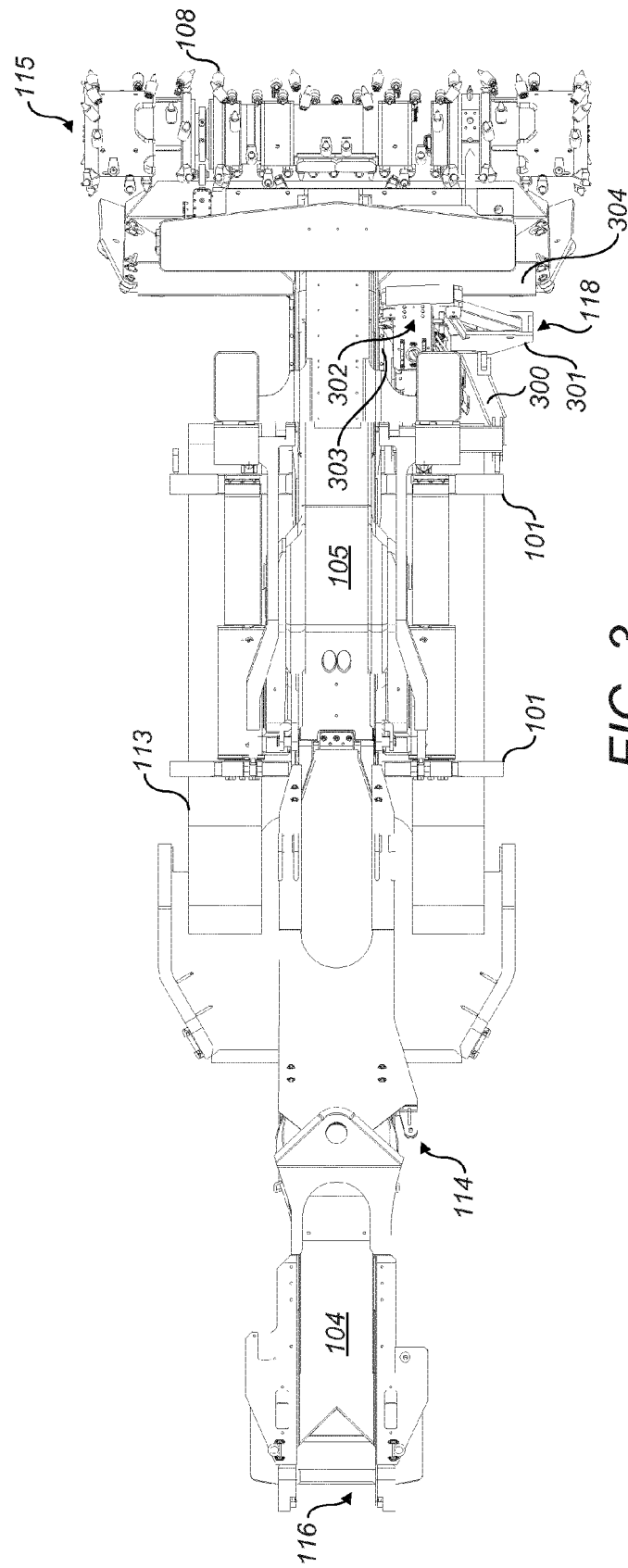


FIG. 2



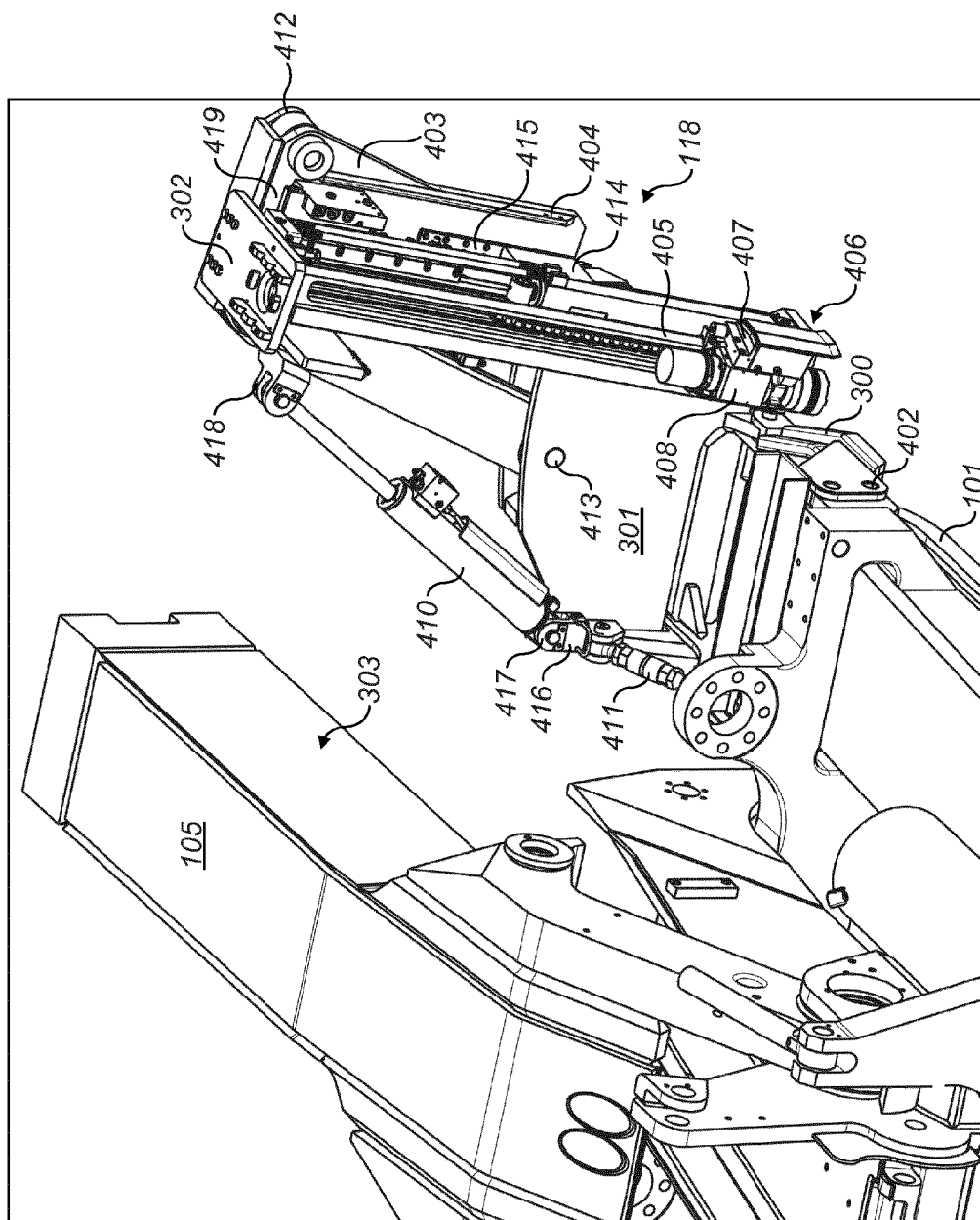


FIG. 4

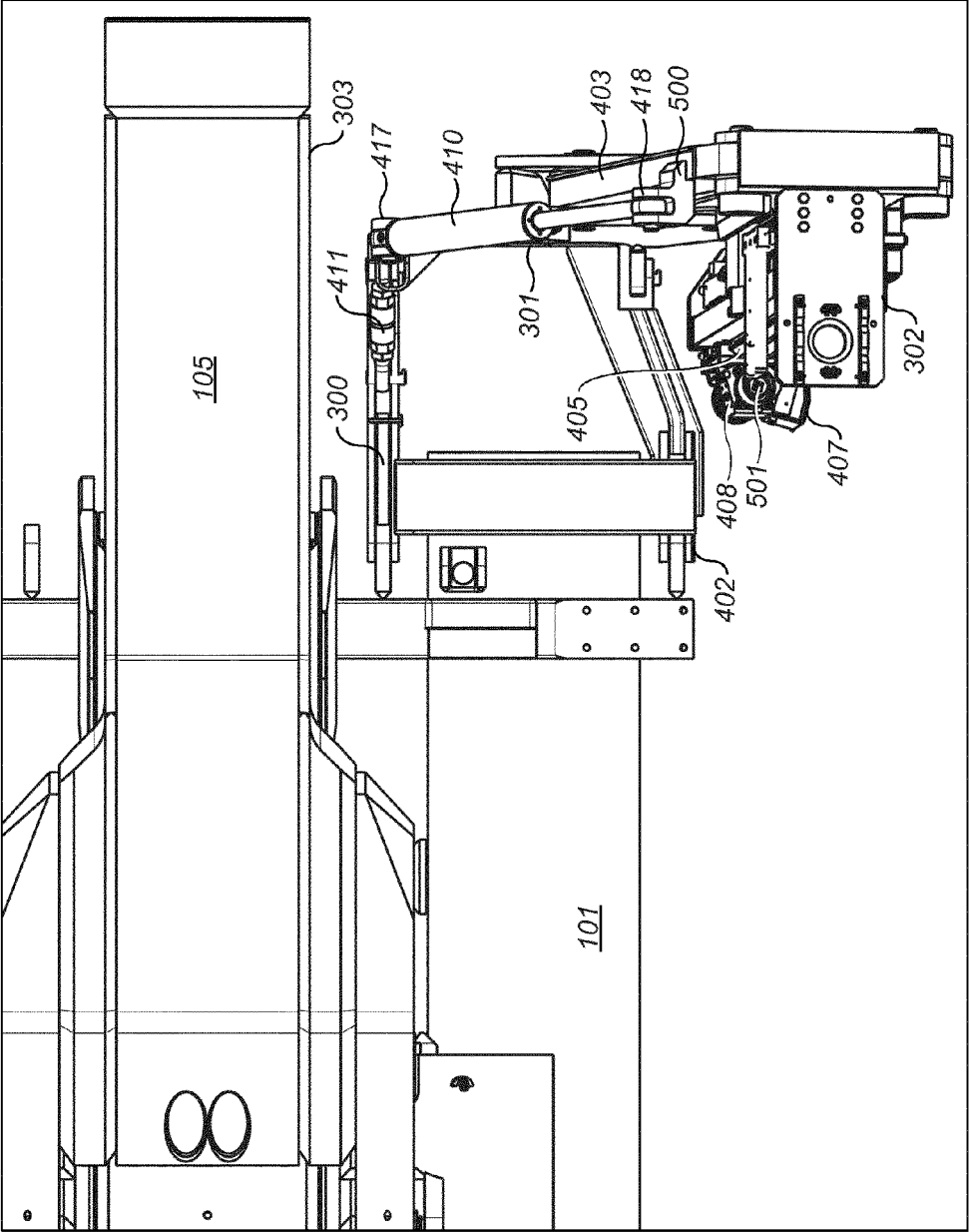


FIG. 5

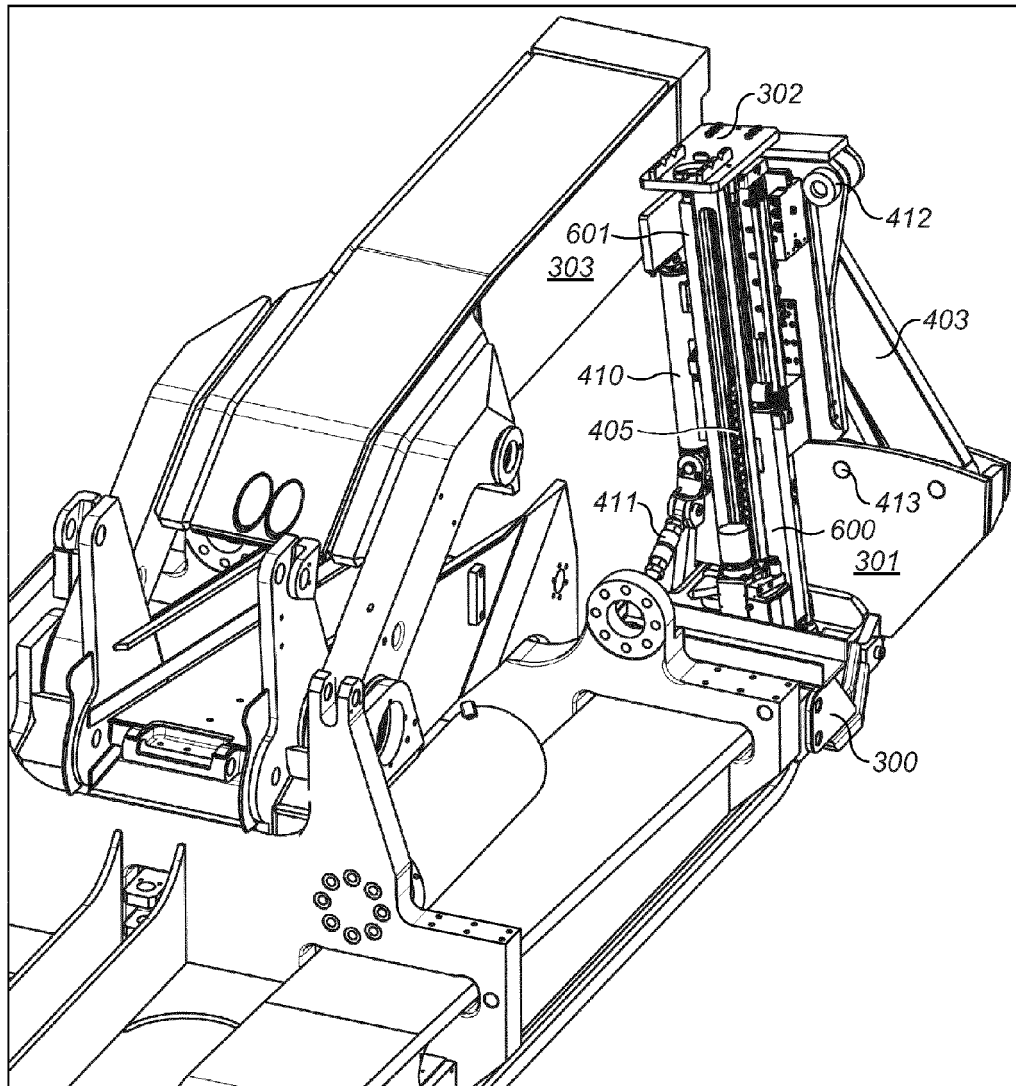


FIG. 6

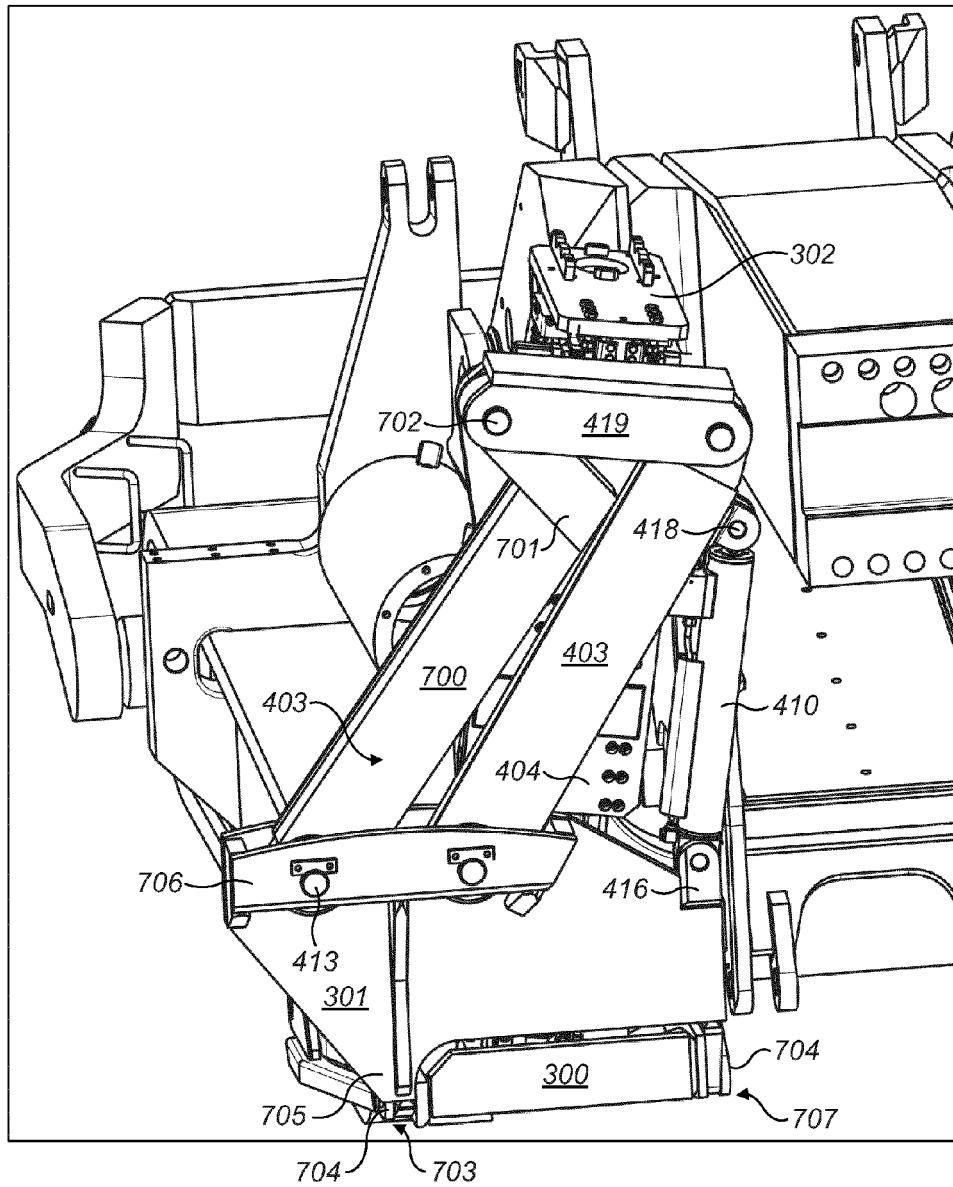


FIG. 7

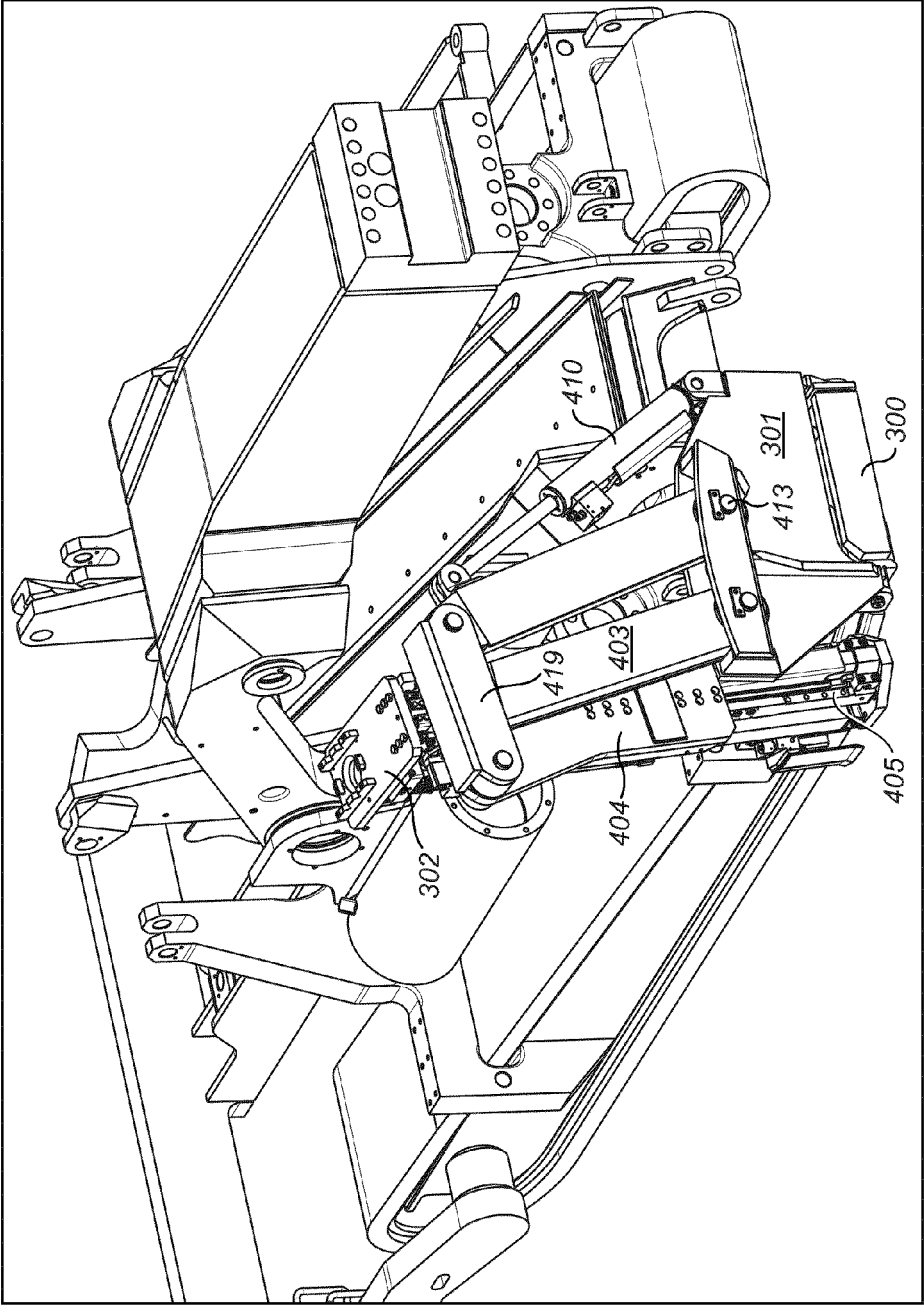


FIG. 8



EUROPEAN SEARCH REPORT

Application Number
EP 13 17 5089

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	DE 31 08 877 C2 (VOEST ALPINE AG [AT]) 13 October 1983 (1983-10-13) * the whole document *	1-14	INV. E21C27/24 E21D20/00
A	US 2003/111892 A1 (NEILSON BRAD [AU] ET AL) 19 June 2003 (2003-06-19) * paragraphs [0038] - [0041], [0046], [0052] *	1-14	
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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 17 December 2013	Examiner Garrido Garcia, M
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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