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(54) **Mining machine cutting head drive assembly**

(57) A mining machine (100) to extract material from a deposit in which a rotatable cutting head (115) is mounted at a boom (105) and is capable of being raised and lowered at the cutting face. The machine comprises a single motor (400) to drive rotation of the cutting head

(115) with the motor mounted at the cutting boom immediately behind the rotating head. A gear assembly (401) is also mounted at the cutting boom (105) and is coupled to the drive motor (400) via an elongate shaft (402).

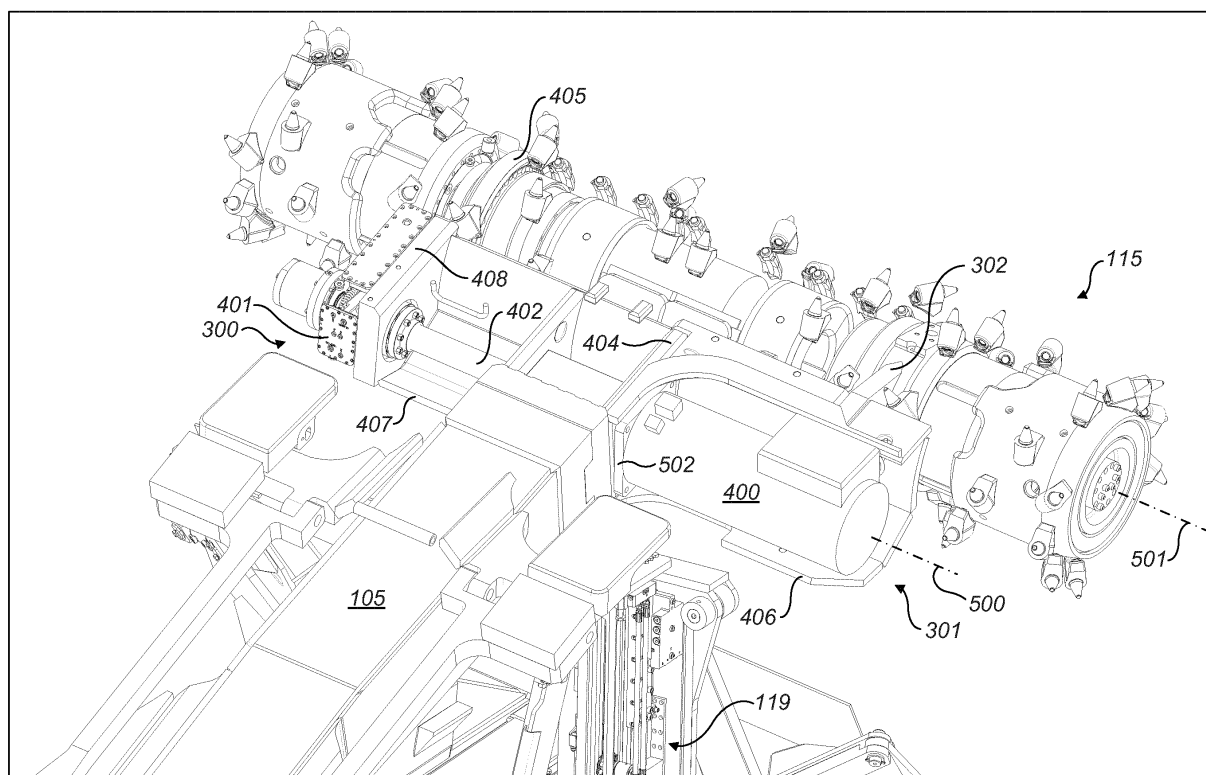


FIG. 5

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Description

Field of invention

[0001] The present invention relates to a mining machine and in particular, although not exclusively, to a bolter continuous mining machine having a rotating cutting head mounted at a cutting boom in which drive components for the rotating cutting head are mounted at a region of the cutting boom.

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] Rotation of the cutting head is typically powered by an electric motor from which drive is routed through a gear assembly. Conventionally, the electric motor is positioned coaxially *within* the elongate cutting head. This arrangement necessitates a rather sophisticated gearing assembly in which a plurality of sets of planetary gears orbit central gears and drive shafts. An example drive arrangement for a continuous miner is described in GB 2476575; WO 00/36230; US 4,047,763 and GB 2018329. However, as will be appreciated, the complex gearing assembly together with the need for extensive seals and bearings increases the operational complexity of the machine and hence the need for regular maintenance and servicing. The number of working component parts also increases the risk of part failure and the overall weight of the machine. What is required therefore is a drive assembly for a mining machine that addresses the above problems.

Summary of the Invention

[0005] It is an objective of the present invention to provide a mining machine and in particular a drive assembly for a mining machine that reduces, as far as possible, the number of component working parts as part of the system to provide a drive transmission for a rotating cutting head of a miner that is lightweight, efficient and operationally robust. It is a further objective to configure the drive assembly to occupy a minimum volume at the region of the rotating cutting head so as to not obscure roof bolting rigs positioned immediately behind the cutting head to achieve roof bolting in close proximity to the cutting face.

[0006] The objectives are achieved by providing a drive mechanism mounted at one end of a cutting boom that mounts the rotating cutting head at the miner. In particular, the cutting boom preferably comprises a generally T-shaped configuration with the base of the 'T' pivotally coupled to the miner with a motor and a gear box assembly mounted respectively at the two upper and lateral arms of the 'T'. In particular, the motor is positioned at, or preferably accommodated within, a first arm of the 'T' whilst the gear box and associated drive components are accommodated in a second arm of the 'T'. An elongate drive shaft extends from the motor to the gear box between the arms and is aligned substantially perpendicular to a main length of the cutting boom. The drive is transferred to the rotating cutting head via one or a plurality of gear carriers that extend from the boom arms to the rotating head.

[0007] Preferably, the cutter motor is electric. Alternatively, the cutter motor may be a hydraulic motor. Preferably, the cutter motor is aligned parallel to a main axis of the rotating cutting head and this is advantageous to both minimise the space taken by the motor and to allow efficient drive transmission. Advantageously, the motor and gear box is accommodated within the end of the cutter boom to be positioned immediately behind the rotating head. In the event of any mechanical problems associated with the motor and/or gear box, service or maintenance axis is relatively straightforward particularly with respect to conventional arrangements where these components are mounted integrally within the cutting head. Additionally, the requirement for sophisticated multiple sets of planetary gears, bearings and seals is avoided to provide a much simpler, robust and more reliable drive configuration.

[0008] The present arrangement is further advantageous by requiring a single motor and gear box operative to supply drive to the entire cutting head. Accordingly, the present configuration provides convenient utilisation of a more high powered motor than conventional arrangements that may comprise two separate motors accommodated within the head having a size limited by the available dimensions of the cutting head interior.

[0009] According to a first aspect of the present invention there is provided a mining machine to extract material

from a deposit, the machine comprising: a main frame; a cutting boom pivotally mounted towards a first end at the main frame; a cutting head rotatably mounted at a second end of the cutting boom, the boom capable of raising and lowering the cutting head relative to the main frame; a cutting head motor to drive rotation of the cutting head and a gear assembly drivably connected between the motor and the cutting head to transmit power from the motor to the head; **characterised in that:** the machine comprises a single motor to drive rotation of the head, the single motor mounted at a first side of the boom at the second end immediately rearward of the cutting head; and the gear assembly is mounted at a second side of the boom at the second end immediately rearward of the cutting head, at least one drive shaft drivably coupled between the motor and the gear assembly.

[0010] Preferably, the cutting head comprises at least one elongate cutting drum and the motor comprises a main axis that is positioned substantially parallel to a longitudinal axis of the cutting drum to allow close positioning of the motor behind the cutting head.

[0011] Preferably, the machine further comprises at least one gear or shaft extending between the cutting head and the gear assembly to transfer drive from the gear assembly to the rotatable cutting head. Preferably, the machine further comprises at least a pair of bearing carriers to mount the cutting head at the boom, the gear or shaft extending through one of the bearing carriers. Such an arrangement is advantageous to provide mounting of the cutting head at the boom whilst creating a housing for components of the drive transmission between the head and the boom. Preferably, the bearing carriers extend between a region of the motor and the cutting head and the gear assembly and the cutting head, respectively. The load of the cutting head is therefore distributed at the supporting boom. The bearing carriers may comprise any generally hollow shell configuration having sufficient structural integrity to mount the components of the cutting head at the forwardmost end of the cutting boom.

[0012] Preferably, the machine further comprises a single elongate drive shaft coupled between the motor and the gear assembly. This is effective to reduce the number of component working parts and hence minimise the weight of the drive transmission assembly. Preferably, the drive shaft is positioned coaxially with an elongate axis of the motor and/or a longitudinal axis of the cutting head to reduce the demand on seals and the need for sophisticated bearings and other interconnecting components. Preferably, the drive shaft is aligned perpendicular to a main axis of the cutting boom and is positioned to extend through a forwardmost end of the cutting boom or a bracket attached to a forwardmost end of the cutting boom. The transmission of drive from the motor to the gear assembly is therefore robust to minimise servicing and the risk of failure.

[0013] Preferably, the boom comprises a first arm housing extending at the first side of the boom at the

second end, the motor accommodated at least partially within the first arm housing. Preferably, the boom also comprises a second arm housing extending at the second side of the boom at the second end, the gear assembly accommodated at least partially within the second arm housing. As will be appreciated the housings protect the internal components within the harsh working environment of the machine. Mounting these components within the boom offers better protection than conventional mounting within the rotating cutting head that is subject to significantly higher shock impacts. Extended longevity and reduced servicing of the motor and its associating mountings/components is therefore a particular advantage with such an arrangement.

[0014] According to the specific implementation, the single motor is configured to drive rotation of each of the rotatable cutting drums at the cutting head such that the mining machine does not comprise a second, third or fourth drive motor associated with the cutting head components. Accordingly, the present invention may comprise a single high powered motor that is capable of more power output than would be available from two separate motors mounted within the cutting head.

[0015] Preferably, the gear assembly is configured to receive drive from the motor via the drive shaft and to transmit the drive to the head in a direction substantially perpendicular to an axis of the drive shaft. Accordingly, an efficient drive transmission pathway is created to maximise power transfer and minimise component wear inherent to complex cutting-head-mounted transmissions common to existing machines.

[0016] Optionally, the machine is a continuous mining machine comprising at least one roof strap bolting rig. Optionally, the machine comprises a bolting rig positioned at either side of the forward end of the cutting boom immediately behind the first and second arm housings that project laterally from the boom. Optionally, the machine comprises a plurality of bolting rigs positioned at either side of the cutting boom immediately behind the cutting head.

[0017] Preferably, the motor is positioned between the at least one bolting rig and cutting head in a lengthwise direction of the machine. The close positioning of the motor and gear assembly behind the cutting head increases the available forward reach of the bolting rig to bolt very close behind the cutting face. This arrangement advantageously provides that, the cutting head is devoid of a drive motor mounted internally within the cutting head. Optionally, the at least one bolting rig is positioned immediately rearward of at least one of the motor and gear assembly.

[0018] Preferably, the machine further comprises at least a first planetary gear mounted internally within the cutting head and drivably coupled to the gear assembly. Optionally, the machine further comprises at least a second planetary gear mounted internally within the cutting head and drivably coupled to the gear assembly. The present arrangement and relative positioning of the motor

and gear assembly at the boom reduces the number of component parts within the cutting head and the complexity of the drive transmission between the motor and the rotating drums. A minimum number of planetary gear arrangements within the cutting head is therefore possible.

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 a perspective view of a bolter mining machine configured for mineral cutting with simultaneous bolting of the mine roof in which a drive mechanism for a rotating cutting head of the machine is mounted at the region of a cutting boom that supports the rotating head according to a specific implementation of the present invention;

Figure 2 is a side elevation view of the mining machine of figure 1;

Figure 3 is a plan view of the mining machine of figure 2;

Figure 4 is an upper perspective view of the front end of the mining machine of figure 3 with components of the cutting head and cutting boom removed for illustrative purposes;

Figure 5 is a further upper perspective view of the forward end region of the mining machine of figure 4 with selected components removed for illustrative purposes;

Figure 6 illustrates schematically a cross sectional view through the cutting head of figures 1 to 3 illustrating selected components of the drive transmission configured to transmit drive to the rotating drums of the cutting head from the drive motor.

Detailed description of preferred embodiment of the invention

[0020] The present drive transmission assembly will now be described with reference to a preferred embodiment by way of example mounted upon a bolter miner being an electrically powered, track-mounted continuous mining machine designed to excavate roadways and install roof bolts simultaneously. Such mining machines comprise a series of cutter drums mounted on a hydraulically actuated frame to enable independent movement of the drums relative to a main frame and tracks. The machine also comprises roof bolters mounted on a stationary part of the main frame that can be operated throughout the cutting cycle.

[0021] 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 rearward 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 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 202 (referring to figure 2) and other associated components as will be appreciated by those skilled in the art. Machine 100 further comprises a gathering head 117 mounted at forward end 102 of main frame 101. 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 from gathering head 117 via conveyor 104.

[0022] 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 head 115 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 rearwardmost part of the continuous machine 100. Cutting head 115 is mounted at the forwardmost end 106 of cutting boom 105 and is positionally supported by a pair of gear carriers 302 that extend from boom 105 and couple head 115 to machine 100.

[0023] In particular, and referring to figures 1 and 3, cutting boom 105 comprises a generally T-shaped configuration in which a base end of the 'T' 112 is pivotally mounted to main frame 101 via pivoting mounting bracket 110. A second forwardmost end 106 of boom 105 comprises a first 'T' arm 301 and a second opposite 'T' arm 300 projecting laterally from the main stem of the boom 105. Each arm 300, 301 is positioned immediately behind head 115 such that the separation gap is minimised between a forwardmost end of arms 300, 301 and a rearward facing side of the rotatable central drum 107.

[0024] Cutting head 115 comprises an inner rotating drum 107 and a pair of cutter drum extensions 118 po-

sitioned coaxially at each end of inner drum 107 as illustrated in figures 1 and 3. It will be noted that cutting drums 107, 118 have been removed from figures 4 and 5 for illustrative purposes only.

[0025] Referring to figures 4 and 5, the drive transmission comprises an electric motor 400 mounted at boom arm 301. In particular, motor 400 comprises a substantially cylindrical configuration and is mounted at a mounting flange 502 secured to one side of a bracket 404 representing a forwardmost part of cutting boom 105. Motor 400 comprises a longitudinal axis 500 that is aligned substantially perpendicular to the main axis of boom 105 as illustrated in figure 5. Additionally, motor axis 500 is aligned substantially parallel to a longitudinal axis 501 extending through the elongate cutting head 115. Motor 400 is concealed and accommodated within an arm housing 406 that projects laterally from the side of bracket 404 immediately behind cutting head 115. Additionally, motor 400 and housing 406 are positioned intermediate between head 115 and a bolting rig 119 (mounted at forwardmost end 102 of frame 101) in the longitudinal axis direction of machine 100. Motor 400 is configured to be as slim as possible such that bolting rig 119 can be positioned as close as possible immediately behind head 115. The opposed left hand arm 300 of boom 105 comprises a corresponding arm housing 407 projecting laterally from bracket 404 immediately behind head 115. A mount block 408 is positioned at an outboard end region of housing 407 and provides a mount for a gear assembly 401. Assembly 401, alternatively referred to as a gear box, comprises a plurality of gears, shafts, seals and bearings and is conventional within the art. Housings 406 and 407 extend completely around motor 400 and gear assembly 401 respectively, but are illustrated as small sections only in figures 4 and 5 for illustrative purposes. Drive from motor 400 is transmitted to gear assembly 401 via an elongate drive shaft 402 aligned coaxial with motor axis 500. Shaft 402 extends through bracket 404 via a pair of apertures 409 at each lateral side of boom 105. Additionally, a longitudinal axis of drive shaft 402 is arranged parallel to axis 501 of head 115. Shaft 402 accordingly extends between the right and left hand arms 301, 300 aligned perpendicular to the main axis of beam 105.

[0026] Referring to figure 6, drive is transmitted from the boom mounted gear assembly 401 to the rotatable cutting head 115 via gear assembly 608 mounted within a gear carrier 302 and extending from arm 300 to head 115. Drive is then transferred from gear assembly 608 to a spur gear 606 mounted about an extension cylinder 604 having a piston 603 mounted at an inboard end and a piston rod 607 mounted at an outboard end. Piston rod 607 is mounted internally within cutter drum extension 118 which, in turn, is provided at each end of the inner cutter drum 107. The outboard end of piston rod 607 is secured via end cap 403. A first planetary gear 605 and a second planetary gear 602 are mounted concentrically about extension cylinder 604 and are configured to orbit

cylinder 604 to transfer drive to the cutting drums 107, 118 so as to rotate cutting teeth 108 at the cutting face. Gear and shaft components 602 to 608 are mounted substantially adjacent gear assembly 401 at a region of cutting head 115 immediately forward of the left hand boom arm 300. The region of head 115 immediately forward of the right hand boom arm 301 is also secured via a gear carrier 302 to further structurally support head 115. A piston rod 600 extends centrally along axis 501 and is surrounded by a drive shaft 601 that includes an extension cylinder. Suitable gear and bearings 405 are mounted at the regions of each gear carrier 302 at head 115.

[0027] Mounting and positioning motor 400 immediately behind head 115 and with axes 500 and 501 parallel to one another provides that drive to the rotating drums 107, 118 is efficiently transmitted through the elongate drive shaft 402 (also aligned parallel with axis 501) and gear assembly 401 also mounted immediately behind head 115. Also, the space occupied by motor 400 and gear assembly 401 is minimised to allow bolting rig 119 (illustrated behind right hand arm 301 but with the option of a second rig 119 mounted immediately behind left hand arm 300) to extend upwardly to provide roof bolting substantially above head 115 and immediately behind the cutting face. Servicing and maintenance access is also facilitated by the relative mounting and positioning of motor 400 and gear box 401. Accordingly, the configuration of head 115 may be optimised for cutting without being compromised due to the internal mounting of the motor and gear assembly according to conventional arrangements.

Claims

1. A mining machine (100) to extract material from a deposit, the machine (100) comprising:

- a main frame (101);
- a cutting boom (105) pivotally mounted towards a first end (112) at the main frame (101);
- a cutting head (115) rotatably mounted at a second end (106) of the cutting boom (105), the boom (105) capable of raising and lowering the cutting head (115) relative to the main frame (101);
- a cutting head motor (400) to drive rotation of the cutting head (115) and a gear assembly (401) drivably connected between the motor (400) and the cutting head (115) to transmit power from the motor (400) to the head (115);

characterised in that:

- the machine (100) comprises a single motor (400) to drive rotation of the head (115), the single motor (400) mounted at a first side (301) of the boom (105) at the second end (106) imme-

- diately rearward of the cutting head (115); and the gear assembly (401) is mounted at a second side (300) of the boom (105) at the second end (106) immediately rearward of the cutting head (115), at least one drive shaft (402) drivably coupled between the motor (400) and the gear assembly (401).
2. The machine as claimed in claim 1 wherein the cutting head (115) comprises at least one elongate cutting drum (107) and the motor (400) comprises a main axis (500) that is positioned substantially parallel to a longitudinal axis (501) of the cutting drum (107).
 3. The machine as claimed in any preceding claim comprising at least one gear or shaft (608) extending between the cutting head (115) and the gear assembly (401) to transfer drive from the gear assembly (401) to the rotatable cutting head (115).
 4. The machine as claimed in claim 3 comprising at least a pair of bearing carriers (302) to mount the cutting head (115) at the boom (105), the gear or shaft (608) extending through one of the bearing carriers (302).
 5. The machine as claimed in any preceding claim further comprising a single elongate drive shaft (402) coupled between the motor (400) and the gear assembly (401).
 6. The machine as claimed in any preceding claim wherein the boom (105) comprises a first arm housing (406) extending at the first side (301) of the boom (105) at the second end (106), the motor (400) accommodated at least partially within the first arm housing (406).
 7. The machine as claimed in any preceding claim wherein the boom (105) comprises a second arm housing (407) extending at the second side (300) of the boom (105) at the second end (106), the gear assembly (401) accommodated at least partially within the second arm housing (407).
 8. The machine as claimed in any preceding claim wherein the motor (400) is an electric or hydraulic motor.
 9. The machine as claimed in any preceding claim wherein the gear assembly (401) is configured to receive drive from the motor (400) via the drive shaft (402) and to transmit the drive to the head (115) in a direction substantially perpendicular to an axis of the drive shaft (402).
 10. The machine as claimed in any preceding claim be-
 - ing a continuous mining machine comprising at least one roof strap bolting rig (119).
 11. The machine as claimed in claim 10 wherein the at least one bolting rig (119) is positioned immediately rearward of at least one of the motor (400) and gear assembly (401).
 12. The machine as claimed in claim 10 or 11 wherein the motor (400) is positioned between the at least one bolting rig (119) and cutting head (115) in a lengthwise direction of the machine.
 13. The machine as claimed in any preceding claim wherein the cutting head (115) is devoid of a drive motor mounted internally within the cutting head (115).
 14. The machine as claimed in any preceding claim further comprising at least a first planetary gear (605) mounted internally within the cutting head (115) and drivably coupled to the gear assembly (401).
 15. The machine as claimed in claim 14 further comprising at least a second planetary gear (602) mounted internally within the cutting head (115) and drivably coupled to the gear assembly (401).

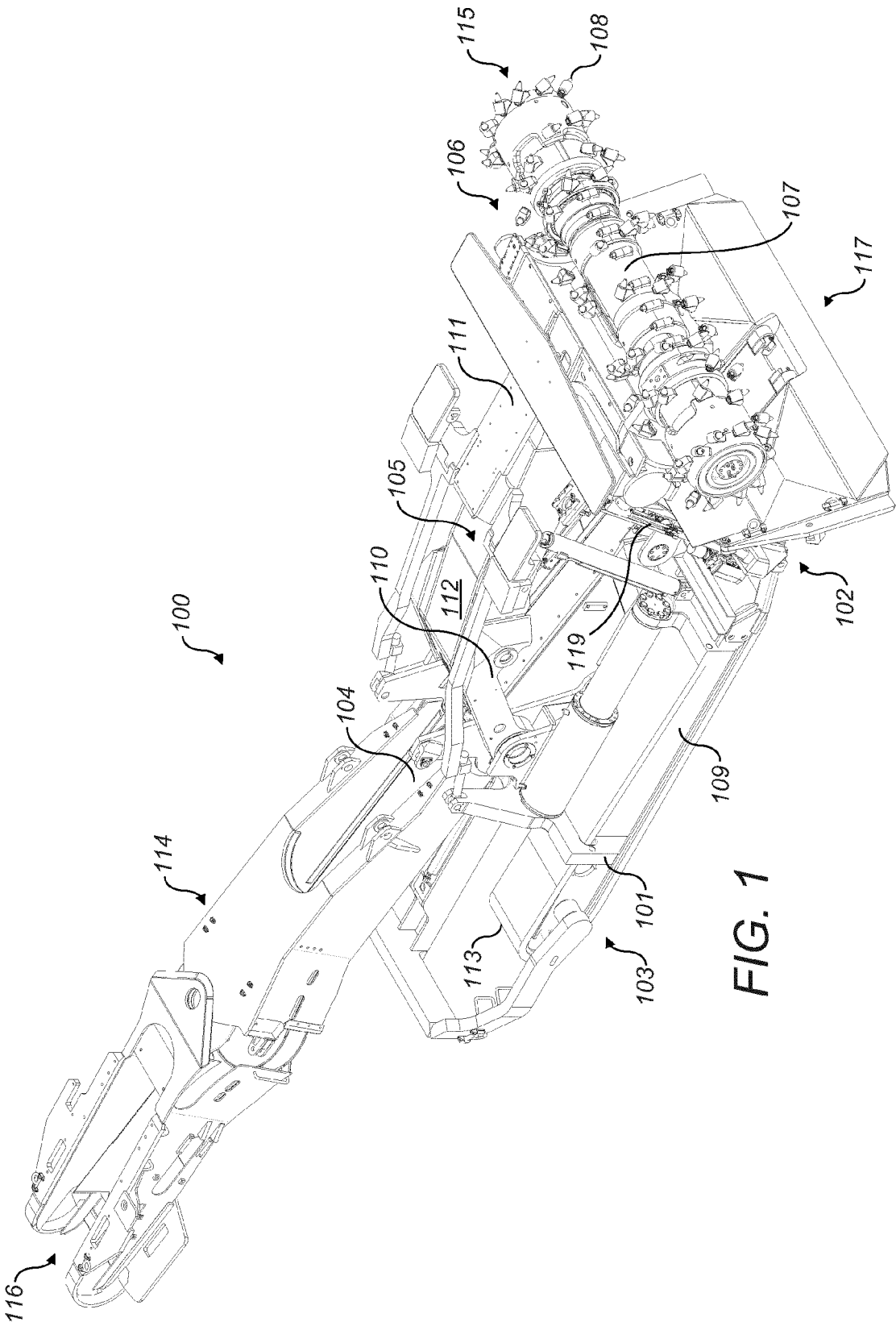


FIG. 1

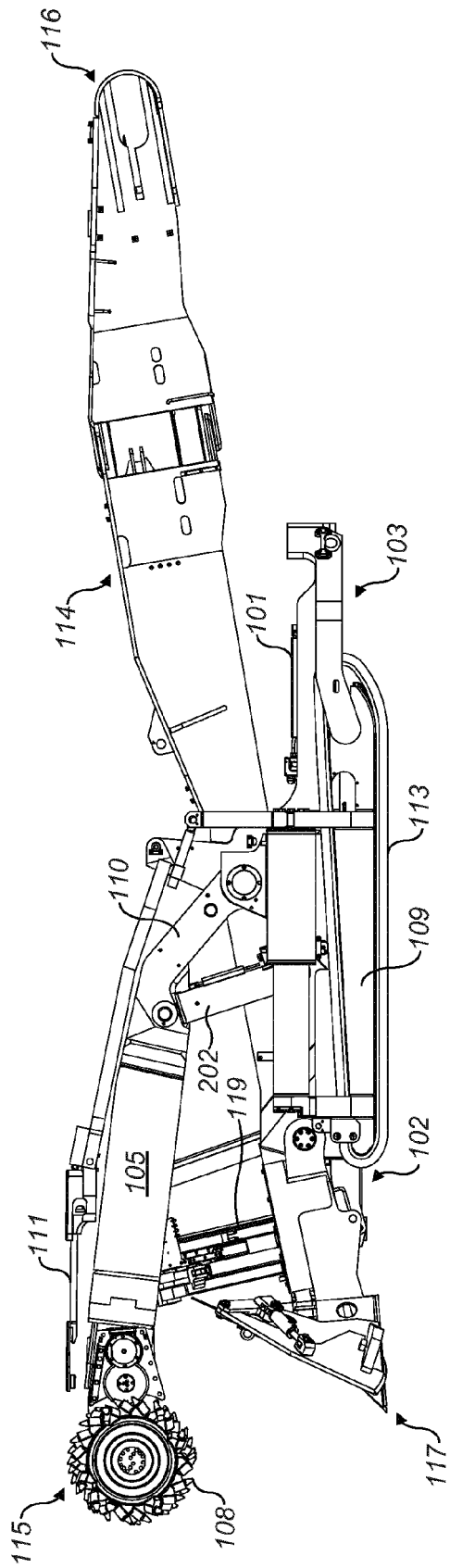


FIG. 2

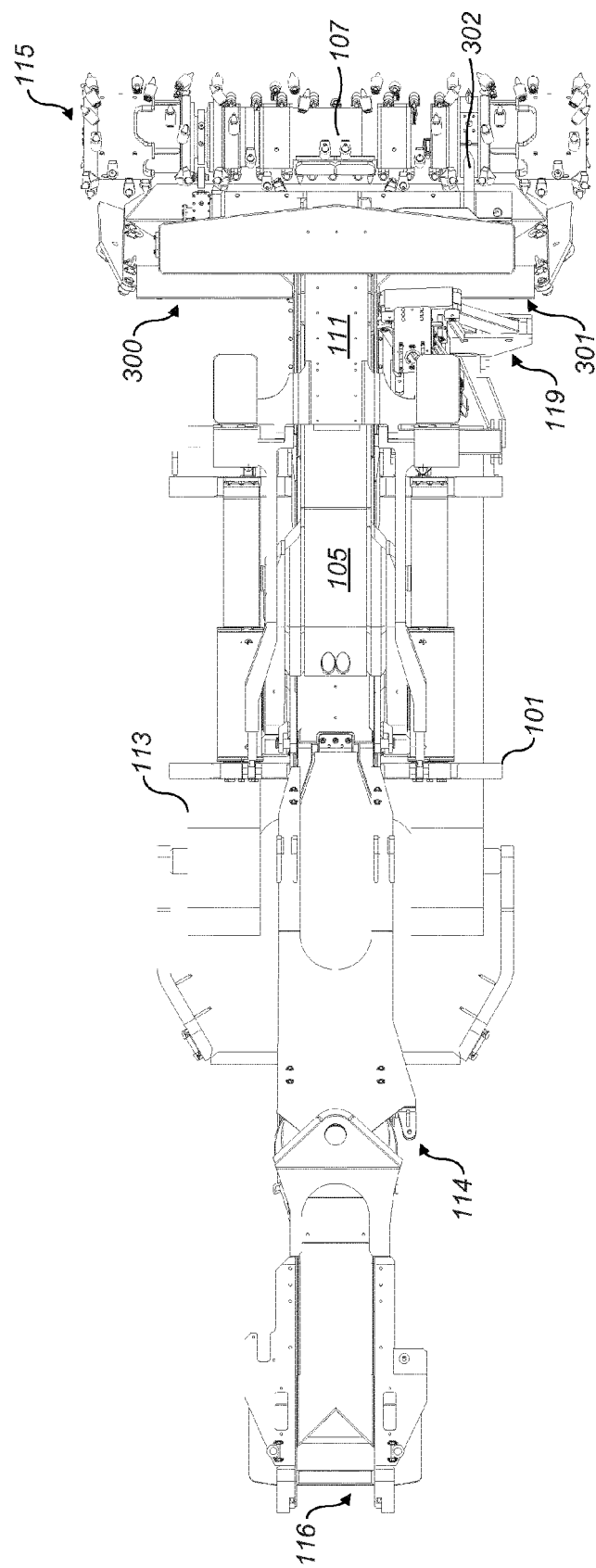


FIG. 3

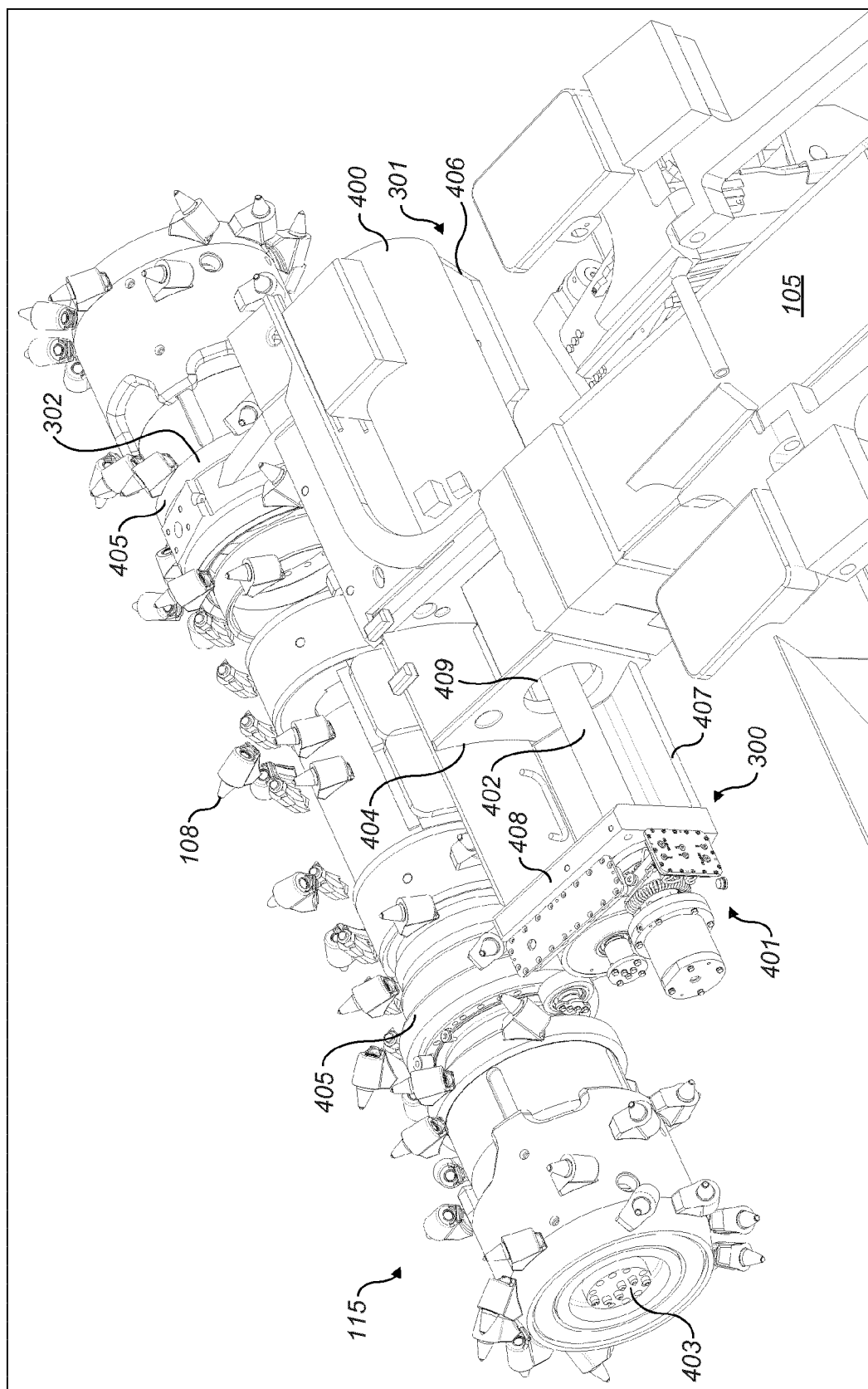


FIG. 4

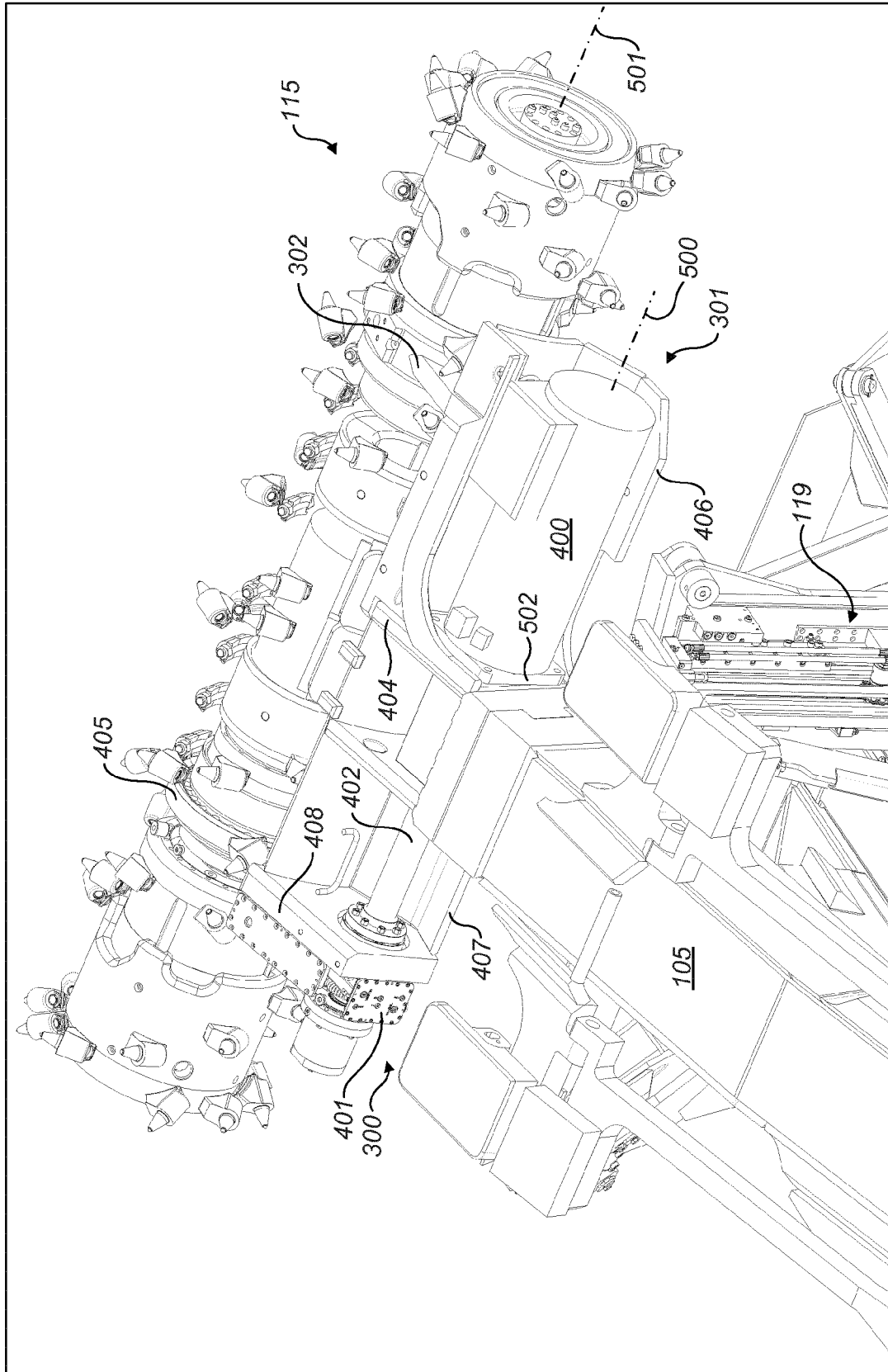


FIG. 5

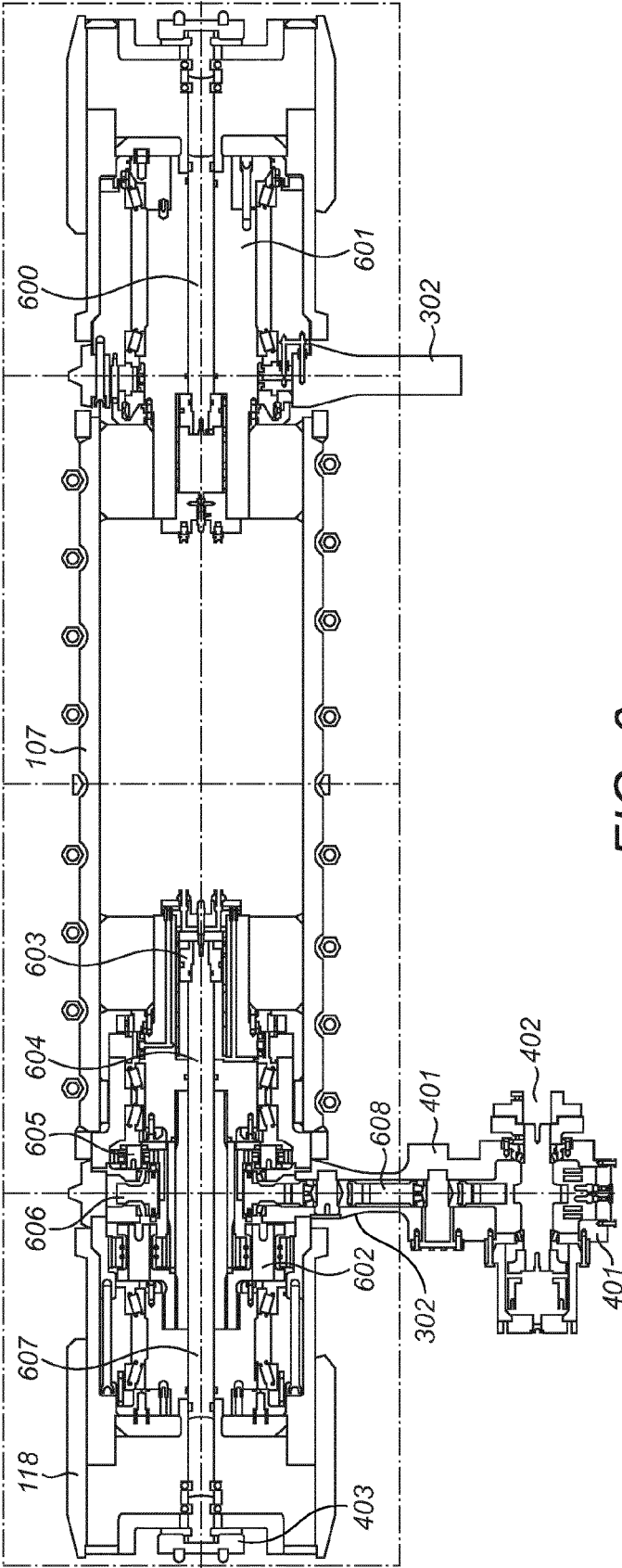


FIG. 6



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**ANNEX TO THE EUROPEAN SEARCH REPORT
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