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(54) **Titre : FOURCHE D'ENSEMBLE BRAS DE GODET AYANT UNE EXTREMITÉ DISTALE DE PARTIE DE TRANSITION A ORIENTATION INCLINÉE**
(54) **Title: DIPPER HANDLE ASSEMBLY YOKE HAVING A TRANSITION PORTION DISTAL END WITH ANGLED ORIENTATION**

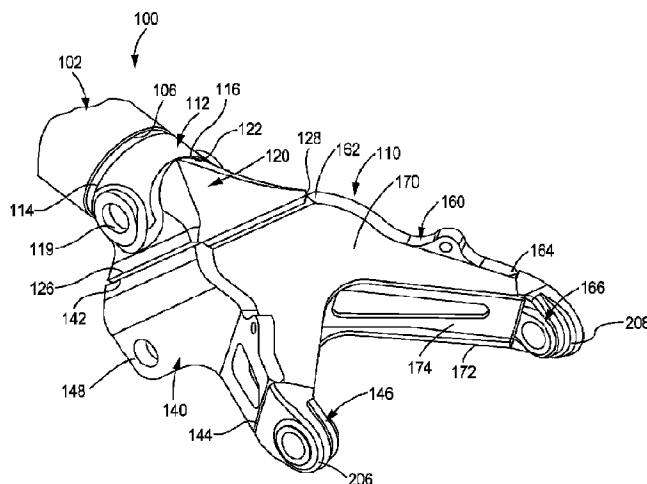


FIG. 3

(57) **Abrégé/Abstract:**

A dipper handle assembly (100, 250, 300, or 400) includes a tube (102) coupled to a yoke (110). The yoke (110) has a collar (112) extending along a collar axis (118), a transition portion (120), a first arm (140) and a second arm (160). The transition portion (120) includes a distal end (124) having first and second lateral sections (126, 128) and first and second transverse sections (130, 132). The first and second lateral sections (126, 128) and the first and second transverse sections (130, 132) all lie in a virtual transition portion distal end plane (180), and the virtual transition portion distal end plane (180) intersects the collar axis (118) at an oblique angle (α).

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Abstract:

A dipper handle assembly (100, 250, 300, or 400) includes a tube (102) coupled to a yoke (110). The yoke (110) has a collar (112) extending along a collar axis (118), a transition portion (120), a first arm (140) and a second arm (160). The transition portion (120) includes a distal end (124) having first and second lateral sections (126, 128) and first and second transverse sections (130, 132). The first and second lateral sections (126, 128) and the first and second transverse sections (130, 132) all lie in a virtual transition portion distal end plane (180), and the virtual transition portion distal end plane (180) intersects the collar axis (118) at an oblique angle (θ).

Description

DIPPER HANDLE ASSEMBLY YOKE HAVING A TRANSITION PORTION
DISTAL END WITH ANGLED ORIENTATION

Technical Field

5 The present disclosure relates to dipper handle assemblies and, more particularly, to a work machine having a dipper handle assembly.

Background

Power shovels are in a category of excavation equipment used to remove large amounts of overburden and ore during a mining operation. One type
10 of power shovel is known as a rope shovel. A rope shovel includes a boom, a dipper handle assembly pivotally connected to a mid-point of the boom, and a bucket (also known as a dipper) pivotally connected at one end of the dipper handle assembly. A cable extends over a sheave at a distal end of the boom and terminates at the dipper. The cable is reeled in or spooled out by electric,
15 hydraulic, and/or mechanical motors to selectively raise and lower the dipper.

More specifically, the dipper handle assembly includes a tube that is coupled to the boom and a yoke coupled to the dipper. In some applications, the scale of the power shovel is such that the handle assembly alone weighs on the order of 20 tons or more. During a digging operation, as the dipper engages the
20 overburden and ore, the yoke and tube may experience significant stresses over time that can lead to cracking or weld failure.

One attempt to improve durability of the dipper handle assembly is disclosed in U.S. Pat. No. 10,865,541 issued to Rhodine et al. on December 15, 2020 (“the ‘541 patent”). Specifically, the ‘541 patent discloses a yoke for a
25 dipper handle having a transition portion formed, at least in part, of a forged metal. Although the yoke of the ‘541 patent may have improved strength by eliminating material defects inherent in casting processes, further improvement in strength characteristics of the dipper handle assembly would be advantageous.

Summary of the Disclosure

In one aspect of the present disclosure, a dipper handle assembly includes a tube having a tube first end and a tube second end. The assembly further includes a yoke, comprising a collar including a collar proximal end
5 coupled to the tube second end and a collar distal end opposite the collar proximal end, wherein the collar extends along a collar axis. The yoke further includes a transition portion including a transition portion proximal end coupled to the collar distal end and a transition portion distal end opposite the transition portion proximal end, wherein the transition portion extends laterally outwardly relative
10 to the collar axis from the transition portion proximal end to the transition portion distal end, and wherein the transition portion distal end includes spaced first and second lateral sections joined by spaced first and second transverse sections. A first arm of the yoke includes a first arm proximal end coupled to the first lateral section of the transition portion distal end, a first arm distal end spaced from the
15 first arm proximal end, a first dipper pin lug disposed adjacent the first arm distal end, and a first pitch brace lug located intermediate the first arm proximal end and the first arm distal end. Similarly, a second arm of the yoke includes a second arm proximal end coupled to the second lateral section of the transition portion distal end, a second arm distal end spaced from the second arm proximal end, a second
20 dipper pin lug disposed adjacent the second arm distal end, and a second pitch brace lug located intermediate the second arm proximal end and the second arm distal end. The first and second lateral sections and the first and second transverse sections of the transition portion distal end lie in a virtual transition portion distal end plane, and the virtual transition portion distal end plane intersects the collar
25 axis at an oblique angle.

In another aspect of the disclosure, a work machine comprises a base configured to be supported on a ground surface, a revolving frame coupled to the base and rotatable about an axis, a boom pivotally coupled to the revolving frame, and a dipper handle assembly pivotally coupled to the boom. The dipper
30 handle assembly comprises a tube including a tube first end and a tube second end, and a yoke. The yoke comprises a collar including a collar proximal end

coupled to the tube second end and a collar distal end opposite the collar proximal end, wherein the collar extends along a collar axis. The yoke also comprises a transition portion including a transition portion proximal end coupled to the collar distal end and a transition portion distal end opposite the transition portion proximal end, wherein the transition portion extends laterally outwardly relative to the collar axis from the transition portion proximal end to the transition portion distal end, and wherein the transition portion distal end includes spaced first and second lateral sections joined by spaced first and second transverse sections. A first arm of the yoke includes a first arm proximal end coupled to the first lateral section of the transition portion distal end, a first arm distal end spaced from the first arm proximal end, a first dipper pin lug disposed adjacent the first arm distal end, and a first pitch brace lug located intermediate the first arm proximal end and the first arm distal end. A second arm of the yoke includes a second arm proximal end coupled to the second lateral section of the transition portion distal end, a second arm distal end spaced from the second arm proximal end, a second dipper pin lug disposed adjacent the second arm distal end, and a second pitch brace lug located intermediate the second arm proximal end and the second arm distal end. The first and second lateral sections and the first and second transverse sections of the transition portion distal end lie in a virtual transition portion distal end plane, and the virtual transition portion distal end plane intersects the collar axis at an oblique angle. The work machine further includes a dipper pivotally coupled to the yoke.

In yet another aspect of the disclosure, a method is disclosed of forming a yoke for a dipper handle assembly. The method comprises forging a transition component. The transition component comprises a collar including a collar proximal end and a collar distal end opposite the collar proximal end, wherein the collar extends along a collar axis. The transition component further includes a transition portion including a transition portion proximal end coupled to the collar distal end and a transition portion distal end opposite the transition portion proximal end, wherein the transition portion extends laterally outwardly relative to the collar axis from the transition portion proximal end to the transition

portion distal end, and wherein the transition portion distal end includes spaced first and second lateral sections joined by spaced first and second transverse sections. The first and second lateral sections and the first and second transverse sections of the transition portion distal end lie in a virtual transition portion distal end plane, and the virtual transition portion distal end plane intersects the collar axis at an oblique angle. The method further includes forming a first arm. The first arm comprises a first arm proximal end coupled to the first lateral section of the transition portion distal end, a first arm distal end spaced from the first arm proximal end, a first dipper pin lug disposed adjacent the first arm distal end, and a first pitch brace lug located intermediate the first arm proximal end and the first arm distal end. The method also includes forming a second arm. The second arm comprises a second arm proximal end coupled to the second lateral section of the transition portion distal end, a second arm distal end spaced from the second arm proximal end, a second dipper pin lug disposed adjacent the second arm distal end, and a second pitch brace lug located intermediate the second arm proximal end and the second arm distal end.

Brief Description of the Drawings

FIG. 1 is a diagrammatic illustration of an exemplary disclosed work machine;

FIG. 2 is an enlarged, perspective view of a dipper handle assembly associated with the work machine of FIG. 1;

FIG. 3 is an enlarged perspective view of a yoke end of the dipper handle assembly of FIG. 2;

FIG. 4 is an enlarged, side elevation view of the yoke end of the dipper handle assembly of FIG. 2;

FIG. 5 is an enlarged, perspective view of a transition portion of the dipper handle assembly of FIG. 2;

FIG. 6 is an enlarged, perspective view of a dipper pin lug provided on the dipper handle assembly of FIGS. 2-5;

FIG. 7 is an enlarged, perspective view of another embodiment of a dipper handle assembly associated with the work machine of FIG. 1;

FIG. 8 is an enlarged, perspective view of a transition portion of the dipper handle assembly of FIG. 7;

5 FIG. 9 is an enlarged, side elevation view of a yoke end of the dipper handle assembly of FIG. 7;

FIG. 10 is an enlarged, perspective view of yet another embodiment of a dipper handle assembly associated with the work machine of FIG. 1;

10 FIG. 11 is an enlarged, perspective view of a yoke and transition portion of the dipper handle assembly of FIG. 10;

FIG. 12 is an enlarged, side elevation view of a yoke end of the dipper handle assembly of FIG. 10;

15 FIG. 13 is an enlarged, perspective view of a dipper pin lug insert provided on the dipper handle assembly of FIG. 10;

FIG. 14 is an enlarged, side elevation view, in cross-section, of a welded joint between a tube and a yoke of a dipper handle assembly;

20 FIG. 15 is an enlarged, side elevation view of a yoke end of a dipper handle assembly, including virtual reference lines illustrating a position of a pitch brace lug aperture axis relative to a crowd pin aperture axis;

FIG. 16 is a schematic block diagram of a method of forming a yoke for a dipper handle assembly; and

25 FIG. 17 is a schematic block diagram of a method of retrofitting a work machine having an existing dipper handle assembly with a replacement dipper handle assembly.

Detailed Description

FIG. 1 illustrates an exemplary embodiment of a work machine 10. Work machine 10 may perform any type of operation associated with an industry such as mining, construction, excavation, or any other industry known in the art.

30 For example, work machine 10 may embody an earth moving machine such as the

power shovel depicted in FIG. 1. In the exemplary embodiment of FIG. 1, work machine 10 may include a base 12, a body 14 operatively connected to base 12, a gantry member 16 rigidly mounted to a top side of body 14 opposite base 12, a boom 18 pivotally connected to a leading end of body 14, a dipper handle assembly 20 pivotally connected to a midpoint of boom 18, a tool 22 pivotally connected to a distal end of dipper handle assembly 20, and cabling connecting gantry member 16, boom 18, dipper handle assembly 20, and tool 22.

Base 12 may be a structural unit that supports movements of work machine 10. In the disclosed exemplary application, base 12 is itself movable, having one or more traction devices such as feet, tracks (shown in FIG. 1), and/or wheels that are driven to propel machine 10 over a work surface 24. In other applications, however, base 12 may be a stationary platform configured for fixed engagement with work surface 24.

Body 14 may pivot relative to base 12. Specifically, body 14 may pivot relative to base 12 about a substantially vertical axis 26. As body 14 is pivoted about axis 26, attached gantry member 16, boom 18, dipper handle assembly 20, and tool 22 may likewise pivot to change a radial engagement angle of tool 22 with work surface 24. In the exemplary embodiment of FIG. 1, tool 22 typically engages with the vertical portion of work surface 24, and the horizontal portion of work surface 24 may be formed as a result of such engagement. The vertical portion of work surface 24 may be removed by tool 22 in subsequent passes and/or by additional machines located proximate work surface 24. Body 14 may house, among other things, a power source 28 that powers the movements of work machine 10.

Gantry member 16 may be a structural frame member, for example a general A-frame member, that is configured to anchor one or more cables 30 to body 14. Gantry member 16 may extend from body 14 in a vertical direction away from base 12. Gantry member 16 may be located rearward of boom 18 relative to tool 22 and, in the disclosed exemplary embodiment, fixed in a single orientation and position. Cables 30 may extend from an apex of gantry member

16 to a distal end of boom 18, thereby transferring a weight of boom 18, tool 22, and a load contained within tool 22 into body 14.

Boom 18 may be pivotally connected at a base end to body 14, and constrained at a desired vertical angle relative to work surface 24 by cables 30.

5 Additional cables 32 may extend from body 14 over a sheave mechanism 34 located at the distal end of boom 18 and around a sheave mechanism 36 of tool 22. Cables 32 may connect tool 22 to body 14 by way of one or more motors and/or transmissions coupled to a drum (not shown), such that a rotation of the motors (and/or transmissions coupled to a drum) functions to reel in or spool out
10 cables 32. The reeling in and spooling out of cables 32 may affect the height and angle of tool 22 relative to work surface 24. For example, when cables 32 are reeled in, the decreasing effective length of cables 32 may cause tool 22 to rise and tilt backward away from work surface 24. In contrast, when cables 32 are spooled out, the increasing effective length of cables 32 may cause tool 22 to
15 lower and tilt forward toward work surface 24.

Dipper handle assembly 20 may be pivotally connected at one end to a general midpoint of boom 18, and at an opposing end to a corner of tool 22 adjacent sheave mechanism 36 (e.g., rearward of sheave mechanism 36). In this position, dipper handle assembly 20 may function to maintain a desired distance
20 of tool 22 away from boom 18 and ensure that tool 22 moves through a desired arc as cables 32 are reeled in and spooled out. In the disclosed embodiment, dipper handle assembly 20 may be connected to boom 18 at a location closer to the base end of boom 18, although other configurations are also possible. In some configurations, dipper handle assembly 20 may be provided with a crowd cylinder
25 (not shown) that functions to extend or retract dipper handle assembly 20. In this manner, the distance between tool 22 and boom 18 (as well as the arcuate trajectory of tool 22) may be adjusted.

Tool 22, in the exemplary embodiments of the present disclosure, is known as a “dipper,” and the terms “tool 22” and “dipper” may be used
30 interchangeably throughout this disclosure. A dipper is a type of shovel bucket having a dipper body 38, and a dipper door 40 located at a back side of dipper

body 38 opposite a front side excavation opening 42. Dipper door 40 may be hinged along a base edge at the back side of dipper body 38, so that it can be selectively pivoted to open and close dipper body 38 during an excavating operation. Dipper door 40 may be pivoted between the open and closed positions
5 by gravity, and held closed or released by way of an actuator system 44. For example, when tool 22 is lifted upward toward the distal end of boom 18 by reeling in of cables 32, a releasing action of actuator system 44 may allow the weight of dipper door 40 (and any material within tool 22) to swing dipper door 40 downward toward work surface 24 and away from dipper body 38. This
10 motion may allow material collected within tool 22 to spill out the back side of dipper body 38. In contrast, when tool 22 is lowered toward work surface 24, the weight of dipper door 40 may cause dipper door 40 to swing back toward dipper body 38. Actuator system 44 may then be caused to lock dipper door 40 in its closed position.

15 In the disclosed embodiments, actuator system 44 may be remotely controlled, such as by way of an electric signal, a hydraulic signal, a pneumatic signal, a radio signal, a wireless signal, or another type of signal known in the art. It is contemplated, however, that a cable may alternatively be mechanically connected to and used to activate actuator system 44, if desired.

20 FIGS. 2-6 illustrate a first example of a dipper handle assembly 100, for use with the work machine 10, having a shape and using materials that advantageously improve strength characteristics of the assembly. The dipper handle assembly 100 includes a tube 102 having a tube first end 104 and a tube second end 106. The tube 102 may be pivotally coupled to a midpoint of the
25 boom 18.

The dipper handle assembly 100 further includes a yoke 110 that is coupled to the tube 102, and which carries the dipper 22. More specifically, the yoke 110 includes a collar 112 having a collar proximal end 114 coupled to the tube second end 106, and a collar distal end 116 opposite the collar proximal end
30 114, as best shown in FIG. 4. The collar 112 may have a cylindrical shape extending along a collar axis 118. The collar proximal end 114 is shown abutting

the tube second end 106, while the collar distal end 116 is approximately located adjacent a crowd pin aperture 119.

The yoke 110 further includes a transition portion 120 coupled to, and generally extending outward from, the collar 112. As best shown in FIGS. 2-5, the transition portion 120 includes a transition portion proximal end 122 coupled to the collar distal end 116, and a transition portion distal end 124 opposite the transition portion proximal end 122. The transition portion 120 extends laterally outwardly relative to the collar axis 118 from the transition portion proximal end 122 to the transition portion distal end 124. The transition portion distal end 124 includes spaced first and second lateral sections 126, 128 joined by spaced first and second transverse sections 130, 132, as best shown in FIG. 5.

The yoke 110 further includes first and second arms 140, 160 coupled to the transition portion 120, which are provided to support the dipper 22. The first arm 140 includes a first arm proximal end 142 coupled to the first lateral section 126 of the transition portion distal end 124, and a first arm distal end 144 spaced from the first arm proximal end 142. A first dipper pin lug 146 is disposed adjacent the first arm distal end 144, and a first pitch brace lug 148 is located intermediate the first arm proximal end 142 and the first arm distal end 144. Similarly, the second arm 160 includes a second arm proximal end 162 coupled to the second lateral section 128 of the transition portion distal end 124, and a second arm distal end 164 spaced from the second arm proximal end 162. A second dipper pin lug 166 disposed adjacent the second arm distal end 164, and a second pitch brace lug 168 is located intermediate the second arm proximal end 162 and the second arm distal end 164.

The yoke 110 further may include additional components for maintaining structural integrity. For example, as best shown at FIG. 3, upper and lower plates 170, 172 may be provided between the first and second arms 140, 160. Additionally, one or more cross-braces 174 may also interconnect between the first and second arms 140, 160.

The shape of the yoke 110 where the transition portion 120 meets the first and second arms 140, 160 is configured to reduce stresses on the yoke 110 during operation. As best shown in FIG. 4, the first and second lateral sections 126, 128 and the first and second transverse sections 130, 132 of the transition portion distal end 124 advantageously lie in a virtual transition portion distal end plane 180 that intersects the collar axis 118 at an oblique angle α . By providing the transition portion distal end 124 at the angle α , the yoke 110 is better able to withstand stresses generated as the dipper 22 engages the work surface 24.

The various portions of the yoke 110 may be formed independently as separate components, or two or more portions may be integrally formed as a composite component. Furthermore, the separate components and/or composite components may be formed of different materials, as discussed more fully below.

In the example illustrated at FIGS. 2-6, the collar 112 and the transition portion 120 are integrally provided as a transition component 200, while each of the first and second arms 140, 160 and first and second dipper pin lugs 146, 166 are provided as separate components. More specifically, the first lateral section 126 of the transition portion distal end 124 defines a first interface surface 202 configured for coupling to the first arm 140, while the second lateral section 128 of the transition portion distal end 124 defines a second interface surface 204 configured for coupling to the second arm 160. The first dipper pin lug 146 comprises a first dipper pin lug component 206 formed independent of the first arm 160, and the second dipper pin lug 166 comprises a second dipper pin lug component 208 formed independent of the second arm 160. In this example, each of the transition component 200, first dipper pin lug component 206, and second dipper pin lug component 208 may comprise forged metal, while the first and second arms 140, 160 may comprise forged metal or, alternatively, non-forged metal.

FIGS. 7-9 illustrate a second example of a dipper handle assembly 250 for use in the work machine 10. The dipper handle assembly 250 of FIGS. 7-9 is similar to the dipper handle assembly 100 of FIGS. 2-6, and therefore like

reference numbers are used for like parts as appropriate. The primary differences between the dipper handle assembly 100 and the dipper handle assembly 250 are the portions that are provided integrally as composite components and the portions that are provided independently as separate components.

5 More specifically, portions of the first and second arms 140, 160 are provided on separate components. The first arm 140 includes a first arm proximal section 140a including the first arm proximal end 142, and a first arm distal section 140b coupled to the first arm proximal section 140a and including the first arm distal end 144. Similarly, the second arm 160 includes a second arm proximal section 160a including the second arm proximal end 162, and a second arm distal section 160b coupled to the second arm proximal end 160a and including the second arm distal end 164. In this example, the collar 112, transition portion 120, first arm proximal section 140a, and second arm proximal section 160a are integrally provided as a transition component 252, as best shown at FIG. 8. The first arm distal section 140b and second arm distal section 160b are formed as separate components that are coupled, respectively, to the first arm proximal section 140a and the second arm proximal section 160a.

 Similar to the dipper handle assembly 100 described above, the transition component 252 of the dipper handle assembly 250 includes the transition portion distal end 124. Furthermore, as best shown in FIG. 9, the transition portion distal end 124 advantageously lies in a virtual transition portion distal end plane 180 that intersects the collar axis 118 at an oblique angle α .

 In the example of the dipper handle assembly 250 illustrated in FIGS. 7-9, the lugs are provided as inserts coupled to the first and second arms 140, 160. More specifically, the first dipper pin lug 146 comprises a first dipper pin lug insert 147 coupled to the first arm distal section 140b, while the second dipper pin lug 166 comprises a second dipper pin lug insert 167 coupled to the second arm distal section 160b. Each of the transition component 252, first dipper pin insert 147, and second dipper pin lug insert 167 may comprise forged metal, while each of the first arm distal section 140b and second arm distal section 160b may comprise forged metal or, alternatively, non-forged metal.

FIGS. 10-13 illustrate a further example of a dipper handle assembly 300 for use in the work machine 10. The dipper handle assembly 300 of FIGS. 10-13 is similar to the dipper handle assembly 100 of FIGS. 2-6 and the dipper handle assembly 250 of FIGS. 7-9, and therefore like reference numbers are used for like parts as appropriate. The primary differences between the dipper handle assembly 300 and the dipper handle assemblies 100, 250 are the portions that are provided integrally as composite components.

More specifically, the dipper handle assembly 300 includes the collar 112, transition portion 120, first arm 140, and second arm 160 that are integrally formed as a yoke component 302, as best shown in FIG. 11. The first dipper pin lug 146 comprises a first dipper pin lug insert 304 coupled to the first arm distal end 144, while the second dipper pin lug 166 comprises a second dipper pin lug insert 306 coupled to the second arm distal end 164, as best shown in FIGS. 10 and 13. Each of the yoke component 302, first dipper pin lug insert 304, and second dipper pin lug insert 306 may comprise forged metal.

Similar to the dipper handle assemblies 100, 250 described above, the transition portion 120 of the yoke component 302 of the dipper handle assembly 300 includes the transition portion distal end 124. Furthermore, as best shown in FIG. 12, the transition portion distal end 124 advantageously lies in a virtual transition portion distal end plane 180 that intersects the collar axis 118 at an oblique angle α .

In any of the examples disclosed herein, the connection between the tube 102 and the collar 112 may be configured to improve strength characteristics. As best shown in FIG. 14, the tube second end 106 includes a tube exterior surface 320 defining a tube exterior surface chamfer 322, and a tube interior surface 324 including a tube root extension 326 extending inwardly toward the collar axis 118. The collar proximal end 114 similarly includes a collar exterior surface 330 defining a collar exterior surface chamfer 332, and a collar interior surface 334 including a collar root extension 336 extending inwardly toward the collar axis 118. The tube second end 106 is joined to the collar

proximal end 114 by a weld 340 disposed in the tube exterior surface chamfer 322 and the collar exterior surface chamfer 332.

FIG. 15 is an enlarged view of an exemplary dipper handle assembly 400. In order to provide the dipper handle assembly 400 with improved strength characteristics, the inventors have identified parameters for locating a pitch brace aperture relative to a crowd pin aperture and a dipper pin aperture. The parameters identify locations for the pitch brace aperture that reduce stresses in the dipper handle assembly during operation.

More specifically, the dipper handle assembly 400 includes a tube 402. A yoke 404 is coupled to the tube 402, and includes a collar 406 extending along a collar axis 408. A crowd pin aperture 410 extends through the collar 406 along a crowd pin aperture axis 412 normal to the collar axis 408. The yoke 404 further includes a transition portion 414 coupled to the collar 406, and spaced first and second arms 416, 418.

The first arm 416 has a first arm proximal end 420 coupled to the transition portion 414 and a first arm distal end 422 spaced from the first arm proximal end 420. A first dipper pin lug 424 is disposed adjacent the first arm distal end 422 and defines a first dipper pin lug aperture 426. The first arm 416 further includes a first pitch brace lug 430 located intermediate the first arm proximal end 420 and the first arm distal end 422, wherein the first pitch brace lug 430 defines a first pitch brace lug aperture 432.

The second arm 418 has a second arm proximal end 434 coupled to the transition portion 414 and a second arm distal end 436 spaced from the second arm proximal end 434. A second dipper pin lug 438 is disposed adjacent the second arm distal end 436 and defines a second dipper pin lug aperture 440, wherein the first dipper pin lug aperture 426 and the second dipper pin lug aperture 440 are aligned along a dipper pin aperture axis 442 extending parallel to the crowd pin aperture axis 412. The second arm 418 further includes a second pitch brace lug 444 located intermediate the second arm proximal end 434 and the second arm distal end 436, wherein the second pitch brace lug 444 defines a second pitch brace lug aperture 446. The first pitch brace lug aperture 432 and the

second pitch brace lug aperture 446 are disposed along a pitch brace aperture axis 448 extending parallel to the crowd pin aperture axis 412.

With continued reference to FIG. 15, a first virtual reference line 450 extends between the crowd pin aperture axis 412 and the dipper pin aperture axis 442. Additionally, a second virtual reference line 452 extends between the crowd pin aperture axis 412 and the pitch brace aperture axis 448. In a first parameter identified by the inventors, an included angle α between the first virtual reference line 450 and the second virtual reference line 452 is used to identify locations of the first and second pitch brace lugs 430, 444 relative to the crowd pin aperture axis 412. In a first example, the included angle α is between approximately 25 to approximately 51 degrees. In a second example, the included angle α is approximately 33 to approximately 43 degrees. In a third example, the included angle α is approximately 38 degrees.

With further reference to FIG. 15, a third virtual reference line 454 intersects the pitch brace aperture axis 448 and is perpendicular to the first virtual reference line 450. The third virtual reference line 454 intersects the first virtual reference line 450 at a point P. In a second parameter identified by the inventors, a distance D between the crowd pin aperture axis 412 and the point P is used to identify locations of the first and second pitch brace lugs 430, 444 relative to the crowd pin aperture axis 412. In a first example, the distance D is between approximately 520 and 1420 millimeters. In a second example, the distance D is between approximately 820 and approximately 1020 millimeters. In a third example, the distance D is approximately 920 millimeters.

As used herein, “virtual” means having the attributes of an entity without possessing its physical form. For example, a virtual reference plane is an intangible or imaginary plane, rather than a physical one, with respect to which, e.g., location and/or orientation of other physical and/or intangible entities is defined.

Industrial Applicability

In practice, a dipper handle assembly is provided with improved strength characteristics. In some examples, the dipper handle assembly is provided with a transition portion distal end 124 that lies in a virtual transition
5 portion distal end plane 180 that intersects the collar axis 118 at an oblique angle α , thereby to better distribute stresses experience during operation. In other examples, the pitch brace apertures are located relative to the crowd pin aperture and the dipper pin aperture within certain parameters described above, thereby to reduce stresses in the dipper handle assembly during operation. The dipper handle
10 assemblies described herein may be sold, bought, manufactured or otherwise obtained in an OEM (original equipment manufacturer) or after-market context. In some cases, the dipper handle assembly may be provided as a kit to repair or retrofit a work machine in the field.

FIG. 16 depicts a method 500 of forming a yoke for a dipper
15 handle assembly. The method 500 includes, at block 502, forging a transition component. The transition component includes a collar, having a collar proximal end and a collar distal end opposite the collar proximal end, which extends along a collar axis. The transition component further includes a transition portion including a transition portion proximal end, coupled to the collar distal end, and a
20 transition portion distal end opposite the transition portion proximal end. The transition portion extends laterally outwardly relative to the collar axis from the transition portion proximal end to the transition portion distal end, and the transition portion distal end includes spaced first and second lateral sections joined by spaced first and second transverse sections. The first and second lateral
25 sections and the first and second transverse sections of the transition portion distal end lie in a virtual transition portion distal end plane, and the virtual transition portion distal end plane intersects the collar axis at an oblique angle.

The method 500 further includes, at block 504, forming a first arm. The first arm includes a first arm proximal end coupled to the first lateral section
30 of the transition portion distal end, a first arm distal end spaced from the first arm proximal end, a first dipper pin lug disposed adjacent the first arm distal end, and

a first pitch brace lug located intermediate the first arm proximal end and the first arm distal end.

The method 500 continues, at block 506, with forming a second arm. The second arm includes a second arm proximal end coupled to the second lateral section of the transition portion distal end, a second arm distal end spaced
5 from the second arm proximal end, a second dipper pin lug disposed adjacent the second arm distal end, and a second pitch brace lug located intermediate the second arm proximal end and the second arm distal end.

In some examples of the method 500, the first lateral section of the transition portion distal end defines a first interface surface configured for
10 coupling to the first arm, and the second lateral section of the transition portion distal end defines a second interface surface configured for coupling to the second arm. In these examples, forming the first dipper pin lug comprises forging a first dipper pin lug component independent of the first arm, and forming the second
15 dipper pin lug comprises forging a second dipper pin lug component formed independent of the second arm.

In additional examples of the method 500, the first arm includes a first arm proximal section including the first arm proximal end, and a first arm distal section coupled to the first arm proximal section and including the first arm
20 distal end, and the second arm includes a second arm proximal section including the second arm proximal end, and a second arm distal section coupled to the second arm proximal end and including the second arm distal end. In these examples, the first arm proximal section and the second arm proximal section may be forged integrally with the transition component.

25 In still further examples of the method 500, the first arm and the second arm are forged integrally with the transition component to provide a monolithic yoke component.

FIG. 17 depicts a method 600 of retrofitting a work machine, having an existing dipper handle assembly, with a replacement dipper handle
30 assembly. The method 600 may include all, or some, of the operations disclosed in Caterpillar Service Information System Document No. M0069644-44, which

covers dipper handle removal and installation for both a hydraulically operated crowd and a rope operated crowd. The method 600 begins at block 602 with removing the existing dipper handle assembly.

At block 604, the method 600 includes providing the replacement
5 dipper handle assembly with a tube and a yoke coupled to the tube. The yoke includes a collar extending along a collar axis, wherein a crowd pin aperture extends through the collar along a crowd pin aperture axis normal to the collar axis, a transition portion coupled to the collar, a first arm comprising a first arm proximal end coupled to the transition portion and a first arm distal end spaced
10 from the first arm proximal end, a first dipper pin lug disposed adjacent the first arm distal end and defining a first dipper pin lug aperture, and a first pitch brace lug located intermediate the first arm proximal end and the first arm distal end and defining a first pitch brace lug aperture. The yoke further includes a second arm comprising a second arm proximal end coupled to the transition portion and a
15 second arm distal end spaced from the second arm proximal end, wherein the second arm is spaced from the first arm, a second dipper pin lug disposed adjacent the second arm distal end and defining a second dipper pin lug aperture, wherein the first dipper pin lug aperture and the second dipper pin lug aperture are aligned along a dipper pin aperture axis extending parallel to the crowd pin aperture axis,
20 and a second pitch brace lug located intermediate the second arm proximal end and the second arm distal end and defining a second pitch brace lug aperture, wherein the first pitch brace lug aperture and the second pitch brace lug aperture are disposed along a pitch brace aperture axis extending parallel to the crowd pin aperture axis. A first virtual reference line extends between the crowd pin aperture
25 axis and the dipper pin aperture axis, and a second virtual reference line extends between the crowd pin aperture axis and the pitch brace aperture axis. An included angle α between the first virtual reference line and the second virtual reference line is between approximately 25 to approximately 51 degrees.

The method 600 further includes, at block 606, coupling the
30 replacement dipper handle assembly to the work machine.

In some examples of the method 600, the included angle α is approximately 33 to approximately 43 degrees. In additional examples of the method 600, the included angle α is approximately 38 degrees.

5 In still further examples of the method 600, a third virtual reference line intersects the pitch brace aperture axis and is perpendicular to the first virtual reference line, with the third virtual reference line intersecting the first virtual reference line at a point P. In these examples, a distance D between the crowd pin aperture axis and the point P may be between approximately 520 and 1420 millimeters.

10 From the foregoing, it will be appreciated that while only certain embodiments have been set forth for the purposes of illustration, alternatives and modifications will be apparent from the above description to those skilled in the art. These and other alternatives are considered equivalents and within the spirit and scope of this disclosure and the appended claims.

15

Claims

1. A dipper handle assembly (100, 250, 300, or 400),
comprising:
a tube (102) including a tube first end (104) and a tube second end
5 (106); and
a yoke (110), comprising:
a collar (112) including a collar proximal end (114) coupled to the
tube second end (106) and a collar distal end (116) opposite the collar proximal
end (114), wherein the collar (112) extends along a collar axis (118);
10 a transition portion (120) including a transition portion proximal
end (122) coupled to the collar distal end (116) and a transition portion distal end
(124) opposite the transition portion proximal end (122), wherein the transition
portion (120) extends laterally outwardly relative to the collar axis (118) from the
transition portion proximal end (122) to the transition portion distal end (124),
15 and wherein the transition portion distal end (124) includes spaced first and
second lateral sections (126, 128) joined by spaced first and second transverse
sections (130, 132);
a first arm (140), including:
a first arm proximal end (142) coupled to the first lateral section
20 (126) of the transition portion distal end (124);
a first arm distal end (144) spaced from the first arm proximal end
(142);
a first dipper pin lug (146) disposed adjacent the first arm distal
end (144); and
25 a first pitch brace lug (148) located intermediate the first arm
proximal end (142) and the first arm distal end (144); and
a second arm (160), including:
a second arm proximal end (162) coupled to the second lateral
section (128) of the transition portion distal end (124);

a second arm distal end (164) spaced from the second arm proximal end (162);

a second dipper pin lug (166) disposed adjacent the second arm distal end (164); and

5 a second pitch brace lug (168) located intermediate the second arm proximal end (162) and the second arm distal end (164);

wherein the first and second lateral sections (126, 128) and the first and second transverse sections (130, 132) of the transition portion distal end (124) lie in a virtual transition portion distal end plane (180), and wherein the
10 virtual transition portion distal end plane (180) intersects the collar axis (118) at an oblique angle (α).

2. The dipper handle assembly (100) of claim 1, wherein:
the collar (112) and transition portion (230) are integrally provided
15 as a transition component (200);

the first lateral section (126) of the transition portion distal end (124) defines a first interface surface (202) configured for coupling to the first arm (140); and

the second lateral section (128) of the transition portion distal end
20 (124) defines a second interface surface (204) configured for coupling to the second arm (160).

3. The dipper handle assembly (100) of claim 2, wherein:
the first dipper pin lug (146) comprises a first dipper pin lug
25 component (206) formed independent of the first arm (140);

the second dipper pin lug (148) comprises a second dipper pin lug component (208) formed independent of the second arm (160); and

each of the transition component (200), first dipper pin lug component (206), and second dipper pin lug component (208) comprises forged
30 metal.

4. The dipper handle assembly (250) of claim 1, wherein:
the first arm (140) includes a first arm proximal section (140a)
including the first arm proximal end (142), and a first arm distal section (140b)
coupled to the first arm proximal section (140a) and including the first arm distal
5 end (144);
the second arm (160) includes a second arm proximal section
(160a) including the second arm proximal end (162), and a second arm distal
section (160b) coupled to the second arm proximal section (160a) and including
the second arm distal end (164); and
10 the collar (112), transition portion (120), first arm proximal
section (140a), and second arm proximal section (160a) are integrally provided as
a transition component (252).

5. The dipper handle assembly (250) of claim 4, wherein:
15 the first dipper pin lug (146) comprises a first dipper pin lug insert
(147) coupled to the first arm distal section (140b);
the second dipper pin lug (166) comprises a second dipper pin lug
insert (167) coupled to the second arm distal section (160b); and
each of the transition component (252), first dipper pin insert
20 (147), and second dipper pin insert (167) comprises forged metal.

6. The dipper handle assembly (300) of claim 1, wherein the
collar (112), transition portion (120), first arm (140), and second arm (160) are
integrally provided as a yoke component (302).
25

7. The dipper handle assembly (300) of claim 6, wherein the
yoke component (302) comprises forged metal.

8. The dipper handle assembly (300) of claim 7, wherein:
30 the first dipper pin lug (146) comprises a first dipper pin lug insert
(304) coupled to the first arm distal end (144);

the second dipper pin lug (166) comprises a second dipper pin lug insert (306) coupled to the second arm distal end (164); and

each of the first dipper pin lug insert (304) and the second dipper pin lug insert (306) comprises forged metal.

5

9. The dipper handle assembly (100, 250, 300, or 400) of claim 1, wherein:

the tube second end (106) includes a tube exterior surface (320) defining a tube exterior surface chamfer (322), and a tube interior surface (324) including a tube root extension (326) extending inwardly toward the collar axis (118);

the collar proximal end (114) includes a collar exterior surface (330) defining a collar exterior surface chamfer (332), and a collar interior surface (334) including a collar root extension (336) extending inwardly toward the collar axis (118); and

wherein the tube second end (106) is joined to the collar proximal end (114) by a weld (340) disposed in the tube exterior surface chamfer (322) and the collar exterior surface chamfer (332).

10. A method (500) of forming a yoke (110) for a dipper handle assembly (100, 250, 300, or 400), the method (500) comprising:

forging a transition component (200 or 252), the transition component (200 or 252) comprising:

a collar (102) including a collar proximal end (114) and a collar distal end (116) opposite the collar proximal end (114), wherein the collar (102) extends along a collar axis (118); and

a transition portion (120) including a transition portion proximal end (122) coupled to the collar distal end (116) and a transition portion distal (124) end opposite the transition portion proximal end (122), wherein the transition portion (12) extends laterally outwardly relative to the collar axis (118) from the transition portion proximal end (122) to the transition portion distal end

(124), and wherein the transition portion distal end (124) includes spaced first and second lateral sections (126, 128) joined by spaced first and second transverse sections (130, 132);

5 wherein the first and second lateral sections (126, 128) and the first and second transverse sections (130, 132) of the transition portion distal end (124) lie in a virtual transition portion distal end plane (180), and wherein the virtual transition portion distal end plane (180) intersects the collar axis (118) at an oblique angle (α);

forming a first arm (140), the first arm (140) comprising:
10 a first arm proximal end (142) coupled to the first lateral section (126) of the transition portion distal end (124);
a first arm distal end (144) spaced from the first arm proximal end (142);
a first dipper pin lug (146) disposed adjacent the first arm distal
15 end (144); and
a first pitch brace lug (148) located intermediate the first arm proximal end (142) and the first arm distal end (144); and
forming a second arm (160), the second arm (160) comprising:
a second arm proximal end (162) coupled to the second lateral
20 section (128) of the transition portion distal end (124);
a second arm distal end (164) spaced from the second arm proximal end (162);
a second dipper pin lug (166) disposed adjacent the second arm distal end (164); and
25 a second pitch brace lug (168) located intermediate the second arm proximal end (162) and the second arm distal end (164).

11. The method (500) of claim 10, wherein:
the first lateral section (126) of the transition portion distal end
30 (124) defines a first interface surface (202) configured for coupling to the first arm (140), and the second lateral section (128) of the transition portion distal end

(124) defines a second interface surface (202) configured for coupling to the second arm (160);

forming the first dipper pin lug (146) comprises forging a first dipper pin lug component (206) independent of the first arm (140); and

5 forming the second dipper pin lug (166) comprises forging a second dipper pin lug component (208) formed independent of the second arm (160).

12. The method (500) of claim 10, wherein:

10 the first arm (140) includes a first arm proximal section (140a) including the first arm proximal end (142), and a first arm distal section (140b) coupled to the first arm proximal section (140a) and including the first arm distal end (144);

15 the second arm (160) includes a second arm proximal section (160a) including the second arm proximal end (162), and a second arm distal section (160b) coupled to the second arm proximal section (160a) and including the second arm distal end (164); and

the first arm proximal section (160a) and the second arm proximal section (160b) are forged integrally with the transition component (252).

20

13. The method (500) of claim 10, wherein the first arm (140) and the second arm (160) are forged integrally with the transition component (250 or 252) to provide a monolithic yoke component (302).

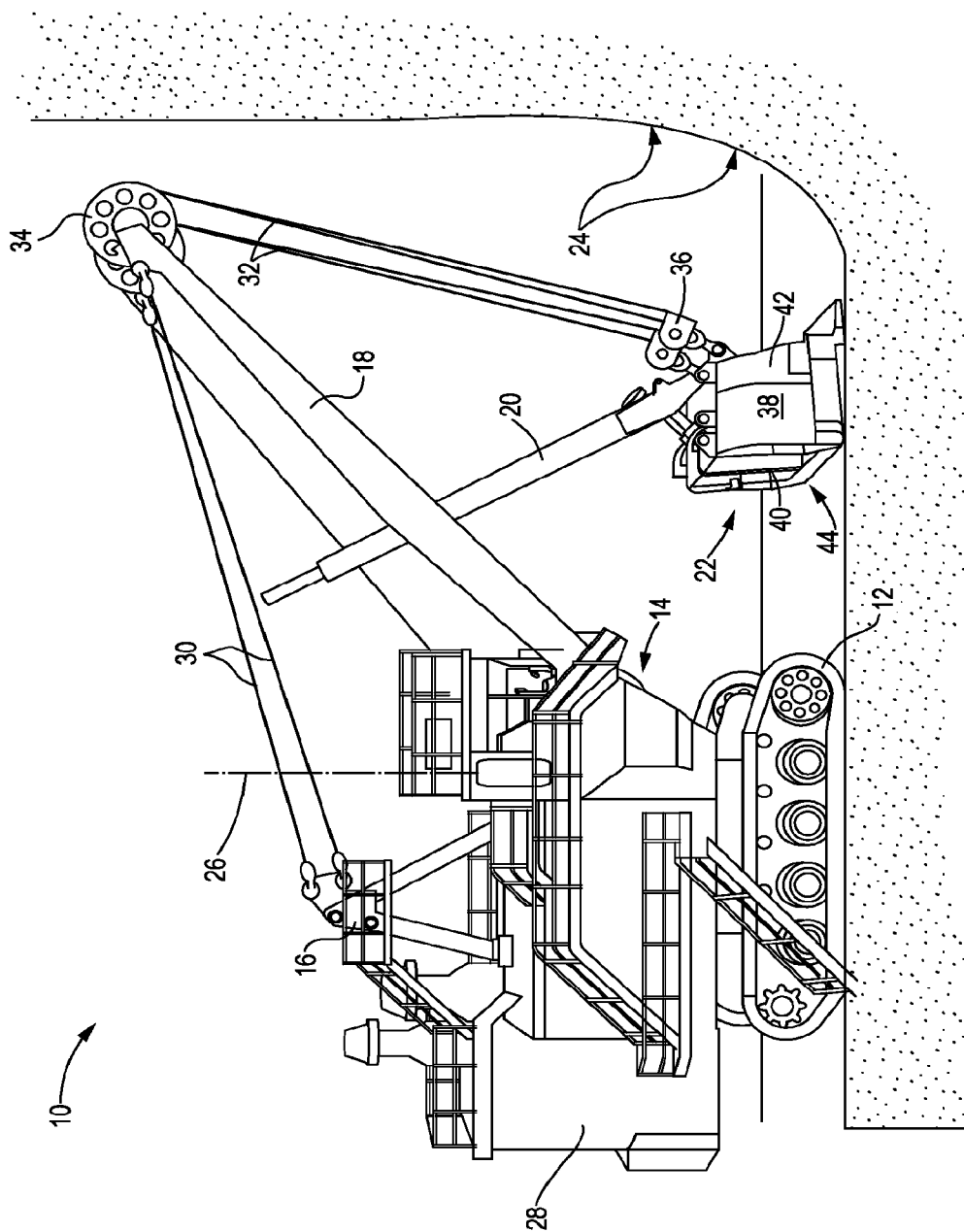
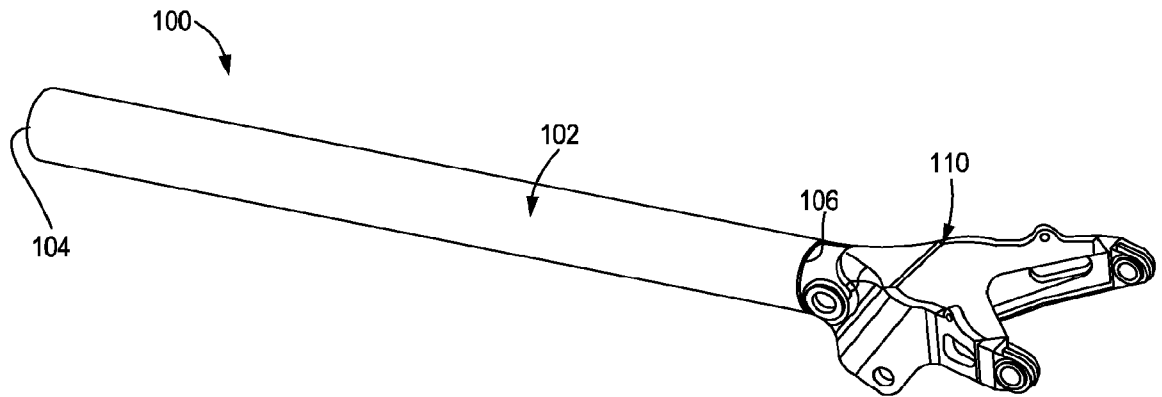
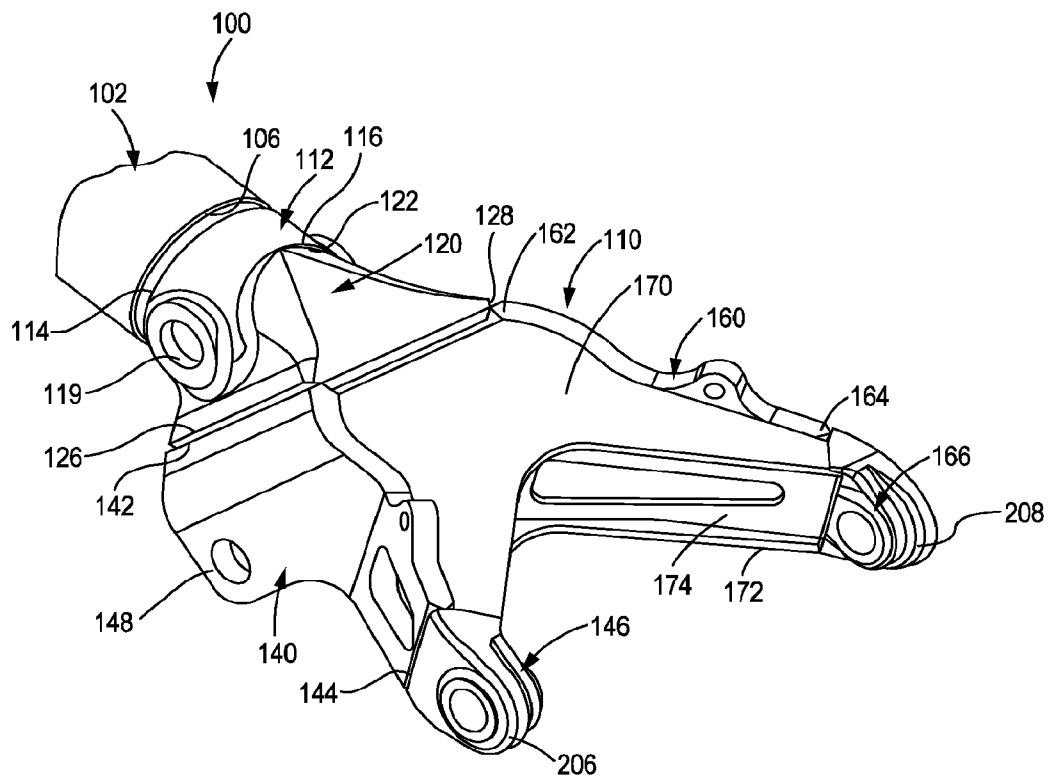
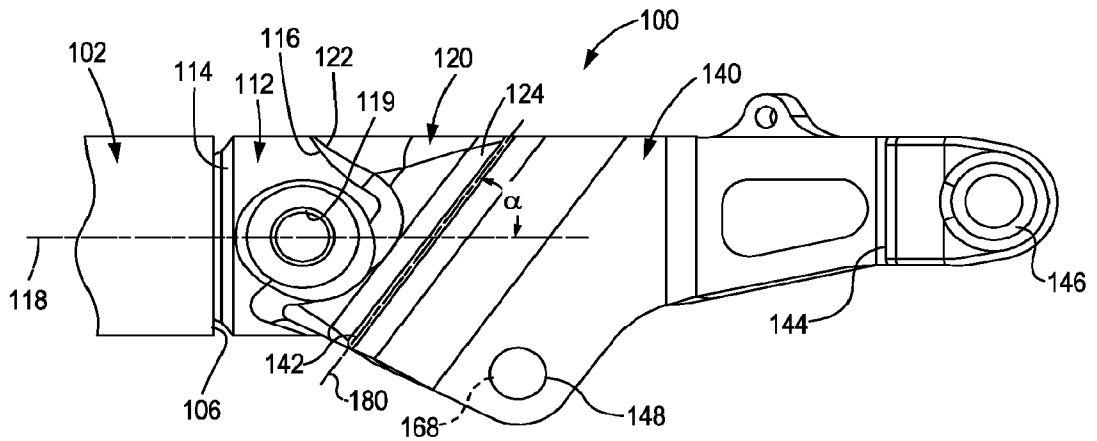
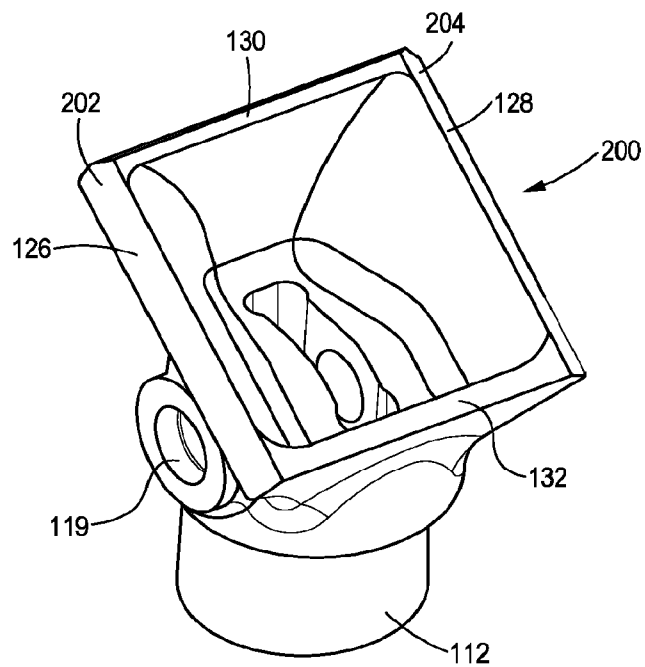


FIG. 1

**FIG. 2****FIG. 3**

**FIG. 4****FIG. 5**

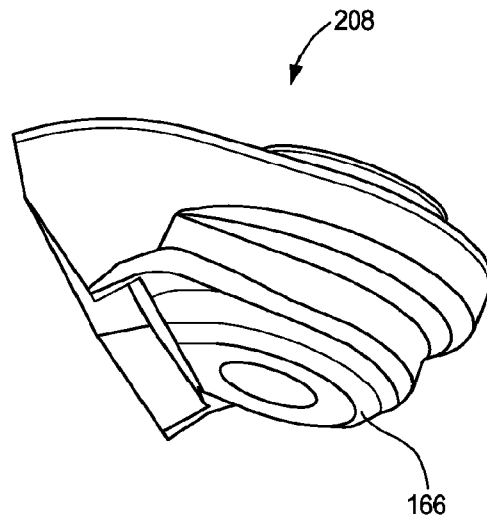


FIG. 6

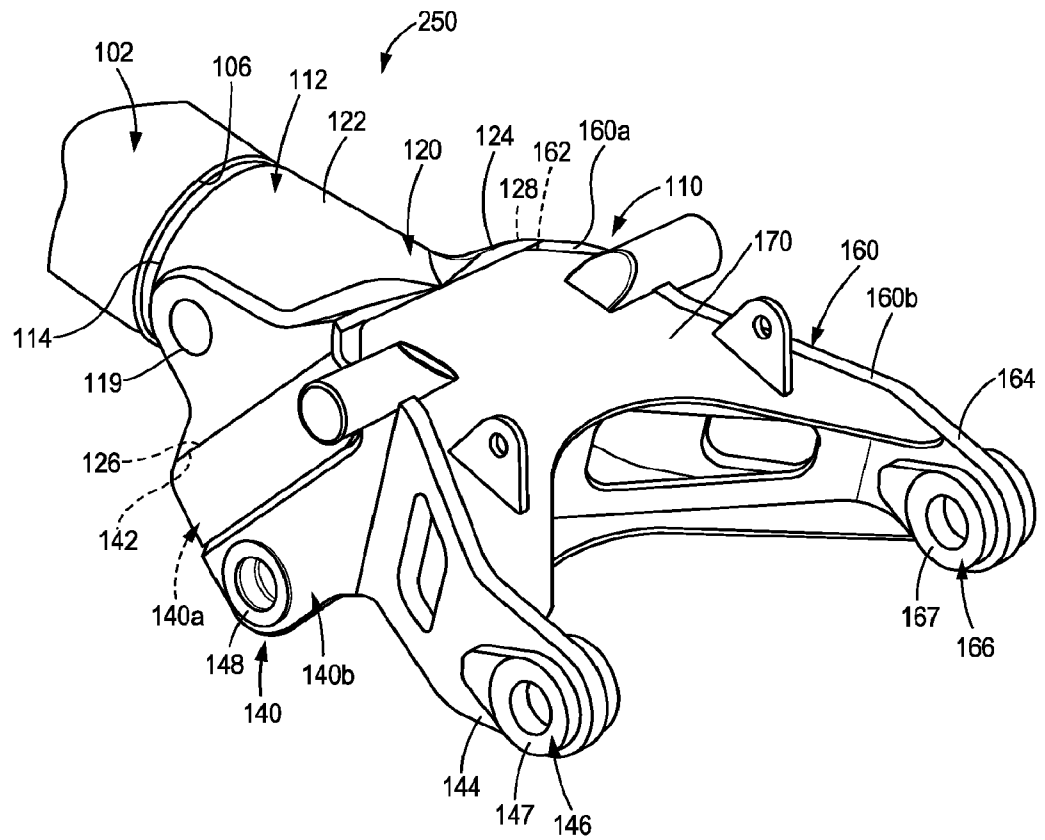
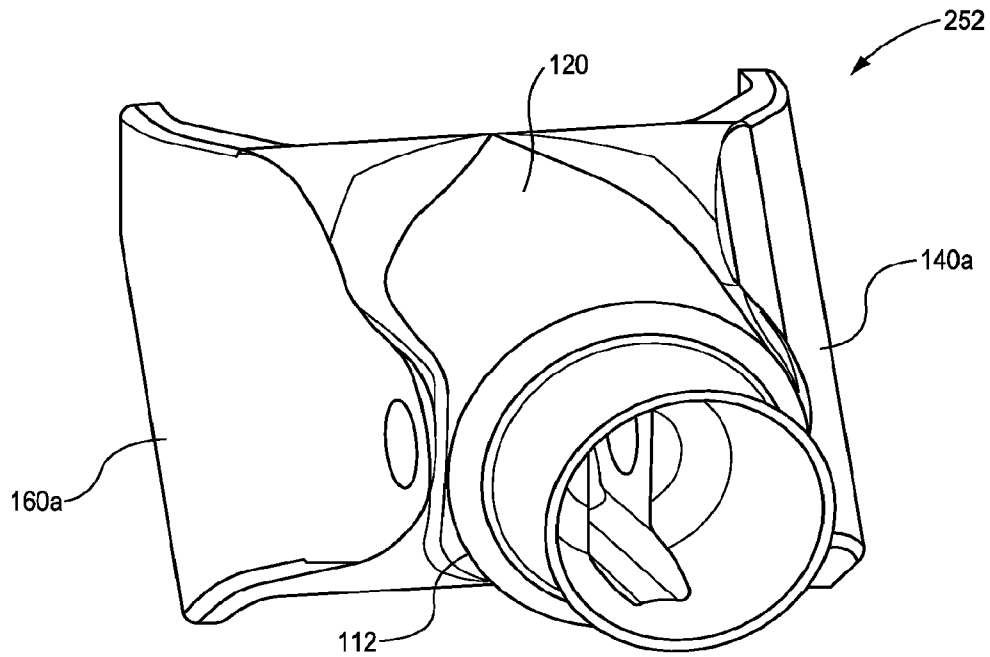
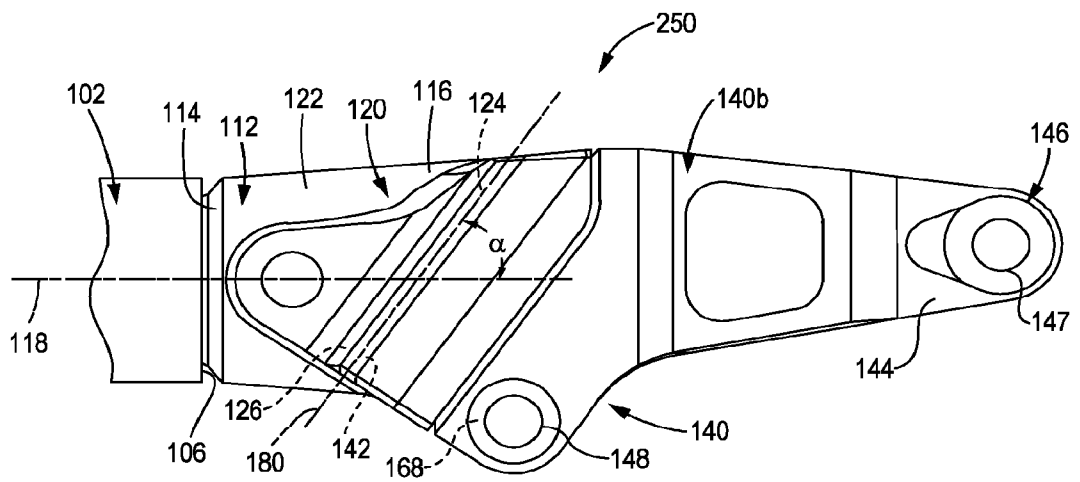


FIG. 7

**FIG. 8****FIG. 9**

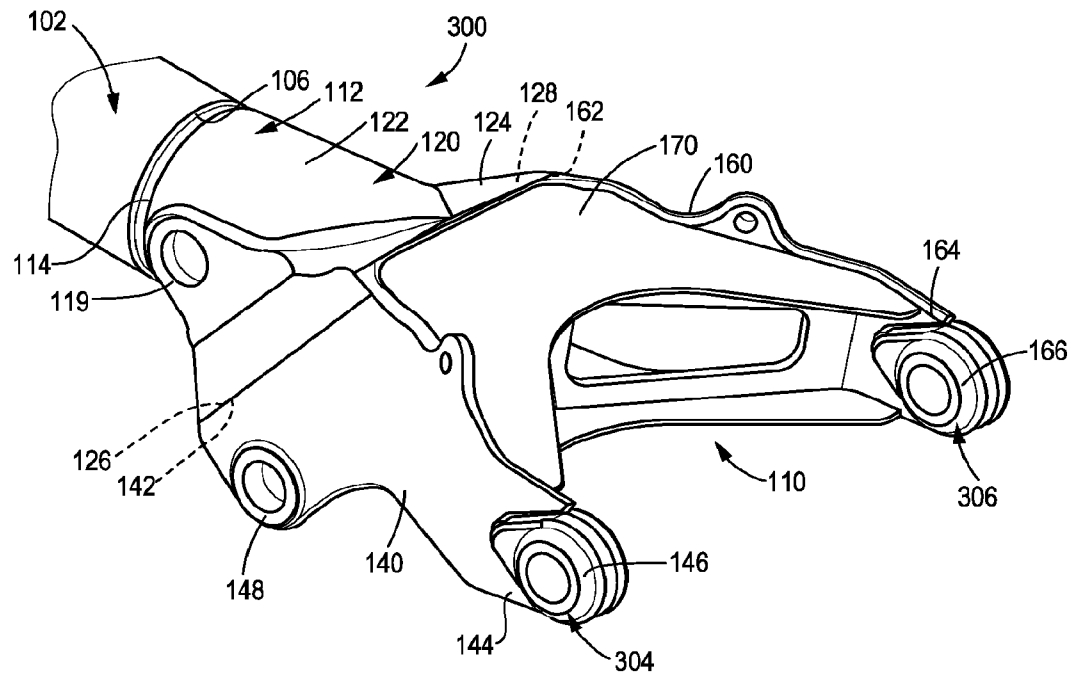


FIG. 10

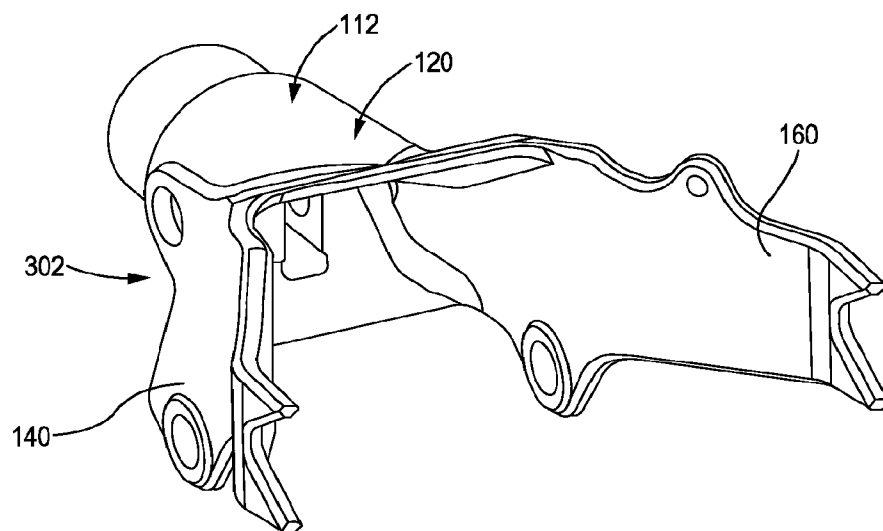


FIG. 11

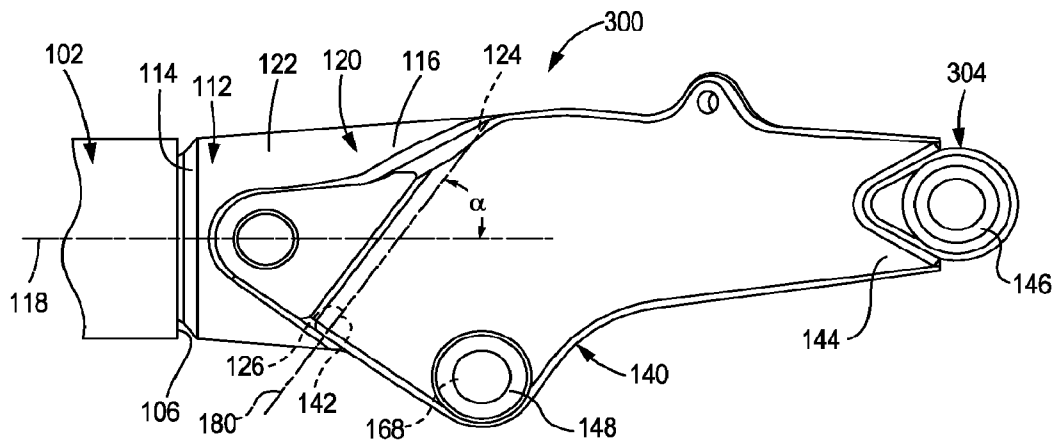


FIG. 12

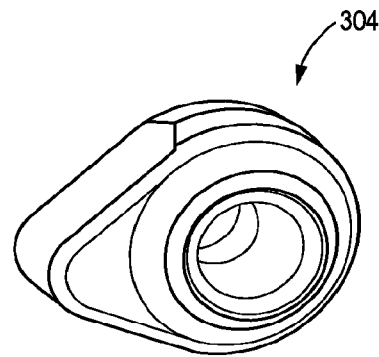
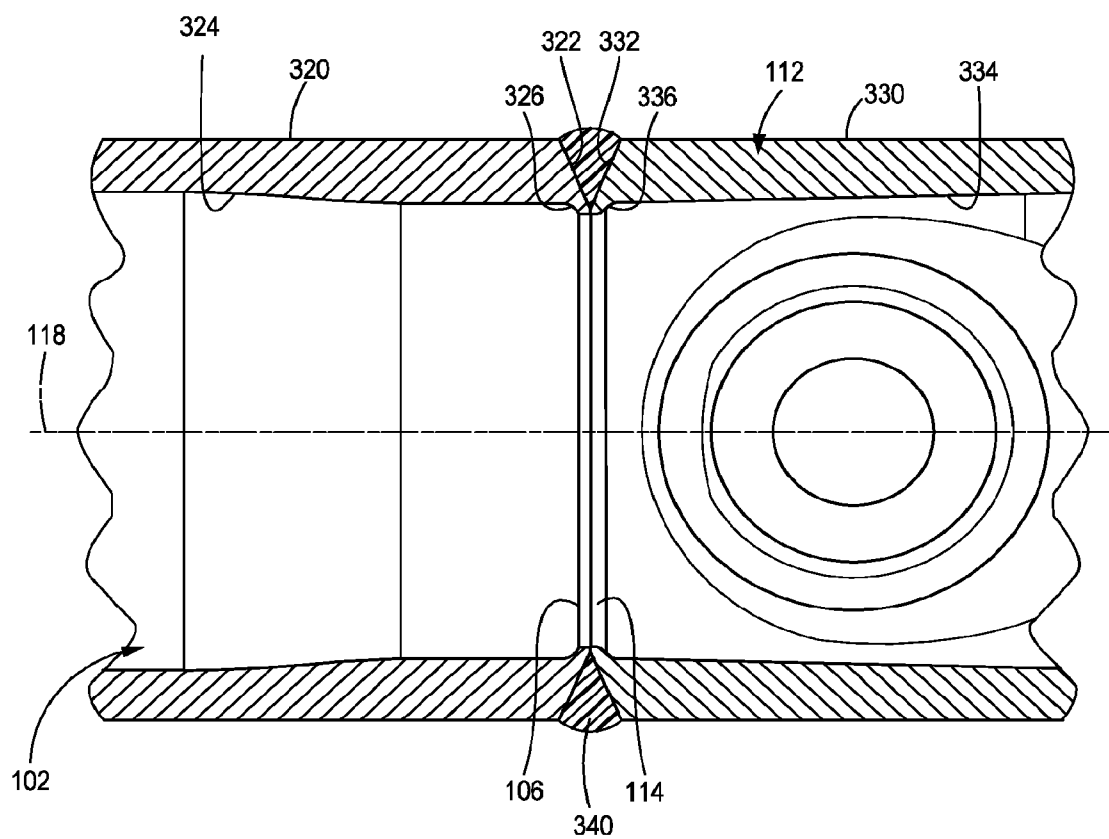
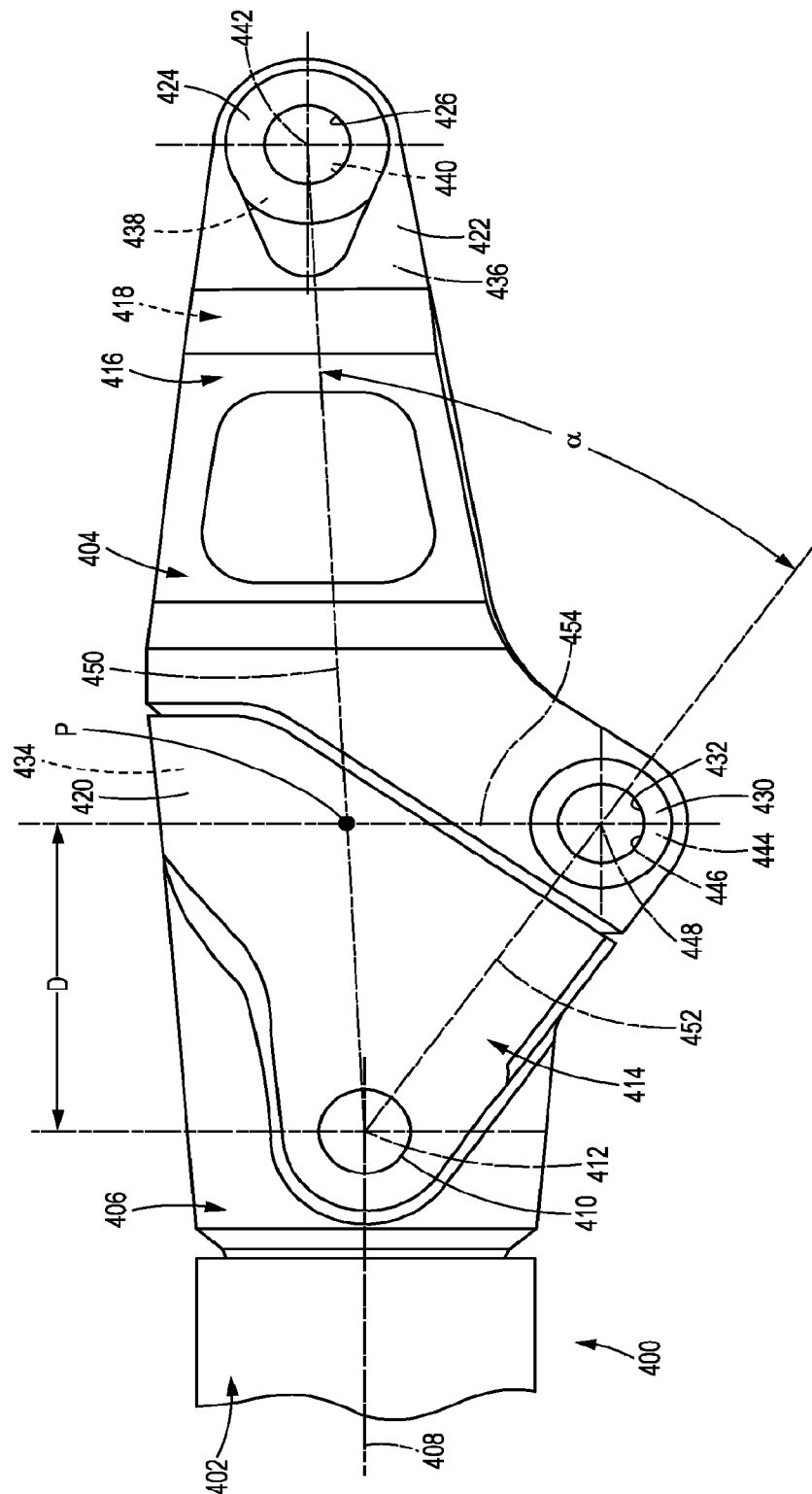
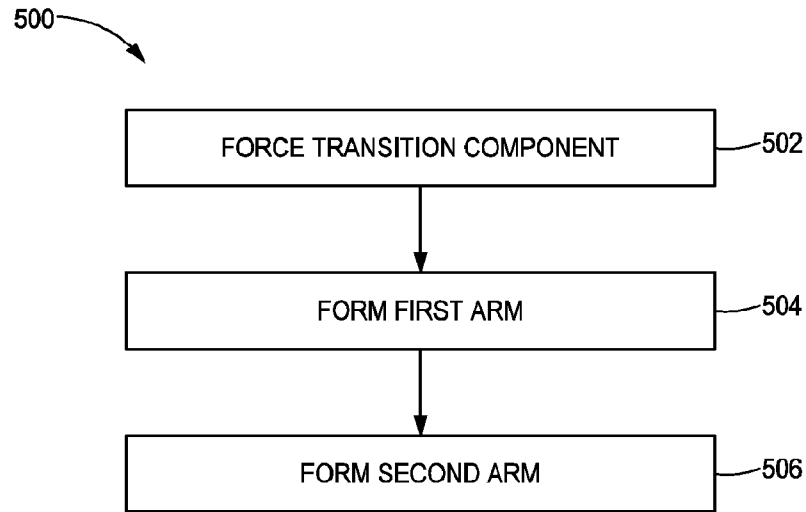
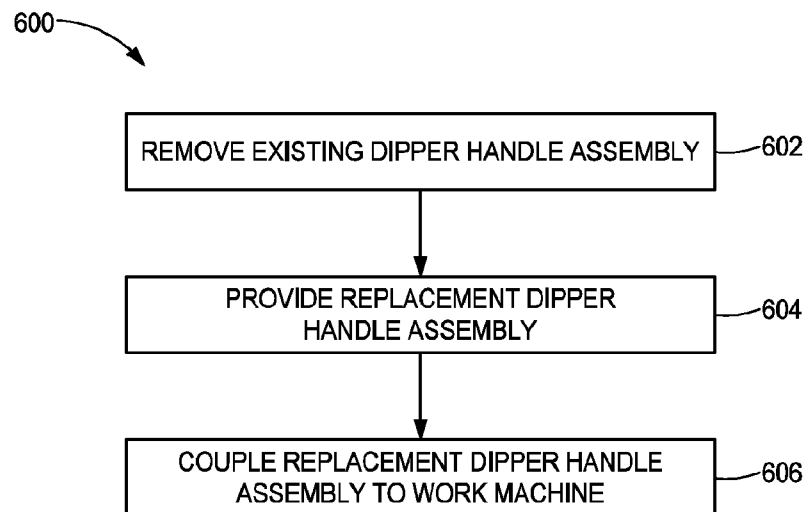


FIG. 13

**FIG. 14**

**FIG. 15**

**FIG. 16****FIG. 17**

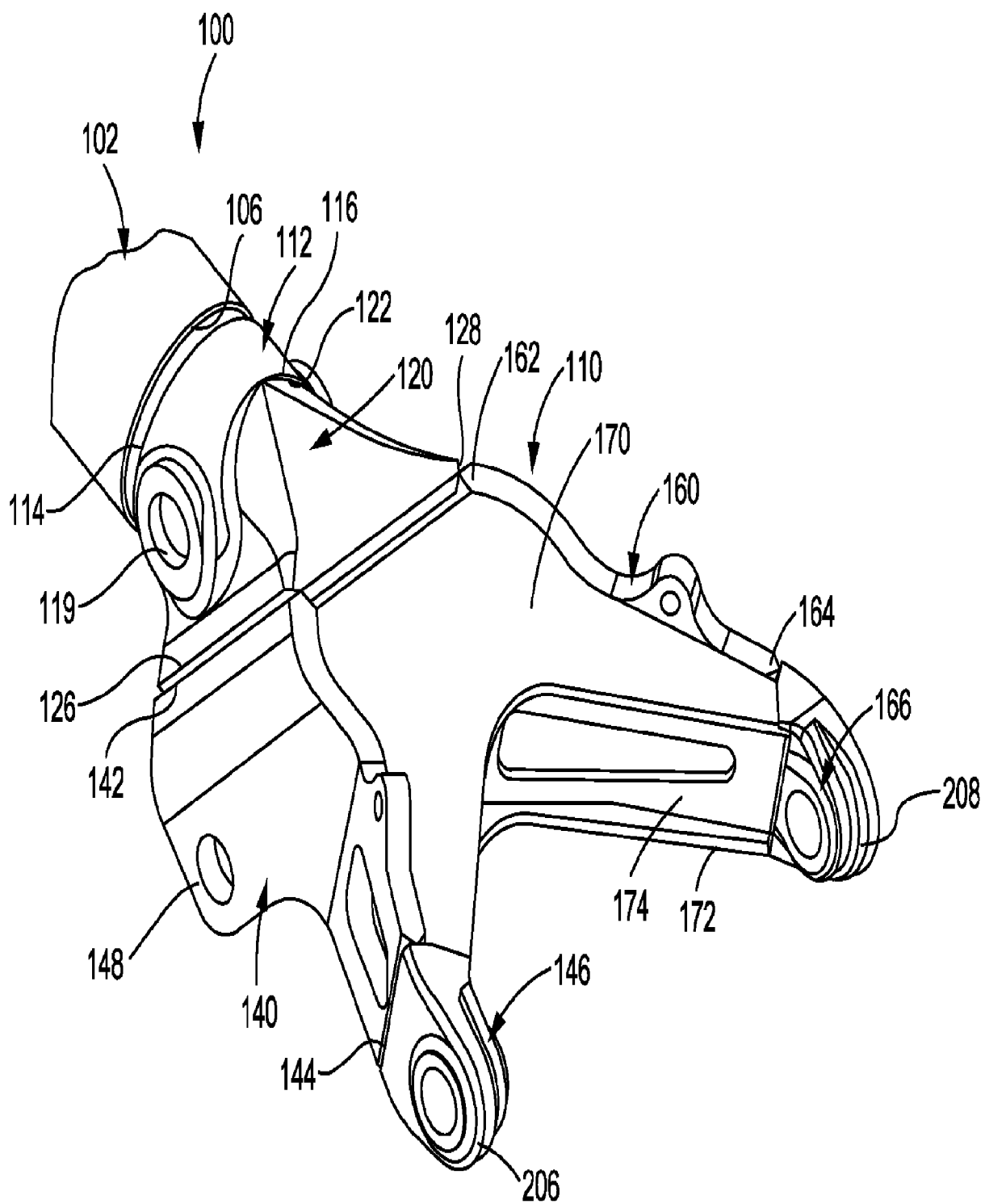


FIG. 3