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(54) **JIG ASSEMBLY FOR SHARPENING MOWER BLADES**

(57) A jig assembly for holding a mower blade and for controlling movement of a grinding tool having a grinding wheel during a sharpening operation on a cutting edge of the mower blade. The assembly comprises a mast, a fixture portion mounted to said mast, and a jig portion pivotally mounted to said mast. The fixture portion further comprises at least one stop limiting movement of the mower blade along a work-supporting surface. A leading edge of the mower blade rests against said stop during the sharpening operation. An intersection axis moves along an arcuate path in a second plane that is normal to said first plane, wherein said intersection axis and a fixture pivot axis are spaced a first distance from one another along a third axis normal to both of said intersection axis and said fixture pivot axis. During the pivoting movement of said fixture portion said intersection axis moves over a range of distances from said third plane, an absolute value of a distance between endpoints of said range defining a second distance, and wherein said second distance is less than one third of said first distance.

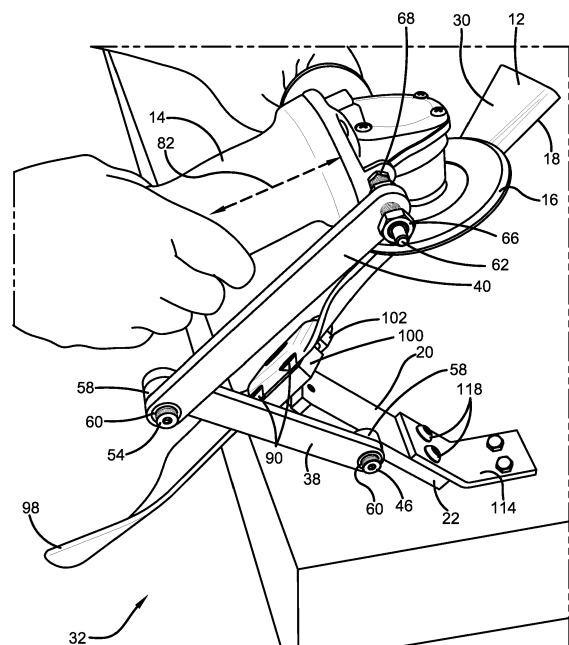


Figure 2

Description

BACKGROUND

1. Field

[0001] The present disclosure relates to structures for holding both a work-piece and a tool during a grinding operation and more particularly a mower blade and a grinding tool.

2. Description of Related Prior Art

[0002] U.S. Pat. No. 9,102,031 discloses an apparatus for sharpening blades. The apparatus is for sharpening blades, such as those used for mowing. A rotary grinder is mounted within an extensible, retractable, and rotatable support assembly. Lockable, rotational adjustment of the position of the grinder about three axes, and translational movement along one axis is thereby provided. A spring attached to one end of the assembly counter-balances the weight of the grinder. An adjacent blade holding fixture maintains the workpiece at a predetermined angle for grinding. A toggle clamp, edge alignment keepers, and a registration pin secure the blade in place. An adapter fixture, including a toggle clamp and an alignment recess, attaches to one end of the blade holding fixture. The adapter fixture has an angled shelf to orient and secure smaller, contoured blades requiring a different edge grinding angle. Once the support assembly is adjustably secured, the grinder is moved along the cutting edge of the blade for sharpening.

[0003] The background description provided herein is for the purpose of generally presenting the context of the disclosure. Work of the presently named inventor, to the extent it is described in this background section, as well as aspects of the description that may not otherwise qualify as prior art at the time of filing, are neither expressly nor impliedly admitted as prior art against the present disclosure.

SUMMARY

[0004] A jig assembly according to claim 1 is disclosed herein for holding a mower blade and for controlling movement of a grinding tool having a grinding wheel during a sharpening operation on a cutting edge of the mower blade. The jig assembly includes a mast, a fixture portion, and a jig portion. The mast can extend between a first end and a second end. The fixture portion can be mounted to the mast. The fixture portion can include a work-supporting surface extending in a first plane and configured to receive the mower blade. A back surface of the mower blade can rest on the work-supporting surface during the sharpening operation of the cutting edge of the mower blade, which is exposed on a front surface of the mower blade. The jig portion can be pivotally mounted to the mast. The jig portion can include an arm

and a tool-seat. The arm can include a plurality of links interconnected to one another. The arm can include at least a first link and a second link moveable relative to one another. The first link can extend between a first end and a second end. The first end of the first link can be pivotally connected to the mast with a first pin. The first pin can define an arm pivot axis. The first end of the first link can be rectilinearly fixed relative to the mast at the first pin. The first link and the second link can be interconnected whereby the second link is prevented from rotating in any plane that contains the arm pivot axis. The tool-seat can be disposed on the second link. The grinding wheel can be connected to the second link during the sharpening operation through the tool-seat.

[0005] According to other features, the first link and the second link can be interconnected for one of relative pivoting movement and telescoping rectilinear movement. The first link can be pivotally connected to the second link with a second pin, the second pin can define a link pivot axis, and the arm pivot axis and the link pivot axis can be parallel to one another.

[0006] In other features, the first link and the second link can have different lengths. The arm pivot axis can be coplanar with a vector normal to the first plane. The tool-seat can include a second pin pivotally engaged with the second link. The second pin can define a pitch axis about which the grinding wheel can pivot during the sharpening operation. The pitch axis and the arm pivot axis can be parallel to one another. The second pin can include a first portion of outwardly-facing cylindrical surface that is smooth and a second portion of outwardly-facing cylindrical surface that is threaded. The tool-seat can also include a sleeve defining inwardly-facing surface. The second pin can be received in the inwardly-facing surface.

[0007] According to additional features, the second link and the tool-seat can be engaged with one another such that at least a first portion of the tool-seat is moveable in a first rectilinear direction that includes at least a first orthogonal component that is parallel to the arm pivot axis and passes through the second link. The tool-seat further can include a second portion fixed with the first portion during movement the first rectilinear direction. The second portion can extend farther than the first portion in a direction normal to the first rectilinear direction. Movement of the first portion and the second portion in the first rectilinear direction can be limited by a hard stop defined when the second portion directly or indirectly contacts the second link. The first portion and the second portion can be unrestrained in movement in a second rectilinear direction that is opposite to the first rectilinear direction such that the first portion and the second portion are freely separable from the second link. The first portion can be further defined as a second pin having a cylindrical profile. The second portion can be further defined as engaging the second link indirectly, through a third portion of the tool-seat.

[0008] According to other features, the fixture portion

can be further defined as pivotally mounted to the mast with a third pin, the third pin defining a fixture pivot axis. The fixture pivot axis can be further defined as transverse to the arm pivot axis. The fixture pivot axis can be further defined as perpendicular to the arm pivot axis. A longitudinal axis can pass through an interior of the mast and the fixture pivot axis can intersect the longitudinal axis within the interior and the arm pivot axis can intersect the longitudinal axis within the interior. The fixture portion can include at least one stop extending above the work-support surface and limiting movement of the mower blade along the work-supporting surface. A leading edge of the mower blade can rest against the at least one stop during the sharpening operation of the cutting edge of the mower blade. An intersection between the leading edge of the mower blade and the at least one stop during the sharpening operation of the cutting edge of the mower blade can extend along an intersection axis. The intersection axis and the fixture pivot axis can be parallel to one another. The intersection axis moves about the fixture pivot axis during pivoting movement of the fixture portion. The intersection axis can move along an arcuate path in a second plane that is normal to the first plane. The intersection axis and the fixture pivot axis can be spaced a first distance from one another along a third axis normal to both of the intersection axis and the fixture pivot axis. A third plane can contain the fixture pivot axis and can be normal to the arm pivot axis. During the pivoting movement of the fixture portion, the intersection axis can move over a range of distances from the third plane. An absolute value of a distance between end-points of the range can define a second distance. The second distance can be less than one third of the first distance. The range can extend across the third plane.

[0009] In other features, the fixture portion can include at least one protuberance and a spring biasing the at least one protuberance outward. The mast further can include a plurality of detents spaced along an arc centered on the fixture pivot axis. The at least one protuberance can be selectively positioned in one of the plurality of detents to maintain the fixture portion in one of a plurality of different orientations relative to the mast.

[0010] According to additional features, the fixture portion can include first and second jaws that can be moveable relative to one another along a jaw axis that can be parallel to the work-supporting surface. The mast can be unitary and integrally-formed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The detailed description set forth below references the following drawings:

Figure 1 is a first perspective view of a first exemplary embodiment of the present disclosure;
 Figure 2 is a second perspective view of the first exemplary embodiment of the present disclosure;
 Figure 3 is a third perspective view of the first exem-

plary embodiment of the present disclosure;

Figure 4 is a right-side view of the first exemplary embodiment of the present disclosure;

Figure 5 is a top-down view of the first exemplary embodiment of the present disclosure;

Figure 6 is a front view of the first exemplary embodiment of the present disclosure;

Figure 7 is a rear view of the first exemplary embodiment of the present disclosure;

Figure 8 is a fourth perspective view of the first exemplary embodiment of the present disclosure, generally from the rear, wherein a fixture pivot axis is normal to the plane of view and a fixture portion of the embodiment is in a first position;

Figure 9 is a fifth perspective view of the first exemplary embodiment of the present disclosure, generally from the rear, wherein a fixture pivot axis is normal to the plane of view and a fixture portion of the embodiment is in a second position;

Figure 10 is a first perspective view of a second exemplary embodiment of the present disclosure, generally from the left and front side;

Figure 11 is a second perspective view of the second exemplary embodiment of the present disclosure, generally from the right and rear;

Figure 12 is a right-side view of the second exemplary embodiment of the present disclosure;

Figure 13 is a top-down view of the second exemplary embodiment of the present disclosure;

Figure 14 is a front view of the second exemplary embodiment of the present disclosure;

Figure 15 is a rear view of the second exemplary embodiment of the present disclosure;

Figure 16 is a first exploded view of part of the second exemplary embodiment of the present disclosure;

Figure 17 is a second exploded view of part of the second exemplary embodiment of the present disclosure;

Figure 18 is a third exploded view of part of the second exemplary embodiment of the present disclosure;

Figure 19 is a first perspective view of part of the second exemplary embodiment of the present disclosure, generally from the rear, wherein a fixture pivot axis is normal to the plane of view and a fixture portion of the embodiment is in a first position;

Figure 20 is a second perspective view of part of the second exemplary embodiment of the present disclosure, generally from the rear, wherein a fixture pivot axis is normal to the plane of view and a fixture portion of the embodiment is in a second position; and

Figure 21 is a third perspective view of part of the second exemplary embodiment of the present disclosure, generally from the rear, wherein a fixture pivot axis is normal to the plane of view and a fixture portion of the embodiment is in a third position.

DETAILED DESCRIPTION

[0012] The present disclosure, as demonstrated by the exemplary embodiments described below, can provide an enhanced jig assembly for sharpening a mower blade. A plurality of different embodiments of the present disclosure is shown in the Figures of the application. Similar features are shown in the various embodiments of the present disclosure. Similar features across different embodiments have been numbered with a common reference numeral and have been differentiated by an alphabetic suffix. Also, to enhance consistency, the structures in any particular drawing share the same alphabetic suffix even if a particular feature is shown in less than all embodiments. Similar features are structured similarly, operate similarly, and/or have the same function unless otherwise indicated by the drawings or this specification. Furthermore, particular features of one embodiment can replace corresponding features in another embodiment or can supplement other embodiments unless otherwise indicated by the drawings or this specification.

[0013] A jig assembly 10 can hold a mower blade 12 and can at least partially control movement of a grinding tool 14 having a grinding wheel 16 during a sharpening operation on a cutting edge 18 of the mower blade 12. The jig assembly 10 includes a mast 20 extending between a first end 22 and a second end 24. In the exemplary jig assembly 10, the mast 20 is unitary and integrally-formed. The exemplary mast 20 is cubic, with rectangular cross-sections in three different orthogonal planes. Thus, embodiments of the present disclosure can include a mast that is simple to manufacture. As will be detailed below, a jig portion and a fixture portion of the jig assembly 10 can both be mounted on a structure that is unitary and integrally-formed. "Integrally-formed" refers to the fact that in the exemplary embodiment the exemplary mast 20 is not formed from substructures that are formed separately and then subsequently joined. The term defines a structural feature since structures that are integrally-formed are structurally different than structures that are comprised of subcomponents formed separately and then subsequently joined. "Integral" means consisting or composed of parts that together constitute a whole and thus encompasses structures of more than one part wherein the parts are either integrally-formed or formed separately and then subsequently joined.

[0014] The jig assembly 10 also includes a fixture portion 26 mounted to the mast 20. The exemplary fixture portion 26 includes a work-supporting surface 28 extending in a first plane. The work-supporting surface 28 is visible as a line in Figures 8 and 9 since the work-supporting surface 28 is normal to the plane of view of Figures 8 and 9. The work-supporting surface 28 can be configured to receive the mower blade 12. A back surface of the mower blade 12 can rest on the work-supporting surface 28 during the sharpening operation of the cutting edge 18 of the mower blade 12. The cutting edge 18 is exposed on a front surface 30 of the mower blade 12.

[0015] The jig assembly 10 also includes a jig portion 32 pivotally mounted to the mast 20. The exemplary jig portion 32 includes an arm 34 and a tool-seat 36. The arm 34 can include a plurality of links interconnected to one another. The exemplary arm 34 includes a first link 38 and a second link 40 moveable relative to one another.

[0016] The exemplary first link 38 extends between a first end 42 and a second end 44. The exemplary first end 42 of the first link 38 is pivotally connected to the mast 20 with a first pin 46. The exemplary first pin 46 defines an arm pivot axis 48. The first end 42 of the exemplary first link 38 is rectilinearly fixed relative to the mast 20 at the first pin 46. The exemplary first link 38 and the exemplary second link 40 are interconnected whereby the second link 40 is prevented from rotating in any plane that contains the arm pivot axis 48. In the exemplary embodiment, the arm pivot axis 48 is coplanar with a vector normal to the first plane. Exemplary vectors are referenced at 50 in Figure 8 and at 52 in Figure 9.

[0017] The exemplary tool-seat 36 is disposed on the second link 40. The grinding wheel 16 is connected to the second link 40 during the sharpening operation through the tool-seat 36. In various embodiments of the present disclosure, the tool-seat can be integrally-formed with the arm 34 or mounted on the arm 34 or can include parts that are integrally-formed with the arm 34 and parts that are mounted on the arm 34.

[0018] In the exemplary embodiment of the present disclosure, the first link 38 and the second link 40 are interconnected for relative pivoting movement. In one or more alternative embodiments of the present disclosure, the first link 38 and the second link 40 could be telescopically engaged together. The exemplary first link 38 is pivotally connected to the second link 40 with a second pin 54. The second pin 54 defines a link pivot axis 56. The exemplary arm pivot axis 48 and the exemplary link pivot axis 56 are parallel to one another. The arm 34 can also include other components to enhance pivoting movement, reduce binding and secure structures together, such as bushings 58 and washers 60.

[0019] The first link 38 and the second link 40 can have different lengths in one or more embodiments of the invention. Figure 4 shows an alternative second link in phantom that is longer than the links 38, 40. Choosing different length allows the pivot angle over which the grinding tool 14 travels during sharpening to change. For example, the greater the distance between the tool-seat 36 and the axis 56, the shorter the pivot angle required over which to move the grinding tool 14. Also, choosing different lengths for the links 38, 40 can allow the jig assembly 10 to more evenly fill product packaging. For example, when the assembly 10 is stored, the link 38 can be positioned to extend toward the end 22 and the link 40 can be sized to extend fully to the end 24.

[0020] The exemplary tool-seat 36 includes a third pin 62, nuts 64, 66, 68, and a sleeve 70. The exemplary sleeve 70 has a threaded exterior and a smooth, cylindrical interior. The exemplary sleeve 70 is received in an

aperture 72 defined by the second link 40. The aperture 72 is spaced from the axis 56 and is centered on an aperture axis 74. The nuts 64 and 66 can be selectively positioned along the length of the sleeve 70 as desired, to accommodate different configurations of the grinding tool. The nuts 64, 66 need not be abutting opposite sides of the second link 40 to prevent any rectilinear movement of the sleeve 70 along the axis 74. In one or more embodiments of the present disclosure, nut 66 can be permanently fixed to sleeve 70 and be used to adjust the combination of 66 and 70 in and out of the aperture 72.

[0021] The exemplary third pin 62 includes a first portion 76 of outwardly-facing cylindrical surface that is smooth. The exemplary third pin 62 also includes a second portion 78 of outwardly-facing cylindrical surface that is threaded. The cylindrical interior of the sleeve 70 defines an inwardly-facing surface and, in the exemplary embodiment, the third pin 62 received in the inwardly-facing surface. The first portion 76 can freely pivot and rotate in the inwardly-facing surface of the sleeve 70. Thus, the exemplary third pin 62 is pivotally engaged with the second link 40.

[0022] Assembly of the grinding tool 14 to the arm 34 can be accomplished as follows. The nut 68 can be threaded on the threaded portion 78. The distance that the nut 68 is positioned along the length of the threaded portion (along the axis 74) can be selected as desired, to accommodate different configurations of the grinding tool. The tip of the threaded portion 78 can then be threadingly engaged with a threaded aperture defined by the grinding tool 14. The third pin 62 can be threaded into the threaded aperture defined by the grinding tool 14 until the nut 68 abuts the grinding tool 14 and prevents further rotation. The exemplary sleeve 70 can then be inserted in the aperture 72. As set forth above, the nuts 64 and 66 can be selectively positioned along the length of the sleeve 70 as desired, to accommodate different configurations of the grinding tool. The smooth portion of the third pin 62 can then be inserted into the interior of the sleeve 70 until the nut 68 abuts the sleeve 70, or the nut 68 abuts the nut 64, or the nut 68 contacts the sleeve 70 or nut 64 and urges the sleeve 70 and nut 64 against the second link 40. The grinding tool 14 can then be operated to perform a guided sharpening operation.

[0023] In the process described above, the second link 40 and the tool-seat 36 are engaged with one another such that at least a first portion of the tool-seat 36 (the third pin 62) is moveable in a first rectilinear direction (referenced in Figure 6 at 80) that includes at least a first orthogonal component that is parallel to the arm pivot axis 48 and passes through the second link 40. In the exemplary embodiment, the first orthogonal component is the only component of the first rectilinear direction 80. However, in other embodiments of the present disclosure, first rectilinear direction may include more than one orthogonal component.

[0024] In addition, the tool-seat 36 includes a second portion (nut 68) fixed with the first portion (the third pin

62) during movement the first rectilinear direction 80, wherein the second portion extends farther than the first portion (the third pin 62) in a direction normal to the first rectilinear direction 80. The movement of the first portion and the second portion in the first rectilinear direction 80 is thus limited by a hard stop defined when the second portion directly or indirectly contacts the second link 40. In the exemplary embodiment, the second portion engages the second link 40 indirectly, through a third portion (sleeve 70). In the exemplary embodiment, the first portion and the second portion are unrestrained in movement in a second rectilinear direction that is opposite to the first rectilinear direction 80 such that the first portion and the second portion are freely separable from the second link 40. Thus, the grinding tool 14 can be easily removed from the arm 34 when the sharpening operation has been completed.

[0025] As set forth above, the nuts 64, 66 can be selectively positioned on the sleeve 70 and nut 68 can be selectively positioned on the third pin 62 as desired in order to laterally position the grinding wheel 16 as desired. Figure 8 shows one possible desirable position of the grinding wheel 16 in phantom. In many operating environments, the same grinding tool 14 will be used repeatedly with the jig assembly 10 and so adjustment of the nuts 64, 66, 68 will not be required for every sharpening operation.

[0026] The cooperation between the arm 34 and the tool-seat 36 allows the grinding tool 14 to move during the sharpening operation. Movement of the grinding wheel 16 can be defined in three dimensions. The movement can be defined in part or in whole by translational or rectilinear movement. The movement can also be defined in part or in whole by rotation or orbiting. A yaw axis of the grinding wheel 16 is the axis of rotation of the grinding wheel 16. The yaw axis is established by the grinding tool 14. In Figure 8, the yaw axis would be vertical based on the perspective of Figure 8 and would appear perpendicular to the axis 74 through a center of the grinding wheel 16. The yaw axis of the grinding wheel 16 and the axis 74 may be perpendicular to and intersect one another, may be transverse but not perpendicular, or may be in different planes in various embodiments of the present disclosure.

[0027] In the exemplary embodiment of the present disclosure, the axis 74 defines a pitch axis of the grinding wheel 16. Rotation of the grinding tool 14 mounted in the tool-seat 36 about the axis 74 can correspond to pitch rotation or pitch orbiting of the grinding wheel 16. Pitch rotation is rotation of the grinding wheel 16 about a lateral axis extending through a center of the grinding wheel 16. Pitch orbiting is movement of the grinding wheel 16 about an axis that is parallel and spaced from the lateral axis that extends through the center of the grinding wheel 16. "Orbiting" does not require movement along a three hundred and sixty degree path. In the exemplary embodiment illustrated in Figure 8, the grinding wheel 16 can engage in pitch orbiting about the axis 74.

[0028] Another axis for defining movement is a roll axis. The roll axis is perpendicular to the yaw axis and to the pitch axis. The roll axis extends longitudinally relative to the edge of the workpiece to be sharpened, generally along the cutting edge 18. The roll axis and the cutting edge 18 of the mower blade 12 can be collinear when the mower blade 12 is held by the fixture portion 26, can be parallel, can be transverse to one another and coplanar, or can be transverse to one another and contained in the spaced parallel planes. Further, if the cutting edge 26 is curved, the spatial relationship between the cutting edge 18 and the roll axis can be variable. In Figure 8, the roll axis would extend into the plane of view. In Figures 2 and 3, an exemplary and nonlimiting roll axis is referenced at 82.

[0029] The exemplary third pin 62 thus defines a pitch axis about which the grinding wheel 16 can pivot during the sharpening operation. The exemplary arm 34 holds the grinding tool 14 so that the grinding wheel 16 does not rotate or orbit about the roll axis. In the exemplary embodiment, the jig portion 32 limits movement of the grinding tool 14 during the sharpening stroke only about the roll axis and in one lateral direction, the one lateral direction 80 limited once the nut 68 is directly or indirectly abutting the second link 40. The operator of the grinding tool 14 can change the pitch by moving the grinding tool 14 about the pitch axis (the axis 74) and can translate along the cutting edge 18. If desired, the operator can apply a relatively low force in the direction 80 to keep the grinding tool 14 resting against the link 40 to maintain the lateral position of the grinding wheel 16.

[0030] The exemplary fixture portion 26 is pivotally mounted to the mast 20 with a fourth pin 84. The exemplary fourth pin 84 defines a fixture pivot axis 86. The exemplary fixture pivot axis 86 is transverse to the arm pivot axis 48. The exemplary fixture pivot axis 86 is perpendicular to and spaced from the arm pivot axis 48. As shown in Figure 8, a longitudinal axis passes 88 through an interior of the mast 20 and the exemplary fixture pivot axis 86 intersects the longitudinal axis 88 within the interior and the exemplary arm pivot axis 48 intersects the longitudinal axis within the interior.

[0031] The exemplary fixture portion 26 also includes at least one stop extending above the work-support surface and limiting movement of the mower blade 12 along the work-supporting surface 28. The exemplary fixture portion 26 also includes four stops 90. In the exemplary embodiment, a leading edge of the mower blade 12 is urged against two of the stops 90 during the sharpening operation of the cutting edge 18 of the mower blade 12. The mower blade 12 is shown in phantom in Figures 8 and 9. Figures 8 and 9 show the mower blade 12 supported at different angles. One angle can be used when sharpening a primary cutting edge 12. Another angle can be used when sharpening a secondary cutting edge on the mower blade, such as a mulching cutting edge.

[0032] An intersection between the leading edge of the mower blade 12 and at least one of the stops during the

sharpening operation of the cutting edge 18 of the mower blade 12 extends along an intersection axis. An exemplary intersection axis is referenced at 92 in Figures 8 and 9. In the exemplary embodiment, the intersection axis 92 and the fixture pivot axis 86 are parallel to one another. The exemplary intersection axis 92 moves about the fixture pivot axis 86 during pivoting movement of the fixture portion 26. The intersection axis 92 moves along an arcuate path in a second plane that is normal to the first plane, the plane of the work-supporting surface 28. The second plane is the plane of perspective of Figures 8 and 9 or parallel to the plane of perspective of Figures 8 and 9.

[0033] The exemplary intersection axis 92 and the exemplary fixture pivot axis 86 are spaced a first distance from one another along a third axis normal to both of the intersection axis 92 and the fixture pivot axis 86. In Figures 8 and 9, the lateral distance between the axes 86 and 92 is referenced at 94 and the vertical distance between the axes 86 and 92 is referenced at 96. The "first distance" in the exemplary embodiment is the square root of the sum of distance 94 squared and distance 96 squared. By way of example and not limitation, the "first distance" in Figures 8 and 9 can be 0.95 inch.

[0034] A third plane contains the fixture pivot axis 86 and is normal to the arm pivot axis 48. The third plane thus appears collinear to longitudinal axis 88 in Figures 8 and 9. In the exemplary embodiment, during the pivoting movement of the fixture portion 26, the intersection axis 92 moves over a range of distances from the third plane. In Figures 8 and 9, these distances are the lateral distances 94. For the first embodiment, the end points of the range are shown in Figures 8 and 9. By way of example and not limitation, the lateral distance in Figure 8 can be 0.08 inch from the third plane (positive to the right of the third plane in Figures 8 and 9) and the lateral distance in Figure 9 can be -0.168 inch from the third plane (negative to the left of the third plane in Figures 8 and 9). The range of the first exemplary embodiment thus extends across the third plane. An absolute value of a distance between endpoints of the range define a "second distance." The second distance is less than one third of the first distance. By way of example and not limitation, using the exemplary values used previously, the "second distance" can therefore be 0.248 inch.

[0035] The ratio disclosed herein between the (i) the distance between the intersection axis 92 and the fixture pivot axis 86 and (ii) the range of lateral movement of the intersection axis relative to the third plane is not a matter of mere design choice. The ratio reflects a principle applied in the present disclosure through structural arrangements in which the intersection axis 92 is maintained in a relatively narrow lateral range during pivoting movement of the fixture portion 26. This keeps the cutting edge 18 and other edges to be sharpened in generally the same plane as a leading edge of the grinding wheel 16 which is held by the jig portion 32. In the exemplary embodiment, for example, the primary cutting edge 18 of

the mower blade 12 can be sharpened when the fixture portion 26 is in the position shown in Figure 8. After sharpening, the fixture portion 26 can be pivoted about the axis 86 to the position shown in Figure 9. A secondary cutting edge, such as a mulching cutting edge, of the mower blade 12 can be sharpened when the fixture portion 26 is in the position shown in Figure 9 without having to adjust or change the position of the grinding tool 14 relative to the second link 40. In other words, the various adjusting structures of the tool-seat 36 would not require adjustment.

[0036] A further benefit of the disclosed embodiment is enjoyed for mower blades that are counter-rotating. The mower blade 12 shown in Figure 2 is not a counter-rotated blade. However, if it were, another, primary cutting edge would be defined in the area referenced at 98. The edges 18 and 98 would generally be along the same roll axis. The arm 34 can be utilized to move the grinding tool 14 along different, sharpening paths for both edges 18 and 98 without having to adjust or change the position of the grinding tool 14 relative to the second link 40 and without having to move the fixture portion 26.

[0037] The exemplary fixture portion 26 also includes first and second jaws 100, 102. Each jaw defines part of the exemplary work-supporting surface 28. The jaws 100, 102 are moveable relative to one another along a jaw axis 104 that is parallel to the work-supporting surface 28. The jaw 100 can receive the pin 84 and be attached to the mast 20. The exemplary fixture portion 26 also includes a handle 106 and a screw 108. The screw 108 threads into the jaw 100 and can freely rotate within the jaw 102. The exemplary fixture portion 26 also includes pins 110 that can extend through the jaws 100, 102 to guide movement of the jaws 100, 102 relative to one another. The pins 110 can be fixed to the jaw 102 and slide in apertures formed in the jaw 100, or vice-versa. The mower blade 12 can be located and held at its center section 112 between the stops 90 by turning (tightening) handle 106 which in turn threads screw 108 into the jaw 100 and brings the jaws 100, 102 closer together. The above described blade holding configuration can hold blades of various length, width and thickness.

[0038] The mast 20 can be releasably mounted to an angled bracket, such as bracket 114. The bracket 114 can be fixed through fasteners 116 to another structure, such as a work bench or a vehicle. The mast 20 can be selectively fixed through fasteners 118 to the bracket 114, mounted when in use and removed when not in use.

[0039] Referring now to Figures 10 - 21, a jig assembly 10a can hold a mower blade and can at least partially control movement of a grinding tool having a grinding wheel during a sharpening operation on a cutting edge of the mower blade. The jig assembly 10a includes a mast 20a extending between a first end 22a and a second end 24a. In the exemplary jig assembly 10a, the mast 20a is unitary and integrally-formed. Thus, embodiments of the present disclosure can include a mast that is simple to manufacture. As will be detailed below, a jig portion

and a fixture portion of the jig assembly 10a can both be mounted on a structure that is unitary and integrally-formed.

[0040] The jig assembly 10a also includes a fixture portion 26a mounted to the mast 20a. The exemplary fixture portion 26a includes a work-supporting surface 28a extending in a first plane. The work-supporting surface 28a is visible as a line in Figures 19 - 21 since the work-supporting surface 28a is normal to the plane of view of Figures 19 - 21. The work-supporting surface 28a can be configured to receive the mower blade. A back surface of the mower blade can rest on the work-supporting surface 28a during the sharpening operation of the cutting edge of the mower blade. The cutting edge is exposed on a front surface of the mower blade.

[0041] The jig assembly 10a also includes a jig portion 32a pivotally mounted to the mast 20a. The exemplary jig portion 32a includes an arm 34a and a tool-seat 36a. The arm 34a can include a plurality of links interconnected to one another. The exemplary arm 34a includes a first link 38a and a second link 40a moveable relative to one another.

[0042] The exemplary first link 38a extends between a first end 42a and a second end 44a. The exemplary first end 42a of the first link 38a is pivotally connected to the mast 20a with a first pin 46a. The exemplary first pin 46a defines an arm pivot axis 48a. The first end 42a of the exemplary first link 38a is rectilinearly fixed relative to the mast 20a at the first pin 46a. The exemplary first link 38a and the exemplary second link 40a are interconnected whereby the second link 40a is prevented from rotating in any plane that contains the arm pivot axis 48a. In the exemplary embodiment, the arm pivot axis 48a is coplanar with a vector normal to the first plane. Exemplary vectors are referenced at 50a in Figure 19 and at 52a in Figure 21.

[0043] The exemplary tool-seat 36a is disposed on the second link 40a. The grinding wheel 16a is connected to the second link 40a during the sharpening operation through the tool-seat 36a. In various embodiments of the present disclosure, the tool-seat can be integrally-formed with the jig portion 32a or mounted on the jig portion 32a.

[0044] In the exemplary embodiment of the present disclosure, the first link 38a and the second link 40a are interconnected for relative pivoting movement. In one or more alternative embodiments of the present disclosure, the first link 38a and the second link 40a can be telescopically engaged together. The exemplary first link 38a is pivotally connected to the second link 40a with a second pin 54a. The second pin 54a defines a link pivot axis 56a. The exemplary arm pivot axis 48a and the exemplary link pivot axis 56a are parallel to one another. The arm 34a can also include other components to enhance pivoting movement, reduce binding and secure structures together, such as bushings 58a and washers 60a.

[0045] The exemplary tool-seat 36a includes a third pin 62a, nuts 64a, 66a, 68a, and a sleeve 70a. The exemplary sleeve 70a has a threaded exterior and a cylin-

dricial interior. The exemplary sleeve 70a is received in an aperture 72a defined by the second link 40a. The aperture 70a is spaced from the axis 56a and is centered on an aperture axis 74a. The nuts 64a and 66a can be selectively positioned along the length of the sleeve 70a as desired, to accommodate different configurations of the grinding tool. The nuts 64a, 66a need not be abutting opposite sides of the second link 40a to prevent any rectilinear movement of the sleeve 70a along the axis 74a.

[0046] The exemplary third pin 62a includes a first portion 76a of outwardly-facing cylindrical surface that is smooth. The exemplary third pin 62a also includes a second portion 78a of outwardly-facing cylindrical surface that is threaded. The cylindrical interior of the sleeve 70a defines inwardly-facing surface and, in the exemplary embodiment, the third pin 62a received in the inwardly-facing surface. The first portion 76a can freely pivot and rotate in the inwardly-facing surface of the sleeve 70a. Thus, the exemplary third pin 62a is pivotally engaged with the second link 40a.

[0047] Assembly of the grinding tool 14a to the arm 34a can be accomplished as follows. The nut 68a can be threaded on the threaded portion 78a. The distance that the nut 68a is positioned along the length of the threaded portion (along the axis 74a) can be selected as desired, to accommodate different configurations of the grinding tool. The tip of the threaded portion 78a can then be threadingly engaged with a threaded aperture defined by the grinding tool 14a. The third pin 62a can be threaded into the threaded aperture defined by the grinding tool 14a until the nut 68a abuts the grinding tool 14a and prevents further rotation. The exemplary sleeve 70a can then be inserted in the aperture 72a. As set forth above, the nuts 64a and 66a can be selectively positioned along the length of the sleeve 70a as desired, to accommodate different configurations of the grinding tool. The smooth portion of the third pin 62a can then be inserted into the interior of the sleeve 70a until the nut 68a abuts the sleeve 70a, or the nut 68a abuts the nut 64a, or the nut 68a contacts the sleeve 70a or nut 64a and urges the sleeve 70a and nut 64a against the second link 40a. The grinding tool 14a can then be operated to perform a guided sharpening operation.

[0048] In the process described above, the second link 40a and the tool-seat 36a are engaged with one another such that at least a first portion of the tool-seat 36a (the third pin 62a) is moveable in a first rectilinear direction (referenced in Figure 6a at 80a) that includes at least a first orthogonal component that is parallel to the arm pivot axis 48a and passes through the second link 40a. In the exemplary embodiment, the first orthogonal component is the only component of the first rectilinear direction 80a. However, in other embodiments of the present disclosure, first rectilinear direction may include more than one orthogonal component.

[0049] In addition, the tool-seat 36a includes a second portion (nut 68a) fixed with the first portion (the third pin 62a) during movement the first rectilinear direction 80a,

wherein the second portion extends farther than the first portion (the third pin 62a) in a direction normal to the first rectilinear direction 80a. The movement of the first portion and the second portion in the first rectilinear direction 80a is thus limited by a hard stop defined when the second portion directly or indirectly contacts the second link 40a. In the exemplary embodiment, the second portion engages the second link 40a indirectly, through a third portion (sleeve 70a). In the exemplary embodiment, the first portion and the second portion are unrestrained in movement in a second rectilinear direction that is opposite to the first rectilinear direction 80a such that the first portion and the second portion are freely separable from the second link 40a. Thus, the grinding tool 14a can be easily removed when the sharpening operation has been completed.

[0050] The exemplary fixture portion 26a is pivotally mounted to the mast 20a with a fourth pin 84a. The exemplary fourth pin 84a defines a fixture pivot axis 86a. The exemplary fixture pivot axis 86a is transverse to the arm pivot axis 48a. The exemplary fixture pivot axis 86a is perpendicular to and spaced from the arm pivot axis 48a. A longitudinal axis passes 88a through an interior of the mast 20a and the exemplary fixture pivot axis 86a intersects the longitudinal axis 88a within the interior and the exemplary arm pivot axis 48a intersects the longitudinal axis within the interior.

[0051] The exemplary fixture portion 26a also includes at least one stop extending above the work-support surface and limiting movement of the mower blade 12a along the work-supporting surface 28a. The exemplary fixture portion 26a also includes four stops 90a. In the exemplary embodiment, a leading edge of the mower blade 12a rests against two of the stops during the sharpening operation of the cutting edge 18a of the mower blade 12a. The mower blade 12a is shown in phantom in Figures 19 - 21. Figures 19 - 21 show the mower blade 12a supported at different angles. One angle can be used when sharpening a primary cutting edge 12a. Another angle can be used when sharpening a secondary cutting edge on the mower blade, such as a mulching cutting edge. Other angles can be used when different blades are sharpened. Figures 19 and 21 show end limits of travel of the fixture portion 26a and Figure 21 shows a position between the end limits of travel.

[0052] An intersection between the leading edge of the mower blade 12a and at least one of the stops during the sharpening operation of the cutting edge 18a of the mower blade 12a extends along an intersection axis. An exemplary intersection axis is referenced at 92a in Figures 8a and 9. In the exemplary embodiment, the intersection axis 92a and the fixture pivot axis 86a are parallel to one another. The exemplary intersection axis 92a moves about the fixture pivot axis 86a during pivoting movement of the fixture portion 26a. The intersection axis 92a moves along an arcuate path in a second plane that is normal to the first plane, the plane of the work-supporting surface 28a. The second plane is the plane of perspective of Fig-

ures 19 - 21.

[0053] The exemplary intersection axis 92a and the exemplary fixture pivot axis 86a are spaced a first distance from one another along a third axis normal to both of the intersection axis 92a and the fixture pivot axis 86a. In Figures 19 - 21, the lateral distance between the axes 86a and 92a is referenced at 94a and the vertical distance between the axes 86a and 92a is referenced at 96a. The "first distance" in the exemplary embodiment is the square root of the sum of distance 94a squared and distance 96a squared. By way of example and not limitation, the "first distance" in Figures 19-21 can be 0.69 inch.

[0054] A third plane contains the fixture pivot axis 86a and is normal to the arm pivot axis 48a. The third plane thus appears collinear to longitudinal axis 88a in Figures 19 - 21. In the exemplary embodiment, during the pivoting movement of the fixture portion 26a, the intersection axis 92a moves over a range of distances from the third plane. In Figures 19 - 21, these distances are the lateral distances 94a. For the first embodiment, the end points of the range are shown in Figures 19 and 21. By way of example and not limitation, the lateral distance in Figure 19 can be 0.657 inch from the third plane and the lateral distance in Figure 21 can be 0.69 inch from the third plane. An absolute value of a distance between end-points of the range define a "second distance," wherein the second distance is less than one third of the first distance. By way of example and not limitation, using the exemplary values used previously, the "second distance" or range can therefore be 0.033 inch.

[0055] The exemplary fixture portion 26a also includes first and second jaws 100a, 102a. Each jaw defines part of the work-supporting surface 28a. The jaws 100a, 102a are moveable relative to one another along a jaw axis 104a that is parallel to the work-supporting surface 28a. The jaw 100a can receive the pin 84a and be attached to the mast 20a. The exemplary fixture portion 26a also includes a handle 106a and a screw 108a. The screw 108a threads into the jaw 100a. The exemplary fixture portion 26a also includes pins 110a that can extend through the jaws 100a, 102a to guide movement of the jaws 100a, 102a relative to one another. The pins 110a can be fixed to the jaw 102a and slide in apertures formed in the jaw 100a, or vice-versa. The mower blade can be located and held at its center section between the stops 90a by turning (tightening) handle 106a which in turn threads screw 108a into the jaw 100a. The above described blade holding configuration can hold blades of various length, width and thickness.

[0056] The mast 20a can be releasably mounted to an angled bracket, such as bracket 114a. The bracket 114a can be fixed through fasteners 116a to another structure, such as a work bench or a vehicle. The mast 20a can be selectively fixed through fasteners 118a to the bracket 114a, mounted when in use and removed when not in use.

[0057] The fixture portion 26a can also include at least one protuberance 118a and a spring 120a biasing the at

least one protuberance 118a outward. In the second exemplary embodiment, as best shown in Figures 17 and 18, the at least one protuberance 118a is a ball bearing mounted in a blind aperture 122a defined in a portion of the jaw 100a. The mast 20a further comprises a plurality of detents 124a is spaced along an arc centered on the fixture pivot axis 86a. The mast 20a can include markings to indicate the angle of the work-supporting surface 28a for each detent 124a. The at least one protuberance 118a is selectively positioned in one of the plurality of detents 124a to maintain the fixture portion 26a in one of a plurality of different orientations relative to the mast 20a.

[0058] The spring force biasing the protuberance 118a can be strong enough to support the weight of the fixture portion 26a and the blade, or the assembly 10a can include a supplemental locking structure 126a. The exemplary lock structure 126a includes a threaded shaft 128a received in a slot 130a in the mast 20a and in a threaded aperture 132a in the jaw 100a. The exemplary lock structure 126a also includes a handle 134a and a washer 60a. After the position of the fixture portion 26a has been selected by moving the protuberance 118a into the desired detent 124a, the handle 134a can be tightened to fix the mast 20a and jaw 100a together. In the second exemplary embodiment, the fixture portion 26a can be rotated to positions between fifteen degrees and forty-five degrees, each position spaced from the next by five degrees.

[0059] While the present disclosure has been described with reference to an exemplary embodiment, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the present disclosure. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the present disclosure without departing from the essential scope thereof. Therefore, it is intended that the present disclosure not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this present disclosure, but that the present disclosure will include all embodiments falling within the scope of the appended claims. The right to claim elements and/or sub-combinations that are disclosed herein as other present disclosures in other patent documents is hereby unconditionally reserved. The following clauses outline aspects of the invention:

1. A jig assembly for holding a mower blade and for controlling movement of a grinding tool having a grinding wheel during a sharpening operation on a cutting edge of the mower blade, said jig assembly comprising: a mast extending between a first end and a second end; a fixture portion mounted to said mast, said fixture portion including a work-supporting surface extending in a first plane and configured to receive the mower blade, a back surface of the mower blade resting on said work-supporting surface during the sharpening operation of the cutting edge of

the mower blade exposed on a front surface of the mower blade; and a jig portion pivotally mounted to said mast, said jig portion comprising: an arm with a plurality of links interconnected to one another, said arm including at least a first link and a second link moveable relative to one another, said first link extending between a first end and a second end, said first end of said first link pivotally connected to said mast with a first pin, said first pin defining an arm pivot axis, said first end of said first link rectilinearly fixed relative to said mast at said first pin, said first link and said second link interconnected whereby said second link is prevented from rotating in any plane that contains the arm pivot axis, and a tool-seat disposed on said second link, the grinding wheel connected to said second link during the sharpening operation through said tool-seat.

2. The jig assembly of clause 1 wherein said first link and said second link are further defined as interconnected for one of relative pivoting movement and telescoping rectilinear movement.

3. The jig assembly of clause 2 wherein said first link is pivotally connected to said second link with a second pin, said second pin defining a link pivot axis, said arm pivot axis and said link pivot axis parallel to one another.

4. The jig assembly of clause 1 wherein said first link and said second link are further defined as having different lengths.

5. The jig assembly of clause 1 wherein said arm pivot axis is coplanar with a vector normal to said first plane.

6. The jig assembly of clause 1 wherein said tool-seat further comprises: a second pin pivotally engaged with said second link, said second pin defining a pitch axis about which the grinding wheel can pivot during the sharpening operation, said pitch axis and said arm pivot axis parallel to one another.

7. The jig assembly of clause 6 wherein said second pin further comprises: a first portion of outwardly-facing cylindrical surface that is smooth; and a second portion of outwardly-facing cylindrical surface that is threaded.

8. The jig assembly of clause 6 wherein said tool-seat further comprises: a sleeve defining inwardly-facing surface, said second pin received in said inwardly-facing surface.

9. The jig assembly of clause 1 wherein said second link and said tool-seat are engaged with one another such that at least a first portion of said tool-seat is moveable in a first rectilinear direction that includes at least a first orthogonal component that is parallel to said arm pivot axis and passes through said second link, said tool-seat further comprising a second portion fixed with said first portion during movement the first rectilinear direction, said second portion extending farther than said first portion in a direction normal to the first rectilinear direction, movement of

said first portion and said second portion in the first rectilinear direction limited by a hard stop defined when said second portion directly or indirectly contacts said second link, and said first portion and said second portion are unrestrained in movement in a second rectilinear direction that is opposite to the first rectilinear direction such that said first portion and said second portion are freely separable from said second link.

10. The jig assembly of clause 9 wherein said first portion is a further defined as a second pin having a cylindrical profile.

11. The jig assembly of clause 9 wherein said second portion is further defined as engaging said second link indirectly, through a third portion of said tool-seat.

12. The jig assembly of clause 1 wherein said fixture portion is further defined as pivotally mounted to said mast with a third pin, said third pin defining a fixture pivot axis.

13. The jig assembly of clause 12 wherein said fixture pivot axis is further defined as transverse to said arm pivot axis.

14. The jig assembly of clause 13 wherein said fixture pivot axis is further defined as perpendicular to said arm pivot axis.

15. The jig assembly of clause 12 wherein a longitudinal axis passes through an interior of said mast, said fixture pivot axis intersecting said longitudinal axis within said interior and said arm pivot axis intersecting said longitudinal axis within said interior.

16. The jig assembly of clause 12 wherein said fixture portion further comprises: at least one stop extending above said work-support surface and limiting movement of the mower blade along said work-supporting surface, a leading edge of the mower blade resting against said at least one stop during the sharpening operation of the cutting edge of the mower blade, an intersection between the leading edge of the mower blade and said at least one stop during the sharpening operation of the cutting edge of the mower blade extending along an intersection axis, and said intersection axis and said fixture pivot axis parallel to one another, wherein said intersection axis moves about said fixture pivot axis during pivoting movement of said fixture portion, said intersection axis moving along an arcuate path in a second plane that is normal to said first plane, wherein said intersection axis and said fixture pivot axis are spaced a first distance from one another along a third axis normal to both of said intersection axis and said fixture pivot axis, wherein a third plane contains said fixture pivot axis and is normal to said arm pivot axis, wherein during the pivoting movement of said fixture portion said intersection axis moves over a range of distances from said third plane, an absolute value of a distance between endpoints of said range defining a second distance, and wherein said second dis-

tance less than one third of said first distance.

17. The jig assembly of clause 16 wherein said range extends across said third plane.

18. The jig assembly of clause 12 wherein: said fixture portion further comprises at least one protuberance and a spring biasing said at least one protuberance outward; and said mast further comprises a plurality of detents spaced along an arc centered on said fixture pivot axis, said at least one protuberance selectively positioned in one of said plurality of detents to maintain said fixture portion in one of a plurality of different orientations relative to said mast.

19. The jig assembly of clause 12 wherein said fixture portion further comprises: first and second jaws that are moveable relative to one another along a jaw axis that is parallel to said work-supporting surface.

20. The jig assembly of clause 1 wherein said mast is further defined as a unitary and integrally- formed.

21. A jig assembly for holding a mower blade and for controlling movement of a grinding tool having a grinding wheel during a sharpening operation on a cutting edge of the mower blade, the jig assembly comprising: a mast extending between a first end and a second end; a fixture portion mounted to said mast, said fixture portion including a work-supporting surface extending in a first plane and configured to receive the mower blade, a back surface of the mower blade resting on said work-supporting surface during the sharpening operation of the cutting edge of the mower blade exposed on a front surface of the mower blade; and a jig portion pivotally mounted to said mast, said jig portion comprising: an arm pivotally connected to said mast with a first pin, said first pin defining an arm pivot axis, a tool-seat disposed on said arm, the grinding wheel connected to said arm during the sharpening operation through said tool-seat, and wherein said arm and said tool-seat are engaged with one another such that at least a first portion of said tool-seat is moveable in a first rectilinear direction that includes at least a first orthogonal component that is parallel to said arm pivot axis and passes through said arm, said tool-seat further comprising a second portion fixed with said first portion during movement the first rectilinear direction, said second portion extending farther than said first portion in a direction normal to the first rectilinear direction, movement of said first portion and said second portion in the first rectilinear direction limited by a hard stop defined when said second portion directly or indirectly contacts said arm, and said first portion and said second portion are unrestrained in movement in a second rectilinear direction that is opposite to the first rectilinear direction such that said first portion and said second portion are freely separable from said arm in the second rectilinear direction.

Claims

1. A jig assembly for holding a mower blade and for controlling movement of a grinding tool having a grinding wheel during a sharpening operation on a cutting edge of the mower blade, said jig assembly comprising:

a mast extending between a first end and a second end;

a fixture portion mounted to said mast, said fixture portion including a work-supporting surface extending in a first plane and configured to receive the mower blade, a back surface of the mower blade resting on said work-supporting surface during the sharpening operation of the cutting edge of the mower blade exposed on a front surface of the mower blade;

a jig portion pivotally mounted to said mast, said jig portion comprising:

an arm pivotally connected to said mast with a first pin, said first pin defining an arm pivot axis, and

a tool-seat disposed on said arm, the grinding wheel connected to said arm during the sharpening operation through said tool-seat;

wherein said fixture portion is further defined as pivotally mounted to said mast with a third pin, said third pin defining a fixture pivot axis; and wherein said fixture portion further comprises at least one stop extending above said work-support surface and limiting movement of the mower blade along said work-supporting surface, a leading edge of the mower blade resting against said at least one stop during the sharpening operation of the cutting edge of the mower blade, an intersection between the leading edge of the mower blade and said at least one stop during the sharpening operation of the cutting edge of the mower blade extending along an intersection axis, and said intersection axis and said fixture pivot axis parallel to one another, wherein said intersection axis moves about said fixture pivot axis during pivoting movement of said fixture portion, said intersection axis moving along an arcuate path in a second plane that is normal to said first plane, wherein said intersection axis and said fixture pivot axis are spaced a first distance from one another along a third axis normal to both of said intersection axis and said fixture pivot axis, wherein a third plane contains said fixture pivot axis and is normal to said arm pivot axis, wherein during the pivoting movement of said fixture portion said intersection axis moves over a range of distances from said third plane,

an absolute value of a distance between end-points of said range defining a second distance, and wherein said second distance less than one third of said first distance.

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2. The jig assembly of claim 1 wherein said arm and said tool-seat are engaged with one another such that at least a first portion of said tool-seat is moveable in a first rectilinear direction that includes at least a first orthogonal component that is parallel to said arm pivot axis and passes through said arm, said tool-seat further comprising a second portion fixed with said first portion during movement the first rectilinear direction, said second portion extending farther than said first portion in a direction normal to the first rectilinear direction, movement of said first portion and said second portion in the first rectilinear direction limited by a hard stop defined when said second portion directly or indirectly contacts said arm, and said first portion and said second portion are unrestrained in movement in a second rectilinear direction that is opposite to the first rectilinear direction such that said first portion and said second portion are freely separable from said arm in the second rectilinear direction.

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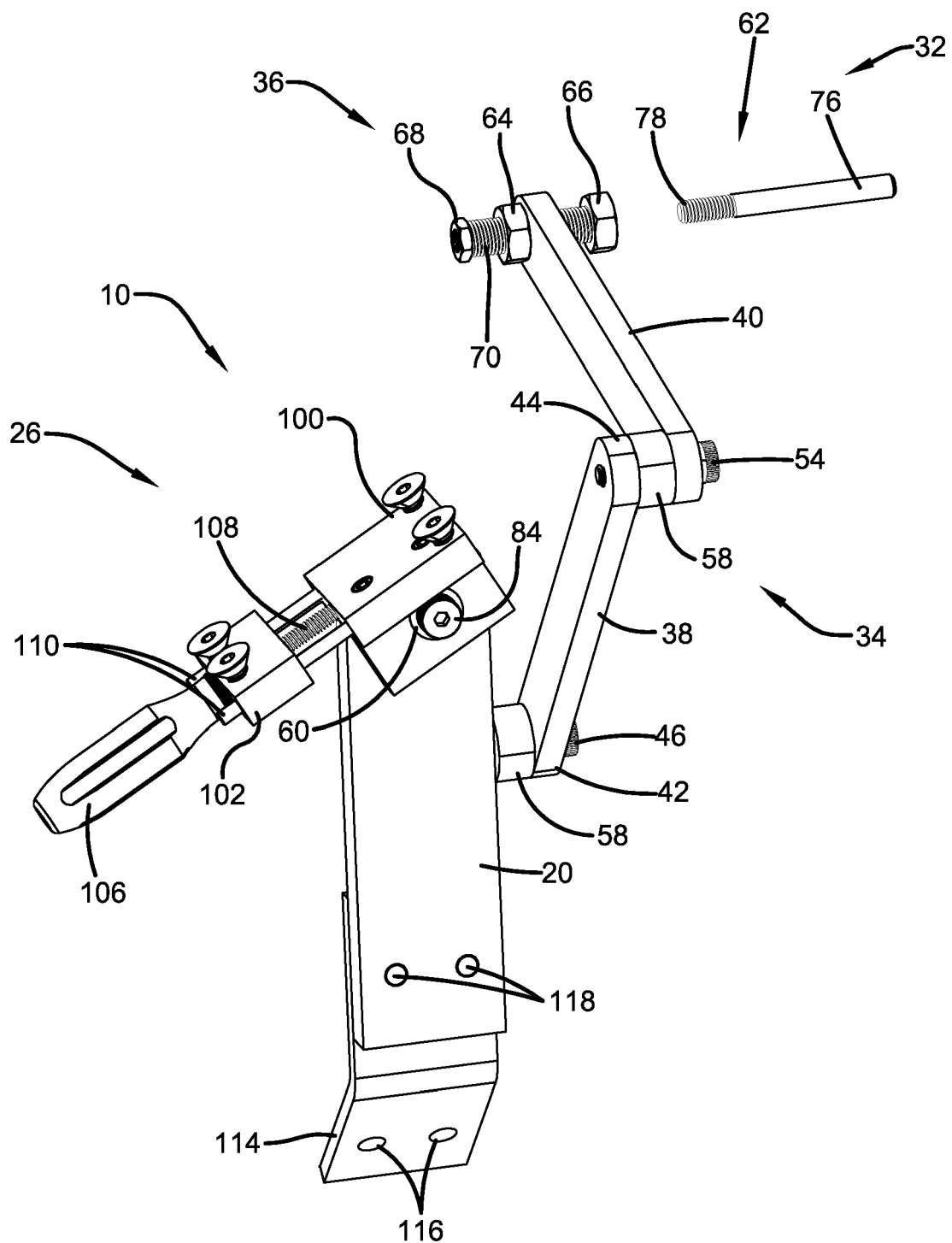


Figure 1

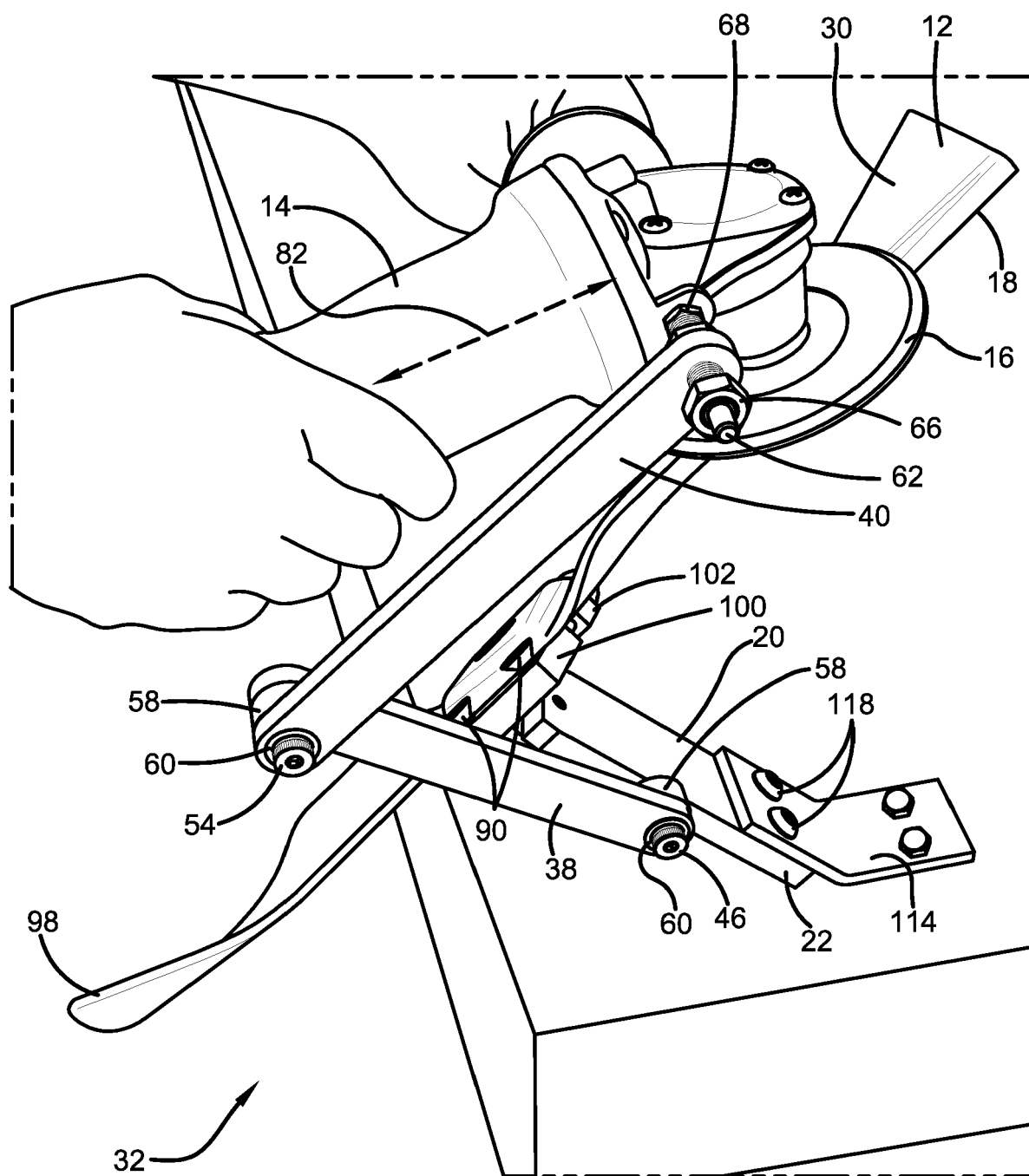


Figure 2

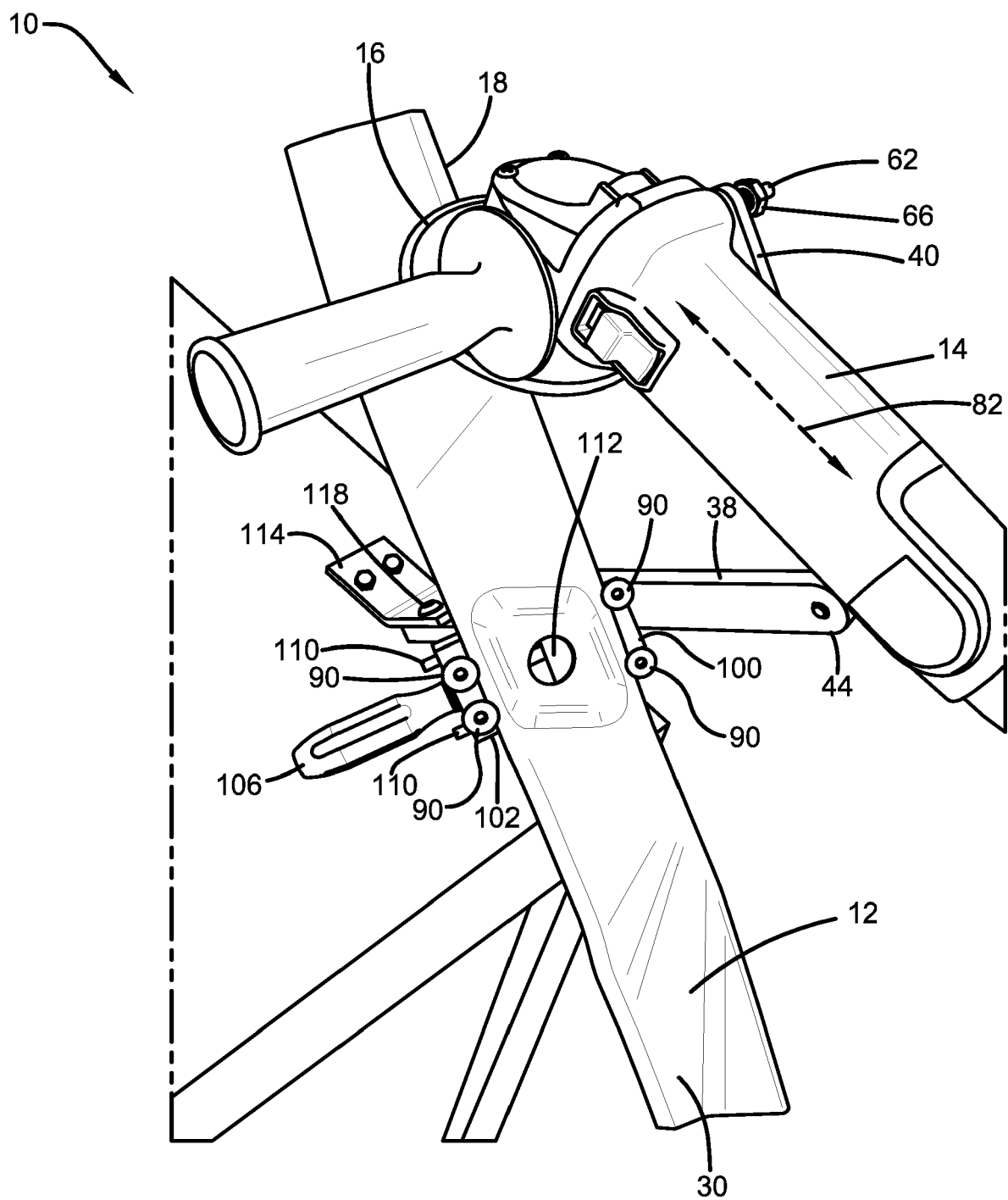


Figure 3

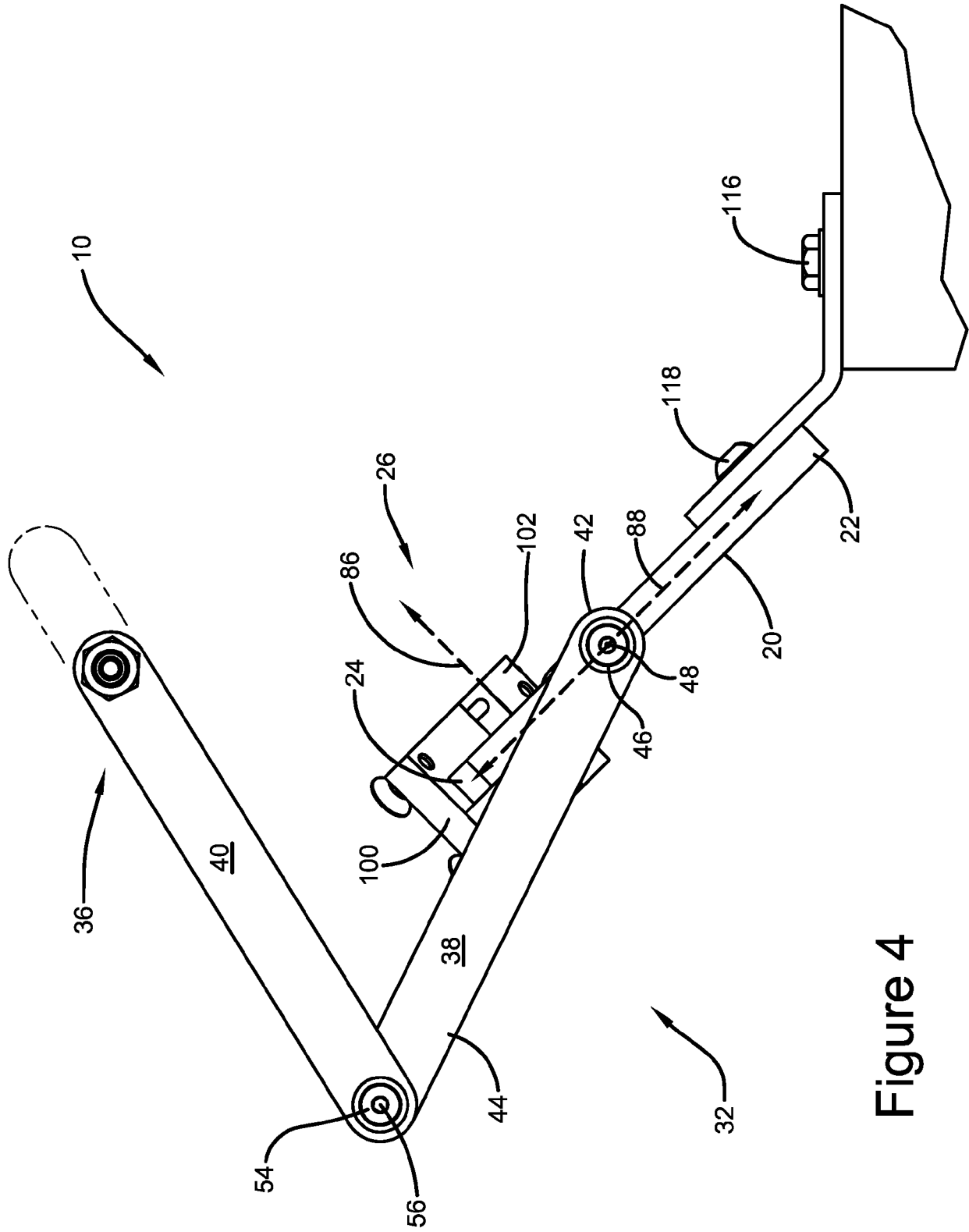


Figure 4

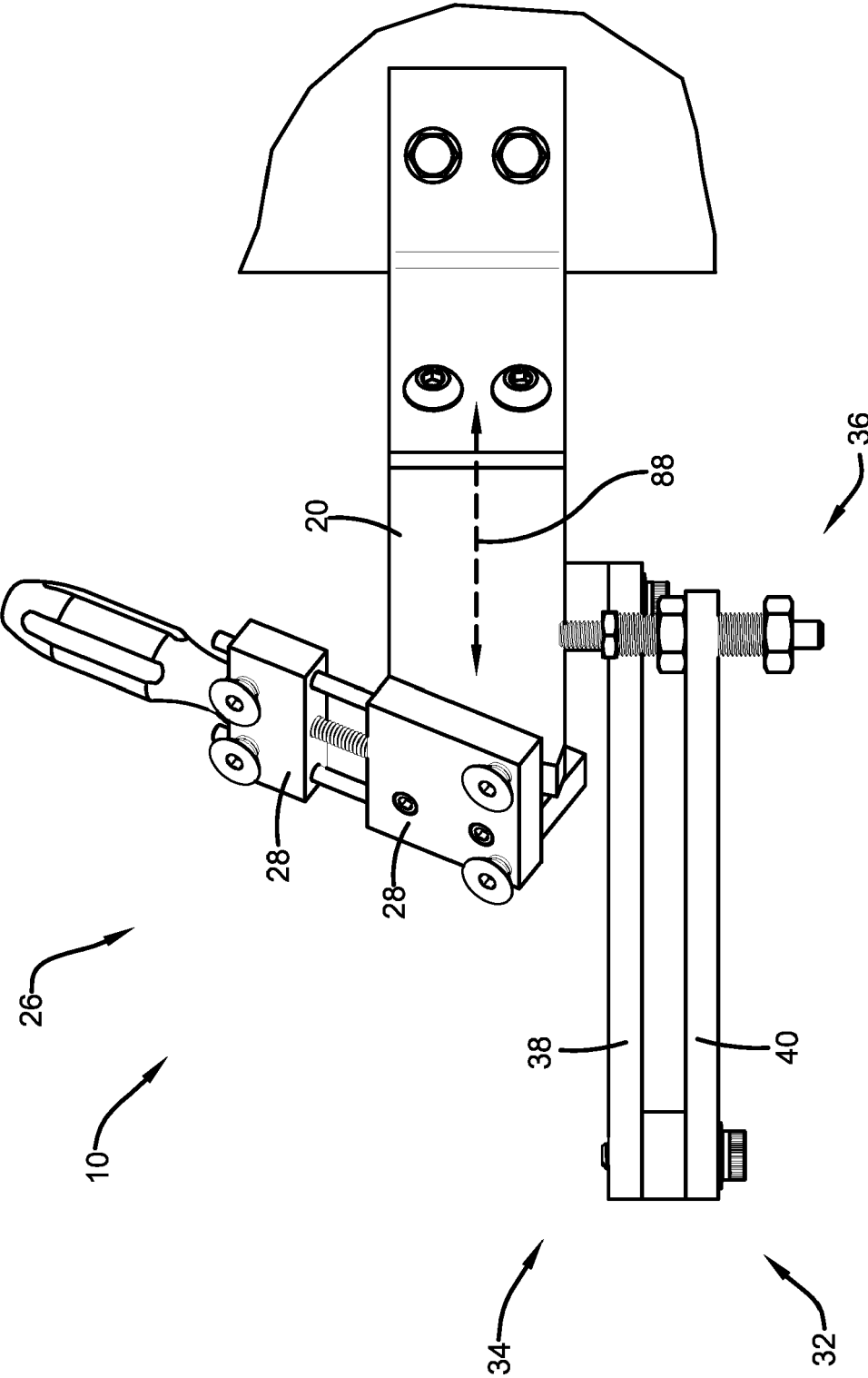


Figure 5

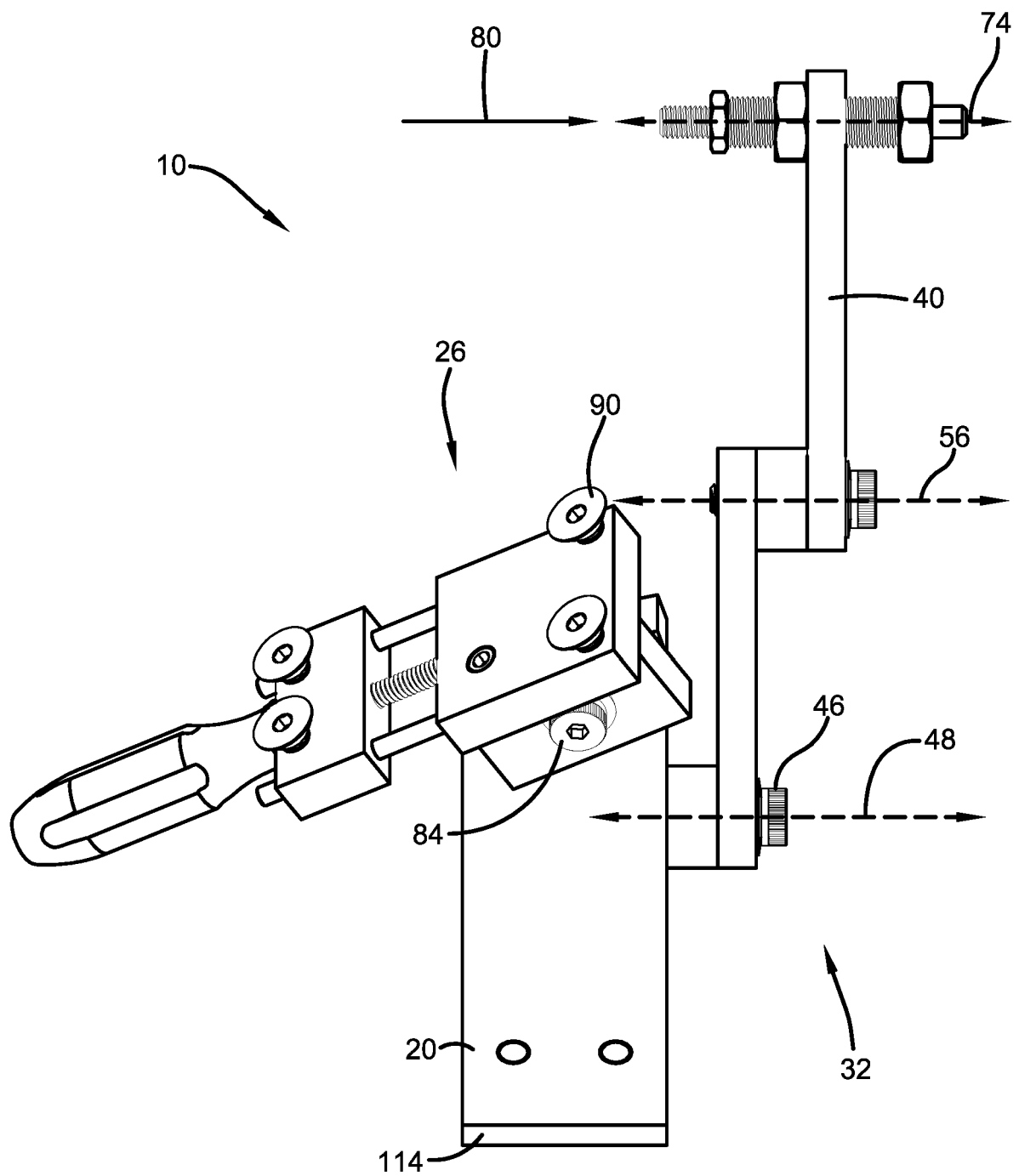


Figure 6

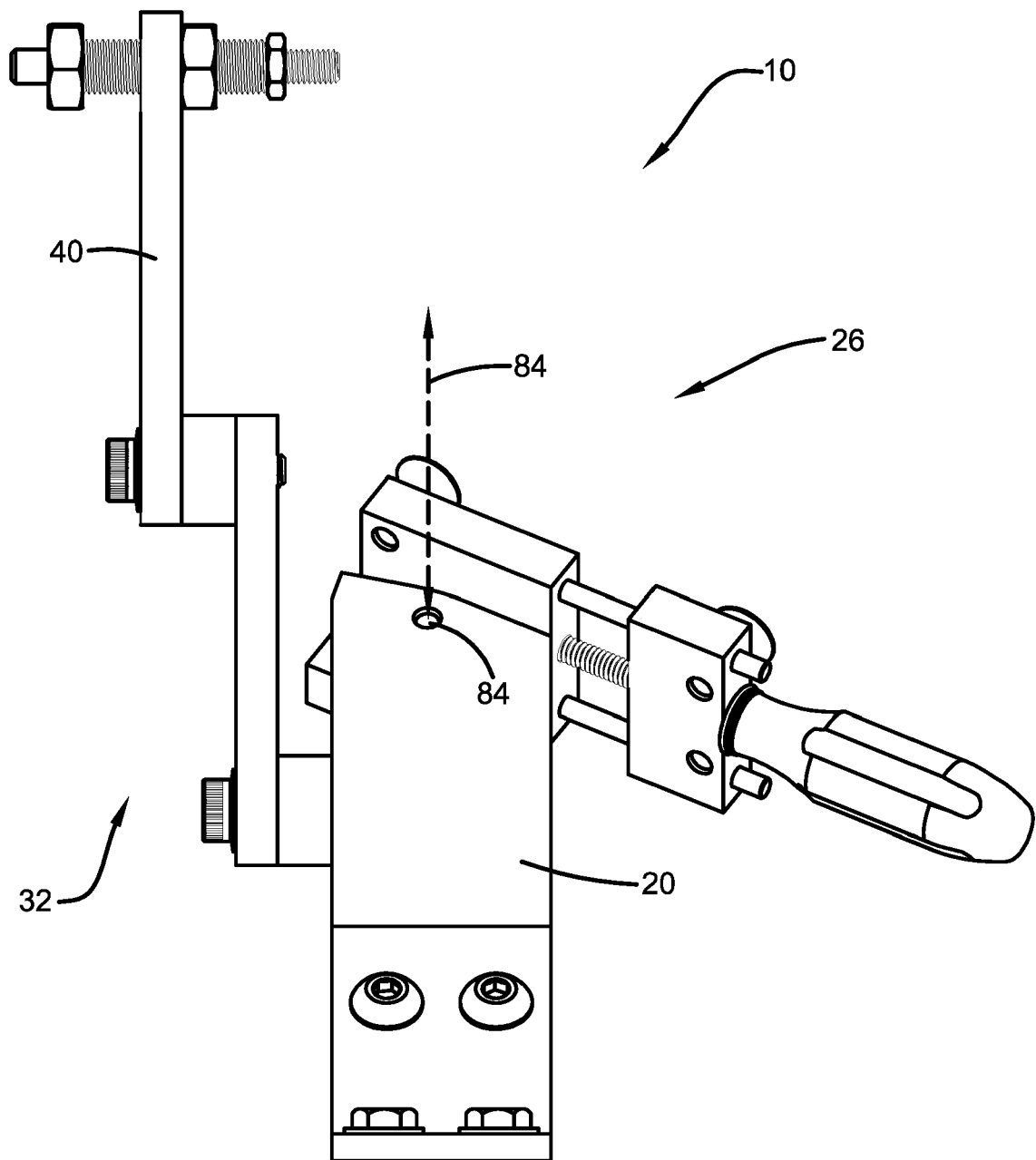


Figure 7

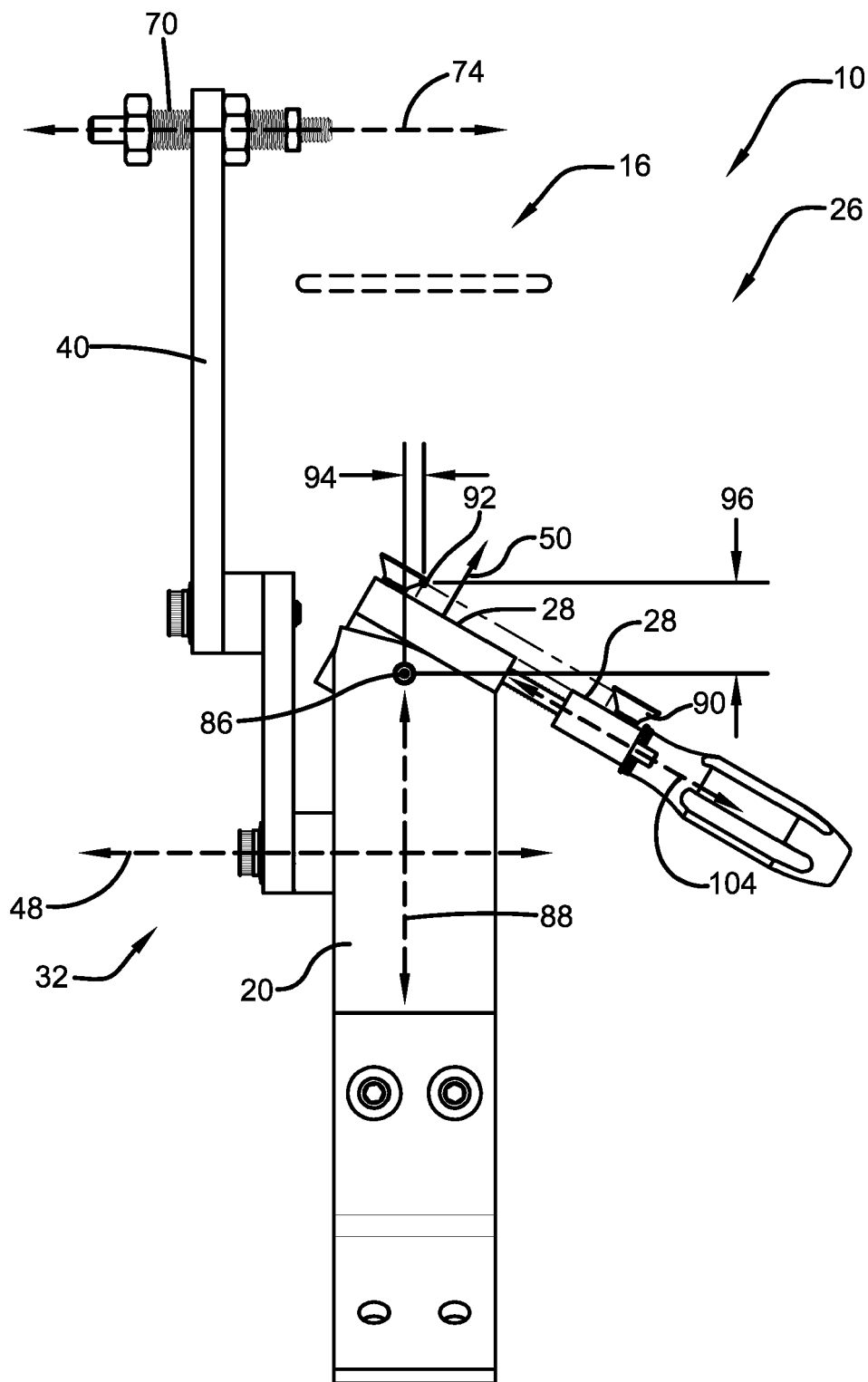


Figure 8

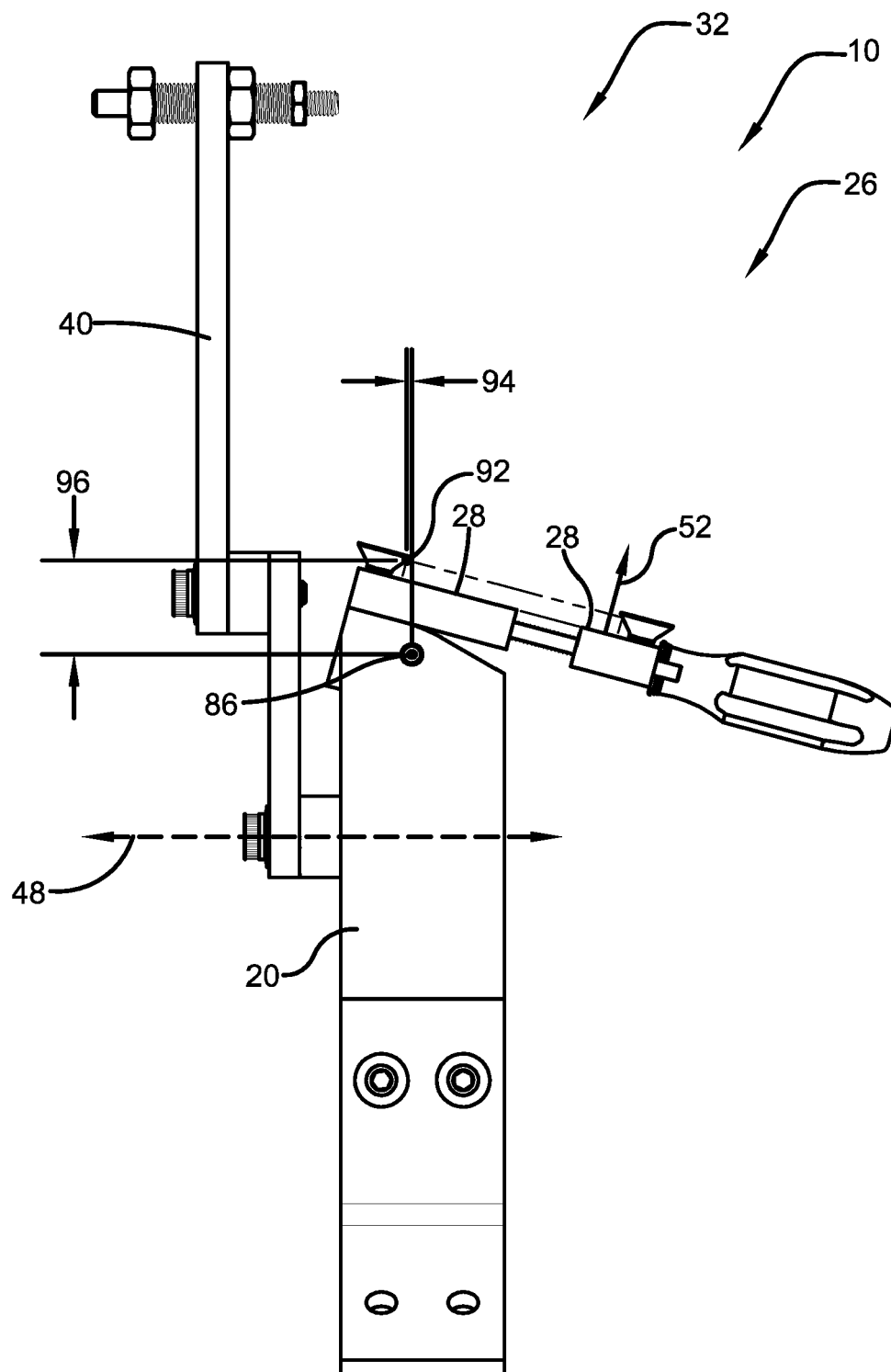


Figure 9

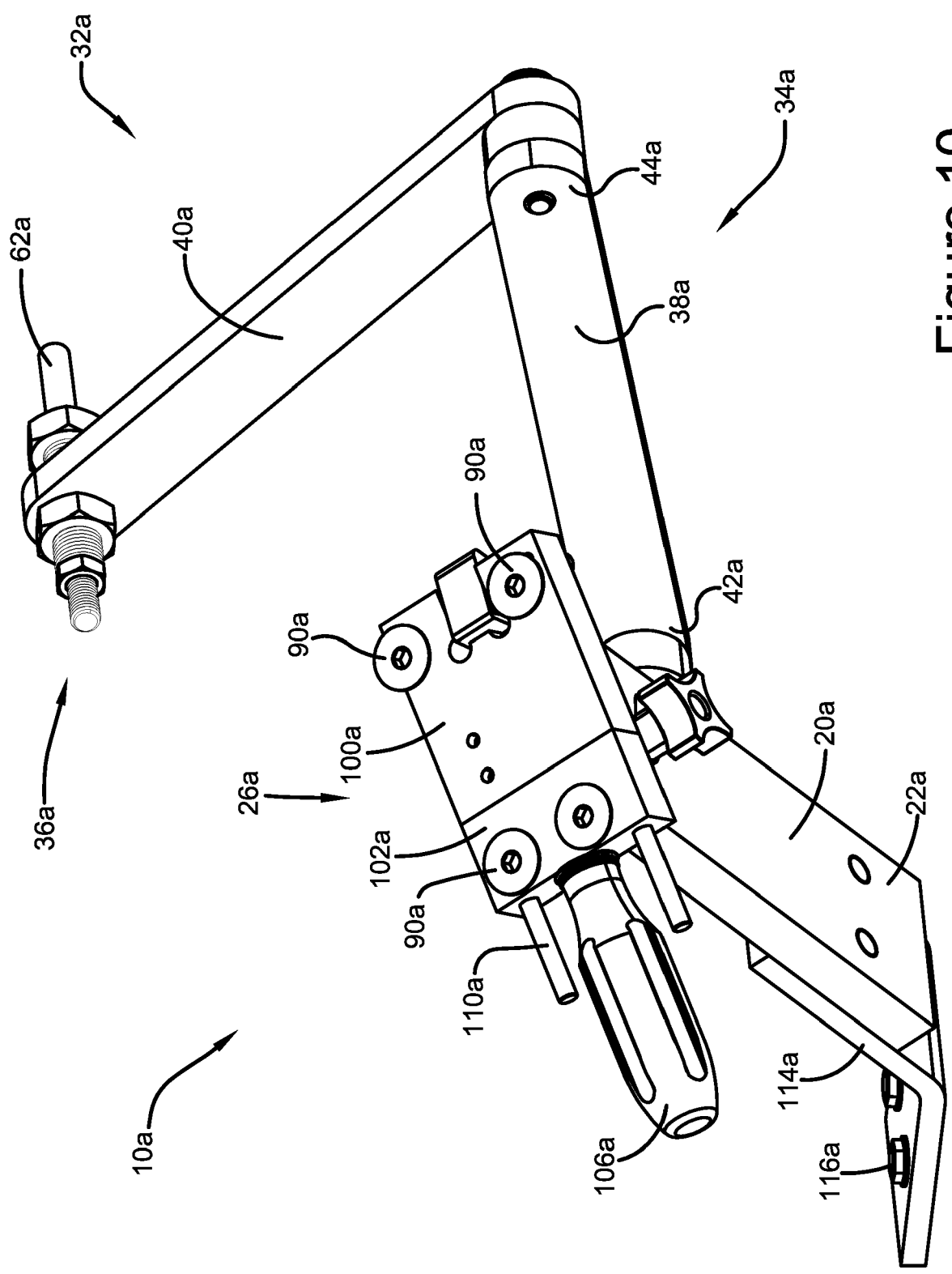


Figure 10

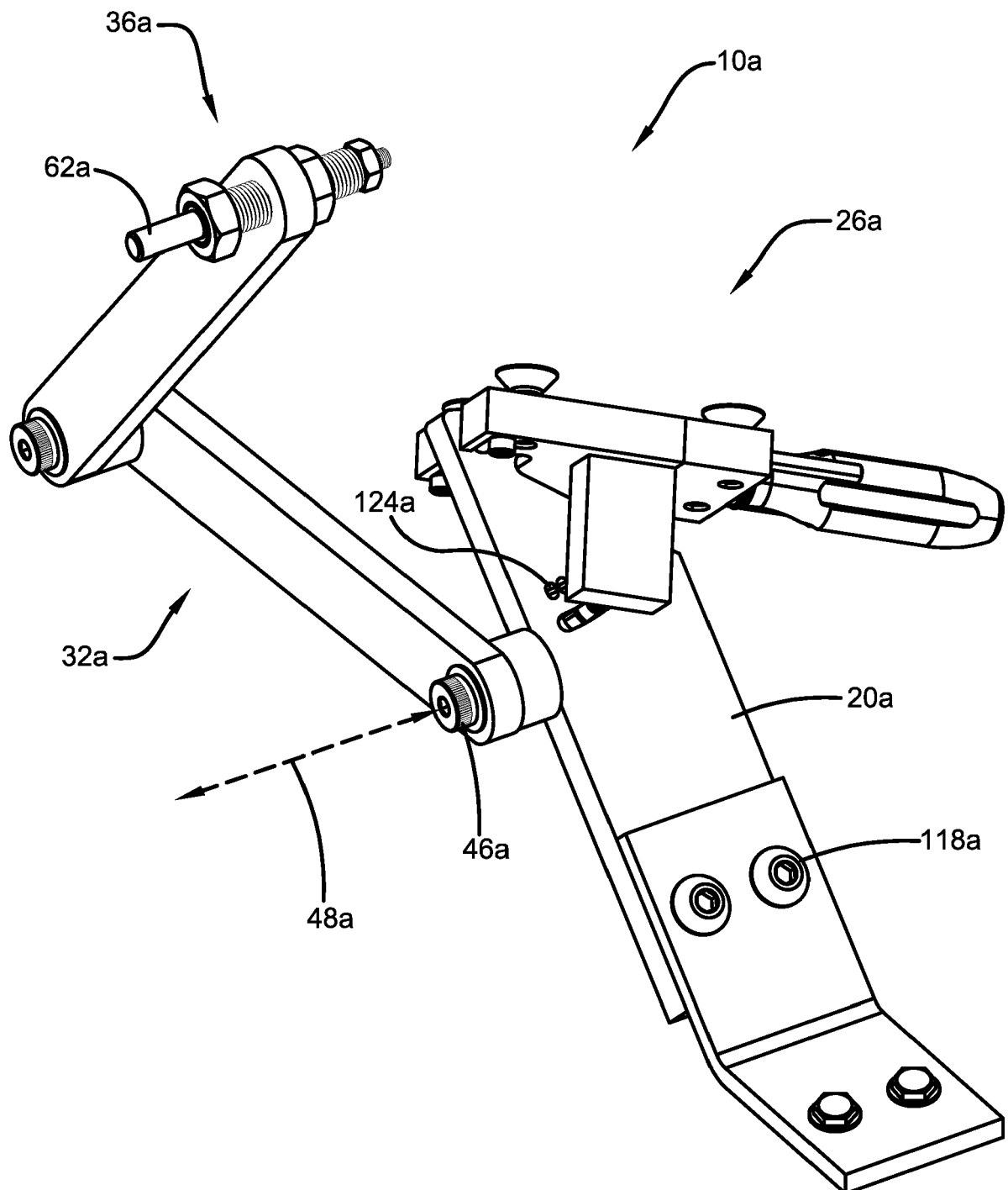


Figure 11

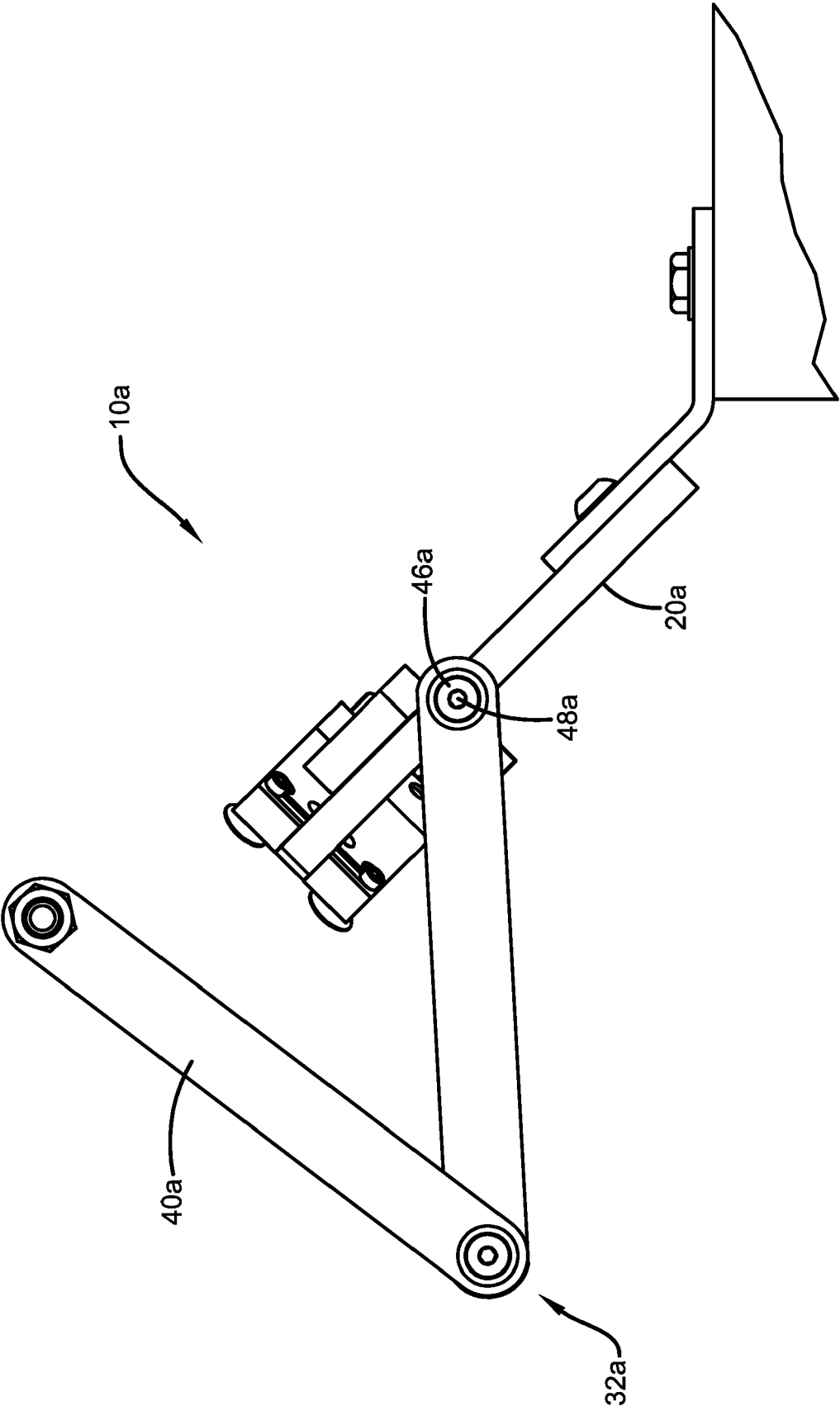


Figure 12

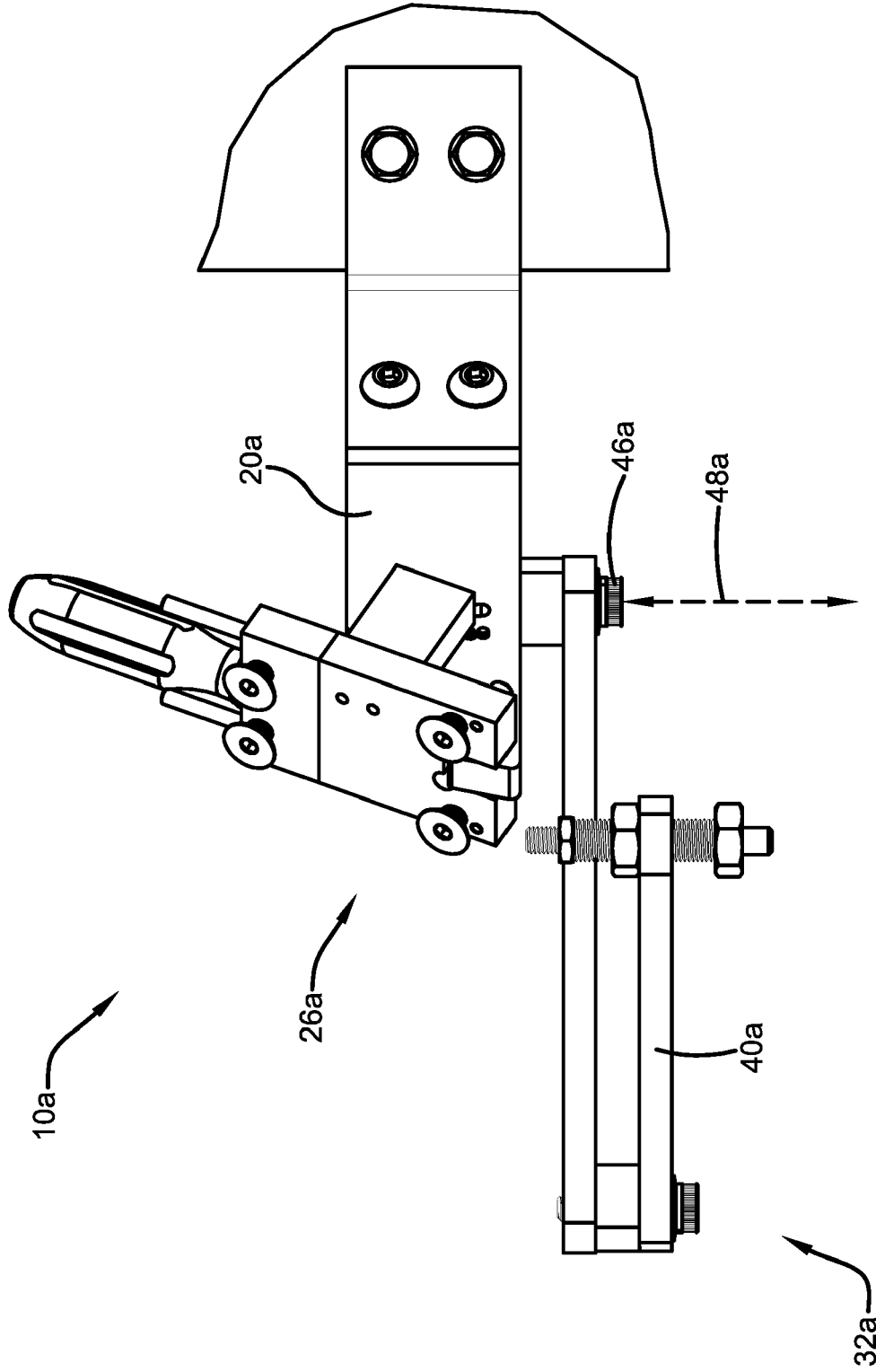


Figure 13

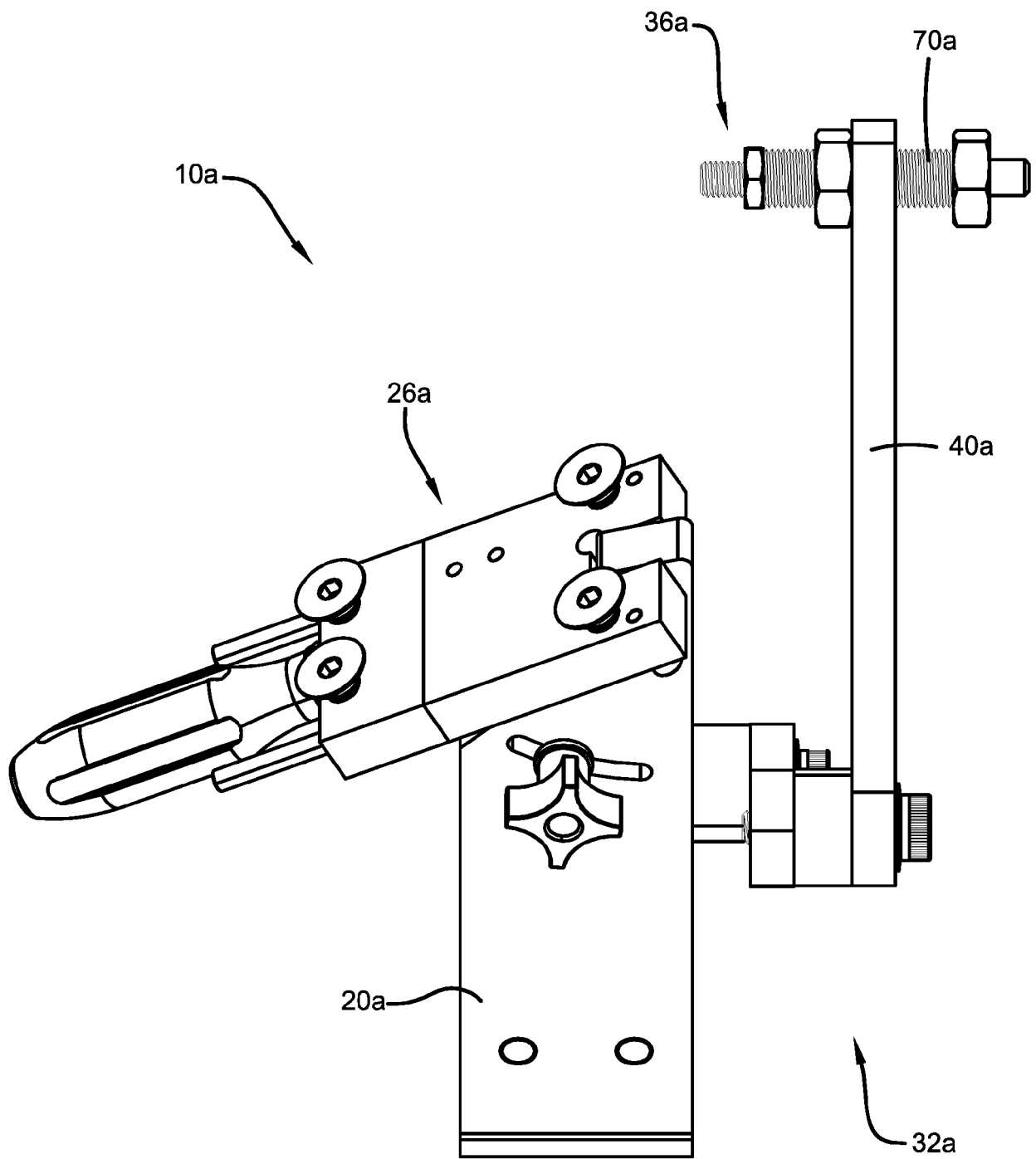


Figure 14

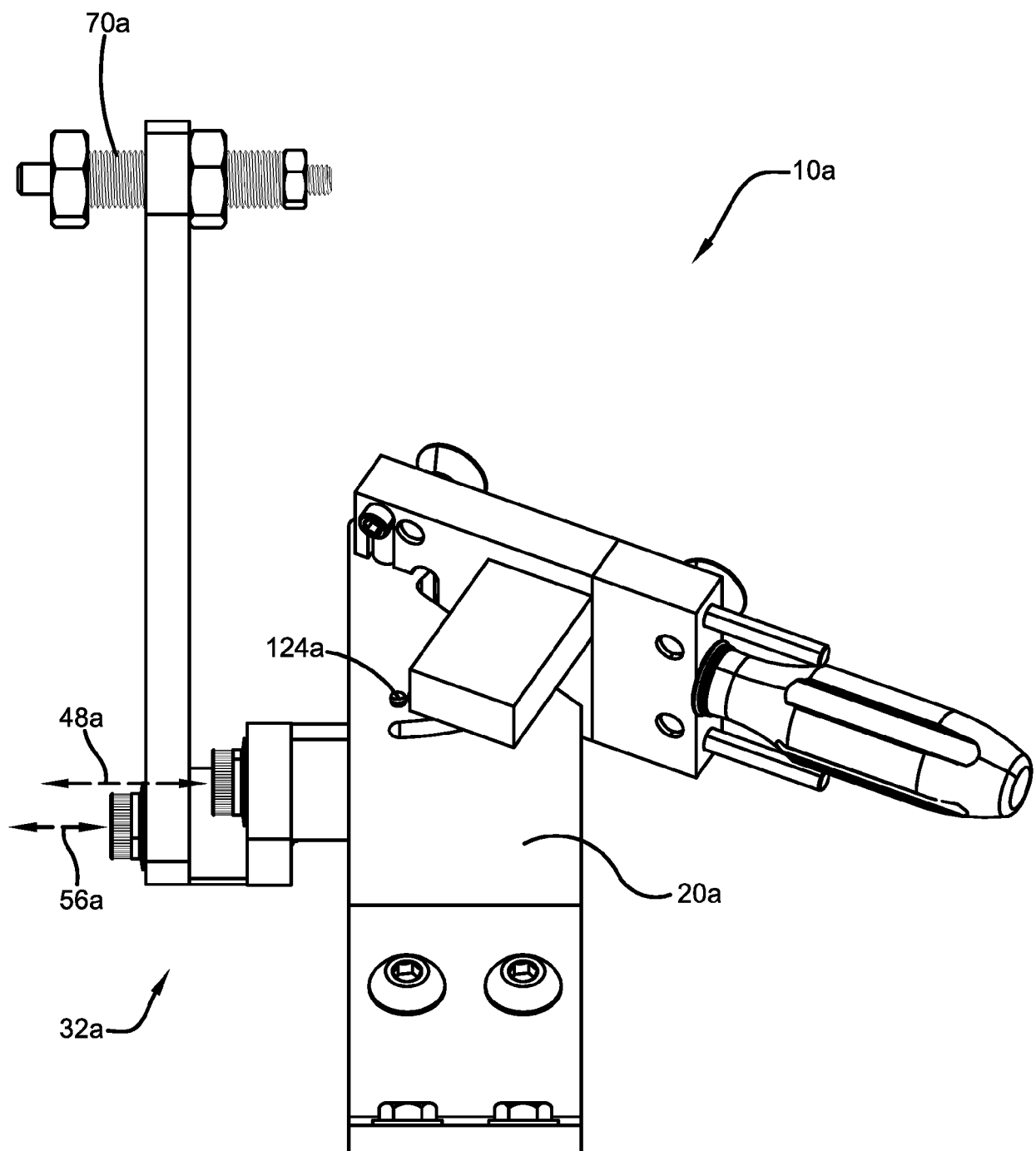


Figure 15

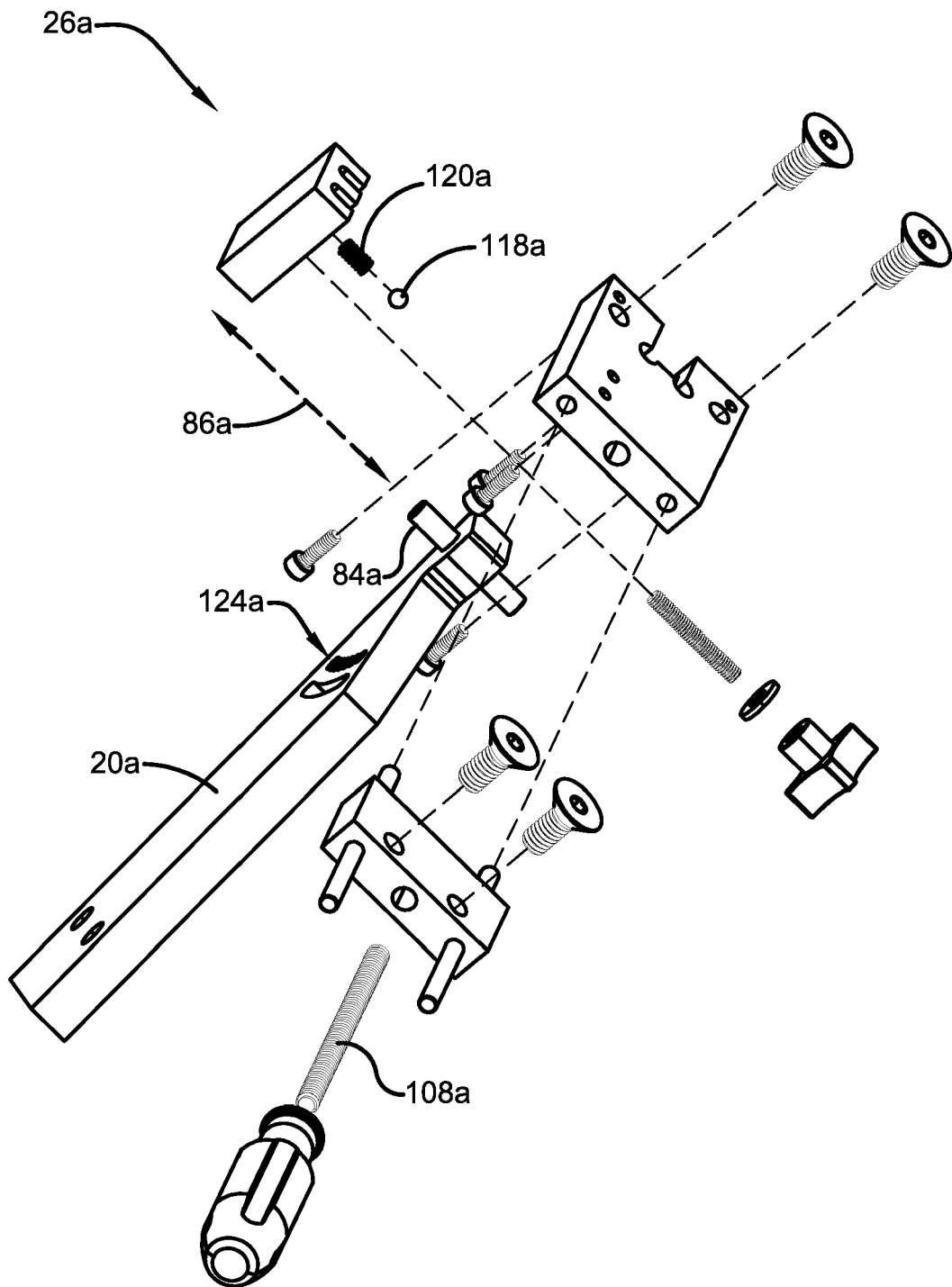


Figure 16

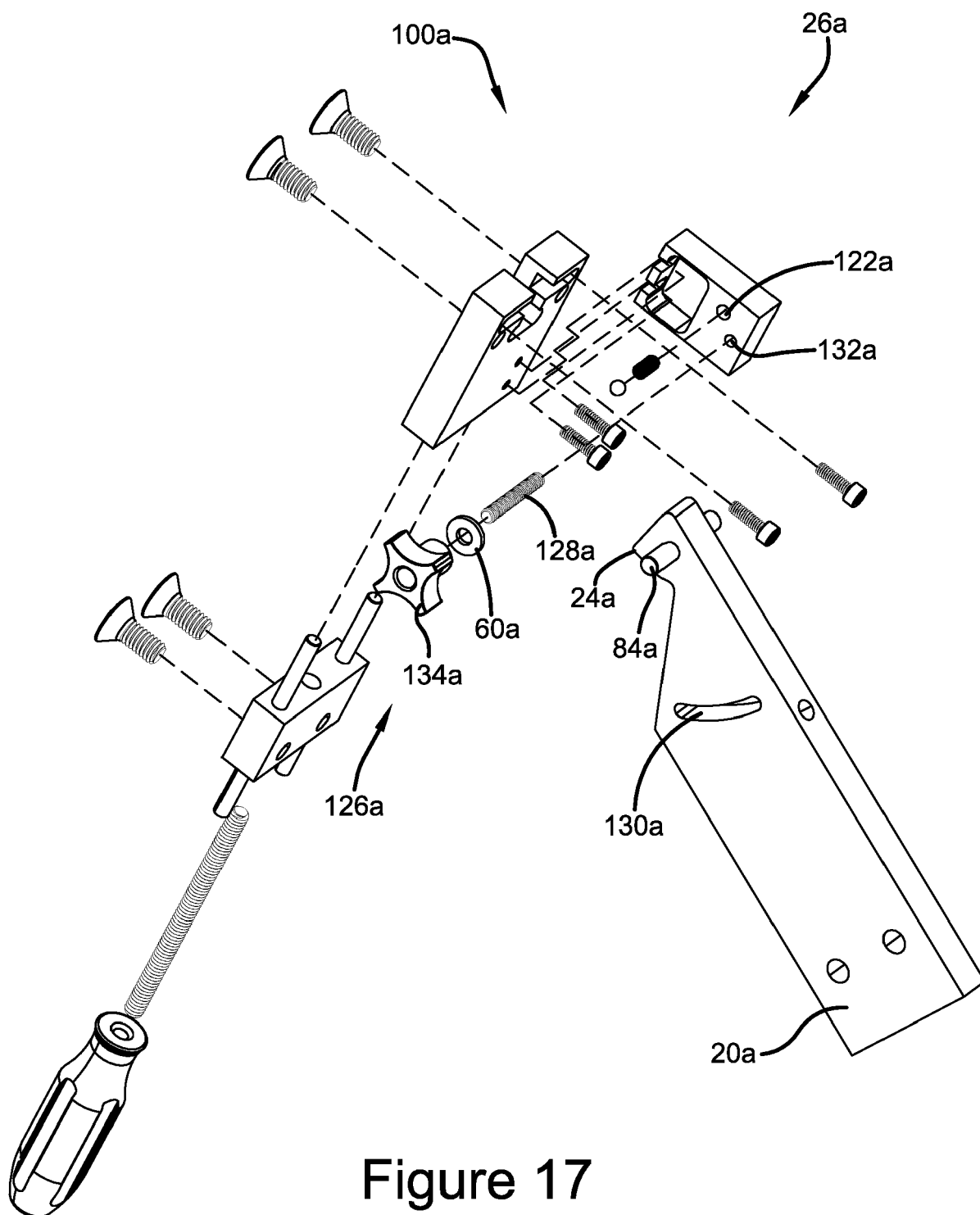


Figure 17

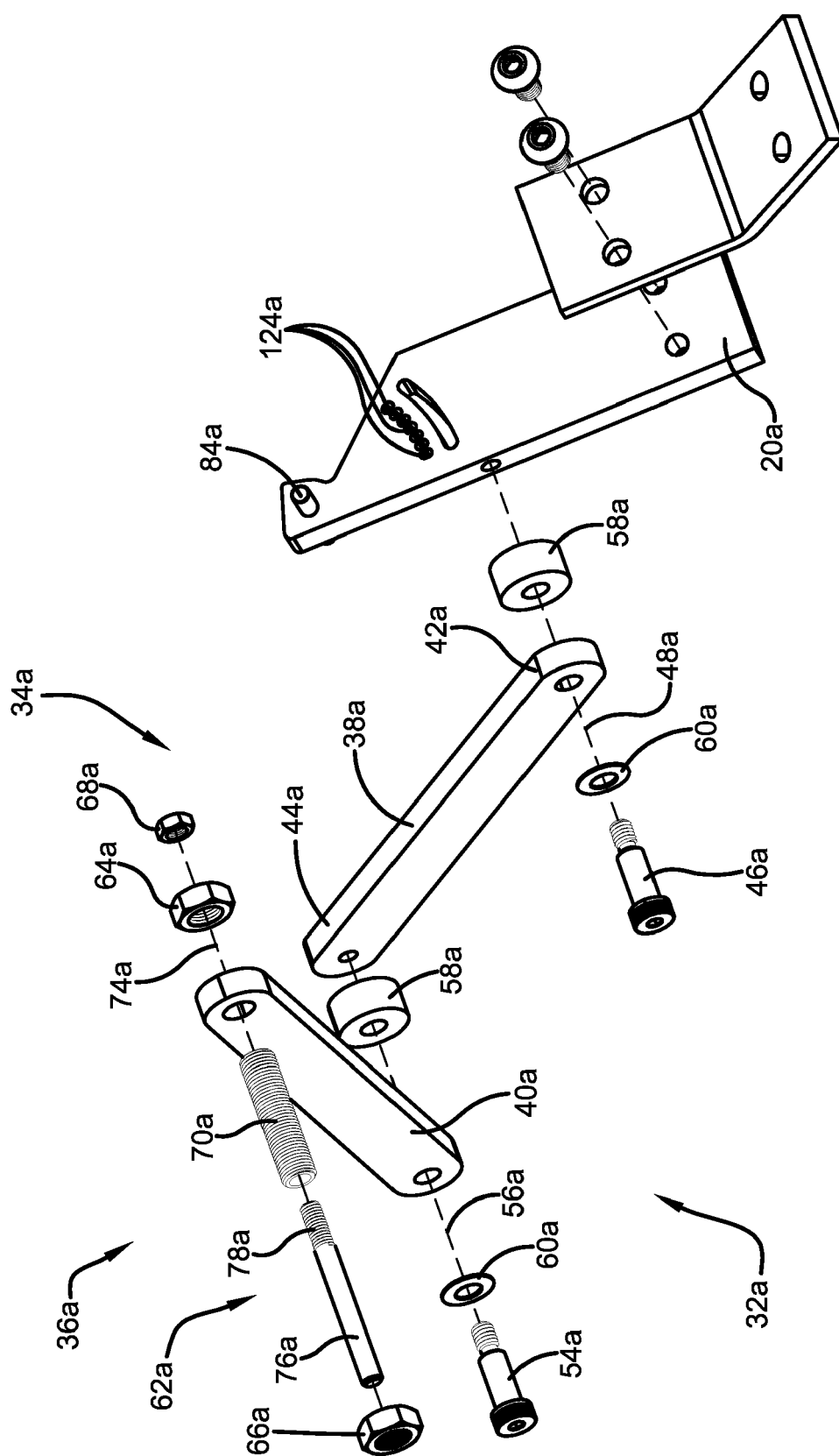


Figure 18

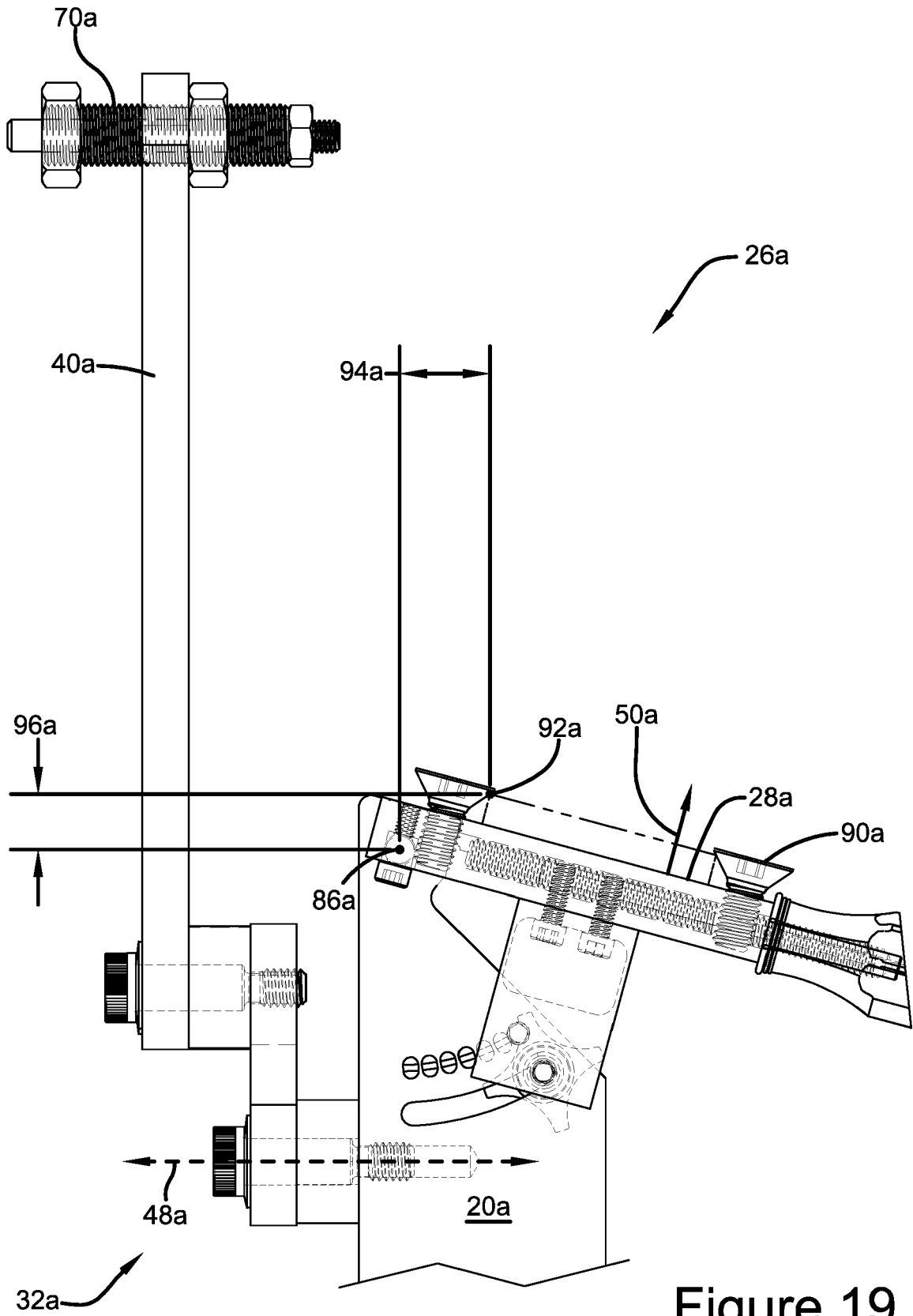


Figure 19

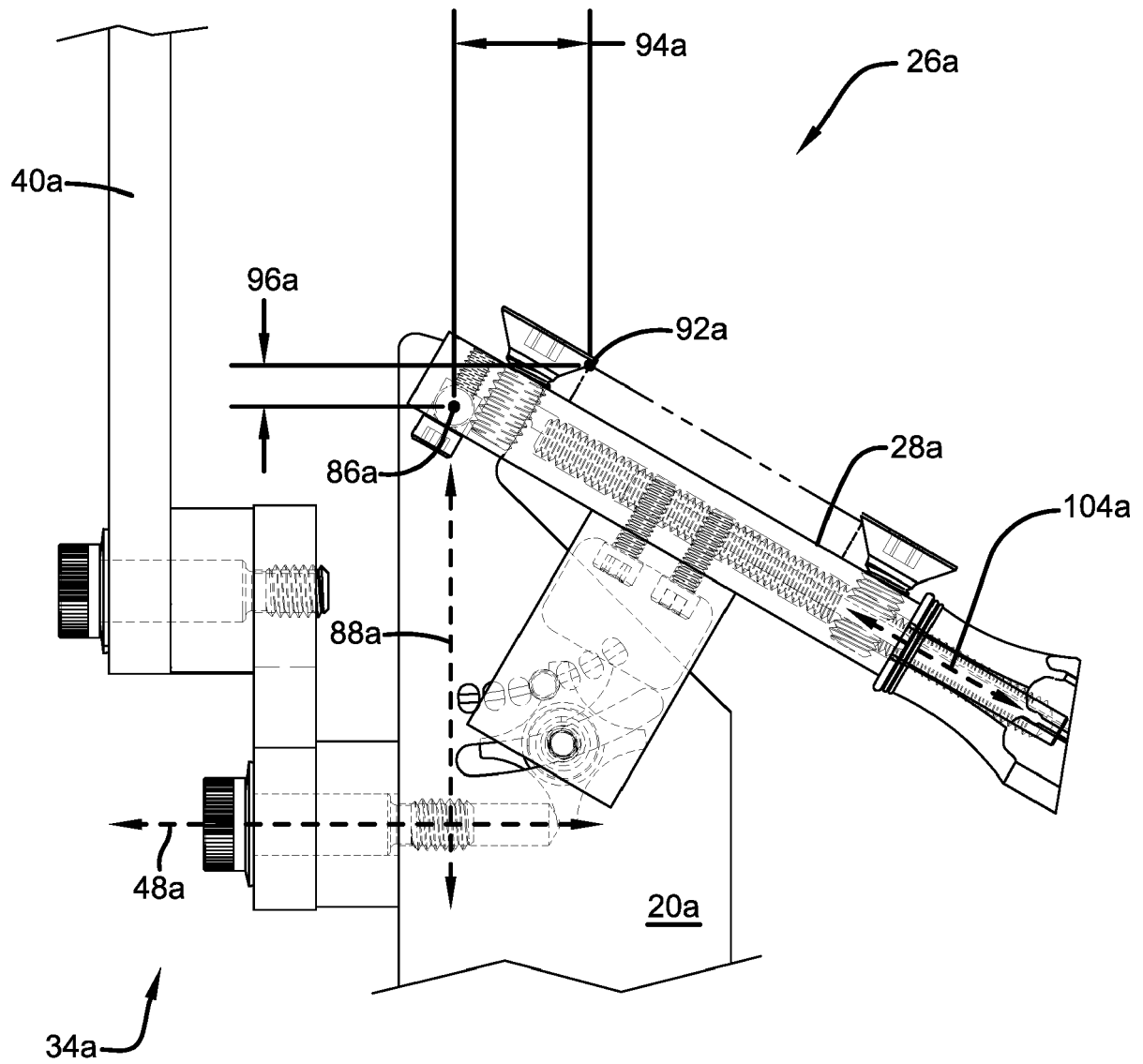


Figure 20

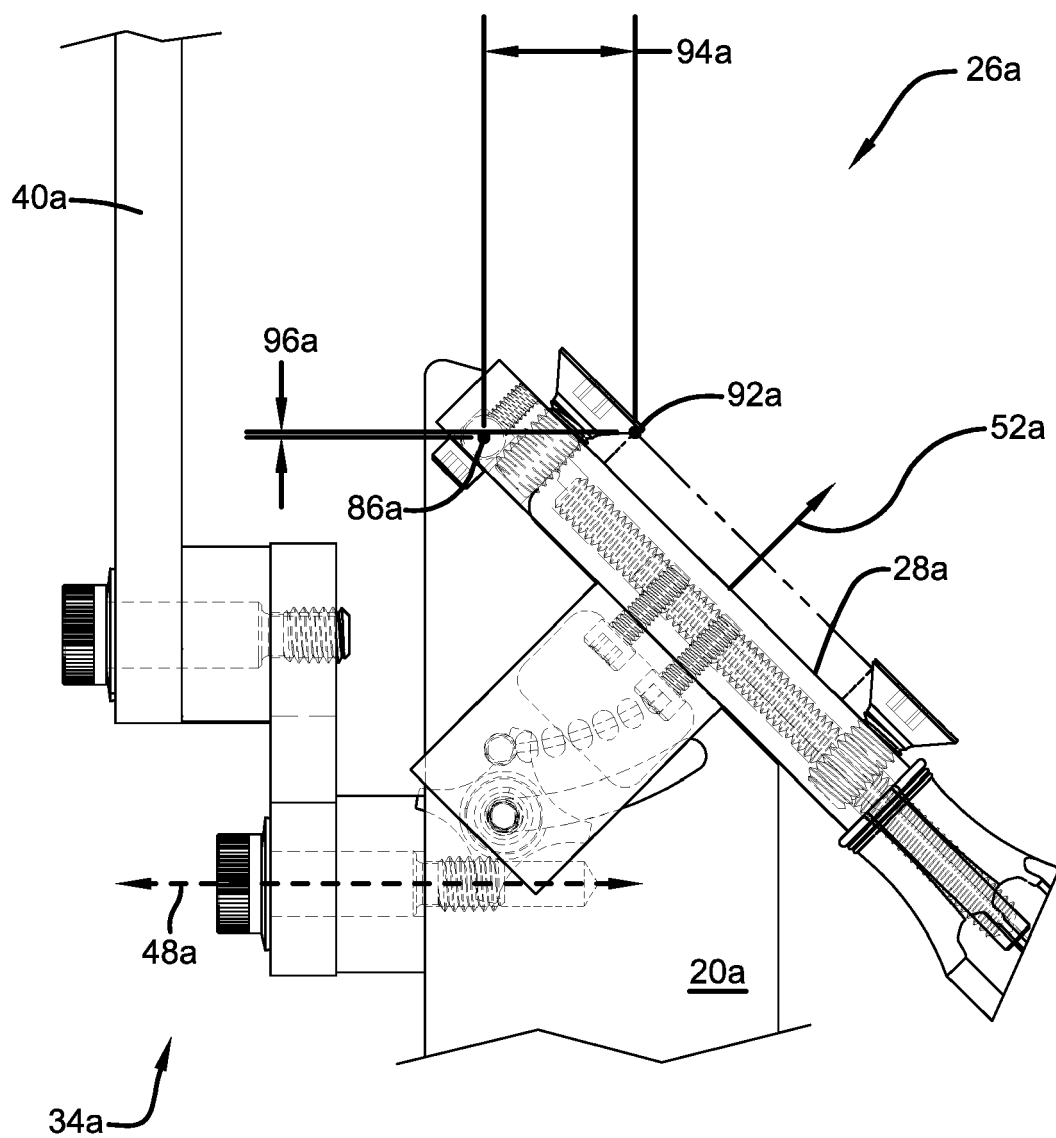


Figure 21



EUROPEAN SEARCH REPORT

Application Number
EP 21 16 0765

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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	US 2008/210056 A1 (CLARK RANDEL R [US] ET AL) 4 September 2008 (2008-09-04) * paragraphs [0001], [0040], [0046], [0047], [0053]; figures 4, 5, 10-12 *	1,2	INV. B24B3/36 B24B3/42 B24B23/00
A	US 2 627 142 A (PICKEL JAMES M) 3 February 1953 (1953-02-03) * c. 2, l. 30-41; c. 3, l. 18-27, 34-70; figure 1 *	1,2	
			TECHNICAL FIELDS SEARCHED (IPC)
			B24B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 10 June 2021	Examiner Bonetti, Serena
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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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 21 16 0765

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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10-06-2021

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US 2008210056 A1	04-09-2008	NONE	
US 2627142 A	03-02-1953	NONE	

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EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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