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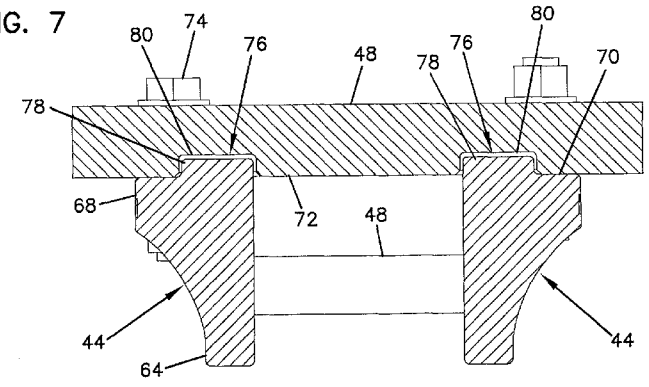
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(54) Title: SHEAR RESISTANT EXCAVATION COMPONENT

FIG. 7



(57) Abstract: An excavation component is disclosed herein. The excavation component includes a cutter structure carrier and a cutter structure carried by the cutter structure carrier. The excavation component also includes a fastener for securing the cutter structure to the cutter structure carrier. The cutter structure carrier and the cutter structure have an interlocking geometry for transferring shear between the cutter structure carrier and the cutter structure so as to reduce an amount of shear applied to the fastener during excavation operations.

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SHEAR RESISTANT EXCAVATION COMPONENT

This application is being filed on 12 July 2010, as a PCT International Patent application in the name of Vermeer Manufacturing Company, a U.S. national corporation, applicant for the designation of all countries except the US, and Mark Cooper, Derrick Deschamp, Jeff Flahive, Dan Hawks, Glenn Meinders, and Michael Vander Hart, citizens of the U.S., applicants for the designation of the US only, and claims priority to U.S. Provisional Patent Application Serial No. 61/225,132, filed July 13, 2009, which application is hereby incorporated by reference in its entirety.

Technical Field

The present disclosure relates generally to excavation equipment. More particularly, the present disclosure relates to trenching chains or other excavating structures for use on excavation equipment such as trenchers, terrain levelers or other equipment.

Background

Trenchers are conventionally used to dig lengths of trenches for laying underground pipe and cable. Most trenchers include a tractor unit equipped with an elongated boom. The boom is typically movable between a raised, generally horizontal position and a lowered, substantially vertical position. The boom typically includes a continuous trenching chain that extends around the perimeter of the boom. The chain includes a plurality of exterior teeth or cutters for engaging the ground to excavate a trench. Trenchers also commonly include a conveyor assembly for transporting the soil that is excavated by the chain away from the trench. Example trenchers are disclosed at U.S. Patent Nos. 6,154,987; 6,014,826; 5,248,188; and 5,199,197.

Summary

One aspect of the present disclosure relates to an excavating component having a shear resistant configuration. In one embodiment, the excavating component can include a cutter structure carrier (e.g., a chain, rope, belt,

drum, or other structure suitable for carrying a cutter structure), a cutter structure mounted to the cutter structure carrier, and a shear resistant interface provided between the cutter structure and the cutter structure carrier. In one embodiment, the cutter structure can be fastened to the cutter structure carrier with removable fasteners, and a shear resistant interlock configuration is provided between the cutter structure carrier and the cutter structure. In certain embodiments, the cutter structure includes a replaceable cutter mounting plate to which one or more cutters are secured, and the cutter structure carrier includes a chain, rope, belt, drum, or like structure.

Another aspect of the present disclosure relates to an excavating component in the form of a trenching chain having a shear resistant configuration. In one embodiment, the trenching chain includes a chain having a link arrangement including a plurality of links pivotally connected together. At least some of the links of the chain can include mounting surfaces to which cutter mounting plates can be fastened. Cutters are secured to the cutter mounting plates. The mounting surfaces and the cutter mounting plates have interlocking geometries configured to transfer shear between the cutter mounting plates and the chain during trenching operations.

A variety of additional aspects will be set forth in the description that follows. The aspects can relate to individual features and to combinations of features. It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the broad concepts upon which the embodiments disclosed herein are based.

Brief Description of the Drawings

Figure 1 is a side view of a trencher;

Figure 2 is a schematic diagram showing various components of the trencher of Figure 1;

Figure 3 is a side view of a trenching chain in accordance with the principles of the present disclosure that can be used with the trencher of Figures 1 and 2;

Figure 4 is a perspective view of a set of links of the trenching chain of Figure 3, a cutter mounting plate is shown attached to the set of links;

Figure 5 is another perspective view of the set of links of Figure 4 with the cutter mounting plate removed;

Figure 6 is a side view of the set of links of Figure 3;

Figure 7 is a cross-sectional view taken along section line 7-7 of Figure 6;

Figure 8 is an end view of the set of links of Figure 3;

Figure 9 is a cross-sectional view taken along section line 9-9 of Figure 8;

Figure 10 is a cross-sectional view taken along section line 10-10 of Figure 8;

Figure 11 is a bottom view of the set of links of Figure 3;

Figure 12 is a perspective view of an alternative set of links in accordance with the principles of the present disclosure;

Figure 13 shows two of the links sets fastened to a cutter mounting plate that extends between the links sets; and

Figure 14 shows links of another trenching chain in accordance with the principles of the present disclosure.

Detailed Description

Figures 1 and 2 show an example trencher 15. The trencher 15 includes an engine 17 coupled to a first track drive 18 and a second track drive 20, which together form a tractor portion 22 of the trencher 15. A boom 24 is pivotally coupled to the tractor portion 22. A trenching chain 26 is mounted on the boom 24. The trenching chain 26 is driven around the perimeter of the boom 24 by a chain drive mechanism 23 powered by the engine 17. The boom 24 is pivotally movable between a raised transport position 25, and a lowered trenching position 27.

When maneuvering the trencher 15 around the worksite, the boom is maintained in the transport position 25 such that the trenching chain 26 generally remains above the ground. To excavate a trench, the boom 24 is lowered toward the trenching position 27 and the trenching chain 26 is driven around the perimeter of the boom 24. When the trenching chain 26 contacts the ground, cutting teeth of the trenching chain 26 penetrate into the ground and begin to excavate a trench. Once the boom 24 reaches the trenching position 27, the tracks 18 and 20 are engaged

causing the tractor to move forward. The trenching chain 26 digs the trench and removes geologic material from the trench as the tractor 22 moves forward.

The trencher 15 is being disclosed for the purpose of illustrating an exemplary environment in which the various aspects of the present disclosure may be implemented. It will be appreciated that a variety of trenchers are known in the art, and that various aspects of the present disclosure can be applied or used in association with any type of trenching device or any other type of excavating or earth moving device (e.g., terrain levelers or other mobile excavation equipment).

Figure 3 illustrates an excavating component 40 (e.g., a trenching chain) in accordance with the principles of the present disclosure. The excavating component 40 includes a cutting structure carrier depicted as a length of chain 41. In other embodiments, the cutting structure carrier can include a rope, belt, drum or like structures. The depicted chain 41 includes inner and outer links 42, 44 that are pivotally interconnected to one another by pivot pins 46. The excavating component 40 also includes cutter mounting plates 48 fastened to the outer links 44 of the chain 41. Cutters 50 (e.g., excavating teeth, excavating bits, etc.) are secured to the cutter mounting plates 48. In other embodiments, the cutter mounting plates 48 can be fastened to the inner links 42 of the chain 41.

Referring to Figures 3 and 4, various reference orientations are depicted to aid in describing the excavating component 40. The referenced orientations include an X reference orientation, a Y reference orientation and a Z reference orientation. The Y reference orientation is perpendicular with respect to the X and Z reference orientations, and the Z reference orientation is perpendicular relative to the X and Y reference orientations. The X reference orientation is parallel to a longitudinal axis 51 of the chain 41 and the Y reference orientation is parallel to pivot axes 53 defined by the pivot pins 46 of the chain 41.

Referring to Figures 4 and 5, a set of the inner and outer links 42, 44 is depicted. The inner link 42 is shown including inner side bars 56 that are generally parallel to one another. The inner side bars 56 are spaced-apart from one another and are positioned on opposite sides of the longitudinal axis 51 of the chain 41. Lengths of the inner side bars 56 are generally parallel to the X reference orientation. Openings 58 extend through the inner side bars 56 in the Y reference orientation. Bushings/thimbles 60 extend between the inner side bars 56 and have end portions secured within the openings 58. Rollers 62 are mounted over the

bushings 60. The bushings 60 maintain the spacing between the inner side bars 56 and the rollers 62 are free to rotate about the bushings 60. In use, the rollers 62 are adapted to engage sprockets used to drive and route the trenching chain 40 about a structure such as a trenching boom. The pivot pins 46 fit inside the bushings 60. The bushings 60 allow the inner side bars 56 to rotate/pivot relative to the pivot pins 46 about the pivot axes 53.

Figures 4 and 5 show aspects of the present disclosure applied to one particular style of chain. However, it will be appreciated that the various aspects of the present disclosure can also be applied to other styles of chain.

Referring still to Figures 4 and 5, the outer link 44 includes outer side bars 64 that straddle the inner link 42. The outer side bars 64 are positioned on opposite sides of the longitudinal axis 51 of the chain 41 and are generally parallel to one another. Lengths of the outer side bars 64 are generally parallel to the X reference orientation. The outer side bars 64 define pin openings 66 that extend through the outer side bars 64 in directions generally parallel to the Y reference orientation. Ends of the pivot pins 46 are affixed within the pin openings 66. Thus, the pins 46 connect the inner links 42 to the outer links 44 and allow the inner and outer links 42, 44 to pivot relative to one another.

Referring to Figures 5-10, the outer links 44 also include flanges 68 having portions that project outwardly from the outer side bars 64 in a direction that extends generally along the Y reference orientation. In one embodiment, the flanges 68 are integrally formed with the outer side bars 64. For example, the outer side bars 64 can be integrally formed with the flanges 68 by a casting process such as an investment casting process. However, in other embodiments, the flanges 68 can be secured to the outer side bars 64 by alternative methods. Furthermore, in still other embodiments, aspects of the present disclosure are applicable for securing cutter structures to the links of chains that do not have outwardly projecting flanges. Also, aspects of the present disclosure are applicable to chains that do not have links arranged in an inner and outer configuration.

Referring still to Figures 5-9, the outer links 44 include plate engaging surfaces 70 that face outwardly from the outer links 44 in the Z reference orientation. The plate engaging surfaces 70 can be provided at least in part on the flanges 68. When one of the cutter mounting plates 48 is secured to a corresponding one of the outer links 44 (see Figs. 7 and 9), the plate engaging surfaces 70 of the

outer link 44 engage and oppose a corresponding interface surface 72 of the cutter mounting plate 48. The flanges 68 define fastener openings 73 that extend through the flanges 68 in directions generally parallel to the Z reference orientation. The fastener openings 73 receive fasteners 74 used to clamp or otherwise fasten the cutter mounting plates 48 to the flanges 68. The outer links 44 are also provided with a structure for preventing or limiting the amount of shear that is applied to the fasteners 74 when the excavating component 40 is used to excavate a trench. For example, a shear transferring arrangement 76 is provided between the flanges 68 and the cutter mounting plates 48 that allow shear to be transferred directly between the cutter mounting plates 48 and the flanges 68 without applying substantial shear to the fasteners 74. In the depicted embodiment, the shear transferring arrangement 76 includes an interlocking geometry between the plate engaging surfaces 70 and the cutter mounting plates 48. For example, the outer links 44 are provided with projections 78 that fit within corresponding receptacles 80 defined in the cutter mounting plates 48. The projections 78 project outwardly from the flanges 68 in a direction extending generally along the Z reference orientation and the receptacles 80 extend into the cutter mounting plates 48 in directions extending generally along the Z reference orientation. In certain embodiments, the projections 78 have a complementary mating shape (i.e., a matching or substantially similar geometric shape) with the receptacles 80. When a shearing load is applied in the X reference orientation between the cutter mounting plates 48 and the outer links 44 (e.g., by engagement of cutters 50 with the ground during trenching), contact between the projections 78 and the portions of the cutter mounting plates 48 defining the receptacle 80 causes shear loads to be transferred directly between the cutter mounting plates 48 and the outer links 44 thereby limiting or reducing the shear load that is transferred through the fasteners 74.

In certain embodiments, the fasteners function to limit movement of the cutter structures in the Z reference orientation relative to the cutter structure carrier, and the shear transferring arrangement limits movement of the cutter structures in the X and Y reference orientations relative to the cutter structure carrier so as to limit the shear carried by the fasteners. It will be appreciated that in certain embodiments at least some shear can be carried by the fasteners. However, the shear transferring arrangement preferably limits the amount of shear carried by the fasteners so as to prevent the fasteners from failing in shear. In certain

embodiments, a majority of the shear is carried by the shear transferring arrangement.

In other embodiments, other types of intermating geometries and configurations can be used. For example, in certain embodiments, the projections and the receptacles may have geometrically dissimilar shapes. Also, in certain embodiments, projections can be provided on the cutter mounting plates 48 and receptacles can be provided in the flanges 68 or elsewhere on the cutter structure carrier. In one embodiment, the projections extend at least partially in a direction perpendicular to the direction of travel of the cutter structure carrier during excavation. The interlocking geometry also simplifies assembling the cutter structure to the cutter structure carrier. For example, by mating the interlocking geometry together, the fastener openings 73 of the plate mounting flanges 68 can be automatically aligned with corresponding openings 75 (see Figure 10) defined by the cutter mounting plates 48 so as to facilitate inserting shafts of the fasteners 74 through the aligned openings during assembly.

As shown at Figure 5, each of the plate mounting flanges 68 defines at least two fastener openings 73, and the shear transferring arrangements 76 are positioned at least partially along an axis 90 that extends through regions defined between the fasteners 74 mounted in the pairs of openings 73 provided through each of the flanges 68. The axis 90 is parallel to the pivot axes 53 of the pivot pins 46.

The plate mounting flanges 68 can also include structure for facilitating tightening the fasteners 74 when the cutter mounting plates 48 are fastened to the flanges 68. In the depicted embodiment, each of the fasteners 74 is shown as a bolt having a shaft 24a threaded along at least a portion of the length of the shaft 74a, a head 74b positioned at one end of the shaft and a nut 74c that threads on the shaft. As shown at Figures 10 and 11, the openings 73 define receptacles 93 positioned at undersides 92 of the flanges 68. The receptacles 93 are adapted to receive heads or nuts of the fasteners 74. Preferably, the receptacles 93 are configured to allow torque to be transferred between the receptacles 93 and the head or nut of the fastener 74 received therein when the fastener 74 is tightened. For example, the receptacles 93 can include one or more flats adapted to engage corresponding flats of the head or nut of the fastener 74 so as to prevent rotation between the head or nut of a fastener 74 and the receptacle 93 during tightening of the fastener 74. The receptacles 93 form portions of the openings 73 that extend

through the flanges 68. Similar receptacles can be provided as portions of the openings 75 defined through the cutter mounting plates 48.

Figure 12 shows an alternative outer link 44' in accordance with the principles of the present disclosure. The link 44' includes flanges 68' having shear transferring projections 78' that are elongated in the Y orientation and are adapted to fit within comparable shaped elongated openings defined in the underside of a cutter mounting plate to facilitate the transfer of shear between the flanges 68' and the cutter mounting plate.

Figure 13 shows an alternative cutter mounting plate 48' that is elongated in the Y reference orientation and that is coupled to two separate, parallel chains 41. This type of configuration can be used on larger trenchers used to excavate trenches having relatively large widths.

In certain embodiments, the chain 41 has a pitch P of at least five inches and the rollers 62 have an outer diameter of at least three and a half inches, or at least three inches. The pitch is defined as the center-to-center spacing between the pivot pins 46. Of course, the aspects disclosed herein are applicable to other sized chains as well.

Figure 14 shows another excavating component 140 in accordance with the principles of the present disclosure. The excavating component 140 includes a plurality of links 143 pivotally connected to one another to form a chain. The links 143 define fastener openings 173 for receiving fasteners 174 used to secure cutter mounting plates 148 to the links 143. The fasteners 174 also extend through openings 175 defined by the plates 148 and are anchored to the links 143 by captured nuts 145 (one shown) mounted within pockets 147 defined by the links 143. A shear transfer arrangement is provided between the links 143 and the cutter mounting plates 148. The shear transfer arrangement includes projections 178 of the links 143 that fit within receptacles 180 of the cutter mounting plate 148. In other embodiments, receptacles can be provided within the links that receive projections of the cutter mounting plates.

From the foregoing detailed description, it will be evident that modifications and variations can be made in the devices of the disclosure without departing from the spirit and scope of the disclosure.

WHAT IS CLAIMED IS:

1. An excavation component comprising:

a cutter structure carrier;

a cutter structure carried by the cutter structure carrier;

a fastener for securing the cutter structure to the cutter structure carrier; and

the cutter structure carrier and the cutter structure having an interlocking geometry for transferring shear between the cutter structure carrier and the cutter structure so as to reduce an amount of shear applied to the fastener during excavation operations.

2. The excavation component of claim 1, wherein the cutter structure includes a cutting tooth secured to a cutter mounting plate.

3. The excavation component of claim 2, wherein the cutting tooth includes a trenching tooth.

4. The excavation component of claim 1 wherein the interlocking geometry includes a projection defined by one of the cutter structure carrier and the cutter structure, wherein the interlocking geometry includes a receptacle defined by the other of the cutter structure carrier and the cutter structure, wherein the projection is received within the receptacle, and wherein the fastener secures the cutter structure carrier and the cutter structure together such that the projection is retained within the receptacle.

5. The excavation component of claim 4, wherein the fastener clamps the cutter structure to the cutter structure carrier.

6. The excavation component of claim 4, wherein the cutter structure carrier includes a chain.

7. The excavation component of claim 4, wherein the cutter structure carrier is selected from the group consisting of a belt, a chain, a rope and a drum.

8. The excavation component of claim 4, wherein the cutter structure includes a cutting tooth secured to a cutter mounting plate.

9. An excavation component comprising:

a chain including an inner link and an outer link pivotally connected to the inner link by a pin;

a cutter structure mounted to the chain, the cutter structure including a cutter mounting plate secured to the chain by fasteners, the cutter structure also including at least one cutter mounted to the cutter mounting plate; and

an interlocking geometry defined between the chain and the cutter mounting plate for transferring shear between the chain and the cutter mounting plate.

10. The excavation component of claim 9, wherein the interlocking geometry includes a projection provided on one of the chain and the cutter mounting plate that fits within a receptacle defined by the other of the chain and the cutter mounting plate.

11. The excavation component of claim 9, wherein at least one of the inner and outer links includes a side bar and a flange that projects outwardly from the side bar, and wherein the interlocking geometry includes a projection provided on one of the flange and the cutter mounting plate that fits within a receptacle defined by the other of the flange and the cutter mounting plate.

12. The excavation component of claim 9, wherein the outer link includes flanges each defining at least first and second fastener openings that receive the fasteners to secure the cutter mounting plate to the outer link, wherein the flanges include portions that project outwardly from side bars of the outer links, wherein interlocking geometries are provided between the outer link and the cutter mounting plate at each of the flanges, and wherein at least portions of the interlocking geometries are intersected by an axis that is parallel to the pivot pin and extends

through regions defined between the fasteners mounted through the first and second fastener openings.

13. An excavation component comprising:

a chain including a plurality of links pivotally connected together;

a cutter structure mounted to the chain, the cutter structure including a cutter mounting plate secured to the chain by fasteners, the cutter structure also including at least one cutter mounted to the cutter mounting plate; and

an interlocking geometry defined between the chain and the cutter mounting plate for transferring shear between the chain and the cutter mounting plate.

14. The excavation component of claim 13, wherein the interlocking geometry includes a projection provided on one of the chain and the cutter mounting plate that fits within a receptacle defined by the other of the chain and the cutter mounting plate.

15. The excavation component of claim 13, wherein at least one of the links includes a side bar and a flange that projects outwardly from the side bar, and wherein the interlocking geometry includes a projection provided on one of the flange and the cutter mounting plate that fits within a receptacle defined by the other of the flange and the cutter mounting plate.

16. An excavation component comprising:

a chain including a plurality of links pivotally connected together;

a cutter structure mounted to the chain, the cutter structure including a cutter mounting plate secured to the chain by fasteners that extend through openings defined by the chain and the cutter mounting plate, the cutter structure also including at least one cutter mounted to the cutter mounting plate;

the fasteners including bolts having heads, the fasteners also including nuts that thread on the bolts;

at least one of the openings including a receptacle for receiving and preventing rotation of either the head or the nut of a corresponding one of the fasteners; and

wherein the chain includes mounting flanges to which the cutter mounting plates are secured by the fasteners, wherein the openings include first openings defined by the mounting flanges and second openings defined by the cutter mounting plates, and wherein the receptacles are defined by the first openings at undersides of the mounting flanges.

17. The excavation component of claim 16, further comprising an interlocking geometry defined between the chain and the cutter mounting plate for transferring shear between the chain and the cutter mounting plate, wherein the first and second openings align with one another when the interlocking geometry is interlocked.

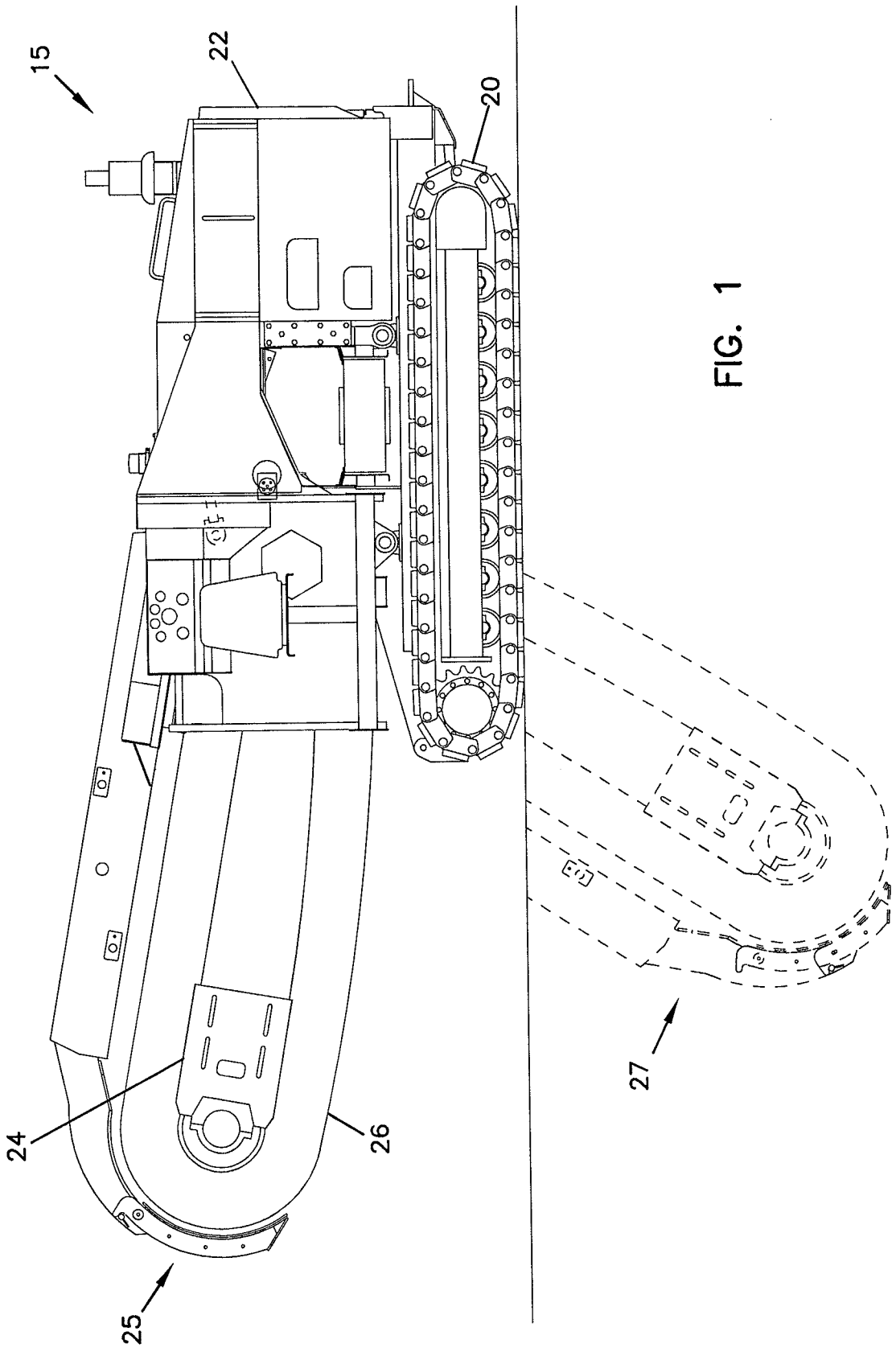


FIG. 1

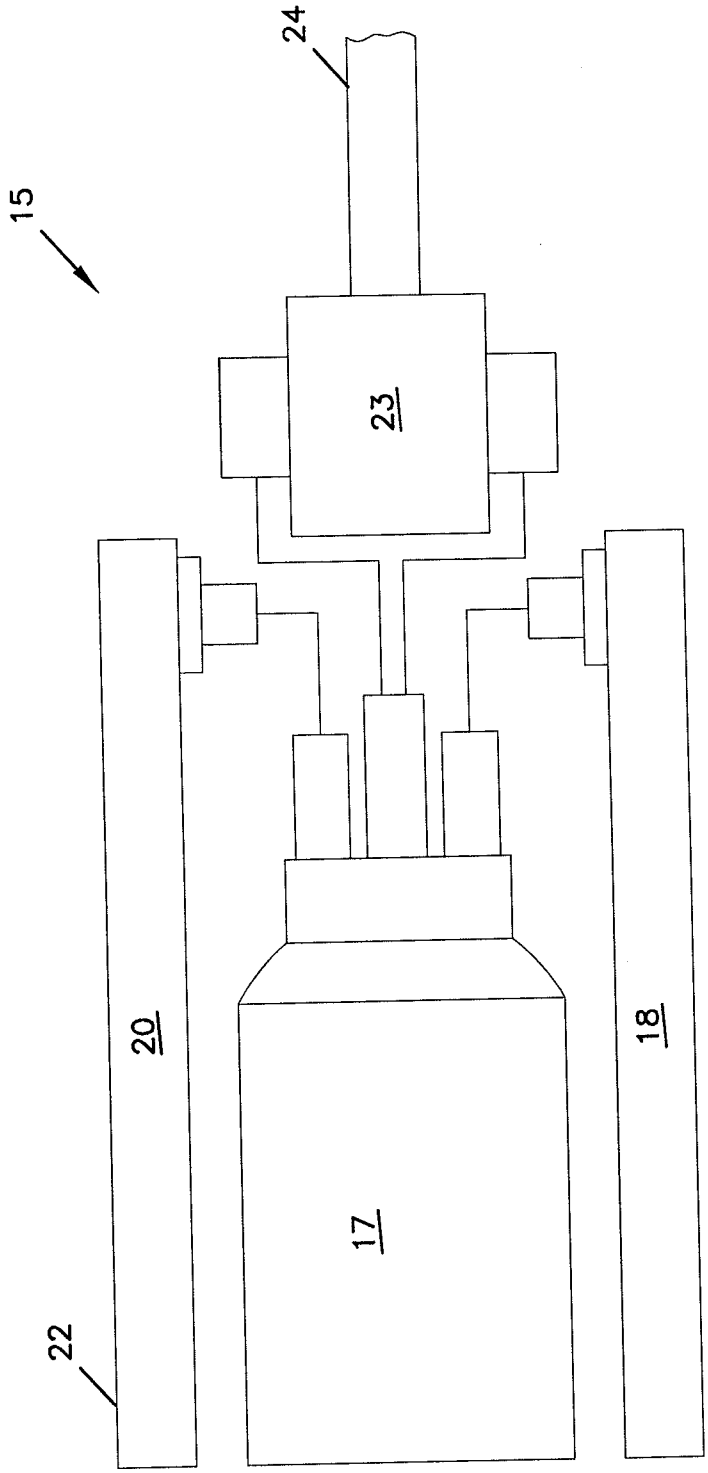


FIG. 2

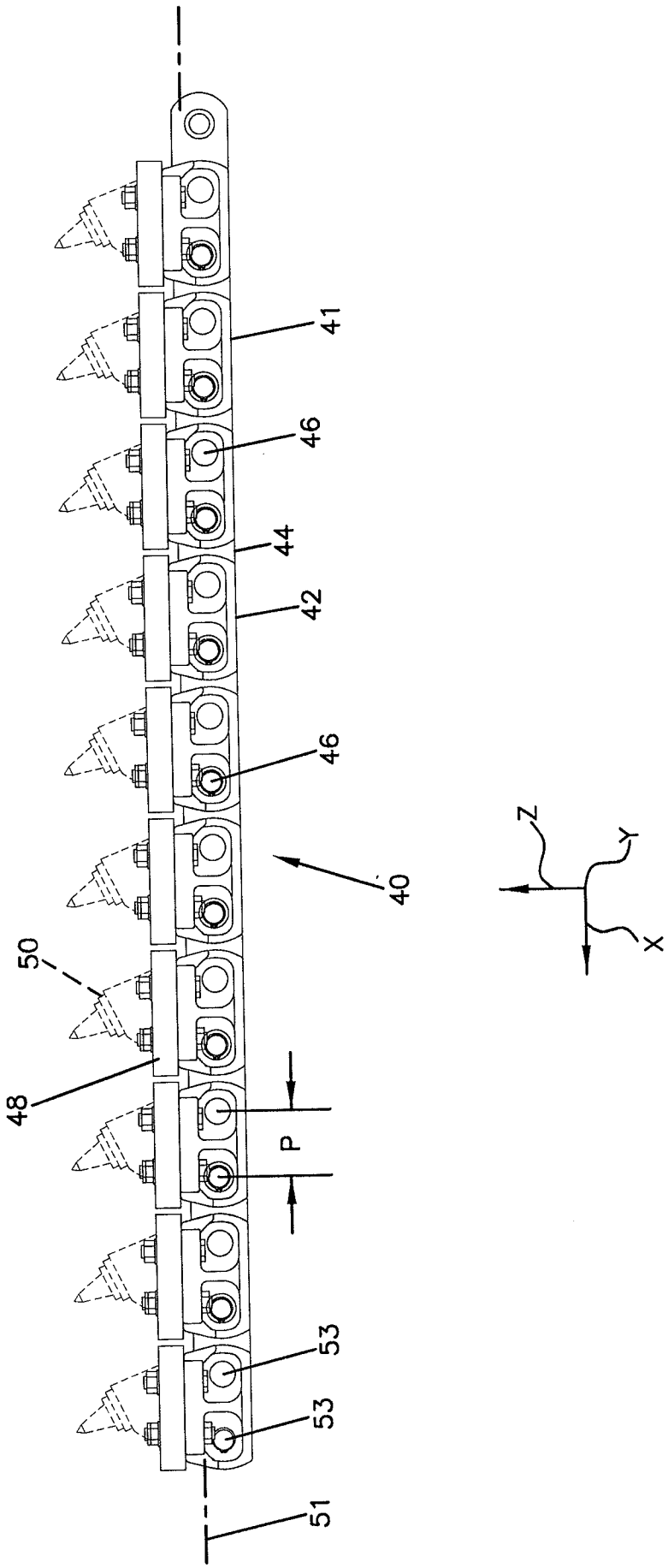


FIG. 3

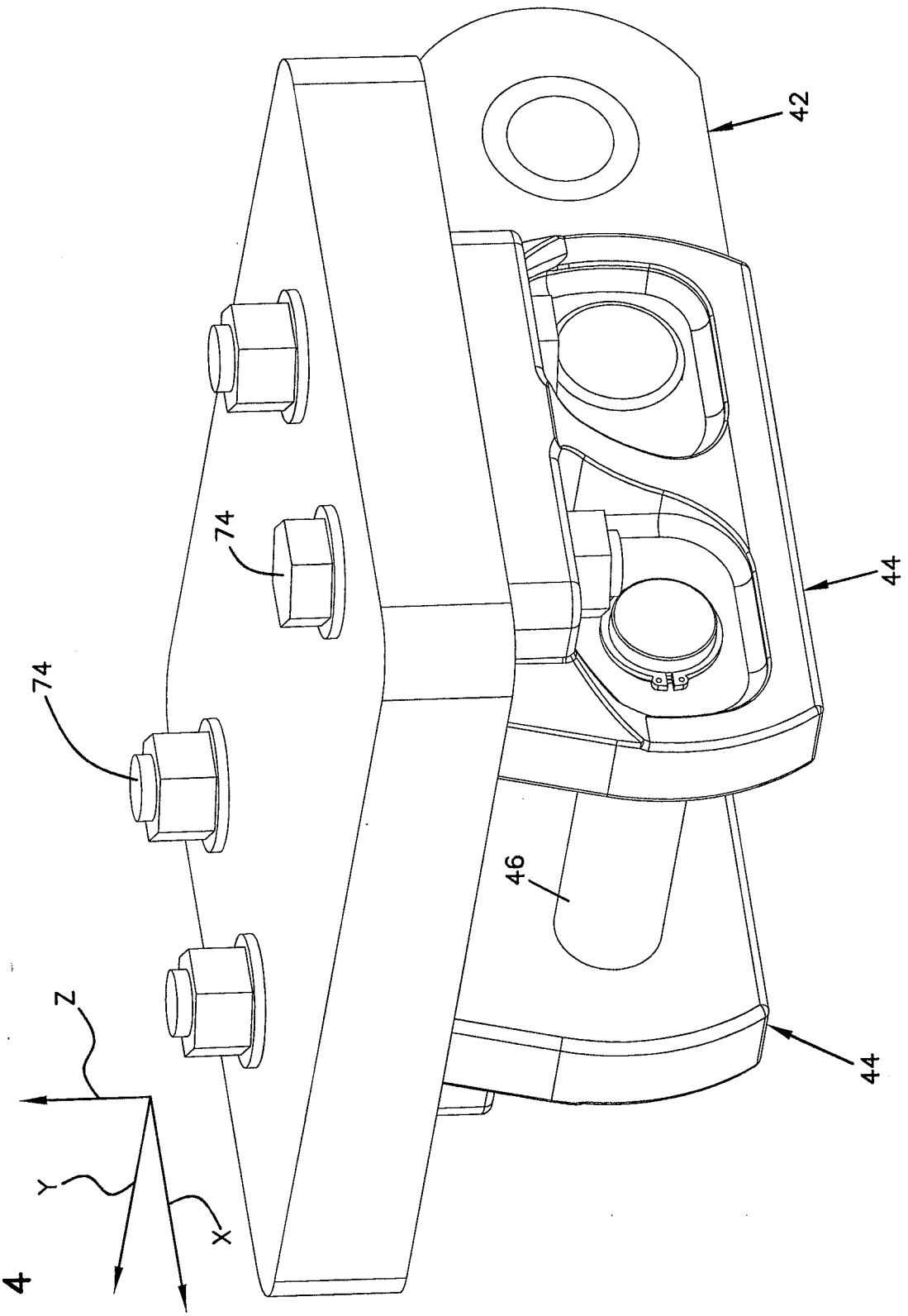


FIG. 4

FIG. 5

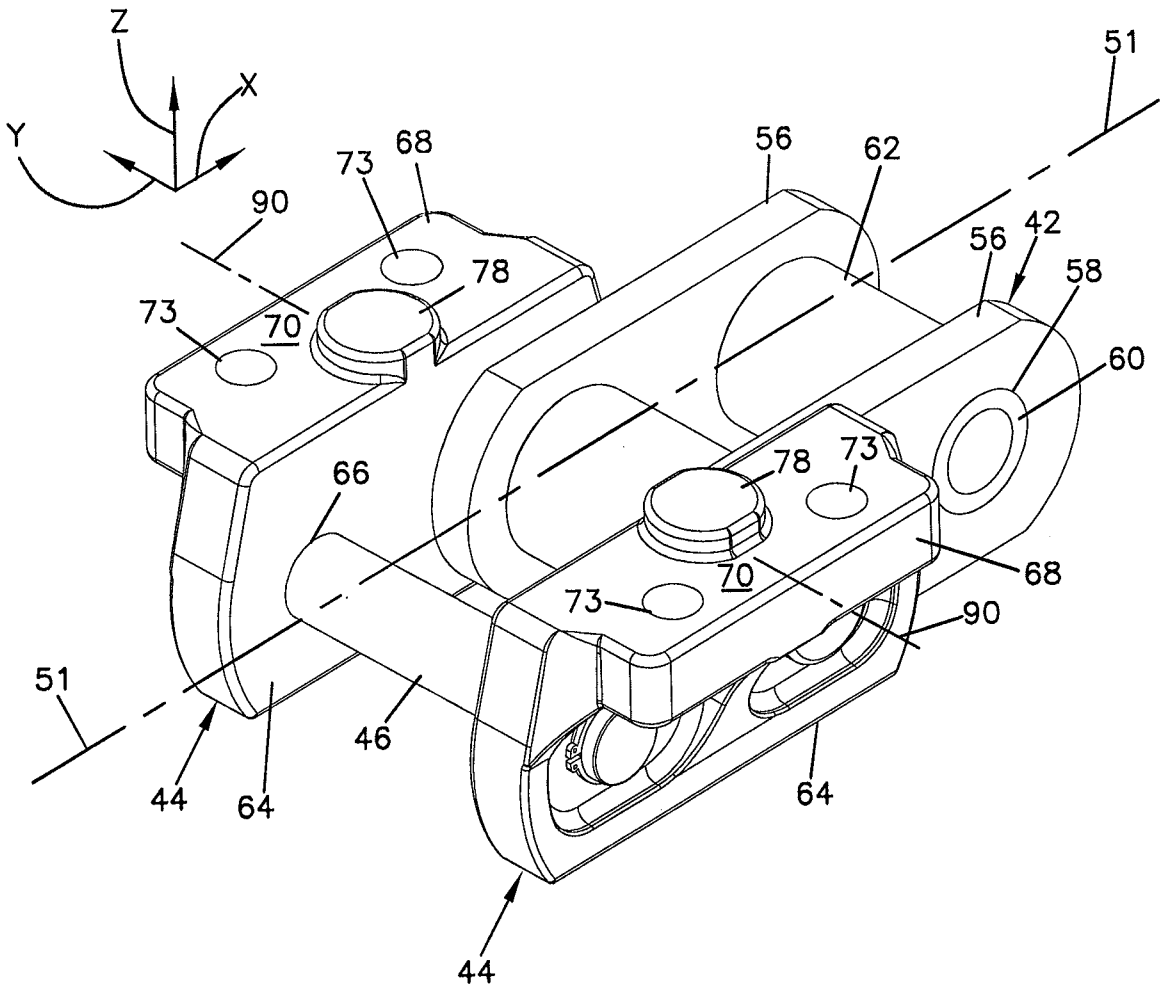

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FIG. 6

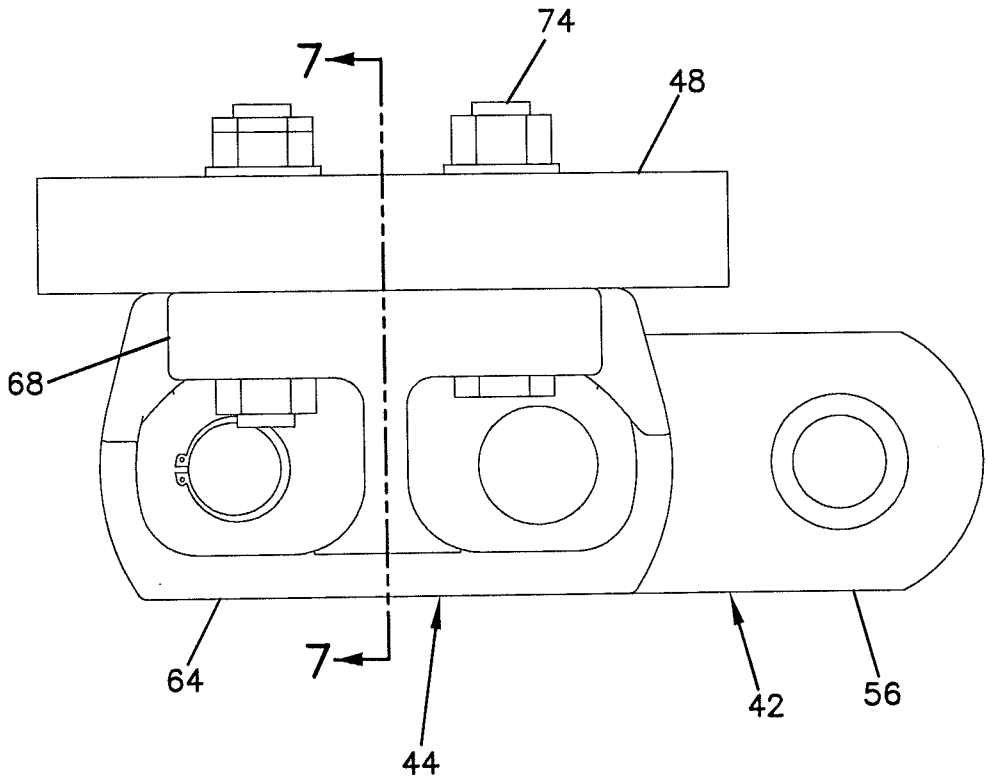


FIG. 7

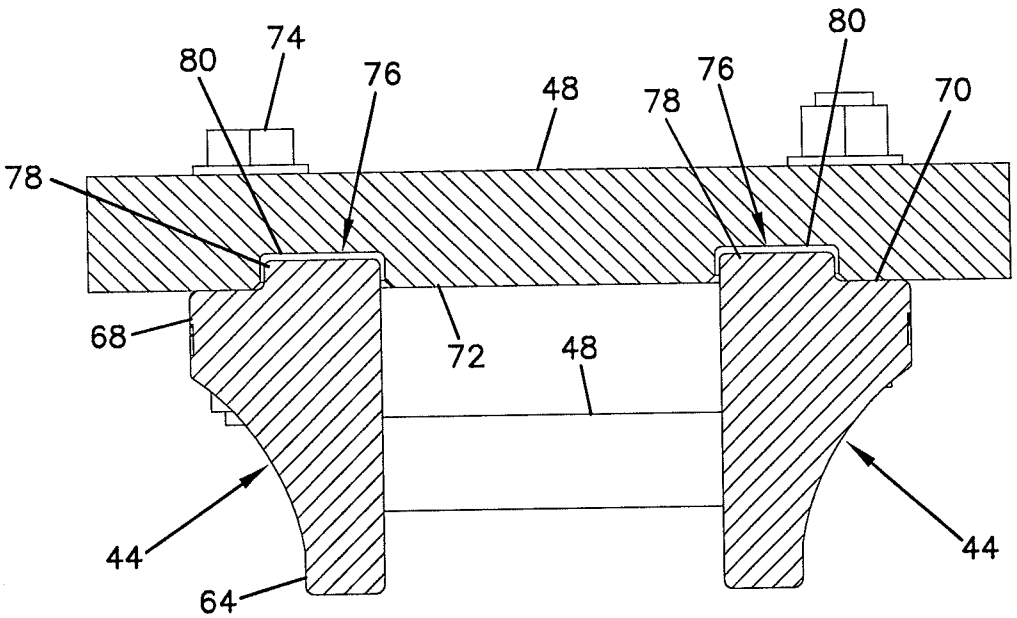


FIG. 8

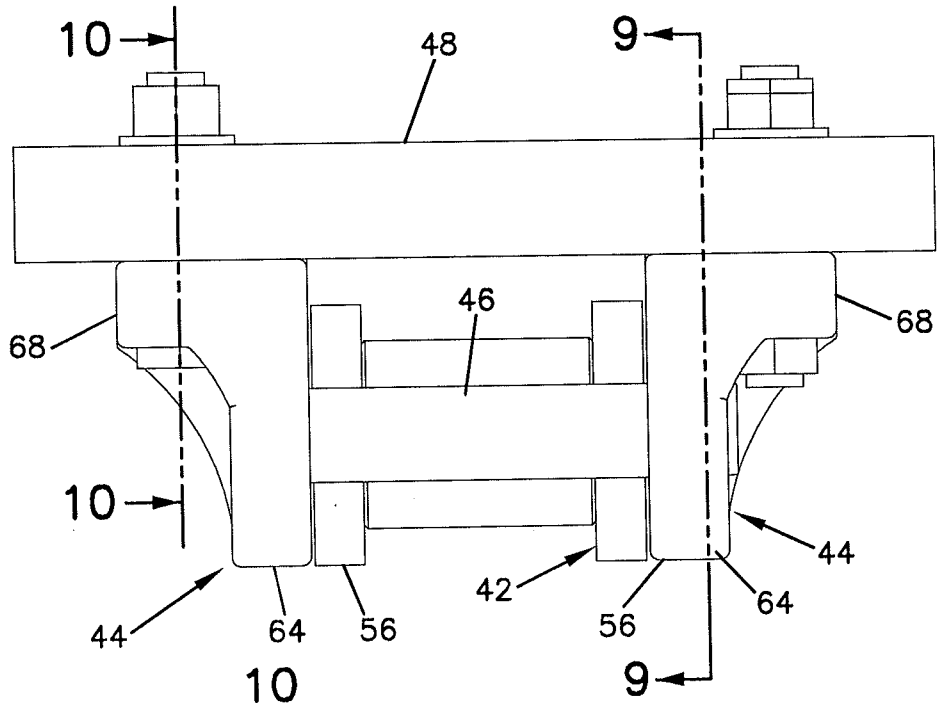

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FIG. 9

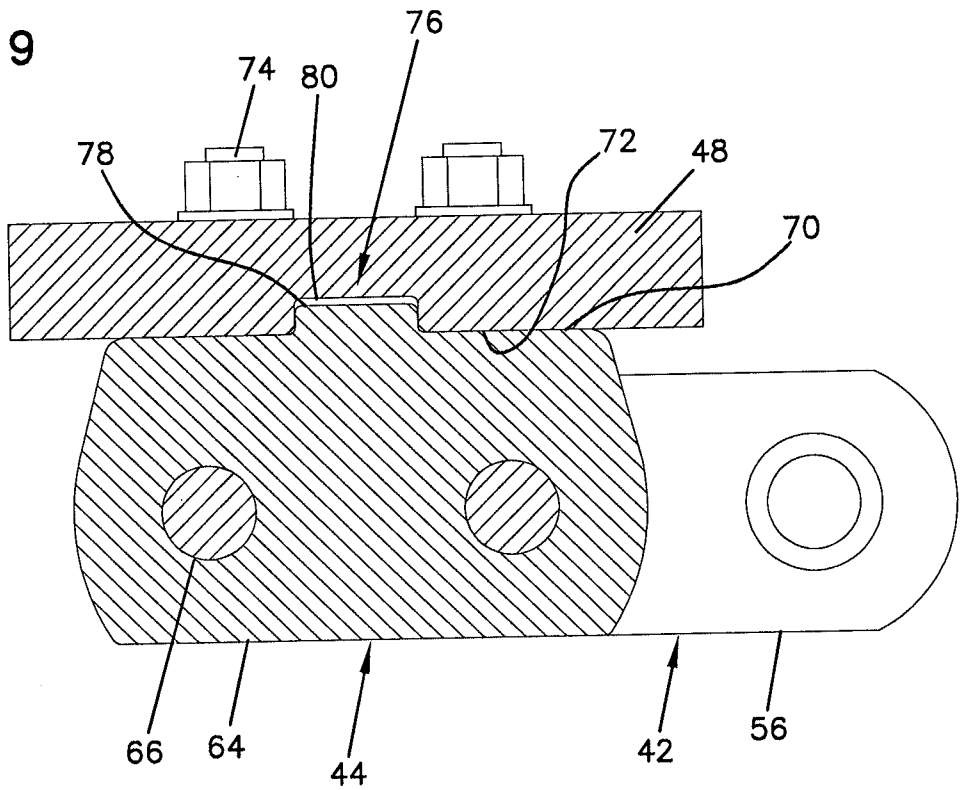

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FIG. 10

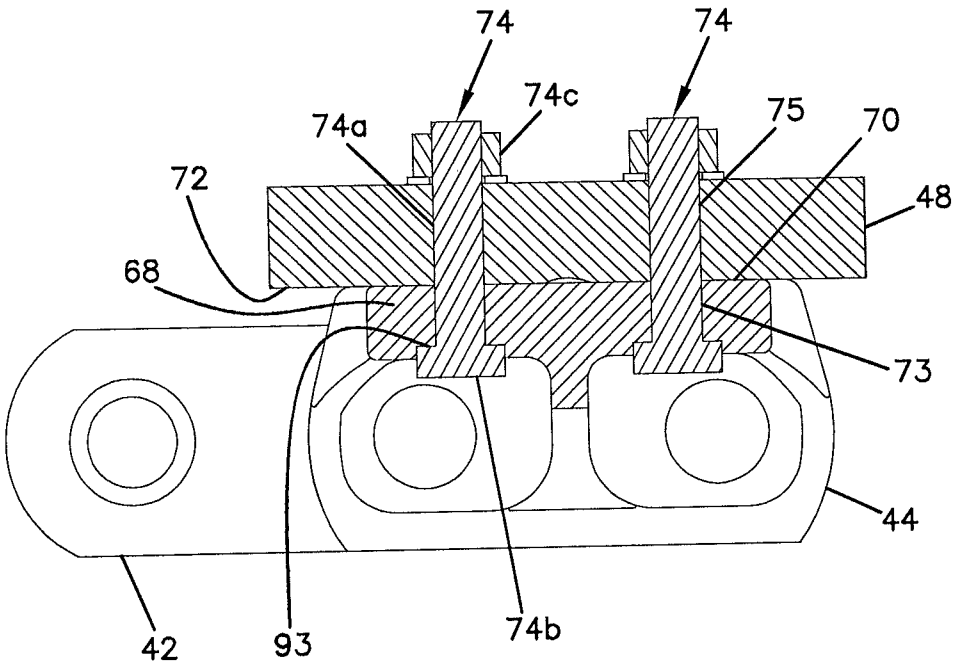


FIG. 11

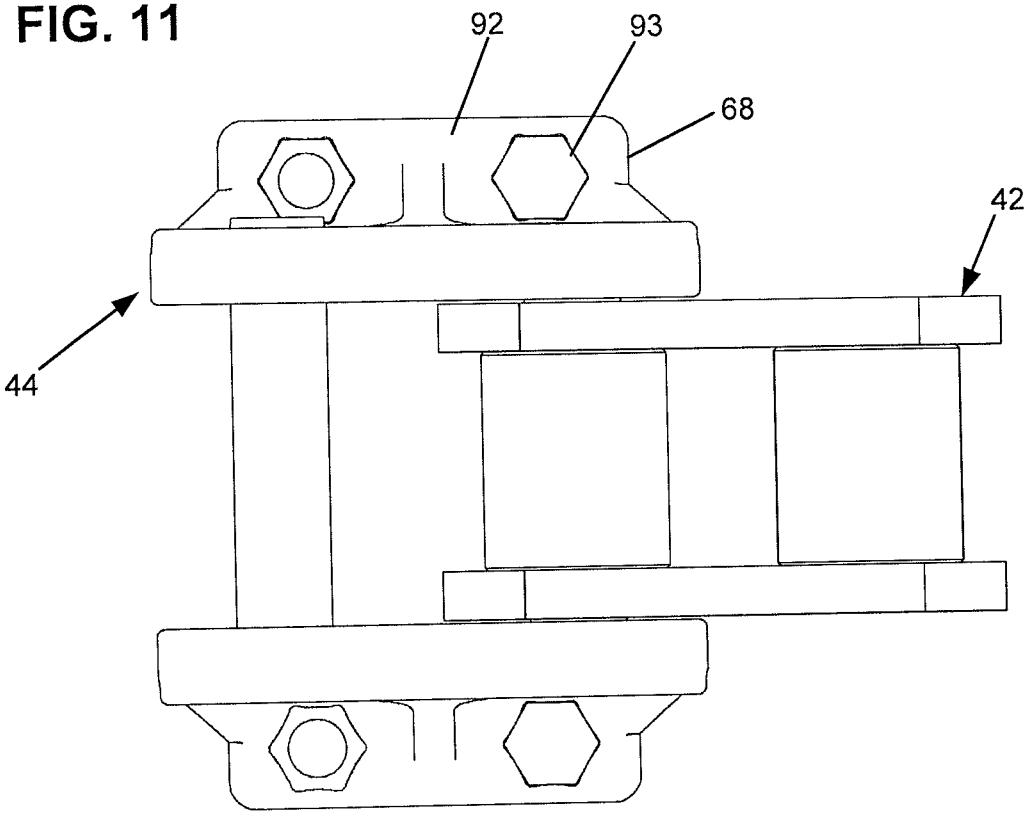
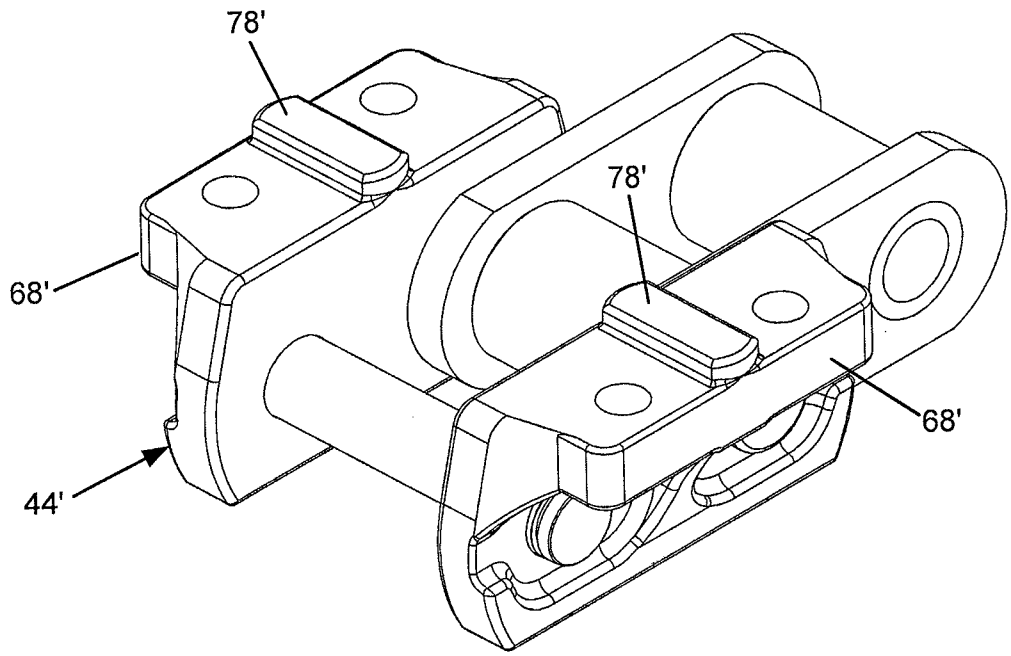


FIG. 12



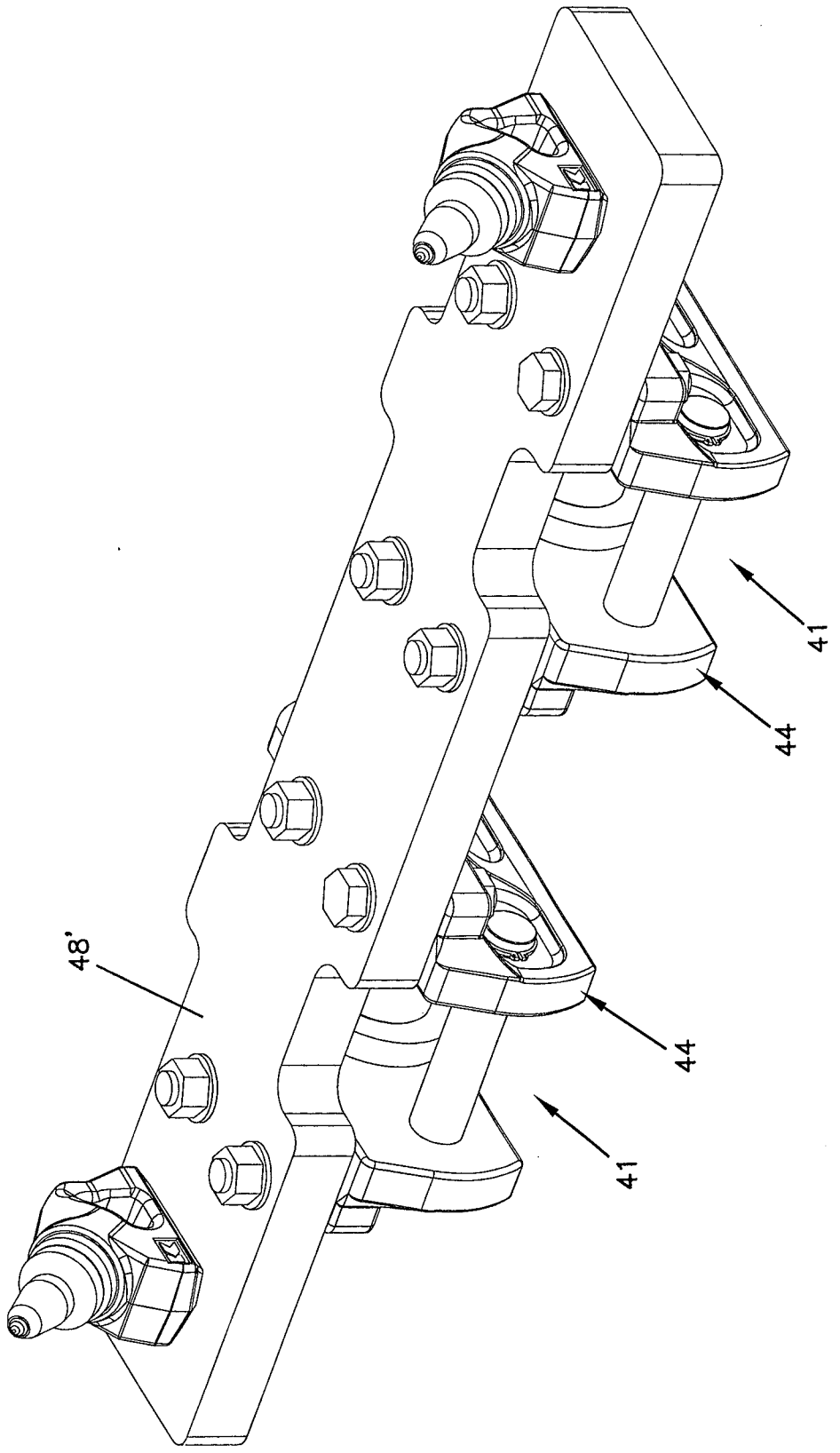
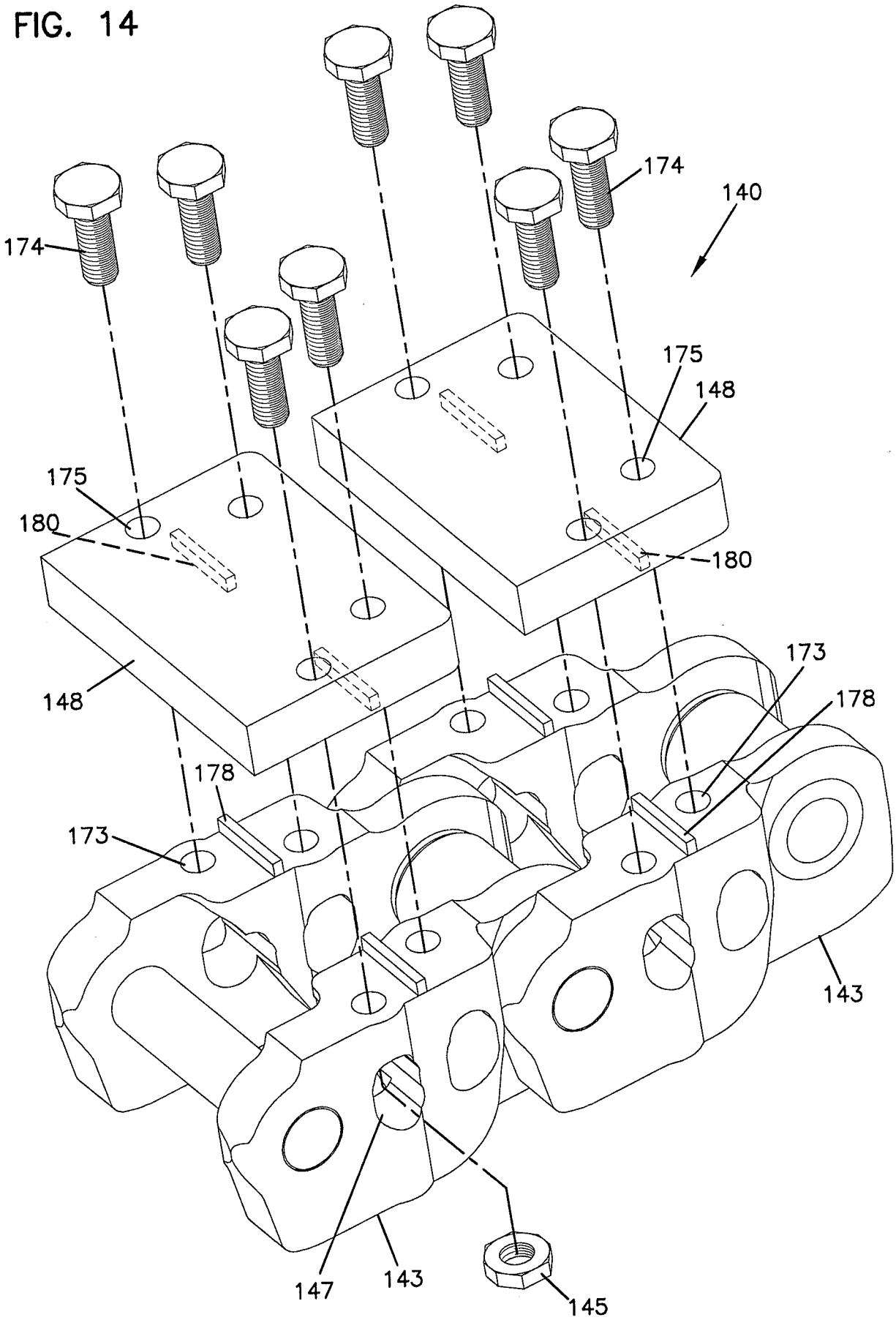


FIG. 13

FIG. 14


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