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**McNeilus et al.**

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(54) **ROBUST GRABBER ARM FOR REFUSE COLLECTION VEHICLE**

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(51) **Int. Cl.**
***B65F 3/04*** (2006.01)
*B65F 3/02* (2006.01)

(52) **U.S. Cl.**
CPC ..... ***B65F 3/041*** (2013.01); *B65F 2003/023* (2013.01); *B65F 2003/0263* (2013.01)

(58) **Field of Classification Search**
CPC ..... B65F 3/041; B65F 3/043; B65F 3/045; B65F 3/046
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

| | | | | |
|---|---|---|---|---|
| 4,401,407 A | | 8/1983 | Breckenridge | |
| 4,898,510 A | | 2/1990 | Weber | |
| 5,020,844 A | | 6/1991 | Pickrell | |
| 5,201,235 A | | 4/1993 | Sutton | |
| 5,209,537 A | | 5/1993 | Smith et al. | |
| 5,447,409 A | | 9/1995 | Grunes et al. | |
| 5,482,180 A | | 1/1996 | Smith et al. | |
| 5,613,822 A | * | 3/1997 | Gasparini | B65F 3/046 414/303 |
| 5,720,589 A | * | 2/1998 | Christenson | B65F 3/26 414/408 |
| 5,772,385 A | * | 6/1998 | Huntoon | B65F 3/043 414/420 |
| 5,833,429 A | * | 11/1998 | McNeilus | B65F 3/00 414/408 |

(Continued)

FOREIGN PATENT DOCUMENTS

| | | |
|---|---|---|
| WO | WO 96/28369 | 1/1996 |

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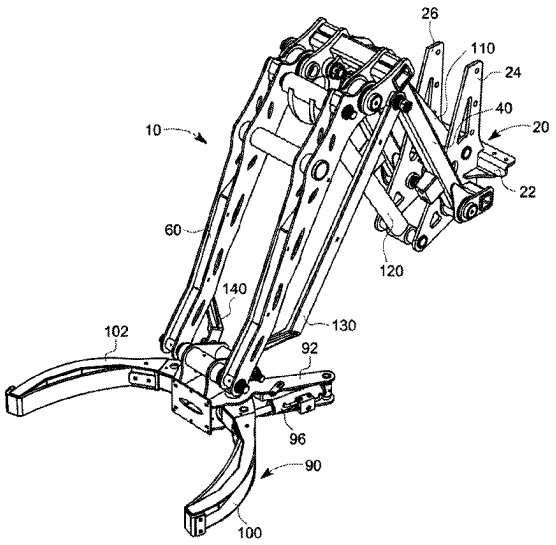
(57) **ABSTRACT**

A robust grabber arm for use as part of a refuse collection vehicle has an inner arm member and an outer arm member which are designed to have parallel beams coupled to one another so that a wide operating profile is created. Further, care is taken in configuring compounds so that each of the hinge points and coupling points are accessible for service and maintenance purposes. To provide additional consistency, common bearings and hinge pins are used throughout, so that maintenance and possible replacement can be easily achieved.

**28 Claims, 14 Drawing Sheets**



(56) **References Cited**

U.S. PATENT DOCUMENTS

| | | | | |
|---|---|---|---|---|
| 5,988,970 | A * | 11/1999 | Holtom | B65F 3/048 414/733 |
| 6,474,928 | B1 * | 11/2002 | Christenson | B65F 3/046 414/408 |
| 6,494,665 | B1 * | 12/2002 | Bingman | B65F 3/08 414/409 |
| 6,551,046 | B1 | 4/2003 | Dorrington | |
| 6,722,839 | B2 * | 4/2004 | Bingman | E01C 23/025 414/517 |
| 9,403,641 | B1 * | 8/2016 | Ghibaudo | B65F 3/02 |
| 9,598,235 | B2 * | 3/2017 | Vasilescu | B65F 3/08 |
| 9,834,377 | B1 * | 12/2017 | Hayes | B65F 3/041 |
| 9,912,130 | B1 | 3/2018 | Burns | |
| 9,956,691 | B1 | 5/2018 | Pentzer et al. | |
| 10,221,012 | B2 * | 3/2019 | Hund, Jr. | B65F 3/04 |
| D846,611 | S | 4/2019 | Chi | |
| 10,899,538 | B2 * | 1/2021 | Nelson | B65F 3/08 |
| 10,994,929 | B2 * | 5/2021 | Haddick | B65F 3/04 |
| 11,001,440 | B2 * | 5/2021 | Rocholl | B65F 3/041 |
| D967,220 | S | 10/2022 | Bangalore Srinivas et al. | |
| 11,884,486 | B2 * | 1/2024 | McNeilus | B65F 3/041 |
| 2001/0038175 | A1 | 11/2001 | Nagai et al. | |
| 2003/0077156 | A1 * | 4/2003 | Bingman | E01C 23/025 414/23 |
| 2004/0113343 | A1 | 6/2004 | Mcintosh et al. | |
| 2013/0285401 | A1 | 10/2013 | Price et al. | |
| 2016/0159571 | A1 * | 6/2016 | Arrez | B65F 3/08 414/409 |
| 2017/0291765 | A1 * | 10/2017 | Kouri | B65F 3/0203 |
| 2017/0297818 | A1 * | 10/2017 | Goedken | B65F 3/08 |
| 2017/0349375 | A1 | 12/2017 | Hund, Jr. | |
| 2020/0102145 | A1 | 4/2020 | Nelson et al. | |
| 2020/0262328 | A1 * | 8/2020 | Nelson | B60P 1/48 |
| 2020/0346856 | A1 * | 11/2020 | Rocholl | B65F 3/0203 |
| 2020/0346859 | A1 * | 11/2020 | Buege | B65F 3/08 |
| 2020/0346860 | A1 * | 11/2020 | Buege | B25J 19/0004 |
| 2023/0086945 | A1 | 3/2023 | Mcneilus et al. | |
| 2023/0129820 | A1 | 4/2023 | Mcneilus et al. | |

* cited by examiner

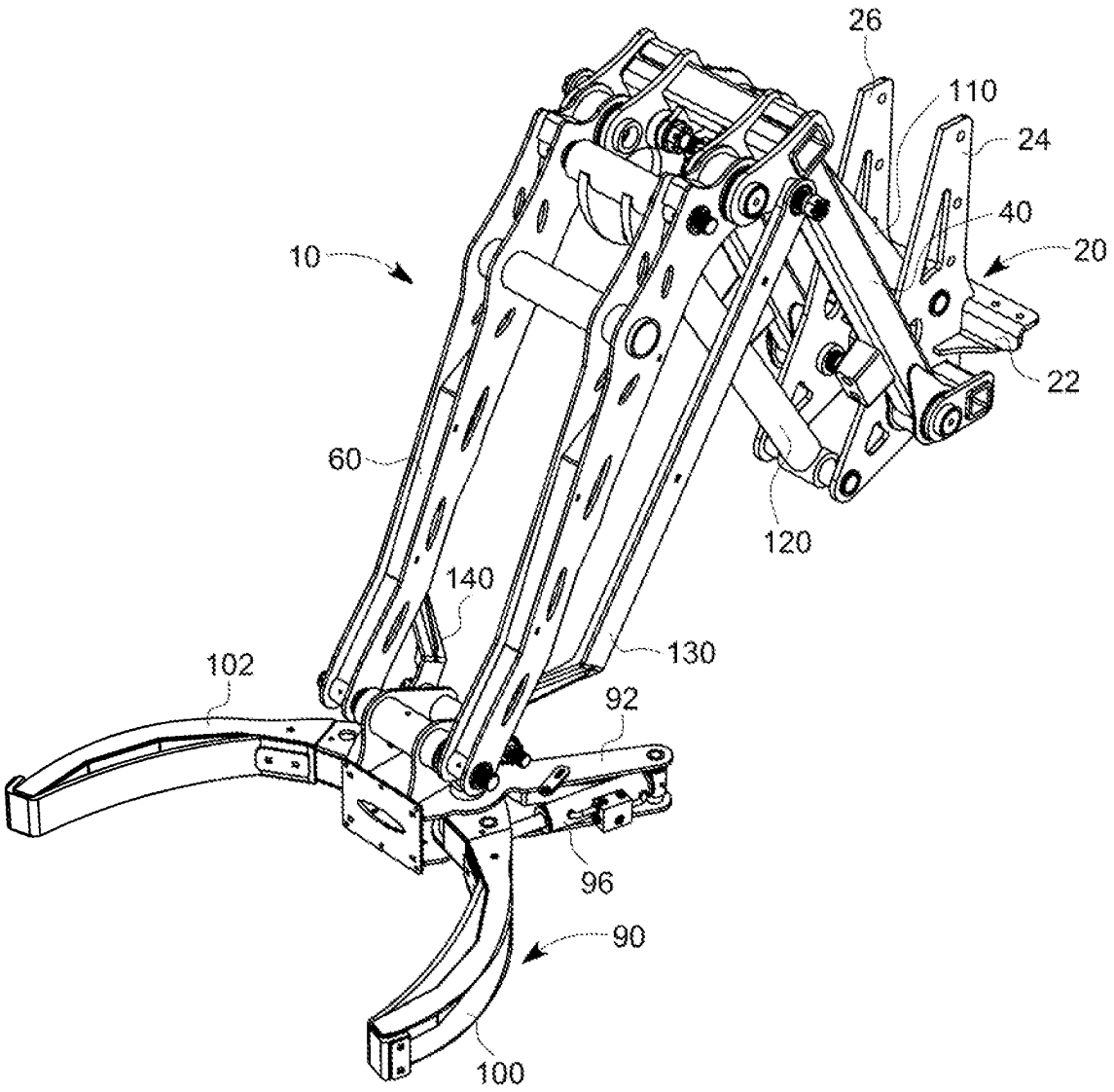



FIG. 1

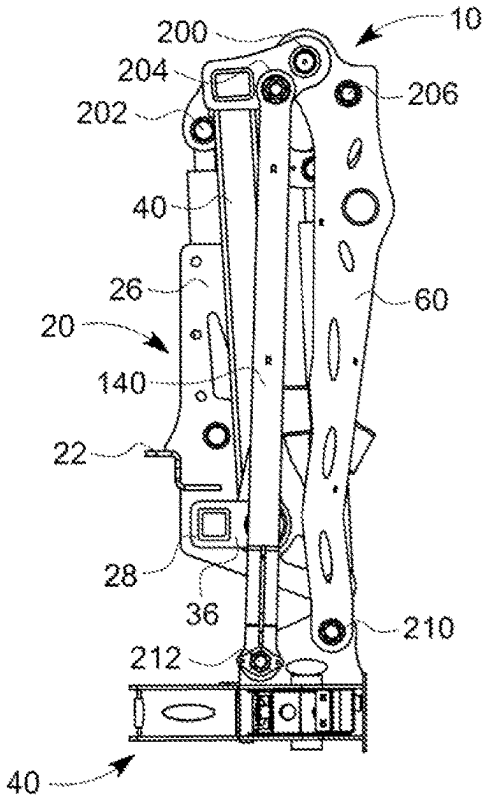

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FIG. 2

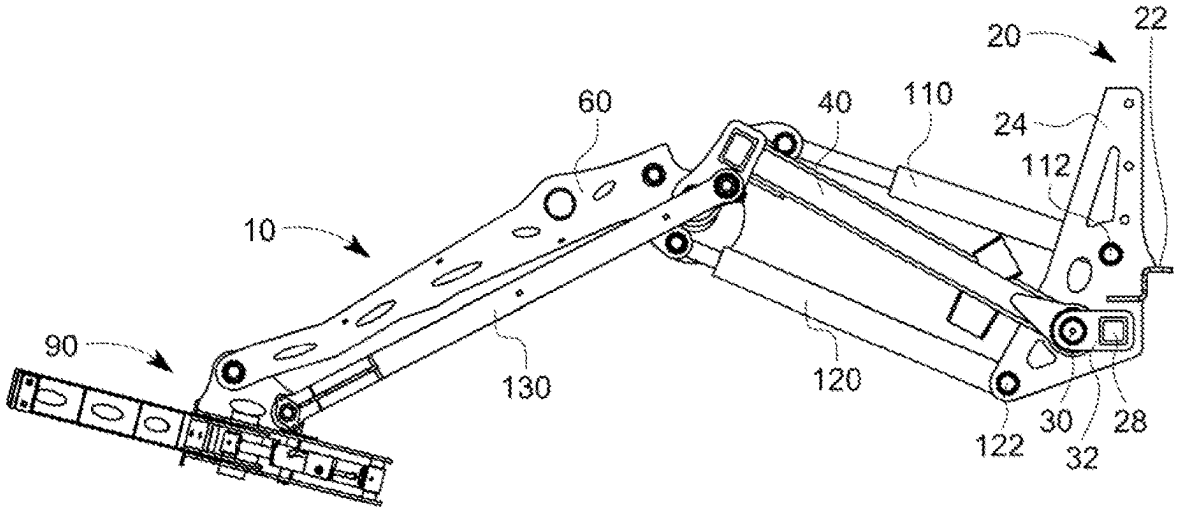
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FIG. 3

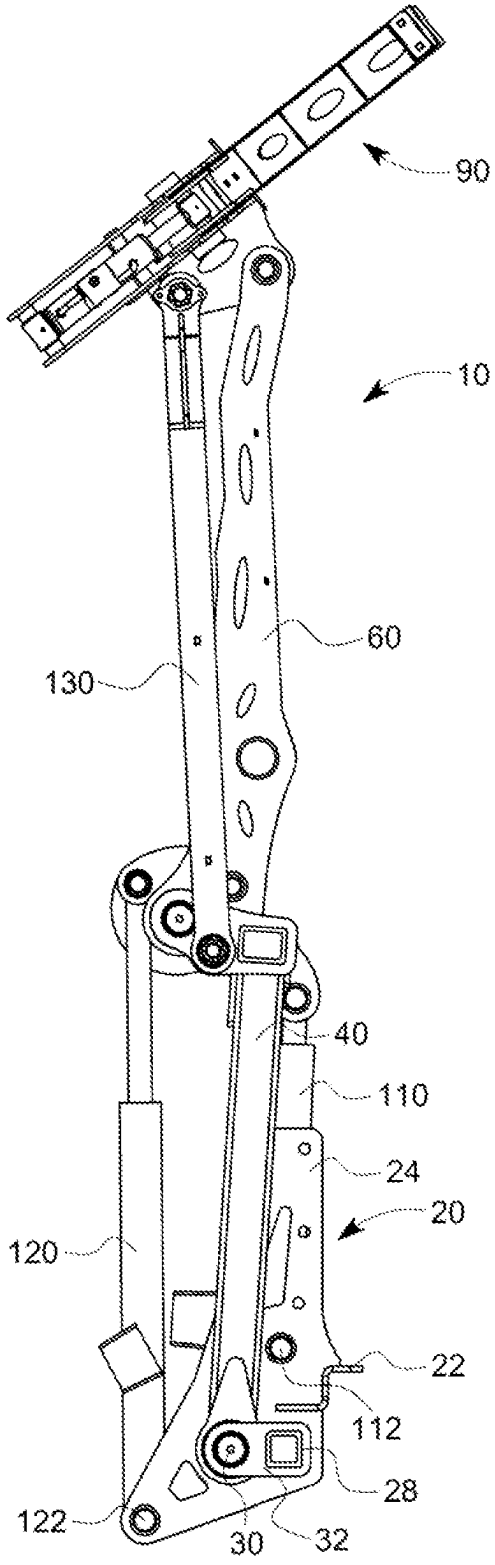


FIG. 4

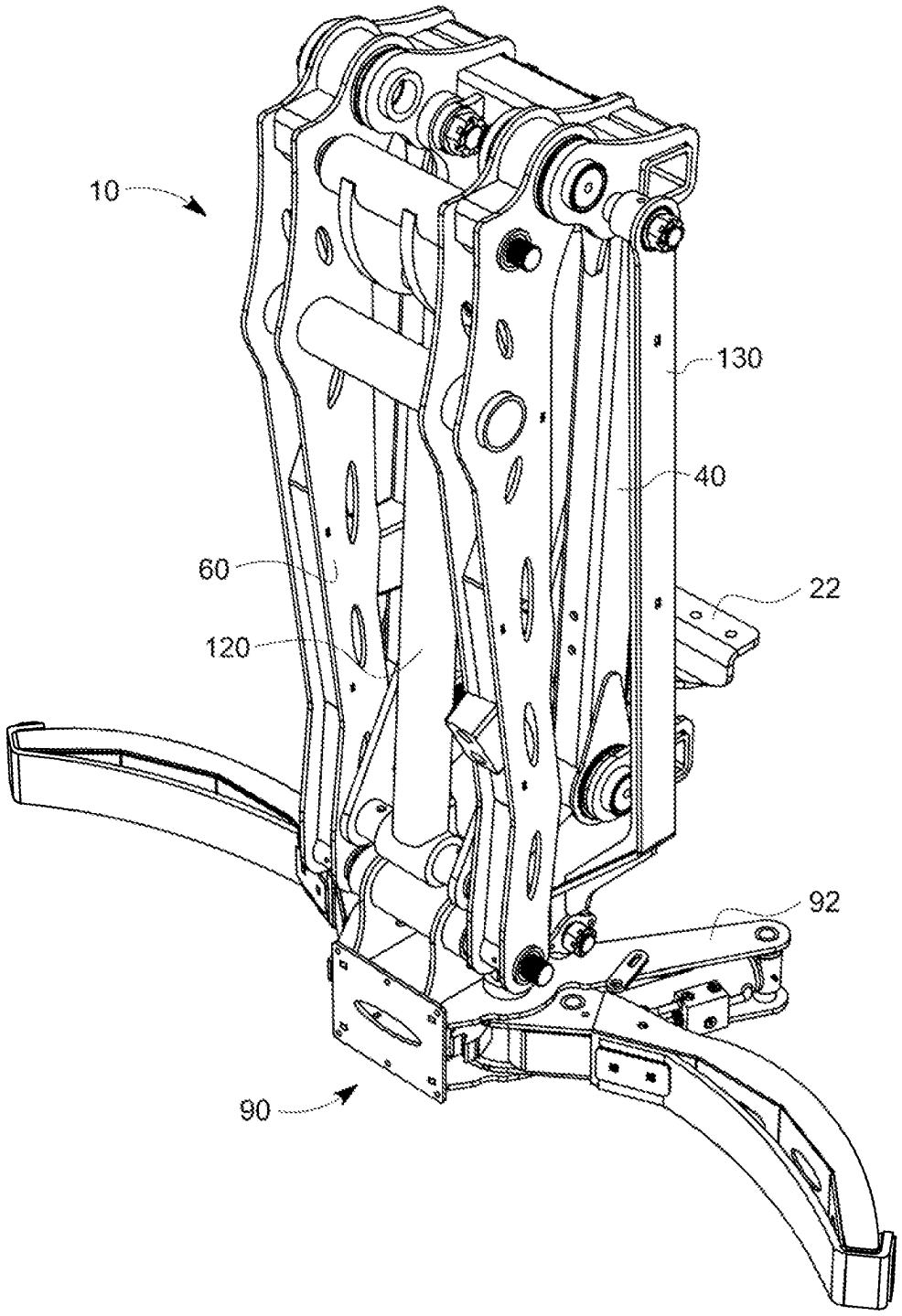


FIG. 5

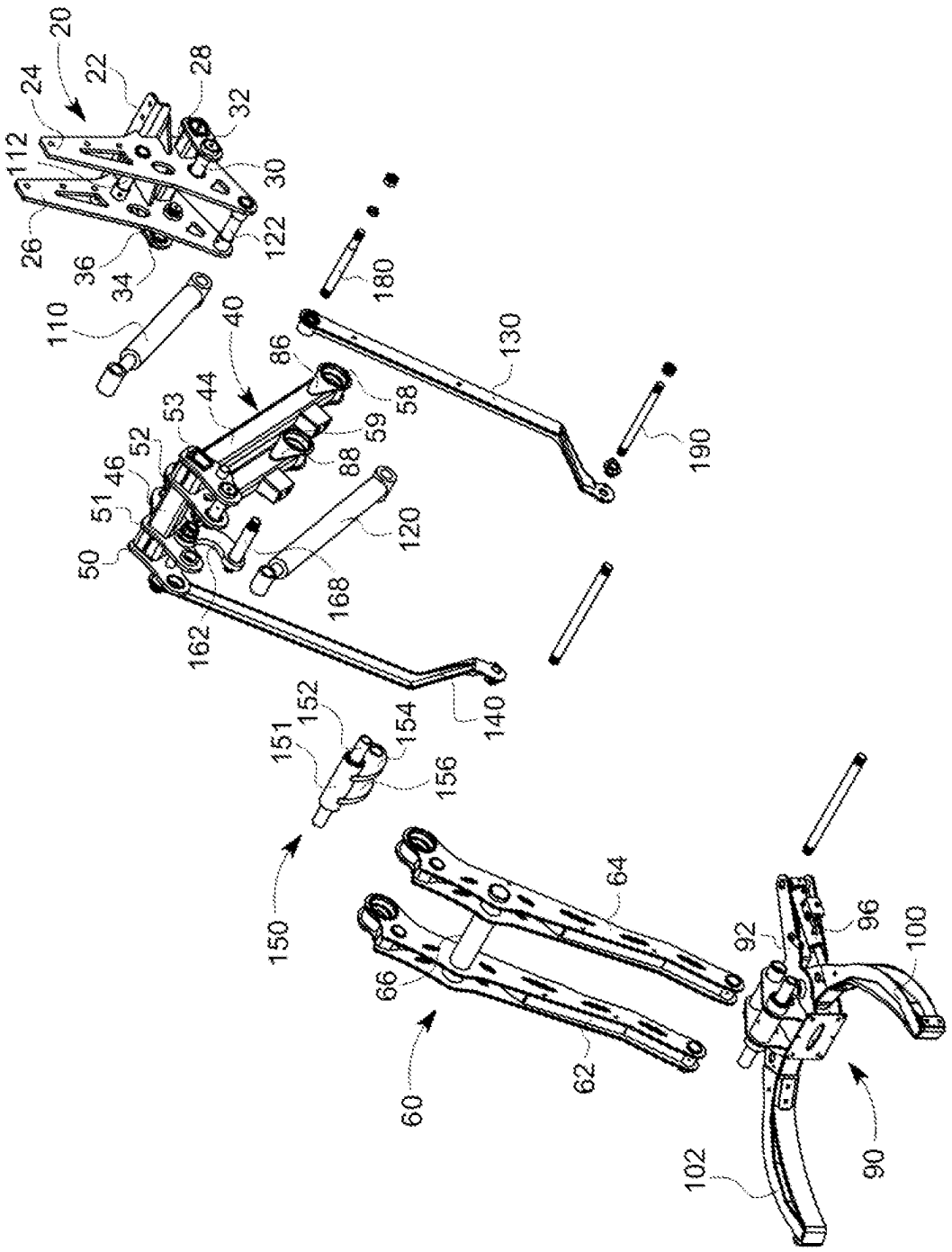
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FIG. 6

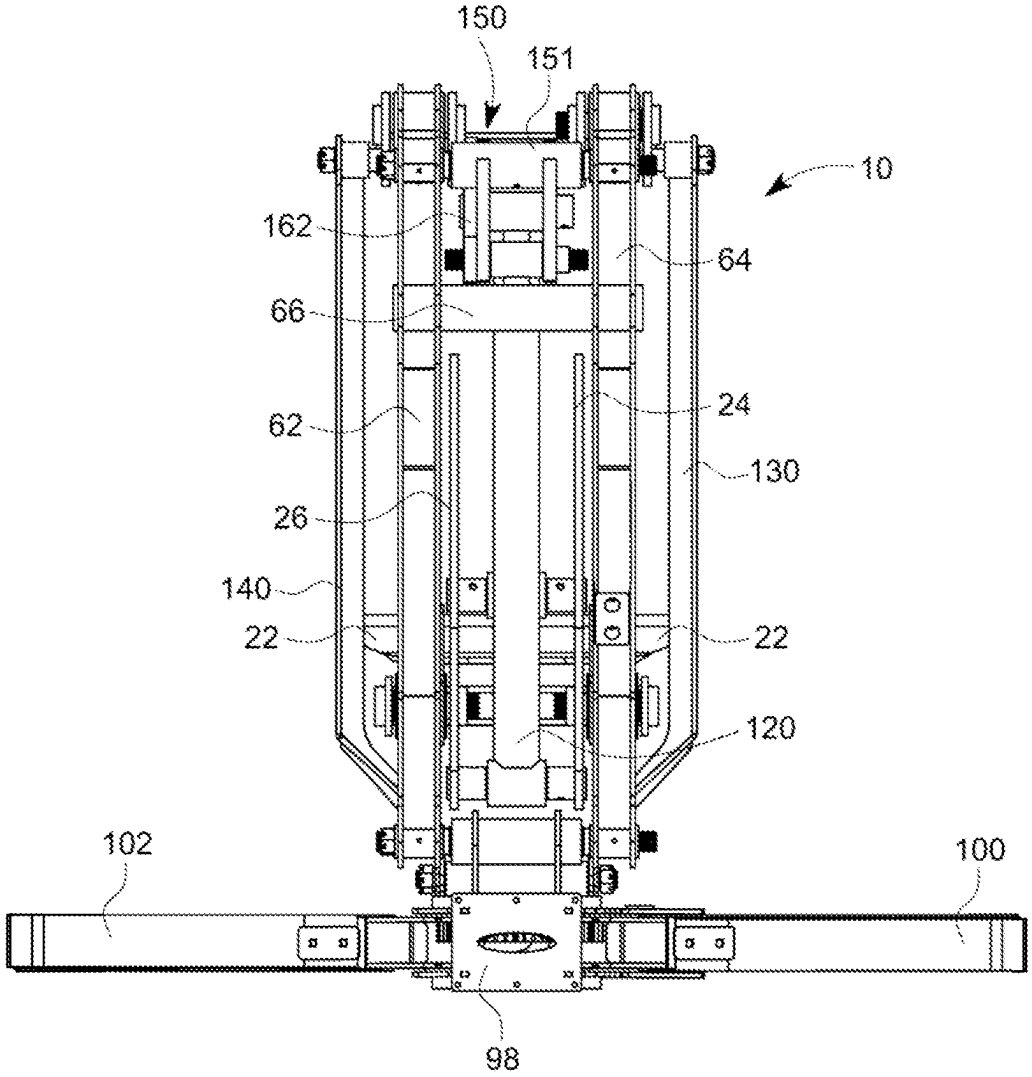


FIG. 7

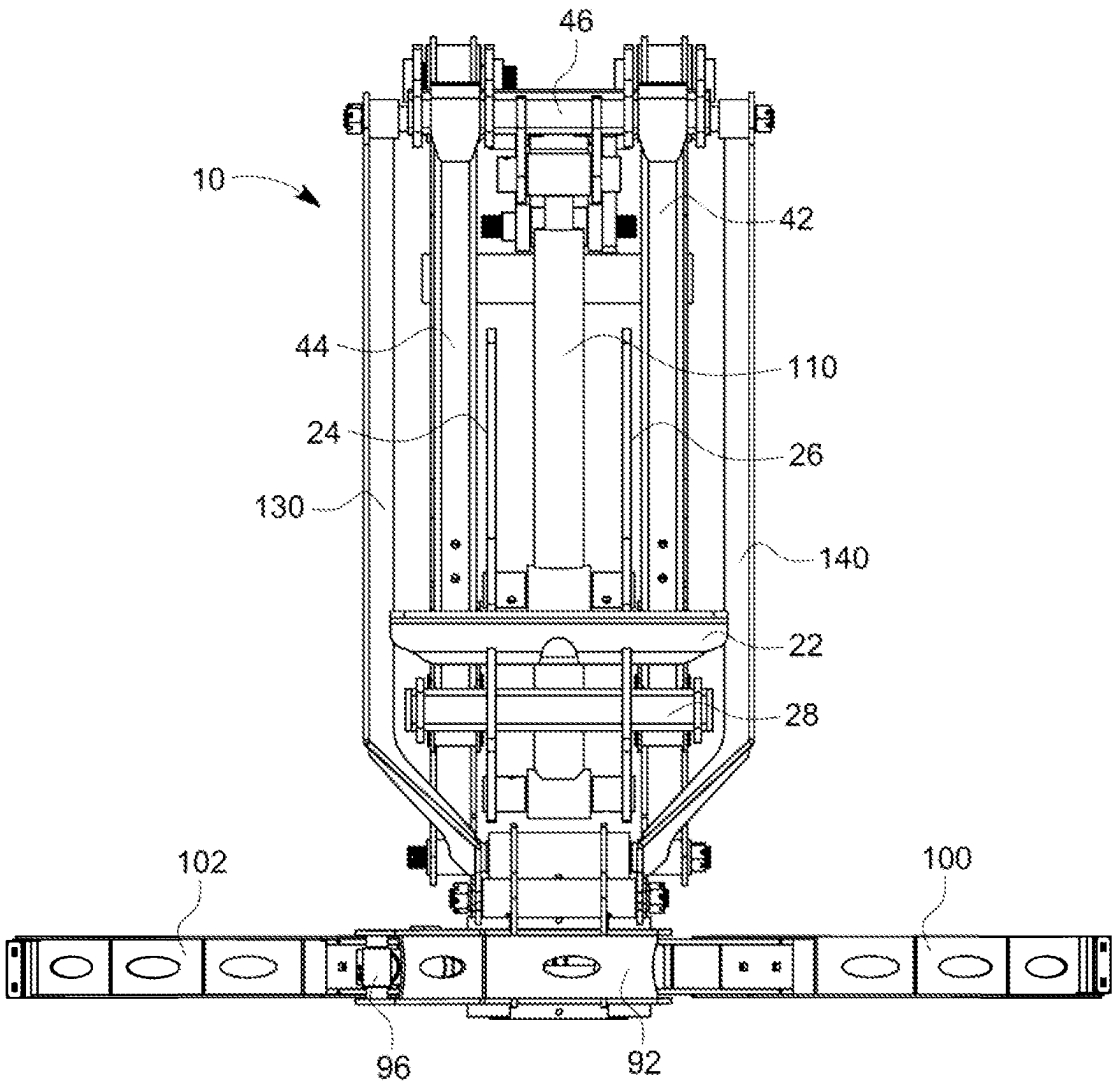


FIG. 8

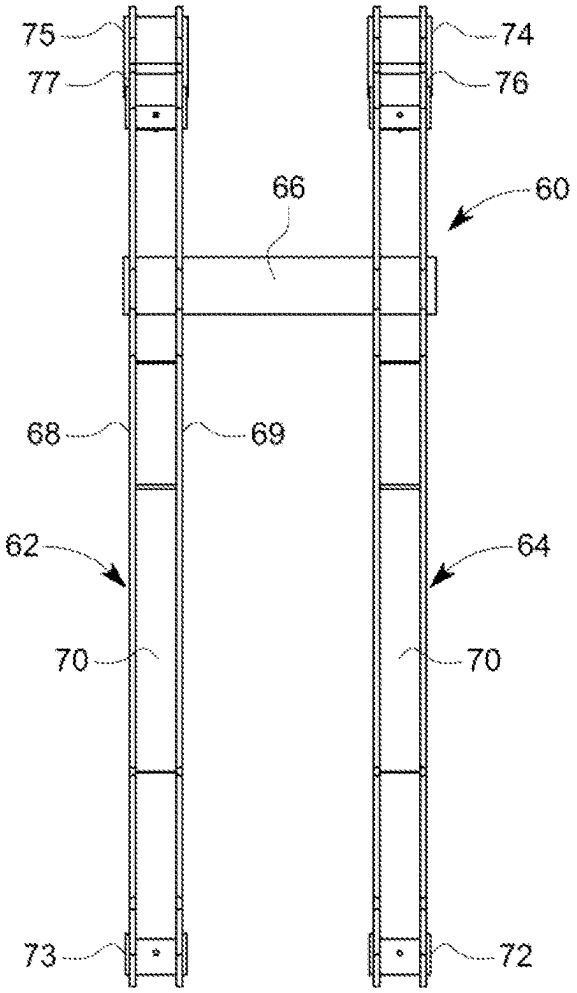


FIG. 9

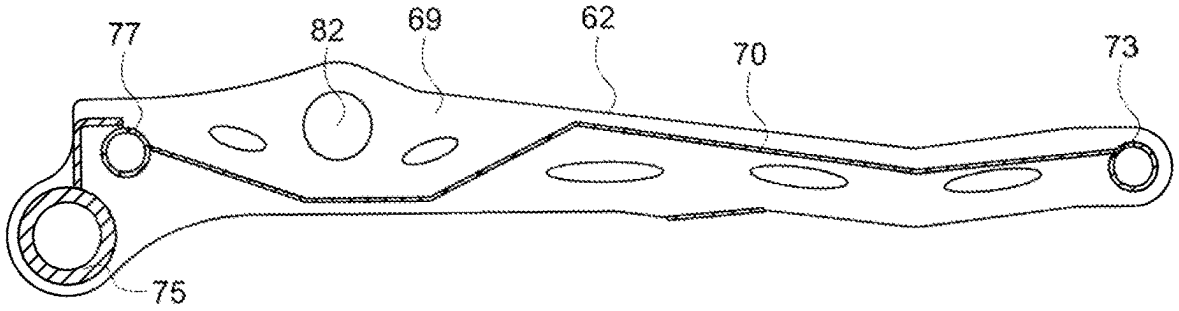


FIG. 10

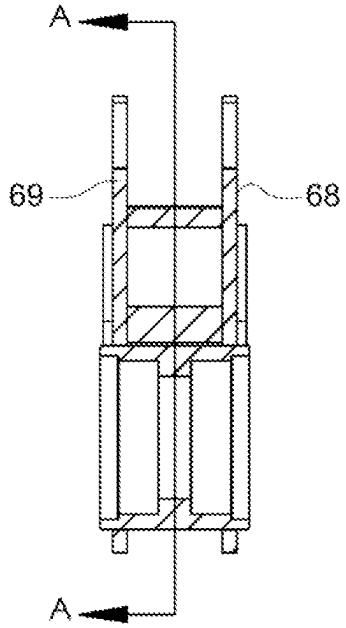


FIG. 11

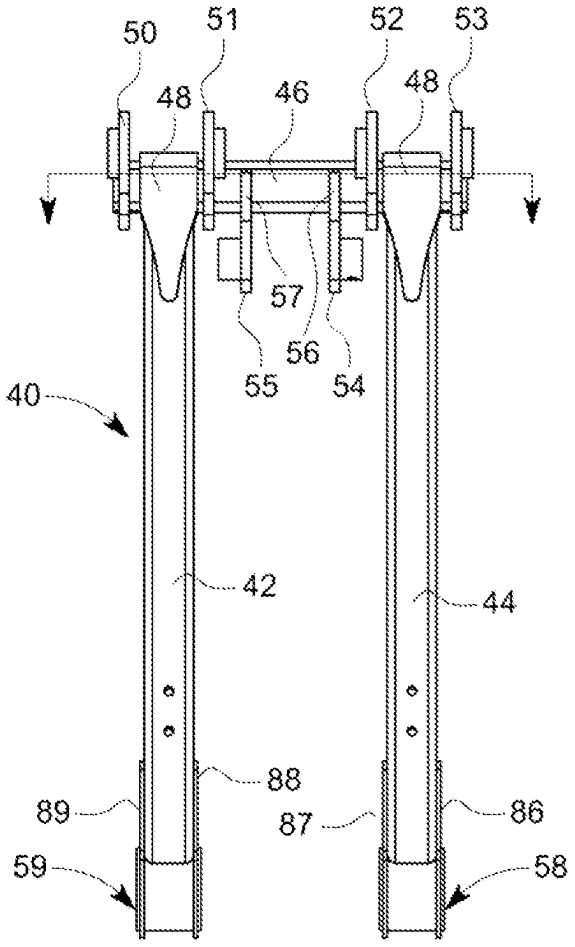


FIG. 12

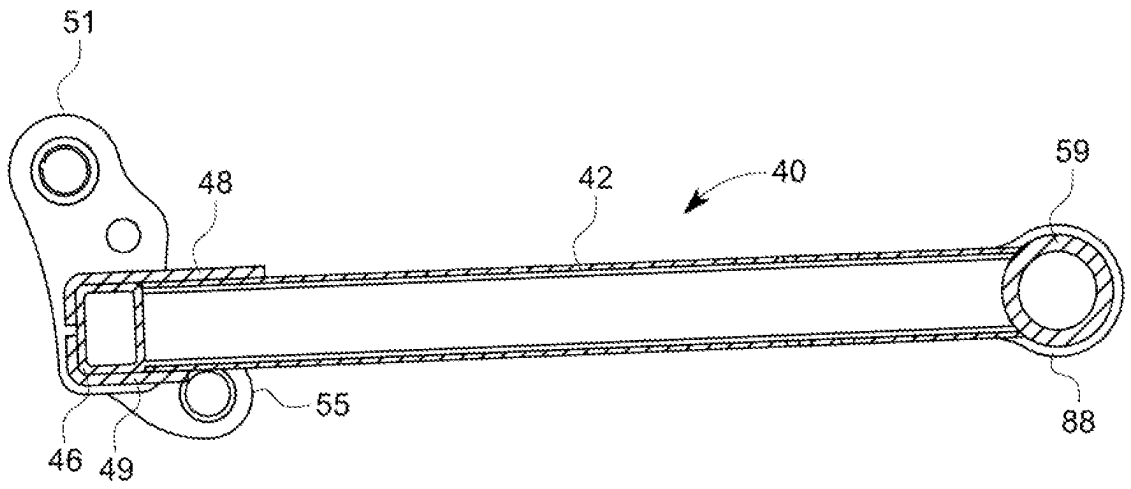


FIG. 13

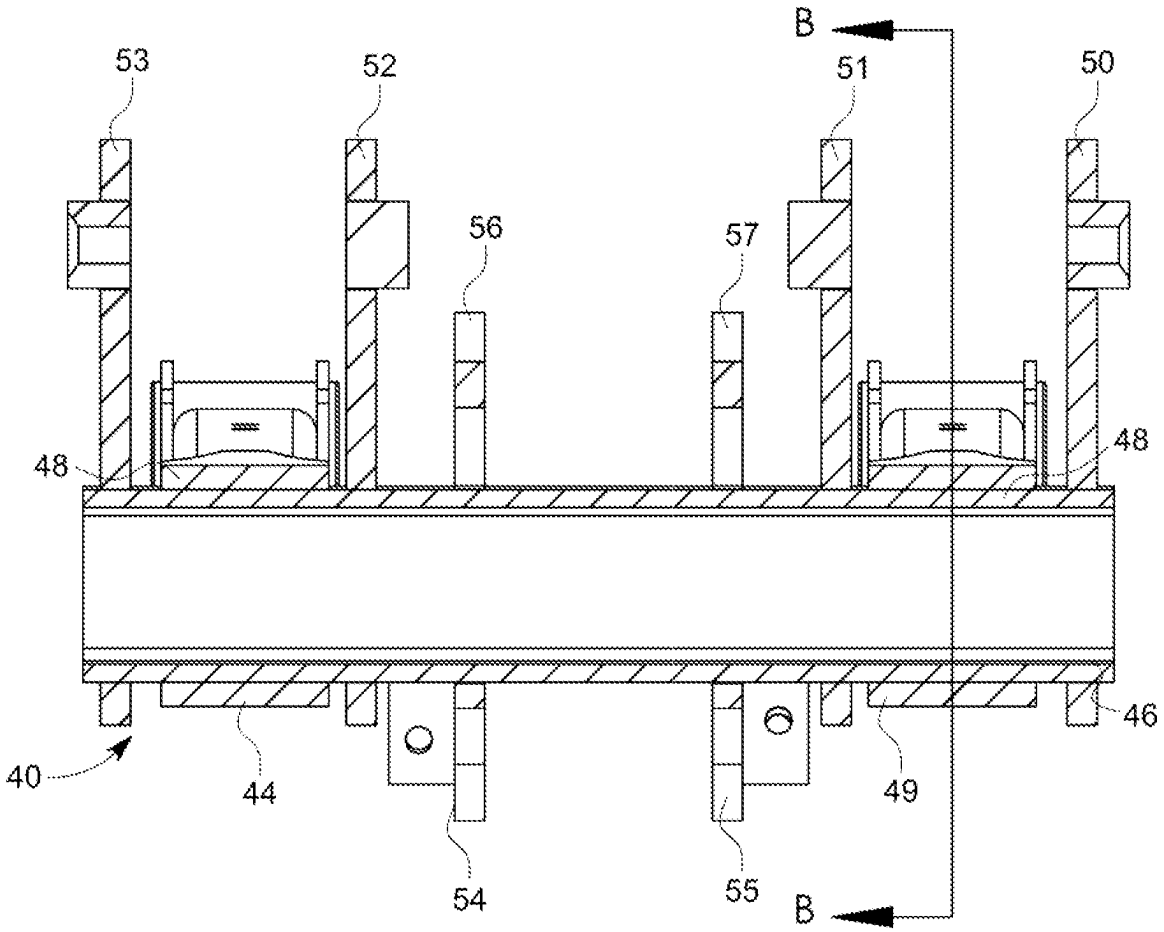


FIG. 14

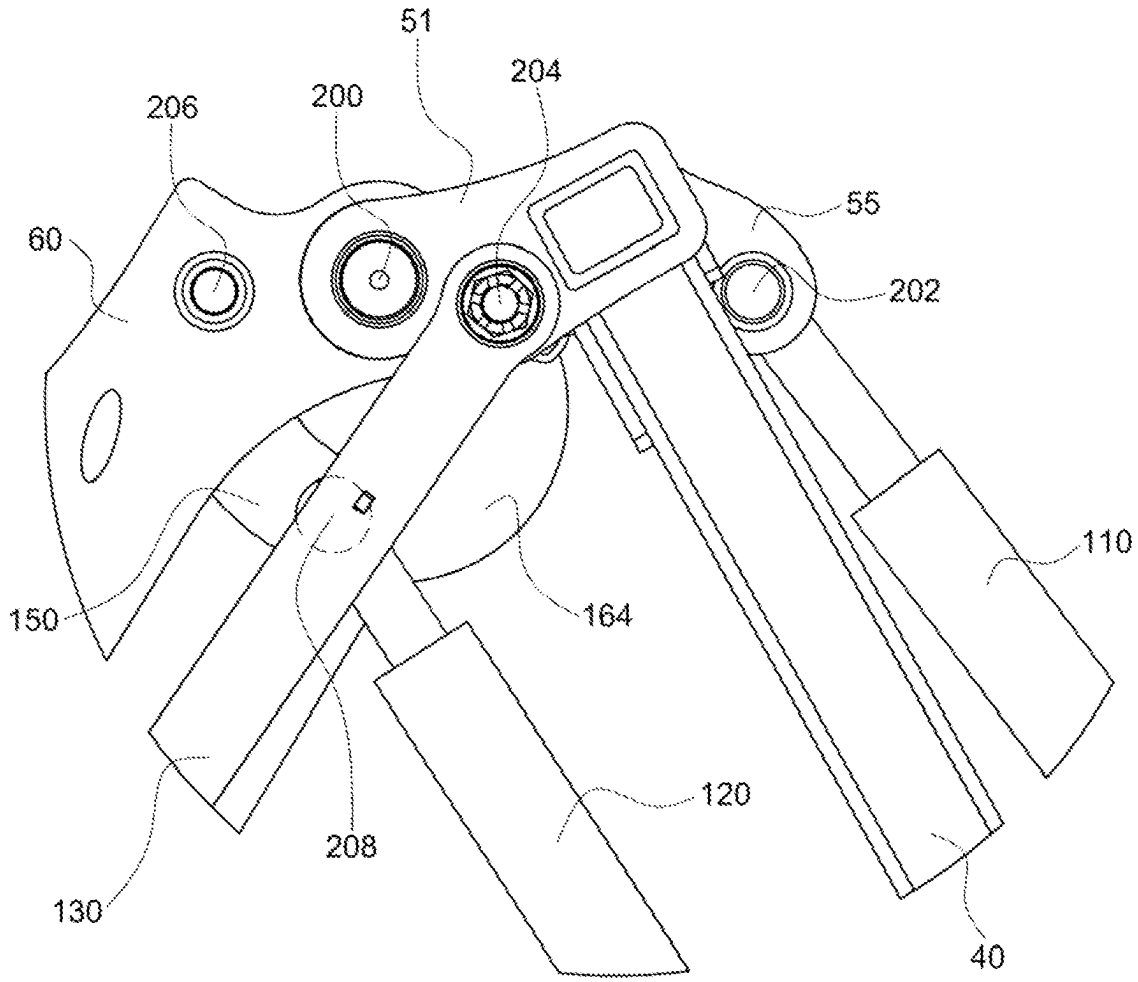


FIG. 15

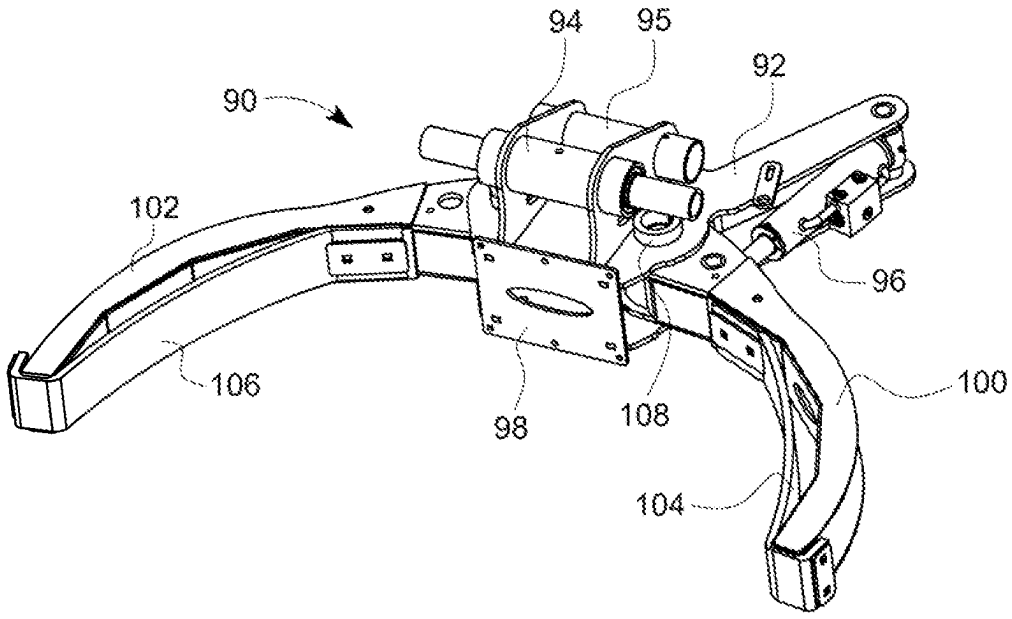


FIG. 16

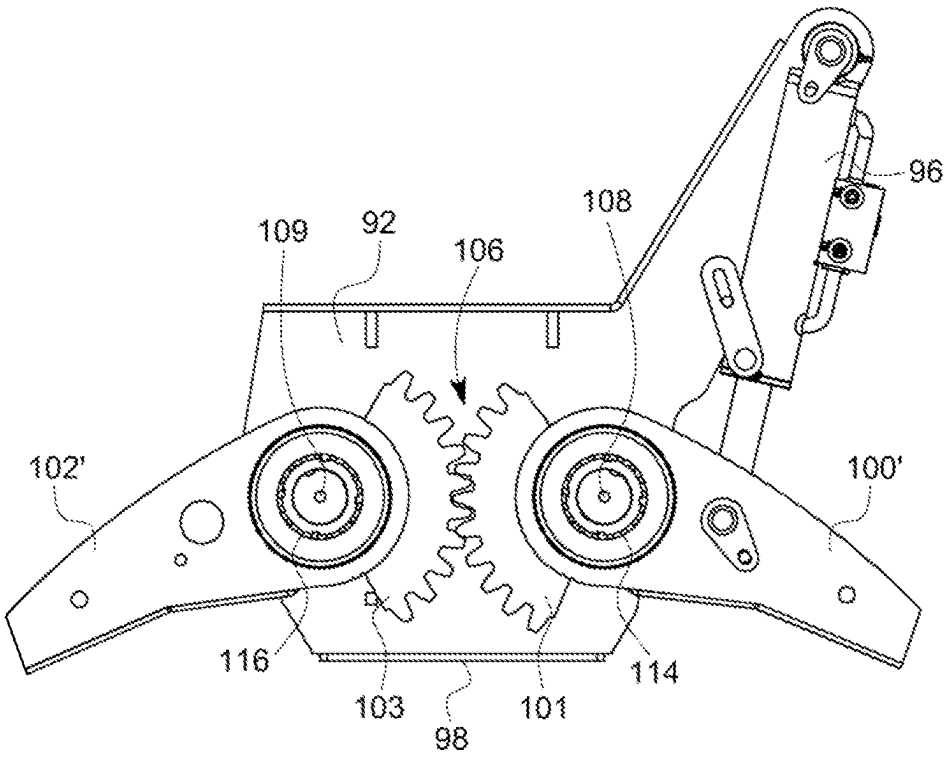


FIG. 17

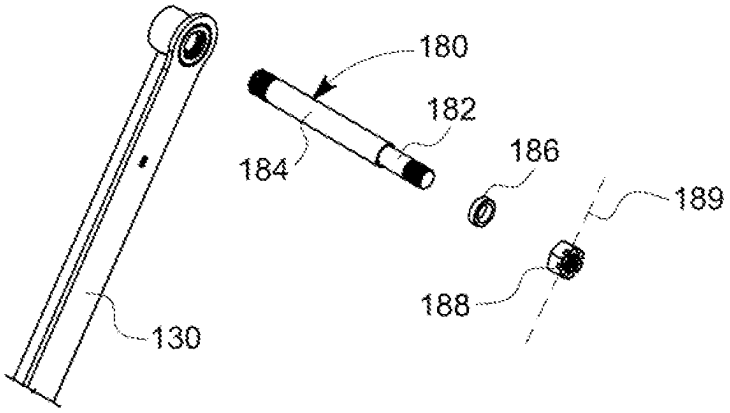


FIG. 18 A

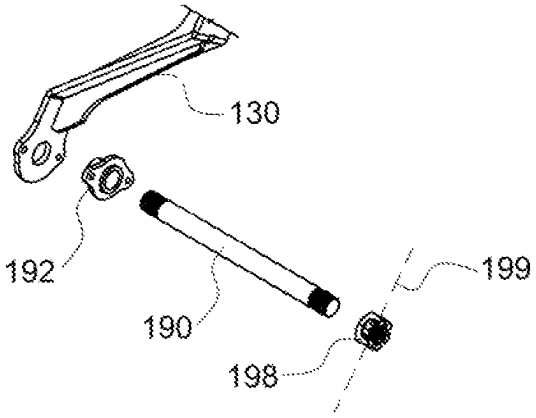


FIG. 18 B

# ROBUST GRABBER ARM FOR REFUSE COLLECTION VEHICLE

## BACKGROUND

Side load refuse collection trucks are widely used in today's society and can be seen operating in many cities, towns and rural areas. These refuse collection trucks include a grabber arm that is located on the curb side of a vehicle, allowing an operator to simply position the vehicle next to refuse containers, and use the grabber arm to retrieve and dump the contents into a refuse collection hopper. While convenient, the grabber arm is a complex device, which typically includes several moving parts and requires maintenance at several locations, including hinge points, connection points, and hydraulic actuators. Although many such systems exist, the durability and maintainability of these mechanisms is a primary concern. Each particular component of the grabber arm can be subjected to severe stresses, especially when the grabber arm is being extended a considerable distance, and is required to carry significant loads. In addition, since the grabber arm is being continuously used throughout any particular operating day and goes through many grabbing cycles, each of the wear points (bearings, pins, bushings, etc.) is subject to considerable wear. Also, refuse collection trucks operate in all types of conditions, often including dirty, muddy, cold, or harsh environments. As such, it is desirable to create a grabber arm that is robust, easily serviceable, and capable of efficiently operating in these conditions.

As mentioned above, serviceability and maintenance of the grabber arm is a primary concern. In many current systems, multiple arm components are coordinating with one another, and access to service points is not always convenient. Typically, such systems are designed in a space saving format, resulting in parts/components being nested with one another, and thus concealing many components. In addition, the type of maintenance required is often unpredictable and varied, thus the ability to remove and/or replace parts is important. This is particularly true for pins, bearings and coupling components. As such, knowledge of known wear points, and consideration of accessibility is a significant concern, and one that has not always been considered in the past.

## SUMMARY

By carefully designing each component of a side load grabber arm with service and maintenance in mind, a grabber system is achieved which is robust, serviceable, efficient, and effective. The grabber arm generally comprises a mounting bracket (which is attachable to a portion of the refuse collection truck), an inner arm, an outer arm, and a grabber mechanism. The inner arm and outer arm are both designed to have two parallel frame members connected by at least one central cross piece. Although using two parallel frame members or beam members necessarily requires the use of additional structures and components, including additional hinge points, bushings, hinge pins and bearings, the resulting structure provides a wider stance, which is very rigid and stable. In addition, each of the hinge points can be positioned or oriented so that they are easily accessible for service purposes. Further, common components, such as common bearings and pins, are utilized throughout the robust grabber arm thus making replacement and service easy and convenience. The grabber mechanism itself is also carefully designed to be driven by a minimum number of hydraulic actuators and thus provides a consistent, repeatable, and robust grabbing motion, which is capable of efficiently handling refuse collection bins.



## BRIEF DESCRIPTION OF THE DRAWINGS

Further details of the various embodiments will be apparent from following description, in conjunction with the drawings, in which:

FIG. **1** is a perspective view of an embodiment of the robust grabber arm;

FIG. **2** is a side view of the robust grabber arm while in the stowed position;

FIG. **3** is a side view of the robust grabber arm while in the extend/pick-up position;

FIG. **4** is a side view of the robust grabber arm while in the dumping position;

FIG. **5** is a perspective view of the robust grabber arm in the stowed position;

FIG. **6** is an exploded view of several components making up the robust grabber arm;

FIG. **7** is a front view of robust grabber;

FIG. **8** is a rear view of the robust grabber;

FIG. **9** is a front view of an outer arm;

FIG. **10** is a first cross-sectional view of the outer arm;

FIG. **11** is a second cross-sectional view of the outer arm;

FIG. **12** is a front view of an inner arm;

FIG. **13** is a first cross-sectional view of the inner arm;

FIG. **14** is a second cross-sectional view of the inner arm;

FIG. **15** is a close-up view of the central hinge point connecting the inner arm with the outer arm;

FIG. **16** is a perspective view of the grabber mechanism;

FIG. **17** is a view of first and second grabber arms which form a portion of grabber mechanism; and

FIGS. **18**A & **18**B are a partial perspective exploded views showing the bearings and easy change links and pins used throughout the robust grabber arm.

## DESCRIPTION

The following detailed description outlines certain features, advantages and characteristics of one embodiment of a robust grabber arm **10** for use as a component of a refuse collection vehicle **16**. Although various references throughout the following detailed description are made to "inner," "outer," "upper," "lower," "front," "back," "first," "second," and other relative terms, it will be understood that these references are relative and are not to be construed as limiting. Additionally, various components can be substituted, replaced or may be identified differently at times throughout this detailed description.

Turning now to FIG. **1**, a perspective view of robust grabber arm **10** is illustrated. As shown, robust grabber arm **10** is in a partially extended position and a related refuse collection vehicle **16** is not shown. As will be discussed in further detail below, when in use robust grabber arm **10** is attached to refuse collection vehicle **16**, it is continuously movable between three primary positions, including a stowed position, a reach (or extended) position, and a dump position.

Generally, robust grabber arm **10** comprises a mounting bracket **20**, which is uniquely configured for attachment to refuse collection vehicle **16**. Robust grabber arm **10** further comprises an inner arm **40**, which is hingedly connected to mounting bracket **20**, an outer arm **60**, which is hingedly attached to inner arm **40**, and a grabber mechanism **90**. As also shown in the figures, inner arm **40** is coupled to

mounting bracket **20** in a manner that allow for rotation about a first axis **21**, while inner arm **40** and outer arm **60** are coupled to one another in a manner to allow rotation about a second axis **41**. Robust grabber arm **10** further includes various components to help control movements and maintain desired alignments. This drive system, or these components, generally comprise a first drive cylinder **110**, a second drive cylinder **120**, a first alignment link **130** and a second alignment link **140**. As will be appreciated, both first drive cylinder **110** and second drive cylinder **120** are hydraulic cylinders which are coupled to hydraulic valves and related components used to control movement. First alignment link **130** and second alignment link **140** are coupled between inner arm **40** and grabber mechanism **90** to maintain desired alignment during operation. In addition, a first central coupling link **150** and a second central coupling link **160** are rotatably attached to outer arm **60** and inner arm **40**, respectively. In this particular embodiment, first coupling link **150** and second coupling link **160** are used to provide an intermediate connection point for one end of second drive cylinder **120**.

As suggested above, grabber mechanism **90** is coupled to an outer end of outer arm **60**. In this embodiment, grabber mechanism **90** generally includes a main grabber bracket **92** utilized to support and accommodate operation of grabber arms **100** and **102** (alternatively referred to as grabber fingers **100** and **102**). Grabber bracket **92** is coupled to outer arm **60** in a manner to allow rotation between these two components about a grabber bracket axis **61**. A third drive cylinder **96** (or grabber cylinder **96**) is part of grabber mechanism **90**, and is utilized to create appropriate movement of grabber arms **100** and **102**. As will be further discussed below, grabber arms **100** and **102** are both rotatably coupled to grabber bracket **92**, and include an internally meshed gear structure **106** to ensure that these two components consistently move in conjunction with one another. Although pins or bearings rotatably coupling first grabber arm **100** and second grabber arm **102** to grabber bracket **92** are accessible, gear structure **106** is hidden or generally shielded by grabber bracket **92**.

In the disclosed embodiment, inner arm **40** and outer arm **60** are specifically designed to form a robust mechanical structure, while also allowing for easy serviceability of components. Referring to FIG. **12**, a front view of inner arm **40** is presented. As shown, inner arm **40** includes a first inner arm beam member **42** and a second inner arm beam member **44** which are generally parallel with one another. At an upper end of both first inner arm beam member **42** and second inner arm beam member **44**, a coupling tube **46** connects these two beam members to one another. In this embodiment coupling tube **46** is a rectangular tube element (sometimes referred to as a box beam). Similarly, first inner arm beam member **42** and second inner arm beam member **44** are rectangular tube elements, each formed of ⅜-inch steel. As will be appreciated, each of these components provide considerable strength and durability.

To illustrate additional details, FIG. **13** provides a first cross-sectional view of inner arm member **40**, while FIG. **14** provides a second cross-sectional view. More specifically, FIG. **14** provides a cross-sectional view along section lines D-D, as shown in FIG. **12**. In a similar manner, FIG. **13** provides a cross-sectional view along the section indicator B-B as shown in FIG. **14**. To provide additional strength and assist in coupling first inner arm beam member **42** and second inner arm beam member **44** to coupling tube **46**, a coupling plate **48** surrounds these elements on one side. A similar coupling plate **49** is utilized on an opposite side. Also attached to coupling tube **46** are a number of attachment ears **50-53**. As will be discussed in further detail below, each of these attachment ears **50-53** accommodate the attachment of additional components to inner arm **40**. In addition, inner arm **40** includes rear attachment flanges **54** and **55** in addition to central attachment flanges **56** and **57**. All of these features contribute to the unique capabilities and robust characteristics of first inner arm beam member **42** and second inner arm beam member **44**.

At a second end of first inner arm beam member **42** and second inner arm beam member **44**, a second attachment structure exists. In this particular embodiment, a number of flanges **86**, **87**, **88** and **89** are attached to first inner arm beam member **42** and second inner arm beam member **44** in a manner to accommodate and support bushings **58** and **59**.

Turning now to FIGS. **9-11**, similar detail regarding outer arm **60** is shown. More specifically, FIG. **9** illustrates a front view of outer arm **60**, which includes a first outer arm I-beam member **62** and a second outer arm I-beam member **64**. As illustrated, a first outer arm I-beam member **62** and second outer are I-beam member **64** are substantially parallel with one another and are configured similarly to provide similar levels of strength and durability throughout. FIG. **10** and FIG. **11** illustrate cross-sectional views of first outer arm I-beam member **62** and show additional detail. Connected between first outer arm I-beam member **62** and second outer arm I-beam member **64** is a coupling tube **66**, which is centrally located and extends substantially perpendicular to each of the I-beam members. In FIG. **10** and FIG. **11**, only first outer I-beam member **62** is illustrated, however, it is understood that second outer arm I-beam member **64** will be configured in the same way.

As best illustrated in FIGS. **9** and **11**, first outer arm I-beam member **62** is configured to have parallel wall members **68** and **69**. These wall members are connected to one another using a central cross member **70** which is uniquely configured and designed to provide support and strength.

As illustrated in FIG. **9**, a bottom portion of outer arm **60** supports a first outer arm bearing **72** and second lower outer arm bearing **73**. At an upper end, a set of primary bearing supports **74**, **75** are provided, along with alignment bearing supports **76** and **77**. As will be discussed in further detail below, these structures are provided to support the rotatable coupling of other components to outer arm **60**. As further illustrated, each of both first outer arm I-beam member **62** and second outer arm I-beam member **64** include a number of relief openings **80** and have an attachment opening **82** configured to receive central coupling tube **66**. These features and the unique design of first outer arm beam member **62** and second outer arm beam member **64** provide a component that is well suited to perform the necessary function, while also being very robust. Further, this provides appropriate separation from other components and easy access to service points. FIG. **10** also illustrates how cross member plate **70** is uniquely shaped to traverse the entire length of first outer I-beam member **62** and is configured to provide strength to desired areas.

As generally discussed above, robust grabber arm **10** is configured to be movable between three primary positions when mounted to a refuse collection vehicle **16**. Referring now to FIGS. **2-4**, these three positions are better illustrated, along with showing the orientation of compounds during operation. As shown when in a stowed position (FIG. **2**), the components of robust grabber arm **10** are positioned to be substantially upright so they can be stowed adjacent to refuse collection truck **16**, so as to avoid interference while

traveling to collection locations. While in the reach position (FIG. **3**), robust grabber arm **10** is configured so it is able to grab refuse containers (not shown) by operating grabber mechanism **90**. Similarly, while in the dump position (FIG. **4**), robust grabber arm **10** is moved so that grabber mechanism has been raised and tilted, thus allowing any contents within a carried refuse container to be dumped into a collection hopper carried by the refuse collection vehicle **16**.

Again, robust grabber arm **10** includes mounting bracket **20** configured to be securely mounted to the frame, body or other supporting structure of refuse collection vehicle **16**. In this embodiment, mounting bracket **20** includes a horizontal support **22**, a first upright plate **24** and a second upright plate **26**. Horizontal support **22** is configured to extend between first upright plate **24** and second upright plate **26** to provide rigidity thereto. In addition, a rectangular coupling tube **28** helps to provide further rigidity, and helps to support other necessary connections. Most significantly, rectangular coupling tube **28** helps to provide further support for an inner arm coupling pin **30**. This additional support is achieved by utilizing a surrounding plate **32** which is securely connected to rectangular coupling tube **28**. A similar second surrounding plate **36** and second inner arm coupling pin **34** exists on an opposite side of mounting bracket **20**. As will be further discussed below, this provides a secure and robust connection structure allowing inner arm member **40** to be rotatably coupled to mounting bracket **20**. In addition, mounting bracket **20** further accommodates a first drive cylinder connecting pin **112** and a second drive cylinder connecting pin **122**, which are used to couple respective portions of first drive member **110** and second drive member **120**.

As generally mentioned above, robust grabber arm **10** includes a grabber mechanism **90** which is uniquely configured to retrieve and dump refuse containers. A detailed perspective view of grabber mechanism **90** is illustrated in FIG. **16**. As shown, grabber mechanism **90** includes grabber bracket **92**, drive mechanism **96**, first grabber arm **100** and second grabber arm **102**. To accommodate connection to other components, and specifically connection to outer arm **60**, first alignment link **130** and second alignment link **140**, grabber bracket **92** includes a primary bushing **94** and a secondary bushing **95**. Both primary bushing **94** and secondary bushing **95** are configured to receive and support related connecting pins. In addition, grabber mechanism **90** includes a front plate **98** which can function as a main contact point when retrieving refuse containers. Front plate **98** may also be configured to support and accommodate the operation of various sensors such a sonar or proximity sensors of various types (not shown).

In the illustrated embodiment, first grabber arm **100** has a first resilient member **104** attached thereto, while second grabber arm **102** also includes a second resilient member **106** attached thereto. In this embodiment, first resilient member **104** and second resilient member **106** are rubber coated fabric strips that can conform to and grab refuse containers. As will be appreciated, each of these components help to grab and contain the refuse container when the grabber arms are moved to surround the outer walls of the refuse container. In operation, drive cylinder **96** will direct movement of first grabber arm **100** and second grabber arm **102**. As seen, first grabber arm **100** is connected to grabber bracket **92** at a hinge point **108**. A similar hinge point **109** exists to support second grabber arm **102**.

As better shown in FIG. **17**, a gear mechanism **106** is included as an integral portion of first grabber arm **100** and second grabber arm **102**, which will cause these two elements to move in unison with one another. The operation of drive mechanism **96** will easily create the desired grabbing motion for first grabber arm **100** and second grabber arm **102**. More specifically, FIG. **17** illustrates a first portion **100'** of first grabber arm **100**, which is rotatably coupled to grabber bracket **92** via a bearing **114** (here, first portion **100'** is configured to support an extension to form first grabber arm **100**). Similarly, a first portion **102'** of second grabber arm **102** is shown as being rotatably coupled to grabber bracket **92** via a bearing **116**. Again, operation of drive mechanism **96** will cause rotation of first grabber arm **100** about hinge point **108** and rotation of second grabber arm **102** about hinge point **109**. In this embodiment, first portion **100'** of first grabber arm **100** has a gear extension **101**, while first portion **102'** of second grabber arm **102** has a related gear extension **103**, with gear extensions **101**, **103** meshing with one another to cause coordinated movement.

Referring again to FIGS. **1**, **5** and **6**, robust grabber arm **10** also includes first alignment link **130** and second alignment link **140**. As indicated, each of these elements are coupled at a first end to inner arm **40**, and at a second end to grabber bracket **92**. Based upon the positioning and configuration of these elements and their relationship with other components, these elements will assist to maintain alignment of grabber mechanism **90** during various stages of operation. The inclusion of first alignment link **130** and second alignment link **140** eliminates the need for additional drive mechanisms to control the positioning of grabber mechanism **90**.

Again, robust grabber arm **10** includes first coupling link **150** and second coupling link **160** which are also uniquely configured to assist in the controlled movement of grabber mechanism **90**. As shown, first coupling link **150** has a central pin **152**, and a pair of connecting tabs **154** and **156**. First coupling link **150** is a unitary element, with coupling tabs **154** and **156** rigidly connected to a main body **151**.

Second coupling link **160** comprises a first coupling plate **162** and a second coupling plate **164**. These coupling plates are configured to support connection to first coupling link **150** via a connection pin **168**. As shown in FIG. **6**, second coupling plate **164** is not present, to allow a better viewing of pin **168**. Pin **168** is aligned and configured to moveably couple first coupling link **150**, second coupling link **160** and second drive cylinder **120** at a central portion of robust grabber **10**.

To better understand the connection of various elements, especially at the central hinge point of robust grabber arm, FIG. **15** provides a partial closeup view of this area. As illustrated, inner arm **40** and outer arm **60** are connected to one another at a central hinge point **200**. First cylinder or first drive mechanism **110** is coupled to rear flange **55** of inner arm **40**, while first alignment link **130** is also connected to inner arm member **40** at an alignment coupling point **204**. Second coupling plate **164** of coupling link **160** is also coupled to inner arm member **40** at the same coupling point **204**. First coupling link **150** is similarly coupled to outer arm member **60** at coupling point **206**. Lastly, second drive mechanism or cylinder **120** is coupled to a pin **168** at a coupling point **208**. As will be appreciated, each of the identified coupling points provide for rotatable coupling, and thus allow for a specific controlled movement.

In the disclosed embodiments, special care is taken to utilize commonly sized connecting pins and heavy duty bearings throughout. As one example, heavy duty 2-inch bearings are used at several locations, such as the central point **200**, the grabber arm hinge points **108**, and the main connection point between mounting bracket **20** and inner arm **40**. In addition, easy change links and pins are utilized

at other locations. As an example of this design approach, FIG. **6** illustrates a plurality of easy change pins **180**, **182** which are selected to be common sizes. In this manner, service is simplified by allowing for common parts. Similar commonality is achieved by utilizing common sizes for bearings and bushings.

As will be apparent from the drawings, each of the service locations are easily accessible, which will allow for removal and/or maintenance of bearings, links and pins, as necessary. The arrangement of service locations and various components is best illustrated in FIGS. **2-4**, which present side views of robust grabber arm **10** in various positions. While in the stored position, hinge points **200**, **202**, **204** and **206** are all easily accessible for service operations. In addition, grabber hinge points **210** and **212** are also accessible from the side. In addition, when moved to an intermediate position, slightly away from refuse collection vehicle **16** (i.e. in the position shown in FIG. **1**), pins **112** and **122** (used for connection to housing bracket **20**) are also easily accessible. Based upon this configuration, it will be fairly straightforward for service personnel to access these positions, and replace or service any pins or bearings needing attention.

As previously mentioned, robust grabber **10** makes use of common sized easy change pins wherever possible. FIGS. **18**A &**18**B illustrate examples of these components. FIG. **18**A presents a perspective view of a first pin **180**, which in this embodiment is used to couple first alignment link **130** with inner arm **40**. In this embodiment, first pin **180** is threaded at both ends, and has a stepped diameter. A lower stepped portion **182** is configured to support and cooperate with a bearing **186**, while a larger portion **184** is configured to interact with an internal bushing within inner arm **40**. A slotted nut **188** is configured to thread onto a threaded end of first pin **180**, and a related locking pin **189** is used to lock the slotted nut **188** in place. Threaded end of first pin **180** has a hole configured to receive a locking pin **189**, and slots provided in slotted nut **188** will be aligned to contain locking pin **189**. As will be appreciated, this structure allows first pin **180** to be securely held in place, but also easily replaceable.

In a similar manner, FIG. **18**B shows second pin **190**, which is used to couple first alignment link **130** with grabber bracket **92**. Here, second pin **190** is threaded at both ends, and is configured to cooperate with a lower bearing **192**, which will be attached to a lower end of first alignment link **130**. Again, a slotted nut **198** is used to hold second pin **190** in place. A locking pin **199** is again used to hold slotted nut **198** in place, configured to be inserted into a hole in second pin **190**, an be positioned within a slot of slotted nut **198**.

Various embodiments of the invention have been described above for purposes of illustrating the details thereof and to enable one of ordinary skill in the art to make and use the invention. The details and features of the disclosed embodiment[s] are not intended to be limiting, as many variations and modifications will be readily apparent to those of skill in the art. Accordingly, the scope of the present disclosure is intended to be interpreted broadly and to include all variations and modifications coming within the scope and spirit of the appended claims and their legal equivalents.

The invention claimed is:

**1**. A robust grabber arm for retrieving refuse collection containers and dumping contents into a collection hopper of a refuse collection vehicle, comprising:

an inner arm having a first end and a second end, wherein the first end is rotatably coupled to the refuse collection vehicle using a plurality of first bearings and is rotatable about a first axis, the inner arm comprising a pair of substantially parallel inner arm beam members situated substantially perpendicular to the first axis and coupled to one another by at least one inner arm cross member, the inner arm beam members further comprising a plurality of attachment ears situated at the second end;

an outer arm having a first end and a second end, wherein the first end of the outer arm is rotatably coupled to the plurality of attachment ears using a plurality of second bearings, with the outer arm and the inner arm being rotatable with respect to one another along a second axis which is not in line with the substantially parallel inner arm beam members, wherein the first axis and the second axis are substantially parallel with one another, the outer arm comprising a pair of substantially parallel outer arm beam members separated from one another while also coupled to one another by at least one outer arm cross member positioned at a predetermined location between the first end and the second end;

a grabber mechanism coupled to the second end of the outer arm via a plurality of third bearings, the grabber mechanism configured to grab and carry a refuse container; and

a drive system configured to selectively cause rotation of the inner arm about the first axis, rotation of the inner arm and the outer arm with respect to one another about the second axis, and movement of the grabber mechanism;

wherein the plurality of first bearings, the plurality of second bearings and the plurality of third bearings are all configured to be interchangeable.

**2**. The robust grabber arm of claim **1** wherein the grabber mechanism comprises a grabber bracket coupled to the outer arm at the second end thereof, the grabber bracket supporting a first grabber finger and a second grabber finger which are movable between an open position and a grabbing position.

**3**. The robust grabber arm of claim **2** further comprising an alignment link coupled to the inner arm and the grabber bracket, thus causing the grabber bracket to be maintained in a predetermined orientation with respect to the refuse collection vehicle.

**4**. The robust grabber arm of claim **3** wherein the inner arm is rotatably coupled to the refuse collection vehicle via a supporting bracket which is coupled to a predetermined location of the refuse collection vehicle.

**5**. The robust grabber arm of claim **4** wherein the drive system comprises:

a first drive mechanism coupled to the refuse collection vehicle and the inner arm, wherein driving the first drive mechanism causes rotation of the inner arm about the first axis;

a second drive mechanism coupled to the refuse collection vehicle and the outer arm, wherein driving the second drive mechanism will cause rotation about the second axis; and

a grabber drive coupled to the grabber bracket and at least one of the first grabber finger or the second grabber finger, wherein actuation of the grabber drive will cause movement of the first grabber finger and the second grabber finger between the open position and the grabbing position.

**6**. The robust grabber arm of claim **5** further comprising:

a pair of main link bearings positioned in line with the second axis coupling the inner arm and outer arm, and

a drive link having a first connection portion rotatably coupled proximate the first end of the inner arm and at

a second connection portion rotatably coupled proximate the first end of the outer arm, with the first connection portion and the second connection portion coupled to one another at a central coupling point, and the second drive mechanism coupled to the drive link at the central coupling point, wherein each of the main link bearings and the central coupling points are accessible from either a first side or a second side of the robust grabber arm.

**7**. The robust grabber arm of claim **6** wherein the plurality of first bearings are aligned with the first axis, wherein the plurality of first bearings and the pair of main link bearings are interchangable.

**8**. The robust grabber arm of claim **4** wherein the inner arm parallel beam members and the inner arm cross member are aligned in an inner arm plane which contains the first axis, and wherein each of the inner arm beam members have a flange extending laterally away from the inner arm beam members at the second end in a direction which is not within the inner arm plane, and wherein the flanges are coupled to the outer arm thereby causing the second axis to be located parallel with but not within the inner arm plane.

**9**. The robust grabber arm of claim **3** wherein the inner arm beam members are box beams, and the at least one inner arm cross member is a box beam coupled proximate the second end and is substantially perpendicular to the inner arm beam members, and wherein each of the pair of outer arm beam members are I-beams comprising a pair of upright walls and a cross wall extending between the upright walls, and wherein the at least one outer arm cross member is a tube extending between the I-beams and is connected to each of the upright walls.

**10**. The robust grabber arm of claim **9** wherein the second axis is positioned at a first predetermined location of the inner arm and the alignment link is coupled to one of the inner arm beam members at a second predetermined location, wherein the first predetermined location and the second predetermined location are adjacent one another and are accessible when the robust grabber arm is in a stowed position and when the robust grabber arm is in an extended position.

**11**. The robust grabber arm of claim **3** wherein the alignment link is coupled to the grabber mechanism and the inner arm via a plurality of easy change pins.

**12**. The robust grabber arm of claim **1** wherein the drive system comprises:

a first drive mechanism coupled to the refuse collection vehicle and the inner arm, wherein driving the first drive mechanism causes rotation of the inner arm about the first axis; and

a second drive mechanism coupled to the refuse collection vehicle and the outer arm, wherein driving the second drive mechanism will cause rotation about the second axis.

**13**. The robust grabber arm of claim **1** wherein neither the at least one inner arm cross member nor the at least one outer arm cross member are in line with the first axis or the second axis.

**14**. The robust grabber arm of claim **1** wherein the inner arm beam members are box beams, and the at least one inner arm cross member is a box beam coupled proximate the second end and is substantially perpendicular to the inner arm beam members, and wherein each of the pair of outer arm beam members are I-beams comprising a pair of upright walls and a cross wall extending between the upright walls, and wherein the at least one outer arm cross member is a tube extending between the I-beams and is connected to each of the upright walls.

**15**. The robust grabber arm of claim **1** wherein the grabber mechanism comprises:

a grabber bracket coupled to the second end of the outer arm and an alignment link;

a first grabber finger rotabaly coupled to the grabber bracket by a first grabber finger attachment bearing;

a second grabber finger rotabaly coupled to the grabber bracket by a second grabber finger attachment bearing and movably coupled to the first grabber finger; and

a drive mechanism coupled to the grabber bracket and the first grabber finger such that actuation of the drive mechanism causes movement of the first grabber finger and the second grabber finger.

**16**. The robust grabber arm of claim **15** wherein the first grabber finger attachment bearing and the second grabber finger attachment bearing are interchangeable with on another, and interchangeable with the pair of bracket attachment bearings and the pair of main link bearings.

**17**. The robust grabber arm of claim **15** wherein the alignment link is coupled to the grabber mechanism and the inner arm via a plurality of easy change pins.

**18**. A refuse collection vehicle, comprising:

a frame supporting a refuse collection body; and

a robust grabber arm coupled to the frame, the robust grabber arm comprising:

an inner arm having a first end and a second end, wherein the first end is coupled to the frame in a manner to allow rotation about a first axis, the inner arm comprising a pair of inner arm beam members and a connecting inner arm cross member coupled to each of the pair of inner arm beam members to provide rigidity to the inner arm, the inner arm further having a plurality of flanges extending from the second end in a direction that is not in line with the pair of inner arm beam members;

an outer arm having a first end and a second end, wherein the first end is coupled to the plurality of flanges extending from second end of the inner arm in a manner to allow rotation about a second axis which is substantially parallel with the first axis and which is positioned to extend through the plurality of flanges, the outer arm comprising a pair of outer arm beam members and an outer arm cross member coupled between each of the pair of outer arm beam members at a coupling location between the first end and the second end to provide rigidity to the outer arm;

a grabber mechanism rotatably coupled to the outer arm at the second end thereof, the grabber mechanism configured to grab and hold a refuse collection container; and

a drive system configured to cause movement of the inner arm, the outer arm and the grabber mechanism so as to cause grabbing of the refuse collection container by the grabber mechanism and movement of the refuse collection container from a ground position adjacent to the refuse collection vehicle to a dumping position above the refuse collection body thereby causing any refuse contained within the refuse collection container to be emptied into the refuse collection body;

wherein the rotatable coupling of the inner arm to the frame, the rotatable coupling of the inner arm to the outer arm and the rotatable coupling of the grabber

mechanism to the outer arm is achieved using bearings which are interchangeable with one another and which can be easily replaced.

**19**. The refuse collection vehicle of claim **18** wherein the inner arm is coupled to the frame via a mounting bracket, wherein the mounting bracket comprises a horizontal support configured to be coupled to the frame of the refuse collection vehicle and a pair of uprights plates configured to accommodate the rotatable coupling of the inner arm.

**20**. The refuse collection vehicle of claim **19** wherein the pair of inner arm beams members are substantially parallel with one another, and wherein the inner arm cross member is positioned at a location which is not aligned with the first axis or the second axis.

**21**. The refuse collection vehicle of claim **19** wherein the outer arm beams members are substantially parallel with one another, and wherein the outer arm cross member is not aligned with the second axis.

**22**. The refuse collection vehicle of claim **19** wherein the robust grabber arm further comprises:

a first drive mechanism coupled to the mounting bracket and the inner arm, wherein driving the first drive mechanism causes rotation of the inner arm about the first axis; and

a second drive mechanism coupled to the mounting bracket and the outer arm, wherein driving the second drive mechanism will cause rotation about the second axis.

**23**. The refuse collection vehicle of claim **22** wherein the robust grabber arm further comprises:

a drive link having a first connection portion rotatably coupled proximate the first end of the inner arm and at a second connection portion rotatably coupled proximate the first end of the outer arm, with the first connection portion and the second connection portion coupled to one another at a central coupling point, wherein the second drive mechanism is coupled to the drive link at the central coupling point, and wherein the central coupling points is accessible from either a first side or a second side of the robust grabber arm.

**24**. The refuse collection vehicle of claim **23** wherein the inner arm and the outer arm are rotatably coupled to one another via a pair of main link bearings positioned in line with the second axis, and wherein each of the main link bearings are accessible from either a first side or a second side of the robust grabber arm.

**25**. The refuse collection vehicle of claim **18** wherein the grabber mechanism comprises:

a grabber bracket rotatably coupled to the second end of the outer arm; and

a container holding system configured to grab and hold a refuse collection container.

**26**. The refuse collection vehicle of claim **25**, wherein the container holding system comprises a first grabber finger rotabaly coupled to the grabber bracket by a first grabber arm attachment bearing and a second grabber finger rotabaly coupled to the grabber bracket by a second grabber arm attachment bearing, wherein the first grabber finger and the second grabber finger are movably coupled to one another so as to cause the first grabber finger and the second grabber finger to move together in a predetermined manner.

**27**. The refuse collection vehicle of claim **26** wherein the robust grabber arm further comprises a grabber drive mechanism coupled to the grabber bracket and the container holding system such that actuation of the drive mechanism causes movement of the first grabber finger and the second grabber finger.

**28**. The refuse collection vehicle of claim **25** wherein the robust grabber arm further comprises an alignment link coupled to the grabber bracket and the inner arm in a manner to maintain a predetermined alignment of the grabber bracket as the robust grabber arm moves between a stowed position, a grabbing position and a dumping position.

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