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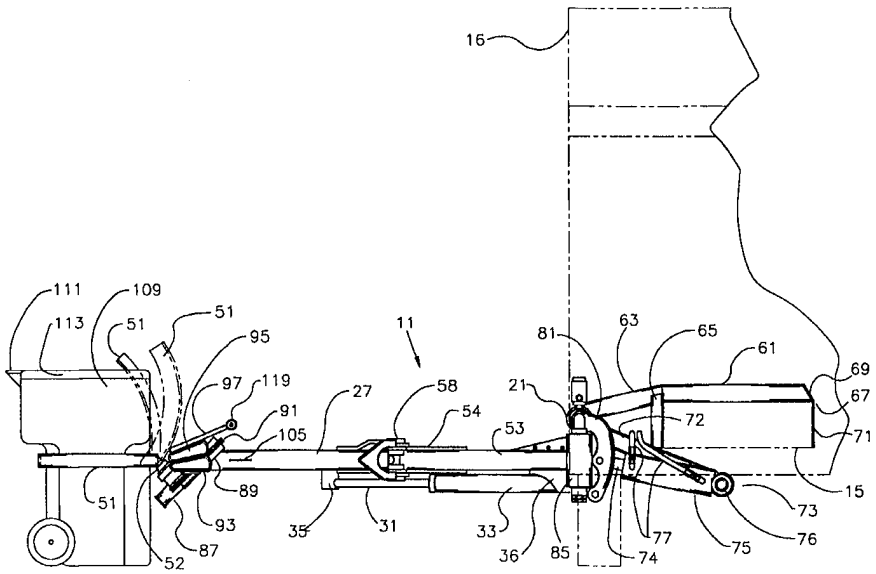

(57) Abstract

The manipulator arm (11) of the present invention mounts over and under a pair of beam shaped chassis members (15) in a vehicle, which typically extend rearwardly of a cab (13). The manipulator arm (11) is carried to the side of a waste collection vehicle and underneath the vehicle's waste collection bin (16). The actuation of the arm (11) is by a first control which extends the arm (11), a second control which induces a pair of grabber arms to swing down at a 45° angle to grasp the individual waste bin (109), and a third control to angularly and pivotally raise the extended arm (11) to and perhaps beyond a vertical position to dump the individual waste container (109) from a position over the vehicle's waste collection bin (16). The third control is limited by a pair of cam operated limit valves (17, 19) which cause the individual waste bin (109) to be slowed during its travel.

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WASTE BIN MANIPULATOR ARM

Field of the Invention

The present invention relates to an improved, simple construction, three control, self velocity limiting manipulator for grasping and dumping refuse containers which is extremely compact, simple to use, and can be installed as a retro-fit on any vehicle.

Background of the Invention

Currently many different shapes and configurations of waste bin manipulators are available, and especially as are customized to operate with a similar wide variety of waste collection vehicles. The most commonly used device is a chain lift device operating from a waste collection vehicle which carries an outwardly actuatable bottom portion. The waste collection vehicle operator must carefully drive, if possible, to approach an individual refuse bin closely and stopping at the correct position as the driver actuates the bottom of the lift device to come near the refuse bin. A wide pair of arms are carried in the wide open position and are actuated to the closed position once the bottom of the lift device is near the refuse bin. The grasping arms swing shut in the horizontal plane and once closed on the individual waste bin it is

lifted to the upper terminus of its travel where it is tilted to dump the refuse into the waste collection vehicle. If the dump is not sufficient, the operator re-operates the device to try to slam the refuse bin into giving up the trapped refuse. Once the bin is sufficiently dumped, it is quickly returned to the ground, typically with a crash in order to minimize the time spent in the operation.

Where the refuse bin is mishandled or roughly handled it will break and need replacement. Most refuse bins are made of high impact plastic, but over time and with exposure to the elements, the plastic hardens and can easily shatter if roughly treated. The cost of replacement is ultimately borne by the resident taxpayer either directly or through government replacement of the individual waste bins through the tax system.

Where the operator of the waste collection vehicle can, he will seek to rush as quickly as possible to release the refuse container. If he has any type of control over the speed of the operation or the timing of the release of the containers or it will virtually always be manipulated to save time.

In addition, most conventional equipment may have many controls. Operation of a high number of controls slows the process and adds to the cost of the unit, and to the time which is required to manipulate the refuse bin. In addition, with many conventional waste collection vehicle units, the manipulation and positioning of the truck can be considered to be a part of the manipulation where the truck has to be edged closer and closer to a waste

bin, especially where restrictions are present. This is usually required where there are obstructions around the waste bin, and most conventional manipulators are limited in the amount of lateral displacement which can be achieved in order to grasp the waste bin. In many cases, adjacent cars and other obstructions force the waste collection vehicle operator to either skip the difficult to reach bin, or to stop, leave the cab of the waste collection vehicle and physically move the waste container to within range of the waste collection vehicle's manipulator device.

What is therefore needed is a compact manipulator device which has safety features to protect waste containers in their handling. The needed device should be universally fittable on a wide variety of vehicles regardless of waste collection bin size or available mounting space. The movement and configuration should operate with minimum wasted motion and have the ability to grasp waste bins located a considerable distance from the waste collection vehicle.

What is also needed is a manipulator system which can be used as a retrofit device to attach to older waste recovery vehicles to replace the worn-out custom supplied manipulator supplied with the vehicle, or to use as an attachment to a non waste recovery vehicle to add the capability of manipulative waste bin loading. The manipulator system will also be sufficiently compact as to enable the design of a waste recovery vehicle having an enlarged refuse storage area, for more efficient waste collection

and requiring less frequent dumping trips.

Summary of the Invention

The manipulator arm of the present invention mounts over and under a pair of beam shaped chassis members in a vehicle, which typically extend rearwardly of a cab. The manipulator arm is carried to the side of a waste collection vehicle and underneath the vehicle's waste collection bin. The actuation of the arm is by a first control which extends the arm, a second control which induces a pair of grabber arms to swing down at a 45° angle to grasp the individual waste bin, and a third control to angularly and pivotally raise the extended arm to and perhaps beyond a vertical position to dump the individual waste container from a position over the vehicles waste collection bin. The third control is limited by a pair of cam operated limit valves which cause the individual wast bin to be slowed during its maximum height of travel and especially slowed during its return to the ground to provide reduced noise handling and long life for the individual waste bins.

Brief Description of the Drawings

The invention, its configuration, construction, and operation will be best further described in the following detailed description, taken in conjunction with the accompanying drawings in which:

Figure 1 is a side view of the manipulator of the present invention

mounted on a vehicle and in retracted position;

Figure 2 is a view taken along line 2 - 2 horizontally along the manipulator of Figure 1, also in retracted position;

Figure 3 is a top view of the manipulator shown in Figures 1 & 2 in retracted position;

Figure 4 is a view similar to that of Figure 2, but illustrating the manipulator in extended position approaching an individual refuse container, and with the grasping arms shown in their upright and intermediate positions in phantom and in their final position surrounding the refuse container;

Figure 5 is a top view of the manipulator of Figure 4, and again grasping the refuse container;

Figure 6 is a bottom view of the manipulator of Figure 5 before actuation of the lift cylinder;

Figure 7 is a bottom view of the extended portion manipulator of Figure 6, and looking into the side of a refuse collection vehicle, with the lift cylinder fully extended;

Figure 8 is a side view of the extended portion of the manipulator of Figure 7 and looking from a position from the front of a refuse collection vehicle, and illustrating the refuse bin in full vertical extension;

Figure 9 is a front view of the manipulator similar to that of Figure 8 and illustrating the engagement of an automatic dumping lever on the side of a container shown in phantom;

Figure 10 is an exploded view of the hardware of the base support which is attached to the chassis of a waste collection vehicle;

Figure 11 is an exploded view of the hardware of the structural portions of the manipulator arm;

Figure 12 is a side sectional view of the angle support upon which the manipulator swings vertically and horizontally and illustrating the cam actuated limiting valves which operate on the manipulator during lift actuation;

Figure 13 is a side view taken along line 13 - 13 of Figure 12 and showing the cam valve engaged;

Figure 14 is an expanded view of the components of a vertical and horizontal hinge from which the manipulator of the invention pivots;

Figure 15 is a rear view of the back, or non engaging side of the grasping mechanism and illustrating the symmetrical chain mechanism and partial view of the actuation cylinder;

Figure 16 is a view of the symmetrical chain mechanism and its actuation cylinder in the retracted position and illustrating a pair of sprockets which are connected to the cylinder with a chain;

Figure 17 is a view of the symmetrical chain mechanism as in Figure 16 and with the actuation cylinder is in the extended position;

Figure 18 is a side view of the symmetrical chain mechanism as in Figures 16 - 17, and illustrating the use of two separate chains on each side

of the mechanism;

Figure 19 is a rearward looking view along the chassis of the vehicle of claim 1 and illustrating a variation in the mounting of the manipulator which facilitates its easy removal;

Figure 20 is a sectional view taken along lines 20 & 21 of Figure 19 and which illustrate interfitting channels which facilitate easy removal and illustrating a locking pin in place;

Figure 21 is a sectional view similar to that of Figure 20, with the locking pin removed and with the interfitting channels partially displaced;

Figure 22 is a top view looking down on the portions of the vehicle 13 which were seen in Figures 19 - 21;

Figure 23 is a bottom view looking upward of the same portion of the manipulator base as was seen in Figure 22;

Figure 24 is a second embodiment of the actuation structures useful with the manipulator 11 of the present invention, and in which the piston is operated longitudinally, in a direction parallel to the length of the vehicle;

Figure 25 is a view of the underside of the actuation structures seen in Figure 24 and illustrating a double-figure eight arrangement where a single length of chain may be used with a moving sprocket to actuate the rotation members, which are shown in the closed position, actuator piston extended;

Figure 26 is a view of the underside of the actuation structures similar to that seen in Figure 25 and wherein actuate the rotation members, which

are shown in the open position, actuator piston retracted; and

Figure 27 illustrates a perspective view of a further embodiment of a mounting bracket using a plate-to-plate engagement with bolted or welded attachment between the bracket and vehicle frame to which it is affixed, for bolted attachment and detachment .

Detailed Description of the Preferred Embodiment

The description and operation of the invention will be best described with reference to Figure 1. Figure 1 illustrates a manipulator 11 shown within the context of a vehicle 13 (shown in phantom), the vehicle 13 having a rearwardly extending frame 15 from which the manipulator 13 depends from support. Typically, the vehicle 13 will be a waste collection vehicle and will also have some larger refuse collection body or container 16 lying over the frame 15. Part of the utility of the manipulator 11 is its ability to rest to the side of, beneath and out of the way of any such larger refuse collection body, regardless of the shape or orientation of the container 16.

The details of the attachment to the frame 15 are obscured by a pair of mechanically activated hydraulic flow restrictors 17 and 19 which operate by cam action. Restrictors 17 and 19 sit atop a horizontal hinge 21 supporting an angled hinge member 23.

A triangular structural enhancement 25 is located above the top of a first extension member, not seen in Figure 1. A second extension member 27 pivots from the first extension member (not seen) by a pivot joint 29.

Below the second extension member 27 a cylinder rod 31 extends from a hydraulic cylinder 33 and pivotally engages the second extension member 27 at a pivot 35. The cylinder 33 is partially hidden behind a plate 36. The other end of the cylinder 33 is supported at the base of the manipulator 11. A strut 37 is seen which extends to engage a pivot 39 which pivots the strut 37 with respect to an extension plate 41. The strut 37 acts with the cylinder rod 31 and hydraulic cylinder 33 to cause the manipulator 11 to extend upon actuation of the cylinder 33 rather than cause the second extension member 27 to simply fold out to the side.

At the end of the second extension member 27, actuation structures 45 are supported. The actuation structures 45 include a symmetrical rotation support 47 which support a first symmetrical rotation member 49 and a second symmetrical rotation member 50. Each of the members 49 and 50 consists of an elongate curved portion 51 for grasping a refuse container, and terminate in shaft portion 52 for rotatable engagement with the symmetrical rotation support 47.

An expanded portion of the pivot 29 is shown in which the second extension member 27 is seen engaging the endmost portion of a first extension member 53 at the end of the second extension member 27. The plate 36 is part of the first extension member 53 near the point where it attaches for pivoting movement. A vertical pivot shaft 55 lies within a pair of spaced apart bearings 57. A set of upper and lower end caps 58 act to

both seal and hold the shaft 55 and bearings 57 in place.

Referring to Figure 2, a frontal view taken along line 2 - 2 of Figure 1, show the flow restrictors 19 as a point of reference, and again shows the manipulator 11 in its un-deployed, or traveling position. An upper support structure 59 can be seen as having vertical depth as one method of achieving the strength necessary to support the weight of the remainder of the manipulator 11, and as will be shown is tubular in shape. Extending downward from the junction of an upper surface 61 is a sloped surface 63 of the upper support structure 59, and an angle brace 65 which is welded to the sloped surface 63 and also bolted to the frame 15, shown in phantom. At the right side of the upper surface 61 and extending downwardly is an angled end cap 67 which has an upper portion 69 welded to and covering the end of the tubular upper support structure 59, and a lower portion 71 which is bolted to the frame 15.

Figure 2 also illustrates a lower support arm 72 having a lower end 73 from which one end of a hydraulic lifting cylinder 75 pivots and depends by connection with a bolt 76. The cylinder 75 is seen connected to a pair of hydraulic lines 77, which would normally be serially connected through the hydraulic flow restrictors 17 and 19 both of which are seen in Figure 1. A hydraulic piston rod 79 is partially seen.

The end of hydraulic piston rod 79 extending from the cylinder 75 is pivotally connected to a lift fitting 81 made up of a pair of spaced apart

plates. The lift fitting which has a top-heavy "3" side profile shape as seen in Figure 2. Extension of the piston rod 79 from the cylinder 75 will cause the lift fitting 81 to angularly rotate about a pivot point within the horizontal hinge 21 which was seen in Figure 1. A corresponding vertical hinge 85 can be seen just below and to the left of fitting 81, and is partially accommodated and surrounded by the plates of fitting 81.

Further details of the actuation structures 45 can be seen as including a grabber actuator piston 87 shown displaced downwardly and to the left of a grabber actuator cylinder 89. A portion of an actuator chain 91 is seen lying along the side of the cylinder 89, as well as a short actuator chain 92 which cooperates with actuator chain 91. The actuator chains 91 and 92 cooperate with a mirror image of chain structures on the other side of the cylinder 89 to cause simultaneous activation of the shaft portions 45.

A pair of impact bladders including a lower bladder 93 and an upper bladder 95 are seen. Upper bladder 95 has an shaker arm 97 which is attached to a plate (not immediately seen) which abuts one side of the upper bladder 95. As will be seen, when the manipulator 11 is in position to dump, the shaker arm 97 will strike or bear against the side of the vehicle causing a refuse bin to shake, in order to remove as much refuse from the container as possible.

Referring to Figure 3, a top view of the manipulator 11 is seen. A better view of first extension member 53 is seen, and the hydraulic

cylinder 33 which actuates extension of the second extension member 29 is partially seen between the first extension member 51 and the second extension member 29. Near the point of connection of the first extension member 53 to the second extension member 27, the extension plate 41 is better seen. The extension plate 41 connects the pivot 39 of the strut 37 with the pivoting action of the vertical pivot shaft 55. Without the strut 37 and plate 41, actuation of the hydraulic cylinder 33 to extend the cylinder rod 31 would simply cause the second extension member to fold about the vertical pivot shaft 55, and the actuation structures 45 would arc to a position rearward of the vehicle 13. The strut 37 causes the second extension member to extend directly away from the vehicle 13, as will be shown.

Also seen in Figure 3 attached to the second extension member 27 is an extension dog 105 of a safety latch having an aperture 107. This enables the manipulator 11 to be locked in place, into a closed position for long travel periods.

Extension of the manipulator 11 is shown in Figure 4, and which is taken generally from the same perspective as was seen in Figure 2. A refuse bin 109 lies at the far left of Figure 4. As the hydraulic cylinder 33 is actuated to push cylinder rod 31 outward, the actuation structures 45 remain oriented away from the vehicle 13 due to an internal parallel maintenance link (not seen in Figure 4) and which will be later described. As such, it makes no difference whether the bin 109 is 3 feet away or located the full

combined distance of both the first and second extensions members 53 and 27, the actuation structures 45 will always be in position to grasp the bin 109.

The bin 109 typically has a hinge 111 to pivot a lid 113. The bin 109 is shown with the hinge 111 oriented away from the manipulator 11. Because the manipulator 11 uses a grasping motion to make its engagement with the bin 109, the orientation of the bin 109 is unimportant. Most two wheel bins have a lift bar at the front which must be engaged in order to properly and safely lift it. The manipulator 11 can lift any type of bin 109 and in any orientation, regardless of the presence of a lift bar. Note that the elongate curved portions 51 swing out and down around the bin 109 as is shown in phantom. Rotation of the curved portions 51 is along the 45° mounting of the axis of the shaft portions 52.

Referring to Figure 5, a top view of the manipulator 11 in substantially the same position as was shown in Figure 4 is also shown without the presence of the mechanically activated hydraulic flow restrictors 17 and 19, for clarity. Other features can be seen including a connector plate 117 which links the shaker arm 97 to the upper bladder 95. Additionally seen is a wheel 119 attached to the end of the shaker arm 97 to enable it to be rollably urged against the vehicle 13, rather than scratching against the side. In addition, the upper and lower bladders 95 and 93 help cushion any striking motion of

the shaker arm 97 against the vehicle 13 for smoother, quieter operation.

Referring to Figure 6, a bottom view of the manipulator 11 gives a clearer view of the grabber actuator cylinder 89 and illustrates a pair of lower grabber sprockets 121 which are connected immediately adjacent the ends of to the shaft portions 52. Grabber actuator cylinder 89 movement, from hydraulic fluid lines 123, causes the chains 91 and 92 to turn the grabber sprockets, one pair of which are grabber sprockets 121 and bring the elongate curved portions 51 around the bin 109 simultaneously.

Also seen is an angled portion 125 which provides a pivot 127 for the strut 37 to pivot. The angled portion 125 is attached to move with the fitting 81 to enable all of the structures connected with the first and second extension members 53 and 27 and the strut 37 to move upwardly operate as a unit. A base plate portion 128 is seen which is adjacent to plate 36 and which forms a structure from which the cylinder 33 pivots about a pivot 129.

Referring to Figure 7, a view similar to the view of Figure 1 shows the next sequence of action after the bin 109 of Figures 5 and 6 is grasped. The extended articulating portion of the manipulator 11, brings the bin 109 straight upward in an arcing motion, pivoting about the horizontal hinge 21. This is accomplished by actuation of the hydraulic lifting cylinder 75 which brings the first and second extension members 53 and 27 to a vertical position with the bin 109 firmly held by the actuation structures.

Referring to Figure 8, a view from the front of the vehicle as the bin

109 approaches the larger refuse bin 16. The wheel 119 of the shaker arm 97 approaches the side of the larger refuse bin 16 to provide leverage to tilt the bin 109. The lid 113 will not normally open until the bin 109 is in a horizontal position.

Referring to Figure 9, the bin 109 is tilted as the shaker arm 97 is pressed by the pressure of the wheel 119. Note that the bin 109 is tilted beyond the horizontal plane. If refuse is stuck within the bin 109, the extended portion of the manipulator 11, including first and second extension members 53 an 27 can be cyclicly actuated to the left and right between the positions of Figure 8 and 9, in order to loosen the refuse and eventually dump it into the larger refuse bin 16.

Referring to Figure 10, an exploded view of the portions of the manipulator 11 adjacent the frame 15 are illustrated and further details revealed. As can be seen, the angle braces 65, and angled end cap 67 is bolted to the to the frame 15. The bolt 76 is seen along with a securing nut 131. The bolt 76 enables a circular fitting 133 at the end of the hydraulic lift cylinder 75. The end of the hydraulic piston rod 79 has a similar circular fitting 135.

As can also be seen, the lower arm support is also a tubular structure having a lower cylindrical surface 137 for fitting against a portion of the bolt 76, and an upper cylindrical surface 139 for fitting against a portion of the horizontal hinge 21. Sloped surface 63 also terminates in a cylindrical

surface 139 and when the upper support structure 59 is brought into place with respect to the lower support arm 72, the cylindrical surface 139 is continuous between the two members to enable space accommodation and fit for the horizontal hinge 21. A "U" shaped reinforcement member 140 is tack welded to the side of the lower support arm 72 it help support the bolt 76.

The angled portion 125 is seen as an "L" shaped fitting which will fit around the angled hinge member at the side of the horizontal hinge 21 opposite the lift fitting 81 in order to provide a balanced support to the pivot 127 which will support the strut 101. The angled portion 125 has a horizontal base portion 141 connected to a horizontal portion 143, the horizontal portion 143 having a circular aperture 145 to accommodate the angled hinge member 23. An edge 147 of the base member is attached to cooperate with the lift fitting 81.

At the upper and left side of the Figure 10, the vertical hinge 85, hinge member 23 and horizontal hinge 21 are shown in exploded fashion and illustrates the bearing and camming surfaces members which are assembled to make the manipulator 11 work quietly and smoothly over a large number of cycles. The parts which comprise the internal workings of the hinges 21 and 85 enable quick and inexpensive manufacturing.

First, angled hinge member 23 is made of an angled length of bar stock of about 2.5 inches in diameter. The hinge member has an "L" shape, of 90°

and includes a horizontal leg 151 and a vertical leg 153. The horizontal leg 151 has an end area 155 which is about three inches long, measured from the tip end of the horizontal leg 151. This three inch long end area 155 is machined down into a slightly smaller diameter and two of the three inches nearest the tip end of the end area 155 carries a 2.25 inch thread. Again, the 2.25 inch thread is about 2.0 inches deep to insure a good hold. The angled hinge member has to withstand a tremendous amount of stress force.

Similarly, the vertical leg 153 has an end area 157 which matches the end area 155 of horizontal leg 151.

Beginning at the lower left of Figure 10, the parts shown include an outer locking nut 161, an inner locking nut 163, a spacer member 165, a washer 167, and a beveled bearing 169. The beveled bearing 169 has a series of preferably cylindrical bearings for maximum distribution of the load. The beveled bearing 169 will also have an inner portion which engages the outer part of the vertical leg 153 against which it will bear. Above the beveled bearing 169 is a conical race ring 171. The use of a machined race ring 171 prevents the need for forming a race surface on the inside of the vertical hinge 85 and allows for the provision of a much harder race surface. The inside of the vertical hinge 85 need only be machined for a concentric step matching the race ring 171.

Above the vertical hinge 85, a matching set of structures, including conical race ring 171, beveled bearing 169, and washer 167 is seen. Above

the washer 167 is a vertical elbow spacer 173 for displacing the vertical hinge 85, and the structures within it, downward slightly, otherwise the washer 167 below the vertical elbow spacer 173 would come all the way up to an inside elbow 175 of the angled hinge member 23. The vertical elbow spacer 173 thus prevents interference with structures on the horizontal leg 151, and prevents the washer 167 fro rubbing directly on the horizontal leg 151. With proper spacing, the inner and outer lock nuts 161 and 163 can be heavily tightened to insure that the vertical hinge 85 assembly will remain in place.

To the right of the horizontal leg 151 is pictured a horizontal camming elbow spacer 177. The interaction between the horizontal camming elbow spacer 177 and the vertical elbow spacer 173 is a meeting bearing relationship as pictured in the drawings. If one of the spacers 173 and 177 is allowed to reach the inside elbow 175, the other of the spacers 173 and 177 would be blocked. This can be remedied by providing a stop at the inside elbow 175 or by providing other structures or keyed surfaces to insure proper placement. Horizontal camming elbow spacer 177 will be jammed against, and move with the angled hinge member 23.

The horizontal camming elbow spacer 177 has a surface which provides a concentric rise or dip for at least one portion of its circularity. It operates in conjunction with the mechanically activated hydraulic flow restrictor 19. When the first and second extension members 51 and 27 are

extended, and begin to reach the end of their upward travel as shown in Figures 8 and 9, the horizontal camming elbow spacer 177 actuates the mechanically activated hydraulic flow restrictor 19 to slow the angular movement of the manipulator 11. The same is true for the mechanically activated hydraulic flow restrictor 17 as will be shown. However, which of the two mechanically activated hydraulic flow restrictors 19 and 17 are used to restrict upward travel is unimportant.

The horizontal camming elbow spacer 177 can also operate in conjunction with the mechanically activated hydraulic flow restrictor 19 to restrict flow when the first and second extension members 51 and 27 are extended, and begin to reach the end of their downward travel approaching the positions shown in Figures 4, 5, & 6. In this configuration, the horizontal camming elbow spacer 177 would actuate the mechanically activated hydraulic flow restrictor 19 to slow the angular movement of the manipulator 11 on its way down. Again, the downward motion could be configured to be damped by the mechanically activated hydraulic flow restrictor 17.

This is an important feature in prolonging the life of the bins 109. Most refuse collection units which use a hook or grabber enable or encourage sharp treatment of the refuse bin 109 in conjunction with its release. No better evidence of this, even with new bins 109, can be seen by following a refuse collection vehicle 13 to see empty bins 109 which are lying on their side near sidewalks and in streets. The bins are strewn about

because they have been slammed downwardly and bounced around. In some cases where the operator has control, this will be more dependent upon that control. However, the longevity and care afforded to a smaller waste bin 109 should not depend upon the care of the operator, or whether he is in a mood to exercise care or not. By utilizing flow restriction, the operator is free to operate the manipulator 11 in as swift and time efficient manner as possible but will be automatically limited against rough treatment of the bin 109. Similarly, the operator is not free to bang the manipulator 11 against the top of the vehicle 13, to make undue noise and cause damage to either the manipulator 11 or to the larger refuse bin 16.

Referring again to Figure 10 and continuing to the right, the other components are the same as were described for the vertical hinge 85, including washer 167, beveled bearing 169, and conical race ring 171. The same members are repeated in reverse order on the other side of the horizontal hinge 21, including conical race ring 171, beveled bearing 169, and washer 167. Beyond washer 167 is another horizontal camming spacer 179. The orientation and surface of the horizontal camming spacer 179 will operate the mechanically activated hydraulic flow restrictor 17. Again, either of the hydraulic flow restrictors 17 and 19 can be set for limiting the upward motion, with the hydraulic flow restrictors 17 and 19 set to operatively limit the downward motion of the manipulator 11.

In addition, a bolt 180 joins the plates which make up the lift fitting 81.

Referring to Figure 11, an exploded view of the first and second extension members 51 and 27 and their associated hardware is shown. From the left, including the vertical hinge 85, the first extension member 51 extends to a pair of flanges including an upper flange 181 and a lower flange 183. These flanges fit within a pair of flanges of the second extension member 27, including upper flange 185 and 187.

A pair of steel bands 189 extend from the second extension member 27 and are attached to the first extension member 53 to have a differential displacement as the first extension member 51 pivots with respect to the second extension member 27. The pair of steel bands 189 extend through the second extension member 27 and terminate at an opening 191. The bands attach to a pivot member 195 which has a pair of spaced apart band brackets 197. The pivot member 195 pivots within the end of the second attachment member 27 in response to the bands 189 to keep the actuation structures 45 which pivotally depend from the pivot member 195 in an orientation normal to the side of the vehicle 13. Bolt 199 and bearings 200 secure the pivot member 195 at the end of the second extension member 27.

Below the flanges 185 and 187, the cylinder rod 31 is seen to have a fitting 201, while its associated hydraulic cylinder 33 has a fitting 203. Bolts 205 attach the fittings 203 and 201 to the second extension member 27 and the first extension member 53, respectively.

The strut 37 has a pair of end fittings 209 which enable bolts 211 to attach

the strut 37 between the extension plate 41 and the pivot 127 of Figure 6. The other components of the second extension member 27 are in a condition as previously shown.

Referring to Figure 12, a partial sectional view of the horizontal and vertical hinges 21 and 85 are shown in relationship to the mechanically activated hydraulic flow restrictors 17 and 19. Mechanically activated hydraulic flow restrictor 17 carries an axially movable piston portion 221 having a roller wheel 223 which bears upon the horizontal camming spacer 179. As the angled hinge member 23 is rotated upward, the horizontal camming spacer 179 will turn and either allow the movable piston portion 221 to axially move in or out to provide a flow restriction between the two ports 225 of the hydraulic flow restrictor 17. As such, the rotational positioning of the horizontal camming spacer 179 is important.

Similarly, the Mechanically activated hydraulic flow restrictor 19 carries an axially movable piston portion 231 having a roller wheel 233 which bears upon the horizontal camming elbow spacer 177. As the angled hinge member 23 is rotated upward or downward, the horizontal camming elbow spacer 177 will turn and either allow the movable piston portion 231 to axially move in or out to provide a flow restriction between the two ports 235 of the hydraulic flow restrictor 19. As such, the rotational positioning of the horizontal camming elbow spacer 177 is important.

Referring to Figure 13, a side view of the components of Figure 12

also illustrates with an arrow the direction of upward pivot which the vertical hinge 85 experiences. This simple configuration provides maximum support and long wear.

Referring to Figure 14, an expanded view of the horizontal and vertical hinges 21 and 85 are shown, similar to that seen in Figure 12, but where the structures of the horizontal hinge 21 are shown in partially exploded view. As can be seen, the inside of the horizontal hinge has a pair of stepped expanded bore portions 241 with which the conical race rings 171 are accommodated. Also seen is the conical side profile of the washer 167. The components are only partially slipped off of the horizontal leg 151. Other components seen are as previously described, but are seen in greater detail and for more understanding.

Referring to Figure 15, a closeup rear view of the actuation structures 45 are shown. The actuation structures 45 at the end of the second extension member 27 can pivot with respect to the second extension member 27 by using the pivot member 195. One of the band brackets 197 is shown connected to one of the bands 189, with the other band 189 and band bracket 197 not seen. The bands 189 are seen at the right side of Figure 15 as somewhat spaced apart and extending through the second extension member 27. All of the structures for actuation depend from the pivot member 195. The pivot member is mounted about the bolt 199 and must have sufficient strength to have good support.

At the bottom of Figure 15, each the grabber sprockets 121 are seen to take the chain 92 partially around a 360° path from a position at the end of the grabber actuator cylinder 89, while a pair of grabber sprockets 251 engage the chains 91. At the tip of the grabber actuator cylinder 89 is a structure 161 which holds the chain 91 at its mid-point fairly securely. From structure 161, each end of the chain 91 extends along the sides of the cylinder 89, wraps around the back side of the sprockets 121 then extends partially toward the cylinder.

Chain 92 is actually two separate chain segments each of which have a first end which attach to a wing segment 255 and a second end which attaches to the sprockets 251 at a point along their periphery.
The wing segment 255 is displaced from the center line of the cylinder 89. Since the piston 87 and wing segment 255 are connected together, and since the cylinder 89 and sprockets 251 and 121 are anchored against translation, hydraulic actuation causes the piston 81 and wing segment 255 to move with respect to the cylinder 87 and the sprockets 121 & 251. This causes the sprockets 121 and 251 to rotate.

Referring to Figure 16, the wing segment 255 attached to the cylinder 89 is better shown. The chain 91 has two ends, each of which are terminated at attached to an associated one of the two sprockets 251 which lie behind the sprockets 121 seen in the foreground of Figure 16. As can be seen, each of the chain segments 92 terminate in a terminal link 257 on the sprockets

121. Each of the sprocket sets 121 & 251 will only need to rotate no more than 180° and the use of terminal links 257 on sprocket 121 with chain 92 and terminal links (not seen) on sprocket 251 with chain 91 do not unduly limit the required motion.

Figure 16 shows a position where the piston 87 is retracted into the cylinder 89. Figure 17 shows the extension of the piston 87 out of the cylinder 89. Since the sprockets 121 are translationally stationary with the piston 87, movement of the cylinder causes both sprockets to turn simultaneously in the opposite direction. This causes the first symmetrical rotation member 49 and second symmetrical rotation member 50 and their related elongate curved portions 51 to move around and grasp a smaller refuse bin 109.

Referring to Figure 17, the piston 81 is in the extended position. The wing segments 255 are translationally fixed to the cylinder 89 and have moved up with respect to the sprockets 121 causing the sprockets 251 to be pulled by the chain 91 and thus rotate. The movement of the cylinder 89 upward moves the wing segments 255 upward and allows the sprockets 121 to turn. Likewise when the piston 81 is actuated to release the bin 109, the piston 81 travels inside the cylinder 89 and the sprocket sets 121 & 251 translate toward the end of the cylinder 89, the wing segments 255 hold the ends of the chain 92 and pull the sprocket sets 121 and 251 in the opposite direction.

Referring to Figure 18, a side view shows the relationships of the chains 91 and 92 as being not only separate segments, but completely parallel oriented. Note that regardless of the position of the piston 81, the orientation of the bottom of the piston 81 and the sprocket sets 121 & 251 do not change.

Since the manipulator 11 is of such high utility due to its low profile and ability to fit underneath an ordinary vehicle, such as a dump truck or other utility vehicle, it would be advantageous to have a manipulator which is readily removable. Removability is especially useful where a fleet of trucks can have its entire manipulator changed out for routine maintenance without tying up the vehicle for the period. In addition, when a business uses different vehicles for different jobs, it can attach the manipulator to a vehicle which best suits the job at hand.

Referring to Figure 19, the vehicle frame 15 is seen as a pair of opposing "u" shaped channel members. A detachable manipulator 300 is seen, many components in common with the manipulator 11. Overlying the frame 15 is a first outer bracket 301 having an end plate 303 attached to the end of the first outer bracket 301 and extending down and to the outside of the frame 15 to the right, seen from the perspective of Figure 19. For strength and stability, a pair of outer brackets are used, but only first outer bracket 301 is visible from the viewpoint of Figure 19.

The other end of the first outer bracket 301 has a through plate 305.

Both the through plate 305 and the end plate 303 are preferably attached with bolts 307. It is intended that the first outer bracket 301, plates 303 and 305 will be permanently attached to each vehicle to avoid having to bolt and un bolt these structures.

An angle brace 309 is seen which extends toward the through plate 305 at an upward angle. Structures to the left of the angle brace 309 are expected to be equivalent to those already shown. Seen is a horizontal hinge 21, vertical hinge 85, a portion of the first extension member 51, lifting cylinder 75 and lower support arm 72. Overlying the first outer bracket 301 is a bin 311 or other storage structure.

Also seen protruding through the first outer bracket 301 is a relatively large diameter locking pin 313 which is secured by a cotter pin 315 to prevent the end of the locking pin 313 from moving back inside the first outer bracket 301. In most cases it may be expected that the locking pin 313 is used as a safety device with some significant bolting to be had to provide secure attachment. The plate 305, when bolting is desired as a main structure through which the manipulator 300 is to be attached, will be solidly connected to the angle brace 309. Further, the plate 305 may be split into sections with one section being permanently secured to the frame 15, and another section attached with the angle brace 309.

Referring to Figure 20, a cross sectional view looking within the first outer bracket 301 shows an inner bracket 317 sized to fit closely within the

first outer bracket 301. The locking pin 313 is seen extending through both the first outer bracket 301 and inner bracket 317. The locking pin 313 prevents disengagement of the inner bracket 317 from the first outer bracket 301, and when used in addition to the bolting of the plate 305 to the frame 15, is used as a safety reserve connection to insure that the manipulator 300 will not become dislodged from the vehicle 13 in the event that the bolts 305 loosen through vibration, negligent tightening and the like. In this configuration, the first outer bracket 301 can remain on the vehicle 13 frame 15 and installation of the manipulator 300 is as simple as lifting the manipulator 300 and its inner bracket 317 into the first outer bracket 301, followed by insertion of the locking pin 313 and cotter pin 315, and possibly bolting of the plate 305 to the frame 15.

Referring to Figure 21, a view with the inner bracket 317 partially removed from the outer bracket 317, is shown with respect to the same sectional relationship as seen in Figure 20. Since the view is looking rearward, a rearward aperture 321 is seen on the outer bracket 317, while a rearward aperture 323 is seen on the inner bracket 317. A corresponding forward apertures on the inner bracket 317 is in alignment with the rearward aperture 323, and a corresponding forward apertures on the first outer bracket 301 is in alignment with the rearward aperture 321. When the inner bracket 317 is fully inserted into the first outer bracket 301, all four apertures, including the forward apertures and the rearward apertures 321

and 323 are in alignment, permitting the locking pin 313 to be inserted. The plate 305, or section thereof shown is also seen as moving with the angle brace 309. In this configuration, the plate 305 will be bolted to the frame 15 as a primary securing mechanism.

Figure 22 is a top view looking down on the portions of the vehicle 13 which were seen in Figures 19 - 21, with a broken away section illustrating the engagement of the locking pin 313 with the first outer bracket 301 and inner bracket 317. The locking pin has an expanded head portion 331, and main body. Beside and parallel to the first outer bracket 301 and inner bracket 317 is a second outer bracket 333 and a second inner bracket 335. The brackets 301, 317, 333 and 335 could be formed as one long bracket, but the use of a pair of members to form a forked bracket works well. It especially spreads the base from which front to rear bearing forces on the frame 13 can be supported. A portion of the second outer bracket 333 is shown broken away to reveal the surrounding relationships. An additional large diameter locking pin 313 could be used with the second outer bracket 333 and a second inner bracket 335 for additional security, or in place of the bolting on of plate 305.

Referring to Figure 24, the end of the manipulator 300 illustrates an alternative embodiment in which a double figure-8 orientation permits the cylinder which actuates the grasping portion of the manipulator 300 to be horizontally inclined along its axis and to apply sufficient power elongated

curved portions 51. A plate 341 supports most of the structures seen for grasping including the shaft portion 52 of the rotation member 50, as well as its elongate curved portion 51. Plate 341 is connected to the second extension member 27. A sprocket 343 is seen associated with rotation member 50, and the sprocket is sized to enable a chain 345 to perform at least one spiral about the sprocket, or in other words, the chain is wide enough, and the sprocket 343 is narrow enough to enable the chain to make a spiral path of travel around the sprocket 343 to complete a figure-8 or the like.

Figure 25 is a view of the underside of the actuation structures including plate 341. Also seen is a sprocket 346 associated with the first cylindrical rotation member 49. At the upper portion of plate 341, a double acting cylinder 347 is seen as fed by a first hydraulic fluid power line 349 and a second hydraulic fluid power line 351. The piston from the hydraulic cylinder terminates in a bolt 353 and a nut 355 which secures a translation plate 357 which supports a double sprocket 359. The double sprocket includes side-by-side sprockets and may be freely rotatable with respect to each other.

The chain 345 is possibly a continuous length of chain. An angled anchor plate 361 is used to anchor one end of the chain 345. An adjustment fitting 363 is provided to enable taughtness of the chain to be adjusted. A second anchored angle plate 365 is located more closely adjacent the double

acting cylinder 347 to secure the other end of the chain 345. The movement of the double sprocket 359 to the left and to the right causes the chain to cause the sprockets 343 and 345 to turn in opposite directions simultaneously to cause the first and second symmetrical rotation members 49 and 50 to turn and come together or turn and open apart.

Referring to Figure 26, the first and second symmetrical rotation members 49 and 50 arms having turned and come together. Note that the angle of view from Figure 25 is such that the first and second symmetrical rotation members 49 and 50 are either up, apart and above the plate, or down, closed and below the plate 341 as seen in Figure 26. Also seen is the piston 361 in extended position. Note that leftward movement of the double sprocket 359 causes a pulling of the chain 345 away from the sprocket 345 causing it to turn clockwise, while at the same time pulling chain from sprocket 346 to 343 and feeding chain to sprocket 343 cause it to turn counterclockwise in exact time with the sprocket 346.

The sprockets 343 and 346 are thus in a figure-8 relationship with respect to the chain 345. Rather than have another fixed sprocket linkage, the moving sprocket linkage enables the figure-8 to be actuated by a motion in parallel to a line between the two sprockets 343 and 346. This action adds to the compactness of the manipulator 300, but without compromising the force producible in the grasping portion of the manipulator 300. In addition, the use of the double sprocket eliminates the possibility for changing tension

in the chain 345 and eliminates the need for a gear which would use energy.

Referring to Figure 27, an alternate bracket arrangement is shown, and which may be advantageously used to support a manipulator 300, particularly where a shop may not have the clearance or equipment which facilitates the withdrawing removal of the manipulator 300 for a significant amount laterally. This is especially useful where a sufficient support undercarriage or dolly is used to move the manipulator 300 on and off the vehicle.

A bracket 400 includes a pair of tubular members 401 and 403. A bin 405 will be likely located over the bracket 400 and is seen ph phantom in order to show the compactness and integrability of the bracket 400 with respect to a frame 15 and bin 405. At the far end of the tubular members 401 and 403 is an end plate 407 which extends over the ends of the tubular members 401 and 403, and downward and engaged to the adjacent frame 15 with bolts and nut sets 409. In addition, the end plate 407 may be welded to the frame 15, and is preferably welded to completely cover and exceed the peripheral edges of the tubular members 401 and 403.

The opposite ends of the tubular members 401 and 403 are likewise covered by an abutment plate 415. Abutment plate 415 is welded to the ends of the tubular members 401 and 403, and may also preferably be welded to the near frame 15. Bolting may also be accomplished of the abutment plate 415 to the frame if it can be done with a low outer profile.

Immediately adjacent the abutment plate 415, and shown almost coextensive with the abutment plate 415 is a manipulator base plate 417. Also shown are a series of bolt apertures 419 which align with similar bolt apertures in the abutment plate 415, and where the plates 415 and 417 cover the side of the frame 15, with bolt apertures in the frame 15. The use of the abutment plate 415 and the manipulator base plate 417 enable additional connective bolting to each other even if such bolting does not extend through the frame 15. This is especially useful where the frame 15 area available is so small that sufficient holding bolts would compromise the integrity of the frame 15 for holding up the vehicle 13 in addition to the manipulator 300. The use of multiple bolt apertures enables a more consistent fit and enables the manipulator 600 to be more rigidly attached to the frame 15. This arrangement is preferable for either larger sized manipulators or where ease of detachability is not as important as structural integrity, or where the manipulator 300 is expected to handle increased loads.

From the manipulator base plate 417, a pair of spaced apart struts 421 are connected to the horizontal hinge 21, the horizontal hinge 21 also connected to the lower support arm 72. The other structures shown in Figure 27 are the same as was shown in the earlier figures.

The invention herein has been described with respect to a waste bin manipulator arm which provides both a simpler actuation with three controls and operation, as well as a gentler and quieter method of handling of refuse

bins, to both extend bin life and save taxpayers money. The invention may be applied to any situation where compact and simple handling is required and which may be employed with original refuse collection vehicles and equipment as well as in a retrofit use.

Although the invention has been derived with reference to particular illustrative embodiments thereof, many changes and modifications of the invention may become apparent to those skilled in the art without departing from the spirit and scope of the invention. Therefore, included within the patent warranted hereon are all such changes and modifications as may reasonably and properly be included within the scope of this contribution to the art.

WHAT IS CLAIMED:

1. A manipulator arm (11) comprising:

a base support (61, 65, 67);

a hinge structure (21, 23, 85) for providing pivoting in a horizontal plane and in a vertical plane;

an extension arm (27, 53) having a first end connected to said hinge structure (21, 23, 85) and a second end;

a grasping bin actuator (45) connected to the second end of said extension arm (27, 53).

2. The manipulator arm (11) as recited in claim 1 wherein said hinge structure (21, 23, 85) further comprises:

a horizontal hinge (21) connected to said base support (61, 65, 67);

an angled hinge member (23) having a horizontal leg (151) pivotally carried within said horizontal hinge (21) and a vertical leg (153);

a vertical hinge (85) supported by and pivotably rotatable about said vertical leg, said vertical hinge (85) connected to said first end of said extension arm (27, 53).

3. The manipulator arm (11) as recited in claim 1 wherein said extension arm (27, 53) further comprises:

a first extension member (53) having a first end pivotally connected to said hinge structure (21, 23, 85), and a second end; and

a second extension member (27) having a first end pivotally connected to said second end of said first extension member (53), and a second end connected to said bin actuator (45).

4. The manipulator arm (11) as recited in claim 1 wherein said bin actuator (45) is attached to said second end of said extension arm (27, 53) to remain oriented away from said base support (61, 65, 67) regardless of the position of said extension arm (27, 53) with respect to said base support (61, 65, 67).

5. The manipulator arm (11) as recited in claim 1 wherein said bin actuator (45) further comprises:

a symmetrical rotation support (47) connected to said second end of said extension arm (27, 53);

a first symmetrical rotation member (49) pivotally supported about a first axis by said symmetrical rotation support (47) and having a first elongate curved portion (51) extending at an angle with respect to said first axis;

a second symmetrical rotation member (50) pivotally supported about a second axis by said symmetrical rotation support (47) and having a second elongate curved portion (51) extending at an angle with respect to said first axis, and operable in concert with said first symmetrical rotation member (49) to grasp an object, said angle enabling said first and second elongate curved portion (51)s to assume an approximately horizontal position when grasping, and an approximately vertical position when not grasping; and

a mechanical power source (87, 89) connected to said first and second symmetrical rotation members (49 & 50) .

6. The manipulator arm (11) as recited in claim 5 wherein said mechanical power source further comprises:

a hydraulic cylinder (89);

a first actuator chain (91) extending from a point secured by said hydraulic cylinder (89);

a hydraulic piston (87) carried within and hydraulically actuated to extend from said hydraulic cylinder (89);

at least a first sprocket (121) engaging said first actuator chain (91) to turn when said hydraulic piston (87) is displaced out of said hydraulic cylinder (89).

7. The manipulator arm (11) as recited in claim 6 wherein said

mechanical power source (87, 89) further comprises:

a second actuator chain (92) having a first end connected to said hydraulic piston (87), and a second end connected to at least a second sprocket (251) rotationally linked to said at least a first sprocket (121) to assist in turning said at least a first and said at least a second sprockets (251, 121) simultaneously.

8. The manipulator arm (11) as recited in claim 2 and wherein said hinge structure (21, 23, 85) further comprises:

a first camming ring (177) carried on said horizontal leg of said angled hinge and which rotates when said manipulator arm (11) is pivoted about an axis of said horizontal hinge (85) ; and

a first mechanically activated hydraulic flow restrictor (19) which restricts hydraulic flow in response to rotation of said first camming ring (177).

9. The manipulator arm (11) as recited in claim 8 and wherein said manipulator arm (11) further comprises a hydraulic lift cylinder (75) having a first pivot end and a second end and a hydraulic lift piston (79) having a first end within said second end of said hydraulic lift cylinder and a second pivot end, and where one of said first and said second pivot ends is connected to said base support (61, 65, 67) and the other of said first and said

second pivot ends is connected to said extension arm (27, 53) for lifting said extension arm (27, 53), wherein said hydraulic lift cylinder is in fluid communication with said mechanically activated hydraulic flow restrictor (19).

11. The manipulator arm (11) as recited in claim 1 and wherein said base support (61, 65, 67) further comprises:

an upper rectangular tube shaped structure (59) for fitting atop a chassis member (15) of a vehicle and having a generally horizontal portion and a downwardly sloping portion 63) terminating at a first end, and having a second end;

a lower rectangular tube shaped structure (72) having a first end adjacent said first end of said upper rectangular tube shaped structure (59) and a second end; and

an end cap (67) covering said second end of said upper rectangular tube shaped structure (59), and providing surface to facilitate attachment to said chassis member (15), the first end of said lower rectangular tube shaped structure (79) connected to the first end of said upper rectangular tube shaped structure (59).

12. The manipulator arm (11) as recited in claim 3 and further comprising:

a strut (37) having a first end pivotally attached to said hinge structure (21, 23, 85) and a second end pivotally attached to said second extension member (27) adjacent but spaced apart from said second end of said first extension member (53);

a hydraulic extension cylinder (33) having a first vertical pivot end and a second end and a hydraulic extension piston (31) having a first end within said second end of said hydraulic extension cylinder and a second vertical pivot end, and where one of said first and said second vertical pivot ends is connected to said hinge structure (21, 23, 85) and the other of said first and second vertical pivot ends is connected to said second extension member (27) and where actuation of said hydraulic extension cylinder (33) causes said first and second extension member (27) to pivotally extend from said base support (61, 65, 67).

13. The manipulator arm (11) as recited in claim 1 wherein said bin grasping actuator (45) is resiliently pivotable with respect to said second end of said extension arm (27, 53), to enable a back and forth motion of said extension arm (27, 53) to pivotingly shake a bin held by said bin grasping actuator (45).

14. The manipulator arm (11) as recited in claim 13 and further comprising a shaker arm connected to said bin grasping actuator (45) and

oriented to make contact with a surface when said bin is held in a position to be emptied to enhance said shaking.

15. A manipulator arm (11) comprising:

a base support (61, 65, 67) for attachment to a chassis member of a vehicle;

a hinge structure (21, 23, 85) for providing pivoting in a horizontal plane and in a vertical plane independently of an angle of pivot in said horizontal plane;

an extension arm (27, 53) having a first end connected to said hinge structure (21, 23, 85) and a second end, said extension arm (27, 53) limited in speed of angular displacement in said vertical plane;

a bin grasping actuator (45) connected to the second end of said extension arm (27, 53), to enable said extension arm (27, 53) to grasp a bin and hold it through pivoting displacement to a vertical position.

16. The manipulator arm (11) as recited in claim 15 wherein said bin grasping actuator (45) further comprises:

a pair of cooperating symmetrical rotation members (49, 50) actuatable from a first approximately vertical position when not grasping to a second approximately horizontal position when grasping; and

a mechanical power source (87, 89) connected to said pair of

cooperating symmetrical rotation members (49, 50).

17. A removable manipulator arm (11) comprising:

a tube shaped outer bracket (301) having an inside, and attachable adjacent a chassis member (15) of a vehicle;

an inner bracket (317) having an outer surface closely slidably fittable within said inside of said tube shaped outer bracket (301);

a holding structure (305) for engaging said inner bracket with respect to one of said chassis member (15) and said tube shaped outer bracket (301);

a hydraulic manipulator arm (11) having a hinge structure (21, 23, 85) for providing pivoting in a horizontal plane and in a vertical plane and attached to said inner bracket (317);

an extension arm (27, 53) having a first end connected to said hinge structure (21, 23, 85) and a second end; and

a bin grasping actuator (45) connected to the second end of said extension arm (27, 53).

18. The removable manipulator arm (11) as recited in claim 17 and wherein said outer bracket (301) has a first aperture and where said inner bracket has a second aperture, positioned such that when said inner bracket is engaged with said outer bracket (301), said first and said second apertures align, and further comprising a locking pin (313) inserted through said first

and said second apertures to hold said inner bracket in engagement with said outer bracket (301).

19. The removable manipulator arm (11) as recited in claim 17 and wherein said outer bracket (301) has a first end connected to a plate for attachment of the outer bracket (301) to a vehicle frame, and a second end.

20. The removable manipulator arm (11) as recited in claim 17 and wherein said inner bracket (317) has a first end for insertion into said outer bracket (301) and a second end and wherein said holding structure further comprises a plate (305) attached to said inner bracket (317) adjacent said second end for facilitating attachment of said inner bracket (317) with respect to said outer bracket (301).

21. A removable manipulator arm (11) comprising:

a hydraulic manipulator arm (11) having a hinge structure (21, 23, 85) including a brace (309) for providing pivoting in a horizontal plane and in a vertical plane and attached to said inner bracket (317);

an extension arm (27, 53) having a first end connected to said hinge structure (21, 23, 85) and a second end;

a bin grasping actuator (45) connected to the second end of said extension arm (27, 53);

an inner bracket (317) having pair of parallel spaced apart inner bracket members (335, 317) connected to and extending away from said brace (309);

an outer bracket (301) having a pair of spaced apart tube shaped outer bracket (301) members each having an inside, and attachable adjacent a chassis member of a vehicle, each of said inner bracket members having an outer surface closely slidably fittable within said inside of an associated one of said outer bracket (301) members.

22. A manipulator for grasping and further comprising:

a rotation support (341);

a first symmetrical rotation member (49) pivotally supported about a first axis by said rotation support and having a first elongate curved portion (51) extending at an angle with respect to said first axis;

a first sprocket (346) connected to said first symmetrical rotation member (49) and rotatable with said first symmetrical rotation member (49);

a second symmetrical rotation member (50) pivotally supported about a second axis by said rotation support and having a second elongate curved portion (51) extending at an angle with respect to said second axis;

a second sprocket (343) connected to said first symmetrical rotation member (49) and rotatable with said first symmetrical rotation member (49), said second symmetrical rotation member (50) operable in concert with said

first symmetrical rotation member (49) to grasp an object;

a chain (345) surrounding said first and said second sprockets in a figure-8 pattern; and

a mechanical power source (347, 361) powerably connected to one of said first and said second symmetrical rotation members (49, 50).

23. The manipulator arm (11) as recited in claim 22 wherein said mechanical power source (347, 361) further comprises:

a hydraulic cylinder (347);

a hydraulic piston (361) carried within and hydraulically actuated to extend from said hydraulic cylinder (347); and

a link (357, 359) connecting said hydraulic piston (361) and said chain.

24. The manipulator arm (11) as recited in claim 23 wherein said link (357, 359) further comprises:

a translation plate (357) connected to said hydraulic piston (361); and

a translation sprocket (359) rotatably supported by said translation plate (357) and engaging said chain (345), said translation sprocket (359) set to forcibly turn when said hydraulic piston (361) is actuated from said hydraulic cylinder (347).

25. The manipulator arm (11) as recited in claim 24 wherein said

chain (345) has a first end and a second end supported by said rotation support (341), and wherein said translation sprocket (359) engages said chain (341) near said first and second ends of said chain (345) such that said translation sprocket (359) will turn as it is moved by said hydraulic piston.

26. A removable manipulator arm (11) comprising:

a bracket (400) further comprising:

a pair of spaced apart tubes (401, 403) each having a first end and a second end;

an end plate (407) attached over the second ends of said pair of spaced apart tubes (401, 403);

an abutment plate (415) attached over the first ends of said pair of spaced apart tubes (401, 403);

a manipulator base plate (417) abutting and attachable to said abutment plate (415); and

a hydraulic manipulator arm (11) having a hinge structure (21, 23, 85) supported by said manipulator base plate (417) for providing pivoting in a horizontal plane and in a vertical plane;

an extension arm (27, 53) having a first end connected to said hinge structure (21, 23, 85) and a second end; and

a bin grasping actuator (45) connected to the second end of said extension arm (27, 53).

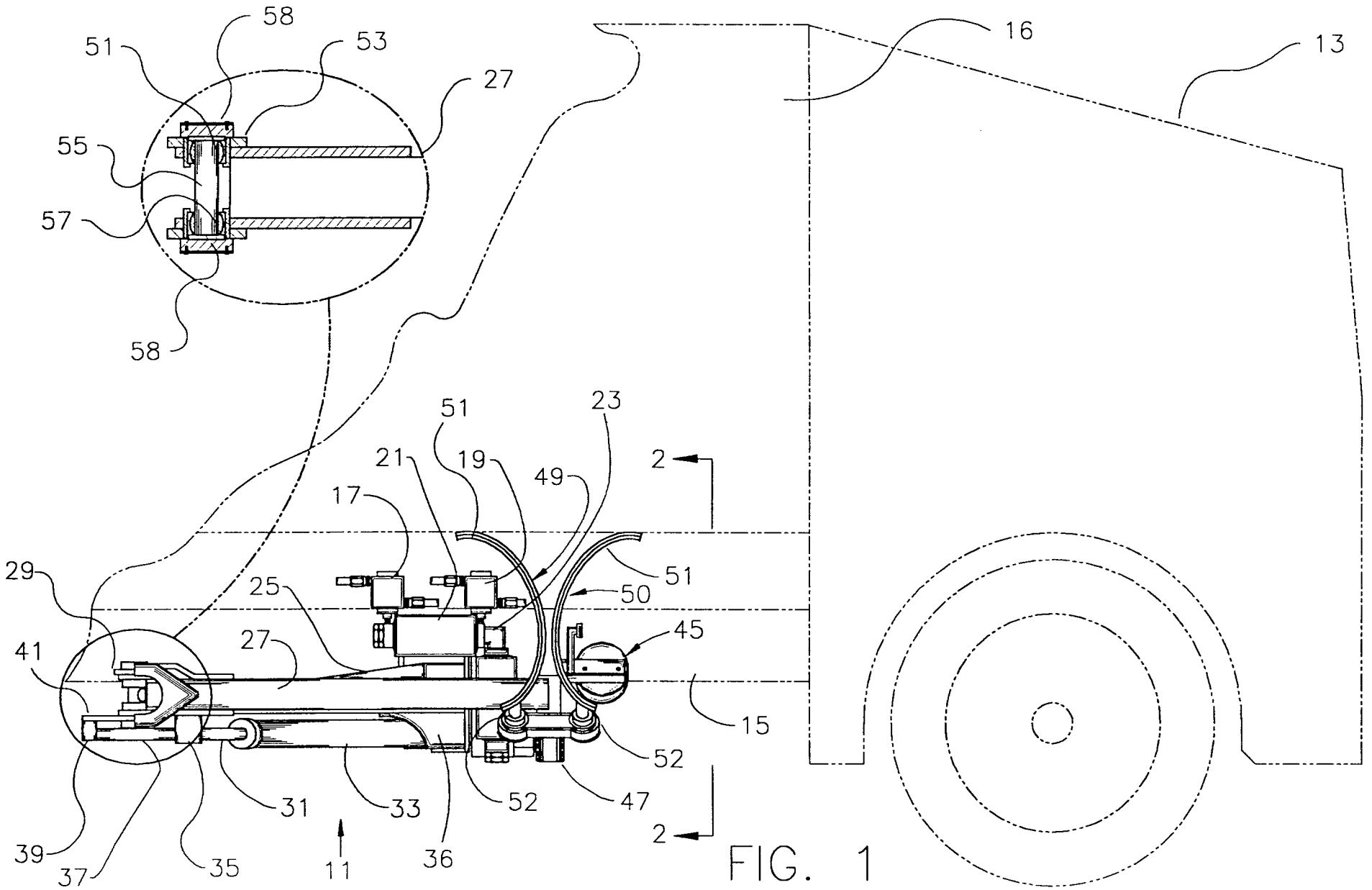
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FIG. 1

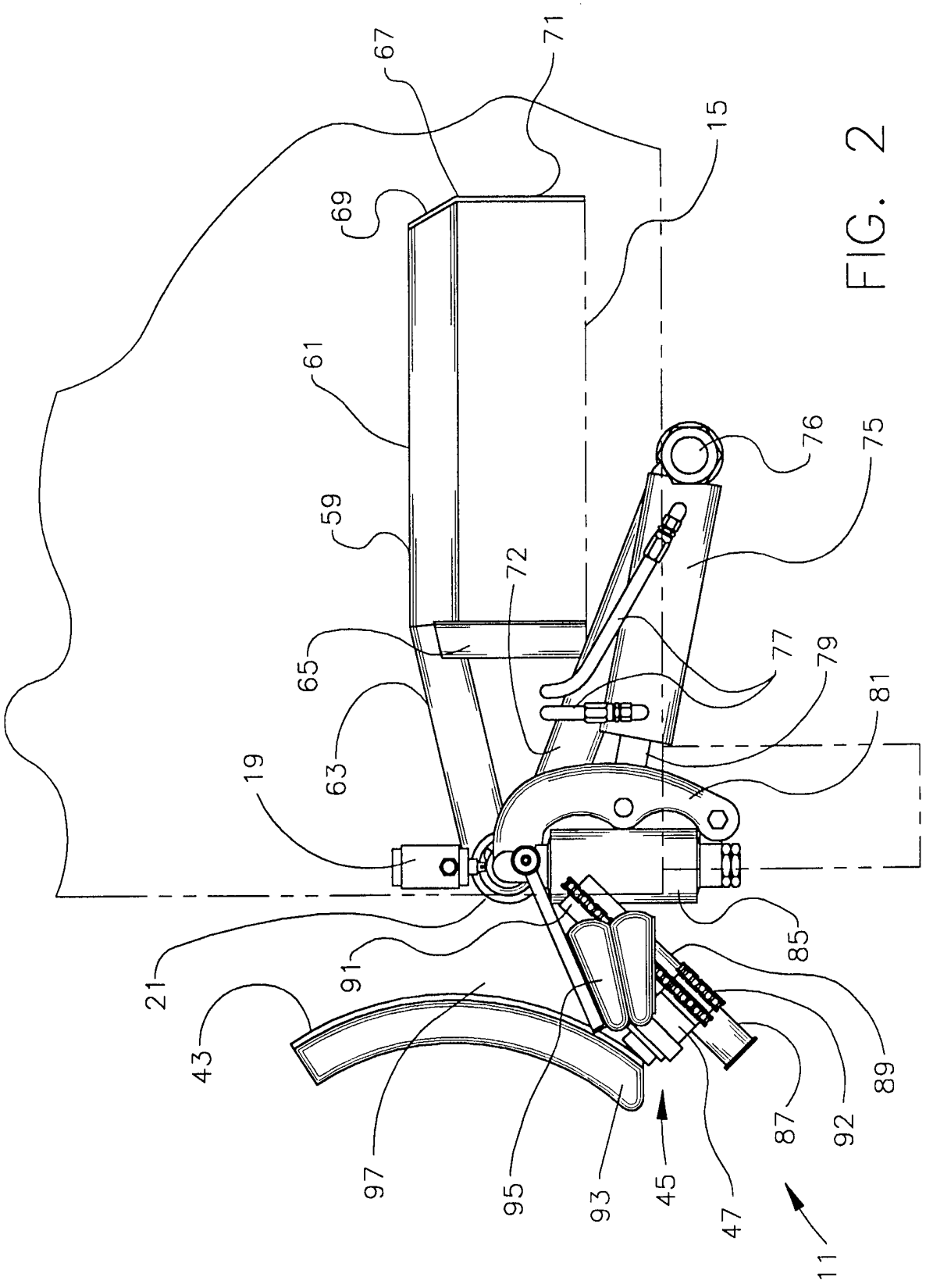
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FIG. 2

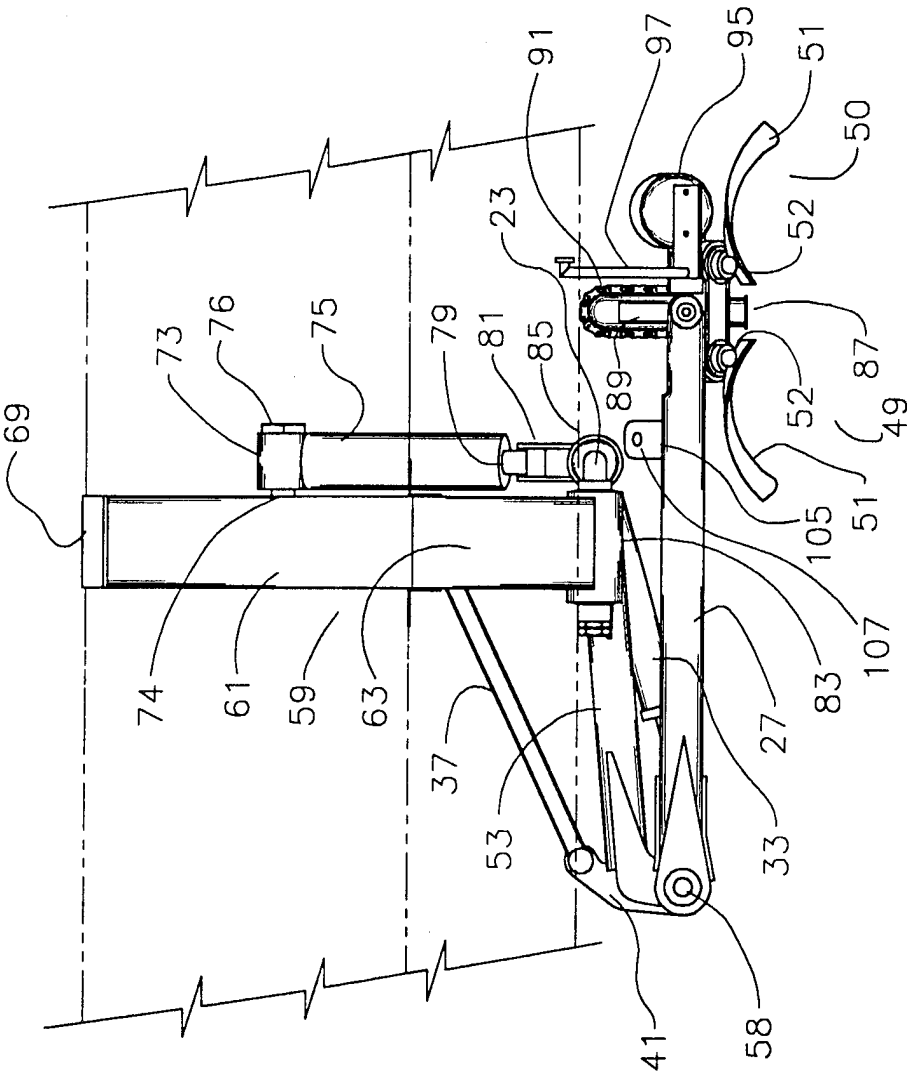
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FIG. 3

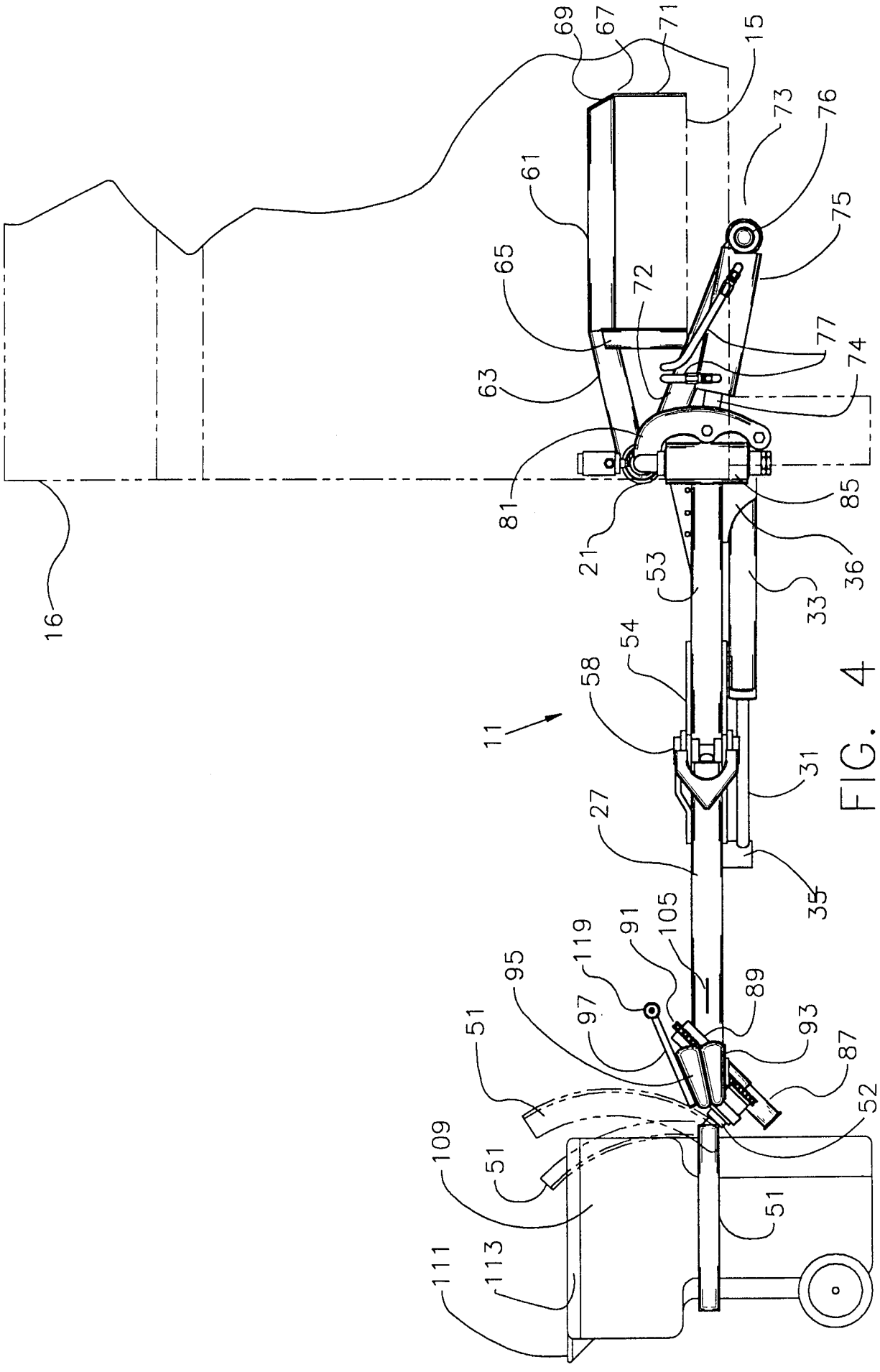
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FIG. 4

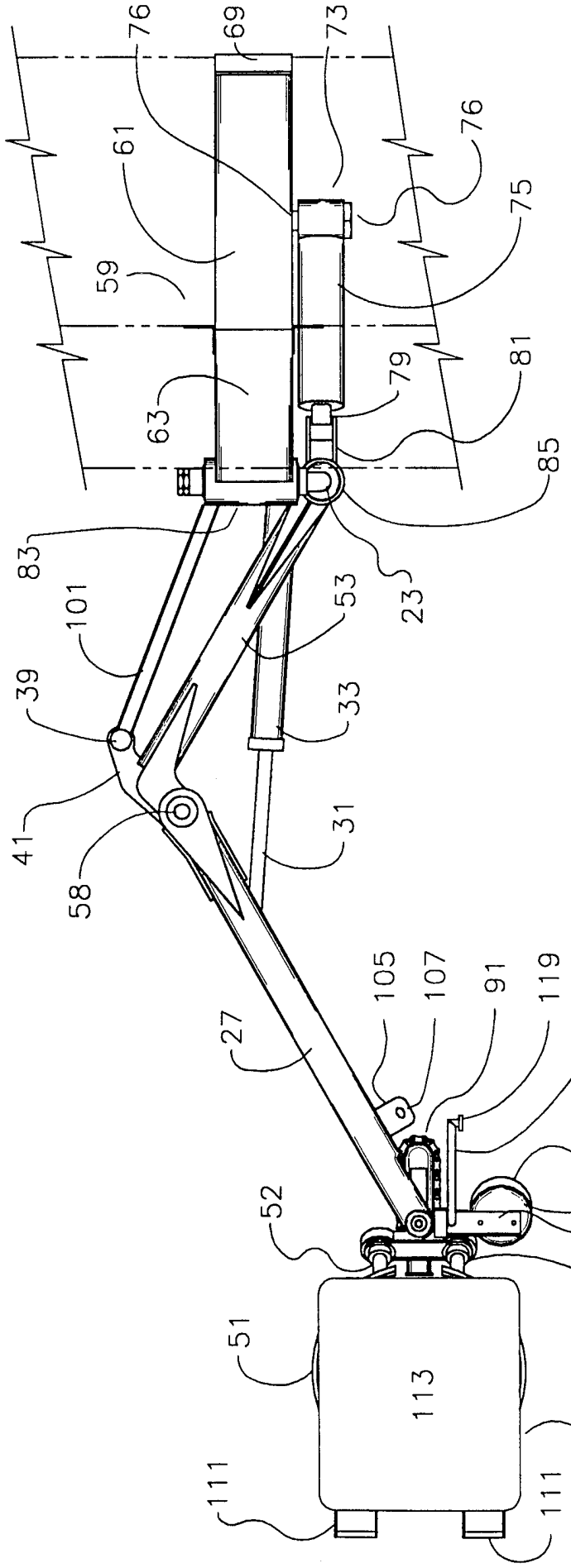
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FIG. 5

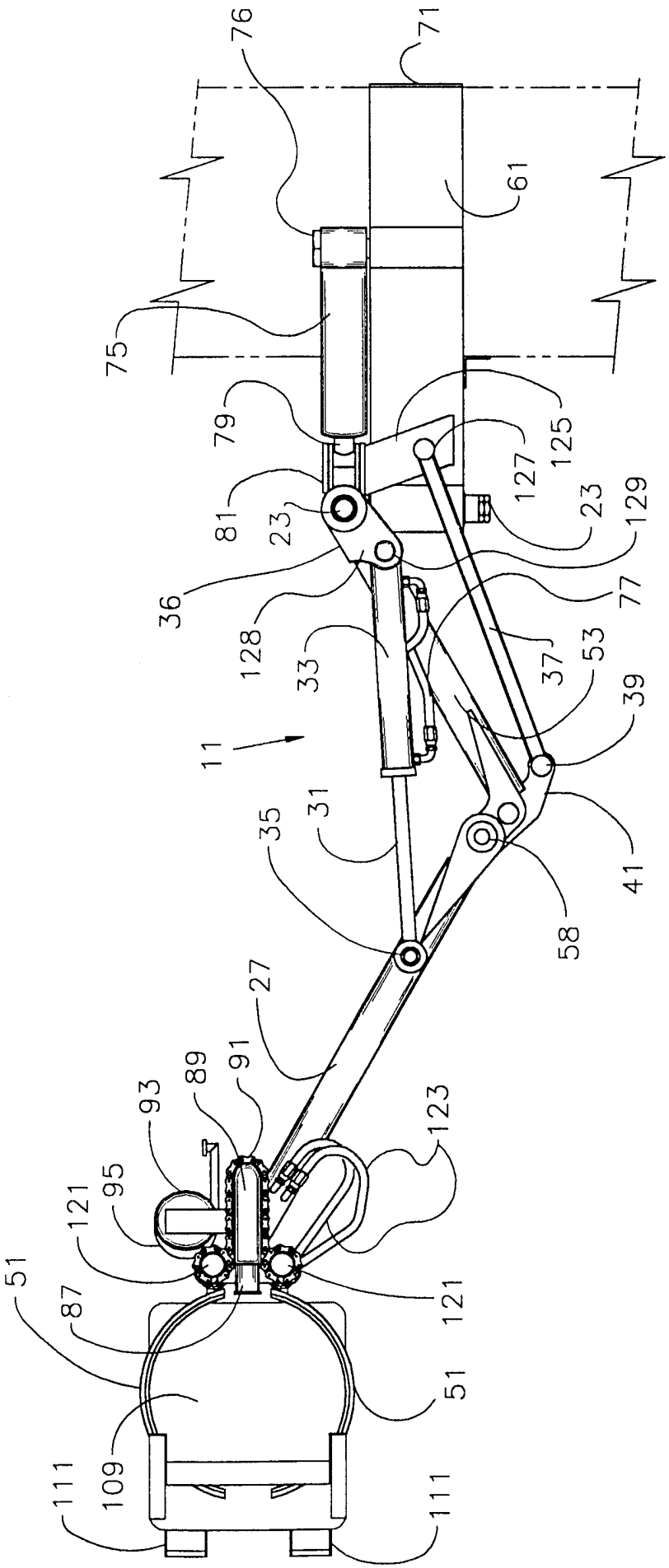
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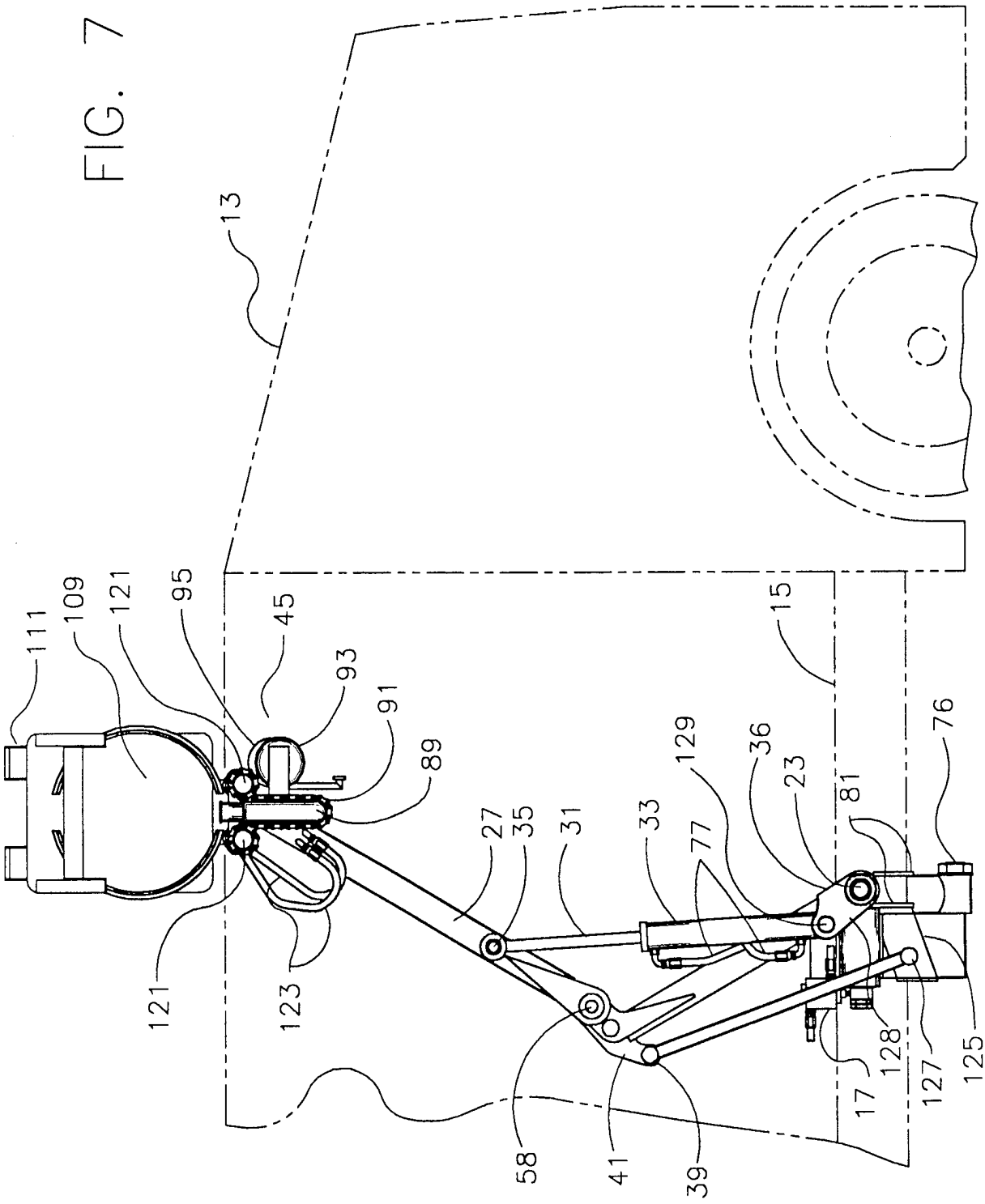
FIG. 6

FIG. 7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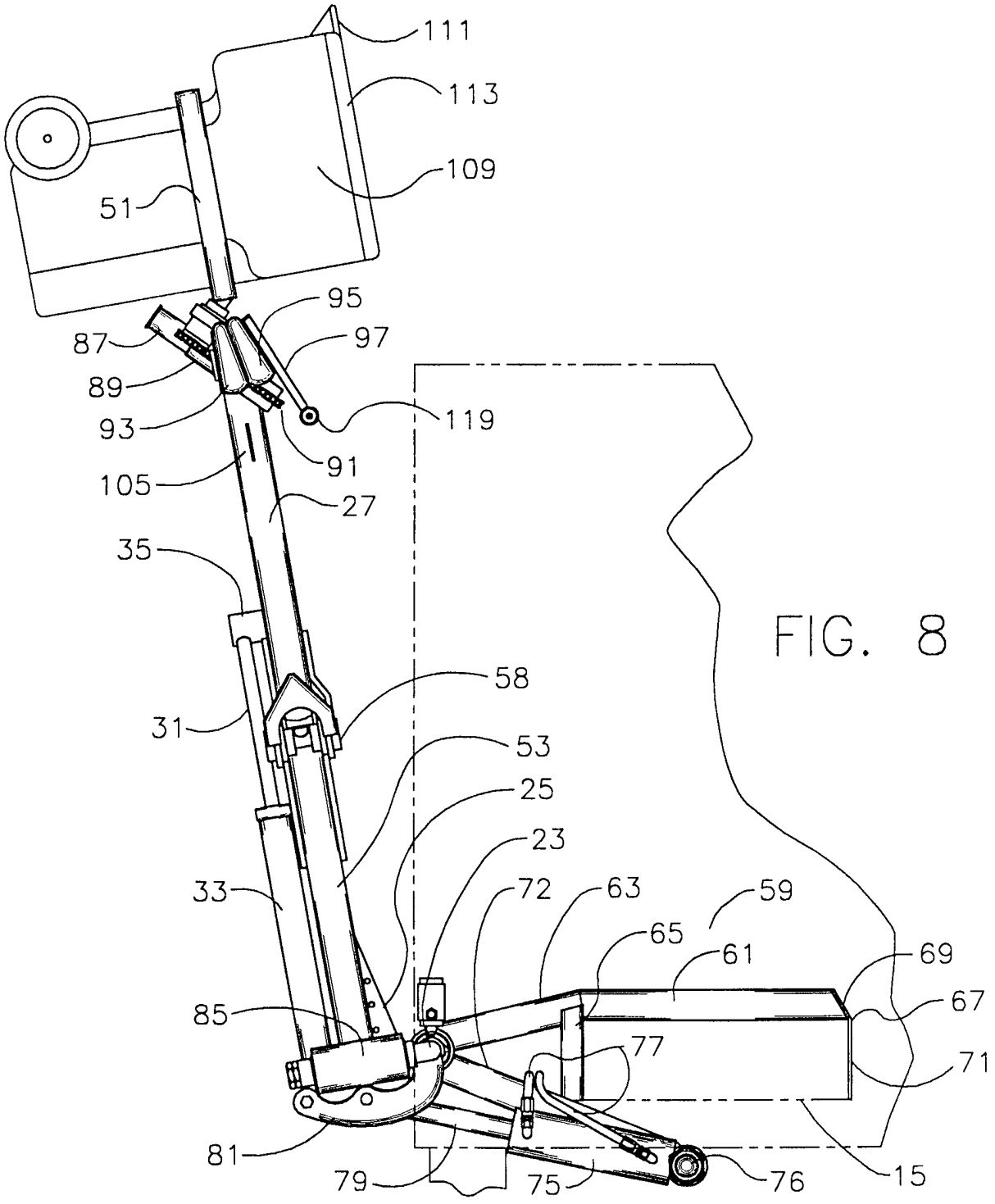
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FIG. 8

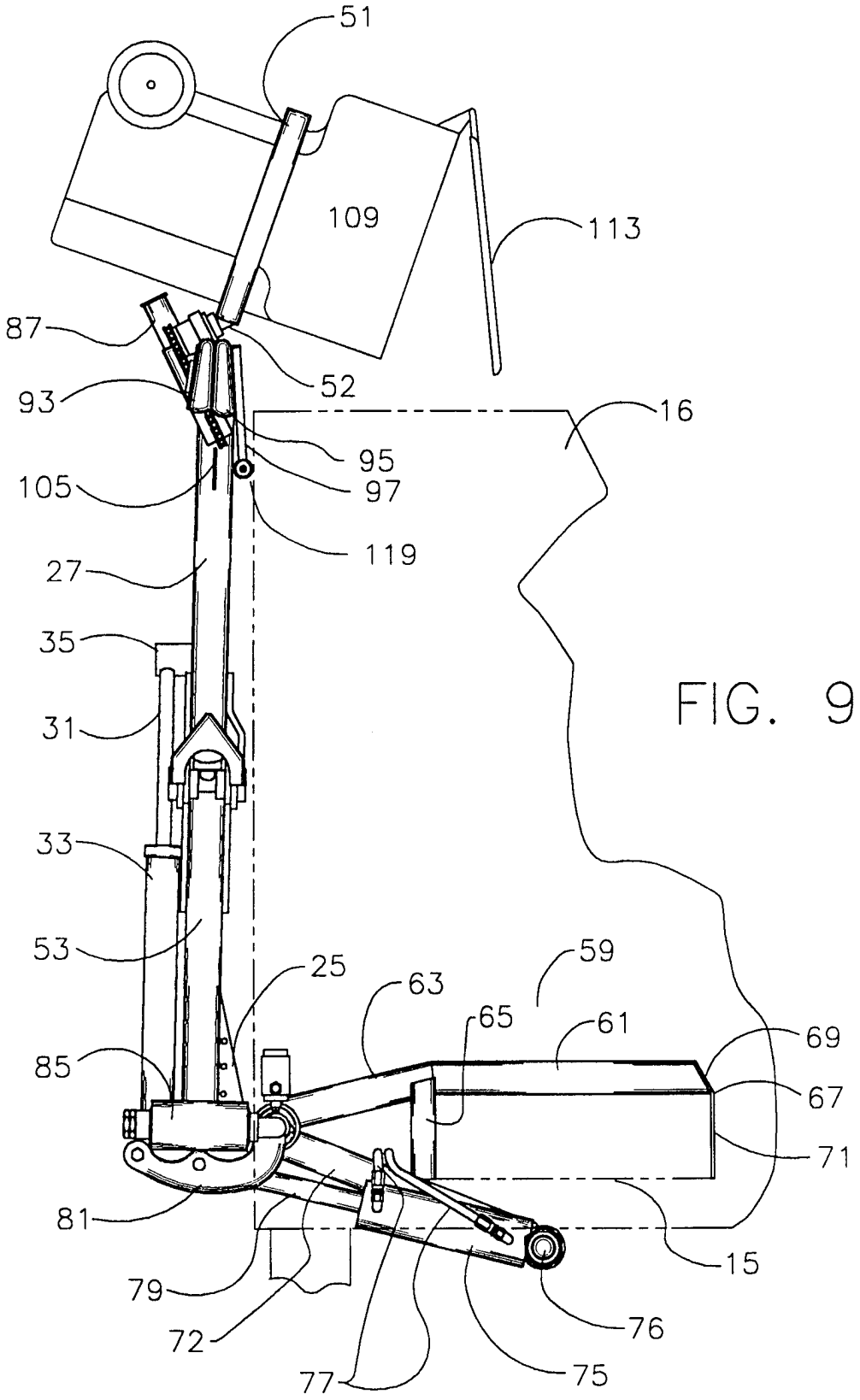
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FIG. 9

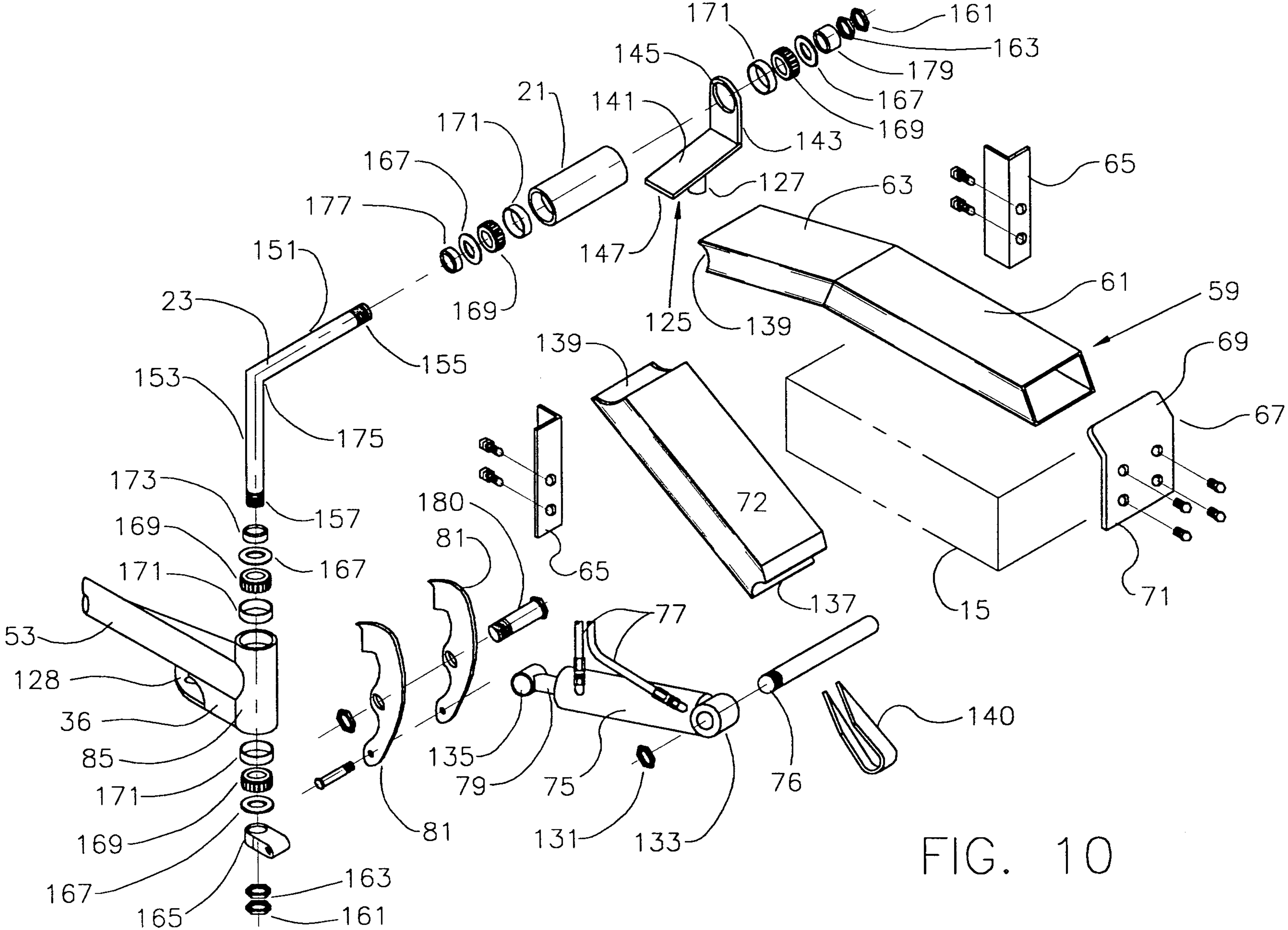
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FIG. 10

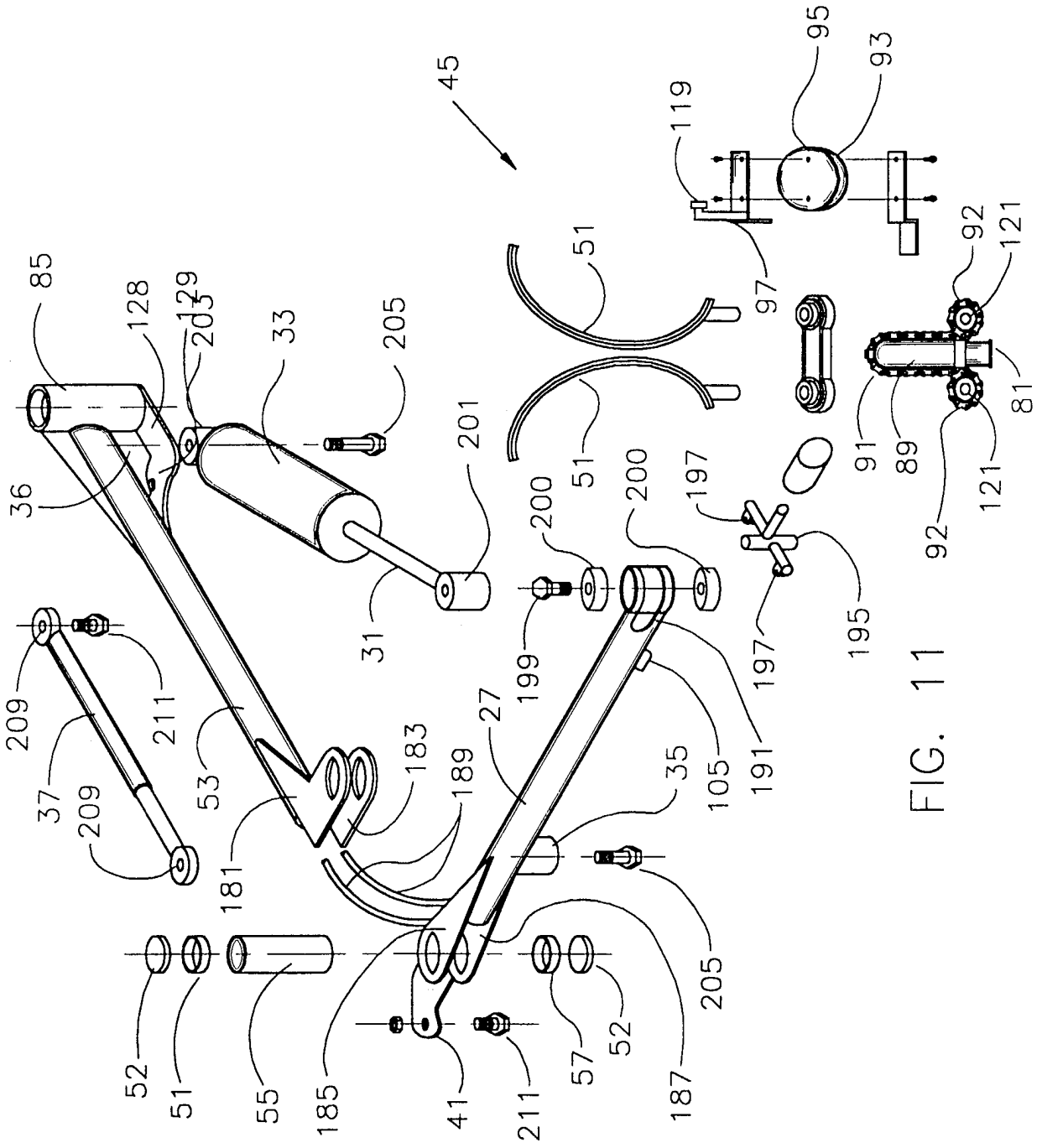
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FIG. 11

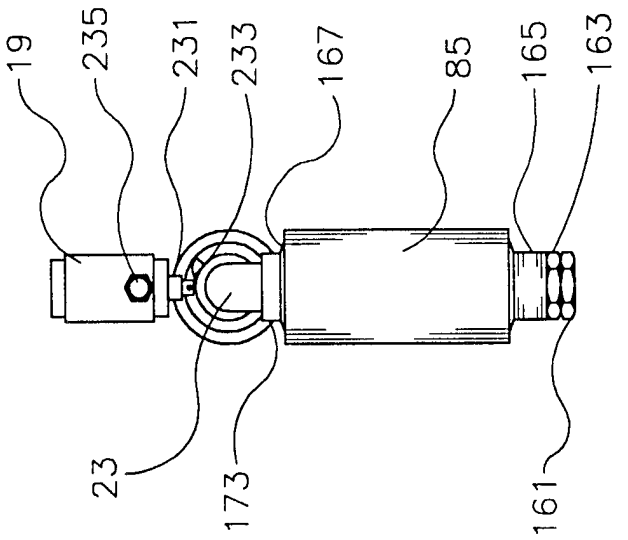
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FIG. 13

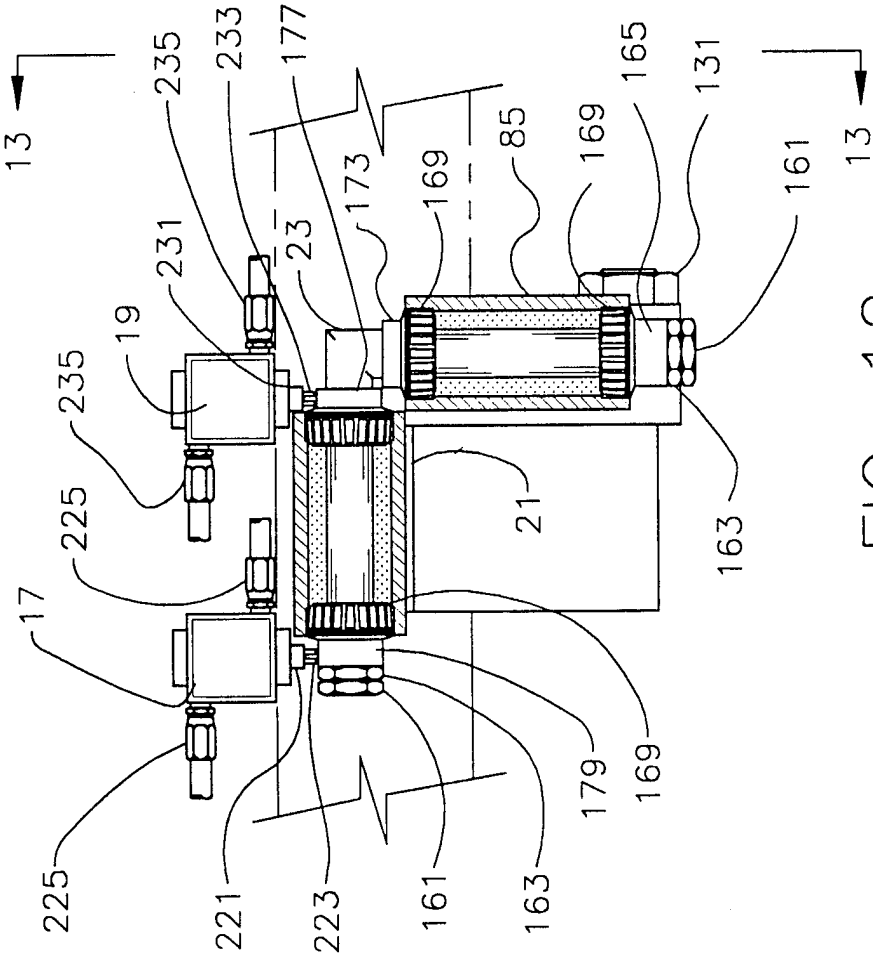
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FIG. 12

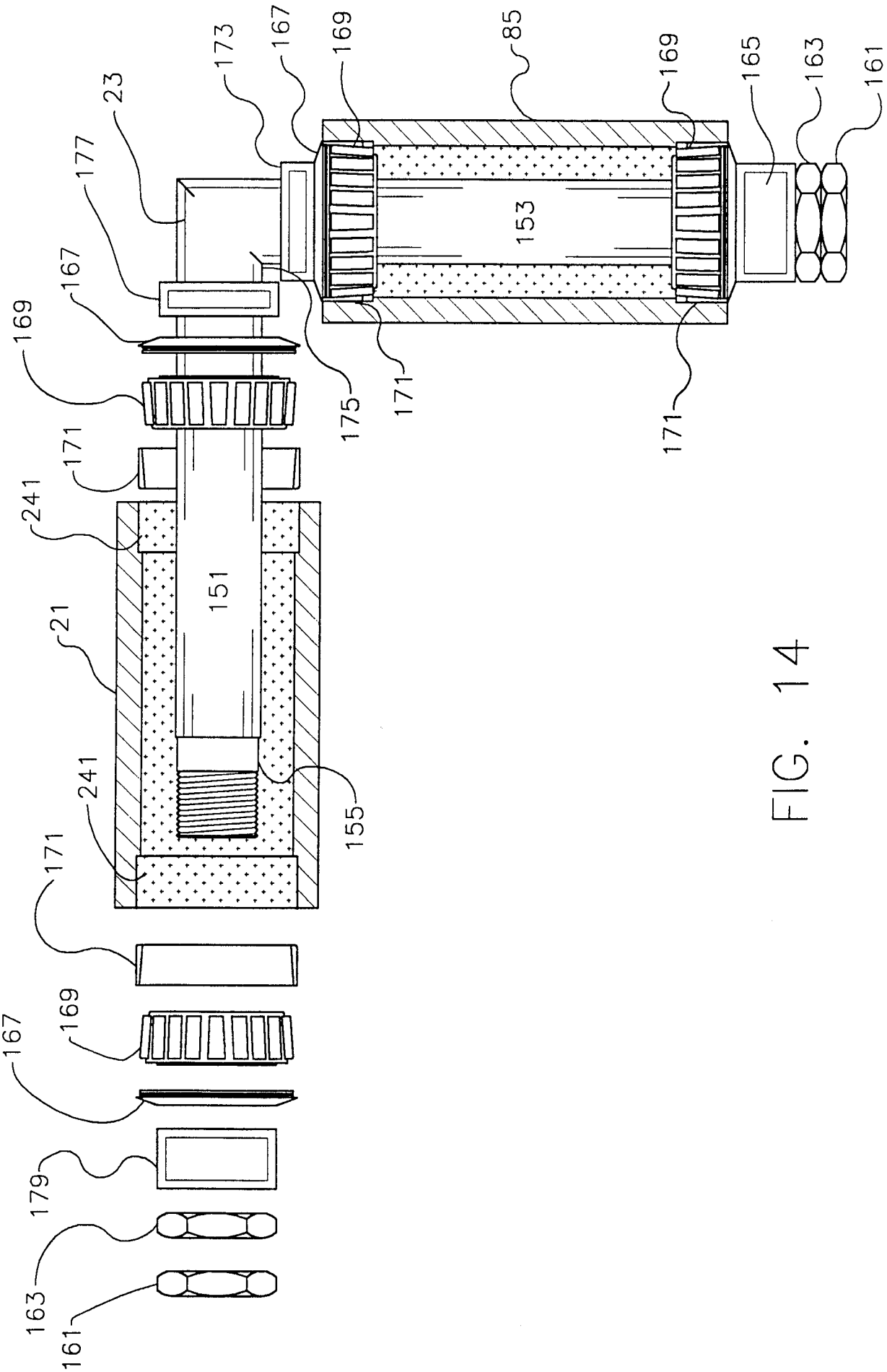
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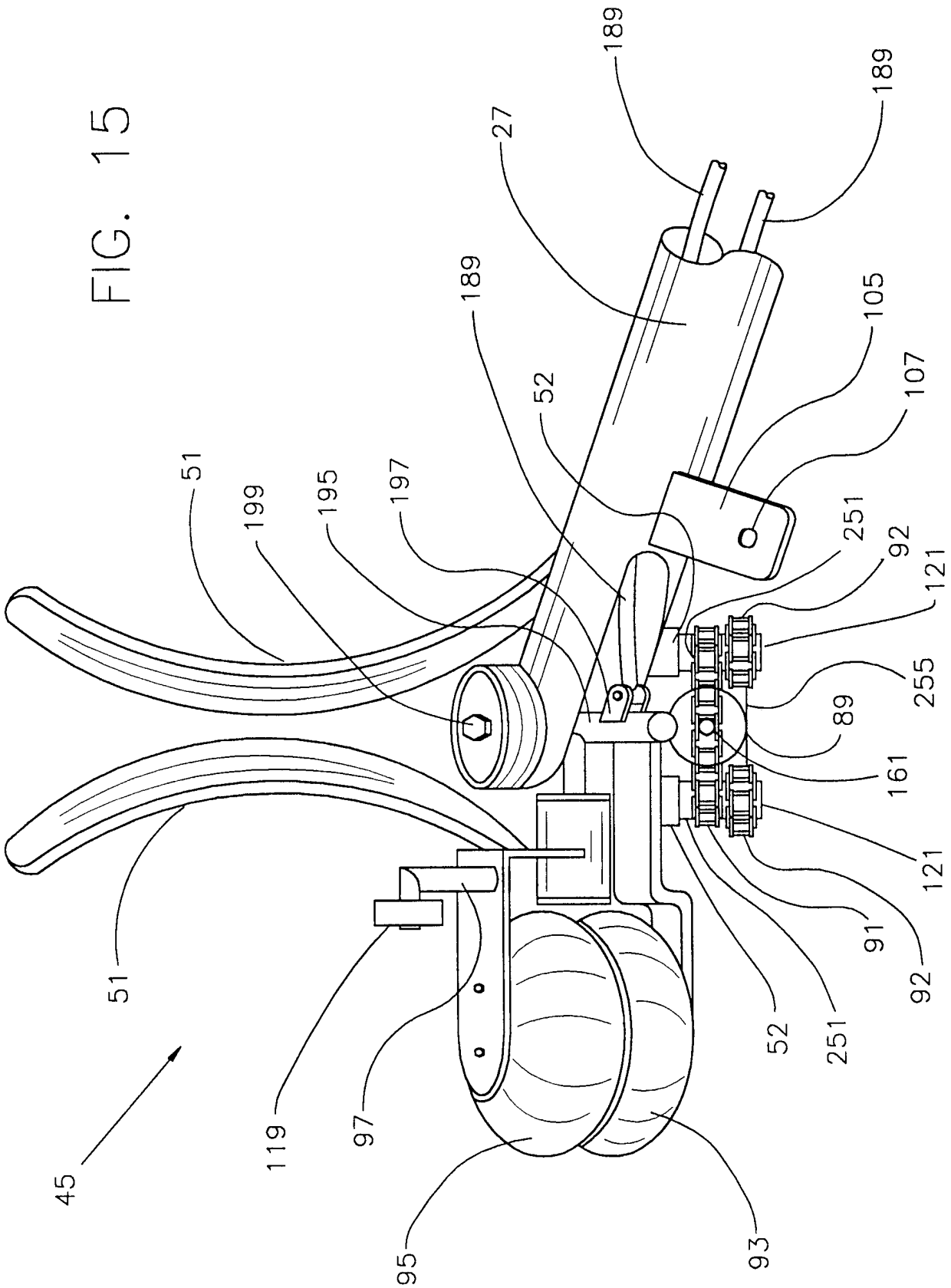
FIG. 14

FIG. 15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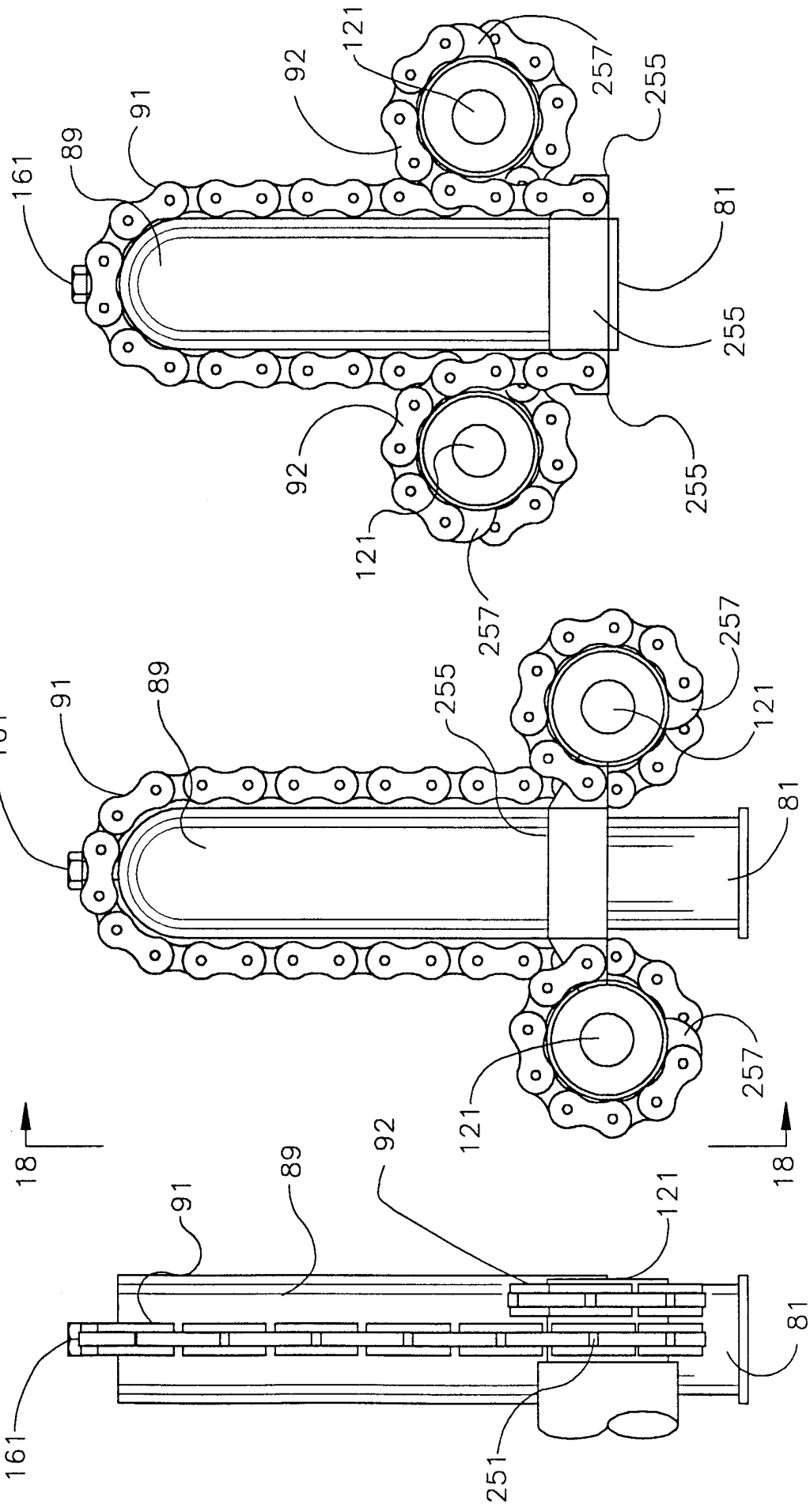

FIG. 16

FIG. 17

FIG. 18

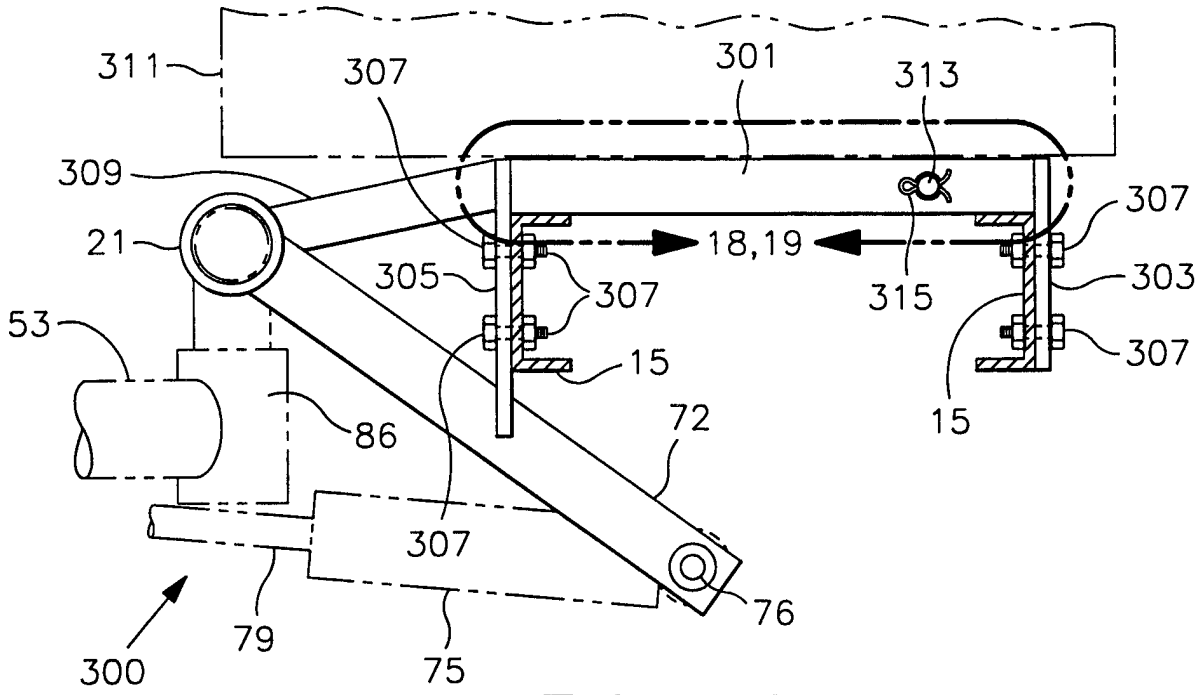

FIG. 19

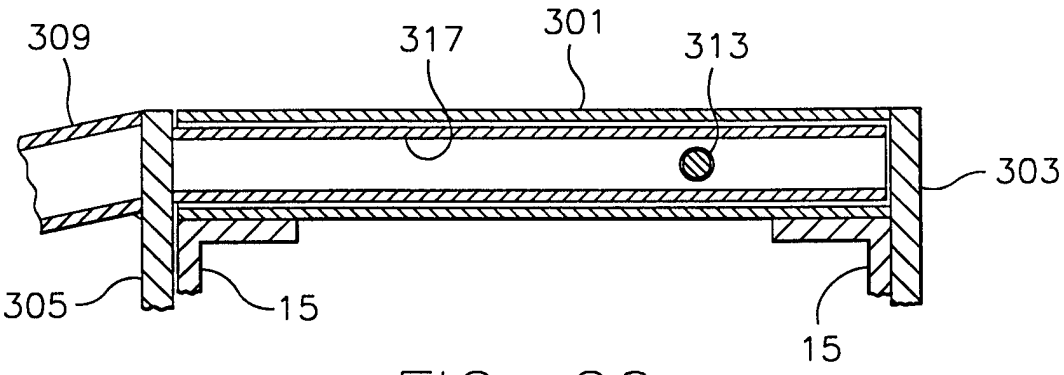

FIG. 20

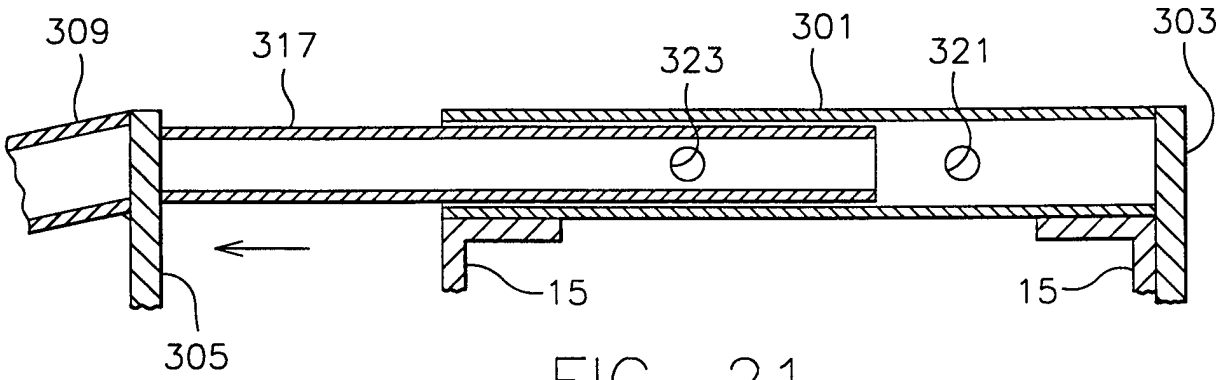

FIG. 21

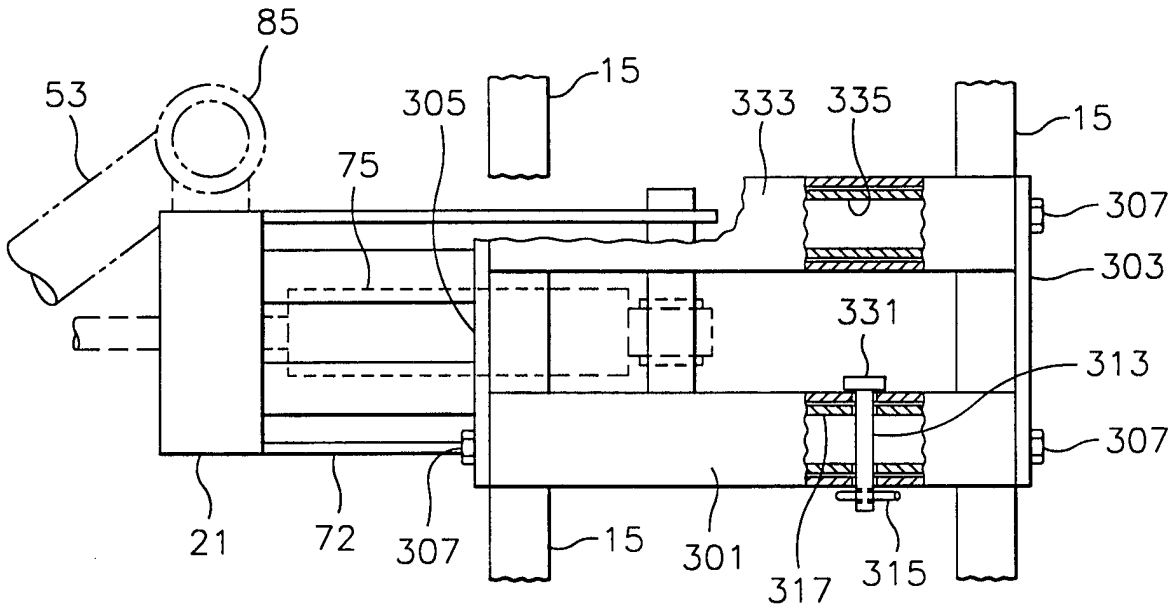
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FIG. 22

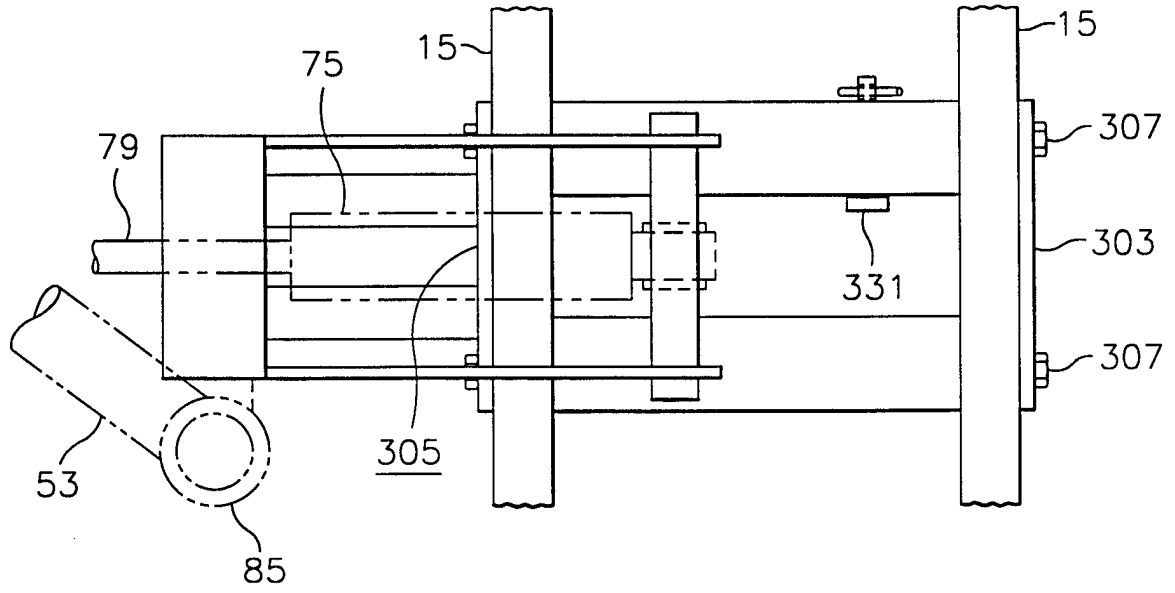
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FIG. 23

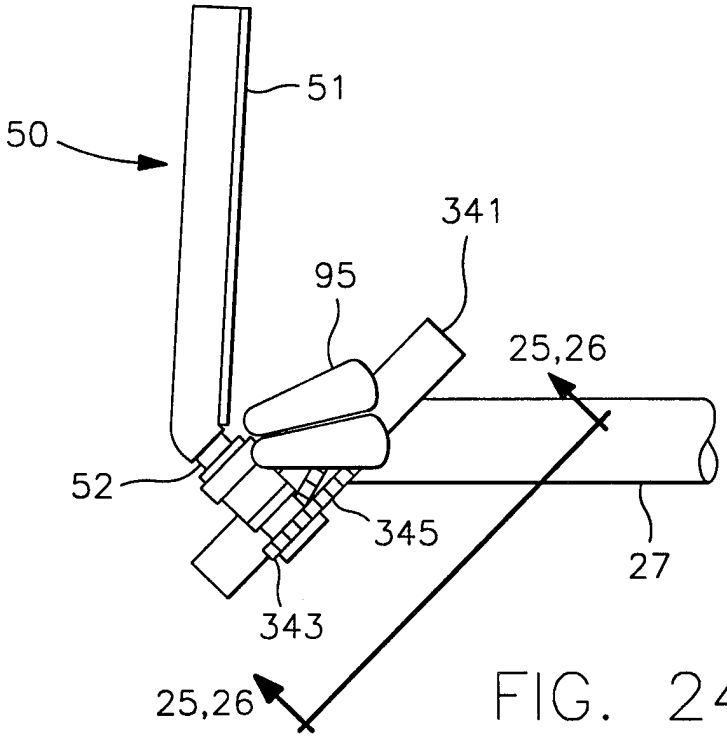
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FIG. 24

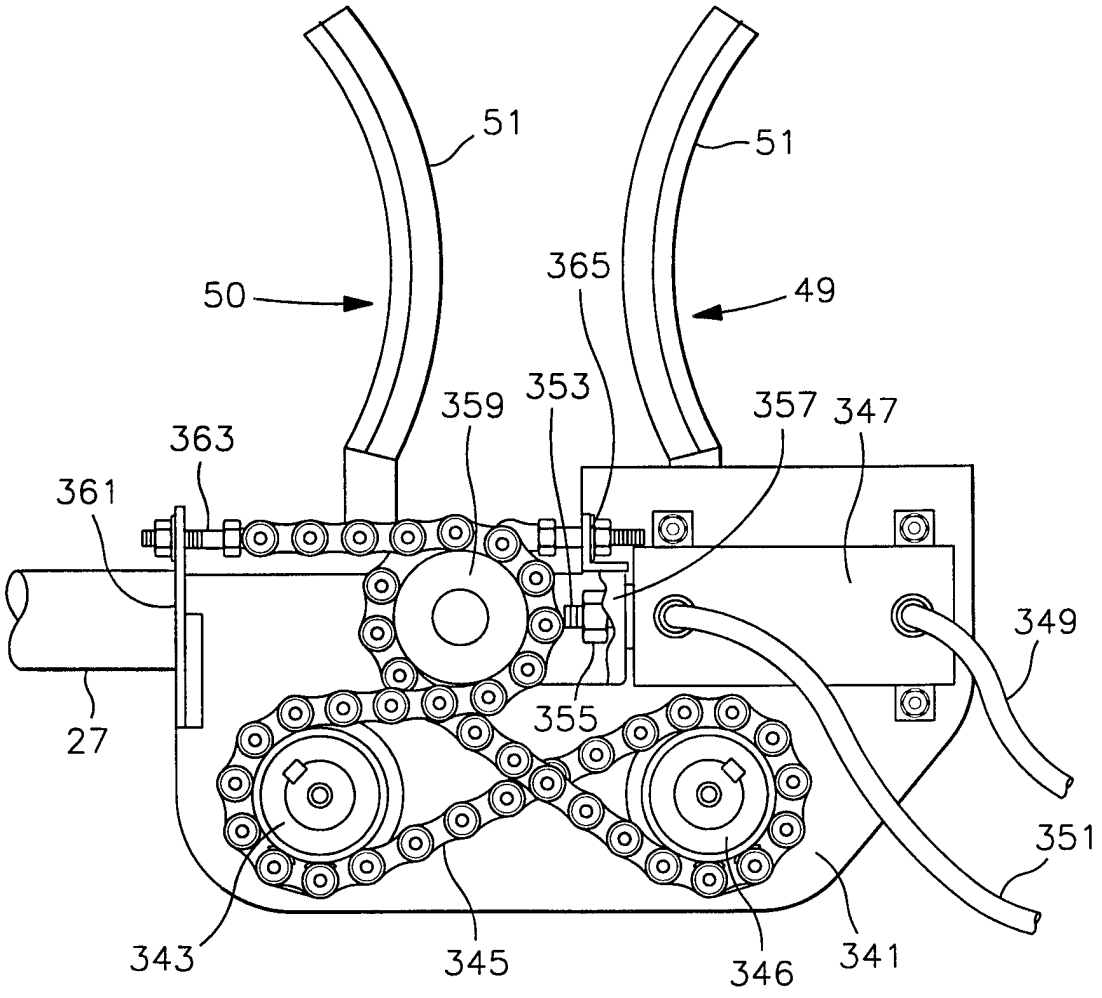
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FIG. 25

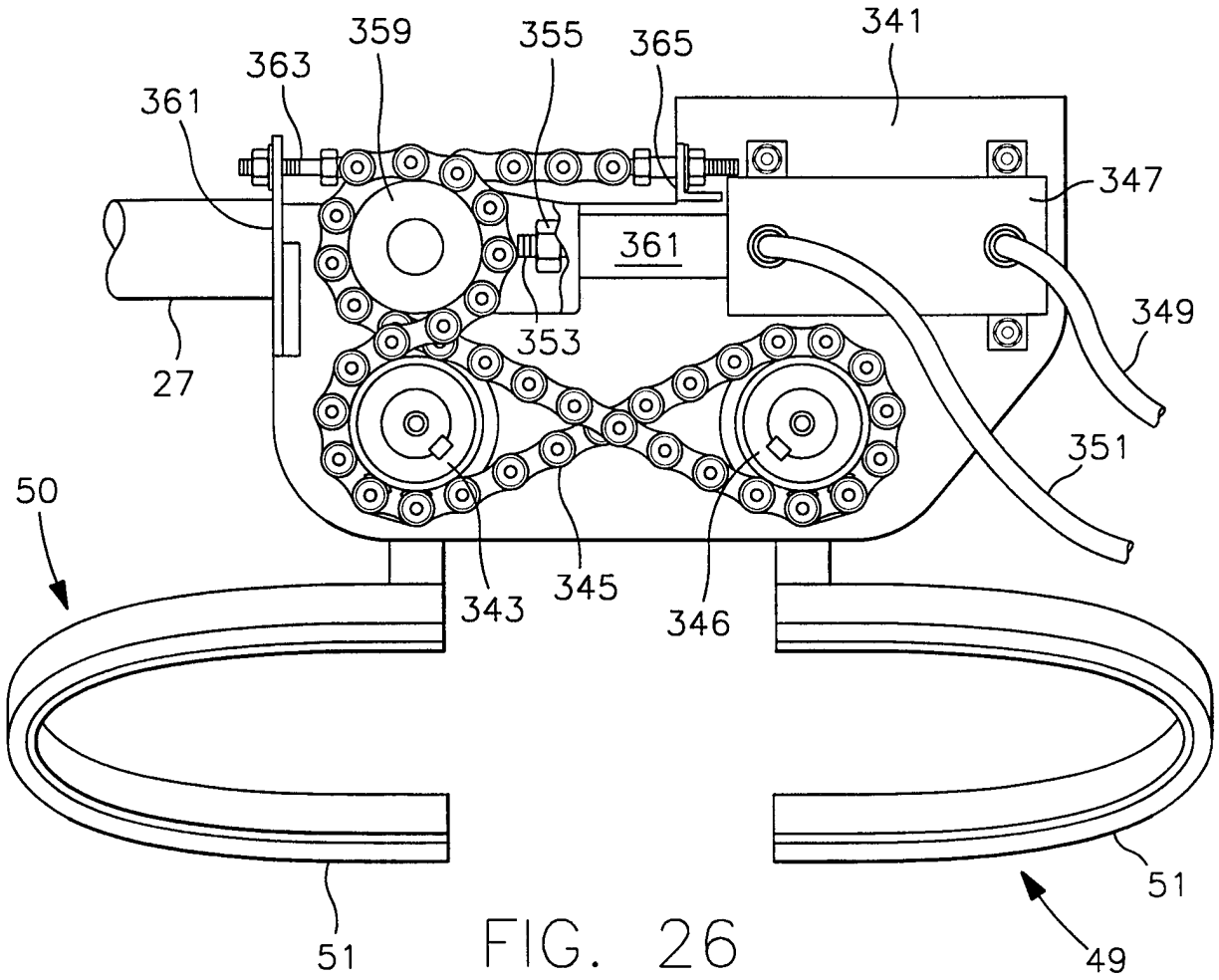
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FIG. 26

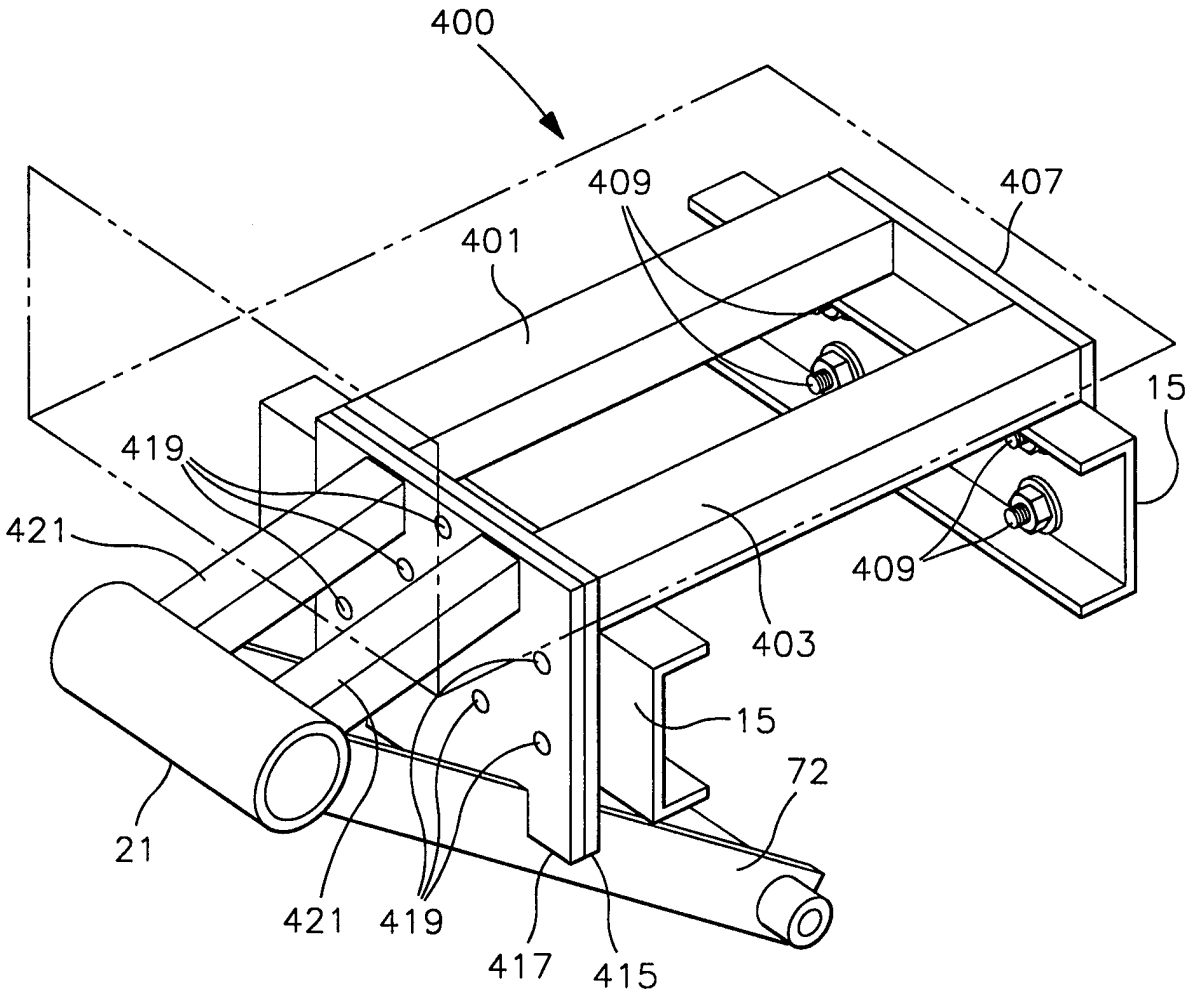

FIG. 27

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/08351

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :B66F 9/18
US CL :414/408

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 414/406, 408, 486, 487, 555, 558; 294/90, 106, 111

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 3,902,614 A (ROBERTS ET AL.) 09 February 1975 (09/02/75) see Fig. 1	22, 23
Y	US 4,358,147 A (HUNGERFORD) 09 November 1982 (09/11/82) see Fig. 1	22, 23
Y	US 4,461,607 A (SMITH) 24 July 1984 (24/07/84) see Fig. 1	16
Y	US 4,543,028 A (BELL ET AL.) 24 September 1985 (24/09/85) see Fig. 2	21, 26
A	US 4,669,940 A (ENGLEHARDT ET AL.) 02 June 1987 (02/06/87)	NONE

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

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"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 08 JUNE 1998	Date of mailing of the international search report 07 JUL 1998
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer for DAVID A BUCCI Telephone No. (703) 308-1113

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/08351

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4,726,726 A (DOSSENA ET AL.) 23 February 1988 (23/02/88) see Fig. 5	17-20
A, P	US 5,651,654 A (CHRISTENSON) 29 July 1997 (29/07/97)	NONE
A, P	US 5,702,225 A (GHIBAUDO) 30 December 1997 (30/12/97)	NONE
Y, P	US 5,720,589 A (CHRISTENSON ET AL.) 24 February 1998 (24/02/98) see entire document	3-5, 13, 14
X, P	US 5,725,348 A (DRAKE) 10 March 1998 (10/03/98) see entire document	1, 2, 15
Y		3-5, 13, 14, 16-21, 26