United States Patent

[11] **3,620,394**

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[54] **LOGGING APPARATUS**
18 Claims, 15 Drawing Figs.

[52] **U.S. Cl.** ..... **214/147 G,** 294/106
[51] **Int. Cl.** **B66c 1/32**
[50] **Field of Search** ..... 214/147, 147 G, 77; 294/106, 88

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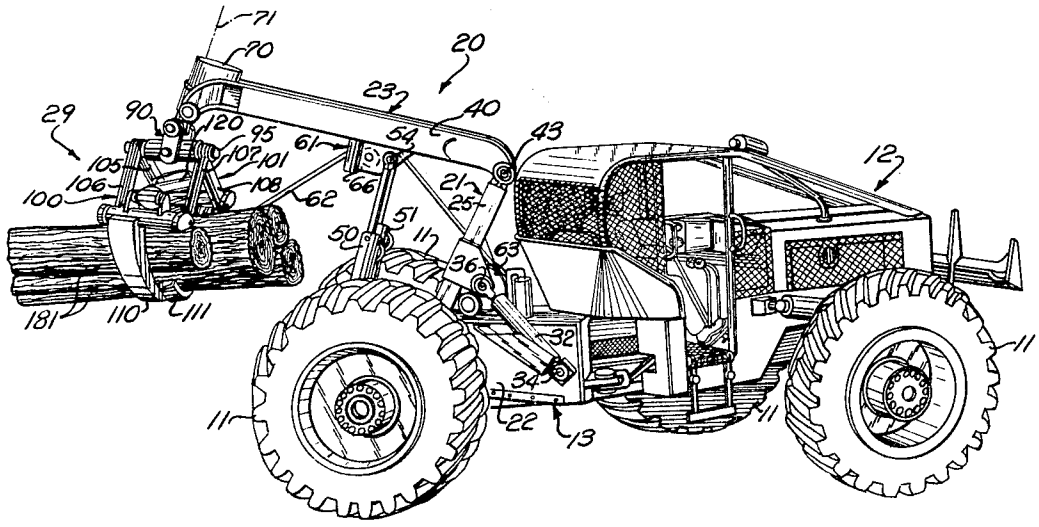
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ABSTRACT: An apparatus for use in handling trees, logs, and the like comprises an articulated vehicle having front and rear vehicle sections which are interconnected for relative pivotal movement about a vertical axis. A boom structure is supported on the rear section and comprises a first boom member which is pivotally connected to the rear section and a second boom member which is pivotally connected to the first boom member. A first power means is interconnected between the rear vehicle section and the first boom section for pivoting the first boom section relative thereto. A second power means is pivotally interconnected between the rear vehicle section and the second boom section for pivoting the second boom section relative to the first boom section. The logging apparatus also includes a hoist or winch mechanism having a cable which is guided through a fair-lead assembly supported on the second boom section. The fair-lead assembly includes a horizontal roller and a pair of vertical rollers which are operative to guide the cable. A grapple mechanism is supported for universal movement on the outer end of the second boom section and includes relatively movable article engagement members or arms which are supported for relative pivotal movement. The grapple mechanism is constructed so that as the article-engaging members are pivoted in a grapple-opening direction, the pivot axes thereof are bodily moved outwardly away from each other so as to effect a relatively wide opening of the grapple mechanism.



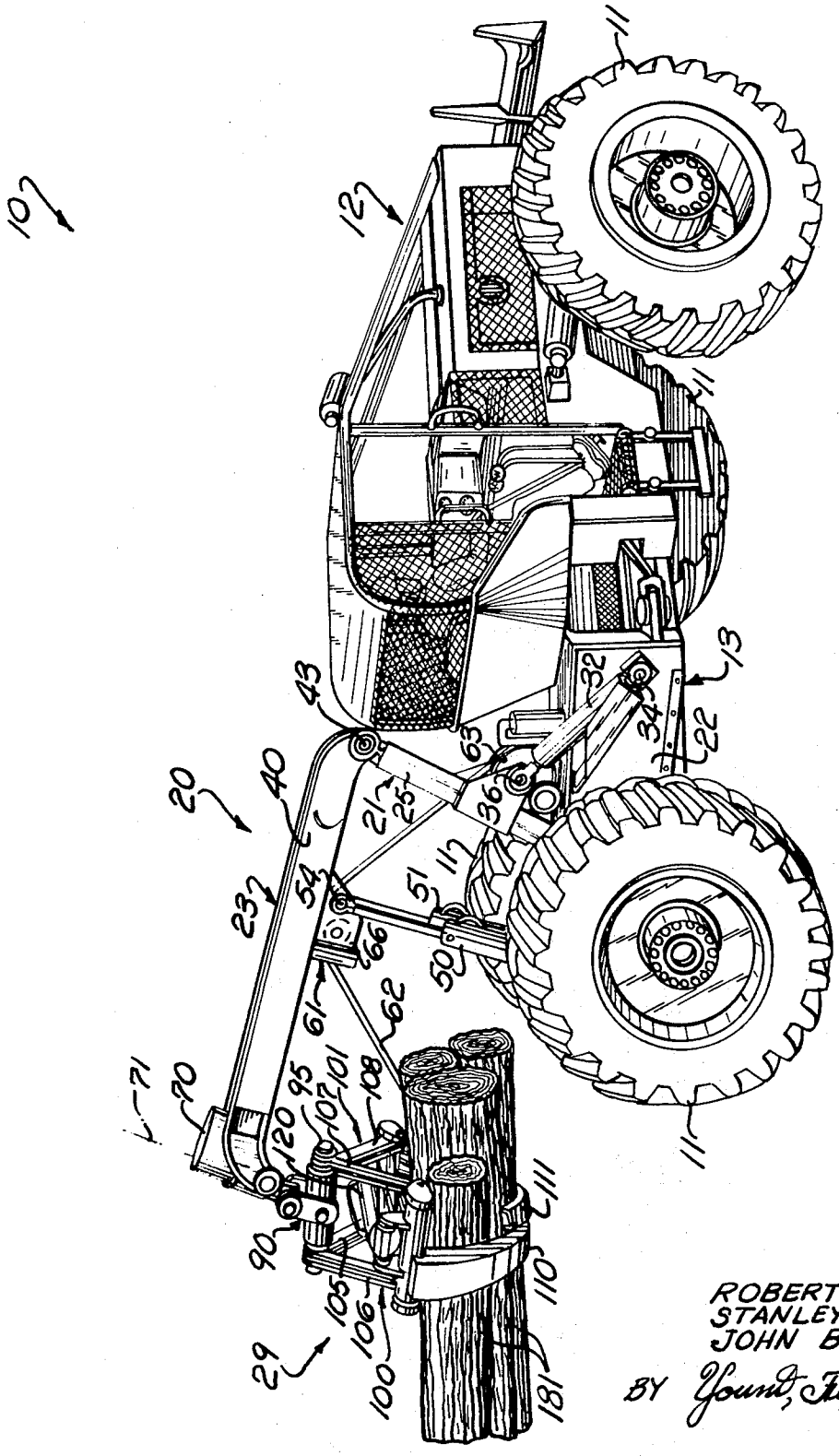


FIG. 1

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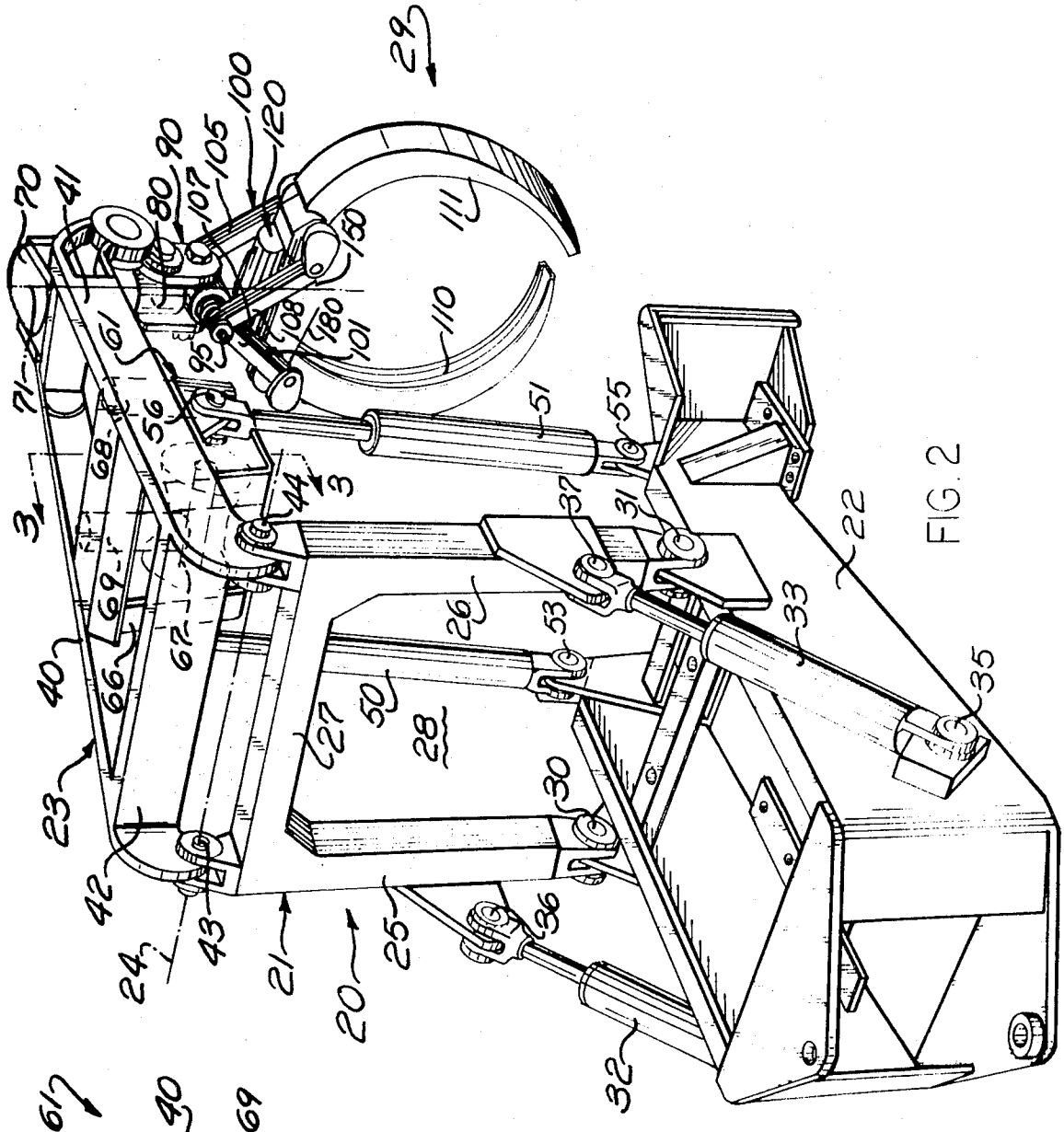


FIG. 2

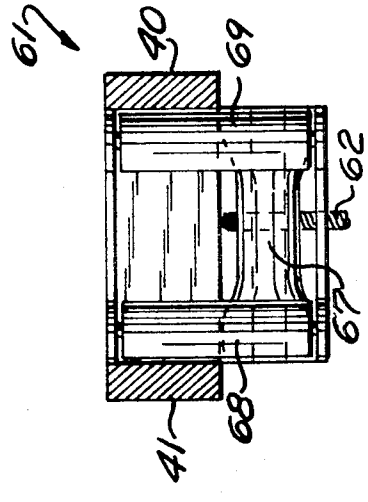


FIG. 3

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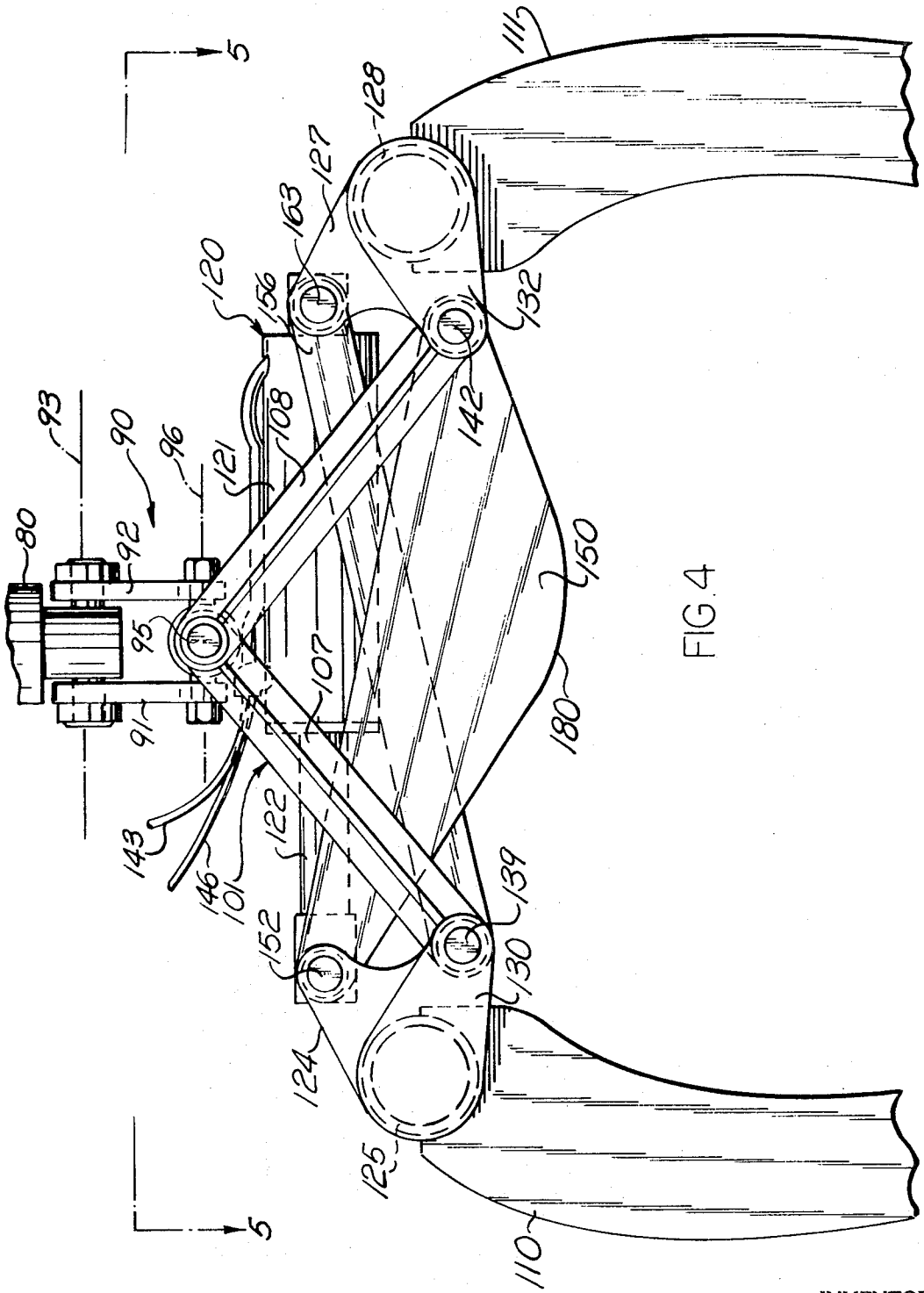


FIG. 4

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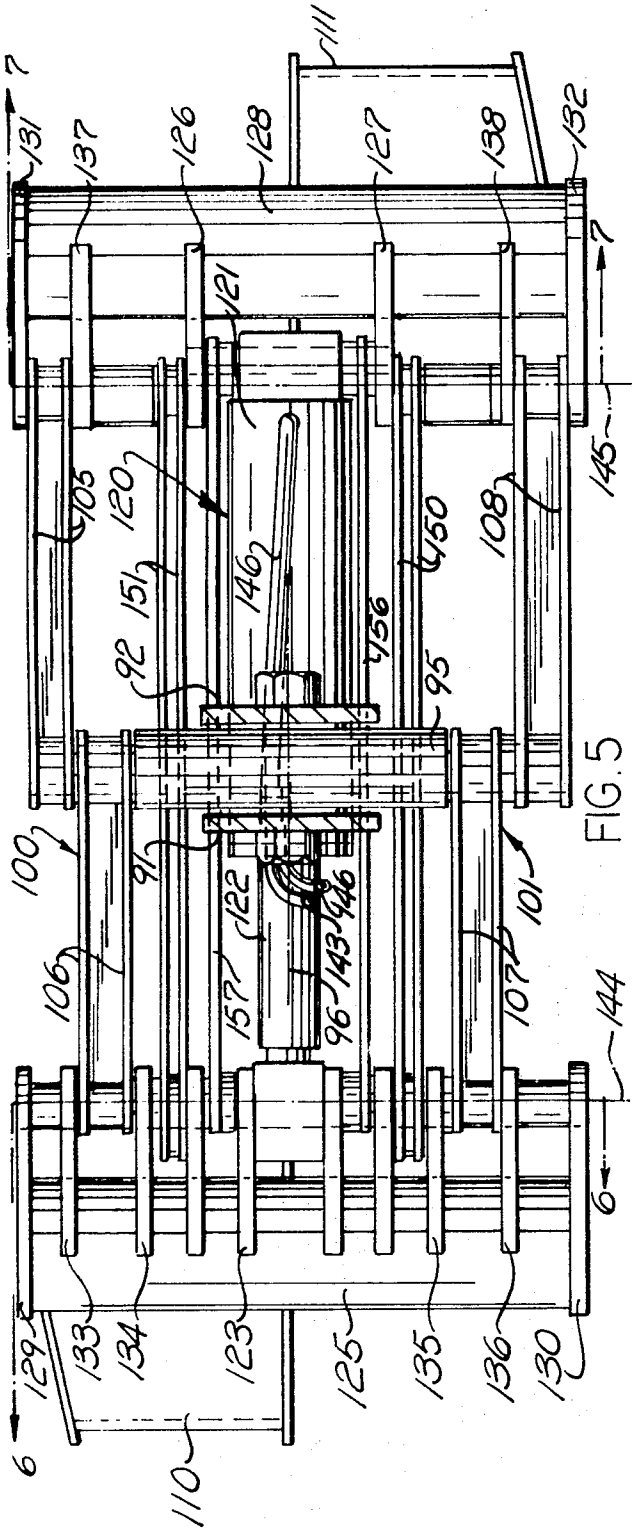


FIG. 5

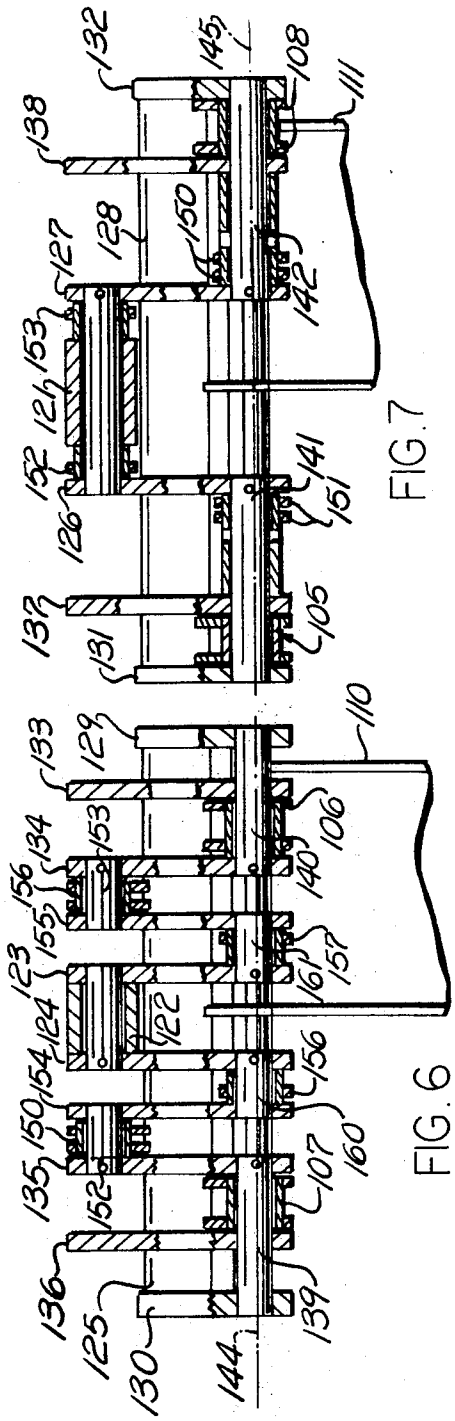


FIG. 6

FIG. 7

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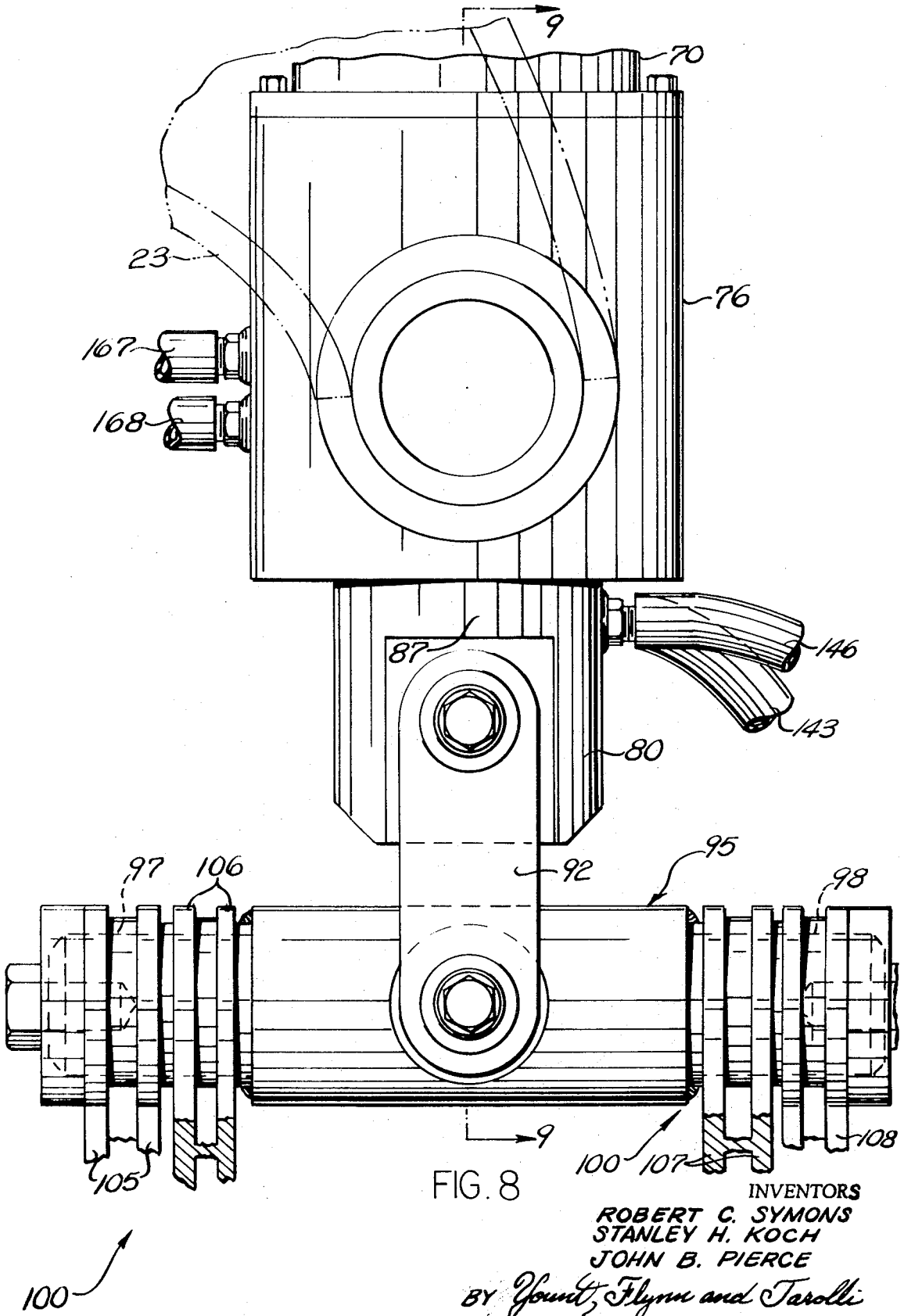


FIG. 8

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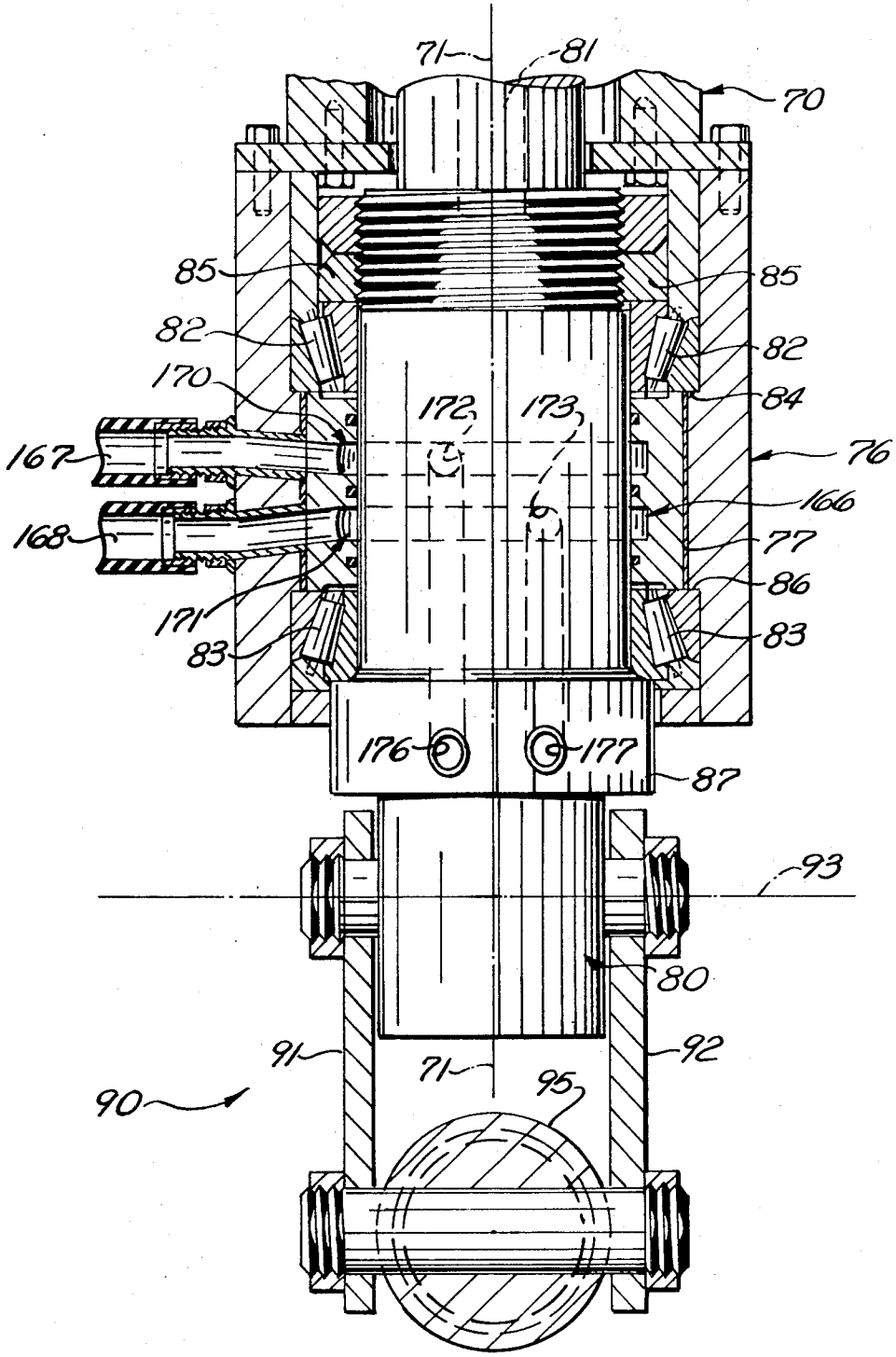


FIG. 9

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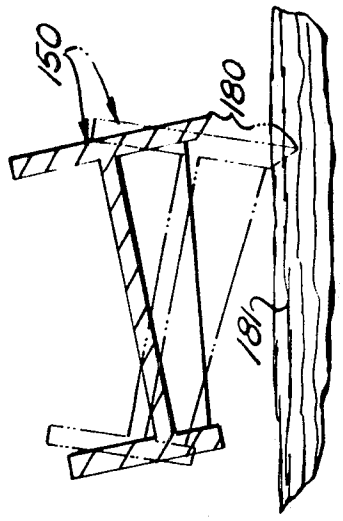


FIG. 10

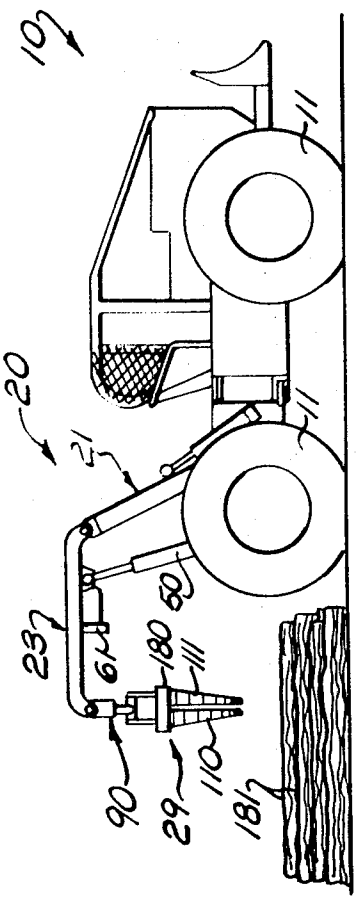


FIG. 11

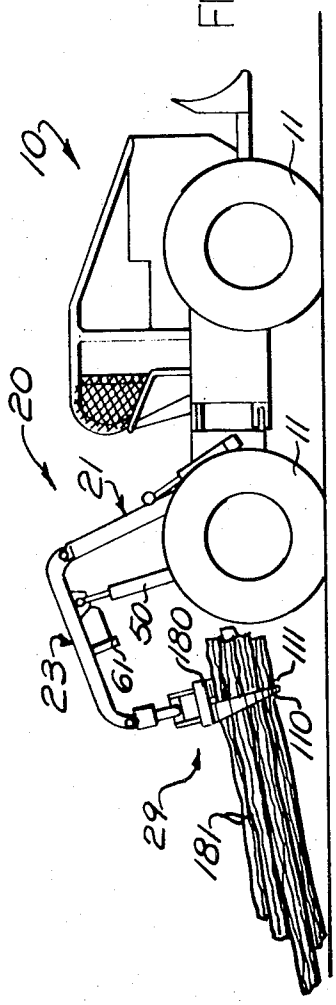


FIG. 12

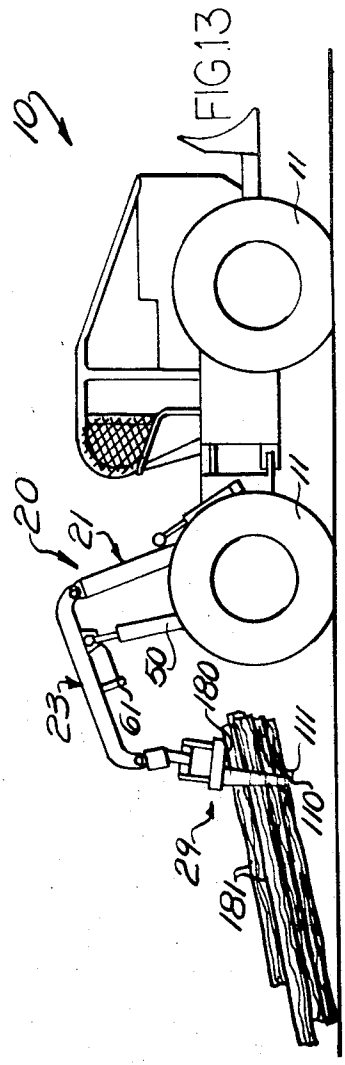


FIG. 13

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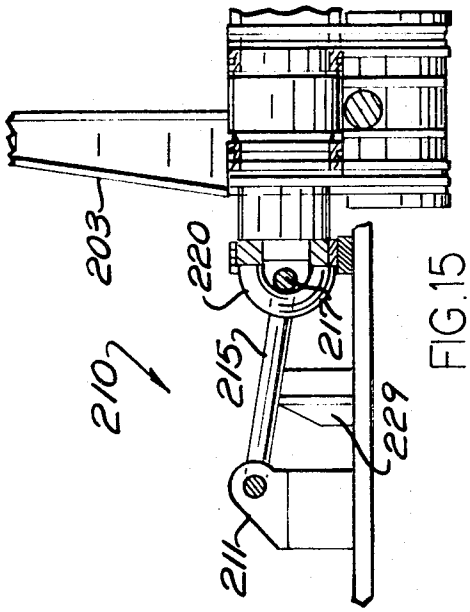


FIG. 15

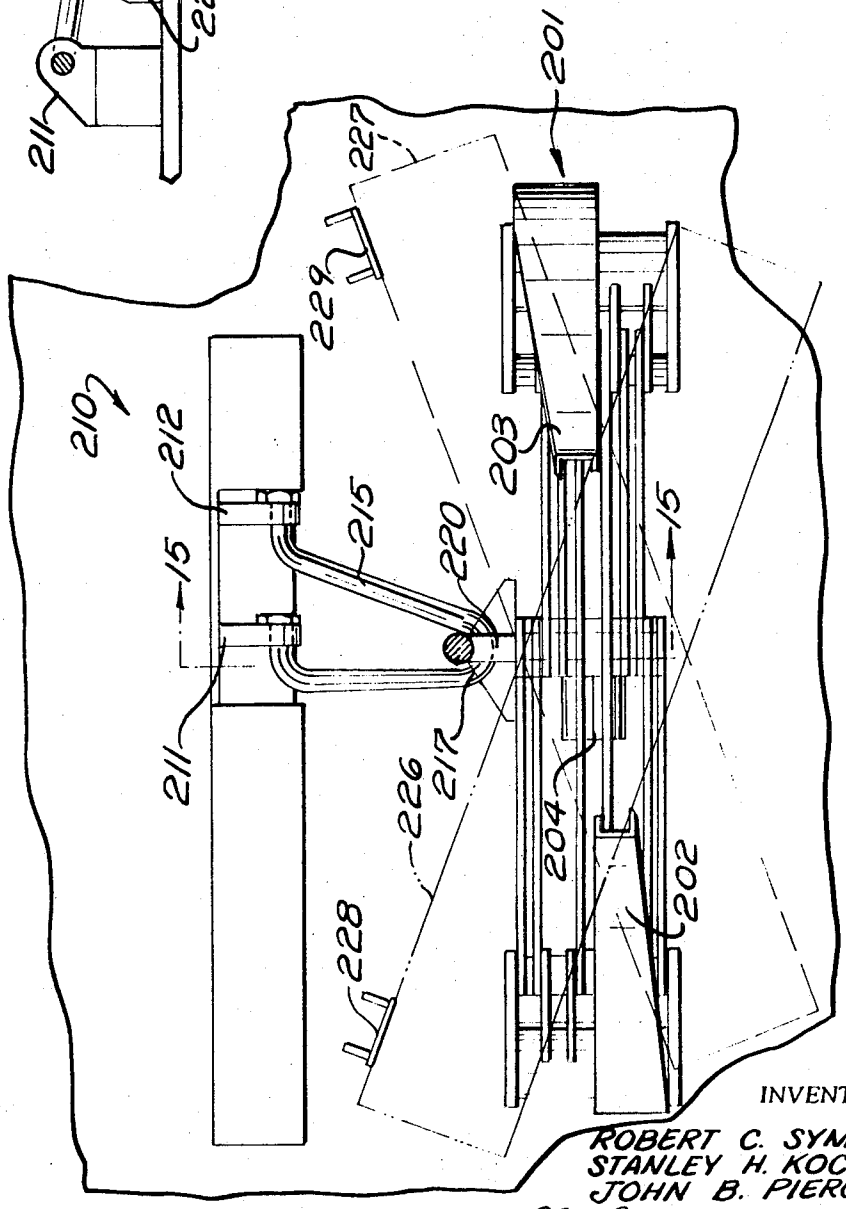


FIG. 14

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LOGGING APPARATUS

The present invention relates to a vehicle for use in handling trees, logs, and the like and, particularly, relates to a grapple skidder which includes a boom structure having a grapple thereon which is used in moving or conveying felled trees.

Grapple skidders are primarily used for conveying felled trees to a tree processing location. At the processing location, the trees may be delimbed, cut to size, and/or otherwise processed. The grapple skidder, due to the fact that it grabs felled trees where they have fallen, must be a readily maneuverable vehicle having an easily operable tree-engaging grab or grapple mechanism. The grapple skidder must also be durable and capable of handling a heavy load of a plurality of trees in an efficient and effective manner.

Known grapple skidders having a boom structure with a grapple thereon have not been entirely satisfactory in that they require a high degree of vehicle maneuvering and skillful operation of controls. The operational problems encountered in maneuvering many known grapple skidders have been accentuated by the provision of boom structures which obstruct an operator's view of the relationship between the grapple mechanism and felled trees. In addition, these known skidders have grapple mechanisms which are relatively limited as to the extent to which their jaws can be opened. Therefore, these grapple mechanisms must be accurately positioned relative to felled trees which are to be engaged by the grapple mechanism. The positioning of these known grapple mechanisms relative to the felled trees is further complicated by the necessity for an operator to avoid entangling long, flexible fluid conduits which have heretofore been associated with hydraulic motors for actuating the grapple mechanisms.

In addition to the aforementioned operational difficulties, many known grapple skidders have proven to be somewhat unsatisfactory due to their limited tree handling capacity. This limited capacity results both from the inability of the grapple mechanisms to engage a relatively large number of trees and an inability of the grapple skidders to effectively grip and retain a relatively large number of felled trees for skidding or conveying. The lack of an effective grip on the felled trees can often result in trees being dropped or lost while they are being skidded to a processing location.

The principal object of the present invention is the provision of a new and improved grapple skidder which is relatively easy to maneuver and is capable of readily handling a plurality of felled trees or logs in an efficient and effective manner with a minimum of operational difficulty.

A further object of the present invention is the provision of a new and improved grapple skidder which includes an articulated vehicle having first and second boom sections which are pivotal relative to each other by first and second power means, both of which act between a rear-articulated vehicle section and the boom sections which they pivot and provide a simple boom structure capable of handling relatively heavy loads.

A still further object of the present invention is the provision of a new and improved grapple skidder of the type which includes a boom structure mounted on a vehicle and a grapple mechanism supported on the boom for engaging felled trees, logs and the like, and wherein the boom is of an open archlike construction which is capable of handling heavy loads without unduly obstructing an operator's view of the relationship between the grapple mechanism and felled trees.

A further object of the present invention is the provision of a new and improved grapple skidder which includes a boom section with a grapple mechanism mounted on the end thereof and a rotary hydraulic motor for effecting rotation of tree-engaging arm members of the grapple mechanism and wherein a universal joint interconnects a rotatable output member of the rotary motor and a support for the tree-engaging arm members to thereby enable the arm members to move universally with respect to the boom while rotating relative thereto.

A still further object of the present invention is the provision of a new and improved grapple skidder, as noted in the next preceding object, wherein fluid for energizing a hydraulic-actuating mechanism for the tree-engaging arm members flows through the rotatable output member of the hydraulic motor to simplify the hydraulic system and eliminate possible entanglement of the hydraulic lines.

A still further object of the present invention is the provision of a new and improved grapple skidder having a grapple mechanism pivotally supported on the end of a boom structure so that the grapple mechanism will pivot relative to the boom structure when a load is engaged in the grapple mechanism and the vehicle is moved in a given direction, and wherein the grapple mechanism includes means for reducing the effective gripping area of the grapple mechanism in response to the pivoting movement whereby the grapple mechanism is capable of effecting a reduction in the cross-sectional gripping area of the grapple mechanism upon a change in the cross-sectional area of the load with the result that a loss of trees from the grapple mechanism due to alignment and weather cocking of the trees as they are being conveyed is minimized.

A more specific object of the present invention is the provision of a new and improved vehicle for handling logs and the like, as noted in the next preceding object, wherein the means for reducing the cross-sectional gripping area of the grapple mechanism includes a knife edge which is located on one side of the grapple mechanism and which moves into engagement with the logs gripped by the grapple mechanism upon pivoting movement of the grapple mechanism.

Another object of the present invention is the provision of a new and improved grapple skidder having a large tree-handling capacity and which includes a vehicle having a boom supported thereon with a grapple mechanism on the end of the boom and wherein a bunk mechanism is also supported on the vehicle to receive trees, logs and the like from the grapple mechanism.

Further objects and advantages of the present invention will be apparent to those skilled in the art to which it relates from the following description of a preferred embodiment thereof, made with reference to the accompanying drawings forming a part of this specification and in which:

FIG. 1 is a perspective view of a grapple skidder having a boom structure with a grapple mechanism carried on the outer end thereof;

FIG. 2 is a perspective view further illustrating the boom structure of the grapple skidder shown in FIG. 1;

FIG. 3 is an enlarged fragmentary sectional view, taken approximately along the section line 3—3 of FIG. 2, illustrating the construction of a fair-lead assembly mounted on the boom structure;

FIG. 4 is an enlarged view of the grapple mechanism of the grapple skidder of FIG. 1;

FIG. 5 is a plan view taken generally along the line 5—5 of FIG. 4, illustrating the construction of the linkage arrangement for use in actuating the grapple mechanism between open and closed conditions;

FIG. 6 is a sectional view taken approximately along the section line 6—6 of FIG. 5, illustrating the relationship of the linkage arrangement to one article-engaging arm of the grapple mechanism;

FIG. 7 is a sectional view taken approximately along the line 7—7 of FIG. 5, illustrating the relationship of the linkage arrangement to another article-engaging arm of the grapple mechanism;

FIG. 8 is an enlarged fragmentary view illustrating the interrelationship between the grapple mechanism, a hydraulic motor for rotating the grapple mechanism, and a universal joint for operatively interconnecting the hydraulic motor and grapple mechanism;

FIG. 9 is a sectional view, taken approximately along the line 9—9 of FIG. 8, illustrating an arrangement for connecting a hydraulic actuator on the grapple mechanism in fluid communication with conduits on the boom structure;

FIG. 10 is a schematic view illustrating the manner in which the grapple mechanism engages felled trees or logs;

FIG. 11, 12 and 13 are schematic views showing the operation of the grapple skidder;

FIG. 14 is a fragmentary top plan view of a modified grapple skidder having a bunk assembly for gripping felled trees or logs; and

FIG. 15 is a cross-sectional view, taken approximately along the section line 15—15 of FIG. 14, further illustrating the construction of the bunk assembly.

The present invention provides a highly improved grapple skidder for handling logs or felled trees. The grapple skidder comprises an articulated vehicle which supports an improved boom structure having an improved grapple mechanism at one end portion thereof. The boom structure includes a pair of open archlike sections which enable an operator of the grapple skidder to readily observe the relationship of the grapple mechanism to articles which are to be gripped or grabbed. These sections of the boom structure are movable relative to each other and the articulated vehicle by hydraulic power cylinders which extend between an end portion of the vehicle and the associated boom sections.

The improved grapple mechanism includes article engaging arms or jaws which can be rotated relative to the boom structure by a hydraulic motor mounted thereon. These arms are connected to the motor by a universal joint which provides for pivoting movement of the arms relative to the boom structure. The grapple mechanism is operable to a relatively wide open condition, to facilitate engaging trees, logs and/or other articles, by a linkage and hydraulic cylinder arrangement which pivots the article-engaging arms outwardly about a pair of axes while simultaneously therewith moving the axes away from each other. To minimize any possibility of entangling fluid conduits or lines, the hydraulic cylinder on the grapple mechanism is connected in fluid communication with conduits on the boom structure by fluid passages extending through a rotatable member mounted on the boom structure. Once the grapple mechanism has grabbed or gripped a plurality of logs and/or trees the grapple skidder begins to move forwardly, the grapple mechanism tends to pivot in such a manner as to reduce the cross-sectional gripping area of the grapple mechanism and force a knife edge into engagement with the logs or trees to thereby maintain a secure grip on them.

A grapple skidder **10** forming a preferred embodiment of the present invention is illustrated in FIG. **1**. The grapple skidder **10** comprises a vehicle which includes an engine and suitable drive mechanism for driving ground-engaging wheels **11** for moving the vehicle along the ground. The vehicle is an articulated vehicle in that it includes a forward vehicle section **12** and a rearward vehicle section **13** which are supported for relative pivotal movement about a generally vertical axis at a connection between the forward and rearward sections **12** and **13**. This relative pivoting movement between the forward and rearward vehicle sections **12**, **13** is effected in a known manner by suitable hydraulic power cylinders. As is also well known, the wheels **11** of the vehicle are capable of pivoting about horizontal axes to enable the vehicle to move across terrain of widely varying slopes while the forward section **12** of the vehicle remains substantially horizontal.

The rearward section **13** of the articulated vehicle supports a boom structure, generally designated **20**. The boom structure **20** includes a first boom section **21** which is pivotally connected to a support platform **22** forming a portion of the rearward vehicle section **13**. The boom structure **20** includes a second boom section **23** which is pivotally connected for movement about a horizontal axis **24** (FIG. **2**) at the end of the boom section **21**. The boom section **21** includes a pair of spaced, vertically extending support portions **25**, **26** which are interconnected at their upper ends by a transversely extending brace or support **27**. The support sections **25** through **27** provide an archlike construction which forms a relatively large opening **28**. An operator of the grapple skidder **10** can look through the opening **28** to view the relationship between a grapple mechanism **29** mounted on an outer end portion of the boom section **23** and logs or felled trees to be engaged by the grapple mechanism (see FIG. **1**). Of course, this relatively high degree of visibility greatly facilitates positioning the grapple mechanism **29** relative to the logs or felled trees to be engaged by the grapple mechanism.

The lower ends of the vertically extending support portions **25**, **26** are pivotally connected to the support platform **22** by suitable pins **30**, **31**, respectively. Suitable power actuator means in the form of a pair of hydraulic cylinders **32**, **33** are pivotally connected at **34**, **35** (see FIGS. **1** and **2**) to the support platform **22**. The piston rods of the cylinders **32**, **33** are pivotally connected at **36**, **37** to the vertically extending support portions **25**, **26**, respectively. Upon actuation of the cylinders **32**, **33**, it should be clear that the boom section **21** pivots about the axis provided by the pivot pins **30**, **31**.

The boom section **23**, as noted hereinabove, is pivotally connected to the boom section **21**. The boom section **23** includes a pair of horizontally extending support members or main stringers **40**, **41**. The members **40**, **41** extend from a base or transverse crossmember **42**. The crossmember **42** is located adjacent to the pivotal interconnection of the boom **23** to the boom section **21**. The pivotal interconnection of the boom section **23** to the boom section **21** is effected by pivot pins **43**, **44**. The boom section **23** is also substantially open so as to enable the operator to look therethrough while the grapple skidder **10** is being operated. Moreover, the support members **40**, **41** of the boom section **23** taper or converge toward each other as they extend outwardly from the cross or base member **42**. Therefore, the boom section **23**, while providing for visibility therethrough, does not have a relatively wide transverse dimension at the outer end thereof.

The boom section **23** is pivotal about the horizontal axis **24** by suitable power means in the form of a pair of hydraulic cylinders **50**, **51**. The hydraulic cylinder **50** acts between the support platform **22** to which it is pivotally connected by a pivot pin **53** and the outwardly extending support member **40** to which it is pivotally connected at **54** (FIG. **1**). Similarly, the cylinder **51** is pivotally connected to the rearward section **13** of the articulated vehicle by a pivot pin **55** (FIG. **2**) and the piston rod is pivotally connected at **56** to the outwardly extending support member **41** of the boom section **23**. From the above, it should be apparent that the boom sections **21**, **23** each comprise an open structure which does not substantially obstruct the operator's visibility. In addition, the boom structure **20** is capable of handling heavy loads which are supported directly on the main members or stringers **40** and **41** by the grapple mechanism **29**.

Due to the relative positioning of the various pivot points for the cylinders **32**, **33** with respect to the pivot pins **30**, **31**, as well as the pivot points for the cylinders **50**, **51**, a wide range of movement of the outer end of the boom structure **20** and grapple mechanism **29** can be effected. The outer end of the boom section **23** can actually be moved to a point below the wheels **11** of the vehicle. Therefore if the wheels **11** of the vehicle were on high ground and there were logs lying on ground substantially below and rearwardly of the vehicle, the boom structure **20** could be operated to position the grapple mechanism **29** to engage these logs.

A fair-lead assembly **61** is mounted on the boom section **23** and is effective to guide a cable **62** (FIG. **1**) which is wound on a conventional winch **63** which will not be described herein in detail, but which is generally designated **63**. The winch **63** is mounted on the support platform **22** of the rearward section **13** of the articulated vehicle. The cable **62** extends through the fair-lead assembly **61** and is guided thereby for movement relative to the boom section **23** so as to effect movement of a load upon operation of the winch **63**. The numerous specific functions and operations of the winch **63** and cable **62** are known and will not be described herein in detail.

The fair-lead assembly **61** is supported on the underside of the boom section **23** and comprises a plurality of rollers (FIG. **3**) over which the cable **62** is guided. More specifically, the fair-lead assembly **61** includes a fair-lead support structure **66** which is suitably secured to the boom section **23**. Within the

support structure 66 is a horizontal roller 67 which is disposed with its axis generally parallel to the horizontal axis 24 of the boom section 23. A pair of rollers 68, 69 are mounted at opposite ends of the roller 67 and have their axes extending substantially transverse to the axis of rotation of the roller 67. However, the axes of the rollers 68, 69 are spaced somewhat forwardly but immediately adjacent to the roller 67.

The cable 62 may be trained around the concave periphery of the roller 67 so as to tend to maintain the cable substantially centrally thereof. However, if the cable is to engage a load which is located sidewardly of grapple skidder 10, the rollers 68, 69 function as guide rollers for the cable and effect a guiding of the cable 62. Upon operation of the winch 63 the load is pulled generally sidewardly toward the boom section 23 and into a position in which it can be relatively easily engaged by the grapple mechanism 29 without substantial maneuvering of the grapple skidder 10.

To operate the grapple mechanism 29 to a position in which it can engage felled trees or logs in different angular relationships with the grapple skidder 10, a rotary hydraulic motor 70 is provided for rotating the grapple mechanism 29 about an axis 71 which extends perpendicular to the axis 24 (see FIG. 2). The rotary hydraulic motor 70 is fixedly secured to a housing or casing 76 (FIG. 9) which is attached to the outer end of the boom 23. The casing or housing 76 defines a chamber 77 into which a shaft member 80 extends. The inner end of the shaft member 80 is suitably secured to an output member 81 of the hydraulic motor 70 so as to provide for rotation of the shaft 80 upon operation of the motor.

The shaft member 80 includes an central portion which is supportingly engaged by bearings 82, 83 in the chamber 77 of the casing 76. The bearings 82, 83 permit rotation of the shaft 80 relative to the casing 76. In addition, these bearings 82 and 83 prevent axial movement of the shaft 80 relative to the casing 76. Accordingly, the bearing 82 abuts an annular shoulder 84 in the housing 76 and a retaining nut 85 on the shaft 80. Similarly the bearing 83 abuts a shoulder 86 on the housing 76 and an annular shoulder 87 on the shaft 80.

The outer end of the shaft 80 is suitably connected with the grapple 29 by a universal joint connection, generally designated 90. The universal joint connection 90 includes a pair of link members 91, 92 (FIGS. 4, 8 and 9) which are pivotally connected to the output end of the shaft 80 for movement about an axis 93 (FIG. 9). The other end of the link members 91, 92 are pivotally connected to a cross-link member or support 95 which extends transversely to the axis 93. The link member 95 may pivot relative to the link members 91, 92 about a pivot axis 96 which is parallel to the pivot axis 93. From the above, it should be apparent that the links 91, 92 pivot relative to the boom section 23 about the axis 93 and the links 91, 92 and the link 95 are capable of relative pivotal movement about the axis 96 which is parallel to the axis 93.

The link 95 at the outer ends thereof has reduced end portions 97, 98, respectively (FIG. 8). These end portions 97, 98 are engaged by grapple support means, 100, 101 for pivotal movement relative thereto about an axis, generally designated 102. The grapple support means 100, 101 are identical in construction and comprise a plurality of arm members which extend downwardly from the end portions 97, 98. The grapple support means 100 includes a pair of support arms 105, 106 are pivotally connected to the support portion 97 and extend angularly downwardly therefrom (see FIGS. 1, 2, 5 and 8). The support means 101 includes a second pair of support arms 107, 108 (FIGS. 4, 5 and 8) which extend angularly downwardly away from the end portion 98 of the support shaft 95. These arms 105 through 108 comprise a support arrangement for supporting the grapple mechanism 29.

The grapple mechanism 29 also includes a pair of article-engaging arm members 110, 111 (see FIGS. 2 and 4) which are utilized to clampingly engage logs or fallen trees in the manner illustrated in FIG. 1. The offset arm members 110 and 111 are mounted for pivotal movement between a widely spaced apart or open condition and a closed condition. Accordingly, the grapple mechanism 29 includes a suitable actuating mechanism 120 for effecting relative pivotal movement of the arm members 110, 111.

The actuating mechanism 120 includes a hydraulic cylinder 121 and a piston rod 122 associated with the cylinder 121. The piston rod 122 is pivotally connected to lug members 123, 124 which are fixedly connected to the arm member 110 by a tubular support section 125. The cylinder 121 is pivotally connected at its base end, that is the end opposite the end from which the piston rod 122 projects, to lug members 126 and 127 secured the arm member 111 by a tubular support portion 128. The support sections 125 and 128 are pivotally connected by end levers or plates 129, 130, 131 and 132 (FIGS. 4, 5, 6 and 7) and lugs 133, 134, 135, 136, and 138 to the support members 105 through 108 of the grapple support means 100, 101. Support pins 139, 140, 141 and 142 (FIGS. 6 and 7) are fixedly secured to the lugs and are pivotally engaged by the arm members 105 through 108.

When fluid is directed into the forward portion of the cylinder 121 through the conduit 143 (FIGS. 4), the piston rod 122 moves into the cylinder 121 to contract the actuating mechanism 120. This relative movement between the piston rod 122 and cylinder 121 effects pivotal outward movement of the arm members 110, 111, respectively, about pivot axes 144 and 145 extending through the support pins 139 through 142. When fluid is directed into the opposite or rearward portion of the cylinder 121 through a fluid conduit 146, the piston rod 122 moves out of the cylinder 121 to expand the actuating mechanism 100. This expansion of the actuating mechanism 100 effects inward pivotal movement of the arm members 110, 111 about the pivot axes 144 and 145.

From the above, it should be apparent that hydraulic fluid is thus suitably controlled and directed into the cylinder 121 to effect pivoting movement of the arm members 110, 111, either toward each other or away from each other in order to effect an opening of the grapple mechanism 29 and gripping of a load therein. The grapple mechanism 29 of the present invention is particularly constructed to provide for a good gathering action and for reducing the necessity of accurately positioning the grapple mechanism by maneuvering of the grapple skidder 10. This results from the fact that the grapple mechanism 29 is constructed so as to effect a relatively wide opening of the grapple mechanism. The wide opening of the grapple mechanism 29 also greatly speeds the pickup of trees even when the tree trunks are concealed by limbs, ets.

In order to effect the wide opening of the grapple arms 110, 111, the grapple mechanism 29 is provided with a linkage means 148 for effecting relative movement between the pivot axes 144 and 145 for the arms 110, 111 while the arms are being pivoted about these axes by operation of the actuating mechanism 100. This structure provides for movement of the pivot axes 144, 145 away from each other as the arm members 110, 111 are pivoting outwardly. As a result, the movement of the arm members 110, 111 not only is effected due to the pivoting movement of the arm members, but also due to the bodily movement of the pivot axes of the arm members away from each other. As a result of this action, an extremely wide opening of the arm members 110, 111 is effected.

The linkage means 148 for providing for movement of the pivot axes 144, 145 in a direction away from each other as the arms 110, 111 are pivoting outwardly includes a pair of identical link members 150 and 151 (FIGS. 4–7). These linkage members are pivotally connected at their ends to the grapple arm 110 and piston 122 by pins 152, 153, 141 and 142 and lugs 135, 154, 155 and 134 (FIG. 6). The linkage means 148 includes a second pair of identical link members 156 and 157. The links 156 and 157 are pivotally connected at their ends to the grapple arm 111 and cylinder 121 by pins 160, 161, 141 and 142 and lugs 154, 124, 123, and 155.

Upon the direction of fluid into the forward portion of hydraulic cylinder 121, the piston rod 122 moves into the cylinder 121 and the hydraulic-actuating mechanism 120 is

contracted. As a result of this movement, the lug 124 connected to the tubular support member 125 is rotated in a clockwise direction, as viewed in FIG. 4, to pivot the arm member 110 outwardly about the pivot pin 139. Similarly, the lug 127 connected to the tubular-support member 128 is rotated in a counterclockwise direction, as viewed in FIG. 4, to pivot the arm member 111 outwardly about the pivot pin 142. This clockwise pivoting movement of the lug 124 results in the link 150 pivoting the pin 142 outwardly or to the right as viewed in FIG. 4 about pivot pin 163. Thus, the grapple arm 111 is pivoted outwardly about the pivot pin 142 while the pivot pin 142 is itself being pivoted outwardly about the pivot pin 163. This combined pivoting movement results in the grapple arm 111 being swung outwardly through a relatively large arc to a wide open position upon operation of the hydraulic actuator 120 to a contracted condition.

The grapple arm 110 is also swung through a relatively large arc to a wide open position upon operation of the hydraulic actuator 120 to a contracted condition This is because the counterclockwise pivoting movement of the lug 127 (FIG. 4), under the influence of the actuating mechanism 120, results in the link 156 pivoting the pin 139 outwardly or to the left as viewed in FIG. 4 about the pivot pin 152. Thus, the grapple arm 110 is pivoted outwardly about the pin 139 while the pin 139 is itself being pivoted outwardly about the pivot pin 152. Therefore, the grapple arms 110, 111 are both pivoted outwardly at the same time about the pivot pins 139, 142, respectively, while the pivot pins 139, 142 are being moved apart to provide for a relatively wide opening of the grapple mechanism 29.

Upon operation of the actuating mechanism 120 to the extended condition of FIG. 4, the grapple arms 110, 111 will be moved back toward each other and the pivot axes will likewise be moved toward each other. Of course, this is merely a reversal on the previous operation of the linkages described hereinabove. In view of the fact that this is a mere reversal of that operation, the closing of the jaws will not be described in detail. It should be clear, however, that the pivot pins 139, 142 will be moved toward each other as the arms 110, 111 are pivoted inwardly. Although the foregoing description of the operation of the grapple mechanism has been made in regard to FIG. 4 and the links 150, 156, it should be understood that the links 151 and 157 are moved in the same manner as the links 150 and 156.

From the foregoing description it is apparent that upon actuation of the hydraulic-actuating means 120, the grapple arms 110, 111 are pivoted outwardly or inwardly depending upon how the fluid is applied to the hydraulic-actuating mechanism 120. The actuating mechanism 120 rotates about the axis 71 upon operation of the rotary motor 70 for the grapple mechanism 29. In order to minimize entangling and flexing of hydraulic cables and fluid conduits which conduct hydraulic fluid to the cylinder 121, the grapple mechanism 29 is provided with a rotary fluid-coupling assembly 166 (FIG. 9). Fluid is conducted to the fluid-coupling assembly 166 by conduits 167 and 168 (FIG. 8) which extend along the boom section 23. The outlet from the fluid coupling assembly 166 is connected to the fluid conduits 143 and 146 (FIG. 8) leading to the cylinder 121.

Upon rotation of the grapple mechanism 29 by operation of the motor 70, both ends of the conduits 143 and 146 are rotated with the grapple mechanism 29 while the conduits 167, 168 remain stationary relative to the boom section 23. To enable this to occur, the coupling assembly 166 includes a pair of annular passages or manifold rings 170, 171 which are connected in fluid communication with the conduits 167 and 168 respectively. The manifold rings each communicate with one of the transversely extending passageways 172, 173 in the rotary shaft member 80. The passageways 172, 173 each communicate with an associated longitudinally extending passageway 174, 175 in the shaft member 80. The passageways 174, 175 extend beyond the casing 76 and communicate with passageways 176, 177, respectively. The fluid conduits 146 and 143 are in turn connected in fluid communication with the passageways 176, 177. Both ends of the flexible hoses or conduits 146, 143 will be rotated upon rotation of the shaft member 80. Therefore, no relative rotation or flexing of the hoses will result from rotation of the shaft member 80. Of course, this minimizes any possibility of entangling the conduits 167, 168, 146 and 143 during operation of the grapple skidder 10. The grapple skidder 10 includes suitable manual control levers which may be operated by the operator of the vehicle in order to control valves which apply fluid pressure or exhaust to the chambers of the cylinder 121 by controlling whether the conduits 169, 168 are connected to a source of fluid pressure or a fluid reservoir.

The grapple mechanism 29 of the present invention is also constructed so as to maintain a gripping engagement with the logs as the logs are being dragged or conveyed by the vehicle. One serious problem that an operator of a grapple skidder 10 has when a load is completely gathered is that the trees very often are spread out and sometimes even cross each other. As a result, the cross-sectional area of the load is relatively great, due to the crossing of the logs. As the grapple skidder 10 begins dragging or skidding the load, the logs or trees tend to align with each other making the area of the load smaller. As a result, the logs or trees tend to become loose in the grapple mechanism and the operator must continually operate a valve in order to close the grapple mechanism to ensure that the grapple will be kept tight on the load as the trees become aligned and the cross-sectional area of the load decreases. This obviously must be done at the proper time in order to avoid the losing of trees and frequently some trees are dropped from the grapple as a result of the failure of the operator to operate the grapple arms at the appropriate time.

To alleviate the foregoing problem of decreasing cross section of the load, the link 150 (FIG. 4) which is located closest to the grapple skidder 10 is provided with a knife edge 180 (FIGS. 4 and 10) on the lower portion thereof. The operation of the knife edge 180 to minimize the loss of trees due to aligning of the trees during conveyance of the grapple skidder is illustrated schematically in FIGS. 11–13. FIG. 11 illustrates the grapple skidder 10 in a position above a load 181 in which the trees may be crossed providing a relatively great cross-sectional load area. The grapple skidder is then operated to tilt the upper part of the grapple mechanism 29 away from the vehicle. As a result, the knife edge 180 is positioned in a rearwardly sloping position such as indicated in solid lines in FIG. 10. The grapple mechanism 29 is then actuated to grip the load and the grapple skidder 10 is operated to convey the load in a forward direction.

As the grapple skidder 10 moves forwardly, the load will tend to shift and the trees or logs will tend to align in the direction of vehicle travel. This is commonly termed "weathercocking". As a result of this alignment, or weathercocking of the load, the cross-sectional area of the load becomes smaller and there is a tendency to lose the trees. However, as the trees are conveyed, the grapple mechanism 29 pivots in a forward direction to a position shown in FIG. 13. As a result of this pivoting, which is provided for by a universal joint connection 90, the knife edge 180 moves downwardly to the position shown in dot-dash lines in FIG. 10. This downward movement forces the knife edge 180 into the load and reduces the load engaging cross-sectional area of the grapple mechanism 29. Therefore the grapple mechanism 29 remains in secure engagement with the load 181 as the grapple skidder 10 moves down the road to thereby prevent a loss of trees.

A modified construction of a grapple skidder is illustrated in FIG. 14. This modified construction includes a grapple skidder of the type described hereinabove. However, in addition to the previously described mechanisms the grapple skidder of FIG. 14 includes a bunk mechanism, generally designated 201. The bunk mechanism 201 is a structure supported on the rear-articulated vehicle section in order to store a plurality of logs or trees and increase the carrying capability

of the grapple skidder. The bunk mechanism **201** comprises a suitable logagripping mechanism which is larger than the grapple mechanism **29** but operates in the same manner as the grapple mechanism **29**. However, the bunk mechanism **201** is positioned with article-engaging or grapple arms **202, 203** extending upwardly. These arms **202, 203** are operated between open and closed positions by an actuating mechanism **204** in the same manner as in which the arms **110** and **111** of the grapple mechanism **29** are operated between the open and closed positions by operation of the actuating mechanism **120**.

The bunk mechanism **201** is supported for universal movement relative to the rear-articulated vehicle section by a suitable support mechanism **210**. The support mechanism **210** includes a pair of lug members **211, 212** (FIG. **14**) which are suitably secured to the rear-articulated vehicle section and extend upwardly therefrom. The lugs **211, 212** are mounted on one side of a longitudinal center line through the rear-articulated vehicle section. A suitable curved or U-shaped link member, generally designated **215** (FIGS. **14, 15**), is pivotally connected at its ends to the lug members **211, 212**. The base **217** of the U-shaped member **215** has a second U-shaped member **220** linked therewith. The link member **215** may pivot in a vertical direction about a horizontal axis defined by the interconnection thereof to the lug members **211, 212**. The link member **220** may pivot about a vertical axis relative to the link **215**. Moreover, some sliding movement of the link **220** relative to the link **214** can be effected. As a result, the bunk mechanism **201** is free for universal movement to any one of a number of angular positions, some of which have been indicated in dashed lines at **226** and **227** in FIG. **14**. A pair of stop members **228, 229** are advantageously mounted on the rear of the articulated vehicle to limit pivotal motion of the bunk mechanism **201**.

From the above, it should be apparent that applicant has provided a highly improved grapple skidder mechanism capable of improved operation and having a substantial number of advantages, and it is intended hereby to cover all changes, adaptations, and modifications thereof coming within the scope of the appended claims.

Having described my invention, we claim:

1. Apparatus for use in handling trees, logs and the like comprising an articulated vehicle having forward and rearward vehicle sections interconnected for relative pivotal movement about a vertical axis, said rearward section including a boom support, a first boom section pivotally connected to said boom support for pivotal movement about a horizontal axis, a second boom section pivotally connected to said first boom section at the outer end thereof, a first power means acting between said boom support and said first boom section for pivoting said first boom section about the horizontal axis, a second power means acting between said boom support and said second boom section for pivoting said first boom section about the horizontal axis, a second power means acting between said boom support and said second boom section for pivoting said second boom section relative to said first boom section, and a grapple mechanism supported at the outer end of said second boom section and operable to grip logs therein; said grapple mechanism comprising a pair of opposing arm members mounted for pivotal movement relative to each other about first axes, actuator means pivotally connected to said arms at second axes spaced from the first axes and operable to pivot said arms about the first axes by moving the second axes relative to each other, a first link disposed adjacent logs gripped by said grapple mechanism extending between the first pivot axis of one of said arms and the second pivot axis of the other of said arms, and a second link extending between the first pivot axis of said other arm and the second pivot axis of said one arm; said apparatus further including means for pivotally connecting said grapple mechanism to said second boom section and for enabling said grapple mechanism to be pivoted to press said first link against logs gripped by said grapple mechanism upon forward movement of said articulated vehicle to thereby enable said grapple mechanism to maintain a secure grip on the logs.

2. An apparatus as set forth in claim 1 wherein said first boom section is an open archlike structure and includes a pair of spaced-apart side members pivotally connected to said boom support and a crossmember extending between outer end portions of said side members to define an open area extending from said crossmember to said boom support to facilitate viewing of said grapple mechanism by an operator of said articulated vehicle.

3. An apparatus as set forth in claim 2 wherein said second boom section includes a pair of support members which are pivotally connected at their inner end portions to said first boom section, said support members converging toward each other in a direction outwardly from said first boom section to provide closely spaced outer end portions, said grapple mechanism being connected to said closely spaced outer end portions of said support members.

4. An apparatus as set forth in claim 1 wherein said actuator means includes a hydraulic cylinder means pivotally connected to said arms, said first and second links being operable to effect relative movement between said first axes upon relative movement between said second axes under the influence of said hydraulic cylinder means.

5. An apparatus as set forth in claim 1 further including universal joint means for operatively connecting said grapple mechanism to said second boom section to enable said grapple mechanism to pivot about a plurality of axes relative to said second boom section.

6. Apparatus for use in handling trees, logs and the like comprising a boom support, a first boom section pivotally connected to said boom support for pivotal movement about a horizontal axis, first power means for pivoting said first boom section about the horizontal axis, a second boom section pivotally connected to said first boom section, second power means for pivoting said second boom section relative to said first boom section, said first and second boom sections each comprising an integral open archlike structure providing for visibility therethrough, said second boom section including a base portion adjacent said first boom section and a pair of support portions extending from said base portion, a grapple mechanism supported on the outer ends of said support portions and operable to grip logs therein, motor means mounted at the outer ends of said support portions, universal joint means operatively connected to said motor means and said grapple mechanism for pivotal movement of said grapple mechanism relative to said second boom section and for rotational movement of said grapple mechanism relative to said second boom section upon operation of said motor means, and an output member connected at one end portion to said motor means and at an opposite end portion to said universal joint means, said grapple mechanism including hydraulic actuator means for operating said grapple mechanism between open and closed conditions, said actuator means being connected in fluid communication with fluid conduits on said second boom section by fluid passageways formed in said output member.

7. Apparatus for use in handling logs and the like comprising a boom section pivotal about a horizontal axis, and a grapple mechanism supported on the outer end of said boom section; said grapple mechanism including a rotatable member supported by said boom section for rotation relative thereto about an axis transverse to said horizontal axis, a pair of relatively movable log-gripping jaws, a support for said jaws, a universal joint means connecting said jaw support and said rotatable member, and hydraulic-actuator means for operating said jaws between open and closed conditions, said rotatable member defining fluid passage means for connecting said hydraulic-actuator means in fluid communication with said boom section while enabling said grapple mechanism to be rotated relative to said boom section.

8. Apparatus as set forth in claim 7 further including motor means mounted on said boom section for rotating said grapple mechanism relative to said boom section, said motor means being operatively connected to said grapple mechanism through said rotatable member and said universal joint means.

9. Apparatus as set forth in claim 8 wherein said grapple mechanism includes actuator means for pivoting said jaws inwardly and outwardly about first axes and for moving said first axes toward each other while said arms are being pivoted inwardly and for moving said first axes away from each other while said arms are being pivoted outwardly to thereby enable said grapple mechanism to be operated between a closed condition and a relatively wide open condition.

10. Apparatus as set forth in claim 9 wherein said actuator means includes a knife edge which is pressed against the logs by the aforesaid pivoting movement of said grapple mechanism.

11. Apparatus for use in handling logs and the like comprising a boom section pivotal about a horizontal axis; and a grapple mechanism supported on the outer end of said boom section, said grapple mechanism including a rotatable member supported by said boom section for rotation relative to said boom section about a first axis transverse to said horizontal axis, a pair of relatively movable jaws, a support for said jaws, universal joint means connecting said support to said rotatable member for rotation therewith, said universal joint means including first link means pivotally connected to said rotatable member for pivotal movement relative thereto about a first axis, second link means pivotally connected to said first link means for relative pivotal movement about a second axis parallel to said first axis, third link means pivotally connected at one end portion to said second link means and at an opposite end portion to one of said jaws and fourth link means pivotally connected at one end portion to said second link means and at an opposite end portion to the other of said jaws, actuator means operated under the influence of high-pressure fluid for operating said jaws between open and closed conditions, said actuator means being operable to pivot said jaws outwardly relative to each other and to simultaneously therewith move said opposite end portions of said third and fourth link means away from each other to enable said jaws to be operated to a relatively wide open condition, and fluid-passage means formed in said rotatable member for connecting said actuator means in fluid communication with said boom section to enable said actuator means to be exposed to a source of high-pressure fluid.

12. Apparatus for use in handling logs and the like comprising a boom section pivotal about a horizontal axis, a grapple mechanism supported on the outer end of said boom section, said grapple mechanism including a pair of relatively movable log gripping jaws and a hydraulic-actuating means for effecting relative movement of said log-gripping jaws, a rotatable member supported by said boom for rotation relative thereto, means connecting said rotatable member and said log-gripping jaws to provide for rotation of said log-gripping jaws with said rotatable member, and fluid conduit means for delivering hydraulic fluid to said actuating means, said fluid conduit means comprising a fluid passageway in said rotatable member and at least one fluid conduit communicating at one end with said fluid passageway in said rotatable member and at the other end with said actuating means.

13. Apparatus as set forth in claim 12 wherein said means connecting said rotatable member with said jaws includes universal joint means operable to enable said grapple mechanism to pivot about first and second transverse axes to facilitate gripping of logs with said jaws.

14. Apparatus as set forth in claim 12 wherein said actuating means includes hydraulic cylinder means pivotally connected to said jaws at first axes and operable to pivot said jaws about second axes spaced from said first axes by moving said first axes relative to each other, a first link extending between the first pivot axis of one of said jaws and the second pivot axis of the other of said jaws, and a second link extending between the first pivot axis of said other of said jaws and the second pivot axis of said one jaw, said hydraulic cylinder means being operable pivot said jaws about the second axes and to move said first and second links relative to each other to effect movement of said second axes relative to each other.

15. A vehicle for handling logs or the like comprising a support; a boom section pivotal about a horizontal axis relative to said support; a grapple mechanism supported by said boom section and operable to grip logs therebetween, said grapple mechanism including a pair of grapple arms which cooperate to at least partially define the gripping area of said grapple mechanism, and linkage means for moving said grapple arms relative to each other; means connecting said grapple mechanism to said boom section and enabling said grapple mechanism to pivot about an axis transverse to the direction of vehicle movement when said grapple mechanism has a load therein, the load in said grapple mechanism being reducible in cross-sectional area when said vehicle moves; and means formed on said linkage means for reducing the cross-sectional gripping area of said grapple mechanism in response to said pivoting movement of said grapple mechanism, said last-named means including knife-edge means formed on said linkage means for engaging the logs upon said pivoting movement.

16. A vehicle as set forth in claim 15 wherein said means connecting said grapple mechanism to said boom section includes a rotatable member, first link means pivotally connected to said rotatable member for pivotal movement relative thereto about a first axis extending transverse to the direction of vehicle movement when said grapple mechanism has a load therein, second link means pivotally connected to said first link means for pivotal movement about a second axis extending parallel to said first axis, and means pivotally connecting said grapple mechanism to said second link means for pivotal movement about a third axis transverse to said first and second axes.

17. A vehicle as set forth in claim 15 wherein said grapple arms are mounted for pivotal movement relative to each other about first axes and including actuator means for pivoting said arms inwardly and outwardly about said first axes independently of said means for reducing the cross-sectional gripping area of said grapple mechanism, said linkage means being arranged for moving said first axes toward each other while said arms are being pivoted inwardly and for moving said first axes away from each other while said arms are being pivoted outwardly to thereby enable said grapple mechanism to be operated between a closed condition and a relatively wide open condition.

18. Apparatus for use in handling trees, logs and the like comprising an articulated vehicle having forward and rearward vehicle sections interconnected for relative pivotal movement about a vertical axis, said rearward section including a boom support, a first boom section pivotally connected to said boom support for pivotal movement about a horizontal axis, a second boom section pivotally connected to said first boom section at the outer end thereof, a first power means acting between said boom support and said first boom section for pivoting said first boom section about the horizontal axis, a second power means acting between said boom support and said second boom section for pivoting said second boom section relative to said first boom section, a grapple mechanism supported at the outer end of said second boom section and operable to grip logs therein, universal joint means for operatively connecting said grapple mechanism to said second boom section to enable said grapple mechanism to pivot about a plurality of axes relative to said second boom section, and motor means mounted on said second boom section and having a rotatable output member connected to a first side of said universal joint means, said grapple mechanism being connected to a second side of said universal joint means whereby operation of said motor means rotates said grapple mechanism through said universal joint means to facilitate positioning of said grapple means relative to said articulated vehicle.

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