ABSTRACT

The mining vehicle for spraying a fluid including a vehicle portion having a propulsion system for propelling the mining vehicle, a boom connected to the vehicle portion, and a hydraulically driven pivot assembly connecting the boom to the vehicle portion. The pivot assembly includes a horizontal axis pivot member to allow the boom to pivot about the vehicle portion about a first horizontal axis. The boom comprises at least three boom arms and a nozzle on an end thereof, with each of the boom arms being pivotable about an adjacent one of the boom arms about a second axis. The second axis is substantially perpendicular to the first horizontal axis.
HORIZONTALLY ROTATABLE MULTI-KNUCKLE BOOM

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to co-pending U.S. Provisional Patent Application No. 61/714,972, filed Oct. 17, 2012, the disclosure of which is hereby incorporated by reference in its entirety.

FIELD OF THE INVENTION

[0002] This invention relates generally to vehicles and, more particularly, to a vehicle having a horizontally rotatable multi-knuckle boom.

BACKGROUND OF THE INVENTION

[0003] Vehicles having spray booms for spraying liquids during mining have typically included booms that can fold, extend and rotate about a horizontal axis perpendicular to a direction of motion of the vehicle. A vehicle having a boom with greater degrees of movement and easier methods of rotation is desired.

SUMMARY OF THE INVENTION

[0004] A first aspect of the present invention is to provide a mining vehicle for spraying a fluid. The mining vehicle includes a vehicle portion having a propulsion system for propelling the mining vehicle, a boom connected to the vehicle portion, and a hydraulically driven pivot assembly connecting the boom to the vehicle portion. The pivot assembly includes a horizontal axis pivot member to allow the boom to pivot about the vehicle portion about a first horizontal axis. The boom comprises at least three boom arms and a nozzle on an end thereof, with each of the boom arms being pivotable about an adjacent one of the boom arms about a second axis. The second axis is substantially perpendicular to the first horizontal axis.

[0005] Another aspect of the present invention is to provide a mining assembly for providing a fluid comprising a base, a boom connected to the base, and a hydraulically driven pivot assembly connecting the boom to the base. The pivot assembly includes a horizontal axis pivot member to allow the boom to pivot about the base about a first horizontal axis. The boom comprises at least three boom arms and a nozzle on an end thereof, with each of the boom arms being pivotable about an adjacent one of the boom arms about a second axis. The second axis is substantially perpendicular to the first horizontal axis.

[0006] Yet another aspect of the present invention is to provide a mining vehicle for spraying a fluid comprising a vehicle portion having a propulsion system comprising wheel for propelling the mining vehicle, a boom connected to the vehicle portion, and a hydraulically driven pivot assembly connecting the boom to the vehicle portion. The pivot assembly includes a horizontal axis pivot member to allow the boom to pivot about the vehicle portion about a first horizontal axis. The boom comprises at least three boom arms and a nozzle on an end thereof, with each of the boom arms being pivotable about an adjacent one of the boom arms about a second axis. The second axis is substantially perpendicular to the first horizontal axis. The mining vehicle also includes a tube system extending between the vehicle portion and the nozzle, with the tube system being configured to supply the fluid from the vehicle portion to the nozzle for spraying the fluid out of the nozzle. At least one of the boom arms is a telescoping arm having the nozzle on a distal end thereof. Each adjacent pair of the boom arms have an actuator pivotally connected thereto for rotating the boom arms relative to each other about the second axis.

BRIEF DESCRIPTION OF DRAWINGS

[0007] FIG. 1 is a side view of vehicle of the present invention.
[0008] FIG. 2 is a side view of a boom of the vehicle of the present invention in a folded position.
[0009] FIG. 3 is a side view of the boom of the vehicle of the present invention in an unfolded position.
[0010] FIG. 4 is a top perspective view of the boom of the vehicle of the present invention in the unfolded and fully extended position.
[0011] FIG. 5 is a top perspective view of a horizontal axis pivot assembly and a first arm of the boom of the vehicle of the present invention.
[0012] FIG. 6 is a cross sectional view of the horizontal axis pivot assembly of the present invention.
[0013] FIG. 7 is a top perspective view of a second arm of the boom of the vehicle of the present invention.
[0014] FIG. 8 is a top perspective view of a third arm of the boom of the vehicle of the present invention.
[0015] FIG. 9 is a top perspective view of a fourth telescoping arm of the boom of the vehicle of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0016] For purposes of description herein, it is to be understood that the invention may assume various alternative orientations, except where expressly specified to the contrary. It is also to be understood that the specific devices and processes illustrated in the attached drawings, and described in the following specification, are simply exemplary embodiments of the inventive concepts defined herein. Hence, specific dimensions and other physical characteristics relating to the embodiments disclosed herein are not to be considered as limiting, unless expressly stated otherwise.

[0017] The reference number 10 (FIG. 1) generally designates a vehicle embodying the present invention. In the illustrated example, the vehicle 10 includes a front vehicle portion 12 and a rear vehicle portion 14. A joint 16 articulates between the front vehicle portion 12 and the rear vehicle portion 14. The joint 16 can be a powered joint or a passive joint. While any joint 16 could be used, an example of a powered joint that could be used is disclosed in U.S. Patent Application No. 61/625,962, entitled ARTICULATION AND OSCILLATION JOINT FOR VEHICLE, the entire contents of which are hereby incorporated herein by reference. While the vehicle 10 is illustrated as having a pivoted front vehicle portion 12 and a rear vehicle portion 14, it is contemplated that the vehicle 10 could be formed of a single fixed body.

[0018] The illustrated front vehicle portion 12 propels the vehicle 10. The front vehicle portion 12 includes an engine for driving the vehicle 10 and at least one pair of driven wheels 17 for propelling the vehicle 10 (e.g., four wheel drive with two
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pairs of driven wheels 17). The pair of driven wheels 17 can be connected by a solid axle or cradle axle. Cradle axles are well known to those skilled in the art and any cradle axle can be used. For example, the front vehicle portion 12 can have the cradle axle discussed in U.S. Pat. No. 4,082,377 entitled AXLE CRADLE MOUNTING HAVING ELASTOMERIC SPHERICAL DÜSCHINGS, the entire contents of which are hereby incorporated herein by reference. The pivot actuator 26 can also be an L30 helical, hydraulic actuator as sold by Helac Corporation® of Enumclaw, Washington. The pivot actuator 26 can be powered hydraulically or by other means. As illustrated in FIG. 1, the external cylinder 38 has hydraulic lines 46 connected thereto for supplying the pivot actuator 26 with hydraulic fluid under pressure (from a source of pressurized fluid on the vehicle 10) to power the pivot actuator 26.

[0022] The illustrated external cylinder 38 of the pivot actuator 26 of the horizontal axis pivot assembly 30 is fixedly connected to the vehicle 10 to allow the internal cylinder 40 to rotate about the horizontal axis 25. The front vehicle portion 12 of the vehicle 10 includes a proximal connection collar 48 and a distal connection collar 50. The proximal connection collar 48 includes a substantially block-shaped base plate 52 and a ring collar portion 54 extending from the base plate 52. The base plate 52 of the proximal connection collar 48 is fixed to the front vehicle portion 12 and the ring collar portion 54 surrounds an exterior periphery of a proximal side circumferential surface of the external cylinder 38 of the pivot actuator 26. The ring collar portion 54 of the proximal connection collar 48 is fixed to the external cylinder 38 of the pivot actuator 26 by any means (e.g., fasteners). Similarly, the distal connection collar 50 includes a substantially block-shaped base plate 56 and a ring collar portion 58 extending from the base plate 56. The base plate 56 of the distal connection collar 50 is fixed to the front vehicle portion 12 (by, e.g., fasteners) and the ring collar portion 58 surrounds an exterior periphery of a distal side circumferential surface of the external cylinder 38 of the pivot actuator 26. The ring collar portion 58 of the distal side connection collar 50 is fixed to the external cylinder 38 of the pivot actuator 26 by any means (e.g., fasteners). It is contemplated that the proximal connection collar 48 and the distal connection collar 50 could be fixed to a plate or similar structure rotatably connected to the vehicle 10 to allow the boom 20 to be rotatable about a vertical axis to provide even greater range of motion for the boom 20.

[0023] In the illustrated example, the horizontal axis pivot assembly 30 further includes a pivot connection 60 fixed to the proximal cap 42 and the distal cap 44 and connected to the first arm 24 of the boom 20 for transferring rotary motion of the pivot actuator 26 to the first arm 24 of the boom 20. The pivot connection 60 includes a top plate 62 fixed to top edges of the proximal cap 42 and the distal cap 44. The top plate 62 is substantially I-shaped when viewed from above and includes a proximal side end 64, a distal side end 66 and a thin extension 68 extending between the proximal side end 64 and the distal side end 66. A top of the proximal cap 42 is fixed to the proximal side end 64 (by, e.g., fasteners) and a top of the distal cap 44 is fixed to the distal side end 66 (by, e.g., fasteners). A plurality of angled struts 67 can extend between the proximal surface of the proximal cap 42 and a bottom surface of the proximal side end 64 of the top plate 62 to reinforce the connection between the proximal cap 42 and the top plate 62. The top plate 62 rotates with the internal cylinder 40 of the pivot actuator 26, the distal cap 44 and the proximal cap 42. The distal cap 44 and the distal side end 66 of the top plate 62 are fixed to the first arm 24.

[0024] The illustrated first arm 24 of the boom 20 is fixed to the horizontal axis pivot assembly 30 to allow the horizontal axis pivot assembly 30 to rotate the first arm 24 and the boom 20 about the horizontal axis 25. The first arm 24 includes a pair of parallel planar side walls 70, an angled middle wall 72
and an end wall 74. The pair of parallel planar side walls 70 have a proximal side edge connected to the distal cap 44 of the horizontal axis pivot assembly 30. A pair of co-planar tabs 76 extend from a distal edge of the top plate 62 of the horizontal axis pivot assembly 30 and are connected to proximal side top edges of the pair of parallel planar side walls 70 of the first arm 24. The angled middle wall 72 of the first arm 24 extends between the pair of parallel planar side walls 70 and is connected thereto. The angled middle wall 72 has a higher proximal side connected to a bottom of the distal side 66 of the top plate 62 of the horizontal axis pivot assembly 30. A lower distal side of the angled middle wall 72 terminates at a bottom distal side of the first arm 24. The end wall 74 extends below the first arm 24. As illustrated in FIG. 3, the top plate 62 of the substantially vertical orientation. A lower edge of the end wall 74 is spaced from the lower distal side of the angled middle wall 72 to create a second arm receiving space 78 therebetween. The second arm 28 is pivotally connected to the first arm 24.

[0025] In the illustrated example, the second arm 28 (FIG. 7) is connected to the first arm 24 of the boom 20 and is configured to be forcibly pivoted relative to the first arm 24. The second arm 28 includes a pair of substantially parallel side wall assemblies 80, a pivot block 82 and an angled stepped plate 84. Each of the substantially parallel side wall assemblies 80 includes an inside plate 86, an outside plate 88 and a substantially oval spanning plate 90. The substantially oval spanning plate 90 extends between and is connected to peripheries of the inside plate 86 and the outside plate 88. The pivot block 82 is connected to and extends between the pair of substantially parallel side wall assemblies 80 at the end of the second arm 28 connected to the first arm 24 (i.e., the proximal side of the second arm 28 is connected to the distal end of the first arm 24). The angled stepped plate 84 also is connected to and extends between the pair of substantially parallel side wall assemblies 80. The angled stepped plate 84 includes, from a proximal side to a distal side thereof, a bottom step 91 and a top step 92, with a middle angled plate 94 extending between the bottom step 91 and the top step 92. The angled stepped plate 84 also includes an upper angled plate 96 at a distal end of the top step 92. The bottom step 91 is located adjacent a first longitudinal edge 97 of the pair of substantially parallel side wall assemblies 80, with the upper angled plate 96 facing away from the first arm 24. The pair of substantially parallel side wall assemblies 80 and an area below the middle angled plate 94, the top step 92 and the upper angled plate 96 define a third arm receiving space 100.

[0026] The illustrated second arm 28 is pivotally connected to the first arm 24 and a first articulating assembly 102 connected therethrough forces rotation of the second arm 28 relative to the first arm 24. As illustrated in FIG. 4, the second arm 28 is connected to the first arm 24 by inserting the proximal end of the second arm 28 having the pivot block 82 into the second arm receiving space 78 of the first arm 24. A pivot pin 101 extends through the pair of parallel planar side walls 70 of the first arm 24, the pair of substantially parallel side wall assemblies 80 of the second arm 28 and the pivot block 82 of the second arm 28 to allow the second arm 28 to pivot relative to the first arm 24.

[0027] In the illustrated example, the first articulating assembly 102 includes a first expandable cylinder 104 having a proximal end pivotally connected to the first arm 24 by a first pin 106 and a distal end pivotally connected to the second arm 28. The distal end of the first expandable cylinder 104 is connected to the second arm 28 at a location adjacent a center area of the second arm 28, but closer to the third arm 32 than the first arm 24 (at a location adjacent an end of the bottom step 91 of the angled stepped plate 84). The first pin 106 extends between the pair of parallel planar side walls 70 above the end wall 74 of the first arm 24. The first expandable cylinder 104 includes a ring surrounding the first pin 106 in a center area 107 thereof. A pair of sleeves 108 surround the center area 107 of the first pin 106 to maintain a position of the first expandable cylinder 104 on the first arm 24. The first expandable cylinder 104 can comprise a pair of telescoping tubes, with the interior tube being driven hydraulically or pneumatically into and out of the exterior tube. When the first expandable cylinder 104 is in a contracted position, the distal end of the second arm 28 is substantially linear. When the first expandable cylinder 104 is in an expanded position, the distal end of the second arm 28 is connected to the third arm 32 rotates toward the first arm 24 as illustrated in FIG. 2. A driver 118 of the exterior tube 10 of the first expandable cylinder 104 can control expansion or contraction of the first expandable cylinder 104 using control levers and/or button (or similar controls).

[0028] The illustrated third arm 32 (FIG. 8) is pivotally connected to the second arm 28. The third arm 32 includes a U-shaped proximal end member 110, a rectangular center tube 112, a fourth arm support member 114 and a U-shaped distal end member 116. The U-shaped proximal end member 110 includes a pivot block cylindrical base 118 and a pair of parallel planar arms 120. The pair of parallel planar arms 120 of the U-shaped proximal end member 110 abuts opposite sides faces 112 of the rectangular center tube 112 to connect the U-shaped proximal end member 110 to the rectangular center tube 112. The fourth arm support member 114 extends from a top face 124 of the rectangular center tube 112. The fourth arm support member 114 has an inverted U-shape and includes a pair of parallel support legs 126 and an angled top plate 128. As discussed in more detail below, the fourth telescoping arm 34 rests on the angled top plate 128 of the fourth arm support member 114 when the boom 20 is in the folded position. The U-shaped distal end member 116 includes a proximal block 130 connected to a distal end of the rectangular center tube 112 and a pair of parallel side plates 132 connected to sides of the proximal block 130.

[0029] The illustrated third arm 32 is pivotally connected to a distal end of the second arm 28 and a second articulating assembly 134 connected therethrough forces rotation of the third arm 32 relative to the second arm 28. As illustrated in FIG. 2-4, the third arm 32 is connected to the second arm 28 by inserting the proximal end of the third arm 32 with the U-shaped proximal end member 110 having the pivot block cylindrical base 118 into the third arm receiving space 100 of the second arm 28. A pivot pin 111 extends through the pair of substantially parallel side wall assemblies 80 of the second arm 28 surrounding the third arm receiving space 100 and the pivot block cylindrical base 118 of the second arm 28 and the pivot block cylindrical base 118 of the third arm 32 to allow the third arm 32 to pivot relative to the second arm 28.

[0030] In the illustrated example, the second articulating assembly 134 includes a second expandable tube 136 having a first end pivotally connected to the second arm 28 by a second arm connection assembly 138 and to the third arm 32 by a third arm connection assembly 140. The second expand-
able tube 136 can comprise a pair of telescoping tubes, with a smaller interior tube 142 being driven hydraulically or pneumatically into and out of a larger exterior cylinder 144 (see FIG. 3).

[0031] The illustrated larger exterior cylinder 144 is connected to the second arm connection assembly 138 of the second arm 28 and is able to pivot relative thereto. The second arm connection assembly 138 (FIG. 7) comprises a pivots pin 146 extending substantially perpendicularly from one of the substantially parallel side wall assemblies 80 of the second arm 28 and a W-shaped receiver 148 having the pivot pin 146 extending through three parallel arms 150 of the W-shaped receiver 148. It is contemplated that the pivot pin 146 and the W-shaped receiver 148 could be rotatable relative to or fixed in position on the second arm 28. The larger exterior cylinder 144 of the second expandable tube 136 has a U-shaped fork extending therefrom on an end opposite to the smaller interior tube 142. Tines of the U-shaped fork are inserted into receiving spaces between pairs of the three parallel arms 150 of the W-shaped receiver 148 and the pivot pin 146 extends through the tines of the U-shaped fork to allow the larger exterior cylinder 144 to pivot about the pivot pin 146.

[0032] In the illustrated example, the smaller interior tube 142 is connected to the third arm connection assembly 140 and is able to pivot relative thereto. The third arm connection assembly 140 comprises a tube 154 extending perpendicularly from a side face 156 of one of the parallel planar arms 120 of the U-shaped proximal end member 110 of the third arm 32. The tube 154 includes a pair of parallel slots 158 in a lower face thereof, with a pair of lobes 160 extending from the lower face of the tube 154 on opposite sides of the pair of parallel slots 158. An end support plate 162 is connected to a terminal end of the tube 154. A pivot pin 164 extends through the end support plate 162, the lobes 160 and into the side face 156 of the one of the parallel planar arms 120 of the U-shaped proximal end member 110 of the third arm 32. The smaller interior tube 142 of the second expandable tube 136 has a U-shaped fork extending therefrom on an end opposite to the larger exterior cylinder 144. Tines of the U-shaped fork are inserted into the parallel slots 158 in the tube 154, with the pivot pin 164 extending through the tines of the U-shaped fork to allow the smaller interior tube 142 to pivot about the pivot pin 164.

[0033] When the second expandable tube 136 is in a contracted position, the distal end of the third arm 32 connected to the fourth telescoping arm 34 rotates away from the second arm 28 as illustrated in FIG. 3 (although the second arm 28 and the third arm 32 could be further extended until the second arm 28 and the third arm 32 are substantially linear). When the second expandable tube 136 is in an expanded position, the distal end of the third arm 32 connected to the fourth telescoping arm 34 rotates toward the second arm 28 as illustrated in FIG. 2. A driver of the vehicle 10 and/or a person outside of the vehicle 10 can control expansion or contraction of the second expandable tube 136 using control levers and/or button (or similar controls).

[0034] The illustrated fourth telescoping arm 34 (FIG. 5) is pivotally connected to the distal end of the third arm 32. The fourth telescoping arm 34 comprises a proximal inner telescoping tube 168, a middle telescoping tube 170 and a distal outer telescoping tube 172, with the distal outer telescoping tube 172 having the articulating nozzle 22 on a distal end thereof. The proximal inner telescoping tube 168 is configured to slingly telescope into and out of the middle telescoping tube 170 and the middle telescoping tube 170 is configured to slingly telescope into and out of the distal outer telescoping tube 172 to selectively shorten and lengthen the length of the fourth telescoping arm 34.

[0035] In the illustrated example, the proximal inner telescoping tube 168 of the fourth telescoping arm 34 comprises a tube 174 having a pair of connection panels 176 on opposite side faces 178 of the tube 174 at the proximal end thereof. Each of the connection panels 176 includes a substantially aligned top opening 180 and a bottom opening 181 (illustrated as being vertically aligned in FIG. 9). Each of the connection panels 176 also includes a connection portion 182 distally located from the substantially aligned top opening 180 and bottom opening 181. The connection portion 182 of the connection panels 176 are connected to the proximal end of the tube 174. A pivot pin tube 184 extends between the top openings 180 in the connection panels 176. A pivot pin extends through the pivot pin tube 184 to pivotally connect a proximal end of the fourth telescoping arm 34 to the distal end of the third arm 32. A distal end of the proximal inner telescoping tube 168 slides into a proximal end of the middle telescoping tube 170. The proximal end of the middle telescoping tube 170 includes a stop member 186 configured to abut the connection panels 176 for preventing the proximal inner telescoping tube 168 from fully sliding into the proximal end of the middle telescoping tube 170. The proximal inner telescoping tube 168 and the middle telescoping tube 170 have mating structure therein for telescoping the proximal inner telescoping tube 168 into and out of the proximal end of the middle telescoping tube 170 as is well known to those skilled in the art (e.g., a hydraulic extendable tube connected to each of the proximal inner telescoping tube 168 and the middle telescoping tube 170).

[0036] A proximal end of the illustrated distal outer telescoping tube 172 is configured to receive a distal end of the middle telescoping tube 170 therein. The proximal end of the distal outer telescoping tube 172 includes a stop member 187 configured to abut the step member 186 on the middle telescoping tube 170 for preventing the middle telescoping tube 170 from fully sliding into the proximal end of distal outer telescoping tube 172. The distal outer telescoping tube 172 and the middle telescoping tube 170 have mating structure therein for telescoping the middle telescoping tube 170 into and out of the proximal end of the distal outer telescoping tube 172 as is well known to those skilled in the art (e.g., a hydraulic extendable tube connected to each of the distal outer telescoping tube 172 and the middle telescoping tube 170). The distal outer telescoping tube 172 includes a tube 188 having a nozzle holding assembly 190 on a distal end thereof.

[0037] In the illustrated example, the nozzle holding assembly 190 (see FIGS. 2, 3 and 9) holds the articulating nozzle 22. The nozzle holding assembly 190 includes a proximal U-shaped plate 192, a holding tube 196, a U-shaped pivot connector 198 and a X-shaped pivot connector 200. The proximal U-shaped plate 192 is spaced from the distal end of the distal outer telescoping tube 172 and extends upwardly from a top surface 202 of the tube 188. The proximal U-shaped plate 192 includes a spanning wall 204 and a pair of parallel connection walls 206. The connection walls 206 are parallel to opposite side surfaces 208 of the tube 188 and include extension portions 210 connected to the side surfaces 208 of the tube 188. The holding tube 196 extends from a distal face of the spanning wall 204 beyond the distal end of
the tube 188. The U-shaped pivot connector 198 includes a middle panel 212 connected to a distal end of the holding tube 196 and a pair of parallel arms 214 extending in a distal direction from the middle panel 212. The Y-shaped pivot connector 200 includes a base block 216 located between the arms 214 of the U-shaped pivot connector 198 and configured to pivot relative thereto. The Y-shaped pivot connector 200 is configured to pivot relative to the U-shaped pivot connector 198 to pivot the articulating nozzle 22 about the distal end of the fourth telescoping arm 34. The Y-shaped pivot connector 200 can be forced to pivot relative to the U-shaped pivot connector 198 in any manner well known to those skilled in the art (e.g., a rotary actuator connected located within the holding tube 196 and connected to the Y-shaped pivot connector 200 for rotating the Y-shaped pivot connector 200 relative to the U-shaped pivot connector 198 under control of an operator).

[0038] The illustrated proximal end of the fourth telescoping arm 34 is pivotally connected to the distal end of the third arm 32. As illustrated in FIGS. 2-4, the fourth telescoping arm 34 is connected to the third arm 32 by inserting the connection panels 176 at the proximal end of the fourth telescoping arm 34 into a fourth arm receiving space 185 located between the pair of parallel side plates 132 of the third arm 32. A pivot pin 183 extends through a pair of co-linear distal openings 226 in the pair of parallel side plates 132 and through the bottom openings 181 in the connection panels 176 to pivotally connect the fourth telescoping arm 34 to the third arm 32.

[0039] In the illustrated example, a third articulating assembly 220 connected between the fourth telescoping arm 34 relative to the third arm 32 forces rotation of the fourth telescoping arm 34 relative to the third arm 32. The third articulating assembly 220 includes a third expandable cylinder 234, which can comprise a pair of telescoping tubes, with a smaller interior tube 240 being driven hydraulically or pneumatically into and out of a larger exterior tube 238 having a first end pivotally connected to the third arm 32. The larger exterior tube 238 of the third expandable cylinder 234 is connected to a third arm tube support 236 of the third arm 32. As illustrated in FIGS. 2, 3 and 8, the third arm tube support 236 comprises a pair of plates 235 having slinged openings 237. A pin 239 extends through the slinged openings 237 and into a proximal end of the larger exterior tube 238 of the third expandable cylinder 234, thereby allowing the third expandable cylinder 234 to pivot relative to the third arm 32. A distal end of the third expandable cylinder 234 is connected to a knuckle assembly 241 connected to both the distal end of the third arm 32 and the fourth telescoping arm 34.

[0040] The illustrated knuckle assembly 241 allows the fourth telescoping arm 34 to rotate about the distal end of the third arm 32. The knuckle assembly 241 includes a pair of outside curved knuckles 224 and a pair of inside curved knuckles 222. The pair of outside curved knuckles 224 each have a proximal end pivotally connected to the pair of parallel side plates 132 of the third arm 32 by a pin or pins 225 extending through proximal openings 230 in the pair of parallel side plates 132 and the proximal ends of the outside curved knuckles 224. A distal end of the outside curved knuckles 224 is pivotally connected to a pin 232 extending through a distal end of the smaller interior tube 240 of the third expandable cylinder 234. The pin 232 connected to the distal end of the outside curved knuckles 224 and the distal end of the smaller interior tube 240 is also pivotally connected to a proximal end of the pair of inside curved knuckles 222. A distal end of the pair of inside curved knuckles 222 is pivotally connected to a pivot pin 245 that extends through the pivot pin tube 184 and the top opening 180 of the connection panels 176 of the fourth telescoping arm 34.

[0041] When the third expandable cylinder 234 is in a contracted position, the distal end of the fourth telescoping arm 34 having the nozzle 22 thereon rotates toward the third arm 32 as illustrated in FIG. 2. When the third expandable cylinder 234 is in the contracted position, the distal outer telescoping tube 172 will rest on the angled top plate 128 of the fourth arm support member 114 of the third arm 32. When the third expandable cylinder 234 moves to an expanded position, the smaller interior tube 240 of the third expandable cylinder 234 allows the pin 232, thereby causing the pair of outside curved knuckles 224 to rotate about the pin 225 in the proximal openings 230 in the pair of parallel side plates 132 of the third arm 32. Furthermore, the smaller interior tube 240 of the third expandable cylinder 234 also allows the pin 232 to thereby cause the pair of inside curved knuckles 222 to rotate about the pivot pin 245 extending through the pivot pin tube 184 and the top opening 180 of the connection panels 176 of the fourth telescoping arm 34. Moving the third expandable cylinder 234 to the expanded position causes the distal end of the fourth telescoping arm 34 having the nozzle 22 thereon to rotate away from the angled top plate 128 of the fourth arm support member 114 of the third arm 32 as illustrated in FIGS. 3 and 4. A driver of the vehicle 10 and/or a person outside of the vehicle 10 can control expansion or contraction of the third expandable cylinder 234 using control levers and/or button (or similar controls).

[0042] In use, the illustrated boom 20 moves the articulating nozzle 22 on an end thereof for spraying a fluid therefrom for use in mining as is well known to those skilled in the art. The vehicle 10 with the boom 20 could also be used in other industries for spraying any fluid. The fluid is supplied to the nozzle 22 from the vehicle through tubing 36 connected to the boom 20. As illustrated in FIG. 3, holding links 250 extending from the fourth telescoping arm 34 can be used to hold portions of the tubing 36 adjacent to the fourth telescoping arm 34. Likewise, rod 252 having tubing sections 254 on ends thereof can extend from the second arm 28 and the third arm 32, with the tubing 36 extending through the tubing sections 254 or with the tubing sections 254 forming a portion of the tubing 36 to support the tubing 36 along the length of the boom 22.

[0043] It is to be understood that variations and modifications can be made on the aforementioned structure without departing from the concepts of the present invention.

We claim:

1. A mining vehicle for spraying a fluid comprising: a vehicle portion having a propulsion system for propelling the mining vehicle; a boom connected to the vehicle portion; and a hydraulically driven pivot assembly connecting the boom to the vehicle portion, the pivot assembly including a horizontal axis pivot member to allow the boom to pivot about the vehicle portion about a first horizontal axis; the boom comprising at least three boom arms and a nozzle on an end thereof, each of the boom arms being pivotable about an adjacent one of the boom arms about a second
The mining vehicle for spraying the fluid of claim 1,
wherein:
the propulsion system comprises wheels.
3. The mining vehicle for spraying the fluid of claim 1,
   further including:
a tube system extending between the vehicle portion and
   the nozzle, the tube system being configured to supply
   the fluid from the vehicle portion to the nozzle for spraying
   the fluid out of the nozzle.
4. The mining vehicle for spraying the fluid of claim 1,
   wherein:
   the hydraulically driven pivot assembly only pivots relative
to the vehicle portion about the first horizontal axis.
5. The mining vehicle for spraying the fluid of claim 1,
   wherein:
   at least one of the boom arms is extendible.
6. The mining vehicle for spraying the fluid of claim 5,
   wherein:
   the at least one of the boom arms that is extendible is a
   telescopin arm.
7. The mining vehicle for spraying the fluid of claim 5,
   wherein:
   the at least one of the boom arms that is extendible has the
   nozzle on a distal end thereof.
8. The mining vehicle for spraying the fluid of claim 5,
   wherein:
   the at least one of the boom arms that is extendible does not
   have an external actuator for extending the at least one of
   the boom arms.
9. The mining vehicle for spraying the fluid of claim 7,
   wherein:
   the nozzle is pivotable about the end of the boom.
10. The mining vehicle for spraying the fluid of claim 1,
    wherein:
    each adjacent pair of the boom arms have an actuator
    connected thereto for rotating the boom arms relative to
    each other about the second axis.
11. The mining vehicle for spraying the fluid of claim 10,
    wherein:
    the actuator comprises a pair of telescopin tubes.
12. The mining vehicle for spraying the fluid of claim 10,
    wherein:
    the actuator is pivotally connected to each of the adjacent
    pair of boom arms.
13. The mining vehicle for spraying the fluid of claim 1,
    wherein:
    the vehicle portion has a front edge and a rear edge; and
    the hydraulically driven pivot assembly does not extend
    beyond the front edge of the vehicle portion.
14. A mining assembly for spraying a fluid comprising:
a base;
a boom connected to the base;
a hydraulically driven pivot assembly connecting the boom
to the base, the pivot assembly including a horizontal
axis pivot member to allow the boom to pivot about the
base about a first horizontal axis;
The boom comprising at least three boom arms and a nozzle
on an end thereof, each of the boom arms being pivotable
about an adjacent one of the boom arms about a second
axis, with the second axis being substantially perpen-
dicular to the first horizontal axis; and
a tube system extending between the base and the nozzle,
the tube system being configured to supply the fluid
from the base to the nozzle for spraying the fluid out of
the nozzle.
15. The mining assembly for spraying the fluid of claim 14,
    wherein:
    at least one of the boom arms is extendible.
16. The mining assembly for spraying the fluid of claim 15,
    wherein:
    the at least one of the boom arms that is extendible is a
    telescopin arm.
17. The mining assembly for spraying the fluid of claim 15,
    wherein:
    the at least one of the boom arms that is extendible has the
    nozzle on a distal end thereof.
18. The mining assembly for spraying the fluid of claim 17,
    wherein:
    the nozzle is pivotable about the end of the boom.
19. The mining assembly for spraying the fluid of claim 14,
    wherein:
    the at least one of the boom arms that is extendible does not
    have an external actuator for extending the at least one of
    the boom arms.
20. The mining assembly for spraying the fluid of claim 14,
    wherein:
    each adjacent pair of the boom arms have an actuator
    connected thereto for rotating the boom arms relative to
    each other about the second axis.
21. The mining assembly for spraying the fluid of claim 20,
    wherein:
    the actuator comprises a pair of telescopin tubes.
22. The mining assembly for spraying the fluid of claim 20,
    wherein:
    the actuator is pivotally connected to each of the adjacent
    pair of boom arms.
23. The mining assembly for spraying the fluid of claim 14,
    wherein:
    the base has a front edge and a rear edge; and
    the hydraulically driven pivot assembly does not extend
    beyond the front edge of the base.
24. A mining vehicle for spraying a fluid comprising:
a vehicle portion having a propulsion system comprising
wheels for propelling the mining vehicle;
a boom connected to the vehicle portion;
a hydraulically driven pivot assembly connecting the boom
to the vehicle portion, the pivot assembly including a horizontal
axis pivot member to allow the boom to pivot about the
vehicle portion about a first horizontal axis;
the boom comprising at least three boom arms and a nozzle
on an end thereof, each of the boom arms being pivotable
about an adjacent one of the boom arms about a second
axis, with the second axis being substantially perpen-
dicular to the first horizontal axis; and
a tube system extending between the vehicle portion and
the nozzle, the tube system being configured to supply
the fluid from the vehicle portion to the nozzle for spraying
the fluid out of the nozzle;
wherein at least one of the boom arms is a telescopin arm
having the nozzle on a distal end thereof; and
wherein each adjacent pair of the boom arms have an
actuator pivotally connected thereto for rotating the
boom arms relative to each other about the second axis.
25. The mining vehicle for spraying the fluid of claim 24,
    wherein:
the telescoping arm does not have an external actuator for extending the telescoping arm.

26. The mining vehicle for spraying the fluid of claim 24, wherein:
the vehicle portion has a front edge and a rear edge; and
the hydraulically driven pivot assembly does not extend beyond the front edge of the vehicle portion.
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